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5. C. FENNER. The Physiography of the Werribee River Area. *Proc. Roy. Soc. Vic.*, n.s., xxxi. (1), pp. 176-313, 1918.

The corresponding references in the text should be " Fenner (1918)," and " (5) " respectively.

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CORRIGENDA.

Volume XXXVII.

Page 15, line 5, for "*vittivaria*" read "*variivitta*"
,, 49, ,, 17, for "subtrigonaiis" read "subtrigonalis"
,, 68, ,, 14, for "*H. atra* read "*U. atra*"
,, 68, ,, 29, for "*Rachionotomysia*" read "*Rachionotomyia*"
,, 71, ,, 33, for "*Ochlerotatus*" read "*Ochlerotatus*"
,, 73, ,, 7, for "*rnatus*" read "*ornatus*"
,, 104, ,, 33, for "*yeringiae*" read "*yeringae*"
,, 116, ,, 45, for "*Lambe*" read "Lambe"
,, 127, ,, 39, for "*stypheliodes*" read "*styphelioides*"
,, 179, ,, 5, for "*Gray*" read "Gray"
,, 196, ,, 11, for "PAUCIPUSTOLOSA" read "PAUCIPUSTULOSA"
,, 226, ,, 25, for "·42" read "1·42".

CONTENTS OF VOLUME XXXVIII.

[Proc. Roy. Soc. Victoria, 38 (N.S.), 1926.]

Art. I.—*The L absorption limits of Lutecium, Ytterbium, Erbium and Terbium.*

By C. E. EDDY, B.Sc.

(Communicated by Professor T. H. Laby.)

[Read 12th March, 1925.]

Summary.

1. The L series absorption wave lengths of Lutecium, Ytterbium, Erbium and Terbium have been measured relative to standard lines.

2. A comparison has been made between the absolute determinations of the wave lengths of the K emission lines of copper and some of the L lines of tungsten.

3. A metal X-ray tube, with a thin window, and capable of operation at 30 kilovolt and 30 milliamperes, has been devised.

4. The values obtained for the absorption limits have been compared with those interpolated by Bohr and Coster. The bearing of these results on the binding energy of electrons in the 5_2 orbit is briefly discussed.

Objects of the Investigation.

To assist in the confirmation of the Bohr atomic theory, experimental evidence regarding the "energy levels" for each element is of importance. The behaviour of the atom as regards energy expresses itself most clearly and most simply in the existence of the absorption limits, and the spectroscopic series terms derived from these serve to determine the atomic states and the energies associated with each. For certain groups of elements, wherein, according to Bohr, an upbuilding of inner uncompleted electron groups takes place, information concerning these limits is especially desirable. At the commencement of this work, no measurements had been published of L series absorption limits of elements in the largest of these groups, that of the rare earths.

The investigation of this region had been delayed by two causes, the difficulty of obtaining samples of rare earths, and the diminution of intensity of the X-ray beam due to absorption in the walls of the tube and the spectrometer system.

This work was made possible by the courtesy of Professor James, of Durham, N.H., and the Welsbach Co. of U.S.A., who placed at the disposal of Professor Laby, of the Natural Philosophy School of this University, samples of four rare earths —Lutecium, Ytterbium, Erbium and Terbium—in an exceedingly pure state. A water-cooled metal X-ray tube of the Coolidge type giving a high X-ray intensity, closely associated with a low-pressure spectrometer, permitted the spectra being obtained with reasonable exposures. The wave-lengths of the absorption edges were determined with reference to standard lines which were photographed on the same film; any desired standard line could be obtained by incorporating the element emitting it in the target material.

Apparatus.

The metal X-ray tube, a sketch of which is shown in Fig. 1, was designed by Professor Laby, and constructed by Mr. Martin. The main body of the tube (A) was constructed of brass tubing, the cathode (C) could be removed by screwing it out of the tube (B), the junction being made airtight with wax. The target portion was very light, consisting of a hollow copper cylinder (T), supported by the two copper tubes (I) soldered through the brass plate (G). The cathode and target portions were separated by a lamp-glass connected to each with sealing wax. The target face was inclined at an angle of 86° to the axis of the tube, and the ray after leaving the target at almost grazing incidence passed out through the window (W), the brass tube (E) carrying a screw thread for attachment to the spectrometer chamber. The window was of mica .06 mm. thick, supported by a copper disc containing a slot 15 mm. long and 5 mm. wide, and was attached by wax.

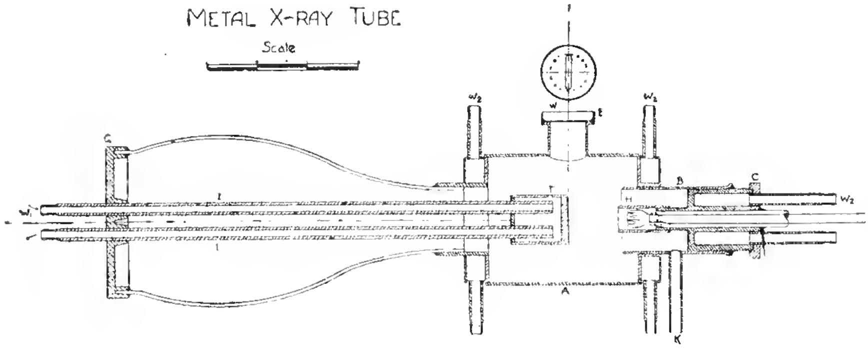

FIG. 1.—Sketch of metal X-ray tube.

The filament was attached to heavy leads passing through an old lamp seal waxed into the Cathode (C), which could readily be removed for the replacement of filaments. The filament hood (H) capable of being screwed backward and forward relative to the filament, served to focus the cathode ray beam on the target. The tube was evacuated through the outlet (K).

A system of water jackets protected the wax joints from the heat generated in the tube, while the target was kept cool by a stream of water passing through the tubes I. As it was impossible to earth either side of the high potential machine, an insulated reservoir as well as an insulated receiver was required for both cathode and anode systems.

The metal X-ray tube possessed one disadvantage. In high vacuum work, considerable difficulty arises owing to the gas which has been absorbed by the glass and metal surfaces being liberated at low pressures. The usual procedure is to expel this gas by a prolonged baking at a high temperature under a low pressure. The number of solder and sealing wax joints in the tube rendered this treatment impossible, but continuous pumping for several days produced an increasingly lower pressure. Later the trouble was to a great extent removed by silver-plating the whole of the metal parts. Once the occluded gas had been removed, the opening of the tube to replace filaments did not cause any difficulty in re-evacuation.

The evacuation of the tube to the degree of vacuum necessary for it to function as a Coolidge tube at first gave considerable trouble. Finally this was accomplished by means of a Cenco oil pump, a Gaede rotary mercury pump and a Langmuir condensation pump in series. The connections between the pumps were made by glass tubing of 15 mm. bore, with short lengths of rubber tubing at junctions to metal. The Langmuir pump was connected to the tube entirely by glass, junctions to metal being effected with wax. Phosphorus pentoxide was used to absorb water vapour, and all portions of the system were thoroughly cleaned and dried before setting up.

Considerable care had to be given to the making of the wax-joints; ordinary commercial sealing wax proved very unsatisfactory, as owing to its coarse grain, small holes appeared on the surface after cooling. The best letter wax gave satisfaction only when the red colour was used, the other colours proving inferior, probably because of the colouring matter present. Later Picein gave excellent results.

The production of the high vacuum was greatly facilitated by the passage of a small discharge current through the tube, such as is used in hardening the usual type of gas tube. During the operation of the tube, the pumps were run continuously.

Two types of filament have been used. During the earlier part of the work, fine tungsten wire was employed. The early filaments had a short life of from 10 to 15 hours; this was probably due to the action of mercury vapour from the Langmuir pump upon the filament (1). The introduction of a glass trap, in which the mercury was condensed, between the tube and the pump greatly minimised this action, and filaments then gave service of upwards of 300 hours.

For reasons mentioned later, a Wehnelt cathode was used in the later part of the work. A Wehnelt filament from a wireless valve was kindly presented by Mr. Foster, of the Western Electric Co., but its use was not practicable owing to the limited electron current obtainable. After several attempts, a filament with much greater electron emission was prepared by coating a platinum wire with a mixture of the oxides of barium and strontium. A very thick coating was obtained which did not disintegrate from the core, and which maintained its full electron emission after 20 hours use.

Both types of filament required prolonged baking at a high temperature to rid them of gas; the latter type especially evolved

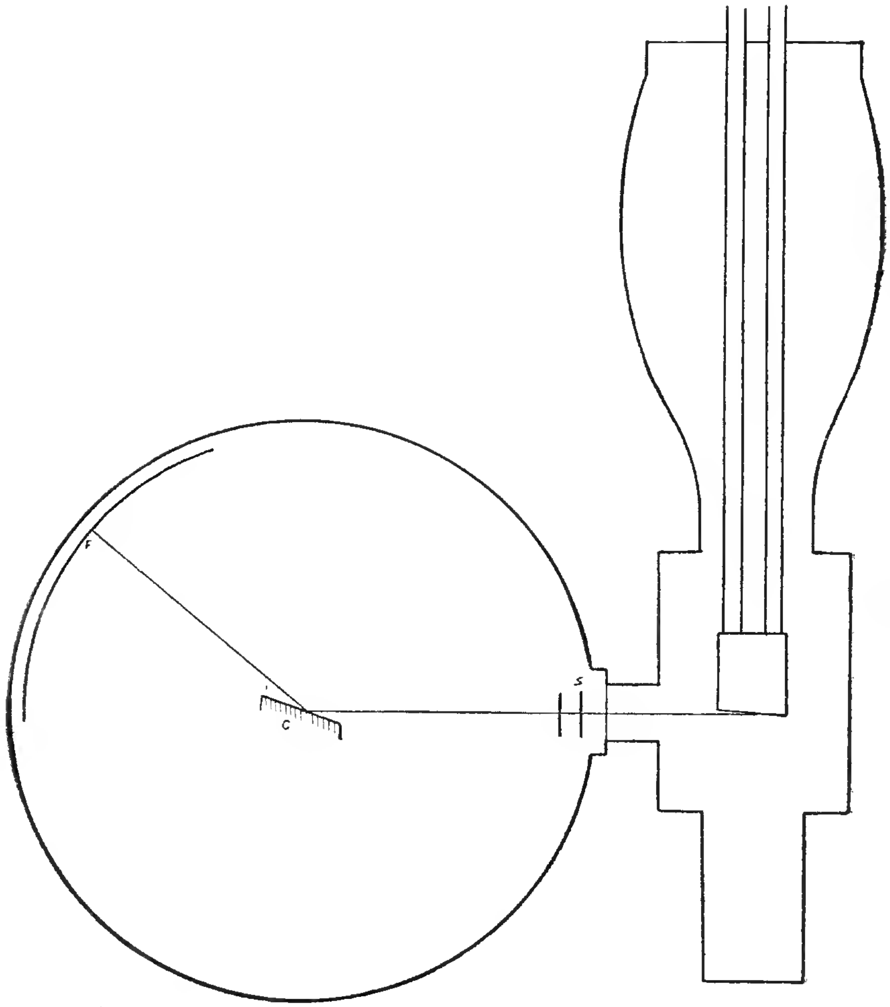

Fig. 2.—Diagram of Tube and Spectrometer.

great quantities during the initial heatings. During this treatment the mercury in both Langmuir and Gaede pumps became contaminated, and required periodical cleaning. After some experimenting, the most satisfactory form of filament was found to be one wound in a small spiral placed at right angles to the axis of the tube. The filament hood was adjusted until the focal spot, as depicted by a pinhole camera photograph taken in line with the slits, showed as a line about 3 mm. long and less than .5 mm. wide. In this way a very intense beam was transmitted through the slit system.

The spectrometer was in essentials similar to that described by Rogers (2), and Martin (3). and only the modifications introduced to suit this work will be mentioned. The crystal table, adapted from a theodolite, was screwed to an iron base plate. The slit system and film holder were carried on iron pillars also screwed to this base. The whole was surrounded by a metal cylinder fitting on the base plate and closed at the top with a sheet of plate glass. The tube was attached to the side of the cylinder (see Fig. 2), so that the window was brought to within 1 cm. of the slits. The attachment of the tube to the spectrometer necessitated that the latter should be insulated from earth by ebonite sheets. The crystal was of Calcite, and was rotated by a shaft passing through a stuffing box in the side of the cylinder and turned by a small motor and reduction gear. The spectrometer was filled with hydrogen at a reduced pressure to reduce the absorption of the rays.

The spectrometer was adjusted in a manner similar to that described by Rogers and by Martin. The focal spot was brought into the line of the slits by setting the crystal at zero, and rotating the tube and chamber on the base plate until an instantaneous photograph showed the crystal to intercept one-half of the beam. As little difficulty was experienced from the wandering of the focal spot, a maximum intensity was thus obtained.

The absorption limits were obtained by passing the general radiation from the tube through the element, and analysing the emergent beam with the spectrometer. The photograph then showed a darkening caused by the continuous radiation of wavelengths longer than the critically absorbed wave-lengths, ending on the short wave-length side with a sharp edge denoting the limit of absorption.

The maximum current passed through the tube was limited by the heating of the high tension generator (a Snook-Victor transformer and rectifier). The X radiation was excited by a potential of 30 kilovolt. the tube being run continuously at from 25 to 30 milliamperes with the tungsten filament, and from 15 to 20 milliamperes with the Wehnelt Cathode. Currents of more than twice this amount have been passed through the tube for periods of a few minutes. The Copper K radiations were at first chosen as standard lines, but on analysing the beam from the target, strong tungsten L radiations were found due to the deposition of tungsten from the filament. This provided a second set of reference lines with a greater wave-length range. Three edges (Ytterbium L_{II}, Erbium L_{III}, and Terbium L_{I}) lay so close to tungsten lines that they could not be distinguished from them. These tungsten lines could not be avoided, since they appeared fairly strongly after an hour's operation of the tube after the insertion of a new target. A Wehnelt Cathode was, therefore, substituted for photographs of these three edges, and the copper lines used as standards.

An absorbing screen of the elements was obtained by spreading a film of Collodion on a clean glass plate, and depositing a small quantity of the earth upon this film. On drying the film and stripping it from the glass, a screen of sufficient thickness was obtained, which produced little absorption of the X-ray beam, other than that due to the characteristic absorption of the element. This screen was fixed on the tube side of the slit.

Photographs of the edges were obtained by a very slow rotation of the crystal over 7 minutes on either side of the edge, and of the reference lines by a short exposure with rapid rotation of the crystal. In cases where an edge was situated close to a reference line, the prolonged exposure in this region resulted in excessive broadening of the reference line; this difficulty was overcome by photographing the reference lines first, and then covering a strip of the film with a copper sheet which prevented further radiation broadening a portion of the reference lines.

To diminish the absorption in the film wrapper, a sheet was made up of tissue paper and aluminium leaf, with a total thickness of .15 mm.; this prevented any action of ordinary light on the film, and absorbed much less radiation than the usual black paper wrapper. "Superspeed" Duplitised X-ray film was used with a rear intensifying screen.

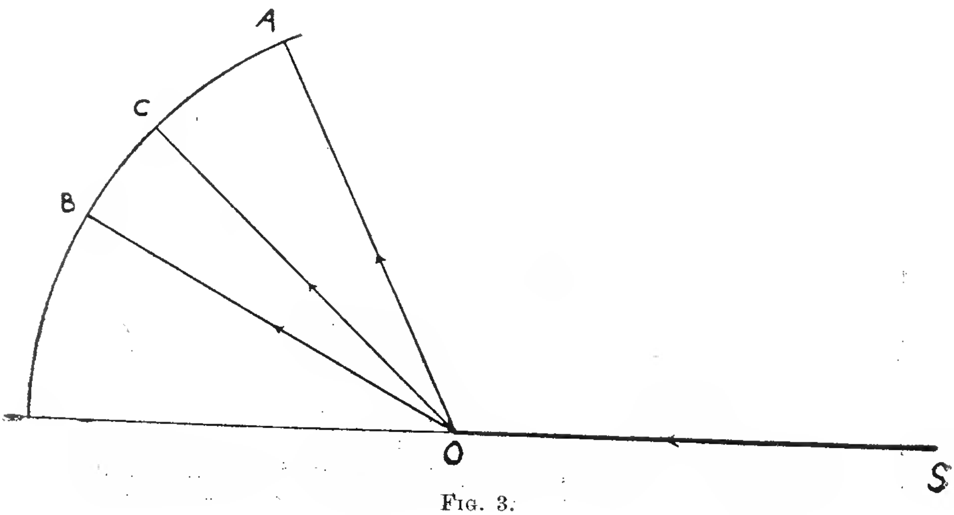

Fig. 3.

The slit width used varied between .075 and .1 mm., with the former the Copper K α doublet (wave-length difference 3.9 X.U.) showed lines on the film distant apart about .16 mm. Exposures of less than 10 minutes were required for the Copper K spectrum; for edges the time varied from 3 to 8 hours with the tungsten filament, and with later improvements and the Wehnelt cathode, from 1 to 4 hours. In general the LI edge required about 3 times the exposure required for the LIII.

Measurement of Films.—The evaluation of the wave-lengths of unknown lines by the reference method can be explained by reference to Fig. 3.

SO is a narrow beam incident upon the crystal face at O. OA, OB represent the paths of two known wave-lengths λ_1, λ_2 reflected at angles θ_1, θ_2 respectively, and OC the path of an unknown wave-length λ_0 reflected at θ_0. If A, C, B be points on a circle with centre O, then $\frac{\text{arc AC}}{\text{arc AB}}=\frac{\theta_1-\theta_0}{\theta_1-\theta_2}$.

If the rays be received on a photographic film bent to form the arc A C B, and the actual distances on the film of AC, AB are X and Y,

$$\frac{X}{Y}=\frac{\text{arc AC}}{\text{arc AB}}=\frac{\theta_1-\theta_0}{\theta_1-\theta_2}, \text{ whence } \theta_0=\theta_1-\frac{X(\theta_1-\theta_2)}{Y}$$

and λ_0 is obtained from the equation $n\lambda=2d\sin\theta$.

The reflection angles for the standard lines have been determined from their wave-lengths, taking "d" for calcite as 3029.04 X.U.

The distances between the lines and edges on the film were measured by a projection method suggested by Professor Laby and developed in this laboratory by Rogers. The film was projected by a lantern on to a vertical screen carried on the platform of a dividing engine; displacements of the platform could be read to .005 mm. The platform was moved until each line in turn was brought to coincide with a fine line on the screen, and the distance read. Magnifications of from 6 to 10 were used, the mean of readings taken at 2 magnifications being taken for each film. By using a high power filament lamp, and varying the current, a clearer definition of the edge could be obtained. The film was then calibrated in seconds per mm. of projection by dividing the angular differences between two standard lines by their distance apart, and the mean taken for values obtained from different pairs of lines. The angle for any unknown line could then be determined from its distance from any standard.

The projection method of film measurement possesses advantages over a microscope micrometer method. Table I. gives a series of displacement measurements. The probable error is shown for the interval $Cu\alpha_1$—$Cu\beta_1$ in which occurs the maximum variation between individual readings. The magnification in this case was about 6.7, so that the probable error for the film proper was less than .004 mm., which was considerably less than that obtainable by means of a microscope. The corresponding probable error in the wave-lengths is less than .03 X.U. In addition the ability to use both eyes in normal light intensities obviates the strain caused by continuous working with the microscope.

TABLE I.

Specimen of Displacement measurements; Distances in mm. from $Cu\alpha_1$

$Cu\beta_1$	$W\beta_1$	$W\beta_2$	Yb L_1	$W\gamma_1$
33.65 mm.	58.76 mm.	67.20 mm.	81.85 mm.	99.90 mm.
33.63	58.80	67.14	81.82	99.90
33.69	58.79	67.16	81.81	99.94
33.67	58.76	67.18	81.79	99.92
33.70	58.79	67.17	81.79	99.89
means 33.668±.02	58.780	67.170	81.812	99.910

A test of the accuracy of measurements by the relative method, even when a large extrapolation is employed, was made by comparing the absolute values which have been determined for tungsten lines with those obtained by measurement relative to the Copper $K\alpha_1$, $K\beta_2$ lines. Siegbahn (4) has determined these latter very accurately. The means of values of the wave-length derived from at least six films for several tungsten lines, and the probable error, are given in the first column of Table II. The second column gives the results obtained by Duane and Patterson (5) by an ionization chamber method, and the third those due to Siegbahn and Dolejsek (6). At the bottom of the table values for three K lines of nickel found on several films are compared with values given by Hjalmar (7).

The extrapolated values differ from those of Duane and Patterson, and from those of Siegbahn and Dolejsek by little more than the probable error, and by no more than the results of these two differ among themselves, thereby showing that the reference method gives an accuracy comparable with that obtained by an absolute method.

TABLE II.

Comparison of wave-lengths of standard lines.
Wave-lengths in X.U. (cm. x 10^{-11}).

Line.	Author.	Duane & Patterson.	Siegbahn and Dolejsek.
Cu α_2	1541.32±.06		1541.22
Cu α_1	1537.30	value assumed	
Cu β_1	1389.33	value assumed	
Cu β_2	1378.4±.2		1378.0
W α_2	1484.45±.07	1484.4	1484.52
W α_1	1473.5±.1	1473.5	1473.48
W β_4	1298.5±.4	1298.9	1298.78
W β_1	1279.1±.1	1279.3	1279.17
W β_3	1259.9±.5	1260.5	1260.00
W β_2	1241.6±.3	1242.3	1241.91
W γ_1	1095.9±.2	1096.4	1095.53
			Hjalmar
NiK α_2	1658.6		1658.60
NiK α_1	1654.1		1654.67
NiK β_1	1496.7		1496.62

Table III. gives the values obtained for the absorption limits. In only two cases (Ytterbium L_{II} and Terbium L_{III}) was extrapolation necessary. The values assumed for the tungsten standard lines (α_1,β_1,β_2, and γ_1) were the means of those of Siegbahn and Dolejsek, and of Duane and Patterson, given above. The results are the means of, in most cases, 3 films.

TABLE III.

The L absorption limits of Lutecium, Ytterbium, Terbium and Erbium. Wave-lengths and /R units.

		Wave Lengths. X.U.			ν/R Units.			
		Author.	C.N.W.	Cork.	Author.	C.N.W.	Cork.	Inter-pol'ted
71	I.	1136.21±.04	1136.2		802.03	802.05		801.1
	II.	1194.0 ±.1	1194.5		763.21	762.87		763.1
Lu	III.	1337.5 ±.2	1337.7		681.32	681.24		681.0
70	I.	1176.4 ±.1	1176.5	1171	774.65	774.55	778.2	773.4
	II.	1238.14±.05		1242	735.85		733.7	735.7
Yb	III.	1382.64±.03	1382.4	1386	659.10	659.20	657.5	659.6
68	I.	1265.5 ±.1	1266.0	1265	720.08	719.78	720.4	718.1
	II.	1335.60±.1	1335.3	1336	682.29	682.45	682.1	682.8
Er	III.	1479.19±.03	1479.6	1478	616.05	615.85	616.0	616.5
65	I.	1417.0 ±.2			643.10			642.4
	II.	1499.4 ±.1			607.75			608.2
Tb	III.	1644.2 ±.1			554.24			553.8

Since the commencement of this work, determinations of the wave-lengths of some of the rare earths have been made by Coster, Nishini and Werner (8), and by Cork (9). Their values for the elements done here are shown for comparison, as well as values of ν/R. The last column contains values of ν/R interpolated by Bohr and Coster (10).

The edges obtained showed two characteristics, in some places, a pronounced "edge" was found, with an interval on the short wave-length side, where a great proportion of the radiation had been absorbed, in others an absorption "line" appeared as a light line on a dark background.

This phenomenon has been noticed by Coster, Nishini and Werner, and by Siegbahn (11), and the appearance of the line or edge was thought to be dependent upon the thickness of the absorbing layer of the element. Owing to the inequalities of thickness in the absorbing layers used in my experiments, in some cases both "line" and "edge" appeared on the same film. The line breadth approximated to that of the breadth of slit, and values of the critical absorption wave-length obtained by measuring to the centre of the line and to the edge showed a discrepancy until a correction corresponding to half the slit width, was applied in the case of the edge values.

The values obtained in this experiment for the absorption wave-lengths agree well with those of Coster, Nishini and Werner; the possible error given by these workers is 0.5X.U, and in no case is the disagreement between their results and mine greater than this. In the case of Erbium, these workers give as reflection angle for the L_{II} edge as 12°44′0″, the wave-length as 1334.9 X.U. and ν/R units as 682.62; but on substitution of this angle for reflection, however, a wave-length of 1335.3 X.U. and a ν/R unit of 682.45 is obtained, and these corrected values have been used in this table.

The values due to Cork show large unsystematic deviations which are probably due to large limits of error. In two cases, edges measured by him lie very close to strong tungsten lines, due to that metal being used as target in his tube. The writer found it impossible to distinguish between the Erbium L_{III} edge 1479 X.U. and the tungsten α doublet at 1473 X.U. and 1484 X.U., and between Ytterbium L_{II} 1238 X.U. and tungsten β_1, 1241 X.U. It would appear that the spreading of the strong lines after exposures of 30 to 40 hours (as used by Cork) would confuse the edge lying close to them.

Comparison between the different ν/R values proves interesting. The interpolated values of Bohr and Coster are interpolated from values determined for elements from N=92 to N=74 and from N=60 to N=55. In the case of the values for the L_{II} and L_{III} limits, the observed values show an unsystematic variation slightly larger than the probable errors. In the values for the L_I limit, however, a systematic deviation of several times the probable error occurs, as is shown in Table IV. and Fig. 4. The probable error in ν/R units in the value of Coster, Nishini, and Werner is less than .25, and in the writer's values less than .1. In Fig. 4, the deviations noticed by Coster, Nishini and Werner and by the writer have been plotted against the atomic number.

TABLE IV.

Deviations in ν/R units from the interpolated values.

Atomic Number.	L I. Author.	L I. C.N.W.	L II. Author.	L II. C.N.W.	L III. Author.	L III. C.N.W.
71	.9	.9	.1	—.2	.3	.2
70	1.2	1.2	.2		—.5	—.4
68	1.9	1.7	—.5	—.4	—.4	—.7
65	.7		—.5		.4	
58		.3				

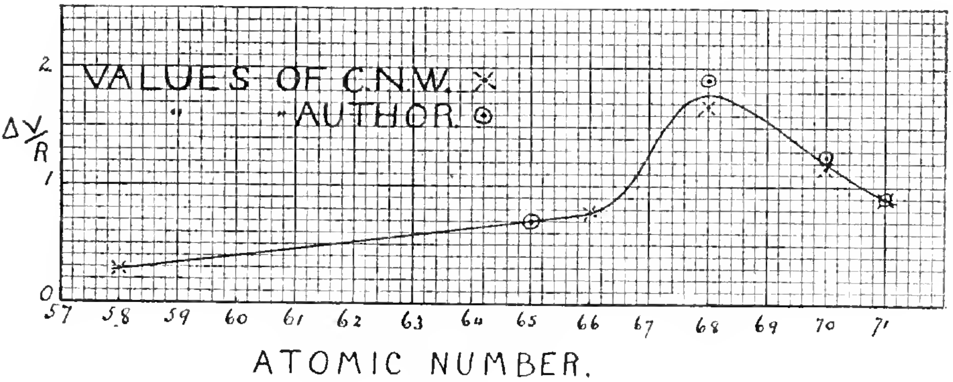

FIG. 4.—Graph of deviations in $\frac{\nu}{R}$ units from the interpolated values.

It will appear that the interpolated values of L I from N=71 to 65 differ from the observed values, and that this deviation has become within the limits of error by the time Cerium (58) is reached.

In providing for the increase of the number of electrons with increasing atomic number, Bohr conceives of four periods of elements wherein electrons are placed in inner orbits after outer orbits have been commenced. In the cases of the iron, palladium, and platinum groups, however, no shell with a higher quantum number than the shell being built up, has reached a stage of completion. For the rare earths group, the O-shell has reached a stage of completion in that it contains two groups of 4 electrons each (the 5_1 and the 5_2 orbits) by the time that Xenon (N=54) is reached. Subsequent increase in the atomic number expands 3 groups, (the 4_1, 4_2, and 4_3 orbits) from 6 electrons each to 8, and a fourth group (the 4_4 orbit) is added. Some irregularities might then be expected.

It appears that the ν/R values for the L_I level arrived at by interpolation are too low, and that a sharp kink in the graph of ν/R against atomic number for this level occurs in the region of the rare earths. Since the energy difference between the outside of the atom and the 5_2 orbit was obtained by Bohr and Coster from the frequency difference between the interpolated values for the L_I edge and the observed frequency of the $L\gamma_4$ line, an increase in the values for the L_I edges would imply an increase of nearly 50 per cent. in the values (vide Bohr and Coster), formerly associated with the 5_2 orbit, and that the binding of electrons in this orbit may be appreciably greater than that of valency electrons.

This work was carried out while the writer was a Fred Knight and University Research Scholar. I wish to thank Professor Laby for his suggestion of this work, and for his valuable advice and interest during its progress. Thanks are also due to Professor James and the Welsbach Co. for their generosity in providing the rare earth samples.

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[Proc. Roy. Soc. Victoria, 38 (N.S.), 1926.]

Art. II.—*Further Notes on Australian Hydroids—V.*

By W. M. BALE, F.R.M.S.

[Read 12th March, 1925.]

Saaba arenosa (Bale).

N.gen. and sp.? Bale, Proc. Roy. Soc. Vic., n.s., vi., 1893, p. 96, pl. iii., fig. 1, 2.

Sacculina arenosa Bale, Proc. Roy. Soc. Vic., n.s., xxxi., 1919, p. 333.

Saaba arenosa Stechow, Archiv. für Naturg. Jg. 88, Abt. A., 1922, p. 154; Zool. Jahrb., Abt. f. Syst., 47, 1923, p. 92.

I inadvertently applied to this form, which Stechow has since named *Saaba,* the name *Sacculina,* which belongs to a well-known crustacean. I noticed the error immediately on publication, but too late for correction. I have, however, to thank several correspondents, who obligingly called my attention to the oversight, in order to enable me to correct it.

I observe also that the same name has been given to a genus of Bryozoa.

Sertularia furcata Trask. (Fig. 1.)

Sertularia furcata Trask, Proc. Calif. Acad. Nat. Sciences, i., 1857, p. 112, pl. v., fig. 2. Clark, Trans. Conn. Acad., iii., 1876, p. 258, pl. xxxix., fig. 3. Torrey, Univ. of Calif. Publ., Zoology, i., 1902, p. 66, pl. viii., fig. 73-75; Idem, ii., 1904, p. 31. Fraser, Bull. State Univ. Iowa, vi., 1911, p. 72, pl. vi., fig. 5. Bale, Biol. Results "Endeavour," iii., 1915, p. 276; Trans. N.Z. Inst. 55, 1924, p. 247.

Sertularia pulchella Nutting, American Hydroids, II. The Sertularidae, 1904, p. 55 (in part).

Sertularia operculata, in part, Hartlaub, Zool. Jahrb., Suppl. vi., iii., 1905, p. 664. Jäderholm, Kungl. svenska Vetenskapsakad. Handl., 45, 1909, p. 97.

Amphisbetia furcata Stechow, Zool. Anzeig., lix., 1923, p. 69.

S. furcata, which is closely allied to *S. minima* and *S. muelleri,* usually grows on "eel-grass" (*Phyllospadix*), which it clothes with a dense forest of simple shoots, directed slightly upward, and attaining about half an inch in length. The main hydrorhizal filaments run straight up the leaves, and are connected by numerous transverse and oblique branches. The peduncles of the hydrocauli are directed upward at a small angle with the hydrorhiza; they are conspicuous from their darker colour, and consist of the apophysis with a single very short internode, which is succeeded by the first hydrothecal internode. The joints at this point are of the very oblique type often incorrectly called "twisted joints." The

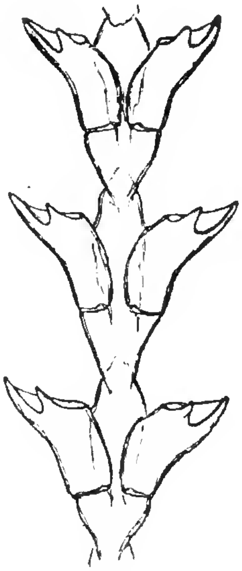

FIG.—1. *Sertularia furcata* Trask. ×40.

hydrorhiza is stout, and exhibits here and there some of the lateral inflections of the perisarc characteristic of typical forms of *S. minima*, but much larger and less regular. Trask calls the hydrorhiza the "main stem," or the "rachis," and the simple shoots "pinnæ," but the latter are not in any regular order, and I have not found the hydrorhiza jointed, as Trask describes it.

The hydrocaulus is divided into rather stout internodes, each bearing a pair of opposite hydrothecæ; the joints are somewhat oblique, but in the older parts of the shoots they become thickened and indistinct. On the lower parts of the shoots the paired hydrothecæ are not adnate to each other, but only approximate in front; it is often only on the upper half of the shoot that they are actually in contact, and then only just at the base. They diverge from the base up, and near the middle are usually still more bent outward, but they again become slightly more ascending at the top, and the two spine-like teeth are accordingly directed more upward than outward. On the lower part of the colony, where they are not in contact, the hydrothecæ bear some resemblance to those of *S. operculata*.

Here and there one finds in the infrathecal chamber one of the little circular orifices in the perisarc which are characteristic of *S. minima* and its allies. They are here minute, and require careful search to discover them, especially as their rim scarcely projects beyond the outer surface of the perisarc.

The opercular structure is highly developed, not merely filling up the sinuses between the marginal teeth, but often projecting all round, so that it resembles an inner bidentate thecostome, the lateral teeth of which subtend those of the true thecostome, but are much shorter and more delicate.

The gonangia are pyriform or obovate, compressed, often a little angular at the shoulders; there is usually only one in a shoot, which springs from below the first hydrothecal internode, but exceptionally there may be two, or even more, always on the proximal portion of the shoot.

From *S. minima* the species is distinguished by its much greater size throughout, and the densely clustered growth, while the hydrothecæ differ in their more divergent lower portion, and in the more upward-directed teeth, and the internodes are usually less broadly rounded at the base.

S. muelleri is quite similar in habit to *S. furcata*, growing on a similar plant, and without microscopical examination the two species might be mistaken for each other. In *S. muelleri*, however, the internodes are much more slender, especially above the hydrothecæ, the latter are more expanding towards the mouth, and the marginal teeth are not so spine-like, but are more triangular. The gonangia vary from one to four or five.

Stechow records the species from Bunbury, West Australia, but it is doubtful if the identification is correct. Its relationship with *S. minima* is so obvious that it could scarcely be overlooked by any observer acquainted with the two species, and since Stechow does not refer it to the genus *Nemella*, proposed by him for the *S. minima* group, (on the assumption that the little orifices in the perisarc represent sarcothecæ), it seems possible that he may have observed a different species. According to a later description and figure it agrees with *S. pumiloides* Bale (*S. minima* var.?).

For my specimens of *S. furcata*, from the coast of California, I have to thank Mr. W. S. Wallace, of the Hopkins Marine Station, Pacific Grove, Cal. The species has not, I think, been recorded from Australia prior to Stechow's reference.

SERTULARIA XANTHA (Stechow).

Sertularia divergens Busk, Voy. of Rattlesnake, i., 1852, p. 392. Bale, Austr. Hydr. Zooph., 1884, p. 81, pl. v., fig. 3, pl. xix., fig. 16; Proc. Roy. Soc. Vic., n.s., xxvi., 1913, p. 131. Billard, Ann. Sci. Nat., 9 ser., ix., 1909, p. 323.

Tridentata xantha Stechow, Zool. Anzeig., lvi., 1923, p. 12; Zool. Jahrb., Abt. f. Syst. etc., 47, 1923, p. 206.

Not *Dynamena divergens* Lamouroux, Hist. Polyp. Cor. Flex., 1816, p. 180, pl. v., fig. 2*a*, 2*b*.

?Not *Tridentata xantha* Stechow, Zool. Anzeig., lix., 1924, p. 64.

Stechow's proposed genus *Tridentata* is characterized by the possession of a third small tooth, situated on the upper border of thecostome. There is no such tooth in the present species, but the superior margin, instead of being uniformly concave, is very slightly curved outward in the middle, so that seen laterally it has somewhat the appearance of a rudimentary tooth.

There is a small linear process projecting into the theca from the outer side, a little above the base, with which the blindsack is connected. In my original specimens it was very delicate, and obscured by the remains of the hydranth, and was consequently overlooked.

I formerly considered *S. flosculus* Thompson as identical with this species, but later, following Billard, referred it to *S. marginata* (Kirchenpauer). It does not seem possible, however, to be certain as to the identity of *S. flosculus.*

The form referred to *T. xantha* by Stechow in his later paper does not appear to be the same. It has stouter thecæ, the width of a pair at the base being ·22 mm., while in the present species it is about ·16 to ·18; it has the node between the first and second pair on the pinnæ "oft undeutlich," and it has up to 12 pairs of thecæ on a pinna, *S. xantha* having only 4 or 5, or rarely 6.

Sertularia tenuis Bale.

Sertularia tenuis Bale, Proc. Roy. Soc. Vic., n.s., xxvi., 1913, p. 129 (synonymy).

Tridentata tenuis Stechow, Zool. Jahrb., Abt. f. Syst. etc., 47, 1923, p. 205.

The remarks under *S. xantha,* regarding the form of the thecostome and the internal processes, are equally applicable to *S. tenuis,* of which *S. xantha* may be a variety.

Sertularia acuta (Stechow).

Sertularia loculosa Bale, in part, Cat. Aust. Hyd. Zooph., 1884, p. 91, pl. iv., fig. 5, 6, pl. xix., fig. 9; Tr. and Proc. Roy. Soc. Vic., xxiii., 1887, p. 93; Proc. Roy. Soc. Vic., n.s., xxvi., 1913, p. 121, pl. xii., fig. 7, 8; Biol. Res. "Endeavour," 1909-1914, iii., 1915, p. 272. Warren, Ann. Natal Gov't. Mus., i., 1908, p. 306, fig. 8, pl. xlviii., fig. 37. Mulder and Trebilcock, Geel. Nat., (2) vi., 1914, p. 9.

Sertularia turbinata Billard, Ann. Sci. Nat. Zool., (9) xi., 1910, p. 19 (in part).

?*Sertularia turbinata* Ritchie, Proc. Zool. Soc., 1910, p. 821.

Tridentata acuta Stechow, Zool. Anz., liii., 1921, p. 231; Zool. Jahrb., Abt. f. Syst. etc., xlvii., 1923, pp. 204, 206.

Sertularia balei Briggs, Aust. Zool., ii., 1922, p. 150.

Not *S. loculosa* Busk (Vide Bale, 1913).

This species has been renamed by Briggs and Stechow to differentiate it from *S. loculosa* Busk. The name chosen by Stechow is rather inappropriate, the species in its usual form having the two theca-lobes very obtuse. Exceptional specimens, however, have sharper lateral teeth and a third superior lobe, which is merely a slight outward curvature of the upper margin seen edgewise, so that in the ordinary aspect it appears a sharp tooth.

SERTULARIA NANA, n. sp. (Fig. 2).

Hydrocaulus simple, minute, divided into internodes each bearing two or three hydrothecæ.

FIG. 2.—*Sertularia nana*, n. sp. ×40.

Hydrothecæ alternate, not close, tubular, divergent, free for about half their length; margin with two large triangular lateral teeth.

Gonangia (?)

Locality.—Port Phillip (Mr. J. Bracebridge Wilson).

Only one specimen observed, growing on *Sertularella peregrina*.

It rises from a flat rounded and lobed base, which also gives origin to a hydrorhizal filament. The shoot is borne on a stout apophysis, from which it is separated by a very oblique node. The arrangement of the hydrothecæ is alternate; between every two the rachis is slender and wavy, but distinct oblique nodes only occur below every second or third hydrotheca, the distance apart of the latter being somewhat irregular.

The whole hydrophyton is about 2 mm. in height and bears 8 thecæ.

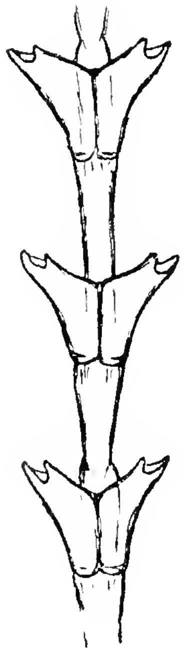

Fig. 3.—*Sertularia gracillima*, n. sp. × 40.

SERTULARIA GRACILLIMA, n. sp. (Fig. 3).

Hydrophyton monosiphonic, branched, very slender. Pinnæ alternate, each borne on a distinct process at the base of a stem-internode, which supports also an unpaired hydrotheca in the axil, and a pair of subalternate hydrothecæ above; first internode of each pinna short, without thecæ, separated from the next internode by an oblique conspicuous joint; the joint between the first internode and the cladophore much less oblique.

Hydrothecæ on the pinnæ in pairs, one or two pairs on an internode, mostly opposite, in contact in front, widely separated at the back, rather slender, the outer side curving outward and the upper part strongly divergent; margin with two strong lateral teeth.

Gonangia.—(?)

Locality.—(?)

This delicate species is closely related to *S. geminata* Bale, which according to Billard is the same as *Desmoscyphus orifissus* Allman. The internodes both of the rachis and the pinnæ are much longer than those of *S. geminata*, and the thecæ therefore much further apart, and they are not so strongly directed forward. In a direct front view the flexure outward of the hydrotheca is a gradual curve; in *S. geminata* it generally appears somewhat angular owing to the upper part being turned more forward.

Allman's figure of the front view could not be identified with either species; his lateral view seems to resemble the present form rather than *S. geminata*.

In my specimens most of the internodes of the pinnæ bear two pairs of thecæ; in *S. geminata* they more often support one pair only. In both species the first pair of hydrothecæ on the pinnæ are not exactly opposite.

The only specimen observed was about one and a half inches high, and had three or four branches. The exact locality was not ascertained.

Further observation may perhaps result in the union of both *D. orifissus* and the present species with *S. geminata*.

Sertularella peregrina, n. sp. (Fig. 4).

Sertularella polyzonias Bale, Catal. Aust. Hydr. Zooph., 1884, p. 104, pl. iii, fig. 1; pl. xix., fig. 25. Hartlaub, Abh. Nat. Ver. Hamb., xvi., 1900, p. 89, pl. v., fig. 3.

Sertularia Gaudichaudi Bale, Biol. Results "Endeavour," iii., 1915, p. 280.

Not *S. polyzonias* (Linn.).

Not *S. Gaudichaudi* (Lamouroux).

Hydrocaulus monosiphonic, simple or with a few irregular branches, divided into internodes each supporting a single hydrotheca on the upper part.

Hydrothecæ alternate, both series in the same plane, adnate about half their length, divergent, ventricose below, contracted above, margin expanding, with four shallow emarginations; three internal compressed vertical teeth, two of which are within the two upper emarginations of the border, and the third below the abcauline marginal tooth.

Gonothecæ ovate, with a few annular rugæ, and a wide tubular neck; summit with three or four conical teeth, sometimes almost obsolete.

Locality.—Port Phillip; Bass Strait.

This species was referred by me in 1884 to *S. polyzonias*, the descriptions then extant not sufficing to distinguish it from that species. Later, in 1915, I referred it to *S. gaudichaudi*, which Billard considered identical with *S. mediterranea* Hartlaub and *S.*

picta (Meyen). Owing to my original specimens being poorly preserved, the internal teeth, which are very delicate, were overlooked. Hartlaub in 1900 mentioned a form from Bass Strait, which, notwithstanding that it possessed internal teeth, he referred to *S. polyzonias;* this was no doubt the same as the species before us.

The confusion which for so long existed between *S. polyzonias* and allied forms has been cleared up by Stechow (1) in two recent papers, supplemented by one of Billard's (2). According to these observers *S. picta* and *S. gaudichaudi* are distinguished from *S. polyzonias* and its more immediate allies by the much longer teeth of the thecostome and by the presence of a stria parallel with the margin. *S. picta* has internal teeth, *S. gaudichaudi* has none. Of

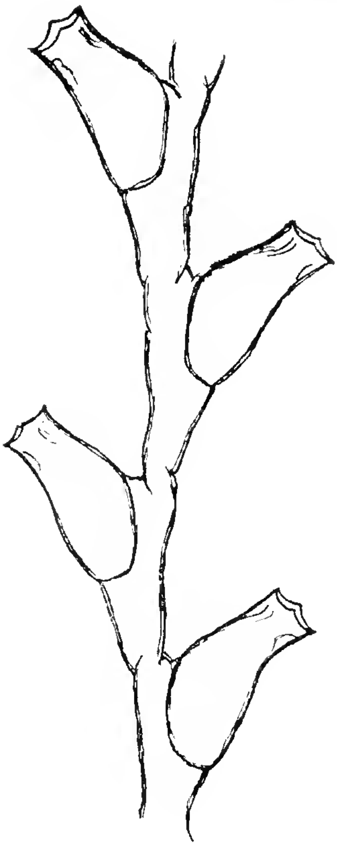

Fig. 4.—*Sertularella peregrina*, n. sp. × 40.

the species classed by Stechow as the *polyzonias* group, *S. polyzonias* itself is distinguished from our species by the absence of internal teeth. *S. ellisi,* according to Stechow, has the internal teeth in the opposite order to those of the species before us, the median tooth, which is larger than the others, being on the adcauline side, while the other two are equidistant from it and from each other; our species, on the contrary, having the median tooth abcauline, just below the inferior marginal tooth, while the others are equidistant. (This arrangement obtains in all species observed by me, irrespective of whether the marginal teeth are three or four). There remains *S. mediterranea,* to which our species is very closely allied, the main difference being that in *S. mediterranea* the outer side of the theca is somewhat produced, so that the aperture is oblique. Stechow indeed describes it as at right angles to the rachis, but in specimens from Biarritz, kindly sent to me by Professor Billard, I do not find the condition so pronounced, nor indeed does it appear so in Stechow's figures. In *S. peregrina* both series of thecæ are almost exactly in the same plane, those of *S. mediterranea* being directed slightly forward.

The gonangia are about ·22 to ·28 mm. in length, the widest part most commonly a little below the middle, and the narrowing upward to the neck rather gradual; the annulations on the upper half or third are wide, but not keeled nor sharply angular. In *S. mediterranea* typical gonangia are somewhat more abruptly contracted to the neck, and the annular ridges are more marked; but in these points, as well as in the number and prominence of the coronal teeth, both species, like others of the group, vary greatly.

THUIARIA TRYPHERA (Briggs).

Sertularia geniculata Bale, Proc. Linn. Soc. N.S.W., Ser. 2, iii., 1888, p. 768, pl. xvii., figs. 6-11.
Sertularia tryphera Briggs, Austr. Zool., ii., 1922, p. 150.
Tridentata tryphera Stechow, Zool. Jahrb., Abt. f. Syst., etc., xlvii., 1923, p. 205.
?*Dynamena conferta* Kirchenpauer, Verhandl, der K.L.-C.d. Akad., xxxi., 1864, p. 10, pl., fig. 4.
Not *S. geniculata* Linn. (*Obelia geniculata*).

Though it is impossible to identify Kirchenpauer's figures of *D. conferta* with this species, I strongly suspect that they are one and the same.

The thecostome is exactly like that of *Thuiaria,* the margin forming two scarcely distinguishable lobes and very thin; though the specimen is not in good condition for examination of the operculum some of the thecæ show almost certainly an abcauline flap.

PLUMULARIA WILSONI, n. nom.

Plumularia delicatula Bale, Journ. Micr. Soc. Vic., ii., 1881, p. 40, pl. xv., fig. 2: Catal. Aust. Hyd. Zooph., 1884, p. 137, pl. xi., fig. 5. Mulder and Trebilcock, Geelong Nat. iv. (2nd Ser.), 1911, p. 115, pl. ii., fig. 1: Id., vi., 1914, p. 43, pl. v., fig. 4.
Not *P. delicatula* Busk, Voy. of Rattlesn., i., 1852, p. 396.
Not *P. delicatula* Quelch, An. and Mag. N.H., 1885, p. 8.

The above name is proposed on account of the priority of Busk's *P. delicatula* (*Aglaophenia*). I have dedicated the species to my friend, Mr. James Wilson, who has often favoured me with specimens of Hydroida and Bryozoa which have been very helpful to me.

AGLAOPHENIA BAKERI Bale.

Bale, Proc. Roy. Soc. Vic., n.s., xxxi., 1919, p. 353, pl. xvii., fig. 7-8.

Examination of additional specimens enables me to give a better description of the corbulæ, those seen originally having been somewhat abnormal. Mature corbulæ are about 3·5 mm. in length, with arcuate rachis and about 13 pairs of leaflets. The sarcothecæ are closely set on the sides of the corbula, a little more sparsely on the front, about 7 in a row; individual sarcothecæ are about ·104 mm. in length. The constrictions of the corbula, mentioned in the original description, are not present in these specimens.

The gonocladium bears a single hydrotheca below the corbula as a rule, but in one instance I observed two.

AGLAOPHENIA DIVARICATA (Busk) var. BRIGGSI, n. var. (Fig. 5).

Aglaophenia divaricata var., Bale, Cat. Aust. Hydr., Zooph., 1884, p. 164.

Aglaophenia divaricata var. *acanthocarpa?* Bale, "Endeavour," Report, iii., 1915, p. 313.

Not *A. acanthocarpa* Allman, Journ. Linn. Soc., Zool., xii., 1876, p. 274, pl. xxi., figs. 1-4.

As Bedot has pointed out in his Systematic Notes on the Plumularidæ, much confusion has existed in regard to *A. divaricata* and its allies, confusion which I have endeavoured to clear up, with the

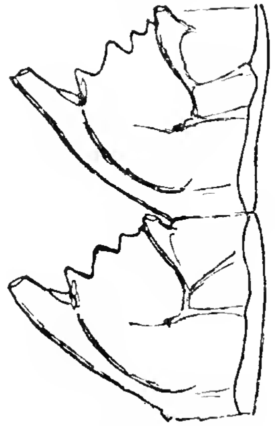

FIG. 5.—*Aglaophenia divaricata,* (Busk) var. *briggsi,* n. var. ×80.

aid of specimens from the British Museum, in a recent paper in the Transactions of the New Zealand Institute. (Vol. 55, 1924.)

The account there given of the New Zealand species, *A. acanthocarpa* Allman and *A. laxa* Allman, will, I trust, suffice to distinguish them from the Australian *A. divaricata.* The latter species, with the varieties *MacCoyi* and *cystifera,* is fully dealt with in the above-cited "Endeavour" Report. In the same paper the form now under consideration is referred doubtfully to the *A. acanthocarpa* Allman, an identification since found to be incorrect.

This variety, which I have seen only from Port Jackson, differs from the type mainly in the septal ridges of the hydrothecal internodes. In addition to the central one, which alone is present in *A. divaricata,* there is one proceeding obliquely forward from the base of the theca. This is much less pronounced than the others, and was formerly overlooked by me; being extremely close to the end of the internode, and the node being for the most part scarcely distinguishable, I mistook it for the actual node.

The marginal teeth of the hydrotheca, especially the anterior one, are somewhat shorter and more acute than those of typical specimens of *A. divaricata.* There is but little tendency to enlargement of the lateral sarcothecæ towards the ends of the hydrocladia, so conspicuous in some forms of *A. divaricata.*

Note on Nomenclature.

Certain specific patronymic names originally written by me with the final "i" doubled, have by observers generally (and by myself in later papers) been written with a single "i." According to the ruling of the International Commission however (Vide Opinion 8), the following forms are correct:—

Tubularia Ralphii.
Plumularia Buskii.
Plumularia Wattsii.
Halicornaria Haswellii.

REFERENCES.

1. Stechow. *Sitzungsberichten der Gesellschaft für Morphologie und Physiologie in München,* 1919, and *Zool. Jahrb., Abt. für Systematik, Jena,* 1293.

2. Billard *Revue Suisse de Zoologie,* 1924.

[Proc. Roy. Soc. Victoria, 38 (N.S.), 1926.]

Art. III.—*Sensitising Powers of Proteins of Parasites as tested by the isolated sensitized uterus reaction.*

By A. W. TURNER, M.V.Sc.

(Walter and Eliza Hall Research Fellow, Veterinary Research Institute, Melbourne University.)

[Read 16th April, 1925.]

Introduction.

This work was carried out for the purpose of investigating the possibility of using the specific sensitiveness of the anaphylactic guinea-pig's isolated uterus as a means of identifying metazoan parasites. The extraordinary sensitiveness of the smooth muscle of anaphylactic guinea pigs, combined with the exquisite specificity of the reaction, as observed in the case of the more common proteins, suggested that, should the same phenomena be met with in the case of proteins of metazoan parasites, one might well apply the method to the specific identification of parasite proteins.

During the course of the work the sensitizing powers of the following parasites were investigated:—*Ascaris equi, Ascaris suilla* and *Toxascaris limbata,* and *Onchocerca gibsoni* as members of the Nematoda; *Fasciola hepatica* as a member of the Trematoda; and *Gastrophilus haemorrhoidalis, G. nasalis* and *G. intestinalis* as members of the Arthropoda.

In addition it was necessary to determine the action on the uterus of a few substances which were needed as preservatives, the following being investigated: Toluol, Chloroform, Phenol and Glycerine.

A few experiments were performed with common proteins, and these serve to demonstrate the phenomena of anaphylactic response and desensitization.

Review of Literature, etc.

The first use of the anaphylactic response of isolated organs was made by Schultz (1). He experimented with sera on isolated guinea pig small intestine and found that a much greater contraction of the smooth muscle occurred when this came from an anaphylactic guinea pig than when it came from a normal pig, the same concentration of serum being used in each case.

This result was greatly extended by Dale (2), who, using the isolated guinea pig uterus horns, was able to demonstrate extremely delicate sensitiveness to the serum proteins used for sensitising, often obtaining a definite anaphylactic response at a concentration of one in a million of the sera used, and in one case, at a concentration of 1:6,500,000 of dry globulin (3); and, when using the purified crystallised egg albumins of the hen and duck, the remarkable result was obtained, that an anaphylactic response occurred at a concentration of 1:500 millions! It appears to be quite an established fact that the degree of sensitiveness is a function of the degree of purity of the antigen and its freedom from other proteins. Dale (3) found that, when multi-sensitization was attempted, using simultaneous inoculations of egg white, horse serum and sheep serum, less clear results were obtained after 19 days, and he concluded that a guinea pig receiving small simultaneous injections of several different proteins acquires to none of them the high degree of sensitiveness which, after the same period, might be expected as the result of injecting any one of them singly. He suggested that possibly a more extended incubation period might be necessary under such conditions. He also observed that it appeared that desensitization to one antigen was not wholly without effect on the sensitiveness to the others, though the results he obtained in the few guinea pigs tested showed that there was some degree of independence. He was also able to demonstrate passive sensitiveness in guinea pigs which had received 5 c.c. of immune or anaphylactic serum.

Regarding the specificity of the isolated guinea pig uterus reaction, he demonstrated a high degree of such in an experiment described in (2). A guinea pig received 1/400 c.c. of horse serum fourteen days previously, and the horns were suspended in a 250 c.c. bath. The following sera were added in 0·1 c.c. amounts successively without effect — sheep, cat, rabbit, dog, man—and also egg white in the same dose. However, on adding 0·1 c.c. of horse serum, an immediate maximal contraction of the muscle occurred. The acme of specificity reactions is described by him (4) in an experiment with duck egg albumin. Dale's results have been confirmed many times; among others, by Nathorff (5), who demonstrated the irritant action of fresh serum, anaphylaxis towards sheep serum, specificity between sheep and horse serum, the phenomena of desensitization ("Anti-anaphylaxie") and multisensitization, using sheep and horse serum. He found that guinea pigs sensitized with a mixture of equal parts of these two sera showed a much greater sensitiveness to sheep serum than to horse serum, no matter in which order they were added to the testing bath. The class of substances which are able to bring about the anaphylactic phenomenon in guinea pigs is that known as the antigens, which are typically the native proteins. Anaphylactogenic properties have been demonstrated for proteins of various origins. Osborne and Wells (6) have demonstrated typical anaphylaxis (*in vivo*) to the crystallized albumin from white of egg and to the crystallized protein from various seeds.

Hartley and Dale (7) observed it with a very highly purified sample of crystallized albumin from horse serum. Any denaturing influence rapidly destroys the antigenic efficiency—e.g., boiling of coagulable proteins, digestion. Ten Broek (8) has shown that racemization of a protein by gentle warming with alkali, completely destroys its antigenic activity; Max Burger (9) also showed similar results. He concluded that amino-acids, pure albumoses, protamines, and acid-albumin are not able to sensitize and that hence all preparations which are prepared by acid hydrolysis, peptic and tryptic digestion from plant and animal protein are unsuitable.

The specificity is also demonstrated by the fact that Wells (10) was able to obtain separate and more or less specific anaphylaxis in the guinea pig with each of the five proteins obtained from hen's egg. Also Wells and Osborne (11) using whole animals, showed that the four proteins of milk, namely, casein, lactalbumin, lactoglobulin and an alcohol-soluble protein, are all immunologically distinct. The globulin sensitized to ox serum and caused a reaction in animals sensitized to ox serum. Also Hartley and Dale (6) found that anaphylaxis discriminated between the three proteins separable from horse serum. They also note that sensitiveness to euglobulin appears first (8-10 days), and that to albumin after about twice as long (16-20 days). There was even clear, though less rigid (? difficulty of purification) distinction between the so-called eu- and pseudo-globulins.

It will thus be seen that the anaphylactic test, and in particular the isolated uterus reaction, has immense possibilities as an agent for demonstrating structural or absolute identity of proteins, and for showing on the other hand differences between proteins which by biochemical methods are very difficult to distinguish. It should be noted, however, that Kritchevsky (12) states that rabbits immunised with the red blood cells of the hen produce anaphylactic antibodies against the red blood cells of the sheep. Nevertheless, we confine ourselves to the guinea pig, and use the isolated uterus test, which appears to be strictly specific.

A few authors have appreciated the significance of the above related facts, and attempts have been made to use the anaphylactic reaction as a diagnostic agent. Thomsen (13) and Uhlenhuth (14) and others have shown that the test can be used as a forensic test for blood spots—by sensitizing guinea pigs with solutions of blood spots, and later testing them (*in vivo*) with a second injection of the suspected protein, but they do not consider the method as reliable as the precipitin test. Yamanouchi (15) has attempted to apply the method to the diagnosis of tuberculosis by attempting to passively sensitize guinea pigs with serum of tuberculosis patients and later testing the animals with tuberculin and he claims some positive results, but this has not been confirmed by others. Pfeiffer (16) and Pfeiffer and Finsterer (17) report positive results in the diagnosis of malignant disease by injecting guinea pigs with press-juices of tumours 48 hours after they received the serum of carcinomatous patients, while these did not occur when normal human serum was used. This has, however, been denied by Ranzi (18). Rhein (19) has shown that the *in vivo* anaphylactic reaction will distinguish between normal urines of various animals, even between those of closely related species, e.g., goat and sheep, and man and ape. Antigenic character of normal human urine was lost by boiling for one hour, or allowing to putrefy for one month, and drying for one month.

In 1912 Guido Guerrini (20) obtained specific anaphylactic reactions by using "nucleoproteins" extracted from various sources—Dog's spleen, Dog's liver, Horse's spleen, Dog serum, *Vibrio cholerae, B. pestis, Fasciola hepatica* and *Dicroecoelium lanceolatum*. Nucleo-proteids were obtained by acid precipitation from alkali extracts of minced tissues (or from bacteria). Organs were perfused with normal saline in an endeavour to remove all traces of blood and serum proteins. It is doubtful whether this is possible, however, in the light of some perfusion experiments performed by Larson and Bell (21), who showed by means of india ink, that only a part of the capillary system is washed out, and who, while not denying the cellular theory of anaphylaxis, point out that Dale's (2) assumption of the bloodlessness of the perfused isolated guinea pig uterus in his experiments is unsound. However, the tissue was then minced and shaken for 24 hours in ice-chest with 20 volumes of 1% aqueous solution of potassium hydroxide. It was allowed to stand, and the supernatant fluid poured off and centrifuged. Then 1% aqueous solution of acetic acid was added, and a precipitate of "nucleoprotein" came down, which was collected on filter paper and dried in vacuo. No attempt to further purify was made. Bacteria were grown in large Petrie dishes, and similarly treated. Parasites were ground in a mortar after washing and similarly treated. Guinea pigs were sensitized by intraperitoneal and subcutaneous inoculation of the following nucleoproteins in 1% solution in 1% aqueous solution of sodium carbonate and tested after 18-28 days.

Dog's spleen nucleoproteid.
Dog's liver ,,
Horse's liver ,,
Horse's spleen ,,
B. pestis ,,
Vibrio cholerae ,,

The second inoculation was made with the other nucleoproteids and specific reactions were obtained with the anaphylactogen.

No experiments were tried of sensitizing guinea pigs with the Helminthic nucleoproteids and of endeavouring to produce distinct specificity between the two which were used.

Another interesting application of the test was by Fellmer (22), who worked with protein extracts of certain Fungi. Among the methods of differentiation used was the anaphylactic (*in vivo*) method, and he concluded that animals can be made anaphylactic by Fungus-protein. The reaction body is transferable to other animals with the serum, and brings on passive anaphylaxis. The anaphylactic bodies are specific.

Though the present work does not deal with bacterial anaphylaxis, it is interesting to note that Smith (23) was able to obtain an anaphylactic response in 7 cases out of 8 of renal tuberculosis, when the isolated uteri of tuberculous guinea pigs were tested with the addition of 3-5 c.c. of urine from these cases, with partial desensitization after shocking. He says that the capacity for specific contraction is markedly diminished or absolutely abolished after a single maximal response. He used urines in which acid-fast bacilli after proved to be *B. tuberculosis* were found, and included in the same testing bath a normal uterus horn as a control.

Among the other publications which have come under our notice bearing on this year's work with Helminth proteins, is one by Shimamura and Fujii (24), obtained only lately, on a highly toxic substance (Askaron), obtained from *Ascaris lumbricoides* (from man and from swine), and *A. megalocephala* (horse). They state that this same substance, which they believe to belong to the Albumose-peptone group, has a fairly wide distribution, and occurs also in *Filaria immitis*, *Gastrophilus* larvae, *Strongylus vulgare*, *Oxyuris curvula*, and *Trichocephalus depressiusculus.* They differentiate the symptoms of Askaron poisoning from Anaphylactic shock by the following points, though the symptoms are very similar to those of anaphylactic poisoning.

(1) Askaron is primarily toxic without previous sensitization.

(2) Also, since the guinea pig is not a natural host of the above parasites, the presence of antibodies against the body substance of the Helminths (mentioned) is not conceivable, and yet Askaron can give rise to a very severe intoxication in guinea pigs.

(3) Askaron, in sufficient amount, can produce poisoning without exception in horses, dogs, rabbits and guinea pigs and in the latter, the individual susceptibility is so constant that the lethal dose is always constant.

(4) Since the absorption of coagulable protein-material from the intestinal canal under normal conditions is not conceivable, the supposition that protein-material of gastro-intestinal parasites can give rise to a constant hypersensitiveness in their hosts is untenable.

(5) Askaron is a substance of Albumose-peptone character, which is not regarded as a good anaphylactogen.

They treated a series of guinea pigs intraperitoneally with 2-5 c.c. of normal horse blood, and after 24 hours injected 1/5th to 1/8th of the M.L.D. of Askaron intravenously. No alteration of the toxicity was shown, showing that normal horse blood does not contain anaphylatoxin against Ascaris, and that Askaron is primarily toxic.

Also no increase in the toxicity of "crude Askaron" (one of the preparations used) or of defatted Ascaris powder was observed when guinea pigs were prepared with a subcutaneous inoculation of ½-1/5th of the M.L.D., and after 14 days' interval, were tested intravenously with ½-¼ of the lethal dose, i.e., no anaphylactic sensitization occurred.

The literature on anaphylaxis towards parasites is, in general, poor; but the best known example of such anaphylactic reaction is that of the characteristic syndrome following the accidental puncture of an *Echinococcus* cyst during the attempted removal of the same, concerning which there is quite an extensive literature.

The conception that parasites can give rise to anaphylactic symptoms in their hosts under certain conditions does not appear to have been further extended till 1916, when Hadwen (26) published a preliminary note on Hypodermal Anaphylaxis. In 1917, Hadwen and Bruce (27) published their paper on "Anaphylaxis in cattle and sheep, produced by the larvae of *Hypoderma bovis, H. lineata* and *Oestrus ovis,*" in which they described serious symptoms and death following the crushing of larvae of *Hypoderma* (the warble fly), which were under the skin of cattle or following intravenous inoculation of aqueous extracts of the same into infested cattle. They also performed similar experiments with sheep infested with larvae of *Oestrus ovis,* the sheep Nasal Bot. They produced probable anaphylactic symptoms in rabbits and guinea pigs with their extracts.

Seyderhelm (28) has tried to explain Equine Pernicious Anaemia as a chronic intoxication with Oestrin, a toxic substance occurring in *Gastrophilus* larvae. In 1916, Favero (29) expressed the opinion that the intoxication described by them following intravenous inoculations of extracts of *Gastrophilus,* was a merely anaphylactic phenomenon.

It was these two latter papers which stimulated Van Es and Schalk (30) to examine the question. They showed, in well-controlled experiments, that *Gastrophilus* larvae living in the stomach of the Horse, could produce sensitization of the animal, with anaphylactic shock following on intravenous inoculation of extracts of such in such amounts as did not affect uninfested horses. From this as starting point they dealt with *Ascaris megalocephala, Trichodectes parumpilosus, Toxascaris limbata,* and *Belascaris marginata, Dipylidium caninum, Taenia serrata, Gyropus ovalis* and *Gyropus porcelli.*

In 1922 appeared Cameron's paper (25) on "Bot" anaphylaxis, in which he attempted to explain a disease known as "Jiggers," occurring in Alberta, Canada, as the result of anaphylactic poisoning due to sensitization towards *Gastrophilus* larvae.

The latest work on the question of anaphylaxis in relation to parasites appeared in 1924, when Bryce, Kellaway and Williams published their study on Hydatid Antigen, etc. (31). They found that hydatid protein is capable of acting as an anaphylactic antigen. In 4 out of 14 cases, they met with a peculiar type of response in which a first testing dose gave a large reaction, almost certainly partly anaphylactic, and then subsequent doses gave a series of smaller contractions.

The transference of passive anaphylaxis to guinea pigs by the sera of infested human patients occurred only irregularly.

Technique of Isolated Anaphylactic Uterus Reaction.

Virgin female guinea pigs of which the weight is somewhat under 250 grams are best used, as the weight becomes 250 grams or a little over at the time at which they are ready for use. Inoculations were given subcutaneously in saline solution; in rare cases intraperitoneally. For passive anaphylaxis, anaphylactic or immune serum was given intraperitoneally.

When the guinea pig is to be used, it is stunned by a blow on the head, the throat is cut and the animal is allowed to bleed to death. If perfusion is to be performed, it is then laid out on a board and perfused; if not, the uterus is removed direct.

Perfusion.—The abdomen is opened up with scissors and the intestines lifted out of the cavity as far as possible. The mesorectum is then divided with sharp scissors and the rectum and accompanying blood vessels divided between double ligatures of cotton thread about 2 inches from the anus. The viscera are turned back, dividing the mesentery, and the body cut across above the level of the kidneys and the cranial half of the animal is rejected. We now have left the caudal half, with the kidneys and adrenals and bladder and uterus. A holding ligature is now put round the descending aorta below the exit of the renal arteries. Only the inferior mesenteric artery branches off now to viscera. The connective tissue is stripped back from the aorta for about an inch, taking care not to injure the vessels, and a loose ligature is passed round, but not tied yet. With points of a very sharp pair of fine scissors a small snip is made in the aorta about half an inch from the holding ligature, and the canula is inserted, using one as big as possible and with a T-piece to remove air bubbles. The canula is ligatured into position by tying the loose ligature. The flow of Ringer at 38°C. is started, and a snip made in the inferior vena cava to facilitate the exit of returning Ringer fluid. A frequently changed pad of warm (38°C.) Ringer is kept over the uterus to keep it warm and moist during perfusion. Perfusion is kept up till the uterus is blanched and bloodless, which, with a good stream issuing from the cut vena cava, takes about 15-30 minutes. The cervix and ovarian end become blanched first, the body last. When the uterus is quite bloodless, the canula is removed after closing the clip controlling the flow here.

Isolation of Uterus is now performed, and when perfusion is not carried out, the isolation is done straight after bleeding of the animal has ceased. Extreme care is used to avoid tension on the uterus during removal, as this destroys its anaphylactic responding powers. The ovary is held with fine forceps, and no tension is exerted, and with sharp scissors the corpus uteri is bisected to the cervix and vagina. It is freed from the broad ligament, etc., and is cut away from the body and placed immediately in the spare bath of Ringer (at 38°C.) with oxygen bubbling.

Preparation for Experiment.—The other horn of the uterus is removed similarly and affixed to the hook which is suspended by a hair from the recording lever. The other (cervical) end is pushed on to the short platinum spikelet and thus fixed to the oxygenation tube. The preparation is submerged very gently into the Ringer bath, taking care not to stretch the muscle at all.

Ringer solution should be rejected if the temperature has been allowed to reach over 45°C., since partial decomposition of the sodium bicarbonate occurs, liberating carbon dioxide and the solution becomes alkaline. In any case, even the bubbling through of oxygen gradually displaces carbon dioxide, with a consequent rise in hydrogen-ion-concentration. Fortunately, the tolerance of the uterus to change in the hydrogen ion concentration is wide enough to prevent this latter factor from becoming of importance. When the uterus is immersed in the Ringer, it is in a state of contraction owing to the handling and the change of environment; and so it must be left till it gradually relaxes to its fullest extent, which takes from 15 to 30 minutes. The writing point is placed against the smoke-blackened drum, which is set in motion to see that the uterus has reached its maximum relaxation. Relaxation may be aided by the use of small weights which are hung on the arm of the lever, but great care must be exercised that excessive tension be avoided. A natural rhythm takes place after relaxation and the extent of this, which is quite small in a young (250 gram) guinea pig, should be noted and compared with the rise produced by addition of substances. The uterus remains suitable for use for 3-4 hours after removal from the body, but later the rhythm becomes exaggerated and erratic. Doorenbos (32), however, used in an experiment guinea pig uterus horns which had been kept in the ice chest overnight in Tyrode solution.

Method of Carrying Out the Test.—The maximum contraction of which the uterus is capable is determined either before the uterus is subjected to the action of any substance, or sometimes between the separate additions of various extracts, etc., or usually, after the substance under investigation has been added, and the effect of that substance has been observed.

For this purpose one used Beta-imidazolyl-ethylamine (otherwise Histamine), in the form of tablets of Ergamine acid phosphate (put up by Parke, Davis and Co.). Histamine is calculated as 1/3rd of the weight of the Ergamine acid phosphate. A concentration of 1 : 5,000,000 of the Ergamine acid phosphate causes a maximal contraction of the virgin guinea pig uterus (=0.01 mgm. in a 50 c.c. bath). By this means one can express the contraction given in response to the addition of any substance in terms of maximal response, e.g., a half-maximal response, etc.

Since many proteins are irritant to the isolated guinea pig uterus if in sufficient concentration (e.g., Horse Serum, *vide* Dale (3), Schultz (1), and in particular because many helminths are known to possess irritant properties, it is essential that any extract of helminth material under examination be first examined for its action on the normal virgin guinea pig uterus before it is applied to the sensitized uterus. For each extract and helminth preparation used, therefore, a series of preliminary tests had to be carried out to determine the maximum concentration of that extract that would not cause stimulation or other phenomenon such as loss of normal rhythm and diminished response to Histamine. This Minimum Non-Stimulating Concentration is called throughout the work, for the sake of brevity, M.N.-S.C., or, where the 50 c.c. bath is used throughout, the actual amount or dose of the extract itself is sometimes merely stated and called the M.N.-S.D.

Once the M.N.-S.C. is known, it is only necessary to set up an isolated uterus preparation from a suitable inoculated guinea pig (i.e., virgin and of reasonable weight) and to wait till the uterus is completely relaxed and is gently and regularly undergoing its normal rhythm. The Ergamine acid phosphate (known throughout the tests as simply " Histamine ") may now be added to the 50 c.c. bath in amount of 0.03 mgm., and the maximal contraction recorded. When the writing point has reached its highest level the Kymograph is stopped and the Ringer fluid (at 38°C.) changed several times, to wash out all traces of Histamine, whereupon the uterus soon relaxes to normal and behaves as before. In order to see whether there is any sensitiveness to the protein under investigation, an amount corresponding to about 75% of its M.N.-S.C. is now added to the bath.

If now a contraction occurs, one can assume that it is due to sensitiveness to the extract, assuming the latter to be in the same condition as when it was tested for M.N.-S.C. This is, of course, always the case when freshly made up solutions of dry powdered helminths are used, but may not be so when stock saline extracts are used. These latter are very liable to undergo a decrease in the hydrogen-ion-concentration, on keeping, and furthermore must be kept under Toluol to prevent bacterial growth. Having procured a response to the addition of extracts, one allows the uterus to gradually relax to normal in the bath; this occurs fairly quickly with a 250-gram guinea pig in which the uterus is thin, but in bigger pigs relaxation may take a long while for completion. If the uterus is not allowed to relax in the bath, and if the bath is changed before this relaxation occurs, full desensitization may not have occurred, and one of the most striking and characteristic phenomena of anaphylactic shock, namely, desensitization, may not be observed. With these bigger uteri, especially if the bath is changed too soon, and before spontaneous relaxation has occurred, two additions of extract may be necessary before every smooth muscle cell is desensitized, and the uterus no longer responds to the normally sub-stimulating dose as it did previously.

After the anaphylactic contraction, if any, has been observed, the Histamine may now be added in order to obtain the maximal contraction.

Since parasites are usually in close association with the tissues of their hosts, and are thus liable to be contaminated with host proteins, it is necessary to consider this important factor when experimenting with them. Even with the intestinal worms, possible contamination with serum or perhaps bowel-wall proteins must be kept in mind, and during the test eliminated by the preliminary addition to the bath, before the parasite extract is added, of extracts containing these non-parasite proteins. In the case of an anaphylactic response to them, absolute desensitization to them must be obtained before the parasite extract is added. In the case of parasites, which are so intimately connected with the tissues of their host that absolute freedom from contamination is extremely difficult, if not impossible, this factor is inevitable. This is the case with extracts of *Onchocerca,* where Ox serum is a contaminant.

It is also a fact, as shown in this work, that a uterus sensitized to a particular nematode or arthropod protein may show sensitiveness to protein of parasites belonging to the same genus, or even order. Hence, if one were endeavouring to prove the identity of two helminths or arthropods by the anaphylactic response to their respective extracts, one could very easily be led astray, and by apparently specific anaphylactic responses, with subsequent desensitization, one might assume the identity of helminths which were perhaps generically distinct. Hence in these cases, this disturbing, though interesting fact, must be allowed for, and may be eliminated as far as the present experiments show for the nematodes used, by the addition of some known nematode extract not identical with the one used for sensitizing. This phenomenon of non-specific sensitization was first observed by Dale when dealing with crystallized egg albumins of the duck and the fowl, though here the two proteins are much further zoologically removed than the proteins of the two arthropod larvae or nematodes used.

Apparatus.—The apparatus used is essentially that described by Burn and Dale (33) in their work on the Standardization of Pituitary Extracts. A short description will be given for the advantage of those who cannot refer to the original article.

It consists of a thermostat bath made of copper, cylindrical in shape. The flat bottomed bath stands on the table, which also supports the recording drum. A hole in the table allows the passage of the glass tube leading to and from the testing vessel, which consists of a cylindrical glass vessel about 2.5 cm. in diameter, and which, when filled to a certain mark, holds 50 c.c. Originally we used baths of 100 c.c. capacity, but found that it was quite practicable to reduce the cubic content of the vessel, thus bringing about a big saving in the consumption of our protein extracts, some of which we had only in limited amounts.

The testing vessel is produced into a glass tube of ¼ inch diameter, which passes through a rubber stopper in the centre of the bottom of the bath and joins a T-tube, one arm of which is continued as a rubber tube, with a pinch-cock, leading to a waste-bucket. The other arm joins a rubber tube, also with a pinch-cock near the junction, and this rubber tube is the inferior extremity of a syphon system leading from a large glass beaker of 3 litre capacity, which is supported on an iron tripod over a bunsen burner about 2′6″ above the table, on a high stool. Once the syphon system is established, filling and emptying of the testing bath is accomplished by a simple manipulation of the pinchcocks. The water bath is kept at 38°C., after being filled by water at that temperature, by means of a carbon filament lamp which can slide to a variable distance into a recess tunnel built into the side of the bath at the bottom. The lamp is adjusted to varying degrees of penetration into the tunnel, depending on the room temperature, and the bath is thus easily kept at the required temperature. The storage vessel, which holds Ringer solution, is kept at 38°C. by means of the adjustable pilot flame of the burner and gives quite a satisfactory constant temperature to the Ringer.

The uterus is fixed in the testing bath by means of a bent glass tube (of ¼″ diameter), the lower end of which is sealed off, and in which is inserted a short piece of stout platinum wire. About an inch from the end is blown a tiny hole in the side of the tube, through which oxygen passes, and bubbles up through the Ringer solution. The contractions of the muscles are recorded by a light, easy-moving lever, from one end of which hangs a hair which is fastened to a bent entomological pin. The ovary is fastened to the hair by the bent pin, and the cervical end of the uterine horn is impaled on the platinum spike, which is a fixed point.

The lever itself consists of a strip of light thin steel soldered to a half of the balance wheel of a clock. This is supported in a frame by means of the centred screws belonging to the balance wheel. The other end of the lever has attached to it a light straw extension, in which lies a piece of thin glass tubing, so bent that its tip can be adjusted at right angles to the surface of the Kymograph, which is covered with smoked glazed paper. The arrangement of the bent glass tubing ensures that the writing point follows the surface of the drum during all excursions of the lever. The drum is turned very slowly by an electric motor.

In our earlier experiments, the uterus was perfused with Ringer solution before being tested, but this procedure was soon discarded, as it appeared to offer no advantages over simply setting up the muscle as taken directly from the animal. For purposes of perfusion we used a glass canula, consisting of a glass bulb about 1½″ long by ¾″ in diameter, in one end of which entered a piece of glass tubing of ¼″ diameter. At the other end of the bulb was a fine constricted tube, which was tied into the aorta. At one side of the bulb was a short piece of tubing with rubber tubing and pinch cock, the purpose of which was to provide an exit for any air bubbles which may have reached the canula. The Ringer came from the same syphon system described above by means of a side tube and stop-cock.

Ringer Solution.—This must be made up from pure chemicals and glass distilled water, i.e., water which has been condensed and received on a glass surface, such as a Liebig condenser.

Stock Solution 1.

Sodium chloride	450.0 grams.
Potassium chloride	21.0 grams.
Sodium bicarbonate	25.0 grams.
Glass-distilled water	2500.0 c.c.

Dissolve the two chlorides in a sufficient amount of the water using warmth if necessary; and dissolve the bicarbonate in more water (cold or below 45°C.). Mix the two and make up to 2½ litres.

Stock Solution 2.

Calcium chloride (anhydrous)	12.0 grams.
Glass-distilled water	100.0 c.c.

Preparation.—Take 50.0 c.c. of Solution 1, and add to it about 800 c.c. of glass distilled water. Add 1.0 c.c. of Solution 2, and make up the whole to 1 litre. Then add 1.0 gram of pure glucose. It should be made up as required daily, but may be kept overnight if needed next morning.

Normal Saline Solution.—Throughout this work, this means a 0.85% solution of pure Sodium Chloride (analytical reagent) in glass distilled water.

Preliminary experiments with common antigens.

G.P. O/40. Received 24 days before 0.1 c.c. of Ox Serum subcutaneously. Bath 50 c.c. capacity.

Horn A. Added 0.01 c.c. Ox Serum (1: 5,000)	—Rapid maximal contraction.
Changed Ringer.	
Added 0.01 c.c. Ox Serum	—Very slow rise to ½ maximal.
Allowed to relax.	
Added 0.01 c.c. Ox Serum	—No response, hence desensitized.
Added 0.0005 gr. Histamine	—Maximal contraction.
Horn B. Not tested.	

This experiment did not attempt to exploit the delicacy of the reaction, as a big concentration (1 : 5,000) was used.

G.P. O/57. Received 35 days before 0.1 c.c. of Rabbit Serum.

Horn A. Added 0.05 c.c. Rabbit Serum (1: 1,000)	—Maximal contraction.
Allowed to relax.	
Added 0.05 c.c. Rabbit Serum	—Very slight rise of ½ inch, slowly coming to normal.
Added 0.05 c.c. Rabbit Serum	—No rise, hence fully desensitized.
Horn B. Exactly the same results as with Horn A.	

The following experiment had the double object of determining the effect of moderate concentrations of Toluol on the sensitive uterus and of seeing whether the delicacy of the reaction was impaired by the presence of Toluol.

G.P. O/19. Wt. 430 grams. Received 74 days before 0.1 c.c. Horse Serum subcutaneously. Bath=50 c.c.

Added 1 c.c. of Saturated Solution of Toluol in Normal Saline.	—No rise.
Added 0.00005 c.c. Horse Serum (1: 1 million)	—Maximal contraction.

Illustrating the specificity of the reaction.

G.P. O/111. Wt. 250 grams. Received 12 days before 1.0 c.c. of Amniotic Fluid of Rabbit.

Horn A. Added 0.1 c.c Rabbit Serum	—Maximal rise.
Allowed to relax.	
Added 0.1 c.c. Rabbit Serum	—No effect. Desensitized to Rabbit Serum.
Changed Ringer.	
Added 0.1 c.c. Amniotic fluid	—No effect.
Horn B. Added 0.05 c.c. (1: 1,000) Horse Serum	—No rise.
Added 0.05 c.c. (1: 1,000) Ox Serum	—No rise.
Added 0.05 c.c. (1: 1,000) Sheep Serum	—No rise.
Added 0.00005 c.c. (1: 1,000,000) Rabbit Serum	—Halting rise to nearly half maximal, returning to normal.
Added 0.01 c.c. (1: 500) Rabbit Serum	—Maximal rise.
Relaxed.	
Added 0.01 c.c. (1: 500) Rabbit Serum	—No rise, hence desensitized.

The result with Horn A is also interpreted as a proof that amniotic fluid does not contain proteins differing from those in blood-serum.

The following was a repetition of one of Dale's experiments on the specificity of the reaction even with two such closely related proteins as hen egg albumin and duck egg albumin, excepting that here the ordinary egg white was used while Dale worked with the purified albumins. Fresh eggs were used and dilutions of the white were made before the test and used.

G.P. O/21 Wt. 435 grams (note the large weight). Received 62 days before 0.1 c.c. of Hen Egg-White subcutaneously. Bath=50 c.c. capacity.

Horn A. Added 0.1 c.c. (1: 500) Ox Serum	—Nil.
Ringer changed.	
Added 0.1 c.c. (1.500) Horse Serum	—Nil.
Ringer changed.	
Added 0.005 c.c. (1: 10,000) Duck Egg-White.	—Maximal contraction.

Added 0.1 c.c. Duck Egg-White (1: 500)	—Almost maximal contraction.
Added 0.1 c.c. Duck Egg-White	—A ¾ maximal contraction, but extremely drawn-out rise.
Added 0.1 c.c. Duck Egg-White	—No response, hence desensitized to Duck Egg-White.
Ringer changed.	
Added 0.000005 c.c. (1: 10 millions) Hen Egg-White.	—No rise within a minute.
Added 0.00005 c.c. (1: 1 million) Hen Egg-White.	—A maximal contraction.

This experiment of Dale's illustrates the fact that while often there is considerable sensitiveness to the non-specific allied albumin, yet on desensitizing to this we can still get the specific sensitiveness to the egg albumin used for sensitization.

Commentary on the above Experiments.—These experiments illustrate that the anaphylactic reaction can occur in a concentration of the Antigen of 1 : 1,000,000 of Ringer; that Toluol does not affect this degree of sensitiveness; that the reaction is very specific; and that sometimes in proteins from very closely related sources sensitiveness to one protein may be accompanied by sensitiveness to the allied protein, but that this non-specific sensitiveness may be exhausted and yet the specific sensitiveness will be still obtained.

Effect of some chemicals on the isolated guinea pig uterus.

Phenol.—Carbolised antigens of Onchocerca material were first used on account of the ease with which they keep free from bacterial contamination, but it was realised after much work at Glenfield, N.S.W., that the phenol was harmful to the uterus, and that it probably in large part accounted for the negative results obtained there.

These carbolised antigens, however, are quite good for sensitizing purposes.

The effect of Phenol, in the form of Carbolised Saline Solution, is shown in the following experiment. The carbol saline in use at this laboratory has the composition—

Phenol	0.5
Sodium Chloride	0.85
Water	100.0

Normal G.P. O/49. Bath=50 c.c. capacity.

Set up and allowed to relax.

Added 0.01 c.c. of Carbol Saline	—A rise of nearly an inch after about 2 minutes. Uterus gradually returned to normal.
Changed Ringer.	
Added 0.0025 c.c. Carbol Saline	**—No effect.**

From this experiment it seemed that it was not advisable to use even 0.01 c.c. of a carbolised antigen=a concentration of

1:100,000 Phenol. Hence it was seen that it was useless to employ such extracts for testing. It was not considered necessary to try the effect of Phenol on the anaphylactic responses of a sensitized uterus.

Chloroform.—This substance was at one stage of the work considered as a possible preservative agent to combine with normal saline solution in the form of a saturated solution, to be used for forwarding Nematode-infested Tabanids to Melbourne.

The result of the following experiments, taken together with an oral communication from Professor Osborne, of the Physiology School, University of Melbourne, that chloroform is able under certain conditions to precipitate at least some albumins, certainly lactalbumin, resulted in chloroform being discarded. Chloroform was used in the form of Aqua chloroformi, B.P., which represents a 0.25% aqueous solution.

Normal G.P. O/49. Bath 50 c.c. capacity.

Set up and allowed to relax.

Added 0.1 c.c. Aqua Chloroformi (B.P.)	—No effect.
Added 0.5 c.c. Aqua Chloroformi (B.P.)	—A sudden relaxation of the muscle denoted by a fall of the pointer and decreased amplitude of the rhythm.
Changed Ringer.	
Added 0.25 c.c. Aqua Chloroformi	—No effect.
Changed Ringer.	
Added 0.5 c.c. Aqua Chloroformi	—Sudden relaxation resulting in a drop of pointer of ¼ in. Amplitude little affected.

Amplitude of rhythm gradually increased till it was almost twice that which was possessed by the uterus at the beginning of the experiment. Frequency also slightly diminished. This phenomenon may have been similar to the usual exaggerated rhythm seen after a uterus has been suspended in the Ringer for some time.

Added 1.0 c.c. Aqua Chloroformi—No further effect.

From this experiment it was seen that 0.5 c.c. of Aqua Chloroformi (B.P.)—which contains 0.25% of Chloroform in water—was inimicable to the normal uterus. This equals a concentration of 1:40,000 of Chloroform.

Toluol.—This substance was chosen as the preservative and bacteriostatic agent needed. It is also used to cover any fluid antigens we possess. The experiment with it described on page 36 is set out again for the sake of continuity.

This experiment had the double object of determining the effect of moderate concentrations of Toluol on the sensitive uterus and of seeing whether the delicacy of the reaction was impaired by the presence of Toluol.

G.P. O/19. Wt. 430 grams. Received 74 days before 0.1 c.c. Horse Serum subcutaneously. Bath 50 c.c.

Added 1 c.c. of Saturated Solution of Toluol in Normal Saline	—No rise.
Added 0.00005 c.c. Horse Serum (1: 1 million)	—Maximal contraction.

Glycerine.—Later on in the course of the experiments, it was found that Toluol possessed some grave disadvantages for the purpose for which it was used in the transporting of material. On the advice of Associate-Professor Young, glycerine was investigated and found to be without effect on the normal uterus in concentrations far above those to which it would be subjected in the course of the testing of material forwarded in a 5% normal saline solution of glycerine.

Normal G.P. N/13. Wt. 240 grams. Bath 50 c.c. Set up and allowed to relax with a normal rhythm, using a 5% Normal Saline Solution of Glycerine.

Added 0.5 c.c. (=1: 2,000 concentration of Glyc.)	—No effect.
Added 1.0 c.c. (=1: 1,000 concentration of Glyc.)	—No effect.
Added 2.0 c.c. (=1: 500 concentration of Glyc.)	—No effect.
Added 5.0 c.c. (=1: 200 concentration of Glyc.)	—No effect.
Added 0.05 mgm. Histamine	—A max. contraction, though a little slower than usual.

Hence the total amount of Glycerine solution added was 8.5 c.c. =a glycerine concentration of about 1 : 138, and the uterus was subjected without apparent irritation, to 1 : 200 concentration at one dose, or a cumulative concentration of 1 : 138.

Sensitising Powers of Various Parasites.

A. Sensitizing Powers of Ascaris equi.

(a) *Preparation of Extract*—

Adult *Ascaris equi* were collected from the intestine of a horse at post mortem. After washing several times in Normal Saline, they were dried with filter paper and cut up in a sterile Petrie dish and placed in the incubator at 37°C. to dry. After 5 days they were quite dry and powdered readily in a mortar.

For use, the powder was shaken with normal saline solution (made with pure Sodium chloride and glass distilled water) in the proportion of 0.1 gram of powdered worm to 10.0 c.c. of saline. Extraction was then occasionally aided in some cases by a few hours in the incubator at 37°C., with shaking at intervals; but usually the mixture was placed in the ice-chest overnight. A small amount of Toluol was added to inhibit bacterial growth.

Before use the mixture was shaken again, and the extracted powder removed by centrifugalisation. The use of normal saline solution ensured that both the globulins and the albumins would be extracted, assuming both or either to be present.

(b) *Determination of M.N.-S.C.*—

This was decided on as 1 : 2,500, and the largest dose that was used in the 50 c.c. bath was 0.01 gram (=a concentration of 1:5,000.

(c) *Test Experiments*—

G.P. O/52. Wt. 295 grams. Bath 50 c.c. capacity. Inoculated 36 days before with the normal saline soluble proteins in 1.0 mgm. of dried powdered Ascaris equi.

Horn A. Set up and allowed to relax.
Added 0.01 c.c. Horse Serum —No effect.
Changed Ringer.
Added 0.25 c.c Antigen I. —Sudden maximal contraction.
(Ringer extract of Worm Nodules)
Changed Ringer.
Added 0.25 c.c. Antigen I. —Halting rise to ¾ maximal.
Changed Ringer.
Added 0.1 c.c. Antigen I. —No effect.
Changed Ringer.
Added 0.0001 gram dried Ascaris equi (1: 500.000) —Very slight rise of ½ inch.
Added 0.001 gram (1:50,000) of Ascaris —Halting maximal contraction.

Horn B. Added 0.01 gram Ascaris equi —Sudden maximal contraction.
Allowed to relax.
Added 0.01 gram Ascaris equi —No effect.
Hence desensitization to the specific Antigen.
Changed Ringer.
Added 0.1 c.c. Onchocerca extract (Antigen I.) —No effect.

G.P. O/53. Wt. 400 grams. Received 90 days before 1.0 mgm. dried Ascaris equi.

Set up and allowed to relax. (Owing to extreme length of uterus only about one half of the horn was used.)

11.27 a.m. Added 0.25 c.c. Antigen I. —No rise.
(Ringer Extract of Worm Nodules)
11.33½ Added 1.0 mgm. Toxascaris limbata —No rise.
11.36 Added 5.0 mgm. T. limbata —No rise.
11.38 Added 1.0 mgm. Ascaris equi—Maximal contraction.
Allowed to relax. Stopped motor.
12.11 p.m. Added 1.0 mgm. Ascaris equi—No rise.
Hence desensitized to A. equi.
Added 0.1 mgm. Histamine —Maximal contraction.

Discussion.—In this uterus, there was sensitiveness to only the specific protein of Ascaris. No sensitiveness to the allied worm Toxascaris.

G.P. 137. Wt. 268 grams. Received 21 days before 2.5 mgm. A. equi.
Horn A. Set up.

Relaxed.
Added 1.0 mgm. A. equi —Quick maximal rise.
Changed Ringer.
Added 10.0 mgm. A. equi —Rise to maximal.
Changed Ringer.
Relaxed.
Added 10.0 mgm. A. equi —No effect.
Therefore desensitized.
Added 10.0 mgm. A. suilla —No effect.
Changed Ringer.
Added 10.0 mgm. T. limbata —No effect.
Added 0.05 mgm. Histamine —Rise to maximal.

B. *Sensitizing Powers of Toxascaris limbata.*

(a) *Preparation of Extract.*—The worms were dried and powdered as for Ascaris and 1% extracts of their protein made.

(b) *Determination of M.N.-S.C.*—1 : 5,000 is the concentration to be used.

(c) *Experiments.*—

G.P. O/60. Wt. 315 grams. Bath=50 c.c. capacity. Received, 50 days before, the normal saline-soluble proteins in 1 mgm. of dried, powdered Toxascaris limbata.

The effect of serums of Horse and Ox were tried, as these may have been present in the small intestine (as food constituents) with the Ascarids.

Horn A. Set up and allowed to relax.

Added 0.1 c.c. Horse Serum —Gradual rise to 1 inch and gradual fall to normal.
Added 0.1 c.c. Horse Serum —A very slight rise (¼ in.)
Added 0.1 c.c. Horse Serum —No effect.
Added 0.1 c.c, Ox Serum —No effect.
Changed Ringer.
Added 0.2 c.c. Antigen I. (Ringer extract of worm nodules) —Almost maximal contraction.
Allowed to relax and changed Ringer.
Added 0.2 c.c. Antigen I. —Very slight rise (¼ in.).
Changed Ringer.
Added 0.2 c.c. Antigen I. —No effect.
Hence desensitized to Onchocerca.
Added 0.25 c.c. Strongylus equinum extract —No effect.
Added 1 mgm. Ascaris equi —No effect.
Added 5 mgm. Ascaris equi —No effect.
Added 1 mgm. Toxascaris limbata —Sudden maximal contraction, which showed a tendency to take a long time to relax.
Ringer changed.
Added 1.0 mgm. Toxascaris —No effect.
Added 1.0 mgm. Toxascaris —No effect.
Hence desensitized to Toxascaris.
Added 0.1 mgm. Histamine —Maximal rise.

Horn B. Added 0.1 c.c. Horse Serum	—No effect.
Added 0.1 c.c. Ox Serum	—No effect.
Added 2.5 mgm. Ascaris equi	—Rise to 1 inch.
Allowed to relax.	
Added 2.5 mgm. Ascaris	—No effect.
Hence desensitized to Ascaris equi.	
Changed Ringer.	
Added 0.2 c.c. Onchocerca Nodule extract Antigen 1	—No rise.
Added 0.2 c.c. Antigen 1	—No further effect.
Added 0.005 mgm. Toxascaris limbata	—No effect.
Added 0.025 mgm. Toxascaris	—No effect.
Added 0.075 mgm. Toxascaris	—No effect.
Added 1.0 mgm. Toxascaris	—Maximal contraction.
Allowed to relax.	
Added 1.0 mgm. Toxascaris	—No effect.
Hence desensitized to Toxascaris limbata.	
Added 0.1 mgm. Histamine	—Maximal rise.

C. Sensitizing Powers of Ascaris suilla.

(a) *Preparation of Extract.*—A large number of specimens of Ascaris suilla was collected from the intestines of pigs at the Abattoirs. After being washed in saline, they were cut up into small pieces in a Petrie Dish, and dried in vacuo over concentrated sulphuric acid. When dried, the mass was powdered and stored in the ice chest. For use a 1% extract was made in normal saline and left overnight in the ice chest. Here again, Toluol was placed over the extract for preservation.

(b) *Determination of M.N.-S.C.*

Normal G.P. N/11. Wt.=290 grams.

Horn A.

2.0 p.m.	Set up.	
2.20	Relaxed.	
2.21	Added 10.0 mgm. A. suilla	—No effect.
2.22	Added 20.0 mgm. A. suilla (Total 30.0 mgm.)	—Slight rise of ⅛ in.
2.25	Added 0.05 mgm. Histamine	—Rise to maximal

Hence from the above, Minimum Stimulating Dose is between 10.0 and 30.0 mgm.

Horn B.

2.33 p.m.	Set up.	
3.15	Relaxed.	
3.17	Added 20.0 mgm. A. suilla	—Slight rise of ⅛ in.
	Changed Ringer.	
3.25	Relaxed.	
3.26	Added 10.0 mgm. A. suilla	—No rise.
3.27	Added 5.0 mgm. A. suilla (Total 15.0 mgm.)	—No rise.
3.28	Added 5.0 mgm. A. suilla (Total 20.0 mgm.)	—Merely a very slight transient rise.
3.29½	Added 5.0 mgm. A. suilla (Total 25.0 mgm.)	—Slight rise, returning to normal slowly.
3.33½	Added 5.0 mgm. A. suilla (Total 30.0 mgm.)	—No response.
3.35½	Added 5.0 mgm. A. suilla (Total 35.0 mgm.)	—No response.

3.37	Added 5.0 mgm. A. suilla (Total 40.0 mgm.)	—Larger amplitude.
3.40	Added 5.0 mgm. A. suilla (Total 45.0 mgm.)	—Slight rise, and then a rise of ½ in. at 3.42 slowly relaxing.
3.57½	Added 5.0 mgm. A. suilla (Total 50.0 mgm.)	—No rise.
4.0	Added 5.0 mgm. A. suilla (Total 55.0 mgm.)	—No rise.
4.2.	Added 5.0 mgm. A. suilla (Total 60.0 mgm.)	—Rise at 4.3½ p.m. of about 1 in., relaxing again.
4.5	Added 0.05 mgm. Histamine	—Rise to maximal.

This experiment shows the tolerance which the uterus can acquire towards an irritant substance when it is added in gradual doses.

In this case a rise of only 1″ was obtained when the bath held 60.0 mgm. of A. suilla, which dose would certainly be stimulating to the uterus if added at once.

From the above the Minimum Stimulating Dose lies between 10 and 20.0 mgm., the latter giving only a very slight rise of ⅛″. The Minimum N.-S.D. may thus be taken as 15 mgm., and 10·0 mgm. may be added to a testing bath with safety.

(c) *Test experiments*—

G.P. O/117. Wt. 385 grams. Received 44 days before 5.0 mgm. A. suilla.

Horn A.

2.32 p.m.	Added 5.0. mgm. A. equi	—After a pause of half a minute, there was a stepping rise to maximal which relaxed to normal by 2.37.
2.40	Added 5.0 mgm. A. equi	—After a pause of 1½ minutes, a stepping rise to ½ maximal, relaxing by 3.47.
	Changed Ringer.	
2.58	Added 5.0 mgm. A. equi	—No rise.
	Therefore desensitized to A. equi.	
3.0	Added 5.0 mgm. T. limbata	—No rise.
3.2	Added 1.0 mgm. A. suilla	—No rise.
3.4	Added 5.0 mgm. A. suilla	—After a pause of 2 minutes there was a stepping rise to ¾ maximal, relaxing by 3.17 p.m.
3.18	Added 5.0 mgm. A. suilla	—No rise.
3.22	Added 0.01 mgm. Histamine	—Sudden maximal rise.

Horn B.

3.48 p.m.	Added 1.0 mgm. A. suilla	—After pause of ¾ minute there was a maximal contraction which relaxed.
4.7	Added 10.0 mgm. A. suilla	—Stepping rise to ½ maximal, relaxed by 4.12 p.m.
4.13	Added 5.0 mgm. A. suilla	—No rise.
	Therefore desensitized to A. suilla.	
4.15	Added 5.0 mgm. A. equi	—No rise.
4.19	Added 5.0 mgm. T. limbata	—No rise.
4.44	Added 0.05 mgm. Histamine	—Maximal contraction.

D. Sensitizing Powers of Onchocerca gibsoni.

(a) *Preparation of Onchocerca Extracts.*—The following extracts were prepared:—

A. Carbolized Saline Extract of Worm Nodule.—Onchocerca nodules were bisected and the fibrous reticulum and pieces of worm scraped out and placed in carbolized saline solution and ground with powdered glass to a fine mulch. The mixture was put in the incubator for a week, at 37°C. Though this extract proved later to have sensitizing properties, it was decided to discard it for two reasons—firstly, that being carbolised it was not fit for actual testing of the uteri on account of the high phenol content (0.5%), and secondly, because it was later realised that incubation of extracts for prolonged periods was bad in principle, because of the liability to lysis and formation of breakdown products.

B. Four nodules were incised, and the pieces of adult female worm removed and placed in normal saline, and shaken in a shaker for half an hour in the hope of removing most of the larvae and ova from the worm. The pieces of female were then picked out and washed eight times by repeated hand shaking in saline, and then centrifuging. They were then ground up by the aid of glass in 40 c.c. of carbolized saline, and placed at 37°C. for three days.

C. A similar extract was made with the exception that the final grinding up was done in normal saline solution. The ground up material and fluid were placed in a test tube, and hermetically sealed and sterilized by exposure in a water bath at 55°C. for one hour on three consecutive days.

D. The saline in which dissection of the nodules had been carried out in preparation of antigens B. and C. was collected after the pieces of adult and many of the embryos and ova had been thrown down in the centrifuge. It was divided into two portions. One portion was filtered to remove debris and embryos and ova, and sealed in a test tube and sterilized fractionally. It was thought that this fluid, presumably containing coelomic fluid of the adult female, as well as serum of the host and perhaps some constituent protein of the fibrous tissue of the nodule, might serve as a sensitizing antigen.

E. The other portion was boiled, the reaction of the fluid being neutral, and the coagulum as well as ova and embryos and debris was filtered off. The filtrate was sealed in a tube, and also passed through the fractional sterilizing with the other non-carbolized antigenic fluids. It was thought that possibly the coelomic fluid might contain some protein not coagulated by heat, similar to caseinogen of milk, but which could act as an antigen. In the event of such being the case, the double object would have been served by ridding the fluid of host proteins (albumins and globulins), and thus of presenting a purer antigen with consequent increase in the delicacy of the reaction. These hopes, as seen later, were not realised.

J. Twelve nodules were dissected and the pieces of adult taken out and ground in 50 c.c. of normal saline solution. Filtered through Gooch crucible and stored under Toluol.

(b) *Precautions and desensitizing agents against non-verminous proteins.*—Since *Onchocerca gibsoni* is a parasite of the subcutaneous and intermuscular connective tissue of the Ox, it is evident that extracts of Nodules will contain proteins of the host—such as blood serum proteins and perhaps proteins peculiar to connective tissue cells. Hence in experiments in which guinea pigs were sensitized to extracts of worm nodule, the necessity arises to desensitize the uterus to ox serum. The possibility that sensitiveness to fibrous tissue cell protein might exist, must not be neglected, and so an extract of fibrous tissue was prepared by grinding in normal saline with glass some aponeurosis and tendon of an ox. This extract, however, appeared to have no effect on the uterus sensitized, and so probably no sensitiveness to fibrous tissue cell protein exists.

As Dale has shown, the purer the Antigen used for sensitization, the more delicate the degree of sensitiveness, and also with multisensitization the degree of sensitiveness to any of the antigens used is much less than it would have been if the uterus had been sensitized to that protein only, and also desensitization to one antigen is not without effect on the degree of sensitization towards the others.

For these reasons it was thought desirable to reduce the number of non-specific proteins in the extracts to as few as possible, and hence an extract of the dissected-out adult female worm was used. This extract gave good results. Guinea pigs sensitized with this extract showed sensitiveness towards ox serum in two cases and not in another.

(c) *Tests performed to determine whether Onchocerca protein could sensitize the uterus.*—The principle in these tests was to inoculate a guinea pig subcutaneously with an arbitrarily determined amount of antigen, in this case 0.1 c.c. After an interval of three weeks or more they were tested in the following manner. After setting up in the Ringer bath and allowing to relax, one added the non-verminous proteins which one might consider to be possibly present in the extract. The two which come to mind are normal ox serum and some extract of fibrous tissue. If any reaction occurred on the addition of these substances a further dose was given, till the uterus was desensitized to these proteins. Then the M.N.-S.D. of the antigen under consideration was given—if then an anaphylactic contraction occurred it was assumed to be due to anaphylactic shock brought about by sensitization towards the verminous protein.

G.P. O/25. Received 61 days before 0.1 c.c. of Antigen A.
Antigen A = carbolized saline extract of worm nodule.
Antigen E = dissection fluid (boiled).
Antigen D = dissection fluid (not boiled).

Set up and allowed to relax —This uterus was rather oestral.
Added 0.05 c.c. Ox Serum —Maximal contraction.
Allowed to relax to normal.
Added 0.05 c.c. Ox Serum —No typical rise, but a gradual contraction of the uterus.
Changed Ringer.
Added 0.25 c.c. Ox Serum —No effect.
(To be sure of the ox serum desensitization)
Changed Ringer.
Added 1.0 c.c. Fibrous tissue extract —A slight transient rise of ½ inch.
Added 1.0 c.c. Fibrous tissue extract —Another rise, but uterus began to become erratic.
Ringer changed.

There appeared to be no special sensitiveness to Fibrous tissue protein.

Added 0.025 c.c. Antigen C. —A maximal contraction.
Changed Ringer.
Added 0.025 c.c. Antigen C. —No effect.
Hence desensitized to the adult Onchocerca.
Added 0.12 c.c. Antigen F. —No effect.
(All that remained)
Changed Ringer.
Added 1.0 c.c. Antigen E. —No effect.
Added 0.25 c.c. Antigen D. —No effect.
Added 0.001 mgm. Histamine —Maximal contraction.

The only reliable result from this experiment was the definite sensitization to adult Onchocerca, and to Ox Serum, as we would expect.

G.P. O/31. Sensitized 53 days before with 0.1 c.c. of Antigen C., prepared by triturating adult female *Onchocerca gibsoni* in Normal Saline Solution. The M.N.-S.D. of this antigen was found to be 0.025 c.c. or a M.N.-S.C. of 1: 2,000.

Set up and allowed to relax —Uterus is somewhat oestral.
Added 0.5 c.c. of Normal Saline Extract of Ox Fibrous Tissue (Necessarily containing Ox Serum) —A maximal contraction, taking a few steps to attain maximum height.
Changed Ringer.

Uterus showed very erratic rhythm and a tendency to gradually contract.

Added 0.001 mgm. Histamine —Maximal contraction.
Changed Ringer.
Added 0.025 c.c. Antigen C. —Sudden maximal contraction.
Changed Ringer.
Added 0.025 c.c. Antigen C. —Sudden almost maximal contraction.
Changed Ringer.
Added 0.025 c.c. Antigen C. —A very halting and oscillating rise to almost maximal.
Changed Ringer.
Added 0.025 c.c. Antigen C. —No effect.
Hence desensitized here.
Added 0.01 mgm. Histamine —Maximal contraction.

In this experiment, although one should have made sure of the desensitization towards host proteins, yet the intensity of the reactions following addition of Antigen suggests that the uterus was sensitive towards this Antigen.

Discussions.—These experiments on *Onchocerca* protein show that this protein is an anaphylactogen, giving a good reaction with the Antigen after removing the sensitiveness due to host proteins (serum). This result has been obtained on four other occasions.

The case of G.P.O/25 should be compared with the findings of Bryce, Kellaway and Williams (34), who noted, in 4 cases out of 14, using as antigen hydatid (*Echinoccus*) fluid, a peculiar type of response, in which a large reaction is obtained with the first dose of antigen, but this does not exhaust the muscle which goes on reacting repeatedly to subsequent doses of hydatid fluid, the Ringer in the bath being changed after each response. The large primary reaction in our case must surely be conceded as at least partly anaphylactic in origin; and the fact that the animal was a big one of weight, about 400 grams, might suggest that the second shock was due to incomplete desensitization of a big uterus horn. But the occurrence of a third though less intense shock seems to be to other causes than anaphylaxis. Note that the uterus was entirely insensitive to the antigen after this third dose. This phenomenon was not noticed again, so that it occurred with one out of five animals tested.

E. *Sensitizing Powers of larvae of Gastrophilus haemorrhoidalis.*

(a) *Preparation of Extract.*—*Gastrophilus haemorrhoidalis* larvae were collected from the stomach of a horse at post mortem, and after washing and identifying, were cut up and dried as for Ascaris, and then powdered. 100 milligrams extracted with 10 c.c. normal saline (1%).

(b) *Determination of M.N.-S.C.*

(c) *Experiment.*

G.P. O/50. Wt. 370 grams. Received 49 days before the Saline soluble proteins in 1.0 mgm. G. haemorrhoidalis larvae (dried and powdered). As possible host proteins, horse serum and a 25% extract in normal saline of horse's stomach were used.

Set up and allowed to relax.

Added 0.1 c.c. Horse Serum	—No effect.
Added 0.1 c.c. Extract of Horse's stomach	—No effect.
Added 1.0 mgm. G. nasalis	—A slight rise of 1 inch, relaxing to normal.
Added 0.5 c.c. Extract of Stomach	—No effect.
Changed Ringer.	
Added 0.05 mgm. Histamine (As uterus had lost its rhythm)	—Maximal contraction of 4½ inches.
Changed Ringer.	
Added 5.0 mgm. G. nasalis	—Immediate rise of 3 inches.
Allowed to relax.	
Added 5.0 mgm. G. nasalis	—No effect.

Added 5.0 mgm. G. nasalis —No effect.

Hence desensitized to G. nasalis.

Added 1 mgm. G. haemorrhoidalis —Immediate rise of 3 inches.

Allowed to relax.

Added 1 mgm. G. haemorrhoidalis —No effect.

Added 2.5 mgm. G. haemorrhoidalis —No effect.

Hence desensitized to G. haemorrhoidalis.

Added 0.5 mgm. Histamine —Rise of 3 inches.

Horn B. Added 0.1 c.c. Horse Serum —No effect.

Added 0.5 c.c. Extract of Stomach —No effect.

Added 1.0 mgm. Ascaris equi —No effect.

Added 10.0 mgm. Ascaris equi —No effect.

Added 1.0 mgm. G. haemorrhoidalis. —Maximal contraction.

Allowed to relax.

Added 1.0 mgm. G. haemorrhoidalis —No effect.

Added 1.0 mgm. G. haemorrhoidalis —No effect.

Hence desensitized to G. haemorrhoidalis.

Added 5.0 mgm. G. nasalis —No effect.

Added 0.05 mgm. Histamine —Maximal contraction.

G.P. O/51. Wt. 410 grams. Received 86 days before 2.0 mgm. dried G. haemorrhoidalis.

Set up and allowed to relax.

Added 0.5 mgm. G. nasalis —No response.

Added 0.05 c.c. Horse Serum —No rise.

Added 5.0 mgm. G. nasalis —No response.

Added 0.5 mgm. G. haemorrhoidalis (=1: 100,000 of dried larvae) —Rise to maximal.

Stopped motor and allowed horn to relax in the exciting medium to procure desensitization.

Added 5.0 mgm. G. haemorrhoidalis —After a long interval there was a halting and oscillating rise to nearly half maximal coming down soon in a typical fashion.

Motor stopped and relaxation allowed.

Added 1.0 mgm. G. haemorrhoidalis —No effect.

Added 0.01 mgm. Histamine —Sudden maximal rise.

Horn B. Set up and allowed to relax.

Added 5.0 mgm. G. nasalis —No rise.

Changed Ringer.

Added 0.05 mgm. G. haemorrhoidalis. (=1:1,000,000 of dried larvae) —After a pause of half a minute, there was an oscillating rise to one-fourth maximal.

Allowed to relax.

Added 1.0 mgm. G. haemorrhoidalis —Rise to half maximal, with a return to normal.

Added 5.0 mgm. G. haemorrhoidalis	—After short pause a small rise to one fourth maximal.
Added 1.0 mgm. G. haemorrhoidalis	—No effect.
Hence desensitized to G. haemorrhoidalis.	
Added 0.025 mgm. Histamine	—Maximal contraction.

Discussion.—This experiment is very similar to the Duck and Hen Egg albumin experiment. While the uterus possesses good sensitiveness towards the non-specific, allied protein, desensitization to this leaves good sensitiveness towards the specific antigen.

But if the uterus is desensitized to the specific antigen first, no sensitiveness is left to the non-specific protein.

We see the close relationship between these two species of *Gastrophilus* larvae which are externally very similar, being differentiated by arrangement of spines on the segments. The possibility suggests itself that if one were confronted with a *Gastrophilus* larva of doubtful identity one might well be able to establish its identity by this method—i.e., testing its extract against guinea pig uteri sensitized with each of the species of *Gastrophilus* after desensitizing to the non-specific proteins by using extract of some other species.

In the second experiment, the analogy to Dale's experiments with the Egg albumins is still further brought out. In this case, as he often found with the albumins, there was no sensitiveness to the allied antigen, *G. nasalis,* but marked sensitiveness to the specific antigen. In the second horn, a reaction was obtained with a quantity of normal saline extract of dried *G. haemorrhoidalis* larvae corresponding to 1 in a million of the dried larvae.

The difficulty in desensitizing is to be explained by the unfavourably large size of the animal. With young 250 gram pigs, desensitization is usually complete after one dose.

It should be noted that in G.P.O/50 (Horn B.) there was no sensitiveness to even 10·0 mgm. of *Ascaris equi,* nor would such be expected. Shimamura and Fujii (24) state that their Askaron (a toxic principle from Ascarids) is also present in many other worms, and also in *Gastrophilus* larvae.

F. Sensitizing Powers of Gastrophilus equi.

(a) *Preparation of Extract.*—As for the other *Gastrophilus* larvae. Like *G. nasalis,* this parasite will not dry to a pulverisable state, but, even after prolonged exposure to concentrated sulphuric acid and even to phosphorus pentoxide in vacuo, it becomes a somewhat moist substance. On this account, we used 5% saline extracts for working, and used larger sensitizing doses for the guinea pigs.

(b) *Determination of M.N.-S.C.*—50 mgm. in a 50.0 c.c. bath is quite non-stimulating.

(c) *Experiments.*—

G.P. O/206. Wt. 290 grams. Received 38 days before 12.5 mgm. G. equi.

Horn A.

3.39 p.m.	Added 25.0 mgm. G. equi	—Maximal rise, relaxing slowly and typically by 3.53.
	Changed Ringer.	
4.3	Added 25.0 mgm. G. equi	—No rise.
	Changed Ringer.	
4.14	Added 5.0 mgm. G. haemorrhoidalis	—No rise.
	Changed Ringer.	
4.22	Added 25.0 mgm. G. nasalis	—No rise.
4.25	Added 0.05 mgm. Histamine	—Maximal rise.

Horn B.

5.9. p.m.	Added 0.15 c.c. Horse Serum	—No rise.
5.14	Added 25.0 mgm. G. equi	—Maximal rise relaxing by 5.25.
	Changed Ringer.	
5.29	Added 25.0 mgm. G. equi	—A slight rise, but probably not anaphylactic.
	Changed Ringer.	
5.38	Added 25.0 mgm. G. equi	—No rise.
	Changed Ringer.	
5.43	Added 25.0 mgm. G. nasalis	—No rise.
	Changed Ringer.	
5.49	Added 5.0 mgm. G. haemorrhoidalis	—No rise.
5.53	Added 0.05 mgm. Histamine	—Maximal rise.

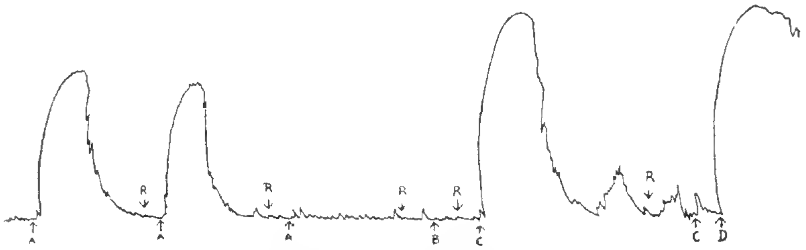

FIG. 1.—Guinea Pig O/206. Weight 290 grams.

Horn B. Received, 38 days before, the normal-saline-soluble proteins in 12.5 mgm. of dried *Gastrophilus equi* larvae.

At "A," 25.0 mgm. of G. equi added; At "B," 25.0 mgm. G. nasalis added; At "C," 5.0 mgm. of G. haemorrhoidalis added; At "D," 0.05 mgm. of Histamine added.

"R" signifies the washing out of the bath with Ringer Solution.

G.P. O/205. Wt. 280 grams. Received 37 days before the Saline-soluble extract of 12.5 mgm. of the dried G. equi.

Horn A.

12.50 p.m.	Set up.	
1.15	Relaxed	
1.16	Added 5.0 mgm. G. haemorrhoidalis	—Almost maximal rise, relaxing by 1.25 p.m.
	Changed Ringer	
1.37	Added 5.0 mgm. G. haemorrhoidalis	—Slower, stepping rise to almost maximal, relaxed by 1.43 p.m.
	Changed Ringer	

1.52	Added 5.0 mgm. G. haemorrhoidalis	—No rise.
	Changed Ringer.	
2.10	Added 25.0 mgm. G. nasalis	—No rise.
	Changed Ringer.	
2.16	Added 25.0 mgm. G. equi	—Rapid rise to maximal, relaxed slowly by 2.31 p.m.
	Changed Ringer.	
2.41	Added 25.0 mgm. G. equi	—No rise.
2.43	Added 0.05 mgm. Histamine	—Maximal rise.

Horn B.

3.37	Added 25.0 mgm. G. nasalis	—No rise.
	Changed Ringer.	
3.45	Added 5.0 mgm. G. haemorrhoidalis	—Almost maximal rise, relaxing by 3.53.
	Changed Ringer.	
4.2	Added 5.0 mgm. G. haemorrhoidalis	—No rise.
	Changed Ringer.	
4.10	Added 5.0 mgm. G. haemorrhoidalis	—No rise.
	Changed Ringer.	
4.47	Added 25.0 mgm. G. equi	—Maximal rise, relaxing by 4.55 p.m.
	Changed Ringer.	
4.59	Added 25.0 mgm. G. equi	—No rise.
5.3	Added 0.05 mgm. Histamine	—Maximal rise.

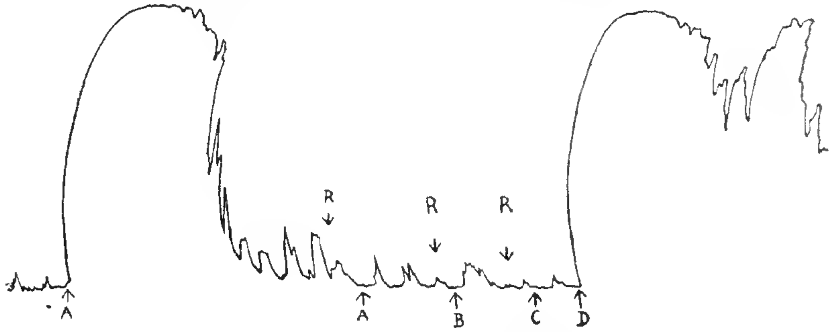

Fig. 2.—Guinea Pig O/205. Weight 280 grams.

Horn A. Received, 37 days before, the normal-saline-soluble proteins in 12.5 mgm. of dried *Gastrophilus equi* larvae.

At "A," 5.0 mgm. of G. haemorrhoidalis added. R signifies the washing out of the bath with Ringer Solution; At "B," 25.0 mgm. of G. nasalis added; At "C," 25.0 mgm. of G. equi added; At "D," 0.05 mgm. of Histamine added.

G. Sensitizing Powers of Fasciola hepatica.

Extract.—Flukes were obtained from livers of sheep, and were well washed with saline. They were then cut up in a petrie dish and placed in the incubator overnight, and next morning they had become a dark thin liquid as though the worms had been dissolved. As autolytic effects were feared the rest of the drying was done over calcium chloride, and concentrated sulphuric acid in vacuo. It dried to a greyish brown substance which readily powdered. A 1% saline extract was used.

Determination of M.N.-S.C.—This was fixed at 1.6666 (7.5 mgm. in the 50.0 c.c. bath). The dose used to test for sensitiveness was fixed at 5.0 mgm. in the 50.0 c.c. bath=a concentration of 1 : 10,000.

Test.—G.P. O/108. Received 13 days before 5.0 mgm. of dried F. hepatica subcutaneously. Wt. 260 grams.

Horn B. Set up.

Relaxed.	
Added 1.0 c.c. Sheep Serum	—No effect.
Added 5.0 mgm. F. hepatica	—Rise to half maximal.
Relaxed.	
Changed Ringer.	
Added 5.0 mgm. F. hepatica	—No rise.
Added 0.01 mgm. Histamine	—Maximal rise.

G.P. O/109. Received 32 days before 10.0 mgm. F. hepatica powder. Wt. 290 grams.

Added 1.0 Sheep Serum	—No rise.
Added 1.0 mgm. F. hepatica	—After a pause of half a minute, got rise to ½ maximal.
Relaxed.	
Added 2.0 mgm. F. hepatica	—No response.
Added 0.01 mgm. Histamine	—Rise to maximal.

Hence in the above experiments we see that *F. hepatica* has sensitizing powers, and that a reaction was obtained at a concentration of 1: 50,000 of the dry powder (extracted).

Conclusions.

1. Protein-containing extracts of parasites can sensitize the uterus of guinea pigs when injected subcutaneously.
2. Such sensitization is strictly specific, though a peculiar simultaneous non-specific sensitiveness may exist towards extracts of other related forms.
3. Desensitization of the uterus towards the non-specific extract still leaves the muscle sensitive to the extract used for sensitizing the guinea pig.
4. Desensitization towards the specific extract abolishes sensitiveness towards the non-specific extract.
5. The above phenomenon is analogous with that of agglutinin or precipitin action.
6. The sensitized uterus reaction suggests itself as a means whereby mutilated parasites might be identified, or whereby the supposed identity of any two parasitic forms might be tested.

I wish here to express my thanks to Prof. H. A. Woodruff, Director of the Veterinary Research Institute, University, who suggested this work; to Dr. C. H. Kellaway, Director of the

Walter and Eliza Hall Institute, Melbourne Hospital, who kindly demonstrated to me the technique of the uterus reaction, and who has constantly offered many helpful suggestions and criticisms; and to Dr. Young and Professor Osborne, of the Physiology School, University, for much advice and help and for the use of apparatus.

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[Proc. Roy. Soc. Victoria, 38 (N.S.), 1926.]

Art. IV.—*Victorian Graptolites (New Series), Part II.*

By WM. J. HARRIS, B.A.

(With Plates I. and II.)

[Read 16th April, 1925.]

Some years ago, when working on the Palaeozoic rocks of the Gisborne district, Mr. W. Crawford and the writer discovered, among other outcrops of fossiliferous rocks, one north of Gisborne, from which we recorded (1):—

Didymograptus caduceus, Salter.
Didymograptus sp.
Tetragraptus quadribrachiatus, J. Hall.
Diplograptus sp.
Climacograptus sp.
Glossograptus sp.
Cryptograptus tricornis, Carruthers sp.
cf. *Cardiograptus* sp.
Trigonograptus ensiformis, J. Hall sp.
Loganograptus cf. *logani*, J. Hall sp.
Phyllograptus sp.
cf. *Thamnograptus* sp.

The comment was made that the finding of *Cryptograptus tricornis* and the common occurrence of *Diplograptus* at the Gisborne outcrop would place it very high in the Lower Ordovician, and that it might be the highest bed yet recognised. A somewhat similar association was found at Woodend, where a small outcrop of decayed shale yielded the first seven forms mentioned above, with the doubtful exception of *D. caduceus*. Many new forms from these beds were put aside for further examination as they presented unfamiliar features. In 1924 Mr. A. T. Woodward, of Bendigo, discovered at Bendigo East fossiliferous shales with a Darriwil fauna, and he has been kind enough to permit the writer to study the graptolites he has collected, and also to examine the area in company with him. The general association of graptolites at one outcrop at Bendigo East seems to be the same as that of the Gisborne locality already referred to. Among forms collected were:—

Didymograptus caduceus, Salter.
Tetragraptus quadribrachiatus, J. Hall.
Diplograptus coelatus, Lapworth sp.
Glossograptus spp.
Climacograptus sp.
Cryptograptus tricornis, Carruthers sp.
Cardiograptus crawfordi, sp. nov. (identical with cf. *Cardiograptus*, supra).

Lasiograptus sp.
Trigonograptus ensiformis, J. Hall sp.
Atopograptus woodwardi, gen. et sp. nov.

This association has thrown further light on the Gisborne material. The specimen of *Didymograptus caduceus* from Bendigo East is a paracmic form with comparatively narrow and parallel stipes, but presents no other special features.

The species common to the Gisborne and East Bendigo outcrops which are dealt with in this paper are:—

Didymograptus nodosus, sp. nov.
Cardiograptus crawfordi, sp. nov.
Cryptograptus tricornis, Carruthers sp.
Atopograptus woodwardi, fam., gen., et sp. nov. (representative of a new family of Graptoloidea—Atopograptidae).

Didymograptus nodosus, sp. nov.

(Plate I., Figs. 1-4.)

Description.—Rhabdosome small. Sicula not large, but conspicuous, nearly 1 mm. long, narrow in proportion to its length. Stipes arising sub-orally, and diverging at an angle of 135-145°, widening gradually, in typical specimens less than 10 mm. long. Thecae 11-12 in 10 mm., of peculiar shape, being apparently slightly curved rectangular tubes, each arising from the preceding theca at a point a little more than half way along its dorsal margin, then running parallel with that theca and continued beyond its aperture. Each theca appears, therefore, to bud directly from its predecessor in such a way that a common canal as distinct from the thecal cavity is indistinguishable. Thecae inclined at a low angle to the axis of the stipe—25° or less. Apertural margin straight and making an acute angle with the axis, its ventral angle acutely pointed.

Remarks.—This graptolite differs from a typical *Didymograptus*, but is provisionally retained in the genus. At first glance it appears as if each theca arises from the trumpet-shaped aperture of its predecessor, but closer examination shows that the two denticles which make the apparent trumpet are the aperture of one theca and the heel of its successor. The description is based on specimens from Gisborne found by Mr. W. Crawford and the writer while working on that area. At Bendigo East localities specimens with more loosely spaced thecae and a more robust aspect are common. This discovery was made too late to enable them to be figured.

Localities.—Not uncommon in the Upper Darriwil shales of Jackson's Creek, north of Gisborne. Very common in the Bendigo-Heathcote railway cutting, S.E. of the Wellsford Rifle Range, and along the main Bendigo-Heathcote road, Bendigo East.

CARDIOGRAPTUS CRAWFORDI, sp. nov.

(Plate I., Figs. 5-7.)

1921. cf. *Cardiograptus*, Proc. Roy. Soc. Vic., n.s., xxxiii., p. 55.

Description.—Rhabdosome, small, heart-shaped, the usual length being about 7 mm., with a breadth of 5 mm. Many specimens are smaller, but these proportions seem to be fairly constant. Sicula large, 2 mm. or more in length, but embedded in the rhabdosome in such a way that its exact measurement is doubtful. The first theca appears to arise sub-orally, and it and the succeeding thecae grow parallel to, and beyond, the aperture of the sicula. Later thecae gradually turn upwards until the most distal are inclined at an angle of 330° to the axis. Thecae, trumpet shaped tubes of the same type as in *D. caduceus,* in contact their whole length. Apertures concave, with a well developed denticle.

Remarks.—This form can be confused with at least three others—*Phyllograptus, Petalograptus,* and *Cardiograptus morsus.* From the first it is distinguished by the absence of the medial stipes and by the difference in shape between the two ends of the rhabdosome. From *Petalograptus* it is distinguished by the difference in position of the sicula and the direction of growth of the thecae. (The ovate end of a *Petalograptus* faces the opposite direction to the aperture of the sicula, in *Cardiograptus* it faces the same way). From *Cardiograptus morsus* it is distinguished by the smaller size, and by less pronounced emargination at the distal end. (This emargination, at first set down as a generic character of *Cardiograptus,* now seems to be specific only). From the young form of *C. morsus* it is barely distinguishable, but as it occurs at outcrops from which the typical *C. morsus* is absent, it appears worthy of specific rank. Its determination adds another name to the list of apparent derivatives from *D. caduceus.*

Localities.—Jackson's Creek, near the Pound, or old Agricultural Show Grounds, Gisborne; Sec. 95, Woodend; Bendigo East.

CRYPTOGRAPTUS TRICORNIS, Carruthers sp.

(Plate I., Figs. 8-10; Pl. II., Fig. 11.)

1858. *Diplograptus tricornis*, Carruthers, Roy. Phys. Soc. Trans. Edin., i., p. 468. (For further references, see Ruedemann, Grap. N.Y., pt. 2, pp. 443-444.)

Description.—Rhabdosome in most cases parallel-sided, less commonly tapering distally, typically 10 mm. long, varying in width according to the mode of preservation; aspect *a* with thecae showing, 2 mm. wide over all; aspect *b* turned 90° from *a*, 1 mm. wide. Sicula 1 mm. long, furnished with virgella and straight or slightly curved lateral spines, which are conspicuous in forms of aspect *b*. Thecae 12-16 in 10 mm., about 1 mm. long, overlapping by about half, at first apparently growing in the same direction as the aperture of the sicula, but soon turning so that the aperture is directed towards the distal extremity as is usual among the Diplograpti. Both ventral and apertural margins are concave, and in most specimens it is impossible to distinguish them without assuming some definite plan of growth. Hence J. Hall figured forms in which he seems to make the apertures open towards the sicular end. In aspect *b* the thecae do not project beyond the parallel sides of the rhabdosome, but their positions are indicated by cross markings. Forms showing every angle of preservation between *a* and *b* may be found, and sometimes the mode of preservation varies in different portions of the same rhabdosome. The virgula is usually distinct, and often produced beyond the rhabdosome, this prolongation being sometimes dilated. In some specimens from Bendigo East the rhabdosome narrows somewhat towards the distal end.

Remarks.—" This most remarkable graptolite," as Dr. Ruedemann (2) calls it, is common both in Great Britain and in North America. J. Hall's sketches might be paralleled by drawings of Victorian specimens, as far as general appearance is concerned. As has been stated, the dimensions and form of the rhabdosome vary according to the direction of compression. The specimens collected by the writer differ from the American and British form in being usually shorter, slightly wider, and with more closely arranged thecae. The sicula is also shorter. As the general features of the rhabdosome closely resemble those of foreign examples, and, moreover, as Dr. T. S. Hall's specimens seem to have been narrower, even the cumulative effect of these differences does not appear to warrant the creation of a separate species. In fact, J. Hall's original drawings might well be supposed to represent Victorian specimens.

Ruedemann (2) states that " it is evident that this small, peculiar graptolite possessed not only a considerable range, and may have extended from the Chazy formation to the base of the Utica, but was well established in Trenton times in both the Atlantic and Pacific oceanic basins and their border seas as the Appalachian and Bohemian-Mediterranean basins." Both in America and Europe it ranges from our Lower to Upper Ordovician, and the same seems to be the case in Victoria. The Chazy formation may, perhaps, best be compared with the Victorian Upper Castlemaine and Darriwil series. At Woodend, Gisborne, Upper Macedon, and Bendigo East, *Cryptograptus* is found with Lower Ordovician forms, while elsewhere it is associated with *Dicellograptus* and other Upper Ordovician graptolites.

Localities.—North of Gisborne; Woodend; Cheniston (Upper Macedon); East Bendigo (Lower Ordovician).

Junction of Jackson's and Riddell's Creeks, (Ba 67); Toolern Creek; Djerriwarrh Creek; Glendoon Creek, and other Gisborne localities (Upper Ordovician). It has also been recorded by Dr. T. S. Hall from Upper Ordovician rocks at Tallong and Stockyard Creek, N.S.W.; and from Mt. Wellington, Mt. Easton, and the Jordan River, all in Northern Gippsland, Victoria.

Order GRAPTOLOIDEA Lapworth.

Family ATOPOGRAPTIDAE, nov.

Uniserial (and uni-biserial?) Graptoloidea, with straight (or flexed?) stipes. Thecae, tubular, with sigmoid ventral curvature and extroverted apertures.

The following summary shows the relation of this new family to other uniserial and uni-biserial graptolites:—

Dichograptidae ..	Thecae, simple sub-cylindrical tubes.
Leptograptidae ..	Thecae, elongated tubes with slight sigmoidal ventral curvature, apertures somewhat introverted, but not introtorted.
Dicranograptidae ..	Thecae, sigmoidally curved tubes, with apertures situated within depressions and often introverted and introtorted.
Atopograptidae ..	Thecae, sigmoidally curved tubes, with extroverted and sometimes extrotorted apertures.

Genus **Atopograptus**, gen. nov.

A uniserial form, with two stipes, in general outline resembling a *Didymograptus*, but with sigmoidally curved thecae with extroverted apertures. The type of the genus is *Atopograptus woodwardi*.

Atopograptus woodwardi, sp. nov.

(Plate II., Figs. 12-15).

Description.—Stipes diverging at an angle of 180°; in the only specimen known, each stipe is about 20 mm. in length and of uniform width throughout—about ·4 mm. over the centre of a theca, and ·7 mm. over the extroverted apertural region. Thecae 7 in 10 mm., of the type of *Monograptus nodifer*, Törnquist, inclined at a very low angle, in contact practically their whole length exclusive of the coiled apertural portion. This apertural region forms a conspicuous lobe which occupies one-half of the total width of the rhabdosome. The ventral margin of each theca shows a slight but distinct ogee curvature. Sicula not observed, but its position clearly indicated by the reversal of the thecae at a central point of the rhabdosome, and by the fact that the thecae immediately on each side of the point of reversal differ in length—2 mm. and ·7 mm.

Remarks.—This extraordinary graptolite was found by the writer while examining with Mr. Woodward the material thrown out from a small shaft at Bendigo East. Had its state of preservation been less perfect its interpretation would have been a matter of great difficulty. However, it is preserved as a mould in light-coloured shale, and the impression is so sharp that plasticene casts can be made without difficulty. There is, therefore, no doubt that it is a bilaterally symmetrical form, although its thecae are of a type hitherto only found among the Monograptidae. It is interesting as carrying back the lobate type of thecae to the Didymograptus stage; in other words it could popularly be described as a *Didymograptus* with lobate monograptid thecae.

Locality.—One well-preserved specimen from Bendigo East. On general evidence the beds are placed as high in the Darriwil series, Lower Ordovician.

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EXPLANATION OF PLATES.

I.

Fig. 1.—*Didymograptus nodosus*, sp. nov. Holotype. Lower Ordovician (Upper Darriwil). Jackson's Creek, north of Gisborne. [13355].*

Fig. 2.—*D. nodosus*, sp. nov. Paratype. Lower Ordovician (Upper Darriwil). Jackson's Creek, north of Gisborne. [13353].

Fig. 3.—*D. nodosus*, sp. nov. Paratype. Fragment showing nature of thecae. Lower Ordovician (Upper Darriwil). Jackson's Creek, north of Gisborne. [13354].

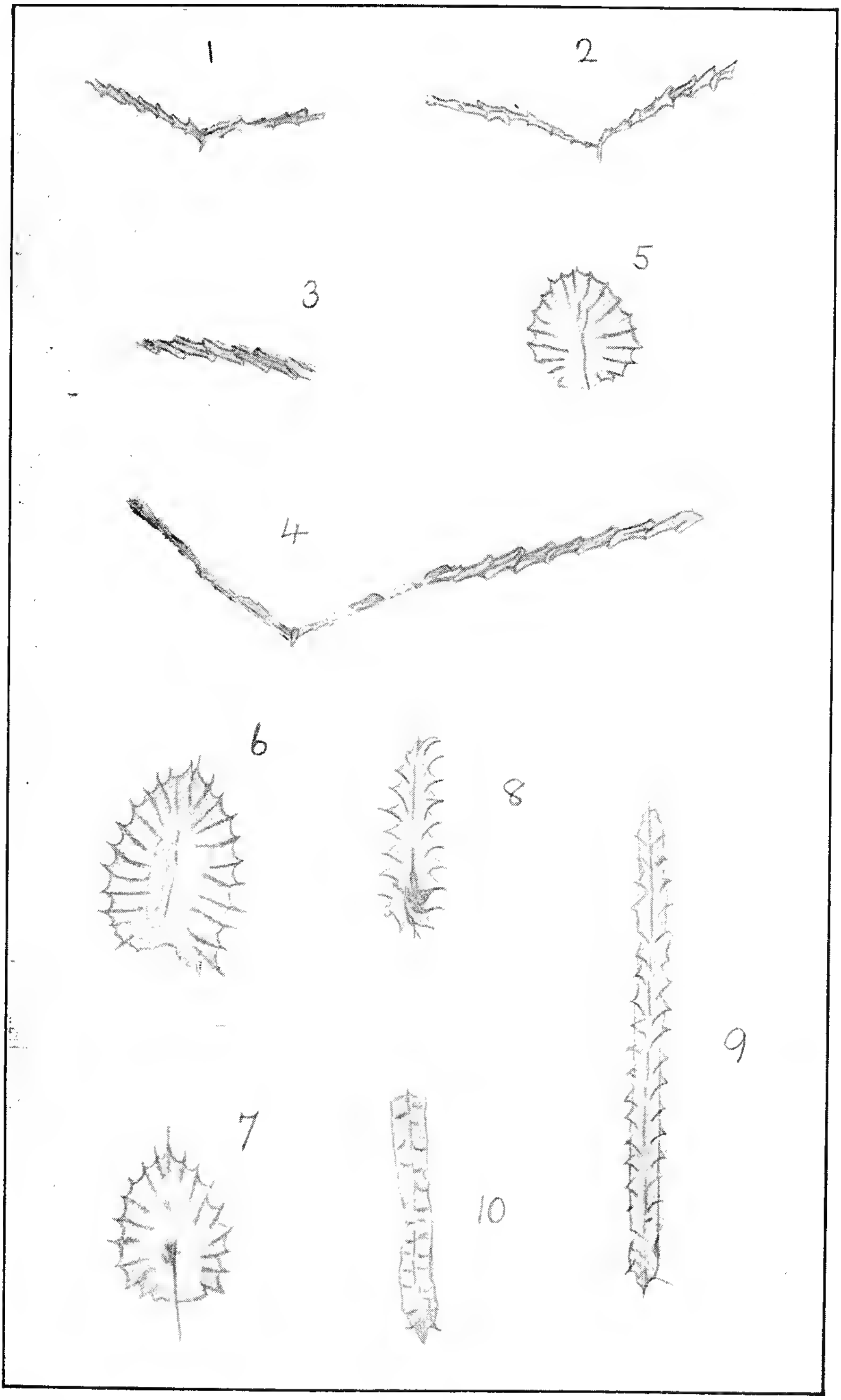
Fig. 4.—*D. nodosus*, sp. nov. Lower Ordovician (Darriwil). Bendigo East (No. 8 shaft, A. T. Woodward). [13356].

Fig. 5.—*Cardiograptus crawfordi*, sp. nov. Holotype. Lower Ordovician (Darriwil). Jackson's Creek, near the Pound, Gisborne. [13357].

Fig. 6.—*C. crawfordi*, sp. nov. Paratype. Lower Ordovician (Darriwil). Bendigo East. [13359].

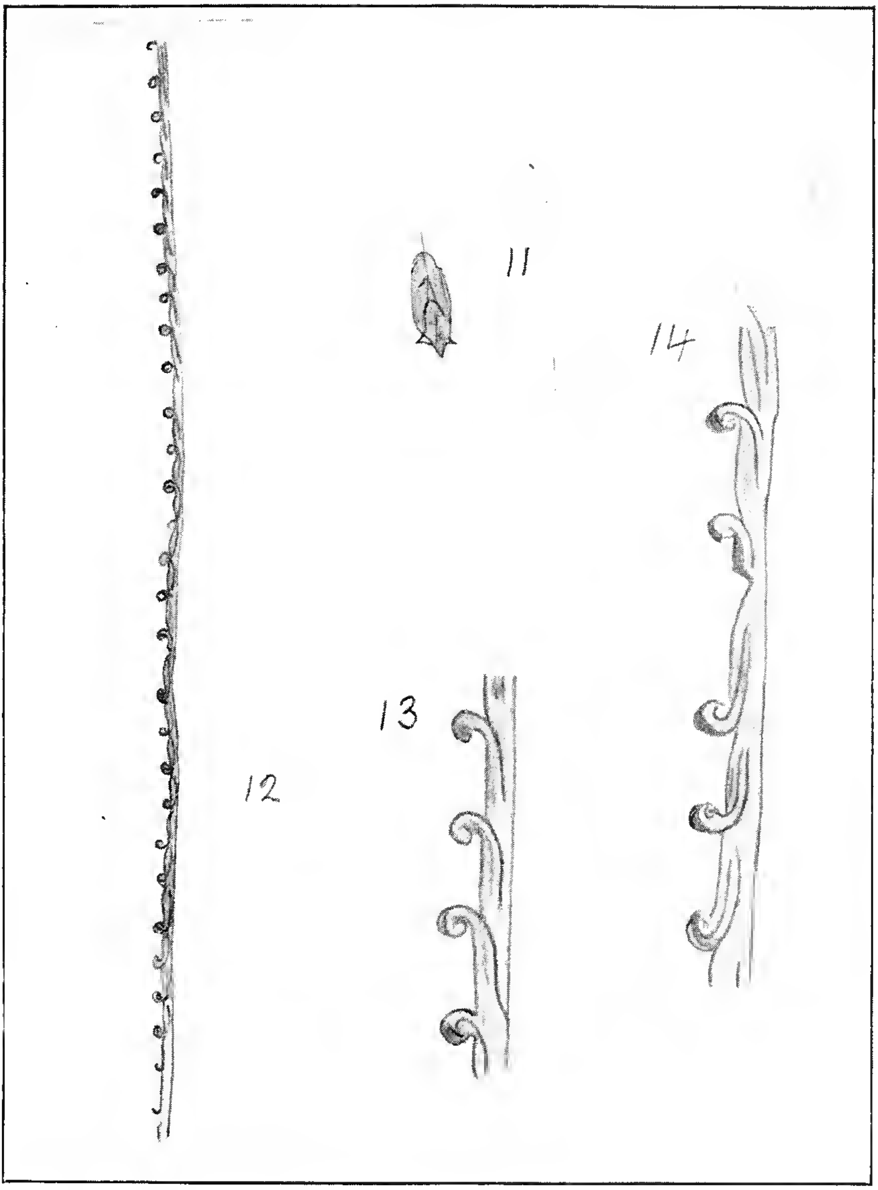
Fig. 7.—*C. crawfordi*, sp. nov. Paratype, showing virgella. Lower Ordovician (Darriwil). Bendigo East. [13360].

*The numbers in brackets refer to registered specimens in the National Museum.



W.J.H. del.

Victorian Graptolites.



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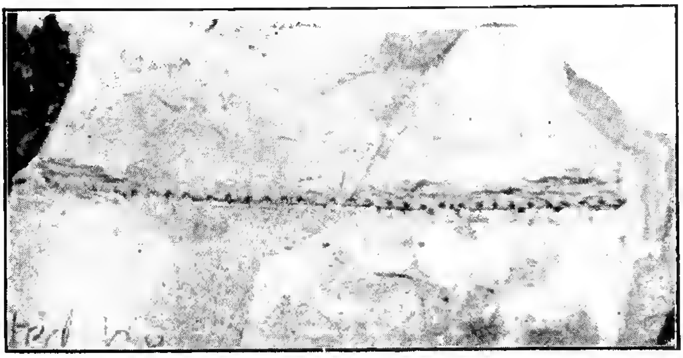

F. Chapman, photo. FIG. 15.

Atopograptus woodwardi, sp. nov. Holotype.

Fig. 8.—*Cryptograptus tricornis,* Carruthers sp. Plesiotype. Lower Ordovician (Darriwil). Bendigo East. [13361].

Fig. 9.—*C. tricornis,* Carr. sp. Plesiotype, showing thecae visible in aspect *a,* and parallel sides as in aspect *b.* Upper Ordovician. Junction of Jackson's and Riddell's Creeks, G.S.V. Ba 67. [13363].

Fig. 10.—*C. tricornis,* Carr. sp. Plesiotype. Aspect *b.* Thecal apertures shown by bars. Upper Ordovician. Junction of Jackson's and Riddell's Creeks. G.S.V. Ba 67. [13364].

II.

Fig. 11.—*C. tricornis,* Carr. sp. Plesiotype. Juvenile form; aspect *a,* on same slab as Fig. 8. Upper Ordovician. Junction of Jackson's and Riddell's Creeks, G.S.V. Ba 67. [13362].

Fig. 12.—*Atopograptus woodwardi,* gen. et sp. nov. Holotype. Lower Ordovician (Darriwil). Bendigo East. [13352].

Fig. 13.—*A. woodwardi,* sp. nov. Same specimen as above. Distal thecae more highly magnified.

Fig. 14.—*A. woodwardi.* Ditto. Sicular portion more highly magnified.

Fig. 15.—*A. woodwardi.* Photograph of type specimen. ×2.

All drawings magnified three and a half times, excepting Figs. 13 and 14, which are enlarged ten and a half times.

[Proc. Roy. Soc. Victoria, 38 (N.S.), 1926.]

Art. V.—*Metallic Replicas of Diffraction Gratings.*

By Z. A. MERFIELD.

[Read 16th April, 1925.]

Owing to the scarcity of high quality Diffraction Gratings and inherent difficulties in their manufacture on a commercial basis, experimentalists have been encouraged to devise methods whereby replicas of existing Diffraction Gratings may be made. Probably the most widely known process is that invented by Thorpe, whereby a cast of the Grating is made in celluloid and subsequently transferred to a glass support of the requisite optical perfection. To obtain this cast, a solution of some nitrated cellulose material in amyl acetate is poured over the surface of the ruling, and after the solvent has evaporated sufficiently, the cast is separated from the original by immersion in water. With judicious care the celluloid film may be manipulated in the water and transferred to the glass support, after which it is set aside to dry. This method, or at least some modification of it, has been extensively practised by Ives, Wallace, and others (1). It is interesting to note that Ives invariably mounted the ruled side of the film towards the glass support, while Thorpe generally mounted it the other way round. Wallace, so far as the author is aware, made no distinction in his preference for either one side or the other.

It will be found, however, if the replica is mounted with the ruled side up the definition of the spectrum is not nearly so good as when it is mounted with the ruled side towards the optical surface. The reason for this is fairly obvious; in the former case any inequality in the thickness of the celluloid film introduces corresponding irregularities into the ruled surface, whereas in the latter case the truth of the ruled surface of the replica is preserved by the optical flat on which it is mounted.

The celluloid replica acts best as a transmission grating, but if the ruled side be mounted face out it may be converted into a reflection grating replica by cathodically depositing platinum or some other metal on it, so as to make the surface reflecting, as described by Gehrcke and Leithauser (2), but it should be borne in mind that in order to obtain the same definition with a grating of this type, the optical surface must be at least twice as accurate.

It is possible to make metallic grating replicas by this method which behave reasonably well in the first order, but in higher orders the definition, and of course the resolving power, fall far short of the original ruling. To overcome this difficulty, Dr. Anderson (3) proposed an ingenious method.

A celluloid replica is first made, and then transferred, ruled side in, on to a carefully prepared optical surface which has been covered with a thin uniform film of resinous material. When dry the whole is gently warmed so as to enable the resin to flow and take a cast of the celluloid replica. On cooling it will be found that the celluloid replica can be stripped off, leaving behind an impression in the resinous film which may be subsequently covered with a reflecting metallic surface by cathode disintegration in a vacuum. A defect of this method seems to be that the shape of the grooves is not well preserved in the final cast, and consequently the intensity and concentration of the diffracted light in a given direction are incompatible with the original ruling.

Other attempts worthy of some note here, because they are essentially different from those already mentioned, are those of Lord Rayleigh and Professor Quincke. Rayleigh actually succeeded in producing replicas by means of photographic contact printing; while Professor Quincke chemically deposited silver on a glass original, and then gradually increased the thickness of this film by electro-deposition of copper until it was strong enough to be peeled off.

Lord Rayleigh (4) found that Professor Quincke's replicas deteriorated after a time, owing apparently to insufficient thickness of the silver film, or perhaps from want of adhesion between the silver and the copper. This defect Rayleigh endeavoured to remedy by increasing the thickness of the silver film, not with copper, but with silver itself. In this he was partially successful, but he mentions that the surface of these replicas suffered from want of flatness, and he came to the conclusion that the use of such gratings must be limited to cases where brilliancy of the spectra is required, and resolving power is not essential. In the papers referred to, Rayleigh describes at considerable length his photographic method, and draws attention to certain inherent defects in the process. Quite apart from these defects, Rayleigh's photographic process is very limited, for it is obviously not possible to reproduce the carefully shaped grooves of the original ruling, which are so essential.

In various publications quite a number of references will be found to the manufacture of Diffraction Grating Replicas, but the processes described seem to differ only in modus operandi from those already alluded to here.

The main purpose of this paper is to describe a novel method whereby a reflection grating replica is obtained direct from the original grating. The replica obtained by the method seems to differ but little from the original ruling in resolving power, and at the same time gives remarkably brilliant spectra. When the replica and the original (silvered) are arranged on the spectroscope so as to enable a fair comparison of the spectra they produce being made, it will be seen that as regards definition it is difficult to discriminate between the two, but the intensity of the light from the replica seems to rival that from the original ruling. The reason for this seems to be mainly on account of the difference in reflecting power of the front and back surface of the metallic film.

The method of producing such a replica is as follows:—The original ruling of glass is silvered by the Brashear process, and is then carefully washed and dried. If nickel, gold, platinum, or any other metal is desired, the original is plated by cathode disintegration in a vacuum. The thickness of the deposit should be about 0.0001 mm. A solution of celluloid in amyl acetate is then poured over the metallic film and set aside to dry slowly. The celluloid film is then covered with a film of vacuum sealing wax, or balsam, and then a cut is made by means of a sharp knife all round the ruled area, and the unrequired margin is removed. It will be found that the celluloid easily comes away, bringing with it the metallic deposit. The next step is to mount the replica, and this is accomplished in the following manner:—An appropriate optical flat is prepared (a piece of good quality plate glass will suffice), and this is laid in contact with the back of the replica and very light pressure applied. The whole is then gently and uniformly heated in an oven until the wax or balsam adheres to the glass support. When cold it will be found that the replica generally separates from the original without difficulty. If the separation is troublesome, it is probably because the adhesive has oozed out and cemented the edge of the replica to the original. If this be the case the support should be separated after gentle warming, the original cleaned with amyl acetate and a fresh start made.

An alternative method which has been found satisfactory is to support the replica on a block of wax. This is accomplished by raising a small metal frame around the replica, and subsequently casting the wax support on to it. For this purpose the most suitable wax yet found is Picene Vacuum Sealing Wax, and also that used in the manufacture of some kinds of cylinder phonograph records. Care, of course, must be taken to cool the whole very slowly, otherwise the perfection of the optical surface of the replica departs considerably from that of the original ruling.

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2. *Verhandlungen der Deutschen Physicalischen Gesellschaft,* 1906.

3. *Astrophysical Journal,* 31, 1910, p. 171.

4. *Phil. Mag.* 11. 1881, p. 196; xlvii., 1874, p. 81.

[Proc. Roy. Soc. Victoria, 38 (N.S.), 1926.]

Art. VI.—*On the Occurrence of the Devonian Genus Arthrostigma in Victoria.*

By ISABEL C. COOKSON, B.Sc.

(With Plate III.)

[Read 14th May, 1926.]

Introduction.

The genus *Arthrostigma* was founded by Dawson (1871), for stems of vascular character occurring in the Lower Devonian rocks at Gaspé, in Canada. Since that time the form *Arthrostigma gracile* Dawson has been recorded by Kidston (1893) from the Lower Old Red Sandstone of Scotland, and has been found in abundance in the Lower Devonian rocks at Röragen, Norway, being described in detail by Halle (1916).

It is the object of the present paper to record the occurrence of two Victorian forms[1] considered as being within the limits of the species as it occurs in the Devonian rocks of the Northern Hemisphere. The specimens described below were found in a series of beds which have been assigned by Chapman (1914) to his Tanjilian division of the Victorian Silurian rocks, an horizon of younger age than the Wenlockian beds of Great Britain; subsequent work by this author (1924) inclines him to the view that this division may eventually be proved to be of Devonian age. At present a diversity of opinion exists as to the exact age of the beds in question, but it is hoped that, by further stratigraphical and palaeontological work now in progress, their age will be definitely determined.

Arthrostigma gracile (Dawson).

Newell Arber (1921) has stated the characters of the genus *Arthrostigma* Dawson 1871 (loc. cit.) in the following words: "Axis very stout, bifurcating and giving off lateral members, irregularly furrowed or ribbed longitudinally, bearing numerous large and long scattered, straight, sometimes falcate, spine-like organs. Axes possessing a slender central strand of vascular tissue. Fructification unknown."

Halle (loc. cit.) has further examined Dawson's species *A. gracile,* and after a detailed examination of abundant material considers that although there are wide variations in the known

1.—In a paper by Adele Vincent, B.Sc., "On the Silurian and Devonian Floras and the Importance of their Discovery in Victoria," *Rec. Geol. Surv. Vic.*, iv. (4), 1926, p. 501, that the author has tentatively referred one of the specimens here dealt with to the genus *Arthrostigma.*

specimens, the presence of transitional forms brings them all within the limits of one species. He has in consequence described three subdivisions, which may be summarised as follow:—

A. "In which the specimens resemble Dawson's type specimens." With stems up to 1 cm. broad, leaves with a broad base, which gradually passes over into the stem on the one hand and a narrow subulate upper portion on the other, the leaves being about equal in length and breadth.

B. "Specimens with unusually densely and regularly placed leaves." Stems 15 mm. broad, leaves falcate 6-8 mm. long, forming an angle of about 10° to the axis of the stem, and being placed at a distance of about 3 mm. above each other.

C. "Specimens with thick, short, distant leaves." Stems about 2 cms. broad, leaves 7-8 mm. long, and the same breadth, slightly falcate with an acute but short apex, and about 1·7 cms. apart.

Description of Specimens.

Specimen I.

Arthrostigma gracile Dawson, Walhalla, Victoria.

No. 22059, Geological Survey of Victoria. Axis stout, 1·5 cms. broad, bearing a few slightly falcate, spine-like leaves, which arise from the main axis at an angle of 30° and at distances of 1-2 cms. The central strand of the axis is not well defined, and the stem, which is only 6 cms. long, shows no sign of branching. The surface was apparently longitudinally ridged, but the excessive pressure on the rock during preservation seems to have practically obliterated this feature except in a few places.

The small spine-like leaves are 4 mm. long, and at their base have a maximum width of 2 mm., the base gradually passing over into a very short, narrow lamina. No leaf scars occur on the surface of the stem, and a central vein is not evident in the leaves.

The distant arrangement of the small leaves on the stem suggests affinities with the members of Halle's third subdivision of the species (loc. cit., pl. i., figs. 9 and 10). The stem, however, is narrower, and the apparently entire leaves, which are considerably smaller in both length and breadth than those of Halle's specimen, seem to be even more reduced than in the Norwegian forms of this subdivision. The present specimen, though fragmentary, shows definite affinities with *A. gracile,* and until more material is available for further study, it is deemed advisable to regard it as belonging to this species.

Specimen II.

Arthrostigma gracile Dawson, Bore 1, Rhyll, Victoria. Depth 327′/350′.

No. 22373, Geological Survey of Victoria.

The specimen was obtained from a bore core in which the bore core was running obliquely to the bedding plane, so that the obliquely fractured surface only shows part of the stem on the edge of the core, one half of the stem being entirely wanting.

The portion of the flattened stem remaining has a breadth of 8 mm., and bears a large number of closely arranged narrow, curvilinear leaves. Small rounded elevations are apparent on the surface of the stem, which may be regarded as the thickened basal portions of the leaves. Only a very faint indication of a thin central vascular axis is seen in the upper portion of the specimen.

The small, somewhat flexuous, leaves have a maximum length of 7 mm., and a breadth of 1 mm., but the variations in their length, together with their blunt distal terminations suggest the possibility that they may not have been preserved in their entirety. The bases of the leaves are slightly thickened, and pass gradually back into the stem. The leaves are crowded on the stem, arising at intervals of about 2-3 mm., as measured at the edge of the impression and at an angle of about 35°.

The affinities of the Rhyll specimen lie with the form described by Halle in his second subdivision of the species (loc. cit., pl. i., fig. 8). The size of both stem and leaves approximates to that description, and in the arrangement of the leaves and their crowded nature they coincide almost exactly.

Conditions of Fossilisation.

It is of interest to make a comparison of the lithological conditions of the beds in which *Arthrostigma* occurs in other countries, with those of the present paper. Dawson's specimens were found " in the sandstones of both sides of the Gaspé basin. The stems were found both flattened and cylindrical, the latter penetrating nearly at right angles."

In Scotland this form occurs in greenish grey flags and thin bedded sandstones of the Lower Old Red Sandstone series, the stems being much compressed.

In Norway *Arthrostigma* occurs in the grey sandstones and slates in the lower and middle part of the series, which consists of 2700 feet of vertical thickness of conglomerates and sandstones, slates and breccias. Halle's specimens were found usually as impressions, but sometimes the original tissue was preserved in a carbonized state, in which material Halle was able to discover by treatment with Schultze's mixture the presence of tracheides of the scalariform type.

Of the Victorian examples, that obtained from the Walhalla district occurs as an impression, with sometimes a vestige of the carbonised tissue, on a fine, closely-bedded light grey shale. The latter has unfortunately, for the preservation of large areas, been subjected to pressure which has caused jointing, so that the rock tends to break into fairly small blocks; but a bedding plane is still predominant, which enables the plant fossil to be naturally preserved.

In the second specimen from Rhyll, the rock in which the fossil occurs is still shale, but strongly indurated and of the texture of a slate. The fossil is well preserved as a carbonized film, the conditions being practically that of anthracite.

In conclusion, I wish to thank the Director, Sir W. Baldwin Spencer, and the Curator of the National Museum, Melbourne (Mr. J. A. Kershaw, F.E.S.), for facilities provided for this work. To Mr. F. Chapman, A.L.S., Palaeontologist to the National Museum, I am greatly indebted for his help, so freely given, during its progress.

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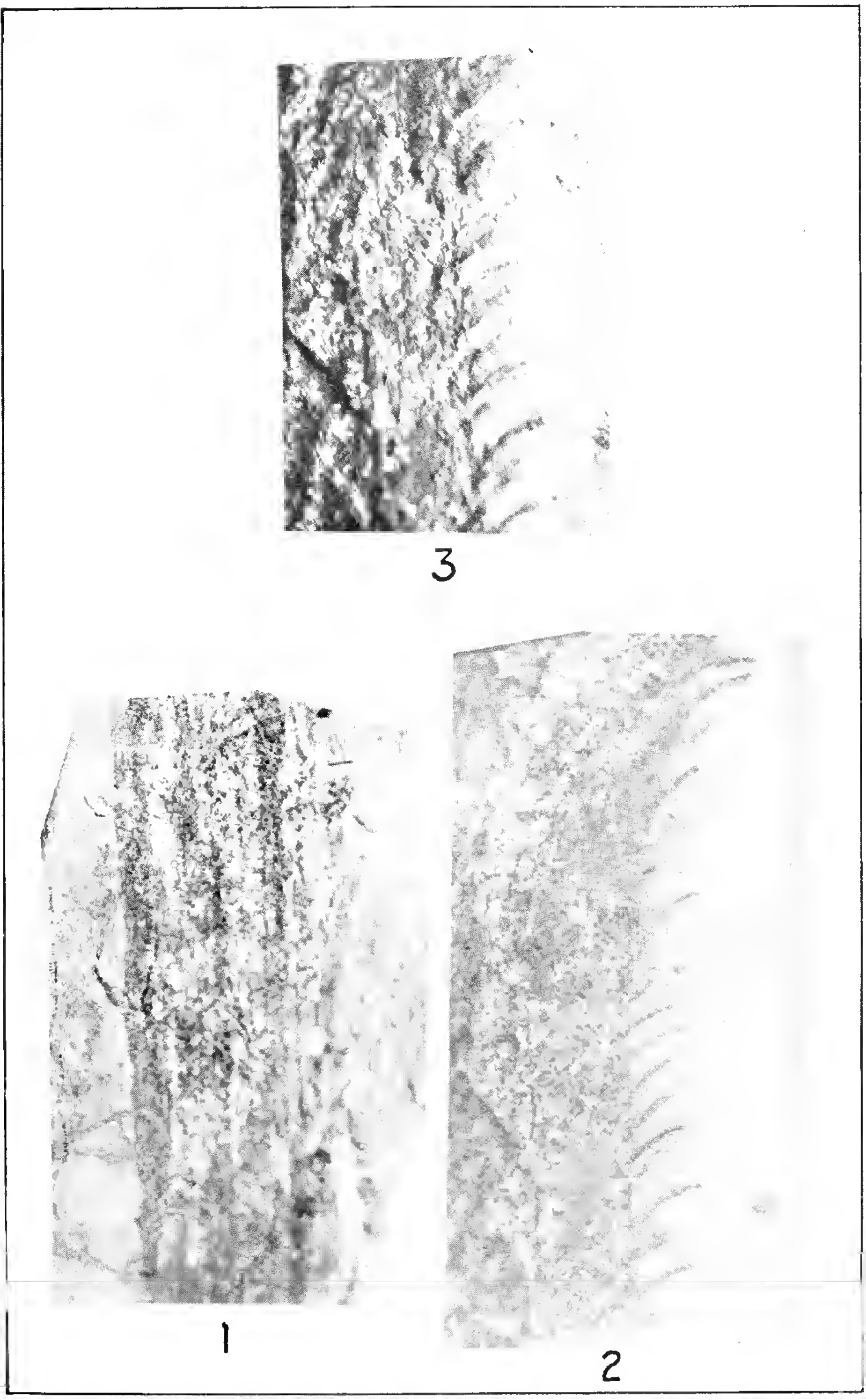
EXPLANATION OF PLATE.

Fig. 1.—*Arthrostigma gracile* Dawson. Walhalla, specimen showing a few scattered emergences. ×2.

Fig. 2.—*A. gracile*, more typical specimen from Rhyll, showing numerous leaf-like outgrowths. ×2.

Fig. 3.—Portion of stem of specimen in Fig. 2, showing surface markings of leaves. ×2.



F.C. photo. Arthrostigma. Eastern Victoria. × 2.

[Proc. Roy. Soc. Victoria, 38 (N.S.), 1926.]

Art. VII.—*Additions to Australian Ascomycetes, No. 2*[1].

By ETHEL McLENNAN, D.Sc., and ISABEL COOKSON, B.Sc.

(With Plates IV.-VI.)

[Read 14th May, 1925.]

The genus *Lamprospora* De-Not., Critt. Ital., 1, 1864.
Syn. *Crouania* Fuckel, Symb. Myc., 320, 1869. Not Crouania Agardh, 1842.
Plicaria Fuckel, Symb. Myc., 325, 1869.
Barlaea Sacc., Syll. Fung., 8, 111, 1889. Not Barlaea Reich, 1877.
Detonia Sacc., Syll. Fung., 8, 105, 1889.
Plicariella (Sacc.) Lindau, in E. and P. Nat. Pfl. 1, 179, 1897.
Barlaeina Sacc., Syll. Fung., 14, 30, 1899.
Pulvinula Boud., Hist. Class. Discom., 69, 1907.

This is a genus of the Pezizineae containing a number of minute forms which are found growing among moss, or occasionally on damp clay. In 1923 specimens of two species were sent to Dr. F. J. Seaver, of the New York Botanical Gardens, who in reply said, "The occurrence of these species in such a remote place is certainly of very great interest, and I trust that you will follow this work and publish a list of the species of this genus for your continent, with full illustration of the spore characters."

The species so far collected are extremely small in size, and although several occur in Victoria they are not readily distinguishable in the field, as they are for the great part practically identical in their macroscopic characters, only microscopic examination revealing the species. They are usually (exceptions noted below) orange red in colour, sessile, sub-globose, with a lacerated margin bordering the hymenium, which is most characteristically papillose due to the ripe protruding asci (cf. Ascobolaceae). The spores are globose, occasionally smooth, but in the great majority of cases they are sculptured, the variations in the type of sculpturing (tuberculated, reticulated, echinulated) being made the basis of the specific characters.

Seaver (1), who has studied the genus in America, includes in it "the smaller plants of the globose-spored type of operculate Discomycetes, except those which are commonly placed with the Ascobolaceae." The forms collected and studied by us agree for the most part with those found in America, and so establish a wide distribution for this genus, which has been already recorded from Europe, North Africa and America.

1.—No. 1 in *Proc. Roy. Soc. Vic.*, n.s., xxxv. (2), p. 153, 1923.

(*a*) *Reticulated spore forms.*

1. Lamprospora crouani Cooke.

(Plate IV., Fig. 1.)

Plants sub-globose expanding and becoming plane or with the hymenium slightly concave, surrounded by a frill-like margin, orange red, 1-3 mm. diam. Spores globose, 13-15 μ diameter, having when mature a reticulated surface. The reticulations are shallow, and from 3-6 sided, with meshes of an approximately uniform size, 3-4 μ in diameter (3 is the commoner measurement). On damp soil, among moss.

Localities.—Beaumaris, near Melbourne, and Chewton, near Castlemaine, Victoria, August, 1923.

This, the type species of the genus, was recorded by Cooke (2) for Victoria under the name of *Humaria* (*Crouania*) *miniata* Fuckel, with spore measurements, given as 15-18 μ. The American plants, according to Seaver (loc. cit.) have spores 15-22 μ in diam., usually about 20-22 μ at maturity.

2. Lamprospora areolata Seaver, var. australis McL. and C.

(Plate IV., Fig. 2*a*,*b*.)

Plants with typical *Lamprospora* characters. Spores 18-20 μ, including the distinct wing which surrounds the spore; without the wing the spore measures 14 μ diam. The surface of the spore is deeply reticulated, the meshes of the reticulations are wider, and seem rather more irregular than those in *L. Crouani*. The diameter of the areolae varies from 5-6 μ, 5 μ being the commonest measurement, i.e., almost double that for *L. Crouani*. A shallow secondary reticulation is present on the spore-surface, which can be clearly seen by focussing (Plate IV., Fig. 2*b*). The meshes of this secondary reticulation are about 2 μ in diameter. On damp soil among moss.

Localities.—Recorded in Part I. of this series (3) for Victoria. Collected in August, 1924, in Mount Lofty Ranges, South Australia.

3. Lamprospora funigera, sp. nov.

(Plate IV., Fig. 3*a*,*b*.)

Plantis 1-3 mm. diam. Hymenio aurantiaco, margine in morem fimbriae circumdato. Ascis cylindricis 15-16 μ diam. Sporis globosis 12-13 μ diam. cum fasciis multis et distinctis et ramosis quae inventae inaequales areas superficiei spori includunt.

Plants scattered, globose when young, expanding at maturity until the hymenium becomes plane or slightly concave, with a well-developed fringe-like margin. From 1-3 mm. in diameter, orange red, hymenium roughened by the ripe protruding asci, finally becoming pitted as a result of their collapse; asci cylindric. 15-16 μ wide. Spores globose, hyaline, at first smooth, but later characterised by several distinct bands extending across the surface of the spore in various directions, resembling a cord wound about its surface. Entire spore 12-13 μ diam. Paraphyses slender, slightly enlarged at their apices.

On the ground among moss.

Localities.—Ringwood, near Melbourne, and Chewton (E. McLennan), May, 1924.

This species seems to us to be distinct from many of those recorded by Seaver (loc. cit.). It appears to have affinities with *L. lobata* Berk. and Curt., and with *L. ascoboloides* Seaver. It differs from the former in its much smaller size, and in the absence of tubercles on the surface of the spore; and from the latter in the fact that the ridges on the surface constantly meet and overlap, and thus enclose definite areas of the spore surface.

(b) *Tuberculated spore forms.*

4. Lamprospora tuberculata Seaver.

(Plate V., Fig. 1.)

Plants with typical *Lamprospora* characters; spores when mature coarsely tuberculate, the tubercules are somewhat unequal in size and so often project further in one place than another, giving to the spore an irregular outline. The tubercles on an average are 4 μ wide at their base, and about 12 are placed around the periphery of the spore. Entire spore, 16-18 μ diameter.

On the ground among moss.

Localities.—Ringwood, Beaumaris and Chewton.

Since the record of this species by the writers (loc. cit.), we have had an opportunity of examining specimens of Seaver's type material, and it was found to be identical with the Australian plants. In addition, material of *Barlaea verrucosa* Rod. has been made accessible to us through the courtesy of Mr. Rodway and the spore characters also agree with those of Seaver's plants.[2]

5. Lamprospora tuberculatella Seaver.

(Plate V., Fig. 2.)

Plants with typical *Lamprospora* characters. The spores bear approximately 25 small tubercles around their periphery, each tubercle being approximately 1 μ broad at its base.

Entire spore, 17-18 μ in diameter.

2.—Rodway in his Tasmanian Discomycetes (4) retains the genus *Barlaea*. If we accept Seaver's definition of the genus it should now be included in the genus *Lamprospora*. *Barlaea verrucosa* Rod. then becomes *Lamprospora tuberculata* Seaver; *Barlaea miniata* Sacc. becomes *Lamprospora Crouani* Cooke, and *Barlaea echinulata* Rod. does not seem to differ in any essential way from *Lamprospora spinulosa* Seaver.

On ground among moss.

Locality.—Chewton, May, 1924.

This form has not previously been recorded from Australia, our specimens seem to agree in every respect with the description and figures of the American plants.

6. Lamprospora Maireana Seaver.

(Plate V., Fig. 3.)

Plants with typical *Lamprospora* characters. Spores with tubercles, about 16 on an average, around the spore circumference. Each tubercle is approximately 2·5 μ wide at its base, and bears secondary roughenings, giving to each a minutely tuberculated surface. Entire spore 17-18 μ in diam. On the ground among moss.

Localities.—Ringwood and Castlemaine, September, 1923, 1924.

As regards the size and number of the tubercles, this species is intermediate between *L. tuberculata* and *L. tuberculatella,* but the secondary roughenings make it readily recognizable as a distinct species; not previously recorded from Australia.

(*c*) *Echinulated spore forms.*

7. Lamprospora Crec'hquerault Crouan.

(Plate V., Fig. 4.)

Plants gregarious, 2-5 mm. diam., hymenium becoming convex in mature plants, with an indistinct margin, ochraceous orange. Spores echinulate, the spines are irregular in both length, 3-4 μ, and breadth, but taper to a very sharp point at the apex. Entire spore 24-26 μ, including the spines, spore itself is from 19-20 μ diam. On wet, clayey soil.

Localities.—Ringwood and Chewton, August, 1924.

This is the only species we have met with that differs in its external characters from the other members of the genus. It is therefore possible to identify it with some degree of certainty in the field.

8. Pseudoplectania nigrella (Pers.) Fuckel,

Symb. Myc., 1869.

(Plate IV., Figs. 4, 6; Pl. VI., Fig. 2.)

Plants gregarious, substipitate, at first deeply cup-like, later becoming expanded cup-shaped, or nearly plane, 0·5-1·5 cms. diam., brownish-black, externally completely covered with brown or black twisted, sparingly septated hairs (Pl. IV., Fig. 4), more numerous at the basal end, where they form a definite mycelial pad, the hyphae of which radiate out into the soil. Hymenium brownish black, smooth and shining. Asci cylindric, about 300 μ long and 13-14 μ broad; spores globose, hyaline, uniseriate, 11 μ in diameter. Paraphyses filiform, occasionally branched, of a brown colour for a great part of their length, about 3 μ thick. On the ground.

Localities.—Ringwood, Vic., and Mt. Compass, South Australia, August, 1924.

9. Plectania melastoma Fuckel, Symb. Myc., 1869.

(Plate IV., Fig. 5*a,b;* Pl. VI., Fig. 3.)

Plants gregarious, substipitate, urceolate; externally brownish-black, slightly roughened, 1-2 cms. broad and 0·75-1·5 cms. high, margin unevenly incised, of a brick-red colour. Stalk short sulcate, clothed with dark rooting hairs. Asci cylindric, about 350 μ long, spores elliptic, smooth, hyaline, 19-20 x 8-10 μ Paraphyses branched, filiform, brown at their apices. On dead branches.

Locality.—Ringwood, August, 1924.

Previously recorded by Cooke (2) from Queensland, under the name *Sarcoscypha* (*Plectania*) *melastoma*.

The two preceding species show marked external resemblances to one another, especially in the young stages. They may be distinguished, however, by their spore-shape, and the fact that in *Pseudoplectania nigrella* (5) the external surface of the peridium (Plate IV., Fig. 4), is completely clothed with dark strigose hairs, which in *Plectania melastoma* occur only in the region of the stalk (Plate IV., Fig. 5*a*).

10. Sphaerosoma trispora, sp. nov.

(Plate V., Figs. 7, 8; Pl. VI., Fig. 1*a,b.*)

Plantis corpulentis colore atro-fusco 1-3·5 cms. diam. sessilibus cum fundamento lato afficu. Hymenio per peridium limitato. Ascis cylindricis, cum iodino haud caeruleis, 350 μ x 50 μ. Sporis 3 raro globosis bis areolatis, fuscis-atris 37-48 μ diam. Maculis primi reticuli 6·5-9 μ ala alta 6-8 μ in margine spori formata. Maculis secundi reticuli latis 3-4·5 μ.

Plants gregarious or scattered, fleshy, brownish-black, 1-3·5 cms. in diameter, sessile, with a broad basal attachment. Their shape is very varied, often at first being cushion-like, with a convex much convoluted upper surface, and later expanding to form an irregular, slightly concave fruit-body (Plate VI., Fig. 1*a*). Some of the smaller specimens, however, instead of showing a well-defined pulvinate character, are plano-concave, with a slightly raised margin from an early period (Plate VI., Fig. 1*b*).

The ascocarp is pale internally, only the outermost portion of the hymenium appearing dark-brown in colour; the hymenium itself is bounded by a distinct peridium.

The asci are broad, cylindric, operculate, not turning blue with iodine, 350 μ x 50 μ. Spores 3, rarely 4, globose, areolate, hyaline when young, and situated towards the middle of the ascus, dark brown, uniseriate at the distal end of the ascus at maturity, 37-48 μ diam.

There is a well-developed reticulum on the surface of the spore, the individual meshes of which enclose regular, hexagonal areas 6·5-9 μ diam., and form a distinct wing 6-8 μ deep around the periphery of the spore. A well-defined secondary reticulum of a shallow nature is disclosed when the actual spore surface is focussed, the meshes of which are also regularly hexagonal, but with a diameter of only 3-4·5 μ. The areolae, in a perfectly mature spore, become masked by the intense brown colour which is developed.

Paraphyses unbranched, septate, clavate, about 12 μ diam., containing brownish granules which, together with the shrivelled asci, afford the brown colouration which obtains in the outer hymenial zone.

On open, damp, clayey soil.

Localities.—Ringwood and Chewton (E. McLennan), May, 1924.

The genus *Sphaerosoma* so far includes three species with echinulate spores, and one, *S. alveolatum* (an Australian form (3)), with reticulate spores. The present species shows affinities with the latter in the type of marking on the spore-wall, and the external form of the plant, but differs, however, in its larger size, the constantly 3-spored ascus, the larger spores, and the presence of a double reticulum.

Cordyceps brittlebankii, sp. nov.

(Plate V., Figs. 5, 6; Pl. VI., Figs. 4, 5.)

Stromate simplici a capite larvarum Heteronycis orto. Stipite gracili, longo 3-5 cms. et lato 1-2 mm., aut simplici aut ramoso, ramis ultimis cum capitulis. Capitulum regione fertili et ovata longa 0·5-1 cm., et lata 2-4 mm. rubra-fusca, et rostro terminato et sterili, longo 4-8 mm. et lato 1-2 mm., constat. Peritheciis cum paraphysibus in capite penitus immersis. Ascis capitatis longis 180-210 μ et latis 7·5-9 μ, duobus finibus contractis et sporis octo, fusoid et hyalinis tres-decem dividuis, longis 48-86 μ et latis 4-5·5 μ divisionibus longis 6-25 μ.

Stroma single, entomogenous, arising from the head of the larvae of *Heteronyx*, a Cockchafer Beetle. Stem slender, 3-5 cms. long, and 1-2 mm. broad, either simple or branched; when the latter, the arrangement is mainly dichotomous, and the ultimate branches, which in the specimens examined do not exceed 6 (Plate VI., Fig. 4), may be terminated by a fertile capitulum. The greater part of this stem lies beneath the surface of the soil, only a small terminal portion, about 0·5 cms. long, supporting the capitulum, being aerial.

Each capitulum consists of an oval fertile region, 0·5-1 cm. long and 2-4 mm. broad, which is of a dark-red-brown colour, faintly punctate by the slightly raised darker brown ostiola of the perithecia; and a terminal practically sterile beak, rather lighter in colour than the fertile area 4-8 mm. long and 1-2 mm. broad.

The perithecia are flask shaped, deeply immersed in the tissue of the capitulum, about 450 μ long, and open by a slightly raised dark brown pore on the surface. Each ascus is capitate, 180-210 μ long, and 7·5-9 μ wide in its broadest region, narrowing towards both ends, terminating at its base in a tapering pedicel, and contains 8 spores which are arranged in such a way that its very characteristic shape results. The spores lie parallel to one another, each individual spore not extending throughout the length of the ascus, usually one spore only reaches each end, the remaining ones being arranged in a spiral fashion in the wider portion of the ascus (Plate V., Fig. 5).

The spores are hyaline, fusoid, 3-10 septate, the majority being 3 septate 48-86 μ long, and 4-4·5 μ broad, the divisions being often unequal and varying from 6-25 μ in length, according to the degree of septation of the spore (Plate V., Fig. 6). From the shape of the spores themselves, it appears very unlikely that these subdivisions give rise to secondary spores. Paraphyses are present in the perithecia, they are long, colourless and filamentous. On larvae of *Heteronyx*.

Locality.—Ringwood (I. Cookson), April, 1924.

The type of ascus, and ascospores of this form are not those usually found in the species of *Cordyceps*. Petch (6) has recently described a new species from Ceylon, *C. Blattae*, in which the ascus is clavate, non-capitate, with fusoid, multiseptate spores, in a parallel bundle spirally twisted. In noting this unusual feature, he further suggests the probability that *C. unilateralis* may also have similar spores, and notes that *C. rhizoidea* has 8 spores, which are about half as long as the ascus and arranged in an irregular bundle, the spores in this case being continuous.

C. Brittlebankii, in two such important features as the nature of the asci and spores, shows affinities with the above-mentioned forms, but differs from *C. Blattae* in the possession of a capitate ascus and from all three in the generally 3 septate spores.

This species has been named after Mr. C. C. Brittlebank, the well-known Australian Mycologist, to whom we are grateful for his interest and help in our work. To Mr. A. O'Brien, of the Agricultural School, Melbourne University, we are indebted for the photographs of the various forms.

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EXPLANATION OF PLATES.

Detailed drawings have been made with the aid of the camera lucida.

Plate IV.

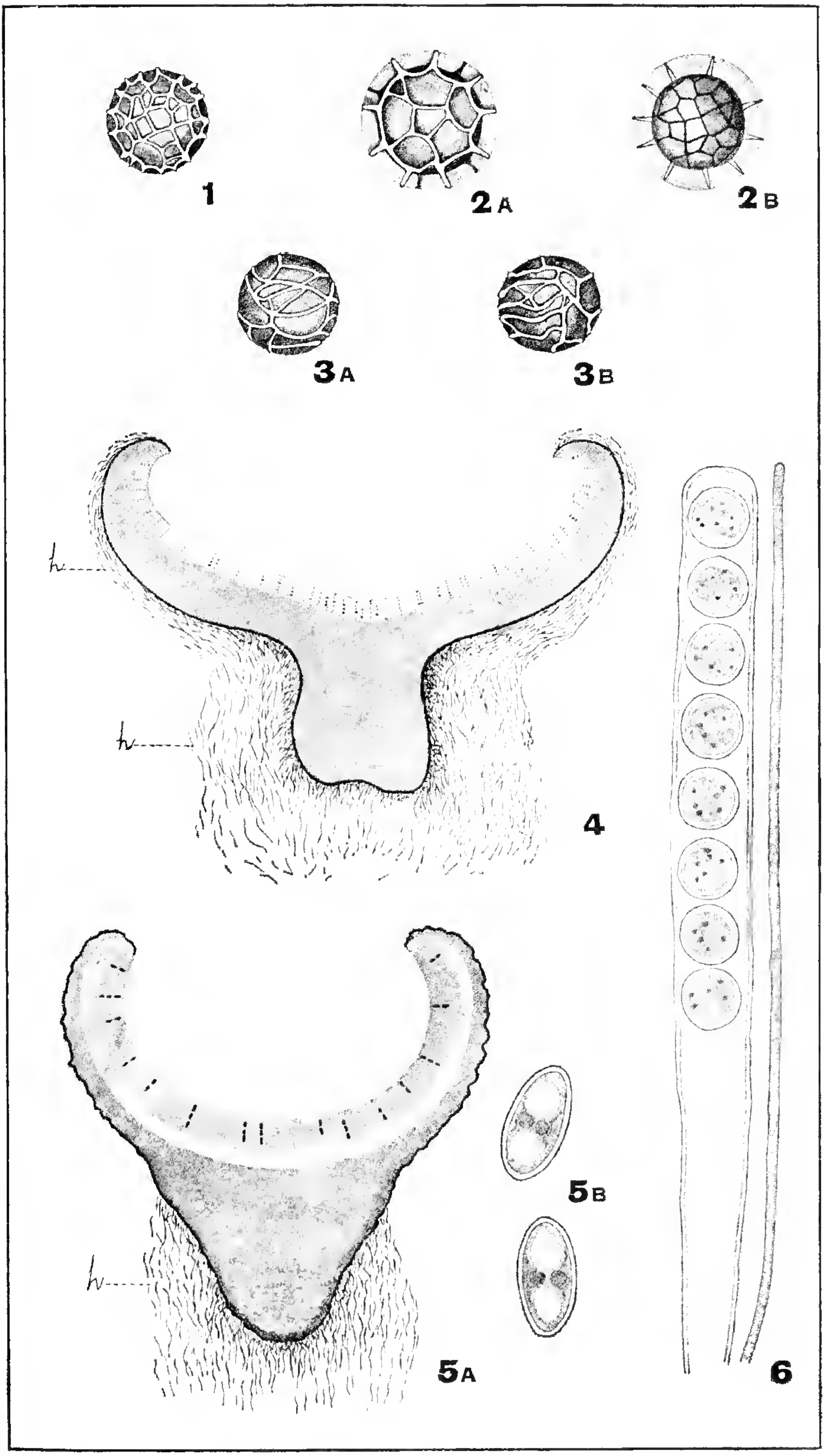
Fig. 1.—Spore of *Lamprospora Crouani*. ×625.
Fig. 2*a,b*.—Spores of *L. areolata* var. *australis*. (*b*) shows the shallow secondary reticulations. ×625.
Fig. 3*a,b*.—Spores of *L. funigera*, sp. nov. ×625.
Fig. 4.—Vertical section through an entire fruit-body of *Pseudoplectania nigrella*, h. hairy external surface. ×8.
Fig. 5*a,b*.—*Plectania melastoma*. (*a*) vertical section through an entire fruit-body, h, hairs which are confined to the stalk-region. ×5. (*b*) spores. ×625.
Fig. 6.—Portion of an ascus and paraphysis of *Pseudoplectania nigrella*. ×625.

Plate V.

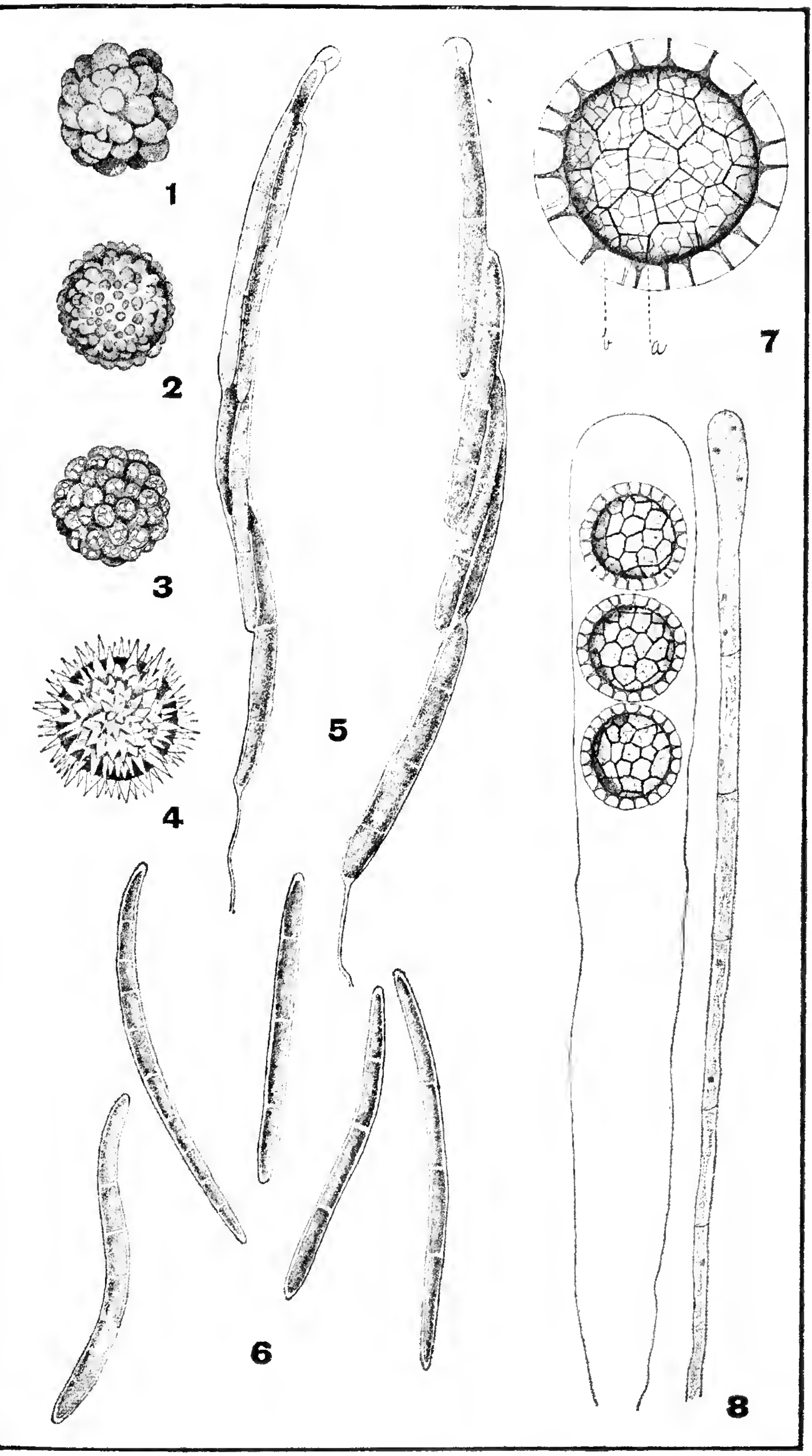
Fig. 1.—Spore of *Lamprospora tuberculata*. ×625.
Fig. 2.—Spore of *L. tuberculatella*. ×625.
Fig. 3.—Spore of *L. Maireana*. ×625.
Fig. 4.—Spore of *L. Crec'hqueraultii*. ×625.
Fig. 5.—Two entire asci of *Cordyceps Brittlebankii*, sp. nov. ×625.
Fig. 6.—Spores of *C. Brittlebankii*, showing varying degrees of septation. ×625.
Fig. 7.—Single spore of *Sphaerosoma trispora*, sp. nov. a, primary reticulum, b, secondary reticulum. ×625.
Fig. 8.—Portion of an ascus and paraphysis of *S. trispora*. ×625.

Plate VI.

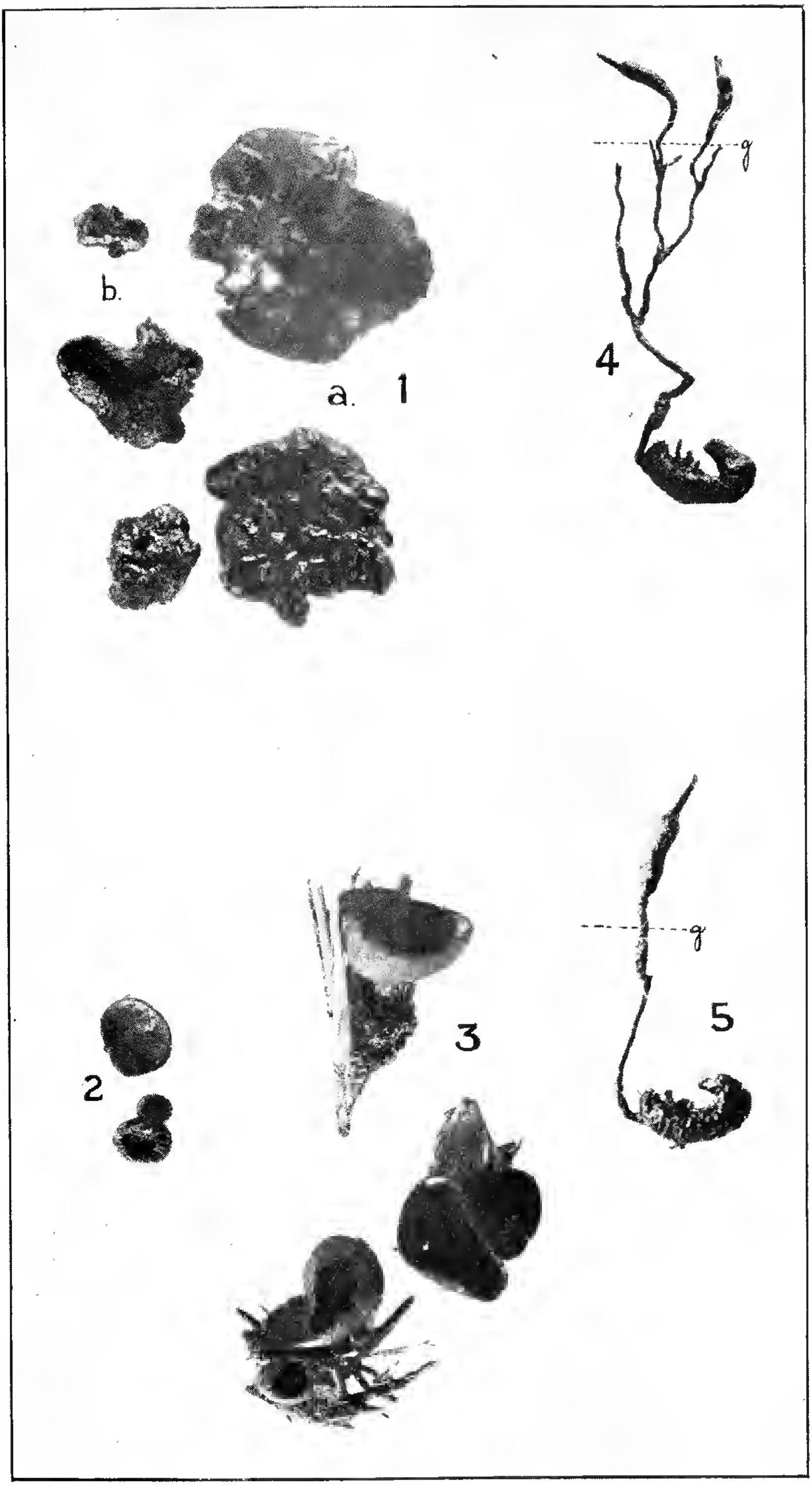
Fig. 1*a,b*.—Plants of *Sphaerosoma trispora*, sp. nov. Nat. size.
Fig. 2.—Plants of *Pseudoplectania nigrella*, small specimens. Nat. size.
Fig. 3.—Plants of *Plectania melastoma*. Nat. size.
Fig. 4.—Branched stroma of *Cordyceps Brittlebankii*, sp. nov. g, ground level. Nat. size.
Fig. 5.—Simple stroma of *C. Brittlebankii*. g, ground level. Nat. size.



Australian Ascomycetes.



Australian Ascomycetes.



A. O'Brien photo.

Australian Ascomycetes.

[Proc. Roy. Soc. Victoria, 38 (N.S.), 1926.]

Art. VIII.—*Contributions to the Flora of Australia, No. 30. Records of and additions to the Flora of Central Australia.**

By ALFRED J. EWART, D.Sc., Ph.D, F.L.S., F.R.S., LESLEY R. KERR, M.Sc., and E. M. DERRICK, M.Sc.

[Read 14th May, 1925.]

During a recent visit to Central Australia to investigate serious cases of cattle poisoning by poison plants on the N. Australian stock route between Wycliffe and Taylor, the senior author took advantage of the opportunity to collect largely in the district traversed. The present paper represents the first working up of some of the material collected, and consists mainly of new records or of additions to the flora of the Northern Territory. The new species will appear in a later paper, with lists of the remainder of the plants collected. With this material, aided by a full working out of the material of the Tate Herbarium in Adelaide, and of Mr. Allan's Herbarium from Darwin, which he has kindly placed at the senior author's disposal, it is hoped ultimately to bring out a second and more complete Flora of the Northern Territory.

CYCADACEAE.

Macrozamia Macdonnelli F.v.M.

Heavitree Gap, Simpson's Gap, and Arltunga, July, 1924, Palm Valley, Krichauff Ranges in great abundance, and also sporadically on the southern or eastern sides of gaps and valleys throughout the Macdonnell Ranges.

CONIFERAE.

Callitris robusta R.Br.

Rocks 13 miles N. of Connor's Well, July, 1924, 12-30 ft.

GRAMINEAE.

Anthistiria imberbis Retz.

Oodnadatta to Alice Springs.

Eriachne melicacea F.v.M.

Wycliffe Well, N.T., June, 1924.

E. obtusa R.Br.

Wycliffe Well, N.T., June, 1924.

Pappophorum nigricans R.Br.

Wycliffe Well, N.T., June, 1924.

*No. 29 in Proc. Roy. Soc. Victoria, n.s., xxxiii., p. 226, 1921.

Eragrostis Dielsii (Pilger) (*E. falcata* Benth. non Gaud.).
Bed of Taylor River, N.T., June, 1924. This was recorded near Hugh R., Macdonnell Range, G. F. Hill, No. 139, 4/5/1911. Stunted specimens under *E. falcata* Gaud., following Bentham.

E. diandra (Steud.).
Stirling Station, July, 1924. Eaten freely by stock.

E. tenella Beauv.
Thring Swamp, Wycliffe, N.T., June, 1924.

CYPERACEAE.

Lipocarpha microcephala Kunth.
Thring Swamp, Wycliffe, N.T., June, 1924.

Cyperus squarrosus L.
Thring Swamp, Wycliffe, N.T., June, 1924.

C. rotundus L.
Thring Swamp, Wycliffe, N.T., June, 1924. Known to the natives as " Yelca."

CASUARINEAE.

Casuarina Decaisneana F.v.M. The Desert Sheoke.
This forms to the south of the Hugh River a belt of open timber 10 to 30 miles in width N. and S. and some 200 miles E. and W. The trees average 30 feet in height, and 1 to 2 feet in diameter. This remarkable forest is near the transition from the 6″ to the 12″ rain belt.

Ficus glabella Bl. (*F. nesophila* F.v.M.).
Barrow Creek Range, 10-12 ft., July, 1924.

F. platypoda A. Cunn.
Simpson's Gap, Macdonnell Range, July, 1924.

PROTEACEAE.

Grevillea agrifolia A. Cunn.
Taylor Range, Central Mt. Stuart, July, 1924.

G. juncifolia Hook.
3-8 m. N. of Taylor Creek, July, 1924.

G. refracta, R.Br.
Taylor Range, July, 1924.

G. stenobotrya F.v.M.
E. Taylor Range, July, 1924.

Hakea intermedia Ewart and Davies.
Alice Springs, 8-12 ft. Woodford wells and bank of river, 9 m. S. of Woodford River, June, 1924.

H. lorea R.Br.
Bank of Woodford River, June, 1924.

var. suberea, Sp. Le Moore.
Alice Springs, 1924. With prominent rough ridges of corky bark. Known to the natives as " Wungeah."

LORANTHACEAE.

Loranthus bifurcatus Benth.
12 m. N. of Ryan's well on Eucalyptus.
L. Exocarpi Behr.
Near Hermannsburg, on *Acacia Farnesiana,* July, 1924.
var. spathulata.
Wycliffe well, N.T., banks of Taylor River, on Acacia, June, 1924.
L. gibberulus Tate.
Burt's Well and Alice Springs, on Grevillea and Hakea.
L. pendulus Sieb. (*L. Miquelii* (Lehm.).
Between Barrow and Taylor Creeks, on Eucalyptus and Acacia, June, 1924.
L. Quandang Lindl.
Between Barrow and Taylor Creeks. Common on mulga, June, 1924. Alice Springs, on Acacia.

SANTALACEAE.

Santalum lanceolatum R.Br.
12 m. N. of Ryan's well, Central Mt. Stuart, July, 1924.

CHENOPODIACEAE.

Rhagodia crassifolia R.Br.
3 m. N. of Mt. Taylor, N.T., June, 1924.
2 m. from Hermannsburg, July, 1924, straggling.
R. nutans R.Br.
2 m. N. of Taylor, N.T., 5-7 ft., June, 1924, straggling.
R. spinescens R.Br.
Near foot of Central Mt. Stuart, 6-8 ft., July, 1924, straggling.
Chenopodium rhadinostachyum F.v.M.
Bed of Taylor River, June, 1924.
C. simularis, F.v.M. and Tate.
Bed of Taylor River, June, 1924.

AMARANTACEAE.

Ptilotus obovatus F.vM.
Alice Springs, July, 1924.
var. grandiflorum.
Burt Plain, June, 1924.
Alternanthera nana, R.Br.
Near Central Mt. Stuart, July, 1924.

PHYTOLACCACEAE.

Gyrostemon cotinifolius Desf.
Horseshoe bend to Wycliffe, June, 1924. Known as Widgeri to the blacks, who eat the sappy roots.

G. ramulosus Desf.

Horseshoe bend to Wycliffe, July, 1924.

Didymotheca cupressiformis Walt.

Wycliffe and Taylor Well, July, 1924. A.J.E.

The Wycliffe specimen tallies with the type of the species in the Melbourne Herbarium. If, as well as the type, may have 1 or 2 carpels to the female flower, as in *D. Tepperi* F.v.M. Diels in Engler's Pflanzenreich wrongly gives *D. cupressiformis* as having 2 carpels only. *D. Tepperi* has a longer and flatter leaf, and a more irregular branching instead of the upright cupressus-like habit of *D. cupressiformis.* The latter was not previously recorded from any definite locality in the Northern Territory.

PORTULACACEAE.

Calandrinia ptychospermae F.v.M.

Wycliffe, June, 1924. Plant remained succulent, and continued to open flowers in Herbarium press for 6 weeks. One of the components of "parachelia" herbage on which stock can graze for months without water.

CARYOPHYLLACEAE.

Polycarpaea triloba Ewart and Cookson.

Near Central Mt. Stuart, July, 1924.

CRUCIFERAE.

Cochlospermum Fraseri Planchon.

Abundant on Macadam Ranges, near Victoria and Fitzmaurice Rivers, Dr. Basedow, 1922.

DROSERACEAE.

Drosera indica L.

Near Wycliffe Well and Thring Swamp, June, 1924.

LEGUMINOSAE.

Papilionaceae.

Brachysema Chambersii F.v.M.

Between Wycliffe and Taylor, and 5-8 m. N. of Taylor Creek, June, 1924.

Isotropis atropurpurea F.v.M.

5-8 m. N. of Taylor Creek. Said to be poisonous to stock, and when tested gave positive results.

Mirbelia aphylla F.v.M.

Near Barrow Creek, N.T., July, 1924. Bagot's Creek, George and Gill's Range, Central Australia, 1894, R. Tate.

M. oxyclada F.v.M.

5-8 m. N. of Taylor Well, N.T., and Taylor Range July, 1924. Near Finke River, Rev. H. Kempe, 1882.

Burtonia polyzyga Benth.

E. Taylor Range, rocky rises, July, 1924.

Gastrolobium grandiflorum F.v.M.

12 m. N. of Wycliffe, N.T., June, 1924. July, 1924.

G. grandiflorum, var. luteum L. R. Kerr, new var.

Bonny Well, N.T., 30 m. N. of Wycliffe Well, June, 1924. Not common. F. A. C. Bishop.

It is a shrub 6-8 ft. high, and has rather longer and narrower leave than the type of *G. grandiflorum*. The flowers are yellow instead of brownish red, and the stalk of the ovary is hairy, especially at the top. Bentham gives the stalk of *G. grandiflorum* as glabrous, but it may be more or less hairy in the type form. Calyx and corolla as in type.

Crotalaria linifolia Linn.

Wycliffe, flowers yellow, June, 1924.

C. dissitiflora Benth.

Between Wycliffe and Taylor, 3-4 ft., June, 1924.

var. eremaea.

Flower yellow. Standard not prominently veined.

C. Mitchelli Benth.

Taylor Creek, June, 1924.

C. Novae Hollandiae D.C.

Central Mt. Stuart and Wycliffe, July, 1924.

Lotus australis Andr.

Wycliffe, N.T., June, 1923.

var. parviflora Benth. (*L.coccineus* Schlect.)

Wycliffe, N.T., June, 1923.

Indigofera boviperda Morr.

Between Wycliffe and Taylor, June, 1924.

I. enneaphylla L.

Taylor Well, June, 1924.

I. linifolia Retz.

Taylor Flat and Taylor Well, June, 1924.

I. viscosa Lam.

Wycliffe, June, 1924.

Swainsona microphylla A. Gray.

5-8 m. N. of Taylor Well, N.T., July, 1924. Taylor Range, July, 1924.

S. oroboides F.v.M.

Taylor Flat, N.T., and Taylor Well, June, 1924. Standard blue and veined, carina yellow.

Aeschynomene indica L.

Central Mt. Stuart, Wycliffe Well, bed of Hansen River, July, 1924.

Glycine tabacina Benth.
2 m. from Teatree Well. July, 1924.
G. falcata Benth.
Alice Springs and Stuart, June, 1924.
Erythrina vespertilio Benth.
5-8 m. N. of Taylor Well, 25-30 ft., "red bean tree," July, 1924.

Caesalpineae.

Petalostylis labicheoides R.Br.
var. cassioides.
Stirling Range, N.T., June, 1924.
var. microphylla, Ewart and Morrison.
Between Wycliffe and Taylor, June, 1924.
Cassia concinna Benth.
E. Taylor Range, July, 1924.
C. desolata F.v.M.
Arltunga, August, 1924.
C. eremophila A. Cunn.
Arltunga, August, 1924, and Horseshoe bend to Wycliffe, June, 1924.
C. notabilis F.v.M.
Wycliffe to Taylor, June, 1924.

Mimosae.

Acacia Hilliana Maiden.
E. Taylor Range, N.T., July, 1924.
A. impressa F.v.M.
Taylor Range, N.T., 3 ft. and 6-10 ft. on rocky rises, July, 1924.
A. leptophleba F.v.M.
Woodford Well, N.T., July, 1924.

Fruit flat, $1\frac{1}{4}''$ long by 6-7/16″ broad. Seeds transverse, flattened and oblong, black and shiny, with a small horseshoe shaped depression on each side, near middle. The plant is apparently rare, the Herbarium possessing only the original type specimen, a small scrap with no fruits, from Stuart's Creek. The fruits were previously unknown. In the type specimen the peduncles are nearly $\frac{1}{2}''$ long, but in the Woodford specimens barely $\frac{1}{4}''$.

A. spondylophylla F.v.M.
Taylor Range and Central Mt. Stuart, July, 1924.
A. stipuligera F.v.M.
E. and W. Taylor Ranges, 6-10 ft. on rocky rises, June, 1924.

ZYGOPHYLLACEAE.

Tribulus hystrix R.Br.
Wycliffe Well, June, 1924. Fruit resembles *T. hystrix*, but flowers almost as small as *T. terrestris*.

EUPHORBIACEAE.

Phyllanthus simplex Retz.
Wycliffe, N.T., June, 1924, 1-1½ ft.
P. rhytidospermus F.v.M.
Taylor Creek, N.T., June, 1924.
Euphorbia myrtoides Boiss.
Seeds greyish and smooth, not rugose, as described in Bentham's Flora Australiensis. Wycliffe, N.T., June, 1924.
E. australis Boiss.
Taylor Range, N.T., June, 1924, 6″-1 ft.
E. eremophila A. Cunn.
Taylor Range, N.T., 2-3 ft., June, 1924, and Wycliffe, 3-4 ft.

SAPINDACEAE.

Dodonaea peduncularis Lindl., var. coriacea Ewart and Davies.
3-4 ft., between Wycliffe and Taylor, June, 1924.
D. viscosa L., var. spathulata.
Simpson's Gap, N.T., July, 1924.

MALVACEAE.

Abutilon Fraseri Hook., var. parviflora.
Taylor Well, June, 1924, 3ft.
Malvastrum spicatum A.Gr.
Stirling Station, July, 1924.
Sida cardiophylla L.
Valley, 9 m. S. of Woodford Well, June, 1924.
S. corrugata Lindl., var. trichopoda.
Taylor, N.T., June, 1924.
S. cryphiopetala F.v.M.
Alice Springs to Stuart, common on rocks, July, 1924.
S. subspicata F.v.M.
Near Barrow Creek, June, 1924.
S. corrugata Lindl., var. trichopoda.
Gossypium australe F.v.M.
Near Central Mt. Stuart, June, 1924.
G. Sturtii F.v.M.
Taylor Well and near Barrow Creek, June, 1924.

FRANKENIACEAE.

Frankenia pauciflora D.C.
Neiles Creek, Oodnadatta, S. Australia, May, 1924.

STERCULIACEAE.

Brachychiton Gregorii F.v.M.
Gulf of Carpentaria and Kimberleys, Dr. Basedow, 1922. The shell of the fruit often carved by the natives.

MYRTACEAE.

Eucalyptus dichromophloia F.v.M.
Mt. Gillen, shrub 5-8 ft., July, 1924. Lower peak of Central Mt. Stuart, July, 1924. These specimens agree with two plants placed under *E. terminalis* in Melbourne Herbarium by F. v. Mueller, such as Finke River, Kempe No. 476, Summit of Mt. Augustus, Forrest, 1883.

E. gamophylla F.v.M.
Rocks 13 m. N. of Connor's Well, N.T., straggling, 5-8 ft., July, 1924.

E. odontocarpa F.v.M.
Central Mt. Stuart, July, 1924.

E. papuana F.v.M.
Heavitree Gap, Macdonnell Range, N.T., July, 1924, on banks of Tod River. "Whitewash gum" of settlers, owing to white mealy surface rubbing off readily when touched.

E. pachyphylla F.v.M.
Near Barrow Creek and Stirling Range, July, 1924.

E. terminalis F.v.M.
Hills near Stuart, N.T., July, 1924. Tessellated box bark. Tree 30 ft., "Udoriba" of aborigines.

Melaleuca genistifolia Sm.
Finke River, Rev. H. Kempee, No. 431.

var. coriacea, new var.
Arltunga, N.T., Aug., 1924, A.J.E. Shrub 6-8 ft. Irregular corky bark, leaves smaller, less than $\frac{1}{4}''$, and more coriaceous.

M. glomerata F.v.M.
Teatree Well, Mt. Stirling Station, July, 1924.

M. lasiandra F.v.M.
No locality given.

Calytrix microphylla A. Cunn.
Between Taylor and Wycliffe, June, 1924.

UMBELLIFERAE.

Didiscus glaucifolius F.v.M.
Flats in sandhills, Horseshoe Bend, July, 1924, E. M. Osborn.

CONVOLVULACEAE.

Evolvulus alsinoides L.
Wycliffe, N.T., Flowers blue, June, 1924.

var. sericeus.
Wycliffe, N.T., Flowers blue, June, 1924.

Ipomaea Davenporti F.v.M.
Wycliffe, N.T., June, 1924.
I. Muelleri Benth.
Wycliffe, N.T. Flowers pink, June, 1924.

BORAGINACEAE.

Halgania solanacea F.v.M.
2-3 ft. Flowers bluish purple, between Taylor and Wycliffe Wells, June, 1924.
Heliotropium ovalifolium Forsk.
Flowers white. Banks of Taylor River, N.T., June, 1924.
Trichodesma zeylanicum R.Br.
Wycliffe, N.T., and 10 m. N. of Woodford Wells, June, 1924.

VERBENACEAE.

Dicrastylis Dorani F.v.M.
Horseshoe Bend to Wycliffe, June, 1924.

LABIATAE.

Prostanthera striatiflora F.v,M.
Hermannsburg, N.T., July, 1924.

SOLANACEAE.

Duboisia Hopwoodi F.v.M.
H. Huddlestone, Stirling Station, N.T., July, 1924.
Nicotiana suaveolens Lehm.
Taylor Flat, N.T., June, 1924. Eaten down freely by stock. Only few plants as yet. Common along the stock route above Old Crown and New Crown stations, and when abundant capable of poisoning travelling stock tempted by its green succulence.

SCROPHULARIACEAE.

Morgania floribunda Benth.
Stirling Station, July, 1924; also from Charlotte Waters, C. Giles, 1875; Finke River, Dittrich, Lindsay's Expedition, 1885-6.
Stemodia viscosa Roxb.
Stirling Station, July, 1924. Palm Valley, 12 m. from Hermannsburg, July, 1924.

BIGNONIACEAE.

Tecoma australis R.Br.
Simpson's Gap, July, 1924, Mrs. Dutton.

MYOPORACEAE.

Eremophila Freelingii F.v.M.

Previously recorded from N. Australia. Simpson's Gap, N.T., July, 1924. Near Dalton and Arltunga, August, 1924. Emily Gap, Macdonnell Range, July, 1924.

E. Latrobei F.v.M.

Horseshoe Bend, Finke River, and Wycliffe, June, 1924.

E. Macdonnellii, F.v.M.

Taylor Well, Teatree Well, July, 1924.

var. macrocarpa.

Taylor Flat.

E. maculata F.v.M.

Taylor, N.T., June, 1924.

Myoporum Dampieri A. Cunn.

Near Hermannsburg, N.T., June, 1924.

CAMPANULACEAE.

Wahlenbergia gracilis A.D.C.

Wycliffe Well, June, 1924; bed of Taylor River.

Goodenia gracilis R.Br., var. lamprosperma.

Wycliffe Well, N.T., June, 1924.

The vegetative characters on which *G. lamprosperma* was distinguished as a separate species by Baron von Mueller are only varietal in character. The specimen of *G. gracilis* recorded in the N.T. flora from 80 m. W. of Powell's Creek, G. F. Hill, 6/7/11, is the variety *lamprosperma*.

G. hederacea Sm.

Between Wycliffe and Taylor Range, Teatree Well, July, 1924.

G. heterochila F.v.M.

Wycliffe Well, June, 1924. Small leaved form.

G. mollissima, F.v.M.

Wycliffe, N.T., June, 1924. Scapes one or more flowered, crenulations of leaves smaller and leaves longer, otherwise like *G. mollissima*.

Goodenia Ramellii F.v.M.

Taylor River, E. and W., June, 1924. 2-3 ft., with rosette leaves.

G. Vilmorineae F.v.M.

Near Barrow Creek, Purple flowers, June, 1924. Taylor River, June and July, 1924.

Scaevola ovalifolia R.Br.

4 m. N. of Taylor River, N.T., 18", blue flowers, June, 1924.

BRUNONIACEAE.

Brunonia australis Sm.

Between Wycliffe and Taylor, June, 1924.

COMPOSITAE.

Calotis porphyroglossa F.v.M.
Wycliffe Well, N.T., June, 1924. Recorded for N. Aust., but not previously from a definite locality in N.T.

Pluchea Eyrea F.v.M.
Wycliffe Well, N.T., June, 1924.

Pterigeron microglossus Benth.
Taylor, June, 1924, and Wycliffe Well, June, 1924. Bentham gives plant as glabrous, or slightly glandular, pubescent, and not over 8″. Our specimens are over 1 ft. high, and are covered with curled, almost woolly, hairs, but in other respects agree with type.

P. macrocephalus F.v.M.
Near foot of Central Mt. Stuart, July, 1924.

P. odorus Benth.
Wycliffe, N.T., and Taylor, June, 1924.

Epaltes australis Less.
Stirling Station and Wycliffe, June, 1924.

Pterocaulon glandulosus F.v.M.
Stirling Range, July, 1924.

P. sphacelatum Benth. and Hook.
Woodford Wells, and Teatree Well, bed of creek, July, 1924.

Helichrysum apiculatum D.Don.
Wycliffe, July, 1924.

Rutidosis helichrysoides D.C.
Finke River, Rev. H. Kempe, 1879. Thring Swamp, Wycliffe, June, 1924.

Centipeda orbicularis Lour.
Stirling Station, and Wycliffe, June, 1924.

Gnaphalium indicum L.
Wycliffe Well, N.T., June, 1924. Not previously recorded from any definite locality.

Myriocephalus Rudallii F.v.M.
C. Aust., C. Winnecke, 1883. Wycliffe Well, N.T., June, 1924. Not previously recorded.

Senecio magnificus F.v.M.
Scattered from Connor's Well to Bourke Well, July, 1924. Also Hansen's Well, July, 1924. 3-4 ft. Not previously recorded, but there is a specimen in the Melbourne Herbarium from Rev. H. Kempe, Finke River, 1877-80.

[PROC. ROY. SOC. VICTORIA, 38 (N.S.), 1926.]

ART IX.—*Additions to the Catalogue of Victorian Marine Mollusca.*

By J. H. GATLIFF and C. J. GABRIEL.

[Read 11th June, 1925.]

This paper embraces eight additional genera, namely, *Astelena, Eurytrochus, Tectarius, Terenochiton, Callistelasma, Icoplax, Haploplax,* and *Heterozona;* also 25 additional species.

We have not included any more alterations in the nomenclature, although many have been made since we read our last paper on 10th November, 1921.

Probably some of the more recent names may not be generally accepted, so we will not refer to them in this paper, but limit it to species that we have not previously recorded as being found on our coast.

CYMATIUM PARTHENOPEUM, von Salis.

1778. *Murex costatus,* Born, Test. Mus. Caes. Vindob., p. 295. Not Pennant 1777.
1793. *Murex parthenopus,* von Salis. Reis. Neap., p. 370, pl. 7, f. 1.
1798. *Tritonium simpulum,* Bolten. Mus. Bolt., p. 128.
1817. *Murex parthenopus,* Dillwyn. Descrip. Cata., vol. 2, p. 696.
1855. *Murex olearium,* auct., not Linnaeus, Hanley, Ips. Linn. Conch., p. 287.
1913. *Septa costata,* Born. Suter, Man. N.Z. Moll., p. 305, pl. 43, f. 2.
1915. *Cymatium australasiae,* Perry. Hedley, P.L.S. N.S.W. for 1914, v. 39, p. 719.
1918. *Cymatium parthenopeum,* von Salis. Hed., Jour. Roy. Soc. N.S.W., v. 51, p. M66.

Hab.—Portland.

Distrib.—Bay of Naples (Dill.), Northern N.Z.; Meditn.; West Ind.; Brazil; Cape of Good Hope; Australia and New Z.; Japan and Society Isls. (Suter); Brisbane to Sydney, Great Australian Bight (Hedley); Japan; Victoria (C.J.G.).

Size.—5×2½ inches (Dill.) 9×5.3 c.m. (Suter).

Remarks.—The Australian specimens are higher proportionately in the spire than the specimen figured by Suter.

DRILLIA SPADIX, Watson.

1886. *Pleurotoma (Drillia) spadix,* Watson. Chall. Zool., v. 15, p. 310, pl. 26, f. 6.
1922. *Inquisitor spadix,* Watson. Hedley, Rec. Aust. Mus., v. 13, p. 245.

Hab.—80 fathoms, Gabo Island ("Endeavour").

DRILLIA LYGDINA, Hedley.

1922. *Melatoma lygdina,* Hed. Id., p. 252, pl. 45, f. 44.

Hab.—150 to 200 fathoms, off Gabo Island ("Endeavour").

Obs.—Size of Type. Length 27, breadth 8.5 mm. "This species is represented by a single specimen with an imperfect apex."

DRILLIA SUBVIRIDIS, May.

1911. *Drillia subviridis,* May. P.R.S. Tas. for 1910, p. 392, pl. 14, f. 18.

1921. *Austrodrillia subviridis,* May. Check list Moll. Tas., p. 76.

1922. *Melatoma subviridis,* May. Hedley, Id., p. 253.

1923. *Austrodrillia subviridis,* May. May, Ill. Index Tas. Shells, p. 75, pl. 35, f. 18.

Hab.—80 fathoms, Gabo Island ("Endeavour").

Obs.—Size of Type. Length 16, breadth 6 mm., but a cotype is 20 mm. long.

MANGILIA BRAZIERI, Angas.

1871. *Clathurella brazieri,* Ang. P.Z.S. Lond., p. 18, pl. 1, f. 21.

1922. *Guraleus brazieri,* Ang. Hedley, Id., p. 312, pl. 52, f. 138.

Hab.—Port Albert (Worcester).

Obs.—Size of Type. Length 6, breadth 1.5 mm. Our Port Albert specimens were identified by Mr. Hedley and resemble his figure but not that of Angas.

MANGILIA MOROLOGUS, Hedley.

1922. *Guraleus morologus,* Hedley. Id., p. 319, pl. 52, f. 146.

Hab.—Western Port. Dredged in 6 to 8 fathoms.

Obs.—Size of Type. Length 8, breadth 3 mm.

MANGILIA CUSPIS, Sowerby.

1896. *Mangilia cuspis,* Sowb., P.Mal. Soc. Lond., v. 2, p. 31, pl. 3, f. 17.

1909. *Clathurella letourneuxiana,* Crosse and Fischer, var. *cuspis,* Sowb. Verco, T.R.S. S.A., v. 33, p. 309.

1921. *Guraleus cuspis,* Sowb. May, Check list Moll. Tas., p. 74, No. 721.

1922. *Guraleus cuspis,* Sowb. Hedley, Id., p. 314.

1923. *Guraleus cuspis,* Sowb. May, Ill. Index Tas. Shells, p. 73, pl. 34, f. 25.

Hab.—Dromana, Port Phillip.

Obs.—Size of Type. Length 8.50, breadth 3 mm.

POLINICES MELASTOMA, Swainson.

1822. *Natica melastoma*, Sw. Zool. Illustr., 1st series, pl. 79.

1855. *Natica sanguinolenta*, Desh. Reeve, Conch. Icon., v. 9, pl. 18, f. 78.

1883. *Natica melastoma*, Sw. Sowerby, Thes. Conch., v. 5, p. 87, pl. 460, f. 100.

Hab.—Lakes' Entrance, on sand banks (Gabriel).

Obs.—As we have now more specimens of this species from other localities we consider that the variation from *Natica plumbea*, Lk. noted by Pritchard and Gatliff and remarked upon by them, see these Proceedings vol. 12 page 191, is constant and therefore list it as a distinct species.

VERMICULARIA NODOSA, Hedley.

1907. *Vermicularia nodosa*, Hed. Rec. Aust. Mus., v. 6, p. 292, pl. 54, f. 8.

Hab.—San Remo, Western Port, and Cowes, Phillip Island.

Obs.—Size of Type. Major diam., 2.25; minor diam., 1.65 mm.

MELANELLA SCHOUTANICA, May.

1915. *Eulima schoutanica*, May. P.R.S. Tas., p. 89, pl. 3, f. 15.

Hab.—Dredged in about 6 fathoms off Portsea, Port Phillip.

HALIOTIS COCORADIATUM, Reeve.

1846. *Haliotis coco-radiata*, Rve. Conch. Icon., v. 3, pl. 13, f. 46.

1918. *Haliotis cocoradiatum*, Rve. Hedley, Jour. Roy. Soc. N.S.W., v. 51 for 1917, p. M41.

1924. *Haliotis coccoradiata*, Rve. Iredale, P.L.S. N.S.W., v. 49, p. 184.

Hab.—Mallacoota (Iredale).

CLANCULUS FLORIDUS, Philippi.

1849. *Trochus floridus*, Philippi. Zeits. f. Mal., v. 6, p. 156.

1851. *Trochus floridus*, Philippi. Conch. Cab., n.s., v. 2, p. 243, pl. 36, f. 15.

1889. *Trochus (Clanculus) floridus*, Phil. Pilsbry, Man. Conch, v. 11, p. 53, pl. 10, f. 12, and pl. 14, f. 12-13.

Hab.—Tellaburga Island (Iredale).

Genus **Astelena**, Iredale, 1924.

ASTELENA SCITULA, A. Adams.

1855. *Ziziphinus scitulus*, A. Adams. P.Z.S. Lond. for 1854, p. 38.

1863. *Ziziphinus scitulus,* A. Ad. Reeve, Conch. Icon., v. 14, pl. 6, f. 44.
1867. *Eutrochus scitulus,* A. Ad. Angas, P.Z.S., Lond., p. 215.
1918. *Astele scitulus,* A. Ad. Hedley, Jour. Roy. Soc. N.S.W., v. 51, for 1917, p. M45.
1924. *Astelena scitula,* A. Ad. Iredale, P.L.S. N.S.W., v. 49, p. 230.

Hab.—Mallacoota (Iredale).

Genus **Eurytrochus,** Fischer, 1880.

EURYTROCHUS STRANGEI, A. Adams.

1853. *Monodonta strangei,* A. Ad. P.Z.S. Lond. for 1851, p. 177.
1867. *Gibbula strangei,* A. Ad. Angas, Id., p. 217.
1909. *Gibbula dacostana,* Preston. P. Mal. Soc. Lond., v. 8, p. 377, fig. in text.
1915. *Gibbula strangei,* A. Ad. Hedley, P.L.S. N.S.W., v. 39, p. 709, pl. 81, f. 45.
1918. *Eurytrochus strangei,* A. Ad. Hedley, Jour. Roy. Soc., N.S.W., v. 51, for 1917, p. M42.
1924. *Eurytrochus strangei,* A. Ad. Iredale, P.L.S. N.S.W., v. 49, p. 184.

Hab.—Mallacoota (Iredale).

CANTHARIDELLA PICTURATA, Adams and Angas.

1864. *Gibbula picturata,* Ad. and Ang. P.Z.S. Lond., p. 36.
1889. *Gibbula picturata,* Ad. and Ang. Pilsbry, Man. Conch., v. 11, p. 215, pl. 37, f. 28-30, and pl. 30, f. 7.
1924. *Cantharidella picturata,* Ad. and Ang. Iredale, P.L.S. N.S.W., v. 49, p. 184.

Hab.—Mallacoota (Iredale).
Obs.—Size of Type. Height, 6 mm. A small, variously coloured species.

CIRSONELLA TRANSLUCIDA, May.

1915. *Cirsonella translucida,* May. P.R.S. Tas., p. 97, pl. 7, f. 38.
1921. *Cirsonella translucida,* May. Check list Moll. Tas., p. 42, No. 353.
1923. *Cirsonella translucida,* May. Index Tas. Shells, p. 45, pl. 20, f. 12.

Hab.—Portsea, Port Phillip; Shoreham, Western Port.
Obs.—Size of Type. Height, 2.5; greatest diameter, 2.5; least 2 mm. "Varies much in size, frequently much smaller than the measurements given." Ours are very small.

BROOKULA CREBRESCULPTA, Tate.

1899. *Cyclostrema crebresculptum,* Tate, T.R.S. S.A., v. 23, p. 219, pl. 7. f. 5.
1918. *Brookula crebrisculpta,* Tate. Hedley, Jour. Roy. Soc. N.S.W., v. 51, for 1917, p. M47.
1921. *Brookula crebrisculpta,* Tate. May, Check list Moll. Tas., p. 42, No. 356.
1923. *Brookula crebrisculpta,* Tate. May, Index Tas. Shells, p. 45, pl. 20, f. 15.

Hab.—Dredged in 6 to 8 fathoms off Rhyll, Phillip Isl., Western Port.

Obs.—Size of Type. Major diam. .9; minor diam. .76; height .9 mm. As the author remarks " This species is distinguishable from *C. angeli* by more turbinate outline, and by its numerous slender axial threads, which extend on to the base."

Genus **Tectarius,** Valenciennes, 1833.

TECTARIUS TUBERCULATUS, Menke.

1829. *Litorina tuberculata,* Menke. Verz. Conch. Samml. Malsburg, p. 10.
1833. *Littorina pyramidalis,* Quoy and Gaimard. Zool. " Astrolabe," v. 2, p. 482, pl. 33, f. 12-15.
1859. *Tectarius pyramidalis,* Quoy and G. Chenu, Man. Conch., v. 1, p. 301, f. 2115.
1924. *Tectarius tuberculatus,* Menke, Iredale, P.L.S. N.S.W., v. 49, p. 243.

Hab.—Mallacoota (Iredale).

PATELLOIDA SUBMARMORATA, Pilsbry.

1891. *Acmaea submarmorata,* Pilsbry. Man. Conch., v. 13, p. 52, pl. 42, f. 69-70.
1924. *Patelloida submarmorata,* Pilsbry. Iredale, P.L.S. N.S.W., v. 49, p. 236.

Hab.—Mallacoota (Iredale).

Genus **Terenochiton,** Iredale, 1914.

TERENOCHITON MATTHEWSIANUS, Bednall.

1906. *Lepidopleurus matthewsianus,* Bednall. P. Mal. Soc. Lond., v. 7, p. 92, pl. 9, f. 1-1*f*.
1921. *Lepidopleurus matthewsianus,* Bednall. May, Check list Moll. Tas., p. 30, No. 228.
1923. *Lepidopleurus matthewsianus,* Bednall. May, Ill. Index Tas. Shells, p. 33, pl. 14, f. 3.
1925. *Terenochiton matthewsianus,* Bednall. Iredale and Hull, Aust. Zool., v. 3, p. 341, pl. 39, f. 3.

Hab.—Victoria (Iredale and Hull).

Genus **Callistelasma**, Iredale and Hull, 1925.

CALLISTELASMA MERIDIONALIS, Ashby.

1919. *Callistochiton antiquus meridionalis*, Ashby. T.R.S. S.A., v. 43, p. 400, pl. 42, f. 7.
1920. *Callistochiton meridionalis*, Ashby. Id., p. 285.
1925. *Callistelasma meridionalis*, Ashby. Iredale and Hull, Id., p. 353, pl. 40, f. 2.

Hab.—Victoria (Iredale and Hull).

Genus **Icoplax**, Thiele, 1892.

ICOPLAX RUFA, Ashby.

1896. *Callochiton platessa*, Sykes (not Gould). P.Mal. Soc. Lond., v. 2, p. 86.
1900. *Callochiton rufus*, Ashby. T.R.S. S.A., v. 24, p. 87, pl. 1, f. *2a-g*.
1911. ?*Callistochiton rufus*, Ashby. Thiele, Die Fauna Sudwest Aust., v. 3, p. 402.
1921. *Callistochiton rufus*, Ashby. Ashby, P.R.S. Vic., v. 33, p. 150.
1925. *Icoplax rufa*, Ashby. Iredale and Hull, Id., p. 348.

Hab.—Port Phillip Heads (J. B. Wilson).

Obs.—Size of Type. Length 16, breadth 10 mm. After describing the species Ashby in his remarks says, "The ornamentation in some respects approximates to Callochiton platessa, but that species is much more strongly pitted or decussated, and the longitudinal scimitar-shaped sulci are absent; also it is more strongly beaked than the species now described."

Genus **Haploplax**, Pilsbry, 1894.

HAPLOPLAX SMARAGDINUS, Angas.

1867. *Lophyrus smaragdinus*, Ang. P.Z.S., Lond., p. 115, pl. 13, f. 28.
1893. *Ischnochiton smaragdinus*, Ang. Pilsbry, Man. Conch., v. 14, p. 137, not pl. 60, f. 20, as in text but vol. 15, pl. 15, f. 27.
1921. *Ischnochiton smaragdinus*, Ang. May, Check list Moll. Tas., p. 31, No. 240.
1923. *Ischnochiton smaragdinus*, Ang. May, Ill. Index Tas. Shells, p. 33, pl. 14, f. 15.
1923. *Ischnochiton* (*Haploplax*) *smaragdinus*, Ang. Ashby, T.R.S. S.A., v. 47, p. 224.
1924. *Haploplax smaragdinus*, Ang. Iredale and Hull, Id., p. 291, pl. 36, f. 1.

Hab.—Eastern Victoria (Iredale and Hull).

HAPLOPLAX LENTIGINOSA, Sowerby.

1840. *Chiton lentiginosus*, Sowb. Mag. Nat. Hist. (Charlesworth), v. 4, new series, p. 293.
1840. *Chiton lentiginosus*, Sowb. Conch. Illustr., f. 120.
1892. *Ischnochiton lentiginosus*, Sowb. Pilsbry, Man. Con., v. 14, p. 135, pl. 27, f. 44.
1924. *Haploplax lentiginosa*, Sowb. Iredale and Hull, Aust. Zool., v. 3, p. 292, pl. 36, f. 5.
1924. *Haploplax lentiginosa*. Sowb. Iredale, P.L.S. N.S.W., v. 49, p. 184.

Hab.—Mallacoota, and Lakes' Entrance (Iredale).

Obs.—Size. Length 27, breadth 18 mm. Varying in colour, but spotted with blue. Pilsbry, Man. Con., v. 15, page 82 says it is apparently distinct from *Ischnochiton cyaneopunctatus*, Kiener, a Cape of Good Hope species.

Genus **Heterozona** Dall, 1878.

HETEROZONA SUBVIRIDIS, Iredale and May.

1916. *Heterozona subviridis*, Iredale and May. P. Mal. Soc. Lond., v. 12, p. 105, pl. 4, f. 2.
1921. *Ischnochiton subviridis*, Iredale and May. May, Check list Moll. Tas., p. 31, No. 246.
1923. *Ischnochiton subviridis*, Iredale and May. May, Ill. Index Tas. Shells, p. 35, pl. 15, f. 6.
1923. *Ischnochiton (Heterozona) subviridis*, Iredale and May. Ashby and Hull, Aust. Zool, v. 3, p. 82.
1924. *Heterozona subviridis*, Iredale and May. Iredale and Hull, Aust. Zool, v. 3, p. 281, pl. 35, f. 4.

Hab.—Ocean Beach, Phillip Island; Portland.

Obs.—Size of Type. Length 30, breadth 16 mm. As noted by the authors a distinctive feature may be observed in the girdle, "Near the shell small pointed or tending to mucronate scales bearing striae, and comparatively regular for about half the width of the rather broad girdle; the outer half covered with minute scales, irregular and somewhat varying in size."

[Proc. Roy. Soc. Victoria 35 (N.S.), 1926.]

Art. X.—*Termites from the Ellice Group.*

By GERALD F. HILL.

(Entomologist, National Museum of Victoria.)

[Read 11th June, 1925.]

The only reference in literature to termites in the Ellice Group appears to be that of Rainbow (1897), in whose account of the insect fauna of Funafuti *Calotermes marginipennis* Latreille is recorded as destroying coconut palms.

I am indebted to Dr. P. A. Buxton for kindly forwarding to me a small collection of termites from this group of islands, comprising soldiers and workers of *Prorhinotermes inopinatus* Silvestri and several series of a rather large species of *Calotermes,* all of which were collected by him between 18th and 24th September in the trunks of living or dead coconut palms. Dr. Buxton states in his notes that the latter is the species referred to by Rainbow; it is, however, quite distinct from *C. marginipennis* Latr., of which I have a good series (from South-Eastern United States) determined by Dr. T. E. Snyder, and it is also distinct from *C. samoanus* Holmgren, from Apia. Samoan Islands, the only described species with which it appears to be very closely allied.

In view of Rainbow's reference to the papers of McLachlan (1883) and Blackburn (1884) on the Hawaiian termites, in which the two American species *C. marginipennis* Latr. and *C. castaneus* Burm. are recorded from Hawaii, and of his discussion upon the possible means by which the former species became introduced first into the Hawaiian Islands and later into the Ellice Group, it may be noted on the authority of Snyder (1922 and 1924) that both species have been misidentified. It is not known upon what evidence Rainbow associated the Funafuti insects with those from Hawaii, but the species described by me in this paper and for which I propose the specific name *rainbowi* is not conspecific with any described Hawaiian form.

In response to an enquiry the Director of the Australian Museum states that the material examined by Rainbow cannot now be found in that Institution.

Calotermes (Neotermes) rainbowi, n. sp.

(Text-Figure 1.)

Imago.

Colour.—Head, thorax and dorsum of abdomen russet; margin of pronotum and apical tergites of abdomen darker; under surface and legs honey yellow, shading to Dresden brown towards the apex of abdomen and tibiae; wings Dresden brown, principal veins darker.

Head (Text-fig. 1*a*).—Less than twice as long as wide, frons slightly concave, with scanty moderately long setae. Eyes large, nearly circular (0·513×0·570), prominent. Ocelli large, rounded, close to eyes. Postclypeus very short, with four long reddish setae. Labrum a little wider (at base) than long, narrowed anteriorly to the truncate apex. Antennae 18-jointed (rarely 19-jointed); 1st joint short and wide, narrowed in the middle; 2nd half as long as 1st, 3rd about as long as 2nd, but narrower at base and wider at apex, or as shown in Text-fig. 1*a*; 4th about as wide as 3rd, but shorter; 5th-15th increasing in length progressively; 16th and 17th equal in length to 15th; 18th markedly shorter and narrower than 17th, narrowest of all. Mandibles as in Text-fig. 1*b*.

Thorax (Text-fig. 1*c*).—Reniform, moderately arched transversely, the margin impressed, anterior margin strongly concave, the sides rounded, posterior margin convex, slightly sinuate in the middle, the entire surface with scanty setae similar to those on head. Meso- and metanotum with posterior margin nearly straight.

Wings.—With the anterior margin ciliate, few setae on principal veins, none on smaller veins, the four principal veins and their branches very distinct throughout their length, the media connected with the radial sector by many stout veinlets, cubitus distinct to the sixth or eighth branch, from thence onward its course, and the course of the remaining branches (7 to 9 in number) is indicated by irregular lines of scale-like micrasters similar to those on membrane.

Legs.—Short and stout, with scanty setae, femora not markedly thickened, tibial spurs long and slender.

Abdomen.—With the apical half of the segments clothed scantily with long setae.

Measurements.—

		mm.
Length, with wings		16·25 — 16·75
Length, without wings		9·25 — 10·50
Head, to apex of labrum, long		2·16
Head, to clypeofrontal suture, long		1·60 — 1·70
Head, at and including eyes, wide		1·82 — 1·92
Pronotum, long	1·25 — 1·30; wide	2·16 — 2·22
Wings, forewings, long	12·50; wide	4·00
Wings, hindwings, long	12·00; wide	3·60
Tibia iii, long		1·60 — 1·65

Soldier.

Colour.—Head orange-rufous, shading to ochraceous-orange on frons and ventral surface; anteclypeus hyaline shaded with ochraceous-orange; pronotum yellow-ochre narrowly margined with darker colour; the whole insect glabrous and with scanty, moderately long setae.

Head.—Widest in middle, slightly rounded on sides, frons flat and not rugose. Labrum (Text-fig. 1*d*) about as long as wide,

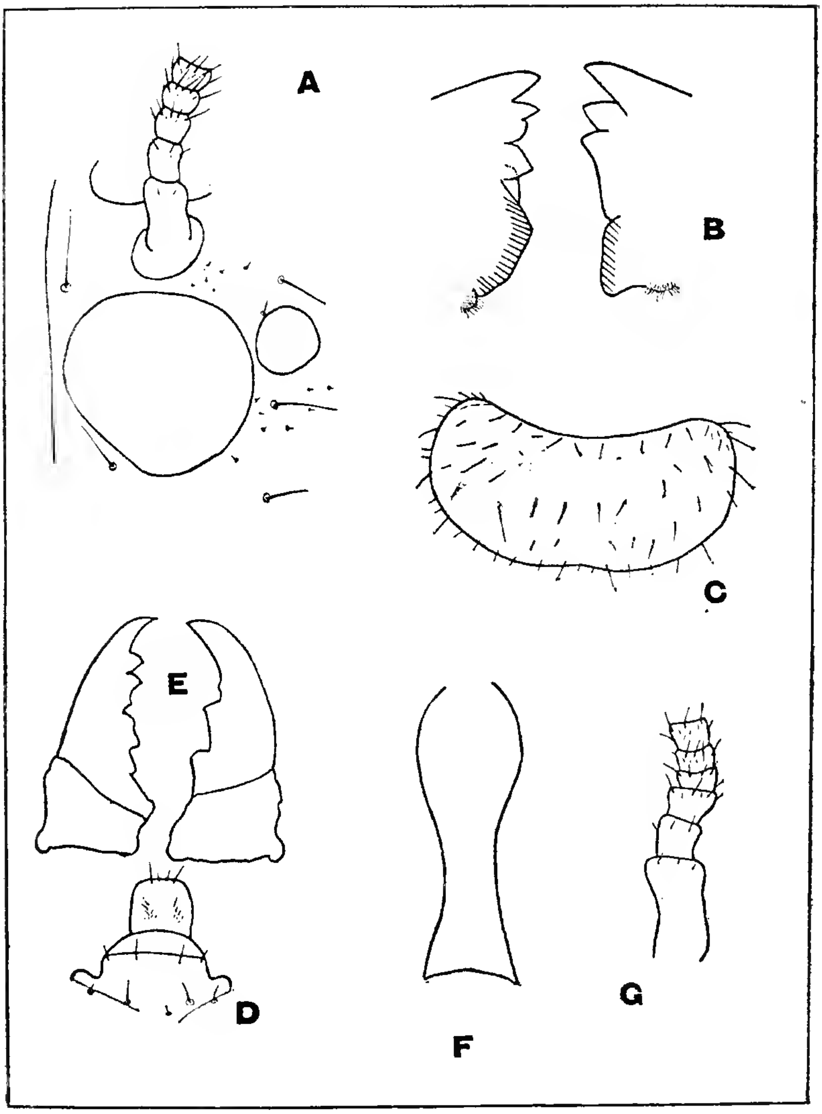


FIG. 1.—*Calotermes* (*Neotermes*) *rainbowi*, n. sp. A, imago, side of head showing eye, ocellus and basal joints of antenna; B, imago, mandibles; C, imago, pronotum; D, soldier, clypeus and labrum; E, soldier, mandibles; F, soldier, gula; G, soldier, basal joints of antenna.

nearly straight on sides, truncate in front. Postclypeus with four moderately large setae near anterior margin. Mandibles (Text-fig. 1*e*) stout; the right with two stout teeth about the middle; the left with two smaller, angular teeth, and one very small one on the apical half, followed by one large blunt tooth and a much smaller one posteriorly. (Gula as in Text-fig. 1*f*.) Antennae (Text-fig. 1*g*) 15- to 17-jointed; 3rd joint about as long as 2nd, but narrower at base, or longer than 2nd and 4th, and subclavate in form.

Thorax.—Pronotum large, wider than head, similar in shape to that of imago.

Legs.—Moderately stout, femora not markedly thickened, claws and tibial spines long and slender.

Abdomen.—With scanty, moderately large setae, as on legs.

Measurements.—

	mm.
Total length - - - - - - - -	12·00 — 13·00
Head, with mandibles, long - - - -	4·85 — 5·13
Head, without mandibles, long - - -	3·15 — 3·53
Head, wide - - - - - - - -	2·50 — 2·67
Gula, wide - - - - - - - -	0·39 — 0·45
Pronotum, long, 1·48 — 1·59; wide - -	2·67 — 2·85
Tibia iii, long - - - - - - -	1·70 — 1·99

Locality.—Ellice Group: Nanumea (Type locality), Funafuti, Nanomaga, Nui and (?) Nukulailai Islands.

The specimens (soldiers and workers only) from the last-mentioned locality appear to be conspecific with the others, from which they differ in the soldier caste in their smaller size (Length 10·00; head with mandibles 3·90, without mandibles 2·56; length of pronotum 0·96, width of pronotum 1·93; gula 0·28; tibia iii 1·14), paler coloured head and shorter and finer setae on head and thorax. The descriptions and measurements are of specimens from a complete nest-series from Nanumea, which agree in all details with similar series from the other islands mentioned. Second- and first-form nymphs, as well as recently moulted imagos, are present in two of the colonies. The oldest individuals of the latter caste do not appear to have attained the maximum degree of chitinisation, as evidenced by the distension of the abdomens with fat-body.

Allied species.—The imago is very similar to *C. samoanus* Holmgr., but it is lighter in colour and has much shorter and scantier setae on pronotum and abdomen. In the soldier caste the proposed new species differs from the Samoan insect in having a much lighter coloured and narrower head, wider gula and relatively longer pronotum. From *C. schultzei* Holmgr. it is distinguished by smaller head, ocelli and eyes, eyes closer to lower margin of head, head and body slightly less setaceous, shorter wings, darker wing-veins and paler wing-membrane. In the soldier caste the gula is wider and the pronotum much larger. The antennae of the New Guinea species are 17- to 19-jointed in the imago and 15- to 17-jointed in the soldier. From the New Britain species which I have provisionally identified and described in the alate form as *C. papua* Desneux (manuscript, June, 1925), it is distinguished by its larger and more arched pronotum, larger and more numerous setae on head and thorax, and paler colour (the latter condition possibly due to immaturity). The eyes and wings are alike in the two species. In the soldier caste it is distinguished by its flattened frons (slightly concave and rugose in the New Britain species), much larger pronotum, more setaceous head, thorax and abdomen and slightly wider gula. The antennae in *C. papua* are 17- or 18-jointed in the imago and 14- to 17-jointed in the soldier. These two species are certainly very closely related to each other, and to a species (soldiers) collected at Gordonvale, N. Queensland, by Mr. F. H. Taylor, which appears to be indistinguishable from *C. irregularis* Frogg., from the coastal districts of North-eastern and North Australia.

Dr. Buxton states that this termite is a serious pest in the Ellice Group, where it tunnels in the trunks of living coconut palms and ultimately destroys them.

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[Proc. Roy. Soc. Victoria, 38 (N.S.), 1926.]

Art. XI.—*The Geology of Green Gully, Keilor, with special reference to the Fossiliferous Beds.*

By IRENE CRESPIN, B.A.

(With Plates VII.-IX.)

[Read 9th July, 1925.]

Contents.

I. Introduction.

Green Gully, Keilor, is situated ten miles west-north-west of Melbourne, and is easily accessible, being about two miles from St. Albans railway station. The stream which drains the Gully is a tributary of the Saltwater River. The presence of a limestone in the locality was recognised as far back as 1893. Since then little work has been done in the area except by Messrs. Hall and Pritchard in 1897, whose account of the geology and the fossils present has been of considerable value in forming a basis for this work. This contribution is the first in which is recorded the fauna contained in the Foraminiferal limestone which, though small in extent, is of considerable interest and importance, while its position in the sequence of the rocks in the area has given rise to some discussion. I have been able to augment considerably the list of fossils, and fairly detailed examination of the microscopic contents of the limestone forms a feature of this work.

The principal references to earlier work include Graham Officer (1893), who was the first to record a limestone at Green Gully, Keilor. He described it as "yellowish and earthy," containing Polyzoa and Echinoid spines. He queried the age of the bed as Pliocene.

Messrs. Hall and Pritchard (1897) issued a list of fossils with a short account of the geology of the area.

F. Chapman (1910) did some work on the Foraminiferal limestone, and listed two species of *Lepidocyclinae,* which also occur at Batesford. Later (1914) he referred to the age of the beds as Janjukian, but possibly on a lower horizon than Batesford. This opinion was based on the presence of *Lepidocyclina verbeeki* at Green Gully.

II. Geology of the Area.

The beds in descending order are as follow:—

Recent	Alluvial deposits.
Kainozoic	Carbonaceous deposit, containing diatoms (estuarine elsewhere).
	Fresh-water limestone or Travertine.
	Newer Basalt.
	Current-bedded sands with quartzite.—Kalimnan.
	Fossiliferous Ironstone Series.—Janjukian.
	Foraminiferal Limestone.—Janjukian.
	Older Basalt.
Palaeozoic	Silurian mudstones and sandstones.

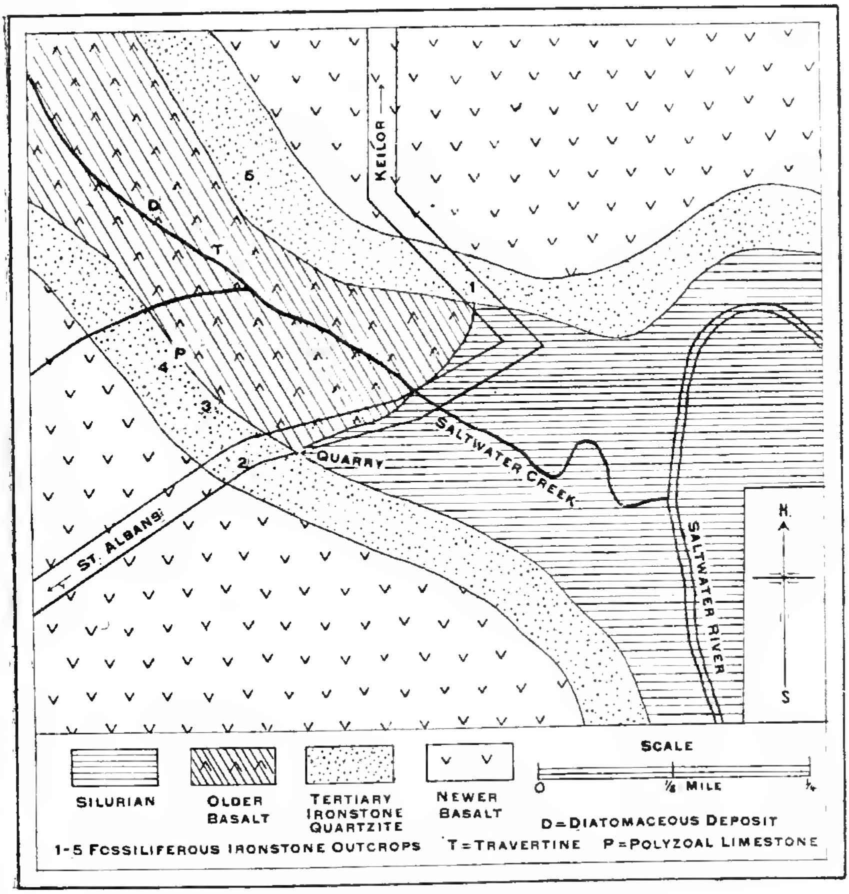

FIG. 1—Geological sketch map of Green Gully, Keilor.

The Silurian forms the bedrock of the area. There is only one small outcrop far up Green Gully, but there are larger exposures along the banks of the Saltwater (or Maribyrnong) River. Fossils such as *Monograptus aplini,* T. S. Hall, *M. priodon,* Bronn, *M. turriculatus,* Barrande, *Cyrtograptus* sp., *Retiolites australis,* McCoy, and *Trachyderma* sp., have been recorded from the neighbourhood of the monocline, 250 yards south of the Keilor Bridge.

The Older Basalt directly overlies the eroded surface of the Silurian in many places and outcrops along the Gully. It is exposed in the road cutting 150 yards north of the bridge which crosses Green Gully, where it is overlain by Janjukian fossiliferous grits, and a little further north by Kalimnan sands. At this point the Older Basalt stands out as a knoll, being exposed to the extent of 8 feet in width and 3 ft. in thickness. The rock is decomposed.

Just south-west of the bridge which crosses Green Gully is a quarry in the Older Basalt, showing practically unaltered basalt overlain by decomposed material. There is a sharp junction between the two. Here the Older Basalt is overlain by fossiliferous ironstone. Further up the Gully it is in contact with the Polyzoal limestone. The two are often separated by an intermediate bed, greyish white in colour, with brownish cavities. This bed represents a partially metasomatic replacement of the Older Basalt by calcareous matter. The structure of the Older Basalt remains in the lath-shaped crystals of felspar and partially altered olivine. Also in other parts there is an intermediate bed, represented by a reddish ferruginous band of altered limestone, traces of the original limestone being seen in the marine organisms like *Amphistegina,* Polyzoa, and *Lithothamnium.* The greater part of this rock is an aggregation of pellets connected together by calcite crystals, some of the included pellets showing concretionary structure which may be due to *Girvanella*-like organisms. (Pl. II., Fig. 11.)

Another part of the section on the south side of Green Gully shows the highest beds of the basalt flow to have a platy structure induced by weathering.

Associated with the Older Basalt in the creek bed is a reddish ochreous deposit representing a highly altered form of Older Basalt.

In the creek columnar structure in the basalt is seen together with perfect convex and concave joints, while elsewhere within the area described spheroidal weathering is characteristic.

The fossiliferous ferruginous beds on the north side and the polyzoal limestone on the south side of Green Gully immediately overlie the eroded surface of the Older Basalt. The polyzoal limestone is 120 feet in width and 5 feet thick, and indicates clear water conditions, which are favourable for the growth of Foraminifera and Corals. The bed is overlain by a narrow band of fossiliferous ironstone, but on the north side of the gully the limestone is absent. To the east the limestone passes into a finely-grained ferruginous fossiliferous ironstone bed, which in its turn passes laterally into a fossiliferous ironstone containing quartz grains. The nature of the fossils in this bed and the abundance of quartz grains present suggest a shore line deposit, while the presence of fossil wood associated with coarse grits, marks either a shoreline or beach deposit. The fossiliferous marine grits pass up into a narrow unfossiliferous bed. These can be compared with the quartz grits in the Kalimnan ironstone at Brighton, where there are concretionary bodies that appear to be infillings and replacements of coastal vegetation.

Overlying the fossiliferous and unfossiliferous grits are current-bedded sands and quartzite, the age of the deposit being probably Kalimnan from its position in the stratigraphical succession and from its lithological characteristics. It has yielded only broken fragments of freshwater shells (? *Cyclas* or *Unio*) and spicules of a fresh water sponge (*Spongilla*). On the south side of the Gully these sands are several feet in thickness, are current-bedded, and contain coarse and fine quartz grains frequently in bands, as well as layers of red ochreous and steatitic bands and nodules. These clean sands of fine quality have been quarried on a small scale in the past. In other localities along the Gully a hard white quartzite, 20 feet thick, overlies the ferruginous grits. The origin of the quartzite seems to be connected with the Newer Basalt flow, since the two are associated in other localities in a similar way.

A thickness of about 25 feet of Newer Basalt caps the quartzite and sands on both sides of the valley. The basalt is vesicular, and in the road cutting platy structure is well developed.

About 300 yards up the creek from the bridge, beyond the red ochre deposit and overlying the old creek bed, is an interesting travertine deposit. It contains boulders of quartzite, ironstone, and Newer Basalt set in a hard magnesitic matrix. Included in this travertine are some perfect little fossils, including Ostracods and numerous shells of the gasteropod, *Coxiella*. The latter genus is a brackish water form, and points to such conditions at the time of deposition. Contrasted with this are the fluviatile conditions of the present day, for in the stream which cuts through the travertine bed is the freshwater shell, *Bithinella*. This clearly shows the change from stagnant to free flowing conditions in the same area within a short geological period. The age of the bed is late Pleistocene or Holocene.

About 50 yards farther up the creek there occurs a carbonaceous deposit with a maximum thickness of 5 feet. It consists of a fine sandy material containing twigs and small pieces of wood. The finer portion consists to a large extent of diatoms, *Actinocyclus Barklyi* and *Campylodiscus echineus*, normally of marine to estuarine habit, with a few freshwater sponge spicules. The deposit frequently shows cross bedding, which can be ascribed to its having been laid down in shallow water subjected to shifting currents. The softness of the material has caused the stream to cut rapidly through it, the result being the formation of steep banks which are still being eroded. The origin of this deposit is still under consideration, since if directly laid down in estuarine swamps, it would involve a greater amount of subsequent uplift—amounting to 120 feet—than seems compatible with the physiography of the area. The age is post-Newer Basaltic.

III. The Limestone Series.

The limestone series is exposed as a lenticle about 250 yards above the bridge, on a steep slope on the south side of Green Gully. The outcrop is only 120 feet long and 5 feet thick, tapering at each end. The rock is composed almost entirely of Foraminifera, Polyzoa and Echinoid spines, whilst Sponges, Corals and fragments of Mollusca have been recorded. The upper portion is a creamy limestone with little trace of iron, contains few quartz grains, and shows imperfect stratification. In places it has been weathered, so that the Foraminifera, especially the *Lepidocyclinae,* and spines of Echinoids stand out conspicuously.

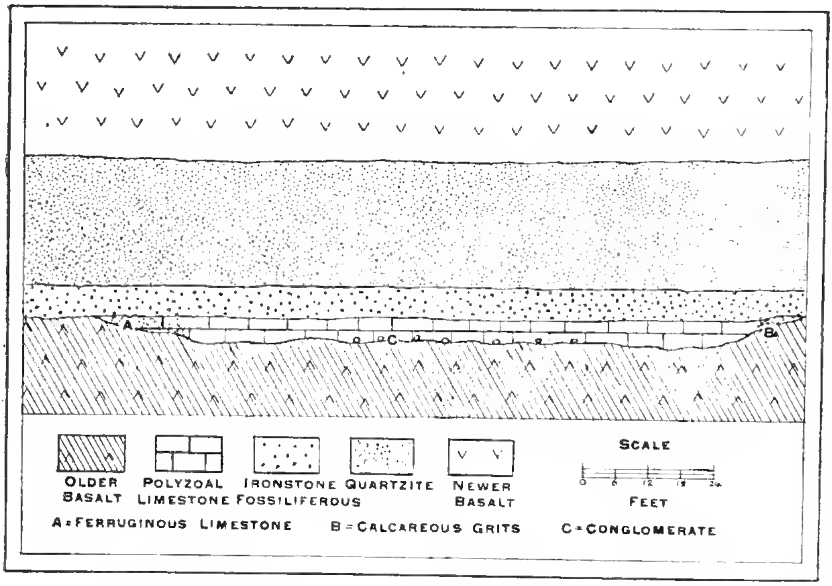

Fig. 2.—Diagrammatic section of the South Bank of Green Gully, Keilor.

This creamy limestone passes down into a darker-coloured ferruginous rock which contains abundant Foraminifera, *Lithothamnium* and quartz grains; the Foraminifera frequently showing perfect cross sections on fractured surfaces of the limestone. Quartz grains are often so numerous as to render it difficult to secure good sections for microscopical examination. This lower part is largely replaced by limonite. In its present indurated state it appears almost cherty, but microscopic examination shows no evidence of silicification.

This dark limestone passes down into a ferruginous limestone conglomerate, whose pebbles, some of which are basaltic and others of calcareous grits, are embedded in an extremely hard calcareous matrix. The nature of the pebbles suggests the conditions of the area at the time of the deposition of the conglomerate. Those of basalt point to the existence of an eroded surface of the Older Basalt, whilst the calcareous grits are the sole remains of a shoreline deposit which presumably covered part of the area. The limestone in which these pebbles are embedded is very hard and contains abundant *Lithothamnium* with numerous quartz grains.

At the northern end this limestone lenticle appears to pass conformably and rapidly up into a calcareous and ferruginous grit. Nearer the centre of the section the change into the ferruginous grits seems to be more abrupt and also a little unconformable. To the south, there is a lateral passage into a ferruginous bed, which is a replacement of the limestone. It consists of a fine-grained, ferruginous limestone with dense limonitic bands. Fossils are not abundant, and include *Antigona hormophora, Thamnastraea sera, Orbicella tasmaniensis* and *Aturia australis.*

IV. The Fossiliferous Ironstone Series.

This is exposed in five different localities on both sides of Gully. The majority of these outcrops vary as to richness of fossil contents, and also in their lithological characteristics. (See Fig. 1.)

Outcrop 1.—This is seen in the road cutting on the north side, about 150 yards above the bridge. The section is similar, but on a small scale, to that which is seen in the Royal Park cutting. Definite relations between Kalimnan sands, fossiliferous grits (Janjukian) and Older Basalt are here well illustrated. The Kalimnan sands contain a large percentage of quartz grains, and are current-bedded. To the west they directly overlie the Older Basalt, while to the centre of the section they cover chocolate-coloured fossiliferous grits, which in their turn rest on Older Basalt. To the east, the grits die out and the Kalimnan is again resting on Older Basalt.

The fossiliferous grits contain a large proportion of quartz pebbles and grains. Fossil remains are numerous, but poorly preserved, and generally in the form of casts. Only a few species are determinable; one of the most interesting being a new species of *Lithophaga* (*L. fabaeformis*). Large pebbles whose shape suggests coprolites, but which are really phosphatic segregations, occur frequently in the grits. The exposure of the fossiliferous grits measures 50 feet in length and 3 feet in thickness. The bed is lithologically distinct from the other ironstone outcrops, being much softer and containing a coarser quartz matrix, whilst perfect fossils are much rarer.

Outcrop 2.—This exposure is on the south bank, about 100 yards up the road from the bridge, and directly opposite Outcrop 1.

The exact vertical extent of this outcrop is difficult to determine, owing to overgrowth and displaced blocks of Newer Basalt and quartzite. The horizontal extent to the west is masked by blocks of Kalimnan sands which have been dislodged, while to the east it skirts the Older Basalt line of outcrop in the direction of the Saltwater River.

The ironstone is concretionary, the segregated layers being particularly noticeable in the vicinity of a fossil or some inclusion. Between these concretionary bands there is much limonitic material, showing in places a thin scaly structure. Cream and chocolate-coloured pebbles are frequently included. The external casts in this locality are very well preserved, and the hard ironstone is especially adapted for their preservation and extraction. Occasionally internal casts are found.

An interesting discovery of fossil wood was here made which throws some important light on the origin and conditions of deposition. This piece of wood came from the upper part of the bed immediately underlying the Kalimnan sands. It is embedded along with very coarse quartz grains in a fine limonitic and sandy matrix.

Outcrop 3.—This bed, which lies on the south bank of Green Gully, below the Green Gully-St. Albans road, is not very thick, and represents a highly limonitic band containing numerous fossil remains, many of which are well preserved. It passes up into unfossiliferous grits. Laterally it merges into the ferruginous limestone.

Outcrop 4.—This exposure directly overlies the Polyzoal limestone. The thickness of the bed is masked by boulders of quartzite and Newer Basalt. In only one case was a fossil recognisable, but fragments of shells were numerous. This is probably "the ferruginous grits," in which Messrs. Hall and Pritchard had been unable to find any fossils. The fossiliferous grits pass up into coarse, unfossiliferous grits.

Outcrop 5.—This outcrop is on the north side of Green Gully, about 400 yards up stream from the bridge. It is similar in all respects to Outcrop 2. The casts of fossils occur in a hard ironstone, are numerous and well preserved. The bed passes upwards into ferruginous grits of varying coarseness, while the bed beneath is covered with vegetation and hill-wash.

Origin of the Fossiliferous Ironstone Series.

The grit-like character of the ironstone suggests a deposit formed along a shallow shore line, while the fossil fauna, including abundant examples of *Patelloida* and *Haliotis* also demonstrates shallow marine conditions.

In conjunction with Mr. Chapman I have examined sections of this ironstone under the microscope, and in a piece of drift wood included in it have recognised iron-secreting bacteria. While the deposit as a whole is indubitably of shallow marine origin as demonstrated by its fossil content, it seems probable that its iron content as suggested by Gruner for American iron formation (J. W. Gruner. The origin of sedimentary iron formations: The Biwabik formation of the Mesabi Range. *Econ. Geol.*, xvii., p. 408, Sept., 1922). " may have been derived from an adjoining land area by ordinary process of weathering, carried to the sea by rivers rich in organic matter, and deposited by micro-organisms."

Messrs. Hall and Pritchard (1897), in writing of a similar ironstone at Flemington, drew attention to what seems a general factor in the formation of such ironstone beds, namely, the imperviousness of the underlying strata. In all these deposits ferruginous material is confined to a particular stratum immediately overlying an impervious bed.

V. Systematic List of Fossils.

Species recognised by the author, and already recorded by previous workers, are marked with an asterisk.*

RECENT.

(a) Diatomaceous deposit.

Plantae.

Actinocyclus Barklyi, Coates.
Campylodiscus echineus, Ehrenberg.

(b) Travertine.

Gasteropoda.

Coxiella striata, Sow. sp.

KALIMNAN.

Kalimnan sands.

Spongiae.

Spongilla sp.

Pelecypoda.

Cyclas? or Unio sp.

JANJUKIAN.

(a) Fossiliferous Ironstone.

Spongiae.

Cliona sp.

Anthozoa.

Fungia pedicella, sp. nov.
Flabellum cf. gambierense, Duncan.

Echinodermata.

Echinus (Psammechinus) woodsi, Laube, var. humilior, Bittner.
*Cidaroid plates and spines, indet.

Polyzoa.

Cellepora sp.
Adeona cf. obliqua, MacGillivray. (Sweet coll.)
Retepora sp.

Brachiopoda.

*Terebratulina suessi, Hutton sp.
*Magellania garibaldiana, Davidson sp.
*Tegulorhynchia coelata, T. Woods sp.
*Terebratella furculifera, Tate sp.

Pelecypoda.

Cucullaea corioensis, McCoy. (Sweet coll.)
Arca (Barbatia) celleporacea, Tate sp.
Arca (Barbatia) simulans, Tate sp.
Arca (Barbatia) consutilis, Tate sp.
Chlamys praecursor, Chapman sp.
Chlamys sturtiana, Tate sp.
Chlamys keiloriana, sp. nov.
*Chama lamellifera, T. Woods.
Hinnites corioensis, McCoy.
Spondylus gaederopoides, McCoy. (Sweet coll.)
*Spondylus pseudoradula, McCoy. (Sweet coll.)
Lima bassi, T. Woods.
Placunanomia ione, Gray.
Lithophaga fabaeformis, sp. nov.
Cardita alata, Tate sp.
Venericardia trigonalis, Tate sp.
Cardium septuagenarium, Tate.
Dosinia cf. johnstoni, Tate.
Callanaitis cf. allporti, T. Woods sp.
Tellina aff. porrecta, Tate.
?Corbula sp.

Gasteropoda.

Patelloida perplexa, Pilsbry sp.
Emarginula transenna, T. Woods.
Montfortula sp.
Haliotis mooraboolensis, McCoy.
*Haliotis naevosoides, McCoy.
Turbo etheridgei, T. Woods.
Turbo hamiltonensis, Harris. (Sweet coll.).
Phasianella dennanti, sp. nov.
Liotia sp.
Calliostoma serratula, Pritchard sp.
Calliostoma sp. nov. Cast, not good enough for description.
Cantharidus exiguus, T. Woods sp.
Cantharidus alternatus, T. Woods sp.
Cantharidus multicinctus, sp. nov.
Astele sp. (Sweet coll.)
Hipponyx antiquatus, Linné.
Gibbula sp.
Vermicularia funicalis, sp. nov.
Turritella septifraga, Tate. (Sweet coll.)
Bittium sp.
*Cerithium flemingtonense, McCoy.
*Potamides sp.
Eglisia triplicata, Tate.
Cypraea parallela, Tate.
Cypraea subsidua, Tate.
Trivia avellanoides, McCoy.
Cassis sp. (Sweet coll.)
Cymatium tortirostre, Tate sp.
Verconella sp.
Fusus tasmanicus, Johnston sp.
?Fasciolaria sp. (Sweet coll.)
Murex asperulus, Tate.
Fusinus cf. simulans, Tate sp.
Latirus transennus, T. Woods sp.
*Conus ralphi, T. Woods.

Pisces.

Lamna compressa, Agassiz.
Isurus retroflexus, Agassiz sp.

(b) Polyzoal Limestone.

Plantae.

Lithothamnium ramosissimum, Reuss.
Lithothamnium amphiroaeformis, Rothpletz.
Lithophyllum hydractinioides, sp. nov.

Foraminifera.

Spiroloculina cf. excavata, d'Orb.
Miliolina agglutinans, d'Orb. sp.
Haddonia torresiensis, Chapman.
Spiroplecta praelonga, Reuss sp.
Carpenteria proteiformis, Goës.
Pulvinulina scabricula, Chapman.
Pulvinulina elegans, d'Orb. sp.
Rotalia calcar, d'Orb.
Rotalia soldanii, d'Orb.
Calcarina defrancii, d'Orb.
Gypsina globulus, Reuss sp.
Gypsina howchini, Chapman.
Gypsina inhaerens, Schultze sp., var. planum, Carter.
Amphistegina lessonii, d'Orb.
Lepidocyclina tournoueri, Lemoine and Douvillé.
Lepidocyclina marginata, Michelotti sp.
Lepidocyclina martini, Schlumberger.
Lepidocyclina verbeeki, Newton and Holland.
Lepidocyclina murrayana, Jones and Chapman.

Spongiae.

Bactronella australis, Hinde.

Anthozoa.

Orbicella tasmaniensis, Duncan sp.
Thamnastraea sera, Duncan.
Mopsea tenisoni, Chapman.

Echinodermata.

Echinus (Psammechinus) woodsi, Laube, var. humilior, Bittner.
Cidaroid plates and spines, indet.

Polyzoa.

Macropora clarkei, T. Woods.

Pelecypoda.

Antigona hormophora, Tate sp.

Cephalopoda.

Aturia australis, McCoy.

Pisces.

Odontaspis sp.

VI. Descriptions of the More Important Fossils Present.

PLANTAE.

Lithothamnium ramosissimum, Reuss sp.

(Plate VII., Fig. 7.)

Nullipora ramosissimum, Reuss, 1848, Haidinger's Naturw. Abhandl., ii. (2), p. 29, pl. iii., figs. 10, 11.

L. ramosissimum, Reuss sp., Gumbel, 1871, Abhandl. K. bayer. Akad. Wiss., xi. (1), p. 34, pl. i., figs. 1*a*-*d*. Chapman, 1913, Proc. Roy. Soc. Vic., n.s., xxxvi. (2), p. 166, pl. xvi., figs. 1*a*-*c*, 2, 3. H. Yabe, 1918, Sci. Rep. Tôhoku Imp. Univ., [2] (Geol.), v. (2).

Observations.—The typical branching form of *Lithothamnium* is present, but never in such abundance as in other limestones in which it occurs, such as at Batesford. The semi-encrusting branches in some of the sections indicate an expanded modification. This form is the predominant one in these limestones.

L. ramosissimum has been already recorded from Sagara, in Japan, with the cells measuring ·025 mm. in breadth. Those in specimens from the Mallee borings are somewhat narrower in dimensions, having a breadth of ·17 mm. The Keilor form has cells measuring ·024 mm. in breadth, and ·038 mm. in length. These cell-measurements approach those of the Japanese form. There is a great deal of variation in the size of the cells, and occasionally they are minute, measuring only ·013 mm. in breadth.

L. ramosissimum is a well known component of Tertiary limestones.

LITHOTHAMNIUM AMPHIROAEFORMIS, Rothpletz.

(Plate VII., Fig. 2.)

L. amphiroaeformis, Rothpletz, 1891, Zeit. Deutschen Geol. Gesell., xliii. (2), April-June, p. 314, pl. xv., figs. 10, 14. H. Yabe, 1918, Sci. Rep. Tôhoku Imp. Univ., [2], v. (1), p. 27 (table).

Observations.—This form differs from *L. ramosissimum* in the dimensions of the cells and in the distinct concentric arrangement of the inner structure of the branch; it also has a differentiated external layer. This appropriate name was given by Rothpletz, who gives figures of the species. Some of the present examples have the inner and external elements well brought out by differential ironstaining. The original description by Rothpletz is based on a specimen from the Chalk (Turonian) of Munich.

The breadth of the cells, ·019 mm.; length, ·028 mm. Extreme dimensions—breadth, ·028 mm.; length, ·043 mm. The average dimensions approximate those of Yabe, who describes the form from the Miocene of N. Borneo.

LITHOPHYLLUM HYDRACTINIOIDES, sp. nov.

(Plate VII., Fig. 3.)

Description.—Thallus thin, encrusting, the first series of cells showing an almost spiral convolution immediately conforming itself to the surface of attachment and followed by a series of more regular habit of minute cubical cells having an approximate diameter of ·028 mm. Some of the transverse walls are incomplete, not extending across from layer to layer, but ending in a spine. This is characteristic of *Hydractinia,* but the cells are much smaller than in that genus, and there is very little doubt, from the structure of the cells, that it is referable to the above plant genus.

Observations.—This species is described from a thin slice of limestone prepared by Mr. J. M. Wilson, who has kindly presented it to the National Museum.

FORAMINIFERA.

Miliolina agglutinans d'Orbigny sp.

Quinqueloculina agglutinans, d'Orb., 1839, Foram. Cuba, p. 168, pl. ii., figs. 11-13.

Miliolina agglutinans, d'Orb. sp., Chapman, 1907. Linn. Soc. Journ. (Zool.), xxx., p. 20, pl. ii., fig. 36. Heron-Allen and Earland, 1924, Journ. Roy. Micr. Soc., p. 132.

Observations.—This form is common in the Victorian Tertiaries, from the Balcombian upwards. It is the first record from Keilor.

Haddonia torresiensis, Chapman.

(Plate VII., Fig. 4.)

Haddonia torresiensis, Chapman, 1898, Linn. Soc. Journ. (Zool.), xxvi., pp. 452-56, pl. xxviii. and woodcut. Jones and Chapman, 1900, Mon. Christ. Is., Brit. Mus., p. 249. Heron-Allen and Earland, 1915, Trans. Zool. Soc. (Lond.), xx. (17), p. 616, pl. xlvi., fig. 22. Id., 1924, ibid., xxxv., p. 615, pl. xxxv., figs. 17-22.

Observations.—This specimen was found in the more compact ferruginous polyzoal limestone, and is represented by a vertical section through the test. It seems to have attached itself to the débris, and extended itself in a mound-like form. The test is of eleven slightly arched chambers. The distal chambers are very much higher and the end of the test shows the series to be more or less recurved on itself. The structure, so far preserved, is comparable with the typical *Haddonia* of tropical and subtropical seas.

It is found at the present day in the Pacific around Funafuti, whilst the original specimen described by Chapman was collected by Professor Haddon in Torres Strait. The Miocene occurrence is in the *Lepidocyclina* limestone of Christmas Island. It has been recorded from Kerimba Archipelago, off the east coast of Africa.

Spiroplecta praelonga, Reuss sp.

Textularia praelonga, Reuss, 1845. Die Verstein. böhm. Kreidef., (1), p. 39, pl. xxi., fig. 14. Heron-Allen and Earland, 1924, Journ. Roy. Micr. Soc., p. 137.

Spiroplecta praelonga, Reuss sp., Chapman, 1892, Journ. Roy. Micr. Soc., p. 3, pl. xi., fig. 5.

Observations.—It is an unusually late appearance for this form, as the species is more typical of Cretaceous deposits elsewhere; as for example in the Gin Gin Chalk. Heron-Allen has lately recorded this species (as *T. praelonga*) from the Janjukian (Miocene) of Batesford. The present form was found in the sorted material.

CARPENTERIA PROTEIFORMIS, Goës.

Carpenteria balaniformis, var. *proteiformis*, Goës, 1882, Rep. Chall. Exped., p. 94, pl. vi., figs. 208-14; pl. vii., figs. 215-19.

Carpenteria proteiformis, Goës, Brady, 1884, Rep. Chall. Exped., p. 679, pl. xlvii., figs. 8-14. Heron-Allen and Earland, 1924, Journ. Roy. Micr. Soc., p. 178.

Observations.—*Carpenteria* is not very abundant in the limestone sections. It shows the strongly tubulated structure of this form.

PULVINULINA ELEGANS, d'Orbigny.

Rotalia (Turbinulina) elegans, d'Orb., 1826, Ann. Sci. Nat., vii., p. 276, No. 54.

Pulvinulina elegans, d'Orb. sp., Chapman, 1910, Proc. Roy. Soc. Vic., n.s., xi. (2), p. 288. Heron-Allen and Earland, 1924, Journ. Roy. Micr. Soc., p. 180.

Observations.—*P. elegans* has been recorded from the Murray Flats (S. Aust.), and at Batesford and in the Mallee Bores (Vic.). In Bore No. 2 it is found ranging from 315-568 ft. (Janjukian) to 260 ft. (Kalimnan). This species seems to be practically confined to the Janjukian as a Tertiary fossil.

PULVINULINA SCABRICULA, Chapman.

Pulvinulina scabricula, Chapman, 1910, Proc. Roy. Soc. Vic., n.s., xxii. (2), p. 288, pl. ii., fig 2*a,b*. Heron-Allen and Earland, 1924, Journ. Roy. Micr. Soc., p. 180.

Observations.—This species is typically Janjukian, being confined to the Miocene of Victoria. It is easily distinguished from related species by the distinctly convex superior surface and ornament of deep pitting. It has been recorded from Batesford and the Mallee Bores. This form was collected from the washings.

ROTALIA CALCAR, d'Orbigny sp.

Calcarina calcar, d'Orb., 1826, Ann. Soc. Sci. Nat., iii., p. 276, No. 1; Modele, No. 34.

Rotalia calcar, d'Orb. sp., Chapman, 1910, Proc. Roy. Soc. Vic., n.s., xxii. (2), p. 289, pl. iii., fig. 2. Heron-Allen and Earland, 1924, Journ. Roy. Micr. Soc., p. 181.

Observations.—This very ornate species is also found commonly at Batesford (Janjukian). It has also occurred sparingly in the older series (Balcombian) at Clifton Bank, Muddy Creek.

Examples of this form were found both in the washings and in thin sections of the limestone.

CALCARINA DEFRANCII, d'Orbigny.

Calcarina defrancii, d'Orb., 1826, Ann. Sci. Nat., p. 276, No. 3, pl. xiii., figs. 5-7. Brady, 1884, Rep. Chall. Exped., ix., p. 714, pl. cvii., figs. 6*a-c*. Heron-Allen and Earland, 1924, Journ. Roy. Micr. Soc., p. 182.

Observations.—Horizontal sections through test of this species show the interseptal canal system distinctly marked out by an infilling of yellow phosphatic(?) material, which may be the initial stage of glauconitization. In some cases even the tubuli are filled with this material.

Messrs. Heron-Allen and Earland point out that the figure of *Rotalia calcar* given by F. Chapman (P.R.S. Vic., n.s., xxii. (2), 1910, p. 289, pl. liii., fig. 2), is referable to *Calcarina defrancii.* As a matter of fact it is sometimes difficult to determine the relationships of the two species owing to weathering; and the distinctness of the two forms was not recognised at the time when Mr. Chapman wrote his paper. Both forms are found at Batesford, in somewhat equal abundance.

GYPSINA HOWCHINI, Chapman.

(Plate VII., Fig. 6.)

Gypsina howchini, Chapman, 1910, Proc. Roy. Soc. Vic., n.s., xxii. (2), p. 291, pl. ii., figs. 4*a,b*; pl. iii., figs. 3-5. Heron-Allen and Earland, 1924, Journ. Roy. Micr. Soc., June, p. 183.

Observations.—This occurrence at Keilor is especially interesting because it is the third locality in which it has been found, the previous ones being Batesford and the Mallee Bores. It is recorded from both sections and washings.

GYPSINA GLOBULUS, Reuss sp.

Ceriopora globulus, Reuss, 1847, Haidinger's Naturw. Abhandl. ii., p. 33, pl. v., fig. 7.

Gypsina globulus, Rss. sp., Chapman, 1907, Proc. Linn. Soc. N.S.W., xxxii. (4), p. 747. Id., 1910, Proc. Roy. Soc. Vic., xxii. (2), p. 290. Heron-Allen and Earland, 1924, Journ. Roy. Micr. Soc., p. 183, pl. xiv., figs. 117, 118. Cushman, 1924, Samoan Foram., Carnegie Inst. pub. No. 342, p. 45.

Observations.—In some respects this form resembles the species *G. howchini,* but is smaller and perfectly spherical. It occurs at Batesford and in the Mallee Bores (Vic.), Malekula (New Hebrides), and Christmas Is. It was found in sections and washings of the limestone.

GYPSINA INHAERENS, Schultze sp., var. PLANUM, Carter.

(Plate VII., Fig. 5.)

Polytrema planum, Carter, 1876, Ann. Mag. Nat. Hist., [4], xvii., p. 211, pl. xxii., figs. 8, 9, 19.
Polytrema miniaceum, Pallas sp., var. *involva*, Chapman, 1900, Journ. Linn. Soc., xxviii., p. 17, pl. ii., fig. 3.
Gypsina inhaerens, Schultze sp., Yabe, 1918, Sci. Rep. Tôhoku Imp. Univ., [2] (Geol.), iv. (1), p. 22, pl. iv. (ii.), fig. 4; pl. v. (iii.), fig. 3.

Observations.—*G. inhaerens* is first mentioned as a Miocene fossil by Chapman in the Christmas Is. Mon., 1900. Yabe described it in *Carpenteria* limestone from British N. Borneo. This occurrence really belongs to that variable form known as *P. planum*, and although Yabe shows some hesitation on this point, Mr. Chapman says there is little doubt as to the identity. This is the first Victorian record, fossil or recent. Its association in Christmas Is. with *Lepidocyclina* is comparable with the present occurrence. It shows intergrowth with *L. ramosissimum*. The chambers are very minute and subquadrate in form.

AMPHISTEGINA LESSONII, d'Orbigny.

Amphistegina lessonii, d'Orb., 1826, Ann. Sci. Nat., vii., p. 304, No. 3, pl. xvii., figs. 1-4.
Amphistegina campbelli, Karrer, 1864, Novara Exped., Geol. Theil., i., p. 84, pl. xvi., fig. 18.
Amphistegina lessonii, d'Orb., Chapman, 1910, Proc. Roy. Soc. Vic., n.s., xxii. (2), p. 294, pl. iii., fig. 6. Cushman, 1919, Foss. Foram. from W. Indies, Carnegie Inst. Washington, publ. 291, p. 50, pl. vii., fig. 7. Yabe and Hanzawa, 1925, Sci. Rep. Tôhoku Imp. Univ., [2] (Geol.), vii. (2), p. 48, pl. vii., figs. 9, 10; pl. x., fig. 4.

Observations.—The flat forms, indicating shallow water, as well as the thick domed-shaped forms, indicating deeper water, occur at Green Gully. The species was also met with at Batesford, Papua, and New Hebrides.

LEPIDOCYCLINA TOURNOUERI, Lemoine and Douvillé.

(Plate VIII., Fig. 7.)

L. tournoueri, Lem. and Douv., 1904, Mém. Soc. Géol. France, xii. (2), p. 19, pl. i.; fig. 5; pl. ii., figs. 2-14; pl. iii., fig. 1. Chapman, 1910, Proc. Roy. Soc. Vic., n.s., xxii. (2), p. 295, pl. iv., figs. 1, 2, 6. Heron-Allen and Earland, 1924, Journ. Roy. Micr. Soc., p. 186.

Observations.—This is quite a typical form of the Batesfordian phase, represented at Batesford, near Geelong, where it is excessively abundant in the lower limestone and more sparingly in the upper beds of the Filter Quarries. There the limestones pass into marls also containing a few of these forms. From the more or less total absence of this species from the material described by Heron-Allen and Earland, Mr. Chapman suggests that their samples came from one of the higher horizons at Batesford.

L. tournoueri is also recorded from the Miocene red limestone of Grange Burn, near Hamilton. The most easterly locality in Victoria is one mile N.W. of the junction of the Lighthouse and Sorrento roads at the back of Cape Schanck. It is also known from Borneo. It was found in the sorted material as well as in thin sections of the limestone.

LEPIDOCYCLINA MARGINATA, Michelotti sp.

Orbitoides marginata, Michel., 1847, Natur. Verh. Holl. Maatsch. Wetensch., Haarlem, iii., p. 45, pl. iii, fig. 4.
Lepidocyclina marginata, Michel., Chapman, 1910, Proc. Roy. Soc. Vic., n.s., xxii. (2), p. 296, pl. iv., fig. 5; pl. v., figs. 1-3. Cushman, 1919, Foss. Foram. from W. Indies. Carnegie Inst. Washington, pub. 291, p. 60, pl. xii., figs. 1, 2.

Observations.—This form is also recorded from Batesford and the lower beds, Muddy Creek (as *Orbitoides mantelli,* Howchin, *non* Morton). It occurs at Keilor with some frequency, although complete specimens are difficult to obtain.

LEPIDOCYCLINA MARTINI, Schlumberger.

(Plate VIII., Fig. 8.)

Orbitoides stellata, Howchin (*non* d'Archiac), 1889, Trans. Roy. Soc. S.Aust., xii., p. 17, pl. i., figs. 9-11.
Lepidocyclina martini, Schl., Chapman, 1905, Journ. Linn. Soc. N.S.W., xxx., p. 272, pl. v., fig. 2. Chapman, 1910, Proc. Roy. Soc. Vic., n.s., xxii. (2), p. 297, pl. iv., figs. 2-4.

Observations.—*L. martini* has a stellate outline, and in vertical section the pillars are more pronounced and closer together than in *L. tournoueri.*

It occurs at Batesford (Vic.) and Santo (New Hebrides). The species was recorded from both sorted material and thin sections.

LEPIDOCYCLINA VERBEEKI, Newton and Holland sp.

(Plate VIII., Fig. 10.)

Orbitoides papyracea, Brady (*non* Boubée), 1875, Geol. Mag., [2], ii., p. 253, pl. xiv., fig. 1.
Orbitoides (Lepidocyclina) verbeeki, Newton and Holland, 1899, Ann. Mag. Nat. Hist., [7], iii., p. 257, pl. ix., figs. 7-11; pl. x., fig. 1.

Lepidocyclina verbecki, Chapman, 1914, Journ. Roy. Soc. N.S.W., xlviii., p. 297, pl. viii., figs. 5, 6; pl. ix., fig. 10 (var. *papuaensis*).

Observations.—Already recorded from Miocene of Sumatra, Borneo, Christmas Is., Formosa, Loo Choo Is., probably Philippines, Malekula (N.H.), Bootless Inlet (Papua). F. Chapman has also recorded it from the Balcombian of Muddy Creek, and a recent examination we have made together shows that this species is also sparingly represented at Batesford, where hitherto it was considered to be absent. (See Nat. Mus. Mem. No. 5, 1914, p. 24.)

LEPIDOCYCLINA MURRAYANA, Jones and Chapman sp.

(Plate VIII., Fig. 9.)

Orbitoides (Lepidocyclina) murrayana, Jones and Chapman, 1900, Mon. Christ. Is. (Brit. Mus.), p. 253, pl. xxi., fig. 10.

Lepidocyclina formosa, Schl., 1902, Samml. des Geol. Reichs. Mus. Leiden, [1], vi. (3), p. 251, pl. vii., figs. 1-3.

Lepidocyclina murrayana, Chapman, 1914. Journ. Roy. Soc. N.S.W., xlviii., p. 296, pl. viii., fig. 7.

Observations.—This form is not uncommon in the sections of the limestone and resembles the Christmas Is. specimens. It occurs also at German E. Africa and Madagascar.

SPONGIAE.

CLIONA cf. MAMMILLATA, Chapman.

Cliona mammillata, Chapman, 1907, Proc. Roy. Soc. Vic., n.s., xx. (2), p. 208, pl. xvii., fig. 3 (not pl. xviii. as in text).

Observations.—The present form resembles the above in the swollen sac-shaped chambers in the crypt. It is associated with a *Cerithium,* in the ironstone. The example described by F. Chapman is from Swan Reach, Gippsland Lakes, in Kalimnan strata.

ANTHOZOA.

ORBICELLA TASMANIENSIS, Duncan sp.

Heliastraea tasmaniensis, Duncan, 1876, Quart. Journ. Geol. Soc., xxxii., p. 342, pl. xxii., figs. 1-3.

Astrangia tabulosa, Tate, 1894, Journ. Roy. Soc. N.S.W., xxvii., p. 145, pl. xiii., fig. 2.

Orbicella tasmaniensis, Duncan sp., Chapman, 1919, Proc. Roy. Soc. Vic., n.s., xxxii. (2), p. 23, pl. i., fig. 1.

Observations.—This form has been recorded from Royal Park and Flinders, Victoria; Table Cape, Tasmania; and Ooldea, S. Australia.

Thamnastraea sera, Duncan.

Thamnastraea sera, Duncan, 1876, Quart. Journ. Geol. Soc., xxxii., p. 343, pl. xxii., fig. 4-6.

Observations.—This form was recorded from both limestone and fossiliferous ironstone.

Fungia pedicella, sp. nov.

(Plate VIII., Fig. 12.)

Description of Holotype.—Cast in ironstone. Corallum of moderate size; depressed, conical, roundly elliptical. Septa numerous and distinctly perforate towards the peripheral zone. Median depression not much elongated. Base of corallum produced into a short pedicle. In the first growth-stage of about 20 mm. (longest diam.), about 80 septa in three cycles.

Dimensions.—Longest diam. (approx.) 40 mm. Shortest diam. (approx.) 32 mm. Height 15 mm.

Holotype collected by Mr. W. J. Parr and presented to Nat. Mus. Coll.

Description of Paratype.—Cast in ironstone. This specimen resembles in general characters the selected holotype, but the corallum is more depressed and the pedicle much more prominent. Moreover, the septa are slightly stronger and the perforations towards the outer zone apparently coarser. In size it agrees with the holotype, and in general with the other characters, and it may be assumed that there is a certain amount of variation which caused the differences mentioned. The paratype has been presented to the Nat. Mus. Coll. [13445]

Occurrence.—Ironstone beds, Outcrop 2, Green Gully, Keilor.

Age.—Janjukian.

Observations.—A similar form from Flemington, collected by the late Mr. J. Walker, is in Nat. Mus. Coll. Another example from Maude is in the Dennant Coll., Nat. Mus. It is represented by a cast in ferruginous limestone.

ECHINODERMATA.

Echinus (Psammechinus) woodsi, Laube, var. humilior, Bittner.

Psammechinus woodsi, Laube sp., var. *humilior,* Bittner, 1892, Sitz. k.k. Akad. Wiss. Wien, ci., p. 337, pl. —, fig. 3.

Observations.—This form was found both in the ironstone in the foraminiferal limestone, the specimen from the latter being much larger. The fossil is depressed, and shows variability in the density of the secondary miliaries. It is also recorded from Royal Park and Batesford, Victoria; Murray Cliffs and Aldinga Cliffs, S. Aust.

BRACHIOPODA.

Tegulorhynchia coelata, T. Woods sp.

Rhynchonella coelata (McCoy MS.), T. Woods, 1878, Journ. Roy. Soc. N.S.W., xi., p. 77.

Rhynchonella squamosa, Tate (*non* Hutton), 1880, Trans. Roy. Soc. S. Aust., iii., p. 32, pl. ix., figs. 9*a*, *b*.

Tegulorhynchia coelata (McCoy MS.), T. Woods sp., Chapman and Crespin, 1923, Proc. Roy. Soc. Vic., n.s., xxxv. (2), p. 181, pl. xi., figs 1, 2; pl. xii., fig. 17; pl. xiii., fig. 27.

Observations.—This species has been fully described in a paper on Austral Rhynchonellacea (1922, pp. 181-3). The discovery of this form at Keilor during the present work, and the realisation that it did not coincide with the true generic definition of *Hemithyris* and *Acanthothyris* led Mr. Chapman and myself to erect the new genus *Tegulorhynchia*. *T. coelata* is fairly common in the fossiliferous ironstone, and its ornament is well preserved in the moulds. It occurs at Table Cape, Tasmania, and at several localities in Victoria and S. Australia.

Chlamys keiloriana, sp. nov.

(Plate VIII., Fig. 13.)

Description of Holotype (Cast).—Left valve of shell only is present, and is probably the more convex. Thirty-eight ribs are present, which may reach forty in complete specimen. Ribs closely scaly, squamation depressed. Furrows flattened, and smooth and of equal space to the ribs. Ears unequal in size and scaly.

Dimensions.—Greatest length of posterior region, circ. 22 mm. Height, circ. 21 mm. Depth in median area, circ. 2 mm.

Observations.—This shell belongs to the same group as *C. antiaustralis*, and seems to foreshadow the later forms of that type, including *C. asperrima*. The difference lies in the transverse squamation of the present form. In *C. antiaustralis* the ribs are flanked by narrower lateral riblets, which are scaly. The main ribs are far apart. The ribs in *C. keiloriana* are much closer together, and more numerous. The squamation is more erect in *C. antiaustralis* and *C. asperrima*. In the former there are 25 ribs, in the latter (Victorian example), 22-24, and in *C. keiloriana*, 28-40. The nearest associate appears to be a species of *Chlamys* yet to be described from Grice's Creek, in the Nat. Mus. Coll.

Occurrence.—Ironstone Beds, Green Gully, Keilor, Outcrop 2.

Age.—Janjukian.

Lithophaga fabaeformis, sp. nov.

(Plate IX., Figs. 14, 15.)

Description of Holotype (Cast).—Shell equivalved, oblong, rounded in front. Beaks near anterior end, short, prominent, close together, extending slightly beyond anterior margin. Dorsal line gently arched. Ventral border slightly undulate. Anterior extremity below the beaks well rounded. Posterior extremity squarely rounded. Growth lines distinctly marked on surface of cast. Thickness is uniform.

Dimensions.—Length ant-post., 17 mm. Approx. thickness of two valves in cast, 4·5mm. Height in anterior region, 4 mm.; in the posterior, 6·5 mm. Dimensions of paratype: length, 11·5 mm.; height, 6 mm.

Observations.—The genus is apparently new to the Tertiary fossil deposits of Australia, although one species has been already recorded under the same generic name, as *L. latecaudatus*, by Pritchard (Proc. Roy. Soc. Vic., 1901, xv., p. 88, pl. xiv., fig. 4). This form, which was found in the Janjukian of Torquay, appears to be more properly referred to the genus *Modiolus*. The well-known living form, *L. truncata*, from Auckland, is anteriorly broader than the fossil form. The beaks are inclined posteriorly rather than anteriorly, as in the fossil form.

Two fossil forms have been recorded in New Zealand, *L. striata*, Hutton, from Shakespeare Cliff, is Pliocene; *L. nelsoniana*, Suter, from Port Hills, Nelson, is Miocene. Both forms are larger than the Australian species.

Holotype presented to Nat. Mus. Coll.

Occurrence.—Ironstone beds, Outcrop 1, Green Gully, Keilor.

Age.—Janjukian.

GASTEROPODA.

PHASIANELLA DENNANTI, sp. nov.

(Plate IX., Figs. 16, 17.)

Description of Holotype (in Dennant Coll., Nat. Mus.).—Shell conical, with five subventricose whorls. Smooth, with the exception of very fine lirae that are more apparent in the weathered specimens, especially on the base of the last whorl. Surface polished. Mouth ovate, the inner lip everted. In the Kalimnan holotype the colour markings are still visible, as a square-checked pattern.

Dimensions.—Height, 14 mm. Width at base, 8·25 mm. Height of aperture, inside measurement, 4·75 mm. Height of aperture, 5·75 mm.

Description of Paratype.—This occurs as a mould in the ironstone, and from the shape of the whorl and general form of the shell with characteristic suture lines, is identical with the form described from the Dennant Coll.

Observations.—In comparison with *P. australis* the whorls are not so high, but slightly more inflated, and with a tendency to become gradated. It is longer and narrower than *P. ventricosa*.

Occurrence.—Holotype, Muddy Creek (Upper Bed). Paratype, Ironstone Beds, Green Gully, Keilor, Outcrop 2.

Age.—Janjukian.

CANTHARIDUS MULTICINCTUS, sp. nov.

(Plate IX., Fig. 18.)

Description of Holotype.—The mould of the shell elongate conical with about 6 whorls. Whorls not strongly inflated. Suture lines distinct but not deeply incised. Ornament consisting of several fine deeply cut spiral sulci on each whorl, numbering 7 on the body whorl.

Dimensions.—Height, 8 mm. Width at base, 4 mm.

Observations.—Compared with the living *Cantharidus pulcherrimus,* the present species is more elongate and has more numerous spiral bands. The suture lines are more deeply cut than in the fossil form.

Occurrence.—Ironstone Beds, Green Gully, Keilor, Outcrop 2.

Age.—Janjukian.

GIBBULA sp.

This form is not precisely determinable on account of the absence of the basal portion of the shell. It is comparable with an undescribed form from Cape Otway, in the Dennant Coll.

VERMICULARIA FUNICALIS, sp. nov.

(Plate IX., Figs. 19-21.)

Description of Holotype.—Gellibrand (in Dennant Coll., Nat. Mus.). Shell tubular, somewhat flattened and irregularly coiled. Surface very faintly ornamented with concentric lirae, giving the shell a slightly corrugated appearance. In the method of coiling there is a tendency to form an irregularly convex shape on one side and concave on the other.

Dimensions.—Diam. of close spiral, 20 mm. Width of aperture, 2 mm.

Description of Paratype.—Curlewis (coll. F. Chapman, pres. Nat. Mus.). The tube is narrower than in the holotype, coiled but more depressed and slightly concave on one side. The surface shows characteristic wrinkling where the shell is preserved, though most of the specimen is in form of a cast.

Dimensions.—Diam. of close spiral, 18 mm. Width of aperture, 1 mm.

Description of Paratype.—Keilor (pres. to Nat. Mus. coll.). Tubular shell about same thickness as in holotype; depressed, with whorls much more numerous than in either the type or the Curlewis paratype. The shell is represented mainly by a cast, though portions of the shell-surface are seen on the hollow mould, and this shows the typical wrinkling of the Gellibrand holotype.

Dimensions.—General width of flat spiral, 25 mm. Width of aperture, 2 mm.

Observations.—Amongst the six species already described by Tate from the Australian Tertiaries, there is none which seems to approach the present species, which is easily distinguished by its comparatively slender tube and flattened and closely coiled shell.

The recent species *V. flava,* Verco, (Pl. IX., Fig. 22) shows, in some examples, that the basal portion has the same tendency as the fossil to form a conoidal type of shell, but it rapidly uncoils into an isolated tube. A figure is given which emphasises this character in specimens obtained from Bass Strait (cable between Flinders and Tasmania). These specimens were kindly lent by Mr. C. J. Gabriel.

Occurrence.—Holotype, Gellibrand; also another specimen from Cape Otway in Dennant Coll. Paratypes, Curlewis, in yellow limestone, Chapman Coll.; and Green Gully, Keilor, in polyzoal limestone.

Age.—Janjukian.

CEPHALOPODA.

Aturia australis, McCoy.

A. zic-zac, Sow. sp., var. *australis,* McCoy, 1876, Prod. Pal. Vic., dec. iii., p. 21, pl. xxiv., figs. 1-5.

A. australis, McCoy, Chapman, 1921, Proc. Roy. Soc. Vic., n.s., xxxiv., p. 12.

Observations.—Among the Janjukian localities for this species are Spring Creek, Torquay, Vic., and Table Cape, Tas. The present form is of medium dimensions.

PISCES.

Lamna compressa, Agassiz.

Lamna compressa, Agassiz, 1843, Poiss. Foss., iii., p. 290, pl. xxxvii., figs. 35-42. Chapman and Cudmore, 1924, Proc. Roy. Soc. Vic., n.s., xxxvi. (2), p. 127.

Observations.—One specimen of this comparatively rare species from Keilor, kindly lent for examination from the Cudmore Collection, has since been presented to the Nat. Mus. Coll.

Isurus retroflexus, Agassiz sp.

(Plate IX., Fig. 23.)

Oxyrhina retroflexus, Agassiz, 1843, Pois. Foss., iii., p. 281, pl. xxxiii., fig. 10.

Isurus retroflexus, Ag. sp., Chapman and Cudmore, 1924, Proc. Roy. Soc. Vic., n.s., xxxvi. (2), p. 130, pl. x., fig. 31.

Observations.—This species is represented in the ironstone series by a well-preserved specimen still attached to the matrix, and although the basal part of the tooth has decayed the outline still shows the characteristic form seen in the above species. Plesiotype pres. Nat. Mus. Coll. Outcrop 2, Green Gully, Keilor.

VIII.—Summary of results.

1.—It is probable that the Older Basalt is a terrestrial flow. At the summit of the flow the junction between the limestone and the basalt is marked by a broken surface of the latter mingled with a dense limestone deposit and quartz grains.

2.—The polyzoal limestone is a single local lenticle found in the one locality on the south bank of Green Gully upstream from the bridge. The basal portion of the limestone series overlying the Older Basalt is more ferruginous and harder than the succeeding yellow limestone, whilst the latter seems to be free from the gritty particles found in the basal portion. The great abundance of *Lithothamnium* in these lower indurated beds points to the existence of shallow water reefs, whilst the rarity or even absence in the yellow limestone above indicates a deepening of the sea in the area.

3.—The upper portion of the limestone series is comparable with the Batesfordian phase in its general faunal aspects, and which F. Chapman regards as Burdigalian in its foraminiferal facies. *Lepidocyclina verbeeki* occurs here with some frequency, and a re-examination of the Batesford limestone shows it to be also represented there.

4.—Where a junction of the limestone and the overlying ironstone is seen, there is sometimes a replacement of the original limestone by ferruginous material, which makes the line of boundary impossible to define.

5.—There is a faunal difference between the limestone and the ironstone faunas, as is seen by the rarity of species in common, the only persistent forms being *Thamnastraea sera* and *Echinus* (*Psammechinus*) *woodsi*, var. *humilior*.

6.—The discovery in the probably Kalimnan sands of spicules of *Spongilla* and broken fragments of *Cyclas?* or *Unio*, suggests a freshwater origin for this deposit.

7.—It seems probable that the Travertine is older than the Diatomaceous deposit, although the evidence is not conclusive.

8.—An interesting feature of the ironstone fauna of the area is the occurrence of certain species which hitherto have been restricted to Table Cape. They comprise the following:—*Thamnastraea sera, Cardium septuagenarium, Turbo etheridgei, Cantharidus alternatus, Fusus tasmanicus.* There are also several others which are not entirely restricted, but are characteristic of the Table Cape fauna.

9.—Seven new species are herein described:—*Lithophyllum hydractinioides, Fungia pedicella, Chlamys keiloriana, Lithophaga fabaeformis, Phasianella dennanti, Cantharidus multicinctus, Vermicularia funicalis.* Of the 22 species enumerated by Hall and Pritchard from Keilor, 10 are common to this list. Of the 19 species recorded by Dennant and Kitson from Keilor, 10 are found in the present list. The total number of species recorded in this paper, excluding indeterminate forms, is 103.

ACKNOWLEDGMENTS.

My thanks are due to Professor E. W. Skeats, D.Sc., for the suggestion of taking up the work of describing the fossil fauna of Green Gully, Keilor, and also for his assistance and advice to me during the work. To the Director and the Curator of the National Museum I express my sincere thanks for placing at my disposal the Sweet Collection, together with other material in the Museum, and for facilities during the progress of the work. My acknowledgments are due to Mr. C. J. Gabriel for his kind assistance in the determination of several of the fossil genera, and also to Mr. W. M. Bale for kindly determining the diatoms mentioned. To Mr. F. Chapman I express my sincere gratitude for his guidance and interest taken throughout the writing of this paper.

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EXPLANATION OF PLATES.

(Numbers in brackets refer to registered specimens in the National Museum.)

Plate VII.

Fig. 1.—*Lithothamnium ramosissimum*, Reuss. Typical branch fractured in the matrix. Polyzoal limestone, Keilor. ×16.

Fig. 2.—*Lithothamnium amphiroaeformis*, Rothpletz. Ferruginous limestone, Keilor. ×16.

Fig. 3.—*Lithophyllum hydractinioides*, sp. nov. Holotype. Initial growth of thallus. Polyzoal limestone, Keilor. ×184. [13456]

Fig. 4.—*Haddonia torresiensis*, Chapman. Vertical section through complete test. Polyzoal limestone, Keilor. ×16.

Fig. 5.—*Gypsina inhaerens,* Schultze sp., var. *planum,* Carter. Vertical section. Polyzoal limestone, Keilor. ×16.

Fig. 6.—*Gypsina howchini,* Chapman sp. Median section. Polyzoal limestone, Keilor. ×28.

PLATE VIII.

Fig. 7.—*Lepidocyclina tournoueri,* Lem. and Douv. Section in polyzoal limestone matrix, Keilor. ×16.

Fig. 8.—*Lepidocyclina martini,* Schl. Vertical section, Polyzoal limestone, Keilor. ×16.

Fig. 9.—*Lepidocyclina murrayana,* Jones and Chapman. Vertical section. Polyzoal limestone, Keilor. ×16.

Fig. 10.—*Lepidocyclina verbeeki,* Newton and Holland. Vertical section, excentric. Polyzoal limestone, Keilor. ×16.

Fig. 11.—Base of ferruginous limestone, Keilor. ×16. Arrows point to *Amphisteginae.*

Fig. 12.—*Fungia pedicella,* sp. nov. Holotype. Ironstone beds, Keilor. Janjukian. Nat. size. [13444]

Fig. 13.—*Chlamys keiloriana,* sp. nov. Ironstone beds, Keilor. Janjukian. ×2. [13446]

PLATE IX.

Fig. 14.—*Lithophaga fabaeformis,* sp. nov. Holotype. Ironstone beds, Keilor. Janjukian. ×2. [13447]

Fig. 15.—*Lithophaga fabaeformis,* sp. nov. Paratype. A shorter form. Ironstone beds, Keilor. Janjukian. ×2. [13448]

Fig. 16.—*Phasianella dennanti,* sp. nov. Holotype. Dennant Coll. Upper beds, Muddy Creek. Kalimnan. ×2. [13450]

Fig. 17.—*Phasianella dennanti,* sp. nov. Paratype. Wax squeeze of a mould. Ironstone beds, Keilor. Janjukian. ×2. [13451]

Fig. 18.—*Cantharidus multicinctus,* sp. nov. Holotype. Ironstone beds, Keilor. Janjukian. ×2. [13449]

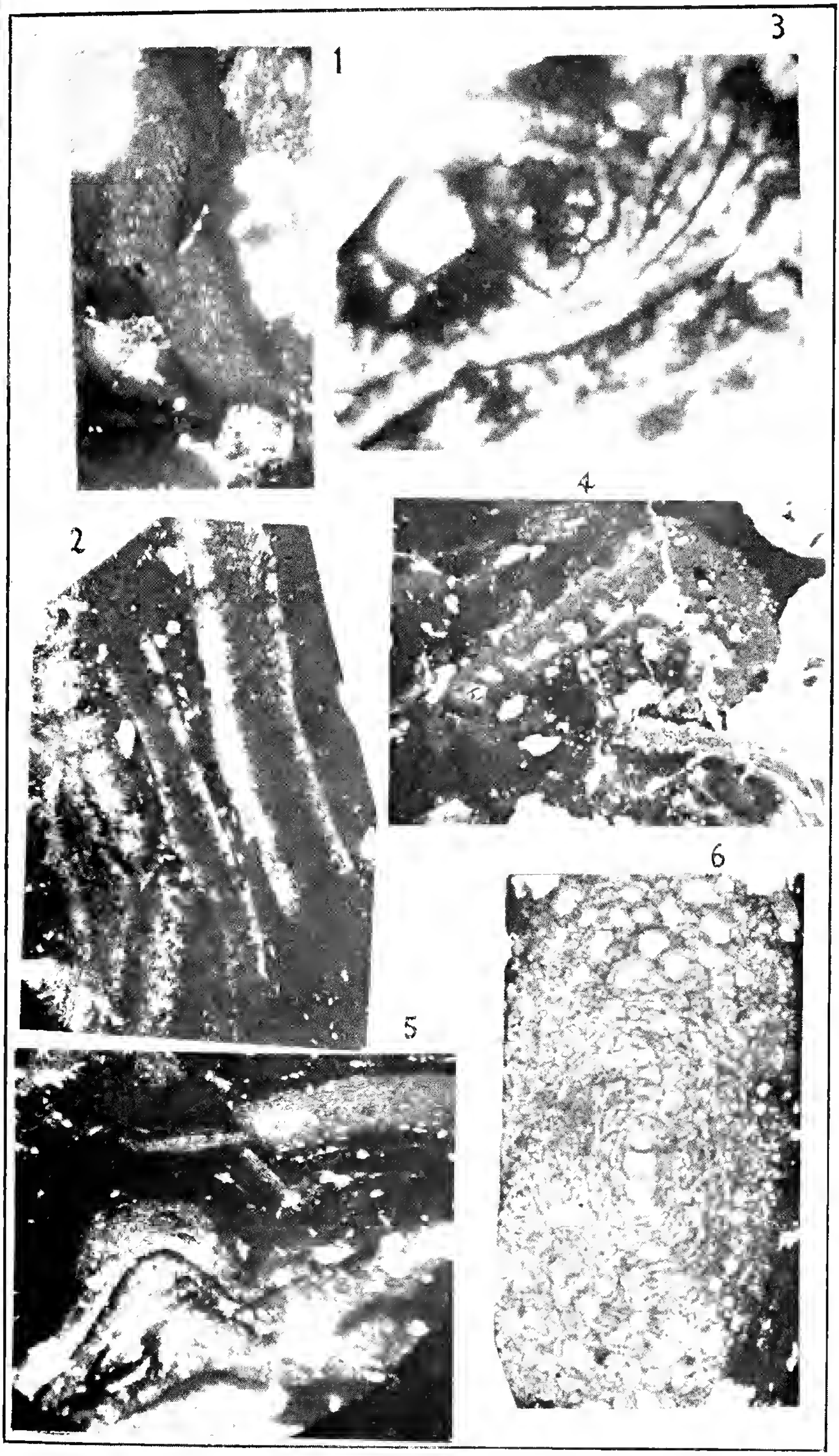
Fig. 19.—*Vermicularia funicalis,* sp. nov. Paratype. Polyzoal limestone, Keilor. Janjukian. Nat. size. [13453]

Fig. 20.—*Vermicularia funicalis,* sp. nov. Holotype. Gellibrand. Dennant Coll. Janjukian. Nat. size. [13452]

Fig. 21.—*Vermicularia funicalis,* sp. nov. Paratype. Curlewis. Janjukian. Nat. size. [13454]

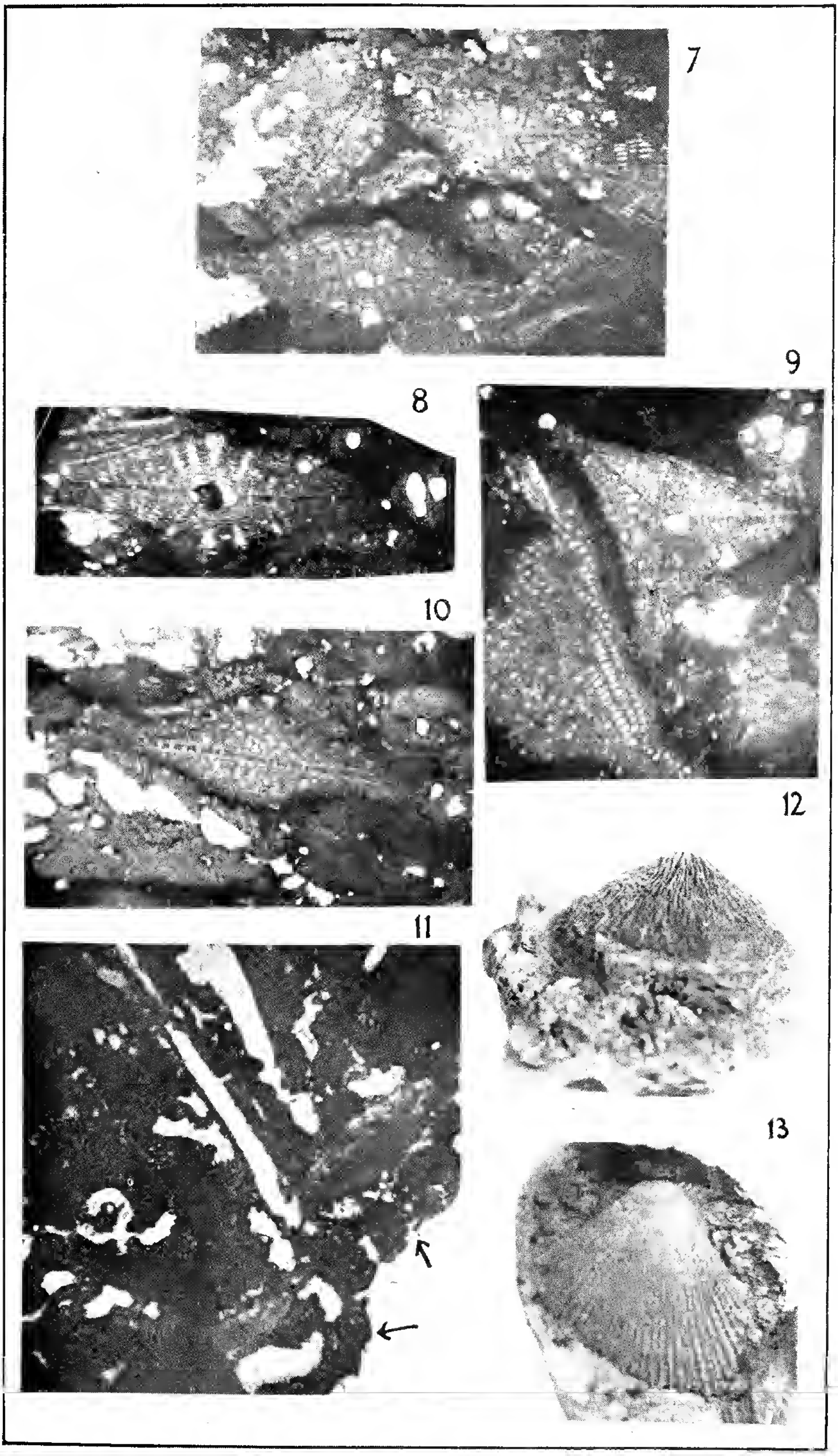
Fig. 22.—*Vermicularia flava,* Verco. Recent. Bass Strait. Nat. size.

Fig. 23.—*Isurus retroflexus,* Ag. sp. Ironstone beds, Keilor. Janjukian. Nat. size. [13455]



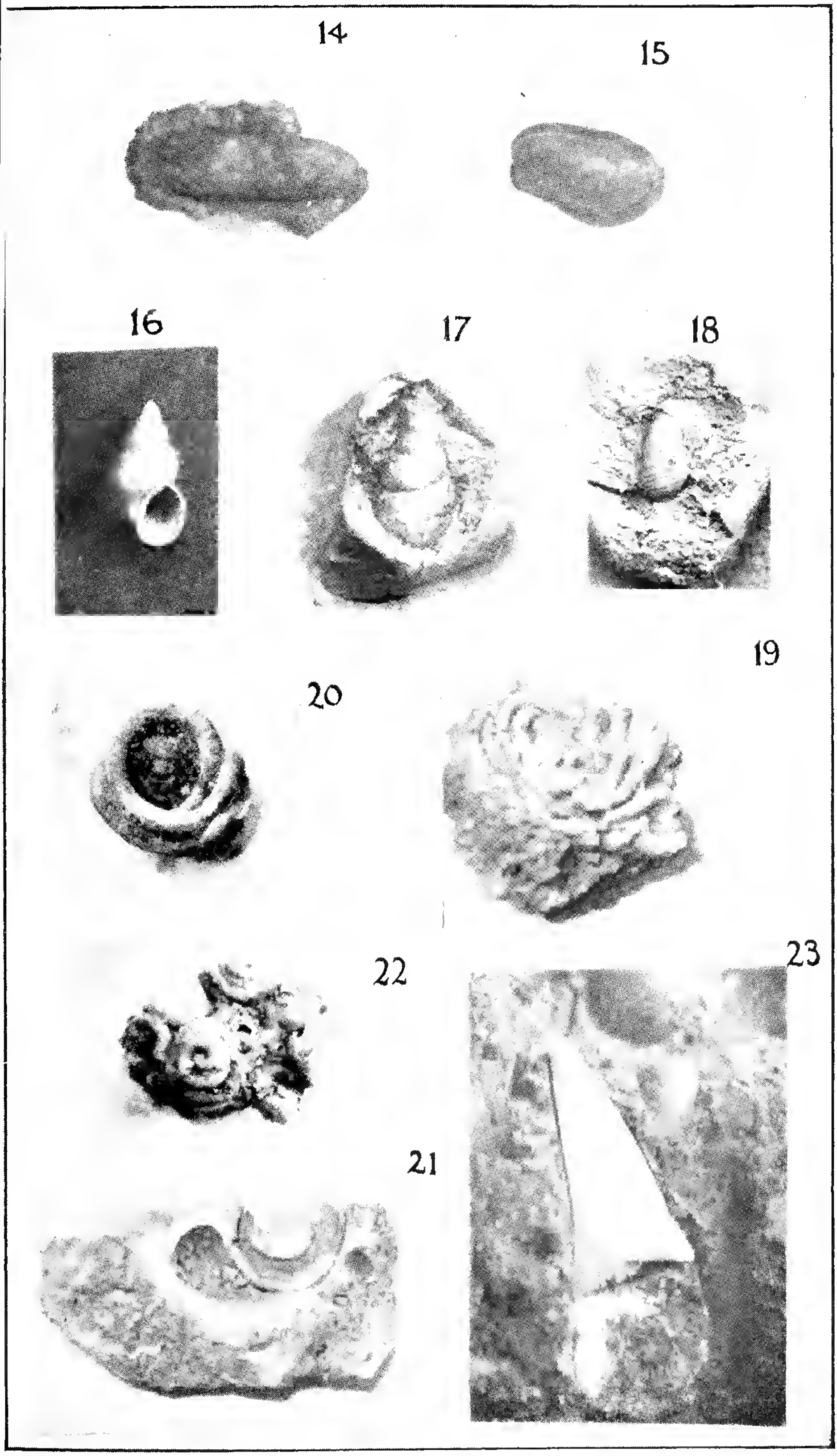
F C et I.C. photo.

Cainozoic Fossils, Keilor.



F.C. et I.C. photo.

Cainozoic Fossils, Keilor.



F.C. photo.

Cainozoic Fossils, Keilor, etc.

[Proc. Roy. Soc. Victoria, 38 (N.S.), 1926.]

Art. XII.—*Geological Notes on Neumerella, and the Section from Bairnsdale to Orbost.*

By FREDERICK CHAPMAN, A.L.S., F.R.M.S.

(Palaeontologist to the National Museum.)

(With Plate X.)

[Read 9th July, 1925.]

I.—Introductory.

The following notes are based on some observations and collections made during an official visit to Neumerella in May, 1915. The Orbost railway line was then under construction, and from the fact that some large fossil casts had been found[1] during the work of excavation in the cuttings, it was evident that the beds there exposed were highly fossiliferous. I was accordingly deputed to explore this new locality in the hope of obtaining some interesting material for the National Museum collections.

The excavations for the Orbost railway showed that a vast deposit of marly limestone extends under the old coastal plain between the Lakes and the Snowy River. My own observations prove, however, that the fauna is practically the same as that of the lower part of the Bairnsdale series, and also shows strong faunal affinities with the Lower Murray Cliffs. There is here recorded for the first time a fairly long list of the smaller organisms, comprising Foraminifera and Ostracoda, groups which have not hitherto received much attention from those compiling local faunas, but which have their particular zonal value.

II.—Previous References to Lower Cainozoic Fossils of Bairnsdale Area.

A list of 23 species of fossils from the banks of the Mitchell River was given by J. Dennant (1891a), which he afterwards increased to more than 60 (1891b).

1.—These fossils were collected by the late Mr. Andrew Kincaid, of the Victorian Railways, to whom I was much indebted for practical help during my short stay at Neumerella.

A comprehensive paper dealing with all the fossiliferous localities of the Lower Mitchell area was published in 1903 by J. Dennant and Donald Clark (1903). The localities therein described in detail belong to the Janjukian and Kalimnan stages, and there appears to be an intermediate one which has not yet been established, but of which there is evidence in the collections at the National Museum. The fossil records from this paper are apparently all included in the next paper referred to.

Dennant and Kitson (1904) published a Catalogue of Cainozoic Fossils from the Mitchell River. This list does not include Polyzoa or Foraminifera.

As regards the Polyzoa, MacGillivray (1895) had already enumerated a large assemblage of species from the Bairnsdale Tertiaries, but that author did not give any indication of the precise locality of the material, nor of the horizon.

A later author on the polyzoa, C. M. Maplestone (1898), does, however, state the locality as Mitchell River, Bairnsdale. In all probability MacGillivray's specimens came from the same place, since it was then easy of access and rich in that material. Maplestone subsequently (1904) gave a list of Polyzoa, with a Table of Mitchell River species.

III.—Fossils collected at Neumerella, near Orbost.

(a) *Characters of the Fossil Bed.*

The fossils collected by myself from May 28th to June 2nd. 1915, in the railway construction works, occurred in a marly limestone of a rich yellow to ochreous colour. A good opportunity was then afforded to examine the details of stratification. since some of the cuttings were deep and the sides fairly clean. Certain bands were apparently rich in remains of cetaceans and fishes, and these, with the fossil crustacea, undoubtedly contribute the appreciable amount of P_2O_5 to be found in this limestone.

Many of the mollusca had their shells well preserved, and distributed along particular bands; but in other cases, where there had been local solution, the shells had been entirely removed. This was especially the case among the larger forms, as the great volutes and *Nautilus*. The dissolved calcic carbonate had in these cases been re-deposited in the neighbourhood, and often over impervious bands, in the form of clusters of dog's tooth spar, whilst some of the hollow shells themselves were filled with the crystals.

(b) *Age of the Bed.*

From an examination of the accompanying list of fossils it will be seen that the fauna is typically Janjukian.

The sharks' teeth, *Isurus retroflexus* and *Odontaspis incurva* are normally Janjukian, though they are known in the basal Kalimnan or remanié beds in Victoria.

The ostracoda recorded are closely matched by the fauna already described by the author from the polyzoal limestone of the Mallee Bores.

Nautilus geelongensis is common in and restricted to the Janjukian, with one exception, known from the Kalimnan of Grange Burn.

Ostrea ingens, Chlamys flindersi and *C. eyrei,* are all restricted Janjukian forms of mollusca.

Among the brachiopods, *Terebratella portlandica* is a Janjukian species.

One of the most conspicuous of the polyzoa is *Cellepora biradiata,* which has hitherto been recorded only from Mount Gambier, whilst it is here noted as well from the River Murray Cliffs, Corio Bay, and Muddy Creek, lower beds.

The tube-worm, *Serpula ouyenensis,* is a typical Janjukian fossil of the Mallee, which has also lately been described from New Zealand by H. Finlay, M.Sc. (1924, p. 449); the New Zealand localities are Pukeuri (Awamoan or Upper Miocene) and Clifden, Southland (Lower Miocene). *Ditrupa cornea,* var. *wormbetiensis* is most commonly found in the Janjukian (Miocene), although not entirely confined to that series.

Of the echinoids, *Cidaris* (*Leiocidaris*) *australiae* is a Janjukian form, along with *Arachnoides* (*Monostychia*) *australis, Eupatagus murrayensis,* and the two forms, *Pentagonaster* and *Antedon.*

Restricted Janjukian corals are seen in *Mopsea tenisoni* and *M. hamiltoni,* whilst the calcareous sponge, *Plectroninia,* has before been found only on the Lower Moorabool and at Flinders.

Of the foraminifera, many species have been noted from other Janjukian localities, such as of Batesford, Torquay, and the Mallee Bores (polyzoal series), although a proportion of them occur also in the Balcombian beds. There, however, they are usually thin-shelled and micromorphic, but in the Neumerella deposits, as in common with other Janjukian strata, they are well proportioned and robust.

(c) *List of Fossils.*

Note.—In the following list of 150 species and varieties, those new to the Mitchell River series are marked with an asterisk. Species herein described and noted in detail are marked †.

CETACEA.

Spp. indet. Vertebrae and fragments of rib-bones.

(One specimen represents two conjoined cervical vertebrae of about the dimensions and form of those seen in a full-grown Killer Whale, *Orca.*)

PISCES.

*†*Carcharias* (*Prionodon*) *aculeatus,* Davis sp.
*†*Squatina gippslandicus,* Chapman and Cudmore.

* *Carcharodon megalodon*, Agassiz.
(Two specimens purchased, one nearly 4½ inches (112·5 mm.) in height.)
* *Odontaspis contortidens*, Ag.
* „ *incurva*, Davis sp.
* *Isurus retroflexus*, Ag. sp.
* „ cf. *desorii*, Ag. sp.
* „ *hastalis*, Ag. sp.
(In the possession of the workmen, but examined and determined.)

BRACHYURA.

Carapaces of (?) Ocypoda.
Appendage joints of portunids and other slender chelae.

OSTRACODA.

* *Macrocypris decora*, G. S. Brady.
* *Bythocypris tumefacta*, Chapman.
* *Bairdia amygdaloides*, G. S. B.
* „ *australis*, Chapman.
* „ *foveolata*, G. S. B.
*† „ *minutissima*, sp. nov.
* *Cythere dictyon*, G. S. B.
*† „ *kincaidiana*, sp. nov.
* „ *scutigera*, G. S. B.
* „ *stimpsoni*, G. S. B.
* „ *parallelogramma*, G. S. B.
* „ *quadriaculeata*, G. S. B.
* „ *rastromarginata*, G. S. B.
* „ *wyville-thomsoni*, G. S. B.
* *Xestoleberis margaritea*, G. S. B.
* *Cytherella pulchra*, G. S. B.
* „ *punctata*, G. S. B.
(Most of these species are figured in my Report on the Mallee Bores.) (Chapman, 1916.)

CEPHALOPODA.

* *Nautilus geelongensis*, Foord.
(A fine cast of a large example was donated to the Museum by Mr. G. S. Rees, of the Victorian Railways. Other specimens were also found by the author.)

GASTEROPODA.

*†*Megalebennus concatenatus*, Crosse and Fischer sp., var. *pyrula*, nov.
*†*Calliostoma semiornata*, sp. nov.
Turritella murrayana, Tate.
* „ *conspicabilis*, Tate.
„ *tristira*, Tate.
*†*Vermicularia funicalis*, Crespin, var. *conferta*, nov.
(?) *Verconella* or (?) *Fasciolaria* sp. (cast).
Cassis exigua, T. Woods.
Cypraea leptorhyncha, McCoy.
* „ *subsidua*, Tate.
(Casts of this species are very common. They represent the gerontic stage of the shell.)
*†*Cypraedia* sp.
(A somewhat similar but undescribed form is found in the Balcombian beds. The present example is in the form of a cast.)

* *Pterospira validicostata*, Dennant and Kitson.
(This specific name is a nom. mut. for *P. alticostata*, Tate sp. The examples are chiefly in the form of casts, often of large size.)

PELECYPODA.

* *Glycymeris gunyoungensis*, Chapman and Singleton.
(Closely matches the variety found at Fyansford. Occurs as a cast.)
* *Glycymeris ornithopetra*, Chapm. and Singl.
(Also occurring as casts.)
Cucullaea corioensis, McCoy.
Dimya dissimilis, Tate.
Lima bassi, T. Woods.
Spondylus pseudoradula, McCoy.
Ostrea ingens, Zittel.
,, *hyotidoidea*, Tate.
* *Modiolus latecaudatus*, Pritchard sp.
Chlamys murrayana, Tate sp.
* ,, *polymorphoides*, Zittel sp.
,, *foulcheri*, T. Woods sp.
* ,, *flindersi*, Tate sp.
,, *sturtiana*, Tate sp.
* ,, *eyrei*, Tate sp.
Pseudamussium yahliensis, T. Woods sp., var. *semilaevis*, McCoy var.
Cardium victoriae, Tate.
* ,, *?septuagenarium*, Tate.
Chama lamellifera, T. Woods.
Antigona dimorphophylla, Tate sp. (Cast.)
* *Callanaitis multitaeniata*, Tate sp. (Cast.)
* *Dosinia johnstoni*, Tate.
?*Teredo* or *Kuphus* sp.

BRACHIOPODA.

Terebratulina suessi, Hutton.
* ,, *catinuliformis*, Tate.
* *Terebratella portlandica*, Chapm.
Terebratula tateana, T. Woods.
Magadinella woodsiana, Tate sp.
Magellania garibaldiana, Davidson sp.
,, cf. *crouchii*, T. Woods sp.

POLYZOA.

Ditaxipora intermedia, Waters sp.
Cellaria contigua, MacGillivray.
,, *rigida*, MacGill.
* ,, ,, var. *venusta*, MacGill.
,, *angustiloba*, Busk sp.
* ,, cf. *marginata*, Münster sp. (fide Stoliczka).
Lepralia burlingtoniensis Waters.
* *Selenaria cupola*, T. Woods sp.
Bipora cancellata, Busk sp.
,, *philippinensis*, Busk sp.
Cribrilina sp.
Porina gracilis Milne Edw. sp.
Smittia tatei, T. Woods sp.
*† *Cellepora biradiata*, Waters.
† ,, *coronopus*, Searles Wood (=*gambierensis*, Busk).
† ,, *fossa*, Haswell sp. (Also a complanate var. of the same.)
Adeona mucronata, MacGill.

* *Idmonea serialis*, Stol.
,, *divergens*, MacGill.
* ,, *?venusta*, MacGill.
,, *hochstetteriana*, Stol. sp., var. *bairnsdalei*, MacGill.
* ,, *incurva*, MacGill.
Retepora bairnsdalei, MacGill.
,, *subimmersa*, MacGill.

VERMES.

* *Ditrupa cornea*, Linné sp., var. *wormbetiensis*, McCoy.
* *Serpula ouyenensis*, Chapman.
(Also Mallee Bores and New Zealand Tertiaries.)

ECHINODERMATA.

* *Cidaris (Leiocidaris) australiae*, Duncan.
Paradoxechinus novus, Laube.
Clypeaster gippslandicus, McCoy.
Arachnoides (Monostychia) australis, Laube sp.
* ,, ,, ,, var. *elongata*, Duncan.
Eupatagus murrayensis, Laube.
* *Pentagonaster* sp.
* *Antedon* sp.

ANTHOZOA.

* *Mopsea tenisoni*, Chapman.
* ,, *hamiltoni*, Thomson sp.
Flabellum gambierense, Duncan.

SPONGIAE.

* *Plectroninia halli*, Hinde.

FORAMINIFERA.

* *Miliolina tricarinata*, d'Orb. sp.
* ,, *agglutinans*, d'Orb. sp.
* ,, *trigonula*, Lamarck sp.
*†*Jaculella ucumerellensis*, sp. nov.
* *Haplophragmium sphaeroidiniforme*, Brady.
* *Textularia gibba*, d'Orb.
* ,, ,, var. *tuberosa*, d'Orb.
* ,, *abbreviata*, d'Orb.
* *Spiroplecta sagittula*, Defrance sp.
* *Clavulina communis*, d'Orb.
* ,, *parisiensis*, d'Orb., var. *humilior*, Brady.
* *Gaudryina rugosa*, d'Orb.
* ,, *pupoides*, d'Orb.
* *Bolivina nobilis*, Hantken.
* *Nodosaria raphanus*, Linné sp.
* ,, *scalaris*, Batsch sp.
* ,, *(Dentalina) consobrina*, d'Orb.
* ,, ,, ,, var. *emaciata*, Reuss.
* ,, ,, *farcimen*, Soldani sp.
* ,, ,, *obliqua*, Linné sp.
* ,, ,, *adolphina*, d'Orb. sp.
* *Lingulina* cf. *costata*, d'Orb.
* *Cristellaria cultrata*, Montf. sp.
* *Polymorphina elegantissima*, Parker and Jones.
* ,, *gibba*, d'Orb.
* ,, *compressa*, d'Orb.
* ,, *communis*, d'Orb.

* *Globigerina bulloides*, d'Orb.
* „ *triloba*, Reuss.
* *Discorbina pileolus*, d'Orb. sp.
* *Truncatulina lobatula*, Walker and Jacob sp.
* „ *ungeriana*, d'Orb. sp.
* „ *refulgens*, Montf. sp.
* *Anomalina ammonoides*, Reuss sp.
* *Pulvinulina repanda*, F. and M. sp.
* „ *elegans*, d'Orb. sp.
* „ *karsteni*, Reuss sp.
* *Rotalia clathrata*, Brady.
* „ *soldanii*, d'Orb.
* *Nonionina depressula*, W. and J. sp.
* *Polystomella craticulata*, F. and M. sp.
* *Operculina complanata*, Defr.
* „ „ var. *granulosa*, Lem.
* „ *ammonoides*, Gron. sp.

IV.—Description of New and Rare Species.

Class PISCES.

Family CARCHARIIDAE.

Genus **Carcharias**, Cuvier.

Sub-genus **Prionodon**, Müller and Henle.

CARCHARIAS (PRIONODON) ACULEATUS, Davis sp.

Galeocerdo aculeatus, Davis, 1888, Trans. Roy. Dublin Soc., [2], iv., p. 8, pl. i., figs. 1-3.

Carcharias (Prionodon) aculeatus, Davis sp., Chapman and Cudmore, 1924, Proc. Roy. Soc. Vic., n.s., xxxvi. (2), p. 119, pl. ix., figs. 19, 20.

Observations.—The Neumerella specimens found by me are referred to in the paper recently published by Mr. F. Cudmore and myself as being " very well preserved and . . . identical with Davis's type specimens from the Miocene of Coleridge Gully, Trelissick Basin, New Zealand." We have there shown that the species ranges from the Balcombian to the Kalimnan in Victoria (Oligocene to Lower Pliocene).

Family SQUATINIDAE.

Genus **Squatina**, Aldrovandi.

SQUATINA GIPPSLANDICA, Chapman and Cudmore.

Squatina gippslandica, Chapman and Cudmore, 1924, Proc. Roy. Soc. Vic., n.s., xxxvi. (2), p. 136, pl. xi. fig. 47.

Observations.—The example of a tooth named above was found on this present collecting expedition to Neumerella. The genus was before unknown as a fossil from the Australian region.

Class CRUSTACEA.

Super-Order OSTRACODA.

Family BAIRDIIDAE.

Genus **Bairdia,** McCoy.

BAIRDIA MINUTISSIMA, sp. nov.

(Plate X., Figs. 2*a,b*.)

Description.—Co-types, right and left separated valves. Carapace seen from the side, subovate, rotund; dorsal margin well rounded, ventral nearly straight, curving posteriorly to meet the dorsal in a blunt point, and anteriorly sharply rounded and truncate towards the dorsal. Edge view of carapace ovate, compressed at the extremities. Surface very finely areolate. Muscle area well defined when moistened, resembling that of a typical *Bairdia.*

Dimensions.—Length, 1 mm.; height of carapace, ·77 mm.; thickness of carapace, ·77 mm.

Observations.—In outline this species resembles a form like *Bairdia foveolata*, G. S. Brady (1880, p. 55, pl. viii., figs. 1*a-f*, 2*a-f*), but with rounder extremities.

Family CYTHERIDAE.

Genus **Cythere,** O. F. Müller.

CYTHERE KINCAIDIANA, sp. nov.

(Plate X., Figs. 1*a-c*.)

Description.—Holotype, a right valve. Seen from the side, sub-rectangular, wider anteriorly, with a flexuose dorsal and nearly straight ventral margin. The anterior margin is broadly rounded, sub-truncated towards the dorsal and generally depressed, with a sub-marginal row of quadrate alveolae. Posterior margin rounded, denticulated with blunt processes and bearing a long sharp spine at the postero-dorsal angle. The surface of the valve gradually rises from the dorsal line to the ventral, and in the postero-median area culminates in a crested process, which merges into a sharp low keel anteriorly, and rapidly disappears posteriorly. The surface from the ventral keeled area to the dorsal is relieved with moderately large areolae arranged in more or less longitudinal lines parallel with the dorsal margin. Carapace in edge view sub-rhomboidal, with the ventral crest measuring nearly one half the height of the valve. Carapace in end view sub-cordate, with salient dorsal spine.

Dimensions.—Length of valve, 1·54 mm.; height of valves, ·84 mm.; thickness of carapace, 1·2 mm.

Observations.—This remarkably ornate ostracod is quite unlike anything met with either in the Australian Tertiary or elsewhere. One of the nearest related forms as to ornament is *Cythere velivola*, G. S. Brady (1880, p. 111, pl. xxiii., figs. 4*a*-*c*), in which, however, the surface ornament is pustulate instead of areolate, and the extremities are much more spinose.

Class GASTEROPODA.

Family FISSURELLIDAE.

Genus **Megatebennus**, Pilsbry.

MEGATEBENNUS CONCATENATUS, Crosse and Fischer sp., var. PYRULA, nov.

(Plate X., Fig. 3.)

Description.—This variety differs from the typical species in having a distinctly pear-shaped apical fissure and coarser pittings of the external shell-surface.

The type of the variety here figured from Neumerella is somewhat angulated in outline.

Observations.—With some reluctance the above example is separated as a new variety, for the species is variable, but not to so great an extent as in the co-ordination of the two characters mentioned in the description. This variety is also found at Fyansford (Dennant Coll.) in beds which I hold to be of similar age, that is, Janjukian.

The species has a remarkable geological range (from Oligocene to Newer Pliocene), and is also living in Port Phillip and Western Port, Victoria.

Occurrence.—Janjukian (Miocene). In limestone, Neumerella, near Orbost, E. Gippsland.

Family TROCHIDAE.

Genus **Calliostoma**, Swainson.

CALLIOSTOMA SEMIORNATA, sp. nov.

(Plate X., Figs. 5, 6.)

Description of Holotype, from Muddy Creek.—Shell conical, apex acute; base flattened or slightly convex. Umbilicus small, open. Mouth sub-quadrate. Shell consists of ten whorls and a smooth protoconch of one and a-half turns. Whorls flat, with about 13 smooth or faintly crenulate lirae and usually with an intermediate finer one. Whorls flat; keel strong, prominent and granulose. Base with about 13 spiral, laminate lirae. In the first whorls there are fine vertical lines of growth which cross the spiral lirae, resulting in a clathrate ornament. This clathration extends into the other whorls but in a lessening degree, and then only in the prominent area beneath the sutural keel of the preceding whorl.

Apical angle of spire, 50°.

Dimensions of Holotype.—Height, 22 mm. Width at base, 21 mm.

Description of Paratype, from Neumerella.—This is a mould of a larger example, showing by a wax squeeze similar ornament to the above. The diameter of the body whorl is about 31 mm.

Observations.—The nearest living forms to *C. semiornata* are *C. nobilis*, Philippi and *C. latecarinata*, Swainson. In these forms, however, the ornament is granulose rather than filiform and clathrate. *Calliostoma suteri* var. *fragile*, Finlay (1923), is a New Zealand fossil form that approaches the present one, but differs in the shorter spire and fewer lirae.

From *C. millegranosa*, Pritchard, this species differs in the sharper keels, the finer lirae, the threadlike growth lines, and the narrower apical angle, which in Pritchard's species is 70°.

Occurrence.—Holotype. Muddy Creek (lower beds). Balcombian. Coll. by Mr. Broomfield (Nat. Mus. Coll.).

Paratype. From Neumerella, near Orbost. In yellow limestone. Janjukian. A mould of a larger example.

Family VERMETIDAE.

Genus **Vermicularia**, Lamarck.

(Plate X., Fig. 4*a-b*.)

VERMICULARIA FUNICALIS, Crespin, var. CONFERTA, nov.

Description.—The present specimens are a fairly constant variation on the above species (Crespin, 1926). They are distinguished by having a more densely coiled shell, which is usually attached to a molluscan shell-fragment or other object, whilst the free, uncoiled portion usually seen in this and allied species is wanting. The shell-surface is similarly finely corrugated as in the specific form.

Dimensions.—Greatest diameter of type of var., 9 mm. Height, 5 mm.

Observations.—The specific form is known from Keilor, Curlewis and the Gellibrand River, all in the Janjukian series, to which the Neumerella outcrop belongs.

Occurrence.—Several examples from the ferruginous and marly limestone of Neumerella, near Orbost. Janjukian.

Family CYPRAEIDAE.

Genus **Cypraedia**, Swainson.

CYPRAEDIA sp.

Observations.—The above genus seems appropriately to include those forms of *Trivia*-like shells which have the parallel or slightly anastomosing riblets confined to the basal portion; and moreover, with a tendency for the spire to be more or less exsert.

A cast of such an example occurs in the Neumerella collection, but since it only slightly indicates the costate character, it cannot be used as a type for description.

A probably allied form is represented in the National Museum collection from the Balcombian beds of Port Phillip, but is not yet described.

The Neumerella cast measures—Length, 39 mm.; width, 26 mm.; height, 23 mm.

The *Trivia pompholugota* of Tate (1890, p. 214), found in the Adelaide Bore, appears to be a similar type of shell, but has a less exsert spire and is very much smaller.

Class POLYZOA.

Family CELLEPORIDAE.

Genus **Cellepora**, Fabricius (*emend.* Busk).

CELLEPORA CORONOPUS, Searles Wood.

Cellepora coronopus, S. V. Wood, 1850, Ann. and Mag. Nat. Hist., xiii., p. 18. Busk, 1859, Pal. Soc. Mon. for 1857, Crag Polyzoa, p. 57, pl. ix., figs. 1-3. Waters, 1879, Ann. and Mag. Nat. Hist., [5], iii., p. 192. Searles Wood, Waters, 1885, Quart. Journ. Geol. Soc., xli. p. 302.

Cellepora gambierensis, Busk, 1860, Quart. Journ. Geol. Soc., xvi., p. 261 (*nomen nudum*). T. Woods, 1862, Geological Observations in South Australia, pp. 74 and 85 (description of zoarium only). T. Woods, 1865 (1861), Trans. and Proc. Roy. Soc. Vic., vi., p. 4, No. 3.

Celleporaria gambierensis, Busk sp., Stoliczka, 1864. Novara Exped., Geol. Theil., i. (2),—Fossil Bryozoa of Orakei Bay, p. 141, pl. xx., fig. 7.

Observations.—After long consideration and a comparison with authentic English Crag specimens in the National Museum, I am convinced of the con-specific standing of the English and Australian forms. Stoliczka suggested a similar identity for the New Zealand Miocene fossils. Waters (*loc. supra cit.*, 1885, p. 303), commenting on a badly preserved specimen from Aldinga, South Australia, states that "so far as this specimen permits a judgment, I certainly agree with him" (i.e., Stoliczka).

In the majority of cases the zoaria of the Australian Miocene examples are much larger than the English specimens, but all gradations in size can be found.

Tenison Woods records this form (under *C. gambierensis*) as attaining the enormous length of 10 or 12 feet, and I have also observed it in the polyzoal limestone at Torquay of almost similar extent.

The detailed characters of the zooecia are comparable with *C. coronopus,* and the solidity and roundness of the branches, together with the tapering form of the extremities, are convincing data.

Occurrence.—*C. coronopus* is found generally in the polyzoal limestone of Australia, as in the Murray Cliffs and at Aldinga, in South Australia; at Torquay and in the Mallee Bores in Victoria; and at Table Cape, Tasmania.

At Neumerella it is commonly represented by fairly large ramose examples.

Cellepora biradiata, Waters.

(Plate X., Figs. 8, 9.)

Cellepora biradiata, Waters, 1885, Quart. Journ. Geol. Soc., xli., p. 306, pl. vii., figs. 11, 12.

Observations.—For many years collectors of Murray River fossils have been acquainted with the above species, though not by name, and it does not appear to occur in any list beyond that of the original author. Waters has figured the broken dorsal surface of the zoarium, and also the whole of the concave, dorsal or under-surface, to show the double radiating lines.

C. biradiata seems to approach *C. tridenticulata,* var. *nummularia* in shape, but the character of the dorsal radii and the mamillated upper zooecial surface are quite sufficient distinction; moreever the proximal margin of the zooecium in *C. biradiata* is without the three narrow teeth seen in *C. tridenticulata,* var. *nummularia.*

Occurrence.—This species is quite a common form in the Murray River Cliffs, S. Australia. The largest specimen in the National Museum measures in its incomplete state, 106 mm. in diameter, and is 67 mm. in height (about $4\frac{1}{4}$ x $2\frac{3}{4}$ inches). One example in the National Museum, from the collection of the Geological Survey of Victoria, was obtained from Corio Bay in the early days of the Survey.

Several examples are included in the Dennant Coll. (Nat. Mus.) labelled "Muddy Creek, older." Judging by the matrix, these evidently came from the upper part of the lower beds (Balcombian); the largest specimen has a diameter of 47 mm.

At Neumerella the specimens are abundant, and of large size, one having a diameter of 64 mm.

Cellepora fossa, Haswell sp.

Sphaeropora fossa, Haswell, 1881, Proc. Linn. Soc. N.S. Wales, v., p. 42, pl. iii., figs. 5, 6.

Cellepora fossa, Haswell sp., Waters, 1881, Quart. Journ. Geol. Soc., xxxvii., p. 343. Id., 1882, ibid., xxxviii., p. 275. Id., 1885, ibid., xli., p. 307. MacGillivray, 1895, Trans. Roy. Soc. Vic., iv., p. 108, pl. xiv., figs. 8-10.

Observations.—MacGillivray regarded this species as a *small* form, "about 5 mm. in diameter," but there are some examples in the MacGillivray Coll. (Nat. Mus.) which are twice this diameter. Waters records a specimen from the Murray River Cliffs "about 25 mm. in diameter," with the "one surface which may be called the under surface, flat; the other is slightly rounded. On the flat surface there are about forty well-marked pits and a few smaller ones."

A specimen in the National Museum collection, from Bairnsdale, has a diameter of 35 mm., and on the flat surface there are about 32 pits. These may have been occupied by similar organisms to the small red actinids found by Haswell occupying cylindrical pits in recent *Cellepora.*

It is of especial interest to note the extensive range in time of this species, for it occurs in the Balcombian of Victoria, thence through the Janjukian of Victoria and South Australia, and again in Recent deposits, but in lower latitudes, as might be expected, off the Queensland Coast.

The fossil occurrences of *Cellepora fossa* are:—

Balcombian.—Balcombe Bay; Muddy Creek (lower beds), Victoria.

Janjukian.—Mount Gambier; Murray River Cliffs; Aldinga, South Australia.

Cape Otway; Curdie's Creek; Shelford; Fyansford; Moorabool River (Griffin's); Bird Rock Cliffs, Torquay; Waurn Ponds; Bairnsdale; Neumerella, Victoria.

Class RHIZOPODA.

Order FORAMINIFERA.

Family ASTRORHIZIDAE.

Genus **Jaculella,** H. B. Brady.

JACULELLA NEUMERELLENSIS, sp. nov.

(Plate X., Fig. 7.)

Description.—Texture arenaceous, consisting of an irregular, tubular test, slightly tapering at both extremities, with the sides irregularly swollen towards the middle. The aboral end commences with a finely arenaceous, white, bulbous chamber, so characteristic of the sub-family Rhabdammininae. Oral aperture circular. Test of a pale ochreous colour.

Dimensions.—Length, 5 mm.; greatest breadth, ·54 mm.

Observations.—This species is curiously like the recent *Jaculella obtusa* figured by Brady in the Challenger Report (1884), on plate xxii., fig. 20. His recent species came from the Faröe Channel, at depths of 350 and 542 fathoms. It differs from the recent species in being fusiform rather than tapering, whilst the texture is finely arenaceous. I have already figured a fossil specimen of *Jaculella*

(*J. ?obtusa,* Brady) from the Balcombian (Oligocene) of Grice's Creek, Port Phillip (Chapman, 1907), but this is nearer the typical *J. obtusa,* and, moreover, does not show the commencement.

Occurrence.—Janjukian. Neumerella, in washings from the limestone.

V.—Stratigraphical Notes on the Area.

From Bairnsdale to the Nicholson River and beyond, the railway passes through low cuttings which reveal a monotonous section of "Torrent Gravels." These, as I have elsewhere shown, are post-Kalimnan, and probably represent the Werrikooian or Upper Pliocene stage in this area (Chapman, 1918, p. 168, et seq. Also Hart, 1921, pp. 75-82). The gravels contain derived pebbles and boulders of silicified wood, presumably of Kalimnan age or even older, and the deposits well represent the products of the denuding agencies which were at work during a time of uplift, when the present land surface was at a far greater elevation than at present.

At the Nicholson River, where the bridge crosses at a height of 48 feet above sea-level, the succession is seen as a basal limestone covered by fine Kalimnan sands, whilst over all lies the sheet of gravel. These fine sands are replaced elsewhere by lake and shore deposits of fossiliferous ironstone, as at Boggy and Moitun Creeks where they contain casts of Kalimnan shells.

The Janjukian marls and limestones are exposed on both sides of the Nicholson River. Through the cuttings, from Bombara and Mossiface to Bruthen, the same torrent gravel is seen, but the underlying rock, which is a pink granite, is not in evidence until one approaches the Mississippi Creek. This granite can be traced as far as Mundic Creek, and is evidently part of the Gabo Island massif, which rock it resembles in having bright red felspar, but which is here even more vivid.

The railway line from Bairnsdale to Nowa Nowa appears to cut through an East and West sunkfield at the base of the foothills, since only the gravels are seen, until Colquhoun is reached. These Torrent Gravels again form the prevailing beds in the sections in the cuttings, until Tostaree is reached. A little to the East of Hospital Creek the Janjukian marly limestone now outcrops from beneath the gravels and underlying sands, and it was here that a very fine tooth of *Carcharodon megalodon*[2] was obtained by one of the excavators in the Railway Construction Camp.

The whole of the succeeding part of the line to Neumerella, cutting across Wombat Creek and Dinner Creek, is in the Janjukian limestone, and it was from the Neumerella end that the present collection was made. The elevated land overlooking the Snowy River Flats, as shown by the section revealed in the railway cutting, seems to be due to a warp-fold structure, where the

2.—Now in the National Museum Collection.

Miocene rocks have been differentially uplifted above the base-levelled plain of the Snowy River foothills This elevated mass of harder rock, of the Miocene limestone, although not marked on the geological map (Everett's, 1902), is really an extension of the Bairnsdale massif, the trend-line of which is about due W. to E., but which from Boggy Creek is seen to be diverted slightly to the N.E. That the elevated strip of the older Tertiary is not continuous is seen by the occurrence of drowned valleys crossing it, as at Lakes Entrance; whilst the submergence of such rivers as the Nicholson and the Tambo belongs to the sunkfield area in the back country to the north.

In the case of the Nicholson River the bed is exceptionally depressed, for 80 feet of alluvial and marine muds were penetrated during the pile driving for the railway bridge, which was then being carried out.

That local folding and faulting has taken place in the East Gippsland coastal country, is frequently demonstrated in the cuttings near the Neumerella end of the Orbost railway. Two sketch sections were made in the cutting, the first of which bears out this point.

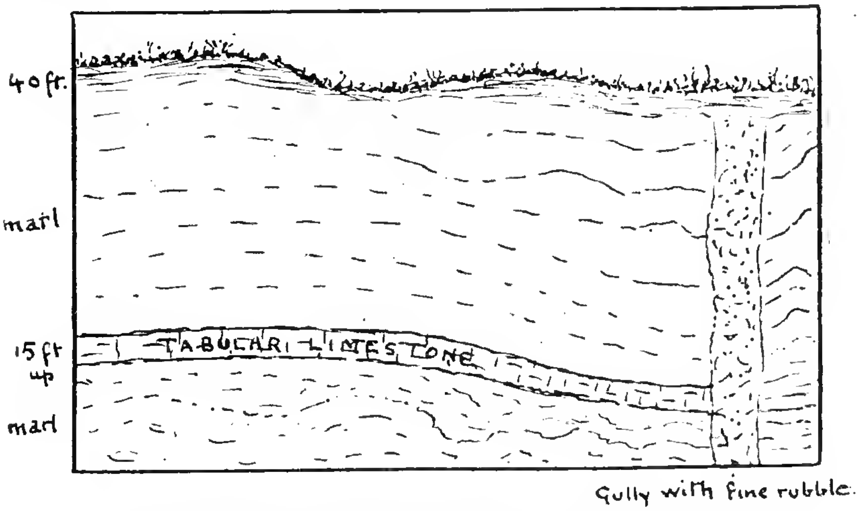


Fig. 1.—Section in Rly. cutting at 22m. 37ch. from Nowa Nowa, towards the head of the line. Showing faulting and folding in the Janjukian Series.

In this section (Fig. 1) there is a vertical thickness of 40 feet of marls and marly limestone. From the base to 15 feet above the marl bed is crumpled or folded. Then comes a band of marly limestone about 2′6″, which shows a major fold. Above this is another marl bed, about 25 feet thick, more gently folded, and dipping towards a fracture line or rift, now filled with fine rubble and sandy clay. This apparent fault occupies the lowest point in the dip of the marl beds.

The section in Fig. 2 shows the general distribution of the fossiliferous bands in the marl beds, together with the intercalated tabular limestone. At the base of the cutting was found the fine cast of a large *Nautilus geelongensis,* now exhibited in the wall case at the National Museum.

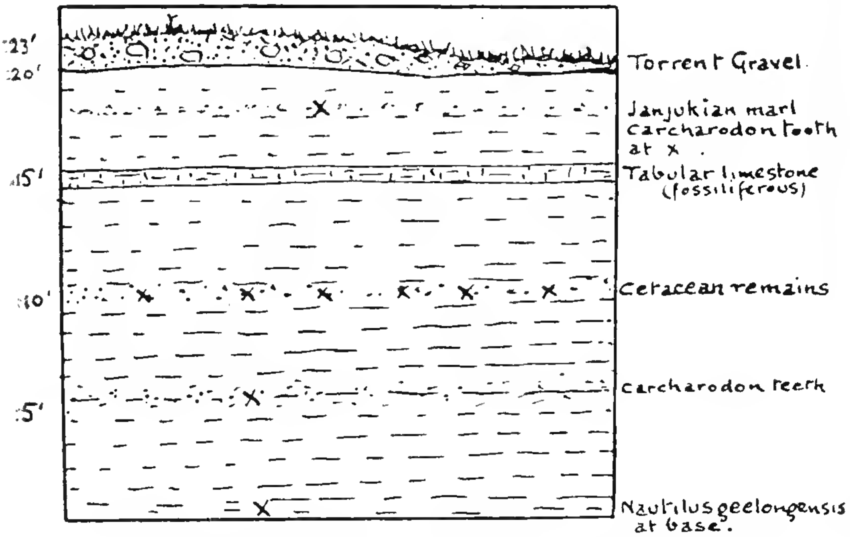


FIG. 2.—Section in Rly. cutting at 23m. 18ch. from Nowa Nowa, towards the head of the line. Janjukian marls and Torrent Gravels.

Teeth of sharks (*Carcharodon*) were found about 5 feet up in the section, cetacean remains at 10 feet, and *Carcharodon* again at about 18 feet. Surmounting this Janjukian bed is the unconformable sheet of Torrent Gravel, about 3 feet in thickness.

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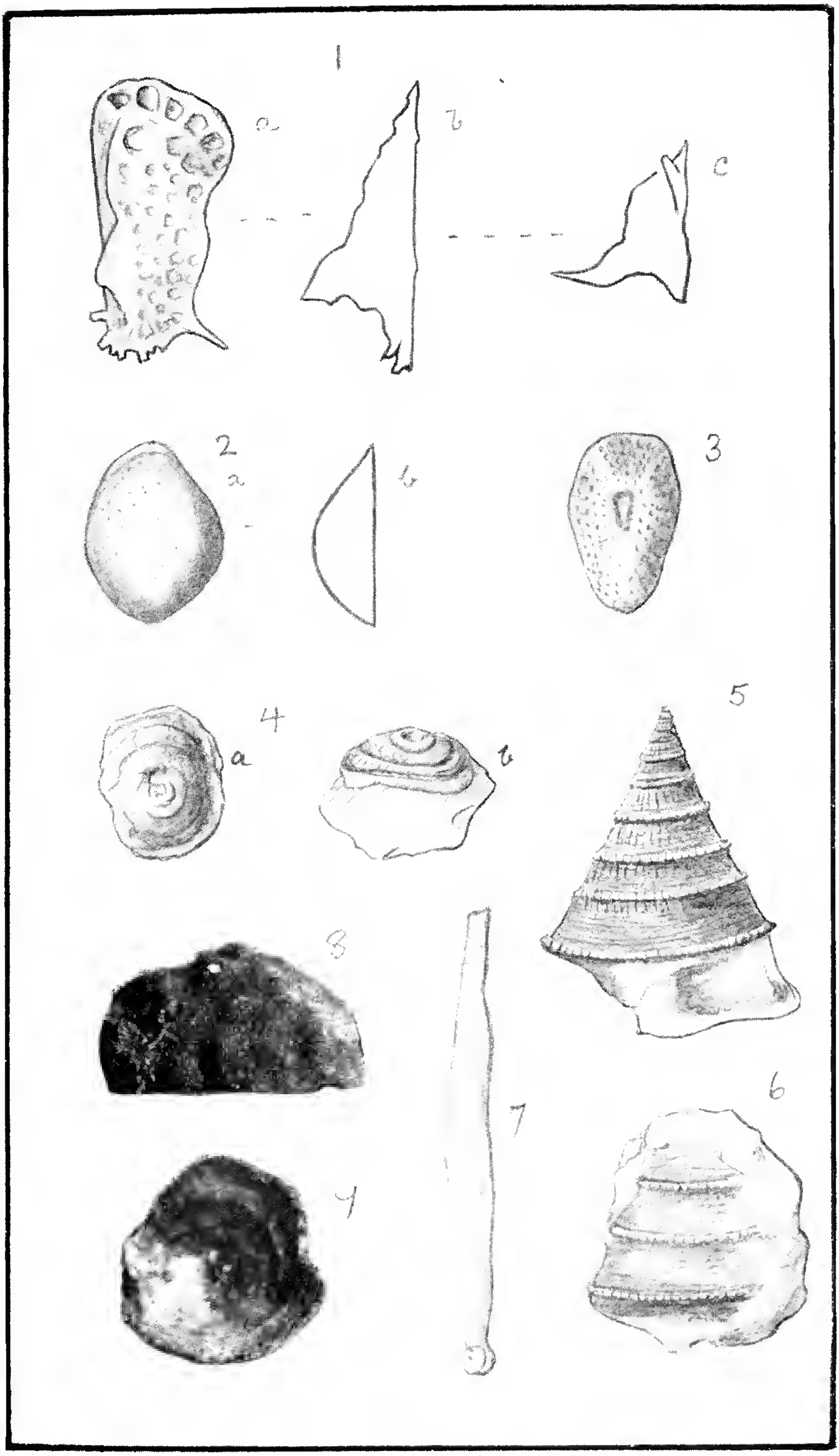

F.C. del. et photo.

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EXPLANATION TO PLATE X.

Fig. 1.—*Cythere kincaidiana*, sp. nov. *a*, side view of right valve; *b*, edge view; *c*, end view. Holotype. Janjukian. Neumerella. ×26.

Fig. 2.—*Bairdia minutissima*, sp. nov. *a*, side view of left valve; *b*, edge view. Cotype. Janjukian. Neumerella. ×26.

Fig. 3.—*Megatebennus concatenatus*, Crosse and Fischer sp., var. *pyrula*. nov. Holotype. Janjukian. Neumerella. ×2.

Fig. 4.—*Vermicularia funicalis*, Crespin, var. *conferta*, nov. *a*, apical aspect; *b*, profile. Holotype of var. Janjukian. Neumerella. ×2.

Fig. 5.—*Calliostoma semiornata*, sp. nov. Holotype. Balcombian. Muddy Creek. ×2.

Fig. 6.—*Calliostoma semiornata*, sp. nov. Wax squeeze from a mould (Paratype) in Janjukian limestone. Neumerella. Nat. size.

Fig. 7.—*Jaculella neumerellensis*, sp. nov. Lateral aspect of test. Holotype. Janjukian, Neumerella. ×13.

Fig. 8.—*Cellepora biradiata*, Waters. Lateral aspect of zoarium. Janjukian. Neumerella. Nat. size.

Fig. 9.—*Cellepora biradiata*, Waters. Underside of zoarium. Janjukian. Neumerella. Nat. size.

[Proc. Roy. Soc. Victoria, 38 (N.S.), 1926.]

Art. XIII.—*The Genus Porotermes (Isoptera).*

By GERALD F. HILL.

(Entomologist, National Museum of Victoria.)

[Read 9th July, 1925.]

Having experienced difficulty in making satisfactory identifications of termites of the genus *Porotermes* I have gathered together as much material as possible in the hope that its examination would reveal characters sufficiently reliable to enable specific determinations to be made with confidence. This hope has not been realised, but the data obtained appears to be of sufficient interest to justify its publication, more especially in view of its probable significance in the study of the larger and economically much more important allied genus *Calotermes*.

I am greatly indebted to Professor N. Holmgren for the type and a co-type of *P. grandis* and *P. froggatti* respectively, and to Mr. W. W. Froggatt for the loan of the types of *P. adamsoni*. The remainder of the specimens examined, representative of 44 colonies, are from the National Museum and my own collections. The contributions to these collections by Messrs. C. Barrett, F. E. Wilson, W. F. Hill and B. F. Hill were of particular interest and are gratefully acknowledged.

Historical.

Porotermes was proposed as a sub-genus of *Hodotermes* by Hagen (1858) for the reception of *Termes quadricollis* Rambur, from Chili. Froggatt (1896) accorded the group generic status under the sub-family Calotermitinae and Silvestri (1903) followed his classification in re-describing *P. quadricollis*. Desneux (1904) established the tribe Hodotermitini to include the genera *Hodotermes, Stolotermes* and *Porotermes*. Holmgren (1911) published a classification, since adopted by many but not all recent writers of note, in which four families and four sub-families were recognised, one of which was re-defined to include only the genera *Calotermes* and *Porotermes*. The first of these genera was subdivided into nine and the second into two sub-genera. Under the sub-genus *Porotermes* (s. str.) were listed *P. quadricollis* (Ramb.), *P. adamsoni* (Frogg.) and *P. froggatti* Holmgren, whilst the sub-genus *Planitermes* contained only the South African species *Calotermes planiceps* Sjöstedt (1904). *P. grandis* Holmgr., the fifth and last of the world's authentic species,[1] was not described until the following year (Holmgren, 1912).

1.—Fuller (1921) inferred that *C. amabilis* Sjöst. is a *Porotermes* and probably the winged form of *P. planiceps*.

Classification.

Key to the genera of Calotermitinae Holmgr.[2]

Imago: i. Ocelli wanting. Empodia wanting. Cerci 5-jointed . . . . *Porotermes.*

ii. Ocelli present. Empodia present. Cerci 2-jointed . . . . *Calotermes.*

Soldier[3]: Cerci long, 5-jointed . . . . *Porotermes.*

Cerci short, 2-jointed . . . . *Calotermes.*

A key to the sub-genera of *Porotermes* need not be given here in view of the distribution of known species.

It may be noted that soldiers of *Stolotermes* bear a superficial resemblance to *Porotermes*, but are easily distinguished by their small size, more flattened head and body, small heart-shaped pronotum and facetted eyes.

Observations.

Porotermes adamsoni (Froggatt).

Calotermes adamsoni, Froggatt, Proc. Linn. Soc. N.S. Wales, xxi., 1896, p. 532.

Porotermes adamsoni (Froggatt), Gen. Insectorum, Fasc. 25, 1904.

It would have been unnecessary to add to the original description of this species, beyond recording that the antennae are 15 to 17-jointed in the imago and 16 to 18-jointed in the soldier, were it not for the fact that it is proposed to discuss another closely allied species in the following pages.

Froggatt noted that the soldiers vary in colour and size and this was evident in the Victorian specimens which I referred to in an earlier paper (Hill, 1921). The largest specimens then known to me fell so far short of the dimensions of the type (unique) of *P. grandis* that there appeared to be little possibility of confusing the two species; in the light of further knowledge, however, this may have actually happened in the case of the series from Healesville and Fern-tree Gully, the soldiers in which equal in size the smallest examples of *P. grandis*. The following detailed measurements of alate imagos and soldiers of *P. adamsoni* are from several complete series from Seaford, Waratah Bay and Lower Tarwin, Victoria, some of which have been compared with the types (from Uralla, N. S. Wales). The imagos in these colonies and in the type series are so closely approximated in size that in most cases one set of measurements only need be given. In the case of the soldier caste the measurements of two examples from each series are recorded except in cases where all

2.—After Holmgren (1911).

3.—There is no true worker caste in this sub-family; in it the functions of that caste devolve upon the immature stages of the winged imago and, possibly, of the soldier. The generic characters of this worker-nymph are the same as those of the soldier.

the individuals in the colony are of approximately the same size. The head and thorax give the most reliable measurements for comparative purposes since these parts are least affected by ordinary processes of fixation. All measurements are of specimens recently removed from alcohol.

Measurements of imagos (from Lower Tarwin, V., 4.3.25):

	mm.
Length with wings - - - - - - -	14·00 — 15·00
Length without wings - - - - - -	7·00 — 8·00
Head, to apex of labrum, long - - - -	1·82
Head, to clypeofrontal suture, long - -	1·42
Head wide - - - - - - - -	1·67
Eyes, diameter, 0·399×0·456 (vertically) -	
Wings, forewings, long 10·75; wide - -	3·30
Pronotum, long, 0·79; wide - - - -	1·40
Tibia iii, long - - - - - - -	1·53

Measurements of soldiers:

	Co-types.	Lr. Tarwin[4]
Total length - - - - -	10·75; 10·75	10·00; 11·25
Head with mandibles, long -	3·81; 3·87	4·33: 4·56
Head without mandibles, long -	2·45: 2·33	2·85; 3·19
Head, wide - - - - -	2·28; 2·22	2·33; 2·50
Antennae, joints - - -	16; 16	16; 18
Gula at narrowest part, wide -	0·399; 0·425	0·456; 0·399
Pronotum, long - - -	0·85; 0·91	0·96; 0·91
Pronotum, wide - - -	1·71; 1·71	1·71; 1·82
Tibia iii, long - - -	1·71; 1·71	1·71; 1·71

	Seaford.	Seaford.	Waratah.	Waratah.
Total length - - -	9·75	9·00	8·75	10·00
Head with mandibles, long -	4·10	3·36	3·60	4·67
Head without mandibles, long	2·85	1·22	2·28	3·19
Head, wide - - - -	2·22	1·82	1·88	2·33
Antennae, joints - -	16·17	16	16	16
Gula at narrowest part, wide	0·399	0·342	0·399	0·342
Pronotum, long - - -	0·91	0·74	0·74	0·91
Pronotum, wide - - -	1·60	1·20	1·36	1·71
Tibia iii, long - - -	1·53	1·36	1·42	1·71

The above tabulation includes the smallest and the largest soldiers known to me that can be definitely determined (from their associated imagos) as *P. adamsoni.*

In a small collection of *Porotermes* received by the National Museum from Mr. Froggatt from New South Wales (Brooklana, (a) in rotten log, (b) in Hoop Pine stump, Gosford, Tuggerah Lakes and Mittagong) there are several series of soldiers and nymphs which appear to be referable to this species. One of them contains an apterous ("third-form") king measuring as follows: Total length 9·75; Head, long 1·99; wide 1·82; Pronotum, long 0·74; wide 1·42; Abdomen, wide 3·13. Except in its smaller size it agrees with the three similar apterous forms (queens) from Mt. Donna Buang, Victoria, referred to under *P. grandis.* It may

4.—From same colony as imagos referred to in above tabulation.

be mentioned here that the smallest soldiers associated with the latter are larger than the co-types of *P. adamsoni,* but smaller than some Tarwin examples of Froggatt's species.

This species appears to be a common one in South-eastern Victoria and New South Wales and it occurs also in South Australia. In nearly every case the colonies have been found in firewood, in dead standing timber or in logs lying upon the ground. Whether it attacks and destroys growing forest trees or not cannot be definitely stated, but it seems most probable that it does. There is at least one authentic record of several living pines (*Pinus insignis*) in a Melbourne suburban garden having been attacked and ultimately destroyed by this insect.

Porotermes froggatti Holmgren.

Kungl. Svenska. Akad. Hand., xlvi. (6), p. 51, 1911; Entom. Mitteilungen, Deutsch. Entom. Mus., i. (9), p. 281, 1912.

Holmgren proposed the above name for a Tasmanian species the soldiers and workers of which, he states (1912), were incorrectly identified as *Calotermes convexus* (Walker) by Froggatt. No description appears to have been published.

In his first paper Froggatt (1896, p. 523) quoted Hagen's description of Walker's species (Hagen, 1858, p. 46) and in his later paper (Froggatt, 1915) merely summarised these descriptions and added that he had not been able to identify this termite in his collections. Holmgren gives no references to literature and I can find no original description by Froggatt of specimens purporting to be *C. convexus* (Walker). Walker described only the winged form of the last-named species, the descriptions of the soldier and worker being by Hagen.

I have before me a co-type of *P. froggatti,* as well as several small series of soldiers and nymphs from the same locality, all of which I believe to be conspecific. The following are measurements of representative soldiers:—

	Co-type.	Launceston.	Nat. Park.	Tas. (Froggatt).
Total length	12·25	12·07; 12·07; 12·25	12·25	15·40
Head, with mandibles, long	5·25	5·07; 5·07; 5·25	5·41	6·38
Head, without mandibles, long	3·64	3·42; 3·42; 3·99	4·16	4·78
Head, wide	3·07	2·67; 2·79; 2·85	3·19	3·81
Antennae, joints . . .	15	15; 16; 15	15	—
Gula, at narrowest part, wide	0·570	0·570; 0·456; 0·570	0·570	0·798
Pronotum, long	1·19	1·59; 1·08; 1·14	1·25	1·53
Pronotum, wide	2·10	1·99; 2·16; 2:16	2·39	2·85
Tibia iii, long . . .	2·28	1·82; 1·99; 1·99	2·22	2·56

In the majority the antennae are 15-jointed, the 3rd joint being conspicuously longer than 2nd and 4th and clavate; when 16-

jointed the 3rd joint is very small and 4th correspondingly reduced in length.

I can find no character by which the soldier caste of this Tasmanian form can be distinguished from *P. grandis,* but it is quite possible that good specific characters are to be found in the imago, which is still undescribed.

Porotermes grandis Holmgren.

Entom. Mitteil., Deutsch. Entom. Mus., i. (9), p. 281, 1912.

Until recently our knowledge of this species has been confined to the original description and remarks upon the unique type, a damaged specimen of the soldier caste (from Otway Forest, Victoria), with which I have compared several series now available for examination. In this caste it is the largest and most striking species known from the Australian Region, and it is probably the most destructive insect to be found in the great forest trees in the Healesville and Gembrook Districts. For the identification of the de-alated imagos and apterous queens referred to below I have relied upon a comparison of their largest associated soldiers with the type.

Imago (king).

Differs from *P. adamsoni* (Froggatt) only in measurements.

In the absence of an alate specimen I have designated the male (king) found in a colony taken at Emerald, Victoria, as the type (morphotype) of this caste. The measurements of this specimen and of the associated queen and soldiers are recorded in the following tabulations. The measurements of a king and queen (from ?Warburton) are given for comparison. It will be noted that they are smaller than the Emerald specimens and in some of their measurements approximate *P. adamsoni.*

Apterous adults.

Apterous reproductive males and females ("Adults of the third form,", Thompson, 1917) appear to be generally present in colonies of this species and are sometimes the only reproductive caste represented. The head is ochraceous-tawny, the thorax and body a little lighter in colour; head, thorax and abdomen sparsely setaceous; eyes wanting. Measurements of examples from Mt. Donna Buang are recorded below.

	Kings and queens.		Apterous queens.
	Emerald.	?Warburton.	Mt. Donna Buang.
Length of body . . .	♂ 9·50; ♀ 10·00	♂ 9·00; ♀ 11·25	10·50 – 11·00
Head, long	2·26	♂ 2·05; ♀ 2.16	2.16
Head, to clypeofrontal sut., long	1·76	♂ 1·71; ♀ 1·59	1·82
Head, wide	2·00	♂ 1·88; ♀ 1·82	1·82 – 1.99
Pronotum, long	♂ 1·02; ♀ 1·08	0·96	0·79 – 0·85
Pronotum, wide	♂ 1·90; ♀ 1·99	1·71	1·52 – 1·71
Tibia iii, long	1·93	1·82	1·93
Eyes, diameter	0·456 × 0·513	0·399 × 0·426	wanting

Brachypterous reproductive males and females ("Adults of the second form,", Thompson, 1917) have not been found in any species of *Porotermes.*

Soldier.

For the purpose of showing the range of variation to be found in soldiers from the same colony and believed to be correctly referred to this species sets of measurements are given of the type and representatives of 7 nest-series from Victoria.

	Type (dried)	Donna Buang[5]	Emerald Dist.[6]
Total length	13·00	12·00; 12·00; 10·50	11·50; 12·00; 11·00
Head with mandibles, long	6·61	4·61; 4·60; 4·21	5·13; 5·35; 4·90
Head, without mandibles, long	5·09	3·13; 3·13; 2·73	3·24; 3·70; 3·36
Head, wide	3·61	2·67; 2·67; 2·85	2·85; 3·02; 3·62
Antennae, joints	—	17; 15; 17	16; 16; 15
Gula at narrowest part	—	0·513; 0·513; 0·627	0·513; 0·513; 0·513
Pronotum, long	—	1·02; 1·02; 1·08	1·02; 1·14; 0·969
Pronotum, wide	2·28	1·99; 1·93; 1·99	1·99; 1·99; 1·88
Tibia iii, long	—	2·16; 1·99; 2·28	1·99; 1·93; 1·93

	Cockatoo.[7]	Cockatoo.	Cockatoo.
Total length	14·00	14·50; 10·00	15·00; 11·25
Head with mandibles, long	6·21	6·00; 4·40	6·55; 4·44
Head without mandibles, long	4·44	4·44; 2·90	4·90; 2·90
Head, wide	3·70	3·30; 2·39	3·59; 2·67
Antennae, joints	15	14; 16	16; 16
Gula at narrowest part	0·627	0·570; 0·513	0·627;
Pronotum, long	1·42	1·31; 1·02	1·42; 1·08
Pronotum wide	2·79	2·62; 1·82	2·79; 2·05
Tibia iii, long	2·56	2·28; 1·82	2·45; 2·22

	Korumburra.	Fern-tree Gully.
Total length	— — —	13·00; 14·50; 10·00; 10·00
Head, with mandibles, long	7·00; 6·84; 6·55; 5·01	6·09; 6·09; 4·44; 4·84
Head, without mandibles, long	5·24; 5·13; 4·84; 3·42	4·44, 4·56; 3·07; 3·36
Head, wide	3·99; 3·47; 3·59; 2·79	3·36; 3·53; 2·62; 2·62
Antennae, joints	16; 17; 15; 16	16; 17; 15; 14
Gula at narrowest part	0·627; 0·570; 0·570; 0·513	0·627; 0·627; 0·570; 0·570
Pronotum, long	1·53; 1·42; 1·42; 1·14	1·14; 1·19; 0·96; 0·97
Pronotum, wide	2·90; 2·56; 2·85; 1·99	2·22; 2·50; 1·82; 1·82
Tibia iii, long	2·85; 2·56; 2·67; 2·05	2·10; 2·10; 1·76; 1·76

From a comparison of measurements of the smallest of the above with those of the largest authenticated examples of *P. adamsoni* it will be seen that size alone could not be depended upon to distinguish these species if only the smallest examples of the former and the largest of the latter were available for

5.—From same colony as apterous queens referred to on page 147.
6.—From same colony as king and queen referred to on page 147.
7.—Measurements of examples from three colonies are given.

examination. In most colonies, however, if marked variation exists at all, as it usually does, there will be found a majority of individuals distinctly below the average size of the larger species (*P. grandis*) or distinctly above the average size of the smaller (*P. adamsoni*) upon which a specific determination may be based. But there are several series in the collection from the lower foothills of the Dandenong and Beaconsfield Ranges which, being of uniform moderate size, might be attributed to either species in the absence of a more reliable character, which I have failed to discover. In *P. grandis* the mandibles may be proportionately a little stouter than in *P. adamsoni*, but the dentition is alike in all three species. The antennae are too variable to be of any use for diagnostic purposes.

The material at my disposal is not sufficient to justify the assumption that the two described Victorian forms are nothing more than races of the same species, but the apparent absence of any structural differences excepting that of size in both the imago and the soldier and the known distribution of the two supposed distinct species suggest that such may be the case. It is worthy of note that all the authenticated Victorian series of *P. adamsoni* are from low, sandy, coastal localities, whilst all the series here definitely referred to *P. grandis* are from heavily-timbered hilly or mountainous districts at elevations of from about 800 feet to 3000 feet above sea-level. The series of doubtful identity are those from the undulating country between the coast and the ranges and from the lower foothills and adjacent gullies.

In conclusion the following may be quoted from Fuller (1915): "It occurs to me that a further knowledge of distribution may show that environment has a marked effect upon the variation of several species, in both form and habit."

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[Proc. Roy. Soc. Victoria, 38 (N.S.), 1926.]

Art. XIV.—*The Occurrence of Helium in a Spa Gas from Daylesford, Victoria.*

By G. A. AMPT and E. J. HARTUNG.

[Read 20th August, 1925.]

Shortly after the discovery of helium in the mineral cleveite by Professor Ramsay in 1895, numerous terrestrial sources of the new element were found. The gases arising from mineral springs proved to contain helium in small amount, and later it was also discovered in the natural gases associated with petroleum wells in America. Some of these gases were shown to contain more than 1% of helium by volume, and large quantities of the element are now extracted commercially by processes of liquefaction and fractional distillation. The largest amount of helium yet found in any natural gas, 5·4% by volume, occurs in a spa gas from Mazières, France. Many of these helium-containing gases are distinctly radioactive.

As far as we are aware, the presence of helium has not hitherto been recorded in any natural gas from Australian sources. A few years ago, one of the Daylesford spa gases was suspected to be radioactive as the result of some experiments carried out by Mr. James Macdonald, manager of Hepburn Spa, Ltd. This suspected activity was confirmed by Sir David Masson and one of us (G.A.) in 1919, and the radioactive material was proved to be radium emanation (radon), present in extremely small amount. Traces of helium must therefore inevitably have been present in this spa gas as one of the products of radioactive change. We have recently carried out a chemical investigation of gas from the same source with the object of finding out whether helium was present in more than minute amount. The general procedure in such cases is to treat the gas with an alkaline liquid to absorb carbon dioxide and other acidic gases, to remove oxygen by absorption in suitable reagents, and to burn hydrogen and other combustible gases by sparking with pure oxygen. The nitrogen is then absorbed by treatment with hot magnesium or calcium, and the residue consists of inert gases of the argon group. Separation of this residue into its constituents involves tedious fractional distillations and adsorptions by cooled charcoal. If only two members of the inert group can be shown to be present, a simple density determination of the gas enables their relative amounts to be calculated without any separation being attempted.

Our analysis of the gas was based on these general lines and consequently involves nothing essentially new. Nevertheless, we feel that the detection of helium in an Australian natural gas for the first time is of sufficient interest to be recorded here.

Two separate samples of the spa gas were examined; they were received in metal cylinders under pressure, and had been drawn direct from the gasometer built over the mineral spring at Daylesford. On arrival in Melbourne, the gas was found to be distinctly radioactive. Preliminary tests showed that gases other than carbon dioxide were present to the extent of only 3 per cent. approximately, and subsequently it was found that the two samples were very similar in composition except, however, that one appeared to have been contaminated slightly with air during collection.

The procedure in each case was the same. Several accurate analyses on small samples were made to determine the carbon dioxide content, and then large volumes of the gas (over 100 litres) were treated with sodium hydroxide solution to free them completely from this constituent. Samples of the remainder were analyzed accurately for oxygen by treatment with alkaline pyrogallate solution and, after complete removal of this element, the residue was examined for hydrogen and other combustible gases, which were proved to be absent. The volume of the gas was now

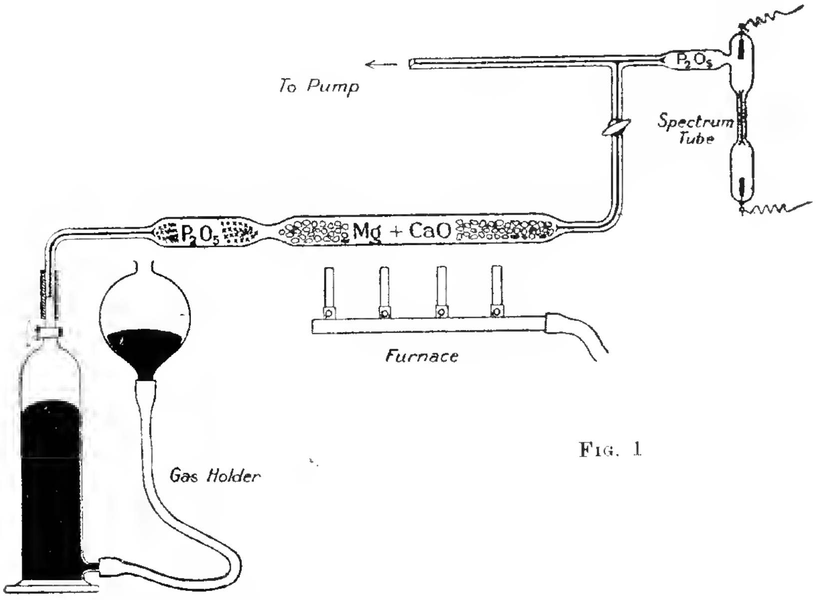

Fig. 1

about $2\frac{1}{2}$ litres and consisted of nitrogen and gases of the argon group. The bulk of the nitrogen was removed by slow passage over red-hot magnesium turnings contained in an iron tube about a metre long.

This treatment reduced the volume of the gas to about 200 c.c., but contaminated it with hydrogen due to the action of traces of water vapour on the magnesium. Complete removal of the remaining nitrogen was effected by passing the gas through a heated layer of an intimate mixture of calcium oxide and magnesium powder contained in a hard glass tube (Fig. 1).

The mixture must be carefully made from recently ignited quicklime, which is quite free from hydroxide and carbonate, otherwise dangerous explosions may result when it is heated.

It was found to be extremely efficient as a nitrogen absorbent, but gave off hydrogen continuously on heating in spite of the greatest care in excluding water vapour. This hydrogen was

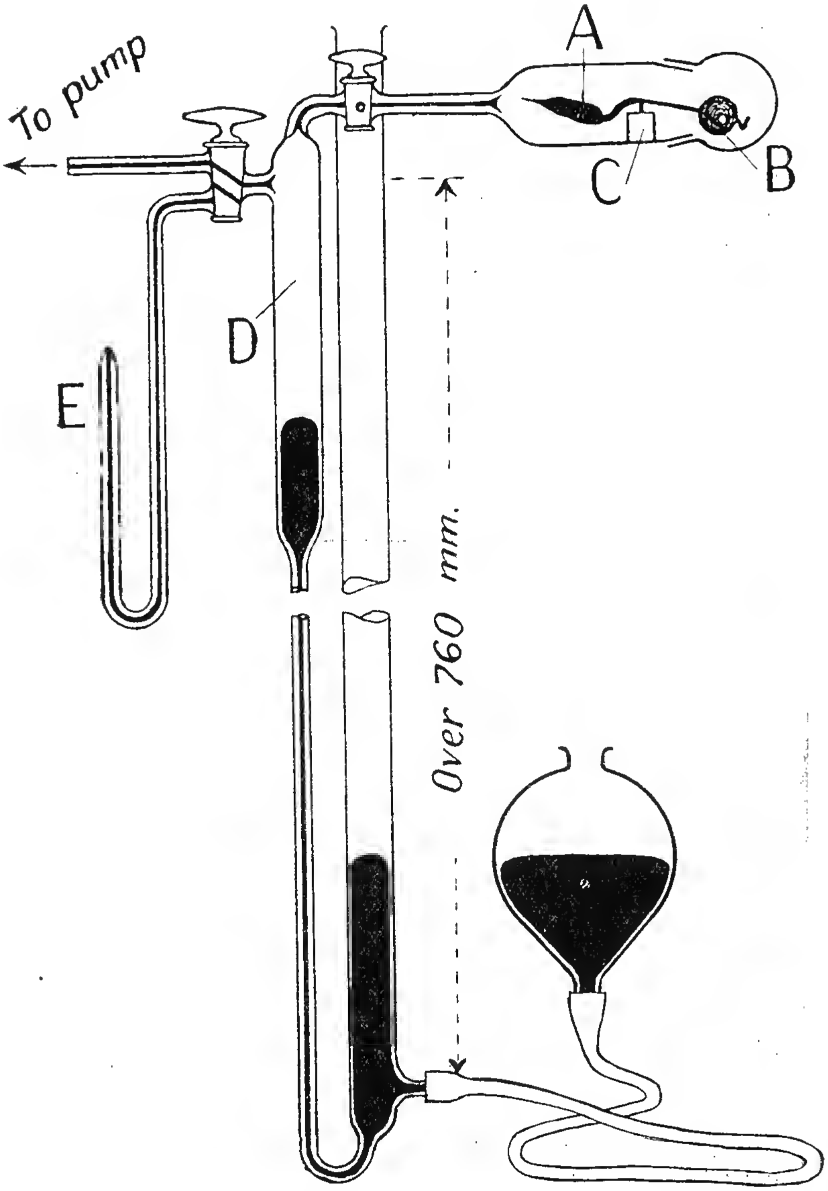

Fig. 2

removed from the residual gas by sparking with pure oxygen and, finally, the volume of the argon group gases was measured.

The volume compositions of the two samples of spa gas were found to be:—

	I.	II.
	%	%
Carbon dioxide	97·30	96·95
Nitrogen	2·30	2·55
Oxygen	0·37	0·46
Inert gases	0·034	0·045

The differences between the two samples may be accounted for by slight contamination of II. with air.

The total volume of inert gases at our disposal was now 47·8 c.c., measured at N.T.P.

Its spectrum was carefully mapped, more than 70 lines being measured. Many of these were faint, and could not be identified, but 23 coincided with known argon lines. Three of the most prominent helium lines were found, one ($\lambda = 6678$) being bright, and the others (5876 and 5016) fainter. Some very faint lines occurred in the positions of brilliant lines in the spectrum of pure neon. The gas was re-purified from possible traces of nitrogen without alteration to its volume or its spectrum. It appeared, therefore, to consist of argon with some helium and a small quantity of neon.

The separation of the gases of the argon group from one another involves much tedious work, and we did not consider the attempt in this case worth while. However, the density was determined as a guide to the approximate composition of the sample. This was performed by means of an Aston silica density balance. This instrument was developed by Aston in 1914 (*Proc. Roy. Soc.* 89A, 439) on the principle of the now well-known Steele-Grant microbalance. A very light silica beam A (Fig. 2) oscillates about a single central knife edge, and carries at one end a sealed silica bulb B containing air.

A pointer at the other end is observed by a microscope, and serves to determine the position of the beam. The balance rests on a polished, horizontal quartz plate C cemented inside a small glass tube, and is kept central by a light ring of silica through which the pointer passes. The case of the instrument communicates by a capillary tube with a manometer D, which is in connection with a small Toepler pump and also with a gas syphon tube E, which serves to introduce the gas.

The theory of the density balance is very simple. The average densities of the two halves of the beam on either side of the central point are very different in virtue of the sealed air bulb on one side. Hence the equilibrium position of the beam depends on the density of the medium in which it is immersed, and for any desired zero position, as read by the microscope, the density of the medium must be the same. If now two sets of measurements are made at the same temperature, one with air in the balance case, and the other with the experimental gas, then the ratio of the respective pressures, at which the pointer is at the zero position in each case, equals the inverse ratio of the molecular weights of the two gases, or

$$\frac{P_1}{P_2} = \frac{M_2}{M_1}$$

The method has the merits of being very rapid and of requiring only a small quantity of the gas for an accurate determination.

With our instrument, an accuracy of 1 part in 1000 was readily obtainable and, using dry air free from carbon dioxide as a standard of comparison, the molecular weight of the inert gas was found to be 35·1. On the supposition that only argon and helium were present, this corresponded with 13·4 per cent. of the latter in the gas. It followed, therefore, that there were 39 parts of argon, and 6 parts of helium in 100,000 parts by volume of the original spa gas. This quantity is so small that it has no commercial significance.

The nitrogen, oxygen and argon present in the spa gas must be largely derived from the atmosphere and gases which have come into contact with the water on its passage through the soil before being collected again to form the mineral spring. As the spa water is approximately at air temperature on emergence, the relative proportions of the atmospheric gases in the spa gas in equilibrium with the water should be approximately the same as those in which they occur in the atmosphere, provided that disturbing influences have not operated. The ratio of oxygen to nitrogen found in the gas is less than that in the atmosphere, which is to be expected from the chemical reactivity of oxygen. The ratio of argon to nitrogen (1 : 59 by the volume) is, however, greater than that in the atmosphere (1 : 80), but, as the difference is not large, and as the balance may have been disturbed by soil actions in which nitrogen itself plays a part, there is really no evidence that some of the argon has come from a truly subterranean source. The helium, however, is derived without doubt from the presence of minute amounts of radioactive material in the strata through which the spring water has percolated.

[Proc. Roy. Soc. Victoria, 38 (N.S.), 1926.]

Art. XV.—*A low-lag thermocouple with a new type of insulation.*

By E. F. J. LOVE, M.A., D.Sc., F.R.A.S., F.P.S.L.

(University of Melbourne.)

[Read 17th September, 1925.]

In the course of investigations carried out recently by the Freezing Meat Committee of the Australian National Research Council, my attention was directed to the need for a well-insulated thermocouple which should lag in temperature as little as possible behind the substances in contact with its junctions. I therefore decided on an attempt to coat the junctions and leading-in wires of the couple with a film of rubber, by deposition from a rubber solution, in the hope that an insulating film might be obtained sufficiently thin and of reasonably lasting quality. The following method proved successful.

The junctions and a sufficient length of the wires were immersed, after cleansing, for about a minute in a solution of crepe rubber in benzine—petroleum motor spirit—allowed to drain and dry in air, and then vulcanized, by immersion for a few seconds in a 3 per cent. solution, also in benzine, of sulphur chloride—S_2Cl_2—followed by drying in air. The commercial solution of rubber used was found to require dilution, in order to obtain a smooth film without the formation of beads; commercial benzine proved a suitable diluent and the proper strength of the solution was quickly found by trial. The film obtained being very thin, a second film—and, in some cases, a third or even a fourth—was deposited over it.

The resulting layer of insulation proves to be tough and elastic, withstands the changes of dimensions and of temperature hitherto encountered in the Committee's work, and adheres well to the metals. Couples so prepared have been calibrated and used by Messrs. Cook and Vickery, who are carrying on researches for the Committee; they inform me that the lag is much smaller than that previously experienced, when the couples employed were insulated by thin glass or thin rubber tubes. As one consequence, the duration of the "latent period" in refrigeration can be fixed much more precisely[1] with the new couples—a result which the Committee's previous work shows to be important. Moreover, the rubber films have proved, so far, to withstand the rough usage to which the couples are necessarily exposed in the Committee's work, without cracking or disintegration; this was not the case

1. The limit of precision is now prescribed, not by the lag of the couples, but by the rate at which the consecutive potentiometer measurements can be carried out.

with the thin tubes, whether of glass or rubber, previously used; nor with thin films of shellac or of celluloid, with each of which—in the hope of reducing the lag—experiments were made before the method here described was worked out.

As the materials employed in preparing this form of insulation are all regular articles of commerce and the operations are extremely simple, the method may possibly find other applications in laboratory practice.

I desire to thank Mr. A. M. Munro (Director of the Chemical Laboratory, Dunlop Rubber Co. of Australasia, Ltd.), in consultation with whom the kind of rubber solution to be employed and the vulcanisation of the films were decided on, and who very kindly presented me with the rubber solution and sulphur chloride used in these experiments.

[Proc. Roy. Soc. Victoria, 38 (N.S.), 1926.]

Art. XVI.—*Delayed Dehiscence in Myrtaceae, Proteaceae and Coniferae.*

By A. D. HARDY.

(With Plate XI.)

[Read 8th October, 1925.]

The following notes are for the recording of the occurrence of delayed dehiscence in several genera each of the families Myrtaceae, Proteaceae and Coniferae. The cause of the phenomenon is for later consideration.

MYRTACEAE (*Eucalyptus, Callistemon, Melaleuca, Tristania*).

In the capsular section of the Myrtaceae (Leptospermeae) fruits often persist with unopened valves long after reaching maturity. In several species of *Callistemon* and *Melaleuca* this is habitual, in *Eucalyptus* it is occasional, and in *Tristania* it is infrequent.

Eucalyptus platypus, var. *acutifolius*, grown near Melbourne, bloomed in its fourth year. By the time the fruit had reached full size the fructiferous twigs were 1/10 inch in thickness and the umbel peduncles one inch long, but by annular increase the former encroached until the peduncles were immersed and the umbels then appeared as if normally sessile on the thick branches into which the twigs had meanwhile developed. The persistent fruits were little if anything larger than those of later production, and seed from 5-year-old capsules germinated. Other species of *Eucalyptus* occasionally retaining seed are *E. obliqua, E. macrorrhyncha, E. capitellata, E. australiana, E. dives, E. viminalis, E. rubida, E. haemastoma, E. elaeophora, E. botryoides*, and *E. cladocalyx*. Immersion occurs in several of these.

Callistemon[1] and *Melaleuca* keep their fruits for long periods with seeds germinable up to at least the 6th year, after which fertility is doubtful, not so much on account of age as owing to the attacks of micro-fungi and minute insects. The fruits of *Melaleuca nodosa* do not become scattered on enlarged branches as do the old fruits of most species of *Callistemon* and *Melaleuca*, but remain crowded round the thin branches, and become hexagonal and pseudo-connate by compression. This compactness of the fruit mass secures immunity from dislodgment of individual fruits by external agencies.

Other species noted, as affected in varying degrees, are *Callistemon lanceolatus, C. coccineus, C. rugulosus, Melaleuca Preissiana, M. styphelioides, M. hypericifolia*, and *Leptospermum scoparium*.

1.—See Ewart, A. J., The Delayed Dehiscence of Callistemon, *Ann. Bot.*, xxi., p. 135, 1907.

PROTEACEAE (*Hakea, Banksia*).

On one tree of *Hakea laurina* fruits of recent years have opened but those of the first five years have remained closed. *H. saligna, H. rostrata, H. nodosa, H. ceratophylla, H. leucoptera* and *H. ulicina* to some extent behave similarly. In a 20-year-old hedge of *H. leucoptera*, observed a few years ago, unopened fruits still clung to the stems near the ground and to a height of about 10 feet, with stalks immersed and the basal parts of the fruits fused with the stem.

In *Banksia*, a genus in which many species fail to produce fruit from the greater number of flowers, two species—*B. integrifolia* and *B. marginata*—have been found to linger occasionally but for shorter periods.

In *Protea mellifera* and *Isopogon ceratophyllus* the normally indehiscent fruits are frequently retained in the heads for many years; and this, as affecting seed dispersal, somewhat resembles delayed dehiscence.

CONIFERAE (*Pinus, Cupressus, Callitris*).

Pinus.—While most pines are reputed to discharge their seeds when the cones are one, two or three years old, many holding the cones long after releasing the seed, a few species are known to retain unopened cones for many years. Among others, the Monterey Pine preserves this habit in Victoria. I have seen an example of *P. radiata* (syn. *P. insignis*) which shows an unopened 8-year-old cone on a 7-inch diameter stem.

Cupressus keeps the opened cones attached for many years, but does not habitually reserve the seed. *C. macrocarpa* may carry closed 7-year-old cones on branches of more than an inch in thickness. Seeds of 5-year-old fruit germinated. An old tree of *C. torulosa* delayed during five years.

Callitris (Cypress Pines) frequently reserves its seed. In *C. glauca, C. verrucosa, C. propinqua, C. calcarata* and *C. tasmanica* I have only occasionally noticed it, but several young trees of *C. Muelleri* have been under observation during many years. The unopened cones persisted through six seasons. Two years ago a bush fire scorched away one side of three trees, exposing the otherwise concealed fruits to sudden and great heat, and later to the attacks of direct sun-rays and hot winds without producing dehiscence.

In all cases, except the stubborn Callistemons and Melaleucas and also *Callitris Muelleri*, fruits of long persistence responded to desiccation, releasing their seeds within a week or two after their removal from the tree. Many cones of *C. Muelleri* taken after four years and kept in a dry place during three years are still closed.

EXPLANATION OF PLATE.

Eucalyptus platypus, var. *acutifolius*, showing fruits of various ages, the oldest with peduncle immersed.

A. E. Walcott, photo. A.D.H., direx.

Eucalyptus platypus, var. acutifolius.

[Proc. Roy. Soc. Victoria, 38 (N.S.), 1926.]

Art. XVII.—*The Annual Variation in the Velocity of Cirrus Cloud over Melbourne.*

By E. KIDSON, O.B.E., D.Sc., F.Inst.P.

[Read 15th October, 1925.]

To determine the direction and velocity of movement of a cloud from surface observations, it is necessary to know both the height of the cloud and its rate and direction of angular movement. To determine the cloud height directly at each observation would be beyond the resources of meteorological institutions. The mean heights of the different types of cloud have, however, been determined from extended series of observations at a number of stations. At Melbourne such a series was obtained by photographic methods (1). With a knowledge of these mean heights, an experienced observer is usually able to make a fairly accurate estimate of the height of any particular cloud.

The angular motion of a cloud is determined by some form of nephoscope, and for the great majority of the Melbourne observations the type used was Besson's Comb Nephoscope. During the last two years, however, a Pilot Balloon theodolite has been substituted. This instrument has proved very satisfactory. A cloud point is observed in precisely the same manner as a Pilot Balloon would be; an estimate of the height of the cloud is made and its component and resultant velocities computed. As all the necessary routine has already been developed in connection with the Pilot Balloon work, in which skill and speed are attained by long practice, the method consumes the minimum amount of time.

The altitude of Cirrus cloud shows a pronounced annual variation which was roughly determined for Melbourne by the observations already referred to (1).

For computing the nephoscope observations prior to July, 1924, the following heights, based on the above determinations, have been used:—

Month	Height km.	Month	Height km.
January	10·0	July	8.5
February	9.5	August	8.5
March	9.5	September	8.5
April	9.0	October	9.0
May	8.5	November	9.5
June	8.5	December	10.0

The height assumed for January may be too great. No photographic measurements were made in that month.

From July, 1924, to date the Pilot Balloon theodolite results, in which the height of the cloud was estimated at the time of observation, have been adopted.

Observations, though not very numerous, are available for the period July, 1897, to June, 1901, when the photographs were being taken at the Melbourne Observatory (1), and for these, of course, the height was determined directly. From September, 1905, onwards, except for a break from January, 1908, to April, 1909, the observations have been fairly regular, the great majority being made by Mr. E. T. Quayle.

To determine the annual variation, the west, east, south and north component velocities for each observation were tabulated for each month, and the mean for all observations computed. Where several observations were made on the same day, the mean for that day only was tabulated in order that the day in question should not be given too much weight. This was desirable, since although there is probably a diurnal variation in Cirrus movements, and, at times, large changes take place with remarkable rapidity, certain characteristics are usually maintained for some days. The minimum number of observations thus rendered available for any month is 122, so that the resulting mean velocities should be fairly reliable. From the methods used the results must necessarily be rough, especially as the number of days on which Cirrus is observed in any month varies within wide limits. It is useless, therefore, to strive for great consistency or refinement in their treatment, provided systematic errors are eliminated so far as possible. It is anticipated, nevertheless, that the final error is unlikely to exceed 10 per cent. of the resultant velocity.

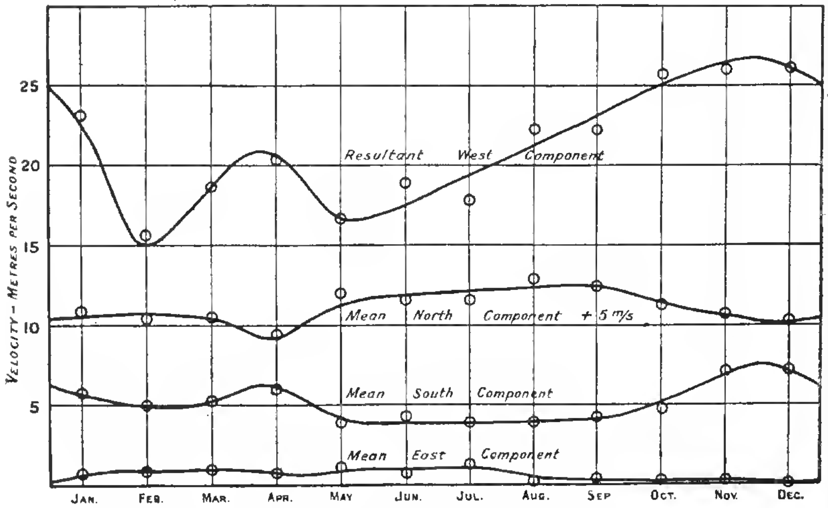

Fig. 1.—Velocity of Cirrus Cloud from Nephoscope Observations at Melbourne.

In Fig. 1 the velocities are given in metres per second. The actual values for each month are indicated by the small circles. The curves were drawn so as to indicate what seemed from a detailed consideration to be the most reliable interpretation of the results. The uppermost curve gives the resultant westerly component, i.e., the resultant eastward motion of the air. The resultant was plotted in this instance because it is, perhaps, the most interesting and important of the observed quantities, and, in any case, the easterly component is never large. The eastward movement is the most marked characteristic of the atmosphere in our latitudes, at least up to the Cirrus level, and the westerly component correspondingly predominates in the Cirrus movement. The mean resultant westerly velocity for the year is 21·1 metres per second. A particle moving with this velocity in the latitude of Melbourne would encircle the earth in about 16·5 days.

The values for the mean northerly (southward moving) component given in the second curve have all been increased by 5 m/s to render the diagram clearer.

In the westerly component, the February minimum seems to be abnormally low. Otherwise the four curves are remarkably consistent, one with another, and of a form not uncommonly met with in quantities so intimately related with the general circulation. The curve for the south component is the most typical. The maximum velocity is reached early in December, while a subsidiary maximum occurs in April. The principal minimum is a very flat one, covering the winter months. It is probable that were sufficient observations available the annual variation in the height of the Cirrus would be found to be very closely similar. Even the existing observations prove a considerable resemblance. Similar remarks apply to the mean eastward velocity of anticyclones over the whole of the Australian region. It is interesting to note, however, that the Cirrus velocity is about two and a-half times that of the anticyclones. The anticyclones—that is, the pressure systems of our weather charts, do not, therefore, move with the currents at Cirrus level.

Other quantities showing relationships in their annual variation with that of Cirrus velocities are the pressure at McMurdo Sound and at Batavia respectively, and the height of the stratosphere. At McMurdo Sound (Lat. 78°S.), where the pressure variation appears to be controlled by the Polar Cyclone, the principal maximum is in December, a secondary one in April, and the lowest minimum at the latter end of winter. At Batavia (6·2°S.) the variation is reversed, the minima being in December and April. In the northern hemisphere the height of the stratosphere has maxima in the corresponding months, June and October. There are not sufficient observations to give a reliable annual variation curve for the height of the stratosphere at any station in the Southern Hemisphere, but Batavia observations indicate maxima in January and May, giving a lag of one month on the other quantities. The proper interpretation of these relationships would bring to light facts of the greatest importance concerning the general circulation of the atmosphere.

The most striking feature of the curves is the opposition between the variations of the northerly and southerly components, the curves being almost mirror images of each other. This signifies that the total motion in the north to south or the reverse direction, or the arithmetical sum of the two components, is nearly constant. It is not, however, quite constant, but has a slight annual variation similar to that of the westerly component. The westerly component is about twenty times as large as the easterly, but, proportionally, they show just the same opposition as do the northerly and southerly components. In this case, also, therefore, the total motion, regardless of direction, has a smaller variation than that of the components.

Generally speaking, the south and west components have a similar annual variation which is the reverse of that of the north and east. The suggested explanation of this interesting relationship is that air with a strong northerly or easterly component in its motion has a different origin from that with a strong westerly or southerly component, moves in a distinct mass, and is separated from it by rather marked surfaces of discontinuity. The northerly and easterly currents presumably correspond with the "Equatorial Air" of the Norwegian "Polar Front" theory and the westerlies and southerlies with the "Polar Air."

The depth of the February minimum may be produced to some extent by local influences, such as the position of Melbourne at the south-east corner of Australia, where the maximum effect of the continent on the air circulation is felt, or it may be due partially to accidental causes, the effects of which will be smoothed out when a larger number of years' results are available. The fact that the northerly and easterly components are smaller in February than the run of the curves would lead one to expect, lends support to the latter suggestion.

The curve for the westerly component differs from that of the southerly, in addition to the depth of the February minimum, in that, instead of a flat minimum during the winter months, there is a continuous increase in velocity from June to December. This type of variation is mirrored in the easterly component, while the southerly type is reversed in the flat winter maximum of the northerly component.

From the above we see that there are two aspects of the annual variation of Cirrus movement. First we have the general mass of air moving with a westerly velocity which varies in the manner shown in the top curve of the figure. With this the southerly component appears to merge naturally. In fact, the westerly velocity may be the result of the continuous degradation of the energy of the southerly winds. On the other hand, the invasion of a strong northerly or easterly wind brings about a reduction in the general velocity. This is in accordance with our experience, easterly winds particularly producing intense anticyclones and general stagnation. Over Melbourne the northerly component is rather stronger on the average than the southerly. The northerlies probably lose their identity in cooling and mixing processes, chiefly in Antarctic and Subantarctic latitudes.

The low velocities in February and in winter are connected no doubt with the oscillation in the general circulation following the seasonal movements of the sun. The best index of this in the Australian region is, perhaps, the latitude of the moving anticyclones. The latter reach their southern limit everywhere in February. The month in which the most northward latitude is reached, however, varies from place to place; in the centre of the continent it is in June, while in the Tasman Sea it is as late as September, hence the flatness of the winter minimum. The low velocities occur in the intervals between the invasion of the temperate westerlies by the tropical easterlies and vice versa.

The variations in the velocity components bear, in most respects, a close resemblance to those in the frequency of occurrence of Cirrus from the corresponding directions as determined by E. T. Quayle (3). That is, the frequency of occurrence increases with increase of velocity. Though there is a falling off in frequency in February and March, however, the February minimum is not nearly so marked as in the velocity. The northerly component is relatively more important when velocities are considered than as derived from observations of direction only. The present results, therefore, give a more northerly mean direction than that obtained by Mr. Quayle (3). From January to April inclusive, the resultant direction differs little from due west (270°), though it is, perhaps, a little south of west in April. Thereafter, there is a sudden change, the direction being approximately 10° north of west (280°) from May to August. A gradual swing follows to the most southerly direction (265°) in November or December.

The fact that the frequency of appearance of Cirrus is roughly proportional to its velocity suggests that the mean velocity of the cloud is greater than that of the air at the same level, which is somewhat unfortunate from the point of view of the interpretation of the results.

The data are not sufficient to determine the characteristic variations of Cirrus movement in seasons of different types. Such evidence as there is indicates that the motion is faster at sunspot minimum than at sunspot maximum.

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2. J. Bjerknes and H. Solberg. The Life Cycle of Cyclones and the Polar Front theory of Atmospheric Circulation. *Kristiania Geofysiske Publikationer.*
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[Proc. Roy. Soc. Victoria, 38 (N.S.), 1926.]

Art. XVIII.—*Contributions to the Flora of Australia, No. 31.** *Additions to the Flora of the Northern Territory and Locality Records.*

BY

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[Read 12th November, 1925.]

The present paper includes further work on the flora of the Northern Territory, and is partly derived from the examination of the collections made by the senior author in 1924. We have, however, also had the privilege of examining the collections made by Mr. C. E. F. Allen during his journeys in the Northern Territory; and the result has already been to add considerably to the recorded flora of the Territory, and to indicate that with further work a revised and more complete Flora of the Northern Territory will be required.

The three new genera described, *Wycliffea, Scorpia* and *Sideria,* are endemic to the Northern Territory. *Wycliffea* (Caryophyllaceae) shows a response to a xerophilous habitat by complete cleistogamy; *Scorpia* is a unique member of the Mimosoideae (Ingeae), possessing a simple leaf and a short gynandrophore; and *Sideria* adds another instance of the reduction of the androecium in the Malvaceae. A description is also given of a new species of *Scaevola.*

Some of the additions to the Flora are plants considered to belong to the Territory by Tate and others, but not included in the "Flora of the Northern Territory," by O. B. Davies and the senior author because of the lack of definite localities for the records.

GRAMINEAE.

Rottboellia exaltata Benth.
Darwin, C. E. F. Allen (No. 467), 28/4/1920.

Ischaemum arundinaceum F.v.M.
Edge of mangrove swamp, Darwin, C. E. F. Allen (No. 456), March, 1920.

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*No. 30 in this Vol., p. 77.

Andropogon bombycinus R. Br.
Porphyrite rocks, Banka Banka Station, C. E. F. Allen (No. 665), June, 1922; Darwin, C. E. F. Allen (No. 457), Feb., 1920; Alice Springs, growing in gullies, C. E. F. Allen (No. 551), July, 1922.

Andropogon gryllus Linn.
Daly River banks, C. E. F. Allen (No. 481), June, 1920.

Themeda triandra Forst.
Alice Springs, C. E. F. Allen (No. 561), July, 1922. Mr. Allen states that this plant is a good fodder.
This species has not previously been recorded from the Northern Territory.

Paspalum orbiculare Forst.
Vestey's Paddocks, Darwin, C. E. F. Allen (No. 438).
This species has not previously been recorded from the Northern Territory.

Panicum semialatum R. Br.
Batchelor Farm flats, C. E. F. Allen (No. 513), 25/3/1922.

Aristida stipoides R. Br.
On quartzite hills and sandstone, Alice Springs, C. E. F. Allen (No. 620), July, 1922.

Sporobolus virginicus Kunth.
Wet places, Vestey's Paddocks, Darwin, C. E. F. Allen (No. 440).

Eriachne mucronata R. Br.
Alice Springs, C. E. F. Allen (No. 555).
This species has not previously been recorded from the Northern Territory.

Eriachne aristidea F.v.M.
Wycliffe Well, A. J. E., June, 1924.

Eriachne obtusa R. Br.
Rocky lands, Alice Springs, C. E. F. Allen (No. 618), July, 1922.

Eleusine indica Gaertn.
Vestey's Paddocks, Darwin, C. E. F. Allen (No. 436).
This species has not previously been recorded from the Northern Territory.

CYPERACEAE.

Cyperus conicus Boeckel.
Vestey's Paddocks, Darwin, C. E. F. Allen (No. 437).

Cyperus eleusinoides Kunth.
Vestey's Paddocks, Darwin, C. E. F. Allen (No. 439).

PROTEACEAE.

Grevillea agrifolia A. Cunn.
On quartzite hill, twenty miles north of Alice Springs, C. E. F. Allen (No. 588), July, 1922.

Grevillea juncifolia Hook.

Sandy tablelands, Kelly's Well, north of Alice Springs, C. E. F. Allen (No. 605), July, 1922.

This species has not previously been recorded from the Northern Territory (see also Contributions, No. 30).

Hakea arborescens R. Br.

Twenty miles north of Powell's Creek, C. E. F. Allen (No. 650).

SANTALACEAE.

Santalum obtusifolium R. Br.

Three miles south of Connor's Well, A. J. E., June, 1924.

This species has not previously been recorded from the Northern Territory.

LORANTHACEAE.

Loranthus Exocarpi Behr. var. spathulata Blakely.

Twenty miles north of Tennant's Creek, C. E. F. Allen (No. 659); Kelly's Well, C. E. F. Allen, growing on *Acacia dictyophleba* and on *Eucalyptus pyrophora* var. *polycarpa.*

This variety has not previously been recorded from the Northern Territory.

Loranthus Maideni Blakely.

Central Mount Stuart, C. E. F. Allen, July, 1922.

This species has not previously been recorded from the Northern Territory.

CHENOPODIACEAE.

Kochia triptera Benth.

Limestone country, 250 miles north of Alice Springs, C. E. F. Allen (No. 673), August, 1922.

This is the first definite locality recorded for this plant in the Northern Territory.

AMARANTACEAE.

Ptilotus alopecuroides F.v.M.

Near Tennant's Creek, C. E. F. Allen (No. 642), July, 1922.

Trichinium obovatum Gaud. var. grandiflorum Benth.

Buxstone Ranges, C. E. F. Allen (No. 579), July, 1922; Macdonnell Ranges, C. E. F. Allen (No. 562), July, 1922; in sandy country, Kelly's Well, north of Alice Springs, C. E. F. Allen (No. 608).

Mr. Allen describes it as "an edible fodder plant for cattle, sheep and camels."

Alternanthera polycephala Benth.

Wycliffe Well, A. J. E., June, 1924.

Gomphrena canescens R. Br.

Roper River, C. E. F. Allen (No. 740), May, 1924.

Mr. Allen states it to be a common herb, much sought after by horses.

NYCTAGINACEAE.

Boerhaavia diffusa L.

Wycliffe Well, A. J. E., June, 1924; near Barrow Creek, Miss Doreen Crook, May, 1925.

A note by J. R. Tovey on a specimen in the National Herbarium dated November, 1909, reads: " It is considered a valuable fodder plant in the deserts of Central Australia. The root is eaten by the blacks, and is named 'Murra.' "

AIZOACEAE.

Trianthema decandra L.

Alice Springs, A. J. E., June, 1924.

Trianthema pilosa F.v.M.

Occasional between Taylor Creek and Wycliffe Well, Sergeant Stott, 1925.

CARYOPHYLLACEAE.

Spergularia rubra Pers.

Wycliffe Well, A. J. E., June, 1924.

This species has not previously been recorded from the Northern Territory.

Wycliffea, n. gen.

Flowers cleistogamous. Sepals 5, green, somewhat scarious at the edge. Petals absent. Stamens 3, hypogynous, shorter than the height of the ovary, persistent in the ripe fruit. Anthers all fertile. Ovary 3-celled. Stigmas 3, capitate, sessile on the ovary. Ovules numerous, attached in two rows in each loculus to a columnar placenta in the centre of the ovary. Capsule membranous, 3-valved, loculicidally dehiscent; sepals persistent and slightly enlarged in the fruit. Seeds many, tuberculate, reniform. Leaves whorled, of unequal size in each whorl. Stipules absent, but a few white scarious scales at the base of the pedicel. Flowers pedicillate, in axillary clusters, the pedicel elongating in the fruit.

This genus appears to have been derived from the Drymaria type by the advent of cleistogamy, which is probably an adaptation to the arid habitat in which it occurs. This character would account for the loss of the style and also of the petals. The fact that the anthers are shorter than the ovary suggests a possibility of parthenogenesis, but the pollen grains in the species described are abundant and appear to be fertile.

Wycliffea obovata, n. sp.

An annual, sparingly hirsute on stems and slightly also on leaves, much branched at the base, with weak, spreading, dichotomously branching stems about 1 foot in length. Leaves obovate-lanceolate, the larger ones up to $\frac{1}{2}$ in. long, shortly petiolate, slightly serrate. Pedicels from 2 to 3 lines long in the fruit.

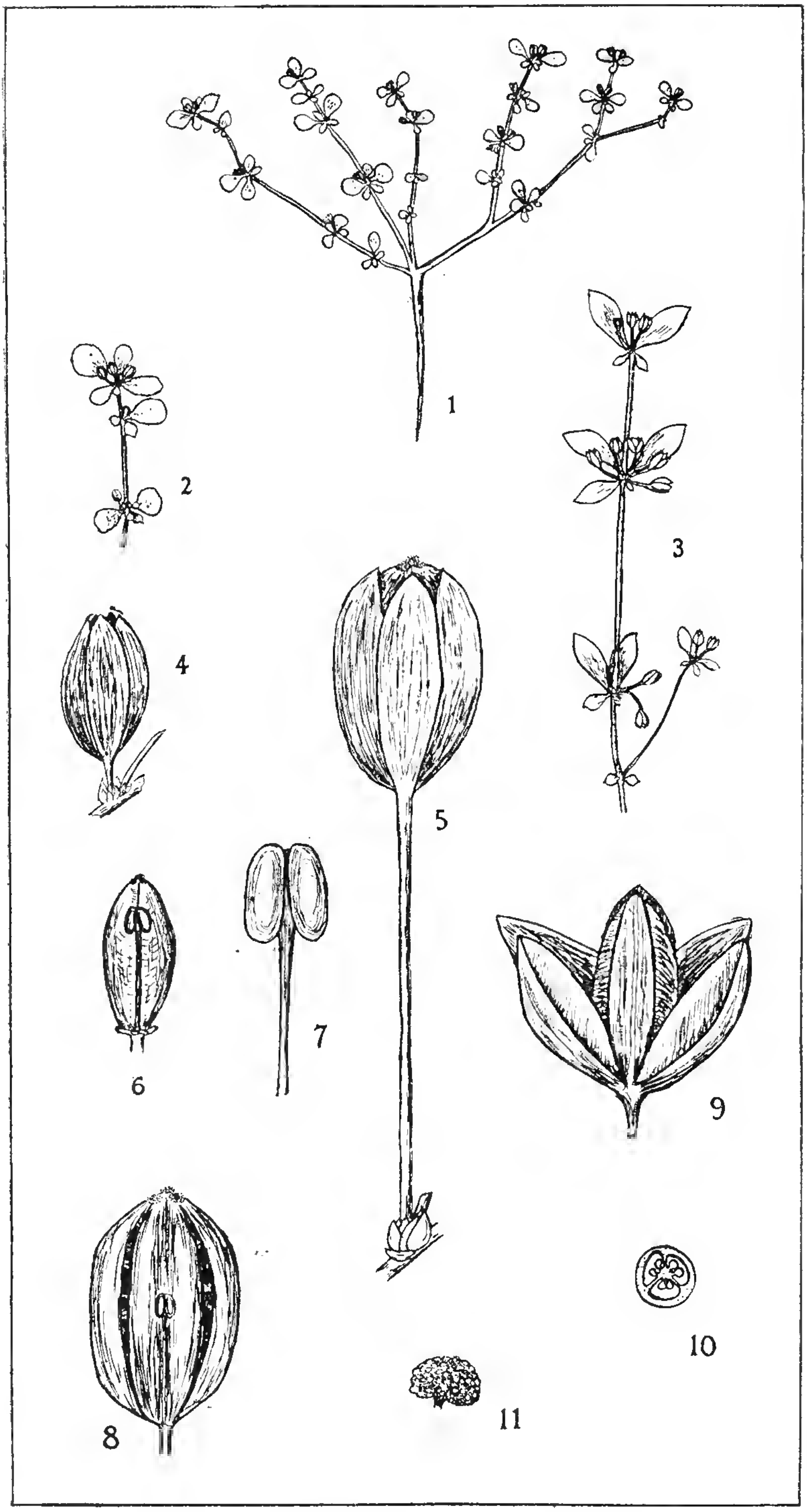

Fig. 1.—Wycliffea obovata and W. rotundifolia.

1. Complete plant of *W. rotundifolia* (× ½); 2. Portion of a branch of *W. rotundifolia* (nat. size); 3. Portion of a branch of *W. obovata* (nat. size); 4. Flower of *W. obovata* (× 12); 5. Fruit of *W. obovata* (× 12); 6. Flower of *W. obovata* with calyx removed. (× 12); 7. Stamen of *W. rotundifolia* (× 24); 8. Fruit of *W. obovata* with calyx removed. (× 12); 9. Dehisced fruit with two front sepals removed (× 12); 10. T. s. ovary of *W. obovata* (× 12); 11. Seed of *W. obovata* (× 24).

Sepals 1 to $1\frac{1}{4}$ lines in length in the fruit, somewhat shorter in the flower.

Wycliffe, A. J. E., June, 1924; Stirling Station, A. J. E., June, 1924.

WYCLIFFEA ROTUNDIFOLIA, n. sp.

An annual, sparingly hirsute on stems and leaves, the latter almost mealy. Habit that of *W. obovata* but smaller in the specimens seen. Leaves obovate-rotund, the larger ones up to $2\frac{1}{2}$ lines in length, shortly petiolate, slightly serrate, somewhat thicker and a darker green than in *W. obovata*. Pedicels from 1 to 2 lines long in the fruit, somewhat shorter in the flower.

Wycliffe, A. J. E., June, 1924.

The distinctions between the two species are almost varietal in character, but they nevertheless appear to be constant, and as the two plants grow in the same locality they are probably not attributable to the influence of differences in environmental conditions.

Polycarpaea brevianthera Ewart and Cookson.

Near Central Mount Stuart, A. J. E., June, 1924.

CAPPARIDACEAE.

Capparis umbonata Lindl.

Darwin, C. E. F. Allen (No. 504), August, 1921.

DROSERACEAE.

Drosera petiolaris R. Br.

Banka Banka Station, south of Powell's Creek, C. E. F. Allen (No. 1671), August, 1922.

Drosera indica Linn.

Banka Banka Station, south of Powell's Creek, C. E. F. Allen (No. 670), August, 1922.

ROSACEAE.

Stylobasium spathulatum Desf.

Taylor Creek to Wycliffe, A. J. E., June, 1924; Taylor's Crossing, C. E. F. Allen (No. 590), July, 1922; forty miles north-north-west of Meyer's Hill, G. F. Hill (No. 241 B), 1911.

LEGUMINOSAE.

Scorpia, n. gen.

Sepals five, free. Petals five, free. Stamens indefinite, the bases of the filaments fused with the stalk of the ovary, forming a short gynandrophore; anthers versatile, short and broad. Ovary bicarpellary, two-celled, sessile on the gynandrophore; style single; stigma terminal, flat and papillose. Ovules numerous, in a single row in each loculus. Pod linear-terete, much twisted, moniliform,

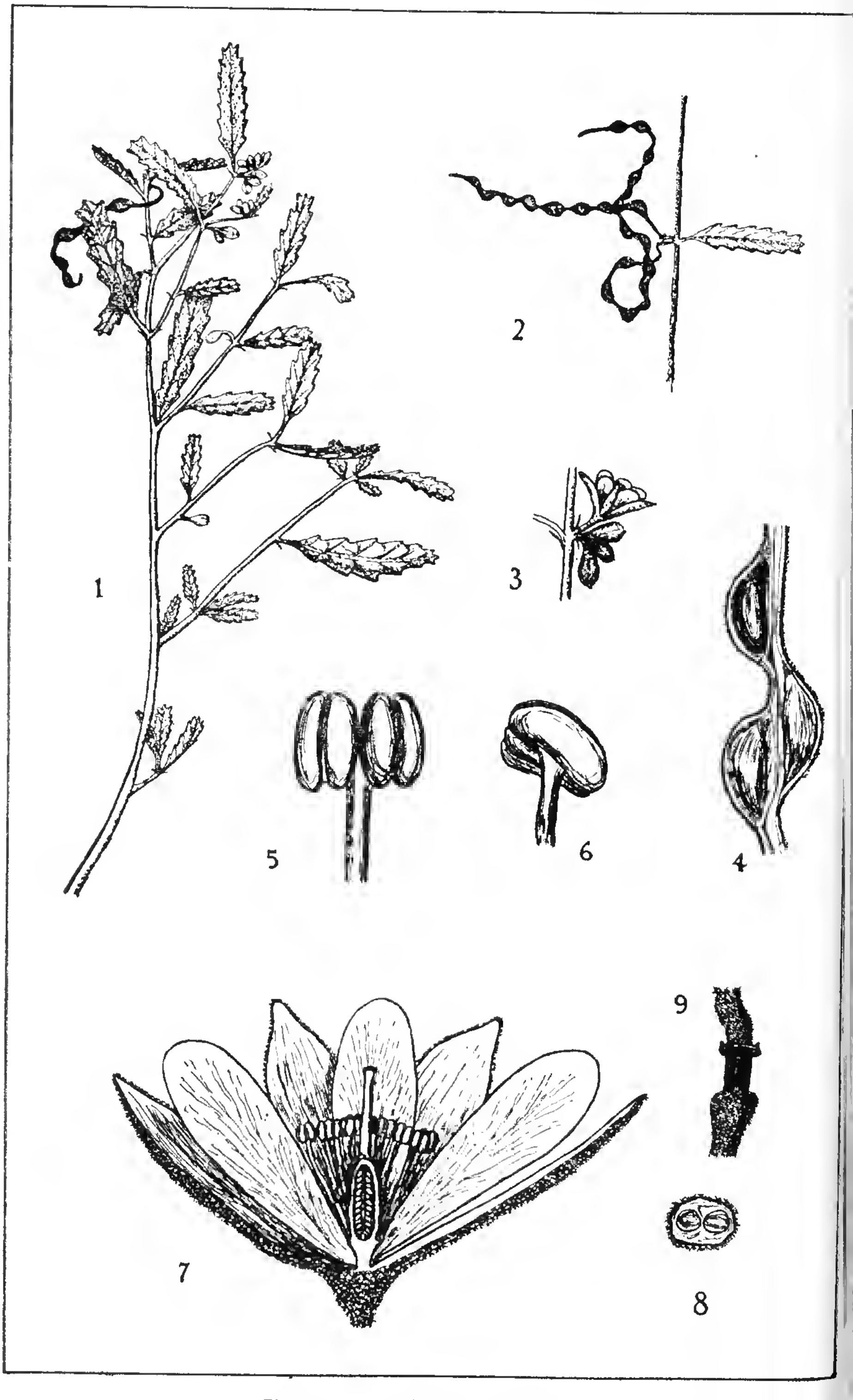

Fig. 2.—Scorpia simplicifolia.

1. Portion of a branch (nat. size); 2. Cluster of fruits (nat. size); 3. Cluster of flowers (× $1\frac{3}{4}$); 4. Portion of one half of open pod, showing one seed and dissepiment. (× 5); 5, 6. Stamen (× 50); 7. L. s. flower (× 13); 8. T. s. ovary (× 26); 9. Base of fruit showing persistent gynandrophore, and rim from which the stamens arise. (× 13).

opening in two valves, with the partition persisting between paired seeds but fused with the wall at the constrictions or where only one seed is present. Seeds dark, surface slightly rough, clavate, attached at the broader end. Leaves simple, more or less opposite. Flowers leaf-opposed, in clusters or solitary.

The bicarpellary ovary and the basal fusion of the stamens suggest that this genus should be placed in the section Ingeae of the Mimosoideae. The gynandrophore, at the same time, is a unique character, as also is the simple type of leaf. It is possible, however, that these may be primitive characters: the gynandrophore may well foreshadow the staminal tube which is an established feature in all other genera of the Ingeae; while the serrated margin of the simple leaves in the species described below perhaps suggests an incipient pinnatisection, which condition would precede the development of the completely pinnate leaf typical of the whole of the Mimosoideae.

SCORPIA SIMPLICIFOLIA, n. sp.

A low shrub, one to three feet high, the leaves, branches, calyx, ovary and pod clothed with a fine stellate indumentum. Leaves opposite or alternate, oblong, somewhat narrowed towards the base, shortly petiolate, serrate, rigid, conspicuously veined. Stipules small, linear, deciduous. Flowers mostly in small cymose clusters, opposed to the leaves, or solitary and leaf-opposed. Sepals lanceolate, $2\frac{1}{4}$ lines long. Petals obovate-lanceolate, narrowed at the base, as long as the sepals. Stamens about 20, $1\frac{1}{2}$ lines in length. Style slightly tapering towards the apex; stigma terminal, papillose. Pod about $1\frac{1}{4}$ inches long, containing about 8 to 20 seeds.

Wycliffe, A. J. E., June, 1924.

Acacia dimidiata Benth.

Table Top, Pine Creek, C. E. F. Allen (No. 480), May, 1920.

Acacia estrophiolata F.v.M.

Stirling Station, Barrow Creek, C. E. F. Allen (No. 646), August, 1922.

Acacia hemignosta F.v.M.

Pine Creek, C. E. F. Allen (No. 474), 8/5/1920.

Acacia Hilliana Maiden.

Tablelands, Ferguson River, C. E. F. Allen (No. 645), July, 1922.

Acacia holosericea A. Cunn.

Stirling Station, Barrow Creek, C. E. F. Allen (No. 647), July, 1922.

Acacia impressa F.v.M.

Ferguson River, twenty miles north of Powell Creek, C. E. F. Allen (No. 645), July, 1922.

Acacia latescens Benth.

Table Top, Pine Creek, C. E. F. Allen (No. 479), May, 1920.

Acacia lysiphloia F.v.M.
Kelly's Well, north of Alice Springs, C. E. F. Allen (No. 610), July, 1922; Ferguson River, twenty miles north of Powell's Creek, C. E. F. Allen (No. 644).

Acacia oncinocarpa F.v.M.
Table Top, Pine Creek, C. E. F. Allen (No. 478), May, 1920.

Acacia salicina Lindl. var. varians.
Roper River, C. E. F. Allen (No. 729), July, 1923; Renner's Springs, south of Powell's Creek, C. E. F. Allen (No. 679), August, 1922.
This variety has not previously been recorded from the Northern Territory.

Acacia spondylophylla F.v.M.
Limestone Hill, Powell's Creek, C .E. F. Allen (No. 669), August, 1922; Wycliffe Well, north of Alice Springs, C. E. F. Allen (No. 601).

Acacia stipuligera F.v.M.
Ferguson River, C. E. F. Allen (No. 646), July, 1922.

Acacia tetragonophylla F.v.M.
Alice Springs, C. E. F. Allen (No. 558), July, 1922.

Acacia tumida F.v.M.
Ferguson River, C. E. F. Allen (No. 648), August, 1922.

Petalostylis labicheoides R. Br.
Tablelands south of Renner's Springs, C. E. F. Allen (No. 675), July, 1922.

Cassia eremophila A. Cunn.
Flats, Buxstone Ranges, C. E. F. Allen (No. 592), July, 1922.

Cassia oligophylla F.v.M.
Limestone country, 250 miles north of Alice Springs, C. E. F. Allen (No. 672), August, 1922.

Cassia Sturtii R. Br.
Wycliffe Creek, C. E. F. Allen (No. 597), July, 1922.

Cassia venusta F.v.M.
Buxstone Ranges, C. E. F. Allen (No. 577), July, 1922.
Mr. Allen records this plant as a tree six to seven feet high.

Brachysema Chambersii F.v.M.
Between Taylor and Wycliffe, and on Murray Downs track, Sergeant Stott, 1925.

Mirbelia oxyclada F.v.M.
Abundant on several portions of the Murray Downs track, Sergeant Stott, 1925.

Gastrolobium grandiflorum F.v.M.
Wycliffe Well, north of Alice Springs, C. E. F. Allen (No. 645), August, 1922.

Crotalaria dissitiflora Benth.
Sandy Valley, Wycliffe Creek, C. E. F. Allen (No. 598), July, 1922.

Crotalaria Novae-Hollandiae, D. C.
Banka Banka Station, south of Powell's Creek C. E. F. Allen (No. 661), August, 1922; plentiful between Taylor and Wycliffe, Sergeant Stott, 1925.

Crotalaria trifoliastrum Willd.
Limestone country, Tennant's Creek. C. E. F. Allen (No 664), August, 1922.

Indigofera boviperda Morrison.
Bonny Well, north of Alice Springs, C. E. F. Allen (No. 604), July, 1922.

Swainsona oroboides F.v.M.
Alice Springs, C. E. F. Allen (No. 611), August, 1922.
This is the first definite locality recorded for this plant in the Northern Territory (see also Contributions, No. 30). According to Mr. Allen it is a fodder plant.

Zornia diphylla Pers.
Wycliffe, A. J. E., June, 1924.

Zornia diphylla Pers. var. gracilis Benth.
Pine Creek, J. H. Niemann. Specimen in National Herbarium, Melbourne.
This variety has not previously been recorded from the Northern Territory.

Glycine tabacina Benth.
Alice Springs, C. E. F. Allen (No. 554).
Mr. Allen describes it as a climbing herb on hills, eaten by horses, camels, etc., making a good fodder.

Erythrina vespertilio Benth.
Tennant's Creek, C. E. F. Allen (No. 599).

EUPHORBIACEAE.

Excoecaria parvifolia Muell. Arg.
North of Newcastle Waters, C. E. F. Allen (No. 634), August, 1922.

Petalostigma quadriloculare F.v.M. var. nigrum Ewart and Davies (=*P. humilis* Fitzg.).
Banka Banka Station, south of Powell's Creek, C. E. F. Allen (No. 667), July, 1922.

ANACARDIACEAE.

Buchanania Muelleri Eng. var. pilosa.
Stony ridges, Stapleton (60 miles from Darwin), C. E. F. Allen (No. 702), December, 1923.

STACKHOUSIACEAE.

Stackhousia viminea Sm.
Wycliffe Well, A. J. E., June, 1924.

RHAMNACEAE.

Alphitonia excelsa Reissek.
Rapid Creek, near Darwin, C. E. F. Allen (No. 535), April, 1922.

MALVACEAE.

Sida cardiophylla F.v.M.
Buckstone Ranges, C. E. F. Allen (No. 580), July, 1922.
This species has not previously been recorded from the Northern Territory (see also Contributions, No. 30).

Sida spinosa Linn.
Newcastle Waters, C. E. F. Allen (No. 651), July, 1922.

Sida virgata Hook.
Hills, Alice Springs, C. E. F. Allen (No. 628), July, 1922.

Urena lobata Linn.
Damp ground, Darwin, C. E. F. Allen (No. 401), August, 1919.
This is the first definite locality recorded for this plant in the Northern Territory.

Sideria, n. gen.

Epicalyx of three distinct, narrow bracteoles. Sepals five, free. Petals five, adnate at the base to the staminal tube, contorted in the bud. Androecium of five stamens and five flat, petaloid staminodia, united at the base to form a very short tube or ring round the base of the ovary. Pollen grains echinate, large and spherical. Ovary five-celled, entire, with three ovules in each cell. Style simple, with five decurrent, linear styles at the apex; one style occasionally subdivided to form six. Fruit dry, the carpels completely united in a loculicidally dehiscent capsule.

This genus belongs to the tribe Hibisceae of the Malvaceae, and lies in systematic position between *Thespesia* and *Cienfuegosia*, having the five carpels of the former and the loculicidal dehiscence of the latter. The nature of the staminal tube is a unique character for a malvaceous type. We may suppose that it represents a reversion to an earlier stage in the evolution of the family, before chorizis of the stamens had become the dominating feature. The inner whorl of the androecium, which alone is present in the Malvaceae, has not only been reduced to ten stamens, but an earlier condition still is reflected in the further reduction of five of the stamens to staminodia; and, concomitantly, the staminal column, which we may suppose to have developed in correlation with chorizis, is practically non-existent.

This is not the only instance of this apparent reversion in the Malvaceae, for *Malvastrum pentandrum* K. Sch. and *Sida oligandra* K. Sch. have only five stamens; and it seems feasible that these types may indicate reversion to a still earlier condition. *Malvastrum* and *Sida* may perhaps be regarded as primitive genera, on account of their incompletely united carpels; *Sideria*, on the contrary, has retained complete syncarpy in spite of the

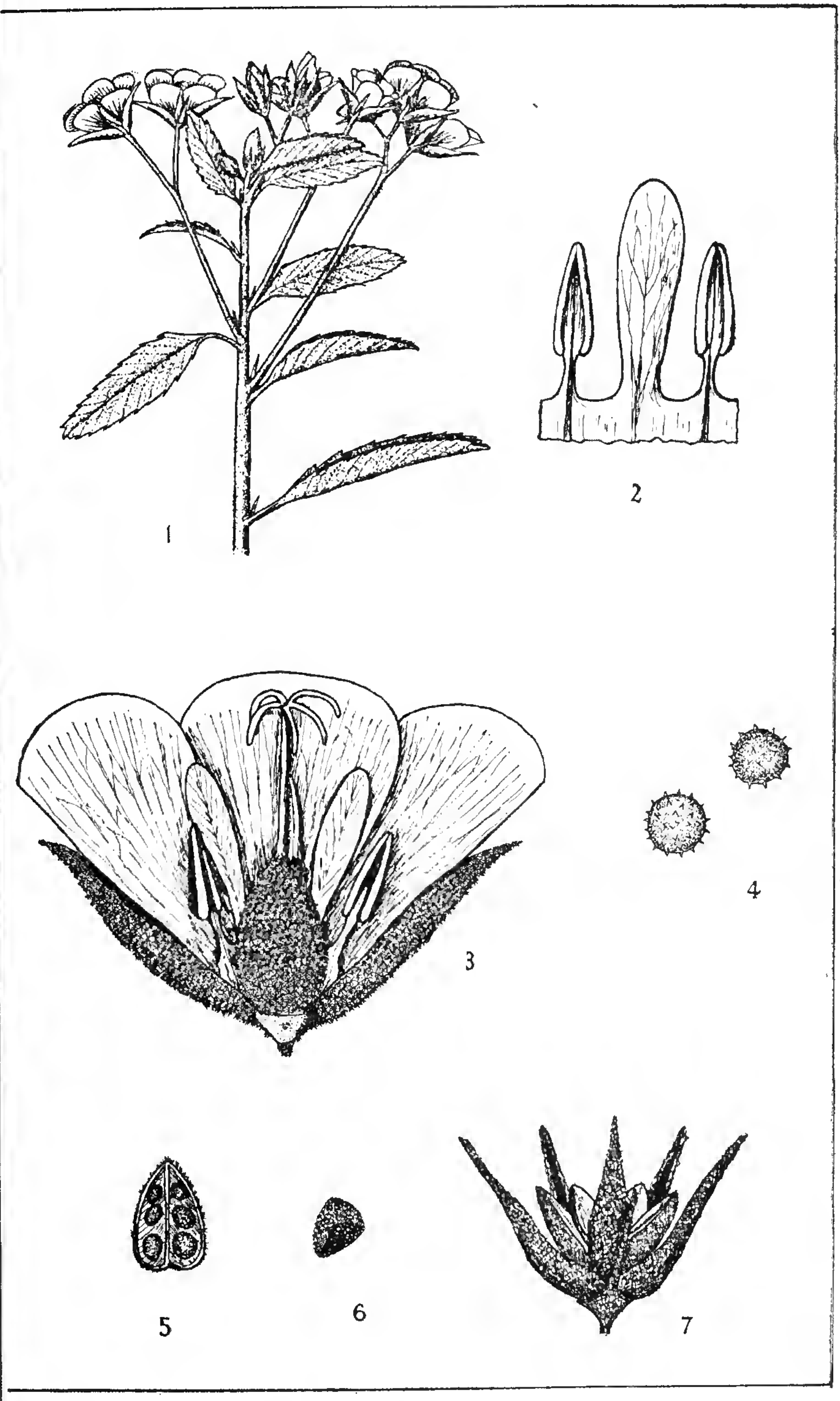

Fig. 3—Sideria reverta.

1. Apex of flowering stem (nat. size); 2. Portion of stamin l tube showing staminodium and two stamens (× 3½); 3. View of flower cut longitudinally thr ugh the centre (× 5); 4. Pollen grains (× 60); 5. Valve of capsule (× 2½); 6. Seed (× 4); 7. Dehisced fruit with persistent calyx and epicalyx (×3).

reversion indicated in the androecium, and is therefore a more advanced type in this respect; inequalities in advancement, however, are a feature characteristic of the whole alliance of Malvales.

SIDERIA REVERTA, n. sp.

Shrub of 4-5 feet; the whole plant except the petals, androecium, and style covered with short, stellate hairs. Leaves serrate, oblong-lanceolate, obtuse, 1-1½ inch long, on petioles about 3 lines in length, with a single subulate stipule in the axil. Inflorescence centrifugal, paniculate to corymbose, the peduncles one to three flowered. Flowers yellow. Epicalyx of narrow and persistent bracteoles. Calyx 6 lines in diameter. Petals broad, 3-4 lines long. Anthers adnate; staminodia oblong, petal-like. Capsule 3-4 lines in diameter. Seeds ovoid-angular, tuberculate.

Taylor's Well, A. J. E., June, 1924.

Gossypium Sturtii F.v.M.

Kelly's Well, north of Alice Springs, C. E. F. Allen (No. 606, July, 1922.

STERCULIACEAE.

Sterculia caudata Hew. (=*Brachychiton diversifolium* R. Br.).

Adelaide River, C. E. F. Allen (No. 505), August, 1921.

This species has not previously been recorded from the Northern Territory.

Sterculia quadrifida R. Br.

Near Mangrove swamps, Darwin, C. E. F. Allen (No. 714).

Waltheria indica Linn.

Wycliffe, A. J. E., June, 1924.

TILIACEAE.

Triumfetta chaetocarpa F.v.M.

Taylor Flat, A. J. E., June, 1924.

This is the first definite locality recorded for this plant in the Northern Territory.

MYRTACEAE.

Xanthostemon paradoxus F.v.M.

Near Mangroves, Darwin, C. E. F. Allen (No. 550).

Eucalyptus alba Reinw.

Banks of Catharine River, C. E. F. Allen (No. 681), August, 1922.

Eucalyptus Foelschiana F.v.M.

In gorges, Pine Creek, C. E. F. Allen (No. 475), 9/5/1920.

Eucalyptus intertexta R. T. Baker.

Newcastle Waters, C. E. F. Allen (No. 636), August, 1922.

Eucalyptus latifolia R. Br.

Mataranko Station, 300 miles north of Darwin, C. E. F. Allen (No. 684), July, 1922; Table Top, Pine Creek, C. E. F. Allen (No. 477), May, 1920.

Eucalyptus phoenicea F.v.M.
Granite hillside, Pine Creek, C. E. F. Allen (No. 470), May, 1920.

Eucalyptus pyrophora Benth. var. polycarpa Maiden.
Alice Springs, C. E. F. Allen, July, 1922.
This species has not previously been recorded from the Northern Territory.

Eucalyptus rostrata Schlecht.
Powell Creek, C. E. F. Allen (No. 649), August, 1922; Daly Waters, C. E. F. Allen (No. 658), July, 1922.

Eucalyptus setosa Schau.
Pine Creek gorge, C. E. F. Allen (No. 469), May, 1920; tablelands 250 miles north of Alice Springs, C. E. F. Allen (No. 676), July, 1922.

Eucalyptus terminalis F.v.M.
Near Darwin, C. E. F. Allen (No. 465), 23/3/1920; Pine Creek, C. E. F. Allen (No. 473), 8/5/1920; Table Top, C. E. F. Allen (No. 730), May, 1920.

Melaleuca leucadendron Linn.
Banks of Attack Creek, C. E. F. Allen (No. 638), July, 1922.

Melaleuca symphyocarpa F.v.M.
Roper River, C. E. F. Allen (No. 736), May, 1924.

Calytrix achaeta F.v.M.
Pine Creek, C. E. F. Allen (No. 468), May, 1920.

Verticordia Cunninghamii Schau.
Pine Creek, C. E. F. Allen (No. 500), October, 1921.

COMBRETACEAE.

Terminalia platyphylla F.v.M.
Katharine River, C. E. F. Allen (No. 722), 26/3/1923.
This species has not previously been recorded from the Northern Territory.

HALORRHAGIDACEAE.

Haloragis heterophylla Brongn.
Wycliffe Well, A. J. E., June, 1924. Has a strong, foetid odour.
This is the first definite locality recorded for this species in the Northern Territory.

SAPOTACEAE.

Sideroxylon Brownii F.v.M.
Batchelor Farm, C. E. F. Allen (No. 712).
Mr. Allen appends the following note: "Tree, 25 feet high; tough yellow heartwood; yields a white, sticky, milky latex."
This species has not previously been recorded from the Northern Territory.

EBENACEAE.

Diospyros pentamera F.v.M.
Banks of Katharine River, C. E. F. Allen (No. 682), August, 1922.

GENTIANACEAE.

Limnanthemum geminatum Griseb.
Lagoon, ten miles from Darwin, C. E. F. Allen (No. 539), May, 1922.

APOCYNACEAE.

Carissa lanceolata R. Br.
Wycliffe, A. J. E., June, 1924.

Alstonia verticillosa F.v.M.
Common in coastal belt, C. E. F. Allen (No. 544).

Wrightia saligna F.v.M.
Stapleton, C. E. F. Allen (No. 708), December, 1922.

CONVOLVULACEAE.

Ipomaea erecta R. Br.
Stapleton, C. E. F. Allen (No. 711), December, 1922.

Ipomaea heterophylla R. Br.
Flats, Batchelor Farm, C. E. F. Allen (No. 507), March, 1922.

BORAGINACEAE.

Heliotropium ovalifolium Forsk.
Dry sandy land, Taylor's Crossing, Buxstone Ranges, C. E. F. Allen (No. 589), July, 1922.

Heliotropium paniculatum R. Br.
Taylor Well, A. J. E., June, 1924.

Trichodesma zeylanicum R. Br.
Attack Creek, C. E. F. Allen (No. 660), August, 1922; common between Wycliffe and Taylor, Sergeant Stott, 1925.
According to Sergeant Stott it is said to be good fodder.

VERBENACEAE.

Vitex trifolia Linn. var. ovata Thunb.
Seashore, near Darwin, C. E. F. Allen (No. 421), January, 1920.
This variety has not previously been recorded from the Northern Territory.

Dicrastyles Dorani F.v.M.
South of Renner's Springs, C. E. F. Allen (No. 678), July, 1922.
This species was not recorded in the Northern Territory Flora, but it is abundant along the track from Old Crown Point to Horseshoe Bend and Deep Well.

Dicrastyles orthotricha F.v.M.
Five to eight miles north of Taylor Creek, A. J. E., June, 1924.

SOLANACEAE.

Solanum Cunninghamii Benth.
Between Wycliffe and Taylor, A. J. E., June, 1924.
Solanum ellipticum R. Br.
Taylor Range and Taylor Well, A. J. E., June, 1924.
Solanum nemophilum F.v.M.
Between Wycliffe and Taylor, A. J. E., June, 1924; near Barrow Creek, A. J. E., June, 1924.
Nicotiana suaveolens Lehm.
Macdonnell Ranges, C. E. F. Allen (No. 630), July, 1922.

SCROPHULARIACEAE.

Stemodia viscosa Roxb.
Osborne Ranges, C. E. F. Allen (No. 594), July, 1922.
Peplidium Muelleri Benth.
Wycliffe Well, A. J. E., June, 1924.

MYOPORACEAE.

Eremophila Christophori F.v.M.
Palm Valley, Hermannsburg, A. J. E., July, 1924.
This species has not previously been recorded from the Northern Territory.
Eremophila Freelingi F.v.M.
Alice Springs, C. E. F. Allen (No. 568), July, 1922.
Mr. Allen appends the following note: "Arunta native name, 'eseta'; used as a medicine by them for chest complaints."
This is the first definite locality recorded for this plant in the Northern Territory (see also Contributions, No. 30).
Eremophila Latrobei F.v.M.
Tea-tree Well, C. E. F. Allen (No. 582), July, 1922.

RUBIACEAE.

Dentella repens Forst.
Wycliffe Well, A. J. E., June, 1924.

CUCURBITACEAE.

Melothria maderaspatana Cogn.
Near Taylor Well, A. J. E., June, 1924.

CAMPANULACEAE.

Wahlenbergia gracilis D. C.
Banka Banka Station, south of Powell's Creek, C. E. F. Allen (No. 662), July, 1922.
Lobelia quadrangularis R. Br.
Wycliffe, A. J. E., June, 1924.

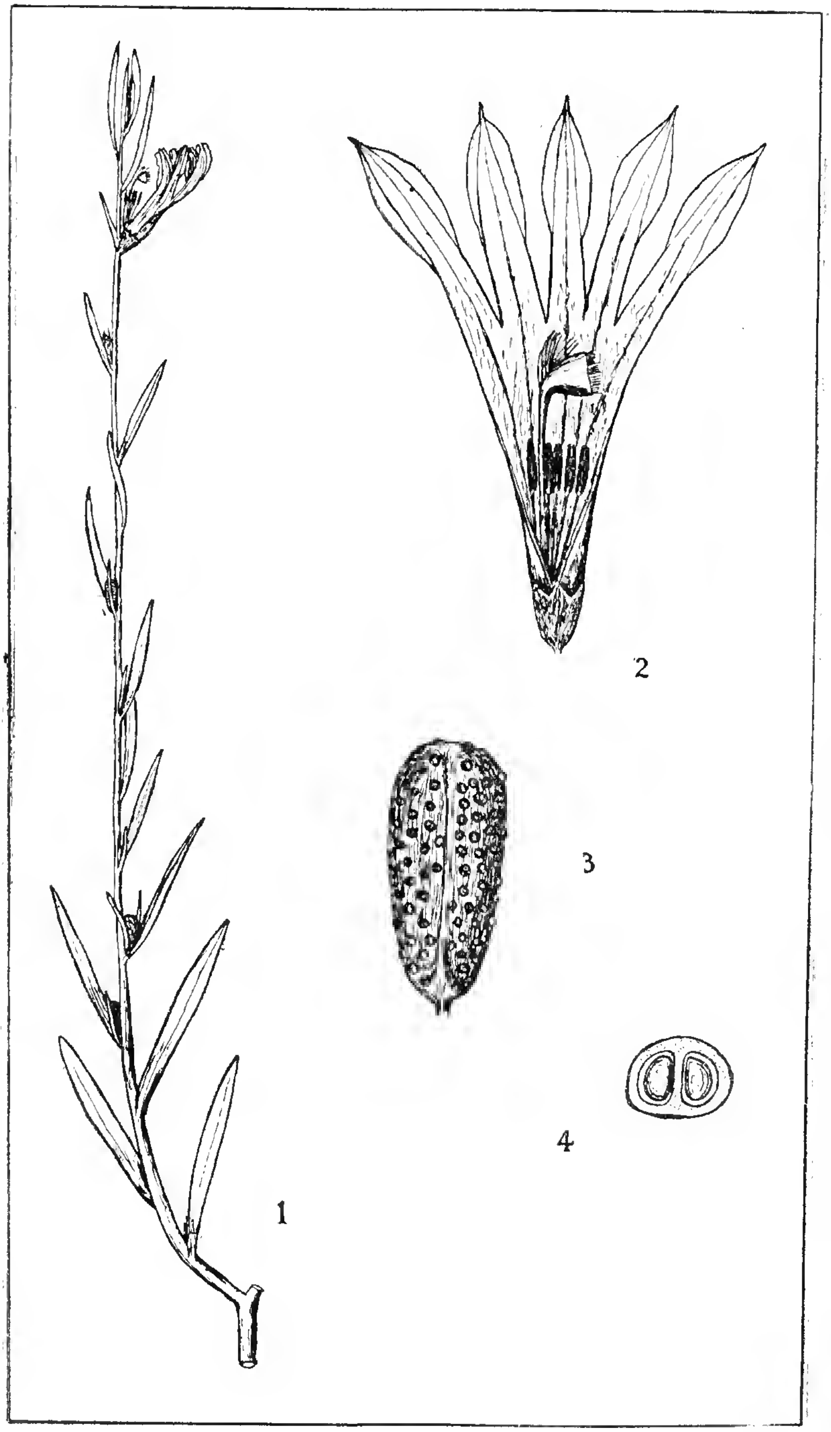

Fig. 4—Scaevola graminea.

1. Branch (nat. size).
2. Flower (× 4).
3. Fruit (× 8).
4. T. s. fruit (× 8).

GOODENIACEAE.

Velleia connata F.v.M.

Between Taylor and Wycliffe, and on Murray Downs track, Sergeant Stott, 1925.

Goodenia heterochila F.v.M.

Between Wycliffe and Taylor, A. J. E., June, 1924.

Goodenia mollissima F.v.M.

Attack Creek, C. E. F. Allen (No. 637), August, 1922.

This species has not previously been recorded from the Northern Territory.

SCAEVOLA GRAMINEA, n. sp.

A small, erect, glabrous undershrub, branching mainly at the base of the stem. Leaves entire, acute, ½ to 1 inch long, linear to linear-lanceolate, sessile, the lower leaves with broad bases, the upper leaves narrowed at the base. Flowers sessile in the axils of the leaves, forming an interrupted leafy spike. Bracteoles two, 3 to 5 lines in length. Calyx with five small distinct lobes. Corolla yellow, ½ inch long, glabrous outside, sparingly hairy in the throat. Ovary two celled. Indusium with a dense tuft of long purple hairs on the back, the apex being ciliate with a dense tuft of much shorter white hairs. Fruit ovoid-oblong, nearly two lines long, tuberculate, one seed in each cell.

Taylor Well, A. J. E., June, 1924.

This species appears to be allied to *S. amblyanthera,* from which it differs in both leaves and exterior of corolla being glabrous, in the nature of the leaves, in the larger bracteoles, and in the presence of a calyx limb.

Scaevola ovalifolia R. Br.

South of Kelly's Well, C. E. F. Allen (No. 643), July, 1922.

Mr. Allen states it to be a fodder plant.

Scaevola parvifolia F.v.M.

Five to eight miles north of Taylor Creek, A. J. E., June, 1924.

BRUNONIACEAE.

Brunonia australis Sm.

Fairly plentiful between Wycliffe and Taylor, Sergeant Stott, 1925.

COMPOSITAE.

Calotis latiuscula F.v.M. and Tate.

On hills, Alice Springs, C. E. F. Allen (Nos. 556 and 622), July, 1922.

This species has not previously been recorded from the Northern Territory.

Calotis porphyroglossa F.v.M.

Ryan Well, north of Alice Springs, C. E. F. Allen (No. 600), July, 1922.

Pluchea Eyrea F.v.M. var. major.

Mount Stuart, C. E. F. Allen (No. 585), July, 1922.

Brachycome ciliaris Lessing.

Osborne Ranges, on rocky, quartzite hill, C. E. F. Allen (No. 593), July, 1922; Macdonnell Ranges, C. E. F. Allen (No. 564), July, 1922; Stirling Station, A. J. E., June, 1924.

This species has not previously been recorded from the Northern Territory.

Pterocaulon sphacelatum Benth. and Hook.

Taylor's Crossing, Buxstone Ranges, C. E. F. Allen (No. 595), July, 1922.

Pterocaulon glandulosum F.v.M.

Rocky Hills, Alice Springs, C. E. F. Allen (No. 618), July, 1922.

Helichrysum ambiguum Turcz.

On rocky hills, Alice Springs, C. E. F. Allen (No. 522).

This species has not previously been recorded from the Northern Territory.

Helichrysum apiculatum D. Don.

Stirling Station, Barrow Creek, C. E. F. Allen (No. 648), August, 1922.

Helipterum Charsleyae F.v.M.

Flats north of Alice Springs, C. E. F. Allen (No. 650).

This species has not previously been recorded from the Northern Territory.

Helipterum moschatum Benth.

Taylor's Crossing, Buxstone Ranges, C. E. F. Allen (No. 591), July, 1922; near Mount Stuart, C. E. F. Allen (No. 584), July, 1922.

This species has not previously been recorded from the Northern Territory.

Myriocephalus Rudallii F.v.M.

North of Tennant's Creek, C. E. F. Allen (No. 639), July, 1922.

Wedelia Stirlingi Tate.

On stony road near Barrow Creek, C. E. F. Allen (No. 587), July, 1922.

This species has not previously been recorded from the Northern Territory.

Senecio Gregorii F.v.M.

Flats, Macdonnell Ranges, C. E. F. Allen (No. 624), July, 1922.

This is the first definite locality recorded for this species in the Northern Territory.

CORRIGENDUM.

In Contributions, No. 30 (this volume, p. 78), insert "MORACEAE" prior to "Ficus."

[Proc. Roy. Soc. Victoria, 38 (N.S.), 1926.]

Art. XIX.—*New or Little-known Fossils in the National Museum. Part XXIX.—On some Tertiary Plant Remains from Narracan, South Gippsland.*

By FREDK. CHAPMAN, A.L.S.

(Palaeontologist to the National Museum.)

(With Plates XII., XIII.)

[Read 12th November, 1925.]

I.—Source and Nature of the Material.

The specimens herein described were obtained through the courtesy of Mr. H. J. Hauschildt, late of the Education Department, Victoria, who presented them to the National Museum Collection, 12/9/06.

The leaves occur in a fine-grained sandstone, which is whitish in places from the quantity of kaolin in the rock. This deposit evidently represents the waste from a former granite country. In a recent examination of this area, in conjunction with the Director of the Geological Survey of Victoria and Mr. F. A. Cudmore, the relations of the plant-bearing beds were made out as follows:—

They occur as a band of a few inches in thickness, forming part of a series of pebbly and sandy clays. These beds underlie the Older Basalt, and pass down into sands and clays often totalling 100 to 150 feet in places. These Tertiary detrital beds rest, in this area, on a denuded surface of Jurassic strata, though in some places in the neighbourhood, on Lower Palaeozoic.

The surfaces of the leaf-impressions are in most cases of a rust-colour to pink, but in some instances they approach to a rich madder-brown. The mineral staining has often strikingly brought out the venation of the leaves, thereby considerably aiding their comparison with similar forms from other localities.

These descriptions were practically finished for publication some years ago, but in view of the systematic work which the late Mr. Henry Deane had then undertaken for the Museum, the notes were not then published. They were later submitted for perusal to Mr. Deane, who expressed his approval of the determinations.

II.—Description of the Leaves.

STERCULIACEAE.

Genus **Sterculia**, Linné, 1747.

Sterculia gippslandica, sp. nov.

(Plate XII., Fig. 1.)

Sterculia sp., Chapman, 1921, p. 118.

Description.—Leaf broad, trilobate, the side lobes bearing basal points; margin coarsely dentate. Petiole thick. Principal ribs rather strong, radiating from the base; two auxiliary veins emerging from the lateral veins at about 45° with the middle vein, and forming the principal veins of the basal lobes. Secondary veins emerging at an acute angle, the finer, at right angles.

Approximate Measurements.—Length from base to apex, 50 mm.; width, 80 mm.

Observations.—Ettingshausen described a somewhat similar form of leaf, based on an imperfect specimen, as *Acer subproductum* (1888, p. 158, pl. xiv., figs. 2, 2*a*, 3), but the shape was more elongate than in the present form. The present species is preferably referred to the indigenous genus *Sterculia* rather than to the genus *Acer*, and this is also in agreement with Deane's conclusions on the Australian Tertiary fossil flora (1902, p. 15).

McCoy recorded a fossil leaf from the Tertiary ferruginous sandstone of Bacchus Marsh, which he says may be "possibly *Acer*," (1874, p. 24); but in all probability it is similar to the present form, at least generically.

Sterculia gippslandica evidently represents a broader type of leaf than Deane's *S. Muelleri* (1902, p. 5, pl. i., fig. 1), from the Pitfield Plains Bore.

Sterculia Hauschildti, sp. nov.

(Plate XII., Fig. 2.)

Description.—Leaf broadly rounded, tending to become indented or palmate, but not so deeply incised as in *S. gippslandica*. Margin of leaf undulate and moderately indented at intervals. Midrib thick, divergent nearer the middle of the leaf than usual in the genus. Lateral veins dichotomizing once. Tertiary venation fine and reticulate.

Dimensions.—Leaf when complete about 65 mm. long by about 55 mm. broad.

SAXIFRAGEAE.

Genus **Weinmannia**, Linné, 1759.

(?)Weinmannia sp.

(Plate XII., Figs. 3, 4.)

Observations.—Two incomplete but large leaves, apparently of a long-ovate shape, are provisionally referred to the above genus, on account of a venation which is closely comparable with that of leaves of the type of *Weinmannia Biagiana*, Mueller. Mr. H. Deane had often discussed with me the same type of leaf found elsewhere, and had come to this conclusion regarding similar leaf-remains in the Bacchus Marsh series.

The principal rib is straight and rigid and the secondary veins are regularly spaced and divergent from the main rib at an angle of about 25°.

MYRTACEAE.

Genus **Tristanites**, Deane, 1902.

Tristanites angustifolia, Deane.

(Plate XII., Fig. 5.)

Tristanites angustifolia, Deane, 1902, p. 23, pl. iii., fig. 1; pl. vi., fig. 7. Chapman, 1921, p. 118.

Observations.—Several leaves of this specific type occur in the Narracan sandstone. The more perfect examples accord in length and width with the measurements given by Mr. Deane, as recorded from Berwick.

Genus **Eucalyptus**, L'Heritier, 1788.

Eucalyptus cf. Kitsoni, Deane.

(Plate XIII., Fig. 6.)

Eucalyptus Kitsoni, Deane, 1902, p. 25, pl. iv., figs. 5, 6, 7. Chapman, 1921, p. 118, pl. viii., fig. 9. Maiden, 1922, p. 188, pl. ccxxiii., figs. 10*a*-*c*.

Observations.—Remains of several slender leaves occur in the Narracan sandstone. These agree in the main with the characters seen in the above species, both in outline and in the angle of venation of the secondary veins. The intra-marginal vein is also clearly seen. The longest leaf measures nearly three inches but the others are less. *E. Kitsoni* has been recorded from Berwick.

MONOMIACEAE.

Genus **Hedycarya,** Forst., 1776.

HEDYCARYA cf. LATIFOLIA, Deane.

(Plate XIII., Fig. 7.)

Hedycarya latifolia, Deane, 1902, p. 27, pl. vi., fig. 3. Chapman, 1921, p. 118.

Observations.—A nearly perfect leaf is found in the present collection, which compares fairly closely with Deane's figured type. The broadly ovate outline with serrated margin and finely reticulated area between the secondary veins are distinct features, all clearly seen in the present specimen. The slightly greater breadth of the leaf, which is circ. 65 mm. long by 60 mm. broad, is hardly of specific difference. Mr. Deane's original specimens occurred in the white clay at Wilson's Quarry, Berwick, overlain by older basalt and resting on a conglomeritic surface of Silurian.

Genus **Mollinedia,** Ruiz. and Pav., 1794.

MOLLINEDIA cf. MUELLERI, Deane.

(Plate XIII., Fig. 8.)

Mollinedia Muelleri, Deane, 1902, p. 16, pl. i., fig. 4.

Observations.—This is here represented by a broadly ovate leaf with wavy and denticulate margin. The venation is typically that of *Mollinedia,* and although the specimen is imperfect, the outline compares closely with this broader species instituted by Deane.

MOREAE.

Genus **Ficonium,** Ettingshausen, 1883.

FICONIUM SOLANDERI, Ettingshausen.

(Plate XIII., Fig. 9.)

Ficonium Solanderi, Ettingshausen, 1888, p. 38, pl. iii., fig. 4.

Observations.—An almost perfect leaf-impression occurs with the specimens from Narracan. It is closely comparable, both in outline and venation, with the above species. The left margin of the leaf appears in the photograph to be irregularly denticulate, but this feature is fictitious, and is due to the overlapping margin where broken away; the lamina has an entire margin.

It is interesting to note that this fossil here occurs for the first time in Victoria. In New South Wales it is found at Dalton, near Gunning, in hard siliceous grit.

LAURINEAE.

Genus **Cinnamomum**, (Tourn.) Linné, 1735.

CINNAMOMUM POLYMORPHOIDES, McCoy.

(Plate XIII., Fig. 10.)

Cinnamomum polymorphoides, McCoy, 1876, p. 31, pl. xl., figs. 1-3. Ettingshausen, 1888, p. 125, pl. xi., figs. 3, 3*a*. Deane, 1902, p. 27, pl. i., figs. 6 and 12. Chapman. 1914, p. 90, fig. 61*a*. *Idem,* 1921, p. 118, pl. viii., fig. 6.

Observations.—Several well-preserved specimens occur here about the identity of which there can be no doubt. One of the leaf-impressions is remarkably distinct, and even the minutest veins are indicated. The principal veins are well shown, together with the tertiary veins of the intermediate area; these are very fine in contrast, and often arise at right angles from the stronger lateral veins and midrib. Another example represents the basal part of a leaf with a thick petiole. This fossil closely resembles Mr. Deane's figure (1902, pl. i., fig. 12), of *C. polymorphoides* from a bore at Pitfield Plains at 100 feet from the surface; the leaf-bed there occurs under two distinct layers of basalt, and is resting on basalt. The second of Mr. Deane's specimens he placed provisionally under this species, but there seems to be no doubt of the accuracy of his determination. Ettingshausen's *C. Leichhardtii* (1888, pp. 41 and 126, pl. iii., fig. 1; pl. xi., fig. 4), appears to be characterised by three strong veins of nearly equal thickness, and tertiary veins disposed almost at right angles to the midrib. The Victorian specimens seem to show every gradation between these two forms.

Cinnamomum polymorphoides has been previously recorded as follows:—In Victoria, from the Bacchus Marsh district, 2 miles W. of Maddingley, and half a mile N.W. of the junction of the Werribee River and Lyall's Creek; from the Cobungra, Bogong and Dargo High Plains in E. Gippsland, under the older basalt; and from a bore at Pitfield, Western Victoria, between basalt. In New South Wales it has been recognised by Ettingshausen in the hard siliceous grit resting on Silurian rock at Dalton, near Gunning, and at Vegetable Creek, in brown carbonaceous clay under basalt. The form *C. Leichhardtii* has also been found at Dalton, and at Newstead, near Elsmore, in concretionary ironstone associated with basalt.

FAGACEAE.

Genus **Nothofagus,** Blume, 1850.

NOTHOFAGUS cf. MAIDENI, Deane sp.

(Plate XIII., Fig. 11.)

Fagus Maideni, Deane, 1902, p. 30, pl. vii., fig. 10. Chapman, 1921, p. 118, pl. viii., fig. 3.

Observations.—The present example is of the same length and proportions as the figured type, but being incomplete it is provisionally referred to this form. It is the under surface of the leaf that is exposed on the rock, showing a strong midrib. The lateral veins are not so clearly distinguishable, but are seen in part, as is also the dentated edge of the leaf. Deane's type came from the leaf-beds of Berwick.

III.—Observations and Summary.

Although no leaves or other plant remains have been actually determined from Narracan, J. H. Wright (1894, p. 29) records the discovery of fossil leaves in the district. In speaking of this leaf-bed in quartzite beneath the Older Basalt at Ordlaw, he says:

"Interbedded with the dense rock appear occasional layers of indurated clay, containing abundance of leaf impressions. Weathered slabs of this hardened clay may be found, which on handling fall to pieces in thin and extremely brittle flakes, each lamination containing a more or less perfect impression of a leaf. I have obtained altogether from different localities where the quartzites occur eight distinct varieties of fossil leaves. Their classification, however, is still incompleted; but they appear to be of Miocene or possibly Eocene age." Wright also mentions (*loc. cit.*) similar leaf-impressions in dark coloured sandstones at Dixon's Creek, in the same district.

From the descriptions of the Narracan plant-remains it will be seen that there occur here certain types of leaves which are found elsewhere, as at Bacchus Marsh, Dargo High Plains, the Cobungra, Bogong, Berwick and Pitfield. In addition to the specific forms recorded from these localities, it is possible, as previously indicated, that the *Acer* (?) sp. recorded by McCoy (1874, p. 24) from Bacchus Marsh, and later referred to by T. S. Hall and G. B. Pritchard (1894, p. 339), may be similar, if not identical with the leaf now described as *Sterculia gippslandica.*

The occurrence of *Ficonium Solanderi* in these beds, although hitherto restricted to New South Wales, is not surprising, since the probable stratigraphical identity of some of the Victorian and New South Wales plant-bearing beds has long been maintained (Wilkinson, 1882, p. 56).

In Victoria, one of the leaf beds above mentioned—that at Dargo High Plains—is found at a height of over 4000 feet above sea-level, whilst in New South Wales leaf-bearing deposits are found up to 5000 feet. This alone conclusively points to considerable elevation of the sub-coastal regions during and after Miocene times, for much of the sedimentary material with plant remains has been deposited in lakes, swamps and alluvial fans which could not have been far removed from the then existing coastal plain.

The relative abundance of *Cinnamomum* in these beds indicates a decidedly warm temperate climate at the time of deposition, when the flora of Northern Australia, which had earlier invaded the south-eastern parts of the continent, has not been pushed back towards its original home.

Like the Tertiary leaf-bearing beds of Berwick and Dargo, the fossiliferous sandstone at Narracan is pre-Older Basaltic. On the other hand, the Bacchus Marsh leaf beds are post-Older Basaltic, and yet the flora presents a close similarity with the first-named. These apparently diverse relationships of the stratigraphy

Fig. 1.—Sketch map of Victoria, showing localities mentioned.

would tend to confirm what has already been assumed, and is in reality to be seen in the field, that there were several flows of the Older Basalt. According to the present writer's conclusions, these older volcanic effusions most likely occurred during Miocene times, when great diastrophic movements were taking place.

Synopsis of Distribution.

Name.	Victoria.	N. S. Wales.
Sterculia gippslandica, sp. nov.	Narracan ?Bacchus Marsh	
,, *Hauschildti*, sp. nov.	Narracan	
?*Weinmannia*, sp.	Narracan Bacchus Marsh	
Tristanites angustifolia, Deane	Berwick Narracan	
Eucalyptus Kitsoni, Deane	Berwick ?Narracan	
Hedycarya latifolia, Deane	Berwick Narracan	
Mollinedia Muelleri, Deane	Pitfield ?Narracan	
Ficonium Solanderi, Ettingsh.	Narracan	Dalton
Cinnamomum polymorphoides McCoy	Bacchus Marsh Pitfield Cobungra Bogong Dargo Narracan	Dalton
Nothofagus Maideni, Deane sp.	Berwick ?Narracan	

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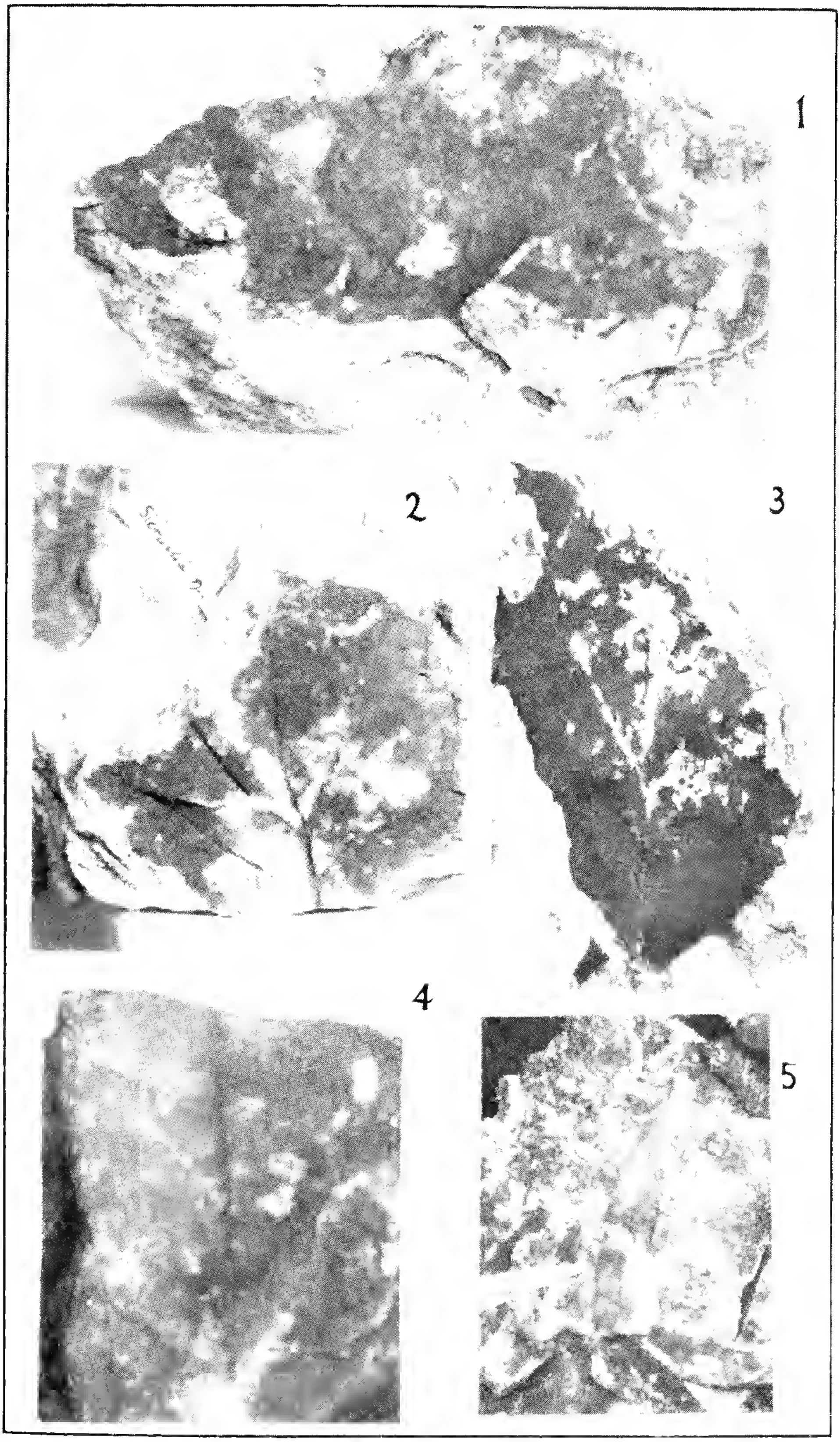
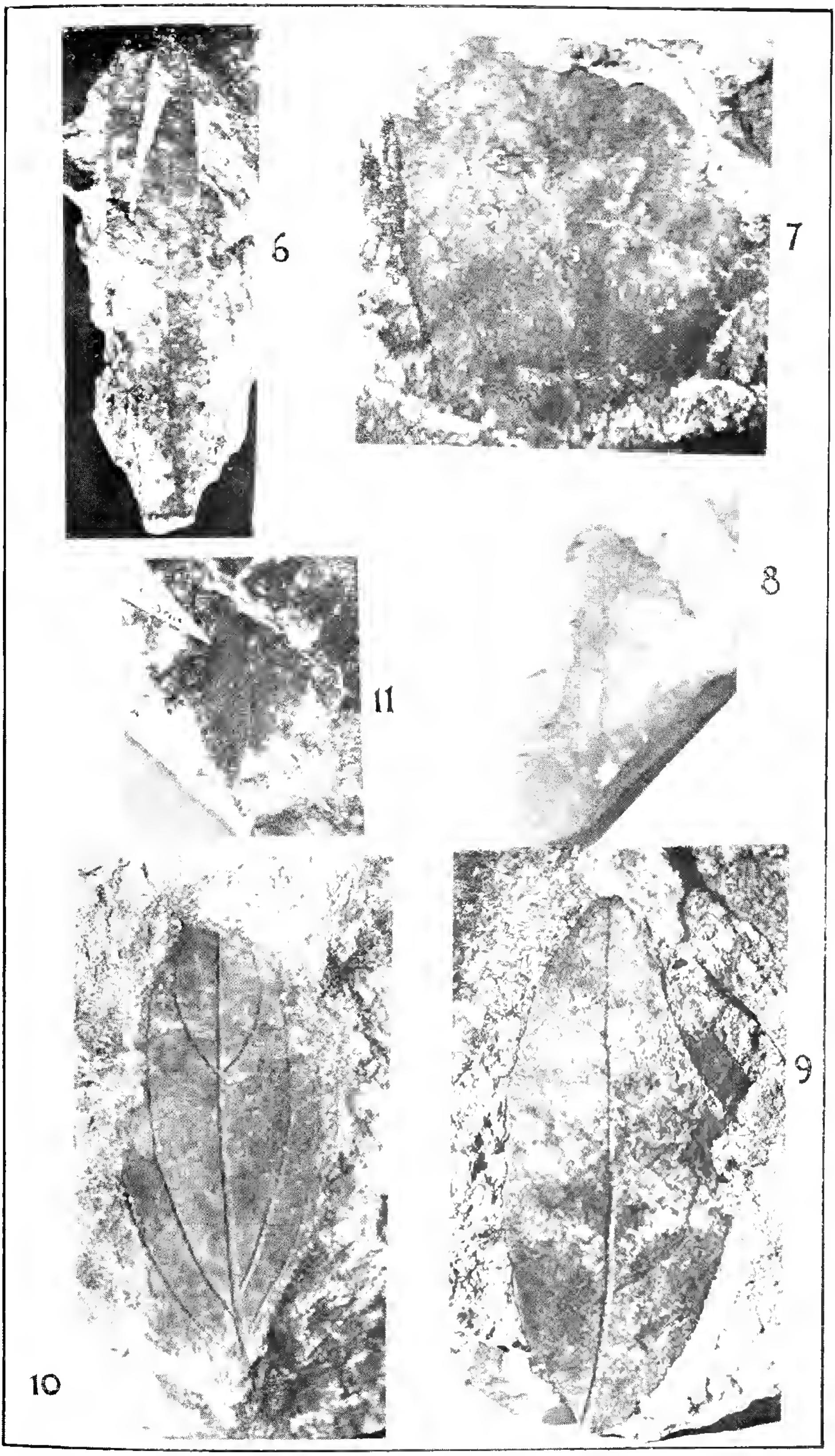


F.C. photo.

Tertiary Plant-Remains: Narracan, S. Gippsland.



F.C. photo.

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EXPLANATION OF PLATES.

(All figures about natural size.)

Plate XII.

Fig. 1.—*Sterculia gippslandica* sp. nov.
Fig. 2.—*Sterculia Hauschildti,* sp. nov.
Fig. 3.—(?) *Weinmannia* sp.
Fig. 4.—(?) *Weinmannia* sp. Another specimen.
Fig. 5.—*Tristanites angustifolia,* Deane.

Plate XIII.

Fig. 6.—*Eucalyptus* cf. *Kitsoni,* Deane.
Fig. 7.—*Hedycarya* cf. *latifolia,* Deane.
Fig. 8.—*Mollinedia* cf. *Muelleri,* Deane.
Fig. 9.—*Ficonium Solanderi,* Ettingshausen.
Fig. 10.—*Cinnamomum polymorphoides,* McCoy.
Fig. 11.—*Nothofagus* cf. *Maideni,* Deane sp.

[PROC. ROY. SOC. VICTORIA, 38 (N.S.), 1926.]

ART. XX.—*Australian Termites (Isoptera). Notes on Stolotermes, Calotermes, and Coptotermes, with descriptions of new species.*

By GERALD F. HILL.
(Entomologist, National Museum of Victoria.)

[Read 12th November, 1925.]

The following consists of (*a*) a brief review of the known species of *Stolotermes* and their distribution, (*b*) notes on six hitherto described species of *Calotermes* and descriptions of two proposed new species and one new variety, (*c*) notes on the six hitherto described Australian *Coptotermes* and descriptions of two proposed new species and one new variety. In the last mentioned genus there are several still undescribed species which it is considered inadvisable to deal with until complete nest-series are available for study.

For translations from the German authors mentioned in the text I am greatly indebted to Miss Lind and P. Sharman, Esq., M.Sc., both of the Presbyterian Ladies' College, East Melbourne.

Genus Stolotermes.

STOLOTERMES VICTORIENSIS Hill.

Proc. Linn. Soc. N.S.W., xlvi., p. 433, 1921.

This species has been taken in rotten logs near mountain streams in the Ferntree Gully and Gembrook Districts, Victoria, on several occasions during the past few years. The colonies are always small and, as a rule, the individuals composing them are scattered throughout several feet of rambling slit-like galleries. The soldier caste is poorly represented. A colony taken on 2nd February comprised a first-form queen, sixteen adult brachypterous males, fifty alate imagos, six soldiers, twelve first-form nymphs and about 200 larvae and second-form nymphs. The brachypterous males have 16-jointed antennae, dark brown antennae, head and abdomen, and apparently fully developed facetted eyes. It has been collected also at Barrington Tops, New South Wales (in rotten log, January), by Mr. H. J. Carter. Measurements of specimens from the last-mentioned locality, which differ from the type series, are as follows:—Imago: head, long 1·31, wide 1·14; pronotum, long 0·45; wide 0·85; eyes 0·272 × 0·289. Soldier: total length 11·00; head, with mandibles, long 4·27, without mandibles 2·85, wide 2·10; gula, at narrowest part, wide 0·238; pronotum, long 0·68, wide 1·02; tibia iii, long 1·42. First-form nymphs variable: the smaller approximating the imagos in size, the larger as follows:—total length 8·25; head, long 1·65, wide 1·48; pronotum, long 0·57—0·68, wide 1·08—1·14. There is only one soldier in the series; it is considerably larger than those in the type series and is nearly as large as the Queensland species *S. queenslandicus* Mjöb.; the latter, however, has two more joints in the antennae, shorter labrum, paler coloured and more slender mandibles and differently sculptured head.

The South Australian Museum collection contains a damaged soldier and several nymphs (carded) of an apparently undescribed species from Mt. Tambourine, S. Queensland (A. M. Lea).

The described species of *Stolotermes* are:—*S. ruficeps* Brauer (New Zealand), *S. brunneicornis* Hagen (Tasmania), *S. queenslandicus* Mjöb. (N. Queensland), *S. australicus* Mjöb. (N. Queensland), and *S. victoriensis* Hill (Victoria). I am indebted to Mr. W. J. Campbell and Professor Sjöstedt for specimens of the New Zealand and North Queensland species respectively. The soldier caste of the Tasmanian species is still undescribed; the imago is represented in the National Museum collection by specimens collected by Mr. A. M. Lea.

Genus **Calotermes.**

Calotermes (Neotermes) insularis (White).

Walker, Cat. Neurop. Ins. Brit. Mus., (3), 1853 (*Termes*). White, Zool. "Erebus" and "Terror," Insects, 1874, (*Termes*). Hagen, Cat. Neurop. Ins. Brit. Mus., (1), Termitina, 1858 (*Calotermes*); Linn. Entom., xii., 1858. Froggatt, Proc. Linn. Soc. N.S.W., xxi., p. 524, 1896. Desneux, Gen. Insectorum. 1904. Holmgren, Kungl. sv. vet. Akad., xlvi., 1911. Hill, Proc. Linn. Soc. N.S.W., xlvi., p. 445, 1921.

The type (imago) is from New Zealand; it is recorded from New Holland by Hagen in 1858 and from Victoria by Froggatt in 1896. The soldier caste was described by me (1921, p. 445) from Victorian specimens associated with imagos which were afterwards compared with the type by Mr. B. Uvarov. The specimen (alate imago) referred to by Froggatt in 1896 is still in the National Museum, and is certainly conspecific with the above, as are other specimens in the same collection labelled "*Termes australis* Walker" (see notes on *C. longiceps* Frogg., p. 194, and *Coptotermes australis* Walker, p. 203.) This species does not appear to have been recognised in New Zealand since the type was collected by Dr. Sinclair, though it may be the species found as nymphs by Dr. R. J. Tillyard in Australian hardwood timber at Shannon, and the species referred to by Mr. P. F. Hill (*in litt.*) as occurring in indigenous timber in the Blenheim District.

CALOTERMES (NEOTERMES) LONGICEPS Froggatt.

Proc. Linn. Soc. N.S.W., xxi., p. 528, 1896.

This species is very closely related to, if not identical with, *C. insularis* (White). Froggatt described the soldier and nymph only (from New South Wales), White's species then being known only in the alate caste from New Zealand and Victoria. Froggatt's type (soldier) differs from typical Victorian examples of White's species only in its slightly smaller size and 20-jointed antennae, both variable characters (Lea's specimens from Stanwell, N.S.W., have 16-19 jointed antennae). The left mandible is described as having only three teeth, but a close examination of the type shows that the two small teeth behind the two large apical ones have been broken off or worn down. The right mandible has two large teeth, the basal one being concealed by the labrum. The gula is 0·456 at the narrowest part, which is within the range found in *C. insularis*, i.e., 0·342—0·456. The antennae in the last-named species have from 15-17 joints—I have seen none with 20 joints, as in Froggatt's type—and the third joint is slightly variable in size, but is never markedly longer and more clavate than the second and fourth. Mr. Froggatt's collection contains a series, including two soldiers, one alate imago and several nymphs, from Colo Vale, N.S.W., which I believe to be conspecific with *C. longiceps*. The imago is somewhat smaller than Victorian examples of *C. insularis*, but appears to be not otherwise different. The latter vary somewhat in total length and size of head and eyes, but the smallest examples I have seen are larger than the New South Wales specimen. In addition to the above Mr. Froggatt has two imagos from Sydney (16.2.06) from firewood which appear to be conspecific with the Colo Vale specimen, and with the following:—Two alate imagos in the National Museum from New South Wales, each of which bears a label in Walker's handwriting, "*Termes australis* var?" and two similar specimens in the South Australian Museum from Dorrigo, N.S.W. Unfortunately, with the exception of two or three good nest-series from Victoria, no complete sets in good condition have been available for examination.

It is difficult to account for the identification by Walker of the two imagos in the National Museum as "*Termes australis* var.?" Walker described his species from specimens collected in Adelaide and Hagen in 1858 redescribed them, noting at the same time that Walker's soldier and worker belonged to another genus (*Calotermes*). Froggatt in 1897 also redescribed the imago from specimens collected in the type locality. From these descriptions it is clear that the imago described by Walker has little resemblance to *Calotermes*, and that it is perhaps correctly placed in the genus *Coptotermes* by Desneux in 1904, Holmgren in 1911, and more recent writers. (See page 203.)

CALOTERMES (NEOTERMES) ROBUSTUS Froggatt.

Proc. Linn. Soc. N.S.W., xxi., p. 529, 1896.

The following supplementary measurements are from the unique type (from Sydney), which Mr. Froggatt has kindly made available for examination on two occasions:—Head, long 2·16; wide 1·97; eyes, diameter 0·658×0·658, distance from lower margin of head 0·235; ocelli, diameter 0·235; pronotum, long 1·08, wide 1·97; tibia iii, long 1·64; antennae 18-jointed.

The soldier now associated with the type in Mr. Froggatt's collection is referred to under *C. denqueti,* n. sp.

CALOTERMES (NEOTERMES) IRREGULARIS Froggatt.

Proc. Linn. Soc. N.S.W., xxi., p. 525, 1896. Holmgren, Kungl. sv. vet. Akad., xlvi., 1911. Hill, Proc. Linn. Soc. N.S.W., xl., p. 111, 1915.

The following series of specimens have been compared and found to agree with the types:—Soldiers from Port Darwin, an alate imago from Bathurst Island (G. F. H.), soldiers and imagos from Groote Eylandt (N. B. Tindale, South Australian Museum Coll.), soldiers from Brisbane (H. Hacker, Queensland Museum Coll.), and soldiers from Gordonvale, Q. (F. H. Taylor). Port Darwin soldiers vary in the width of the gula (one-sixth to one-seventh as wide as head), and in the size of the head and eyes. The antennae are 14-jointed in the few perfect specimens in this series. Measurements of soldiers from Port Darwin: Total length 11·50; head and mandibles, long 4·56-6·00; head without mandibles, long 3·00-3·70; head, wide 2·28; pronotum, long 1·14-1·42, wide 1·99-2·22.

CALOTERMES (CALOTERMES) ?CONDONENSIS Hill.

Proc. Linn. Soc. N.S.W., xlvii., 1922.

Mr. J. Clark collected an alate imago of a species of *Calotermes,* s. str., with a colony of *Calotermes obscurus* (Walker) at Ludlow, South-West Australia, which may be the undescribed imago of the above species (from Condon, North-West Australia). It is almost indistinguishable from the imago of the Victorian (Kiata) insect recently described in These Proceedings (Hill, 1925, p. 207), as *Calotermes* (*C.*) *oldfieldi.* From the last-mentioned species the West Australian specimen differs only in having slightly larger eyes and eye facets, 18-jointed antennae; longer and wider antennal joints (especially from 10-18th), narrower and more arched pronotum and darker wing-veins.

Measurements.

	mm.
Length with wings	15·50
Length without wings	7·50
Head, to apex of labrum, long	1·76
Head, to clypeofrontal suture, long	1·48
Head, at and including eyes, wide	1·48
Eyes, diameter	0·408×0·425
Ocelli, diameter	0·136×0·221
Pronotum, long 1·31; wide	1·59
Tibia iii, long	1·42

The similarity between these two forms suggests that if the specimen under notice proves to be conspecific with *C. condonensis,* the Victorian form may represent a race or variety of the West Australian insect; but the differences between the soldiers of *C. condonensis* and *C. oldfieldi,* as enumerated in the description of the latter species, appear to be specific, and should be so regarded until complete series are obtained from West Australia. The New South Wales insect described further on in these notes (p. 201) as a variety of *C. oldfieldi* is clearly closely allied to the above. It might be mentioned that Ludlow is approximately 950 miles southward from Condon, 1400 miles westward from Kiata, and over 2000 miles westward from Brooklana, which is about 700 miles North-West from Kiata.

CALOTERMES (GLYPTOTERMES) ?CLARIPENNIS Hill.

Proc. Roy. Soc. Vic., n.s., xxxvii. (2), p. 212, 1925.

Several imagos (carded) collected by Mr. A. M. Lea on Norfolk Island are closely allied to *C. affinis* Mjöb. and to *C. claripennis* Hill. In view of their present condition and the absence of soldiers it seems advisable to regard them provisionally as a variety of the last-named species (from Lord Howe Island).

CALOTERMES (NEOTERMES) DEUQUETI, n. sp.

Soldier.

Colour.—Head orange-rufous; labrum somewhat paler than head; anteclypeus whitish, often much retracted.

Head (Text-fig. 1).—Long and narrow, parallel on the sides, with very few setae; frons concave, with a distinct median depression extending from the postclypeus to the transverse suture, and with a few obscure sinuous lines from its outer margin towards the middle; clypeus with anterior margin truncate, a row of four strong setae on the anterior part of the postclypeus; labrum large, spade-shaped, sometimes markedly retracted, strongly convex in the middle and towards the apex, the sides impressed; mandibles black, with the thickened basal part dark ferruginous like antennal carinae, similar to those of *C. insularis,* but more slender. Antennae 14- to 16-jointed; 3rd joint

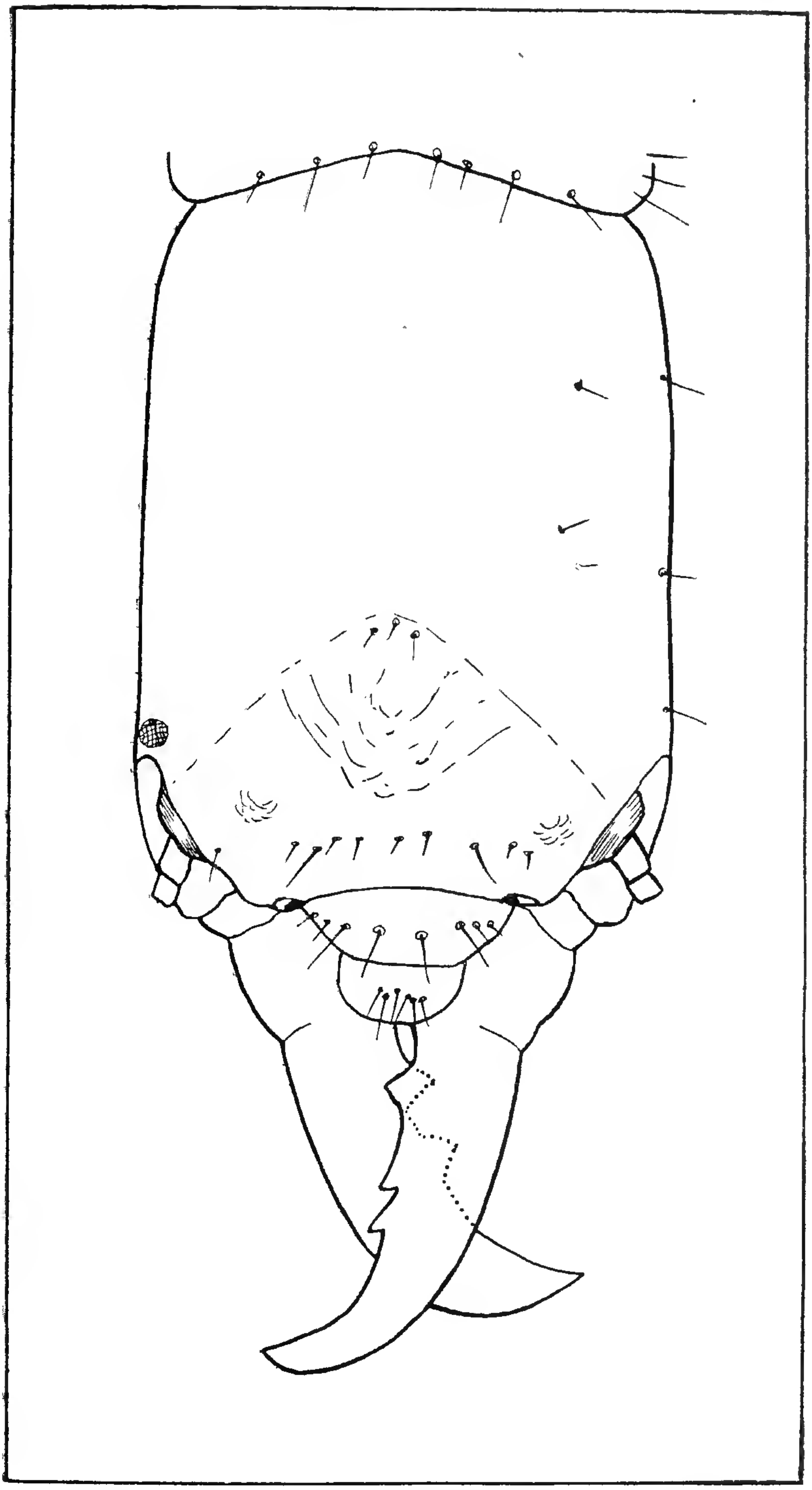

Fig. 1.—*Calotermes* (*Neotermes*) *deuqueti*, n. sp. Head of soldier.

fully as long as 1st, but narrower, narrow at base, swollen towards apex, dark in colour, much longer than 2nd and 4th (which are equal in length), intermediate in form between that of *Calotermes*, s. str., and *Neotermes* (in one specimen one antenna has 3rd joint as in *Neotermes*). Gula long and narrow, 0·342 to 0·399 at its narrowest part, its posterior end only slightly widened (markedly widened in *C. insularis*).

Pronotum.—Short and very wide, as wide as, or a little wider than, head, not markedly arched for the genus, with scanty long and short setae, anterior margin concave, not notched in the middle, sides almost straight or broadly rounded, not narrowed posteriorly, with narrow impressed margin, posterior margin almost straight (slightly sinuate in one specimen).

Legs.—Short and moderately stout, with scanty long and short setae.

Abdomen.—With scanty long and short reddish setae along the apical margin of each sclerite.

Measurements.

	mm.
Total length	11·50 — 12·00
Head, with mandibles, long	5·13 — 5·58
Head, without mandibles, long	3·30 — 3·70
Head, wide	2·33 — 2·45
Head, deep	1·76
Pronotum, long, 1·25; wide	2·28 — 2·62
Tibia iii, long	1·53

Locality.—New South Wales: Lismore (C. F. Deuquet, July 1922, per J. Clark).

Allied species.—From *C. insularis* (White) it is distinguished by its smaller size, relatively longer, narrower and shallower head, differently shaped pronotum, more slender mandibles, more distinctly grooved and differently sculptured frons, enlarged third antennal joint and ill-defined striae on ventral genae. From *C. irregularis* Froggatt it differs in the last mentioned characters and also in having a relatively longer and narrower head, narrower gula, longer and more slender mandibles, more concave and differently sculptured frons, shorter and wider pronotum, the latter more concave in front, straighter on the sides and posterior margin.

The possibility that the insect described above is the hitherto undescribed soldier of *C. robustus* Frogg. is suggested by the fact that Mr. Froggatt has placed in the tube with the type (imago) of his species a soldier of a very closely allied, if not the same, species, thus clearly indicating his opinion as to its identity, though he did not refer to it in his later paper in 1915. The type was described from a single specimen captured at a light indoors, so that, in the absence of data, there is some reason for questioning the identification of the soldier now associated with it. The specimens described above do not agree entirely with the latter, and as there is no reason, other than that given above, for connecting them with any described species, I have deemed it expedient to describe them here in preference to adopting one of the alternatives.

Type soldier in the National Museum of Victoria.

CALOTERMES (?GLYPTOTERMES) PERANGUSTUS, n. sp.

Imago (de-alated).

Colour.—Upper surface auburn, wing-stumps darker; sternites and tibiae buckthorn-brown, femora paler; labrum yellow.

Head.—Finely shagreened, with a few short setae, a little longer than wide, sides slightly narrowed posteriorly, the summit slightly concave and with a few obscure rugae in the middle in line with the middle of the eyes. Clypeus very short, with pale-coloured and slightly sinuate anterior margin. Labrum very short and narrow, not reaching apex of mandibles, a little longer than wide, about one-third as wide as head, nearly straight on sides and almost truncate in front. Eyes rather small (0·289×0·306—0·306×0·340), 0·119—0·170 from lower margin of head, and not very prominent. Ocelli broadly oval (0·085×0·119), very close to eyes. Antennae incomplete; 1st joint short and stout; 2nd about half as long and two-thirds as wide as 1st, nearly quadrate; 3rd a little longer and wider than 2nd, narrower at base; 4th and 5th about as long as 2nd, moniliform; 5th-7th increasing in length progressively.

Thorax.—Pronotum narrower than head, markedly concave in front, anterolateral angles scarcely rounded, sides sloping slightly to the nearly truncate posterior margin, on either side an impressed area behind the anterior margin, anterior and lateral margins impressed and bearing a scanty fringe of short and moderately long hairs, these almost wanting on remainder of surface. Posterior margin of meso- and metanotum concave. Wing stumps almost hairless, showing base of veins very distinctly, those of forewings large, extending midway between posterior margin of pronotum and apex of metanotum, those of hindwings very small, extending very little beyond the apex of those of the forewings.

Legs.—Moderately long and stout, with very few short setae; femora stout, hind femora about half as wide as long; claws long and slender; tibial spurs markedly so, the latter serrate.

Abdomen.—Long and narrow, the segments fringed with scanty short setae apically, sixth and seventh sternites of female very large and equal in length.

Measurements.	mm.
Total length - - - - - - - - -	5·30 — 5·60
Head, to apex of labrum, long - - -	1·08 — 1·14
Head, to clypeofrontal suture, long - -	0·94
Head, wide - - - - - - - -	0·97
Pronotum, long 0·57; wide - - - - -	0·91
Tibia iii, long - - - - - - -	2·70 — 3·00

Soldier.

Colour.—Head ochraceous-tawny behind shading to russet anteriorly; mandibles black with dark castaneous base; pronotum same as back of head, remainder of thorax and tergites of abdomen buckthorn-brown; legs and under surface chamois.

Head.—Finely shagreened and almost devoid of setae, long and narrow, parallel on the sides, broadly rounded behind, frons broadly concave, slightly rugose and sloping gradually to the clypeus. Clypeus short and very wide, a row of eight setae near anterior margin, the two middle ones well separated from each other and from a group of three near each lateral margin, the anterior margin straight and without pale border. Labrum short and wide, with narrowly impressed margin, sides and anterior margin rounded and together almost forming a semicircle, a group of about twelve moderately long setae near the apex and two pairs of short ones behind the middle. Eyes small, sometimes faintly pigmented, well separated from the posterior margin of the antennal foveolae. Mandibles short and broad, strongly incurved at tips, the right with a triangular tooth about the middle and a larger but similarly shaped one nearer the base, the left with a pair of triangular teeth before the middle and a slightly larger one nearer the base. Antennae 11- to 13-jointed; variable in number of joints and segmentation in same individual; 1st joint short and stout; 2nd much shorter and narrower, about equal to 4th but sometimes shorter than 3nd; 3rd generally shortest of all and narrower than 2nd and 4th, but sometimes longer and wider; 5th always larger than 4th; 5th to apical joint decreasing in length progressively; apical joint very short and narrow. Gula very long and narrow.

Thorax.—Pronotum small, about as wide as head, short, with narrow impressed margin, margin with scanty fringe of small setae, anterior margin deeply and widely concave, a deep oblique impression on each side midway between the middle and the lateral margin, antrolateral corners narrowed, sides sloping rather sharply to the slightly sinuate posterior margin. Posterior margin of meso- and metanotum as in pronotum and generally showing posterolateral prolongations or wing rudiments.

Legs.—Very short and stout, with very few setae, femora of hind legs more than half as wide as long. Claws and tibial spurs large, the latter serrate.

Abdomen.—Glabrous, long and narrow, widest at base and tapered to the bluntly pointed apex, tergites with scanty fringe of pale short setae.

Measurements.

Total length - - - - - - -	6·50 — 6·75
Head, with mandibles, long - - -	2·45 — 2·80
Head, without mandibles, long - - -	1·82 — 2·10
Head, deep - - - - - - - -	1·08 — 1·14
Head, wide - - - - - - - -	1·14 — 1·19
Gula, at narrowest part, wide - - -	0·57 — 0·74 rarely
Pronotum, long 0·65 — 0·68; wide -	1·02 — 1·14
Tibia iii, long - - - - - -	0·62

Nymphs of first form.

Antennae 13-jointed; wing rudiments bright ferruginous; eyes faintly pigmented; total length 6·00.

Locality.—New South Wales; Wauchope (20/9/25).

Mr. W. W. Froggatt, who collected the specimens described above, states that the colony was found in parallel galleries in the stem of a living tree.

Allied species.—The soldier differs from *C. iridipennis* Frogg. in its smaller size, lighter colour, wider and more rounded labrum, different arrangement of setae on clypeus, and wider concavity on frons. The imago of Froggatt's species is a much larger and darker insect. From the imago of *C. tuberculatus* Frogg. it differs in its smaller head and larger eyes (measurements of *C. tuberculatus*: Head to apex of labrum 1·31, to clypeofrontal suture 1·02, wide 1·14; eyes 0·255×0·289). The soldiers of the last-mentioned species are very distinct. From the imago of *C. eucalypti* Frogg. it differs in having larger head, eyes and pronotum (measurements of *C. eucalypti*: Head to apex of labrum 1·02, to clypeofrontal suture 0·80, wide 0·85; eyes 0·238×0·255; pronotum long 0·55, wide 0·85). From *C. brevicornis* Frogg. the imago differs in having only 3 apical spurs on tibiae, much smaller eyes and much darker head. The soldiers differ markedly in having no median anterodorsal prominence on head and different labrum. From the imago of *C. nigrolabrum* Hill it differs in having larger eyes and more quadrate (proportionately longer) pronotum. The soldier of the last-mentioned species is a much more robust insect with distinctly different frons. Compared with the soldier of *C. rufinotum* Hill the proposed new species has a much smaller head and pronotum, the latter sclerite being less quadrate. *C. trilineatus* Mjöb. is a much larger species in both castes.

Type imago and soldier in the National Museum of Victoria.

Calotermes (Calotermes) oldfieldi Hill, var. chryseus, n. var.

Imago.

Differs from the typical form (from Kiata, Victoria) described in These Proceedings (n.s., xxxvii. (2), p. 207, 1925), in being smaller and of lighter colour (the latter possibly due to immaturity). The head, eyes, ocelli and pronotum are distinctly smaller and the antennae are composed of only 16 joints (not 19-20, as in typical form). Wings typical of the sub-genus; forewing with five or six branches from the radial sector, the last one or two generally short and weakly chitinised; cubitus with about twelve branches, all feebly chitinised. Hindwing with radial sector as in forewing; media branching from radial sector a little beyond the suture; cubitus with about fourteen branches, all feebly chitinised. Nymphs with creamy white wing rudiments.

Measurements.

	mm.
Length, with wings - - - - - -	13·00 — 14·00
Length, without wings - - - - - -	6·50 — 7·50
Head, to apex of labrum, long - - -	1·48 — 1·70
Head, to clypeofrontal suture, long - -	1·08 — 1·31
Head, wide - - - - - - - -	1·19
Eyes, diam. - - - - - - - -	0·357 × 0·374
Pronotum, long 1·02: wide - - - -	1·31 — 1·42
Forewings, long, 11·00 — 11·50; wide - -	2·90
Tibia iii, long - - - - - - - -	1·00

Soldier.

Differs from the typical form in its smaller size, smaller and less setaceous head and smaller pronotum, the latter distinctly less deeply and more obtusely notched anteriorly. The antennae in the only two perfect specimens are 13-jointed. The mandibles are generally similar to those of the typical form, but in one specimen there is only one apical tooth on the left and in another a normal apical tooth with a very small tooth at its base.

Measurements.

	mm.
Total length - - - - - - - -	7·50 — 8·00
Head, with mandibles, long - - - -	3·30 — 3·80
Head, to labial suture, long - - - -	2·16 — 2·45
Head, wide - - - - - - - -	1·42 — 1·48
Pronotum, long, 1·02 — 1·14; wide - -	1·42 — 1·60
Tibia iii, long - - - - - - - -	0·85 — 0·91

Localities.—New South Wales: Brooklana (W. W. Froggatt), ?Lismore (C. Deuquet, per J. Clark).

The Brooklana specimens (type colony), which were captured on 21/10/25 in a fallen dead tree, comprise young larvae and nymphs in all stages of development, several alate and de-alated males and females and several soldiers. The second colony includes a first-form king and queen, a few soldiers and several nymphs. The imagos are smaller than the Brooklana specimens, with which they agree in other respects; the soldiers have heads of uniformly smaller size (somewhat smaller than the smallest in the type colony) and 10-jointed antennae.

Allied species.—From *C. condonensis* Hill the soldier differs in having a very much smaller and paler coloured head, very slightly widened in the middle (widest part) and not narrowed posteriorly, with noticeably fewer setae, frons glabrous and with wider concavity, mandibles variable but generally similar in dentition, antennae 13-jointed, 3rd joint variable but always long and strongly clavate, the 4th and following joints distinctly more globular. The gula and pronotum are similar in form in the two species, but proportionately smaller in the New South Wales insect.

Type imago and soldier in the National Museum of Victoria.

Genus **Coptotermes.**

?Coptotermes australis (Walker).

Cat. Neurop. Ins. Brit. Mus., iii., p. 525, 1853 (*Termes*). Hagen, op. cit., i., p. 23, 1858; Linn. Entom., xii., p. 173, 1858 (*Termes*). French, Destructive Ins. Victoria, ii., p. 137, 1893 (*Termes*). Froggatt, Proc. Linn. Soc. N.S.W., xxii., p. 738, 1897 (*Termes*). Desneux, Gen. Insectorum, p. 34, 1904 (subgen. *Coptotermes*). Holmgren, Kungl. sv. vet. Akad. Handl., xlvi., p. 73, 1911 (*Coptotermes*). Mjöberg, Arkiv. för Zool., xii., 1920.

The soldier and worker castes of this species are unknown and our knowledge of the imago has not been advanced since 1897, when Froggatt redescribed it from specimens collected by Tepper in Adelaide (type locality). In view of the disagreement between the original description of this species and Hagen's re-description and figure of the type the following abstract from a letter received recently by Mr. J. A. Kershaw from Dr. G. A. K. Marshall is of special interest:—

"The unique type is in very bad condition, but it is undoubt-"edly distinct from the two species sent" [*Coptotermes acinaciformis* (Frogg.) and *C. flavus* (Hill)]. "In *Termes australis* "Walk. the general type of venation is like that of *C. flavus*, but "the forewing is much larger and proportionately broader "(12·6×4·2 mm. as against 9·0×2·4 mm.). In the forewing the "median separates from the radius at the basal suture (not in "the wing-stump as in *flavus*), and lies very close to the cubitus; "it reaches the margin and forks at about the same place as in "*flavus*, but both the branches are simple, in its upper edge "there are five or six very faint short branches in the basal half; "the microtrichia are distinctly less numerous than in *flavus*, "and the micrasters are 4-rayed, or perhaps it would be more "correct to say that they are four-sided cones. The pronotum "is distinctly narrower than the head with the eyes, and its shape "is indicated in the accompanying sketch drawn by means of a "camera lucida."

The sketch shows a pronotum quite unlike that of any known Australian *Coptotermes*, but distinctly *Eutermes*-like in outline. If *Termes australis* Walker is a *Coptotermes* at all, it is clearly quite distinct from any member of the genus as yet recorded from this Region.

French in 1893, in recording *Termes australis* "Hagen" as destructive to vines and fruit trees in Victoria confuses two quite distinct species in the plate accompanying his notes. His figures 5 and 6 appear to represent the alate imago of *C. acinaciformis*, *C. flavus* or a closely allied species, and his figure 10 the soldier of *Calotermes insularis* (White).

Coptotermes lacteus (Froggatt).

Agric. Gaz. N.S.W., p. 297, 1897; Proc. Linn. Soc. N.S.W., xxii., p. 721, 1897; Dept. Agric. N.S.W., Farmers' Bull., No. 60, 1915. Silvestri, Die Fauna Südwest Australiens, ii. (17), p. 293, 1909. Mjöberg, Arkiv. för Zool., xii. (15), p. 29, 1920. Hill, Proc. Linn. Soc. N.S.W., xlviii., p. 159, 1923.

The National Museum possesses a fine series of co-types (from Shoalhaven, N.S.W.), with which have been compared soldiers and workers collected at Lion Mill, W. A., by Michaelsen and Hartmeyer, and identified by Silvestri as above, soldiers and workers from Alice River, N.Q., collected and similarly identified by Mjöberg, a complete series from Gosford, N.S.W. (A. Musgrave, 2/10/25) and soldiers and workers from Nepean River, N. S. W. (Musgrave). The two last-mentioned series are undoubtedly correctly referred to *C. lacteus*, but the others are, in my opinion, *C. acinaciformis*, to which species I refer also about 90 of the 180 colonies of *Coptotermes* examined during the preparation of these notes.

In referring to the type imago in an earlier paper (Hill, 1923, p. 43) I stated that the colour of the head is hazel and that of the wings russet. In the better preserved co-types referred to above and in Musgrave's recently captured specimens the colour is much darker and agrees with the original description.

The following measurements are those of co-types from Shoalhaven, N.S.W.:—

Imago.

	mm.
Length with wings	15·00 — 15·50
Length without wings	6·50 — 7·00
Head, to clypeofrontal suture, long	1·02 — 1·08
Head, to apex of labrum, long	1·25 — 1·36
Head, wide	1·25
Eyes, diam.	0·306×0·306 — 0·323×0·323
Pronotum, long 0·74; wide	1·08 — 1·14
Forewing, long, 11.25 — 11·75; wide	3·13 — 3·24
Tibia iii, long	1·08 — 1·14

Soldier.

Total length	3·50 — 3·90
Head, with mandibles, long	1·93 — 2·10
Head, to apex of labrum, long	1·42 — 1·48
Head, to anterior margin of fontanelle, long	1·14 — 1·31
Head, wide	1·08 — 1·14
Antennae, 15- or 16-jointed	
Gula, width at narrowest part	0·272 — 0·289
Pronotum long, 0·40 — 0·45; wide	0·80 — 0·85
Tibia iii, long	0·97

The measurements of soldiers given in my earlier paper are those of Uralla specimens in the South Australian Museum which I now consider to be referable to *C. acinaciformis.*

Coptotermes acinaciformis (Froggatt).

Proc. Linn. Soc. N. S. W., xii., p. 740, 1897; Dept. Agric. N. S. W., Farmers' Bulletin, No. 60, 1915. Hill, op. cit., xl., p. 92, 1915, and xlvii., p. 159, 1922.

To this species I refer specimens from over 90 colonies, some of which differ from the typical form and doubtless represent local races of our most widely distributed species. As a rule there is very little difference in individuals from the same colony but both soldiers and workers from different colonies often vary in size and in the number of joints composing the antennae.

The following tabulations summarise measurements of a series of specimens from 12 colonies (in which all the castes are represented) from various parts of the continent:—

Measurements of imagos.

	mm.
Length with wings	11·50 — 13·00
Length without wings	6·00 — 7·00
Head, to apex of labrum, long	1·36 — 1·48
Head, to clypeofrontal suture, long	0·91 — 1·02
Head, wide	1·19 — 1·31
Eyes, diam.,	0·340×0·340 — 0·408×0·408; generally 0·340×0·340.
Ocelli	0·102×0·136 — 0·119×0·187
Pronotum, long	0·68 — 0·85; generally 0·74
Pronotum, wide	1·14 — 1·22; generally 1·14
Forewings, long	8·75 — 9·50; generally 9·25
Forewings, wide	2·73 — 3·00; generally 2·85
Tibia iii, long	0·97 — 1·25
Antennae, number of joints,	18 — 21; generally 19.

The antennae in the type series are said to be 17-jointed; this number appears to be exceptional and has not been found in any of the colonies examined during the preparation of these notes. In two colonies a few individuals have 18-jointed antennae and in one the number varies from 19 to 21; in all other colonies the number is 19. The maximum number of joints is found in a colony from Banks Is., and is correlated with eyes of the maximum diameter.

Measurements of soldiers.

Total length	5·00 — 5·30
Head, with mandibles long	2·28 — 2·73; generally about 2·50
Head to apex of labrum, long	1·76 — 2·16; generally about 1·88
Head, to frontal opening, long	1·31 — 1·53; generally about 1·42
Head, wide	1·14 — 1·88; rarely more than 1·19
Gula, at narrowest part, wide	0·204 —0·272; generally about 0.255
Frontal opening, internal diam.	0·102 —0·136; generally about 1·19
Pronotum, long	0·45 — 0·53; generally about 0·50
Pronotum, wide	0·80 — 0·96; generally about 0·91
Tibia iii, long	0·91 — 1·10; generally about 1·02
Antennae, number of joints	15 —17; generally 16

In the type series the antennae are 17-jointed, which number occurs in a few individuals only in a large colony (from Townsville) in which the majority are 16-jointed. In only one colony (from Mildura) are all the antennae 15-jointed.

Colonising flight.—The alate imagos are to be found over a longer period than appears to be the case in the three other species recorded from South-Eastern Australia, i.e., *C. lacteus, C. sedulus* and *C. flavus*, which have been found respectively from 28th August to 9th October, during October, and from 29th October to 19th November. The earliest record for *C. acinaciformis* appears to be 18th December (Hacker, Brisbane), and the latest 29th May (Hill, Northern Territory). No field notes are available at present regarding the Western Australian species *C. michaelseni* and *C. raffrayi.*

Localities.—The type locality is Hall's Creek, Kimberley Division of Western Australia; it has been recorded also by Froggatt in 1915 from Kalgoorlie (Central Division of Western Australia) and by me in 1922 from several Northern Territory and North Queensland localities. To these localities should now be added the following:—Northern Territory: Bathurst Island, all castes, G. F. H. 2/11/16; Torres Strait: Banks (Moa) Island (all castes), Rev. G. A. Luscombe 8/1/21, ?Thursday Island, soldiers and workers; Nth. Queensland: Meringa, all castes, F. H. Taylor 31/12/24 (in National Museum), Magnetic Island, all castes, N. Paskin, Jan., 1923, Torrens Creek, all castes, G. F. Cook 4/2/22, Malanda, soldiers and workers, G. F. H.; South Queensland: imagos, H. Hacker 18/12/11 (in Queensland Museum); New South Wales: Sydney, all castes, A. R. McCulloch 22/12/20 (in Australian Museum, No. 48.288); Victoria: Mildura, all castes, C. French 11/1/25 (in National Museum), ?Mooroopna, soldiers and workers, F. E. Wilson (in National Museum), ?Violet Town, soldiers and workers, C. Oke (in National Museum), Linga, soldiers and workers, F. E. Wilson, ?Bamawm, soldiers and workers, W. F. Hill; Western Australia: Kalgoorlie, imagos, H. Morrison per J. Clark (previously recorded by Froggatt from this locality, but caste not stated), ?Lion Mill, soldiers and workers, J. Clark, ?Tammin, soldiers and workers, J. Clark.

Coptotermes raffrayi Wasmann.

Proc. Linn. Soc. N. S. W., xxv., p. 244, 1900). Hill, op. cit., xlvi., p. 264, 1921, and xlvii., p. 160, 1922.

Mr. J. Clark has collected this species in the following hitherto unrecorded Western Australian localities:—Mundaring, Albany, Hovea, Capel, Denmark and Ludlow.

Coptotermes michaelseni Silvestri.

Die Fauna Südwest Australiens, ii. (17), p. 293, 1909.

Further Western Australian records are:—Merredin (L. J. Newman), Tammin (J. Clark) and Hovea (J. Clark).

Coptotermes sedulus Hill.

Proc. Linn. Soc. N. S. W., xlviii., p. 40, 1923.

The National Museum Collection contains specimens from the following additional Victorian localities:—Berwick, soldiers and workers, from trunk of orchard tree, G. F. H. 13/1/24; Harrietville and Wandiligong, soldiers and workers, C. Barrett; Marysville, soldiers and workers, under log, J. A. Kershaw, Wilson's Promontory, all castes, J. A. K. 9/10/24; Waratah, soldiers and workers, in log, B. F. Hill; Cockatoo, all castes, G. F. H. 19/9/24. In the same collection there is a series, including alate imagos, collected by the late F. P. Spry at Ferntree Gully on 28/8/20, from "a clayey nest four feet from the ground on the trunk of living Eucalypt tree"; few species mature so early in the Spring.

Colonising flight.—The colonising flight observed at Cockatoo in September, 1924, commenced over a considerable area of heavily timbered, hilly country early in the afternoon of 18th and continued until dusk, during which period one flight was traced to its source in the trunk of a very large fallen tree, the interior of which was almost completely destroyed and filled with earthy material. The same colony "swarmed" again on the following afternoon, as did others in the same locality, and for two or three hours countless thousands of insects were on the wing. From one large standing tree, the lower trunk of which showed extensive damage and the characteristic filling of clayey matter, these insects issued for more than an hour in an uninterrupted stream from numerous circular or slit-like openings in the nest-wall.

In the description of the soldier the antennae are said to be 16-jointed and the diameter of the frontal opening 0·175; in the abundant material now before me there are many examples with 15-jointed antennae and frontal opening with an internal diameter of only 0·119. This species is closely allied to *C. lacteus*, especially in the soldier caste, but it is undoubtedly specifically distinct.

Coptotermes flavus, n. sp.

Imago.

Colour.—Head, thorax and wing-stumps cinnamon-brown, lower lateral and posterior margin of head somewhat paler; tergites generally Mars-yellow shading to Sudan-brown, the first to fourth sometimes cinnamon-brown; antennae, labrum, postclypeus, palpi, legs and undersurface dull yellow-ochre; tibiae and apical half of sternites dark yellow-ochre; anteclypeus whitish; wings light fuscous, veins much darker than membrane. The entire insect densely setaceous.

Head.—Longer than wide, posterior margin hemispherical, anterior margin narrowed sharply to the base of the clypeus; eyes moderately prominent and small (0·272×0·289 to 0·285×0·306), 0·119 from lower margin of head; ocelli moderately large (generally 0·085×0·136, rarely 0·085×0·153), contiguous with, or about half their width from, eyes; a light coloured area larger than the ocelli on each side of the head between the anterior margin of the ocelli and the posterior margin of the clypeus; clypeus short and wide, four and one half times wider than long,

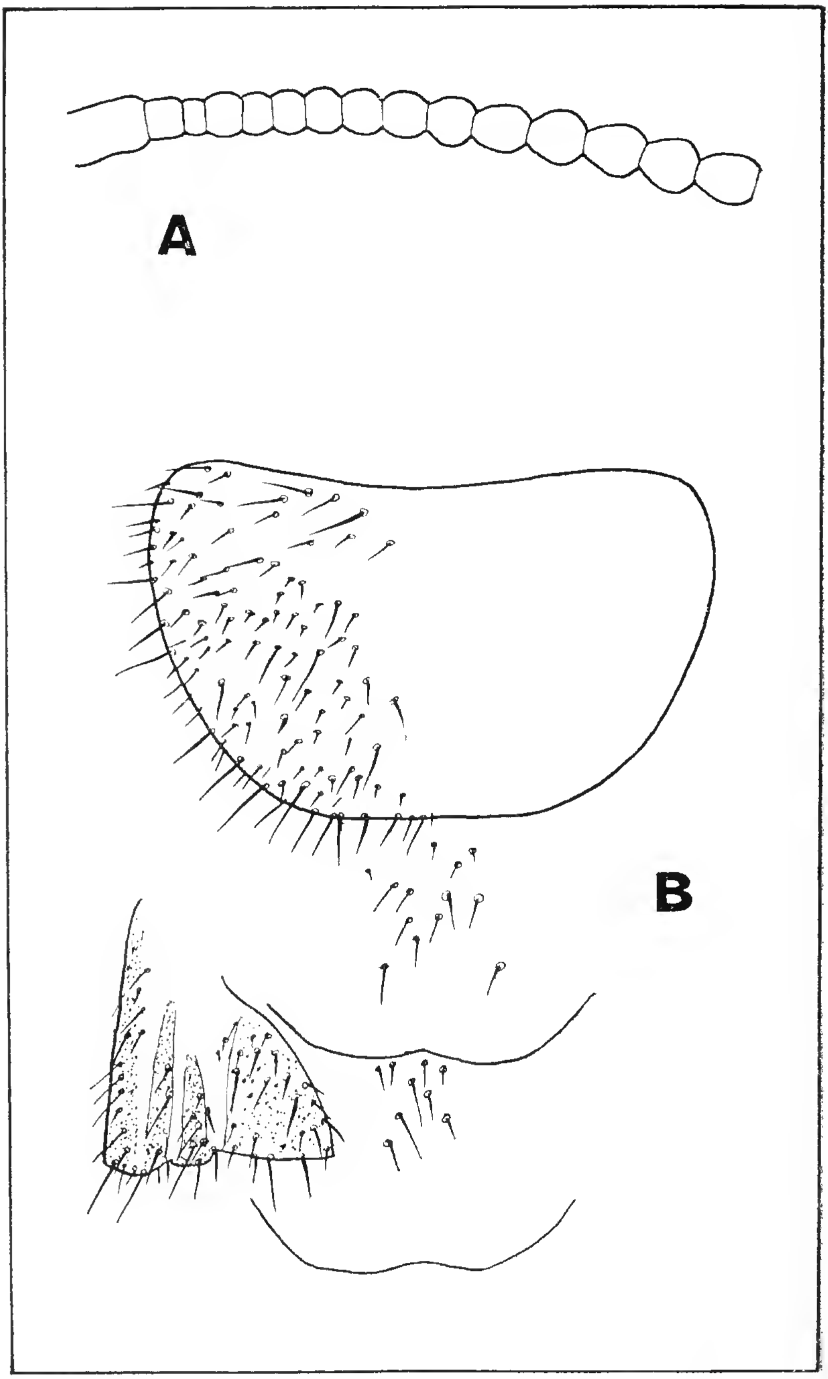

Fig. 2.—*Coptotermes flavus*, n. sp. A, imago, antenna; B, imago, thorax.

slightly rounded behind, only slightly convex above, with indistinct median suture and a few moderately long and many short setae; anteclypeus with anterior margin slightly rounded. Labrum small, widest about the middle, narrowed anteriorly to the truncate apex. Fontanelle indistinct. Antennae (Text-fig. 2*a*) 19-jointed; 2nd joint half as long as 1st, cylindrical; 3rd less than half as long as 2nd, shortest of all; 4th twice as long and noticeably wider than 3rd; 5th and 6th smaller than 4th.

Thorax (Text-fig. 2*b*).—Pronotum large, a little narrower than head, anterior margin widely emarginate in the middle, antero-lateral angles rounded, sides rounded and a little narrowed to the slightly sinuate posterior margin. Posterior margin of meso- and metanotum a little more sinuate than that of pronotum.

Wings.—Long and narrow, the two anteriormost veins very distinct and markedly setaceous along their entire length; media and first five or six branches of cubitus distinct only at their proximal end; cubitus with nine or ten branches. Membrane densely setaceous and very densely covered with micrasters. Stumps of forewings large, extending beyond the apex of the mesonotum, very setaceous, shaded with dark brown, base of veins very distinct; stumps of hindwings small, extending half way between the apex of the mesothoracic stumps and the apex of the metanotum.

Legs.—Moderately long and slender, very setaceous, the tibiae slightly darker than the femora and tarsi.

Abdomen.—Long and narrow, very little widened in the middle, the tergites densely clothed with long and short golden setae, the spiracles on first seven visible segments very distinct as brown, oblique spots.

Measurements.

	mm.
Length with wings - - - - - - -	11·25 — 12·25
Length without wings - - - - - -	4·50 — 5·50
Head, to apex of labrum, long - - -	1·25 — 1·30
Head, to clypeofrontal suture, long - -	0·91
Head, wide - - - - - - - -	1·00
Antennae, long - - - - - - -	1·71
Pronotum, long 0·63 — 0·68; wide - -	0·91 — 1·08
Forewings, long 9·00 — 9·50; wide - -	2·40 — 2·90
Tibia iii, long - - - - - - -	0·96

Soldier.

Colour.—Head yellow-ochre, legs and antennae chamois.

Head (Text-fig. 3*a,b*).—Moderately setaceous, rounded behind and on the sides, widest about the posterior one-third, then narrowed gradually to the base of the mandibles where it is a little more than one-half as wide as at widest part. Labrum acuminate, the apex hyaline and bearing two long setae. Antennae 15- (rarely 16-) jointed; 3rd joint about as long as 4th but narrower; 5th-7th progressively longer, or, when 16-jointed, the 3rd very short and narrow, 4th a little longer.

Thorax.—Pronotum (Text-fig. 3*c*) moderately setaceous, the anterior one-fourth raised, the anterior margin arcuate and strongly emarginate in the middle, anterolateral corners narrow, sides sloping sharply to the slightly sinuate posterior margin.

Legs.—Moderately short and stout, clothed with long reddish setae, scanty of femora, rather numerous on tibiae; claws long and slender.

Abdomen.—Markedly setaceous, short and moderately wide, widest in the middle, narrowed from the 5th tergite to the bluntly pointed apex. Cerci and styli long and markedly setaceous.

Measurements.	mm.
Total length - - - - - - - -	4·45 — 4·50
Head, with mandibles, long - - - -	1·82 — 1·99
Head, to frontal opening, long - - -	1·14 — 1·20
Head, to apex of labrum, long - - -	1·48 — 1·65
Head, wide - - - - - - -	1·02 — 1·08
Thorax and abdomen, long - - - -	2·28 — 2·55
Gula, at narrowest part, wide - - -	0·255 — 0·272
Frontal opening, internal diam. - - -	0·102 — 0·119
Pronotum, long, 0·42 — 0·45; wide - -	0·68 — 0·78
Tibia iii, long - - - - - - -	0·91

Worker.

Colour.—Head antimony-yellow with a ferruginous spot at the articulation of the mandibles; antennae and legs cream.

Head.—A little longer than wide, broadly rounded behind, straight on the sides to near the base of the mandibles, with scanty pale setae. Postclypeus about two-thirds wider than long, arcuate behind, truncate in front, with a row of about six setae anterior margin, median suture indistinct. Labrum very small, rounded, markedly convex. Antennae 15- (rarely 16-) jointed.

Thorax.—Pronotum shorter and less setaceous than that of soldier, otherwise similar.

Legs.—More slender and less setaceous than those of soldier.

Abdomen.—With scanty pale setae.

Measurements.	mm.
Total length - - - - - - -	4·00 — 4·50
Head, to apex of labrum, long - - - -	1·42 — 1·48
Head, to clypeofrontal suture, long - - -	0·91
Head, wide - - - - - - -	1·14 — 1·19
Pronotum, long 0·40; wide - - - -	0·74

Localities.—Victoria: Melbourne (type loc.), Beaconsfield, Marysville, Traralgon.

The description of the imago is based on specimens collected on the wing at about 5 p.m. on 29/10/23 in my garden, where additional specimens were taken four days later, and, also, on 19/11/24 and 26/10/25. The parent colony has not been located, but it is probably situated in one of the numerous Eucalypt stumps or roots to be found in the near vicinity. The soldier and worker morpho-

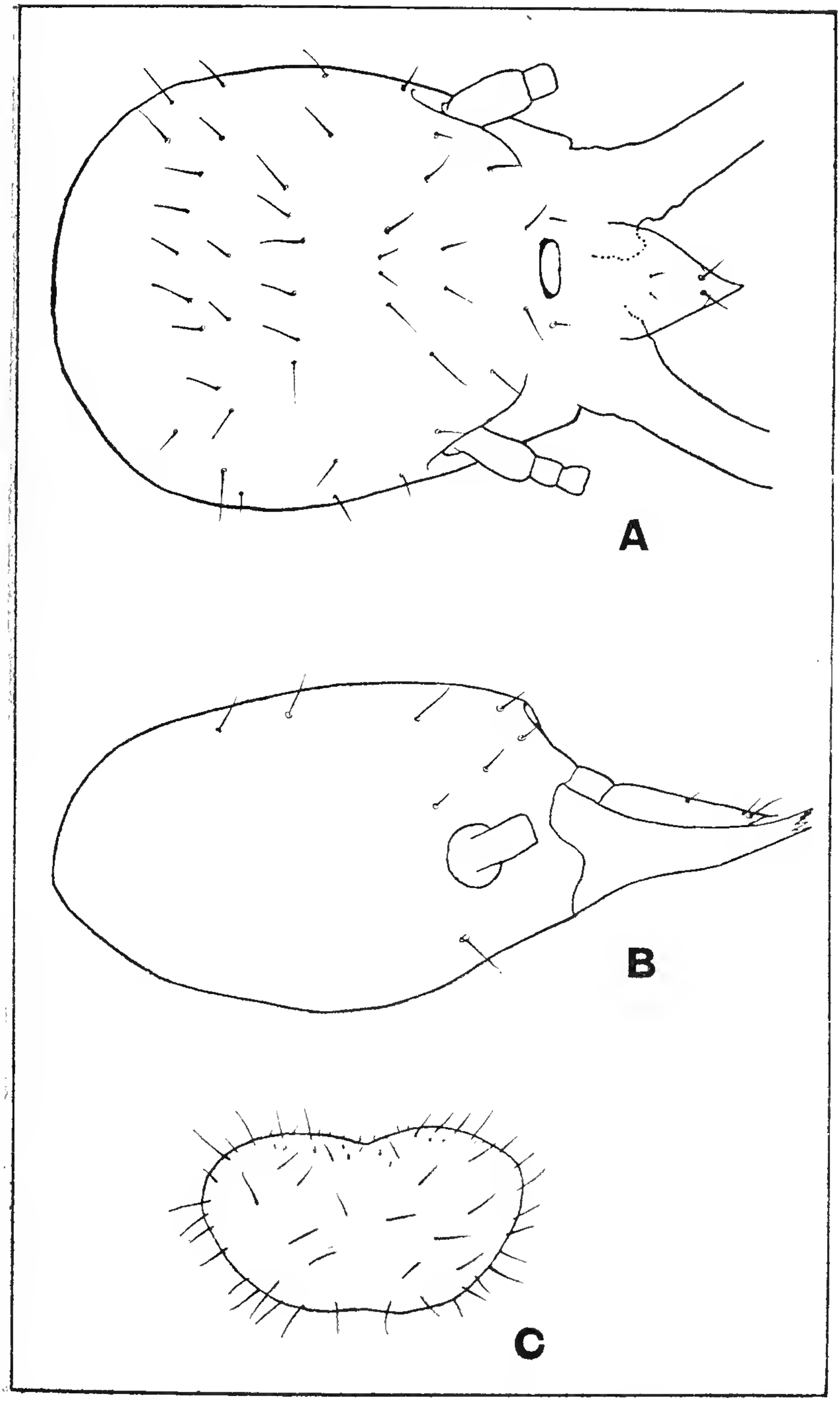

FIG. 3.—*Coptotermes flavus*, n. sp. A, soldier, head from above; B, soldier. head in profile; C, soldier, pronotum.

types are from Marysville, where several colonies, including one in which all the castes are represented, were taken by Mr. J. A. Kershaw in November. Imagos were taken at Beaconsfield by Miss J. C. A. Traill and myself in November, and near Traralgon by Miss J. Galbraith about the middle of the same month.

Allied species.—The imago is most closely allied to *C. acinaciformis*, from which species it is distinguished by the head, eyes and ocelli being smaller, pronotum smaller, more deeply notched anteriorly, wings distinctly darker in colour, with fewer and smaller microtrichia, wing-membrane densely covered with micrasters (wanting in *C. acinaciformis* and *C. raffrayi*). The legs are similar in colour, but the under surface of abdomen is somewhat brighter in the proposed new species.

C. flavus, var.

The National Museum has received from Mr. W. W. Froggatt a complete nest-series collected at Pilliga Scrub, New South Wales, 30/10/24, which appears to be best regarded as a variety of the above. From the typical form the imago differs in having wider head, longer body, larger eyes, larger ocelli, shorter wings, smaller and fewer micrasters on wing-membrane.

Measurements.	mm.
Length with wings	11·25 — 12·25
Length without wings	6·50 — 7·00
Head, to apex of labrum, long	1·25 — 1·36
Head, to clypeofrontal suture, long	0·85 — 0·91
Head wide	1·19
Eyes, diameter 0·340×0·340 — 0·357×0·357	
Eyes, from lower margin of head	0·85 — 0·108
Ocelli 0·102×0·153 — 0·119×0·170	
Pronotum, long 0·68; wide	1·02
Forewings, long 9·00; wide	2·90
Tibia iii, long	1·00

The soldiers differ very little from the typical form. The head is generally slightly smaller, the antennae are 14- (rarely 15-) jointed, and are generally, though not always, differently segmented, the last three joints decreasing in size progressively and the last two much narrower.

Measurements.	mm.
Total length	4·00 — 4·35
Head, with mandibles, long	1·82 — 1·93
Head, to apex of labrum, long	1·53
Head, to frontal opening, long	0·14
Head, wide	0·97
Gula, at narrowest part, wide	0·255 — 0·272
Pronotum, long 0·45; wide	0·70 — 0·74
Tibia iii, long	0·80

The worker appears to differ only in having 14- (rarely 15-) jointed antennae.

Coptotermes labiosus, n. sp.

Imago.

Colour.—Amber-brown above, vertex of head suffused with darker brown; under surface and legs buckthorn-brown, tibiae and apical segments of abdomen somewhat darker than remainder of under surface; wings almost hyaline, tinged with pale yellow, veins light brown at base only, otherwise very little darker than membrane.

Very similar to *C. flavus*, n. sp., from which it differs as follows:—Head and thorax lighter in colour and markedly less setaceous, pronotum smaller and more rounded on the sides, wings distinctly lighter in colour and with distinctly fewer and smaller micrasters and microtrichia.

Measurements.	mm.
Length with wings - - - - - -	11·50
Length without wings - - - - - -	5·25
Head, to apex of labrum, long - - - -	1·14
Head, to clypeofrontal suture, long - - -	0·87
Head, wide - - - - - - - - -	1·02
Eyes diameter 0·272×0·289	
Antennae 19-jointed	
Pronotum, long 0·63; wide - - - -	0·97
Forewings, long 9·00; wide - - - -	2·80
Tibia iii, long - - - - - - - -	0·91

Soldier.

Distinguished from *C. flavus* by its smaller head and body, the former markedly narrowed anteriorly, long and narrow labrum (extending well beyond the middle of mandibles in the species under notice but not reaching the middle in *C. flavus*), smaller pronotum, the sides of which are more rounded. The antennae, which are incomplete, have 3rd joint smallest. It is also similar to *C. michaelseni* Silv., from which it is distinguished by the head being distinctly more narrowed in front.

Measurements.	mm.
Total length - - - - - - - - -	4·00
Head, with mandibles, long - - - - -	1·71
Head, to frontal opening, long - - - -	1·10
Head, to apex of labrum, long - - - -	1·53
Head, wide - - - - - - - - -	0·91
Gula, at narrowest part, wide - - - -	0·272
Pronotum, long 0·34; wide - - - -	0·62
Tibia iii, long - - - - - - - -	0·68

Worker.

Colour.—Head clay-colour, with large whitish area on summit.

Head.—Rounded, widest in front, narrowed on the sides to the broadly rounded posterior margin, flat on vertex, with scanty short pale setae. Clypeus a little more than half as long as wide, strongly convex, glabrous. Labrum short and markedly convex. Antennae 14-jointed; 3rd joint shortest and narrowest, closely fused with 4th; 5th and 6th nearly equal; 7th-13th broadly oval, 7th very little shorter than 13th; 14th a little longer and narrower than 13th.

Thorax.—Pronotum small, much narrower than head, rather deeply notched and bent up in front, antero- and posterolateral angles sharply rounded, posterior margin nearly straight, clothed with scanty pale setae, as on remainder of thorax and abdomen.

Measurements.	mm.
Total length - - - - - - - - -	4·00
Head, to apex of labrum, long - - - -	1·14
Head, to clypeofrontal suture, long - - -	0·85
Head, wide - - - - - - - -	1·08
Pronotum, long 0·35; wide - - - -	0·62

Localities.—South Australia: Barton (A. M. Lea); ?Victoria: Mallee District.

Described from a small colony comprising three alate imagos, three soldiers and several workers, from the South Australian Museum collection. The Victorian specimens include imagos collected at Redcliffs and Ouyen by Messrs. A. S. Cudmore and F. E. Wilson, and soldiers and workers collected at Piangil and Linga by the last-named gentleman and Mr. C. Oke respectively. The examples from Ouyen, which were captured at a light in October, have 18- 19-jointed antennae and are a little smaller than those in the type colony.

Type imago, soldier and worker in the South Australian Museum; paratypes in the National Museum of Victoria.

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————, 1925. *Proc. Roy. Soc. Vic.*, n.s., xxxvii. (2) pp. 207-228.

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Walcott, R. H., Technological Museum, Melbourne. ... 1897

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Singleton, F. A., M.Sc., Geology School, University, Carlton. 1917
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Thorn, Wm., 37 Chrystobel-crescent, Hawthorn 1907
Traill, J. C., B.A., B.C.E., "Myoora," Toorak-road, Toorak. 1903

Treloar, H. M., Meteorological Bureau, Melbourne ... 1922
Trüdinger, W., Gerald-street, Murrumbeena 1918
Turner, A. W., M.V.Sc., Veterinary School, Parkville 1925
Wilcock, E. L., B.Sc., Dookie College, Dookie, Vic. ... 1925

Williamson, H. B., F.L.S., "The Grange," Corner Waverley-road, East Caulfield. 1919
Wilson, F. E., 22 Ferncroft-avenue, E. Malvern 1921
Wilson, Major H. W., O.B.E., M.C., C.de G., B.Sc., 630 Inkerman-road Caulfield. 1923
Woodward, J. H., Queen's Buildings, No. 1 Rathdown-street, Carlton. 1903

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The names of new genera and species are printed in italics.

END OF VOLUME XXXVIII.

[PUBLISHED 31ST JULY, 1926.]

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OF THE

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1927.

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CONTENTS OF VOLUME XXXIX.

[Proc. Roy. Soc. Victoria, 39 (N.S.), Pt. I., 1926.]

Art. I.—*Contributions to the Flora of Australia, No. 32.** *Additions to the Flora of the Northern Territory.*

By A. J. EWART, D.Sc., Ph.D., F.L.S., F.R.S., and
LESLEY R. KERR, M.Sc.

[Read 11th March, 1926.]

GRAMINEAE.

Ectrosia agrostoides Benth.

Batchelor, N.T., and near Darwin, N.T., 26/7/11, No. 104, G. F. Hill. This was recorded as *Triraphis mollis*, in the Northern Territory Flora. It is probably often confused with this species or with *Ectrosia leporina*, and is probably more widely distributed than would appear from the records.

Ectrosia spadicea R.Br.

Thring Swamp, Wycliffe, N.T., June, 1924; from the Herbert River to Carpentaria, 1886, Lieut. Dittrich; Gilbert River, Queensland, Armit, No. 902.

This is closer to *E. agrostoides* than to *E. leporina*.

EUPHORBIACEAE.

Euphorbia petala, n. sp.

Wycliffe Well, June, 1924, A.J.E.

A small prostrate herb with a central deeply descending tap root and slender spreading branches a few inches in length; leaves on very short stalks, mostly opposite, with an oblique base and broadly oblong; flowers crowded at the ends of the branches, axillary or terminal, with prominent pink appendages resembling petals; glands prominent, appendages of the involucre with a fringed border, the stalk of the ovary projecting well beyond the "flower," sterile hairs between the stamens (male flowers), the stalk of each stamen prominently jointed near the tip, seeds smooth, style very short, not deeply bifid.

The plant shows affinities to *E. filipes*, *E. myrtoides*, *E. Drummondi* and *E. alsiniflora*. *E. filipes* is a much taller, diffusely erect plant, and has a much longer and more deeply bifid stigma. *E. myrtoides* has an erect habit, larger leaves, and only very small petal-like appendages. *E. petala* differs from *E. Drummondi* in having smooth, not rugose, seeds, and in having petal-like appendages as in *E. alsiniflora*. It has, however, the habit of *E. Drummondi*, and differs from *E. alsiniflora* in having smaller glands, and the petal-like appendages relatively much larger.

* No 31 in *Proc. Roy. Soc. Vic.*, n.s., XXXVIII. p. 164, 1926.

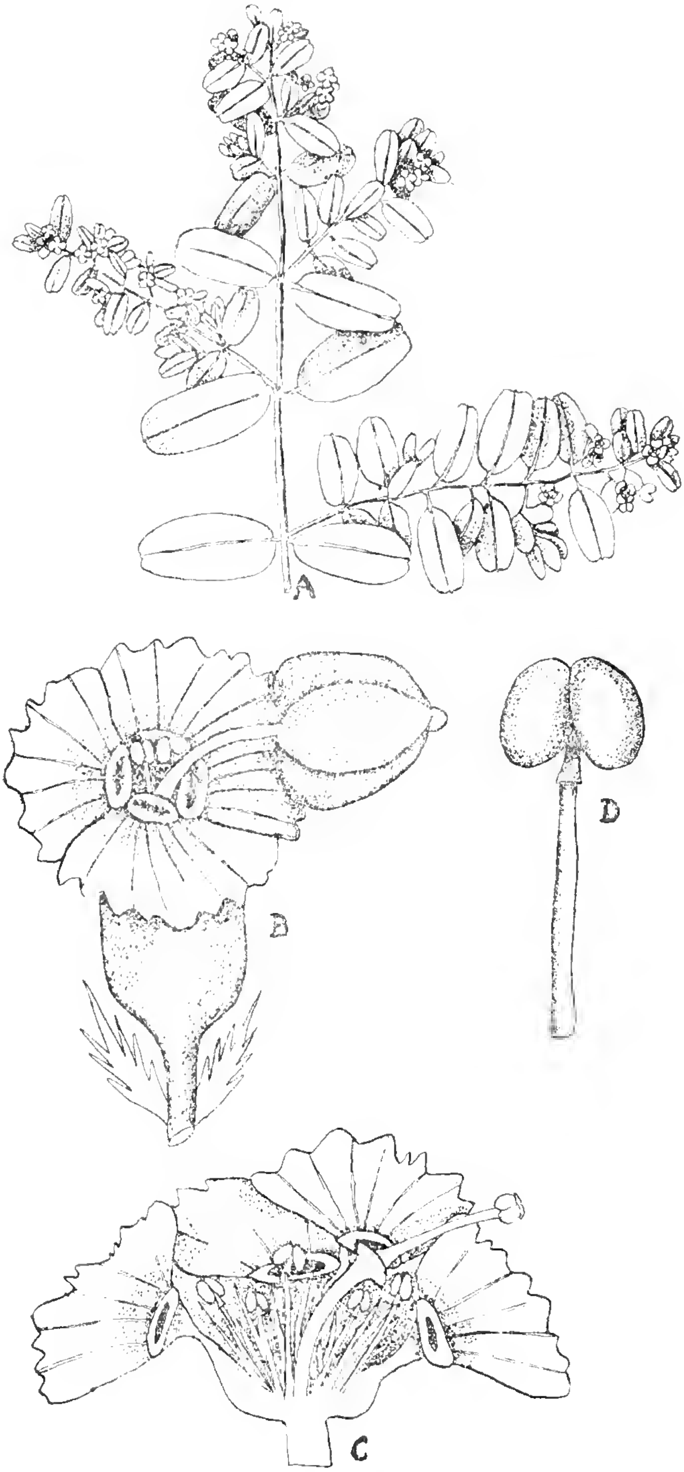

Fig. 1—Euphorbia petala, n. sp.

A, Portion of flowering shoot; B, single inflorescence enlarged, showing the petaloid rays to the involucral glands; C, the same in vertical section, showing the male flowers with their appendages and the stalked central female flower; D, single male flower.

PAPILIONACEAE.

INDIGOFERA UNCINATA, n. sp.

A slender attenuated shrub of almost tree-like habit and 6 to 8 feet in height; leaflets paler beneath, covered with small whitish appressed hairs, usually seven leaflets, lanceolate or elliptical; stipules forming small pointed thorns; flowers axillary, clustered at the ends of the racemes, buds with a rusty tomentum. The racemes open out in fruit; corolla dark purplish red and caducous, usually only one flower showing at a time in each raceme, pod linear an inch or rather more in length, thick with the dorsal and ventral sutures prominent, the surface hairy and with pithy partitions between the rather large seeds. The hairs rub off the ripe pods readily.

This plant appears to be the same as that placed by Bentham as *Indigofera brevidens* var. *uncinata*. There is also a variety *uncinata* of *I. australis* in the Tate Herbarium (Wirrabirie, R. Brown, Oct., 1882), which has curved thorny stipules, but has the more numerous leaflets and flowers of *I. australis*. The flowers of *I. australis* are purple to pale fuchsia in colour, whereas this plant has more darkly red flowers. It is intermediate between *I. australis* and *I. brevidens*, but is less whitish hoary than the latter, has the characteristic thorny stipules, has smaller flowers than both species, is taller than either, with a woody stem, and is almost like a small attenuated tree 6 to 8 feet high.

Forrest expedition, 1874 (without locality); towards Alice Springs, Flint, 1882; Gawler Ranges, R. F. Sullivan; Camp 17, S. Australia, R. Helms (Elder expl. exped.), 1891; Tarella, W. Bauerlen, No. 116, 1887; Cobar, N.S.W., J. M. Curran, 1887; Mt. Watson, near Birkgate River, R. Helms; Taylor Range, N.T., A. J. E., June, 1924. One doubtful specimen without locality (ex. Herb. Melb., Dr. Mueller, Jan., 1853), which was seen by Bentham, has the thorny stipules less developed, but has the smaller flowers and taller shrubby habit of *I. uncinata*. The legumes are, however, shorter and glabrous.

INDIGOFERA UNCINATA, n. sp., var. MINOR.

Hastings River, Dr. Beckler; Barrier Range, Dr. Beckler, 1861; Gascoyne River, W.A., J. Forrest, 1882.

This plant was placed under *I. australis*, as variety *minor* by Bentham. It represents a further divergence from the *australis* type. The hairiness of the leaves is more prominent, the leaflets are five in number and smaller, the stipules are spiny but smaller, the whole plant is very woody, and the stem notched.

Fig. 2—Indigofera uncinata, n. sp.

PTYCHOSEMA TRIFOLIATUM F.v.M.

This interesting plant, whose yellow flowers and trifoliate leaves at a distance give it the appearance of a creeping *Lotus*, was described from imperfect non-fruiting material by Mueller in Wing's *Southern Science Record*, 1882, ii., p. 72. It is already recorded from Central Australia, but as abundant material was obtained in the bed of the Hansen River, near Central Mt. Stuart, by the senior author in 1924, a full description and figure of the plant is given.

A slender attenuated herb with a deeply descending tap root and slender prostrate spreading branches one to two feet in length, and trifoliate leaves on long, slender leaf stalks, the leaflets small, bi-lobed and obovate, glabrous and non-glandular. Stipules lanceolate, small but prominent. Flowers solitary, on long stalks, leaf opposed. Sepals five, the three anterior sepals united half-way up, the tube campanulate, the lobes bluntly pointed, the two posterior sepals united nearly to their tips.

Standard yellow, with a spot at the throat of the flower, about as broad as long, with two rounded lobes narrowing to a stalk, the whole about as long as the carina. Alae yellow, on slender stalks, small, narrow, somewhat spathulate, and about half the length of the carina. Carina a paler greenish yellow, with small purplish spots or veins outside (as also on the outside of the vexillum), the petals united near the tip by their ventral edges and with free projecting terminal lobes. Stamens ten, all loosely united nearly half way up, the sheath split posteriorly, and persisting at the base of the pod. Anthers versatile, two celled, oblong. Style long, slender, tapering and glabrous. Stigma very small, but terminal and capitate. Ovary prominently stalked, ten to twelve ovules. Fruit flat, about 20 mm. long by 4 mm. broad, the valves pale and thin, with usually 6 to 8 rounded-oblong seeds on long laterally inserted stalks, radicle short but bent.

The genus *Ptychosema* was based by Bentham upon a non-fruiting specimen of *P. pusillum*, from W. Australia, and this is the only species described in Bentham's Flora. Since then Mueller described two additional species, *P. anomalum* and *P. trifoliatum*, the first species having pinnate foliage, the last-named trifoliate. The two first species appear to be very rare, whereas *P. trifoliatum* extends in various localities from the Northern Territory to W. Australia, mostly in sandy flats near soaks, or in river beds. The ovary is not sessile, but stalked; the carinal petals are only partially united, all the petals have prominent stalks, the anthers are versatile, and the radicle is short but curved. *Lamprolobium* is closely allied, but has a short but quite straight radicle. Bentham placed both genera in the Galegae next to *Tephrosia*, mainly on account of their pinnate foliage, and Engler's Pflanzenfamilien adopts the same systematic position. *P. trifoliatum* has, however, the foliage of the

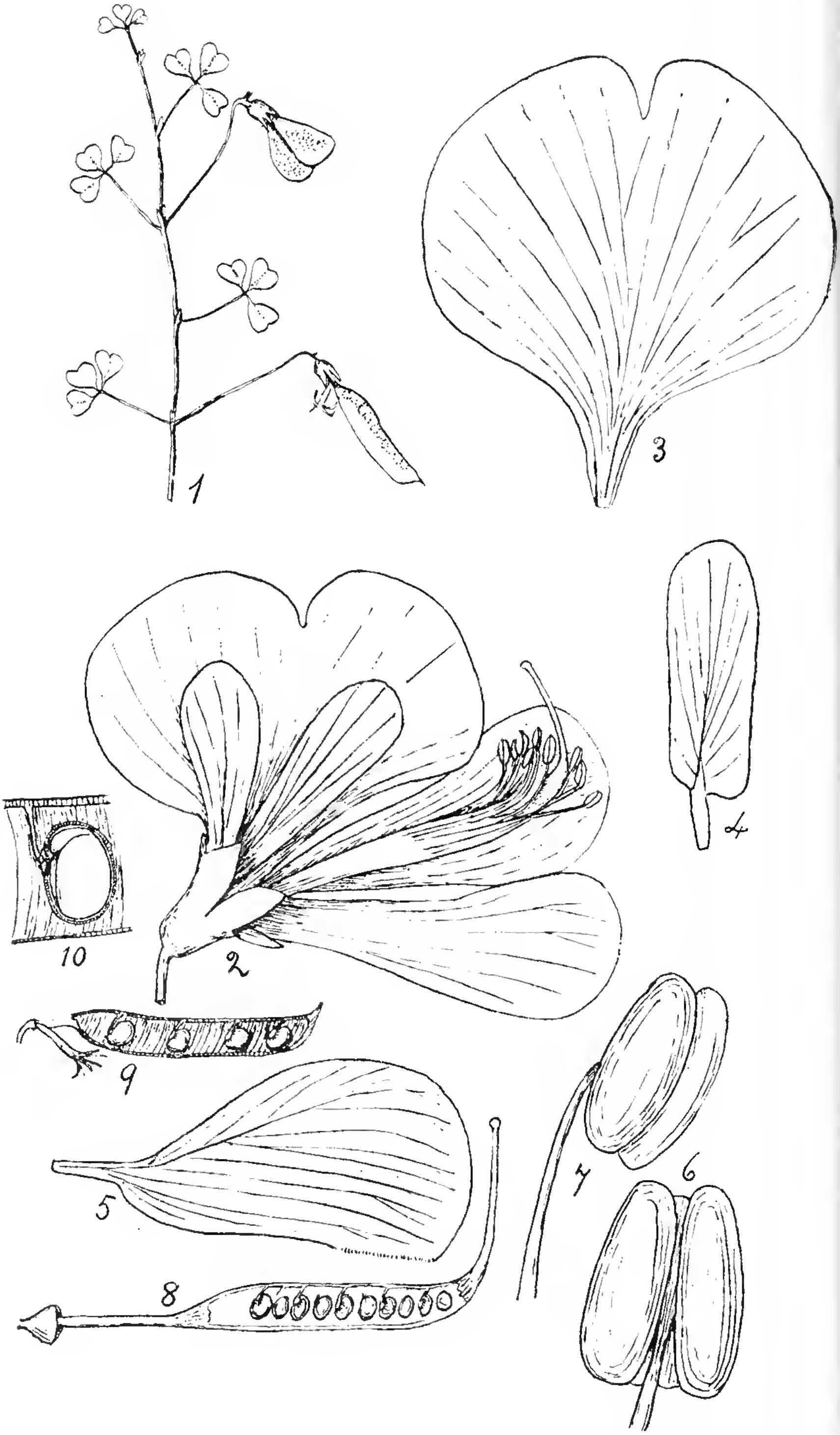

Fig. 3—Ptychosema trifoliatum, F. v. M.

1, Tip of a branch, with flowers, fruit and leaves; 2, flower, with the carina pulled down and opened out; 3, standard; 4, ala; 5, carinal petal; 6, stamen from the back; and 7, from the side; 8, young ovary enlarged and side removed; 9, fruit $1\frac{1}{2}$ times natural size, one valve removed; 10, portion of valve with a single seed, half of the seed coat removed.

Genistae, and the split staminal sheath and general structure of the flower in all the species undoubtedly justifies the transference of both genera from the Galegae to the Genistae, placing them between *Rothia* and *Goodia*.

MYRTACEAE.

Eucalyptus gilleni, n. sp.

Mt. Gillen, N.T., July, 1924, A.J.E.

A low, densely-branched shrub, spreading from the base, about 6 to 8 feet high, with a smooth bark on the branches, becoming rougher and more box-like on the older stems, but not fibrous. Leaves shortly stalked with the petiole usually twisted so as to place the lamina vertical, linear-ovate to lanceolate, bluntly pointed, thick, very coriaceous, pale green on both sides, intramarginal vein prominently developed, and frequently with a second fainter intramarginal vein nearer the edge of the leaf; lateral veins diverging at an angle of about 45°; young shoots angular, mid-rib red. Fruits shortly stalked, usually in clusters of three, occasionally in twos, or even single, and either on terminal leafless branches or on leafy shoots opposite the leaves or in their axils, peduncles short, thick and more or less angular; capsules sessile almost globular, with an equatorial rim and a dome-shaped top with four, or less commonly three, short valves with flattened incurved tips; seeds not winged.

The fruit somewhat resembles that of *E. macrorrhyncha,* but the bark is quite different. The nearest affinity appears to be *E. Oldfieldii,* but the general habit and the short angular common pedicel are distinctive features. Although the flowers have not been seen, the species appears to be quite distinct.

Juvenile leaves narrow, ovate lanceolate, pointed, shortly stalked, opposite and becoming alternate later; venation almost identical with the adult leaves, except that the intramarginal vein is thinner and single and the leaves less coriaceous than the adult; oil glands not numerous, but more prominent on the juvenile foliage. The plant is strongly xerophytic, and only grows so far as is known on the southern slope of Mt. Gillen, among tufts of porcupine grass. It grows well in Melbourne, forming a rather graceful small shrub, but seems reluctant to flower.

GOODENIACEAE.

Velleia prostrata, n. sp.

Wycliffe Well, June, 1924, A.J.E.

A small prostrate herb arising from a short thick root-stock, with slender straggling branches up to 18 inches in length, or even more. Leaves opposite, lanceolate, narrowing at the base, but without a distinct petiole. At each leaf axil and in the forks of the branches are tufts of whitish hairs. Inflorescence, a loose

Fig. 4—Eucalyptus gilleni, n. sp.

1, Adult leaves with double intramarginal vein and axillary fruits; 2, juvenile leaves; 3, fruiting branch, the leaves fallen.

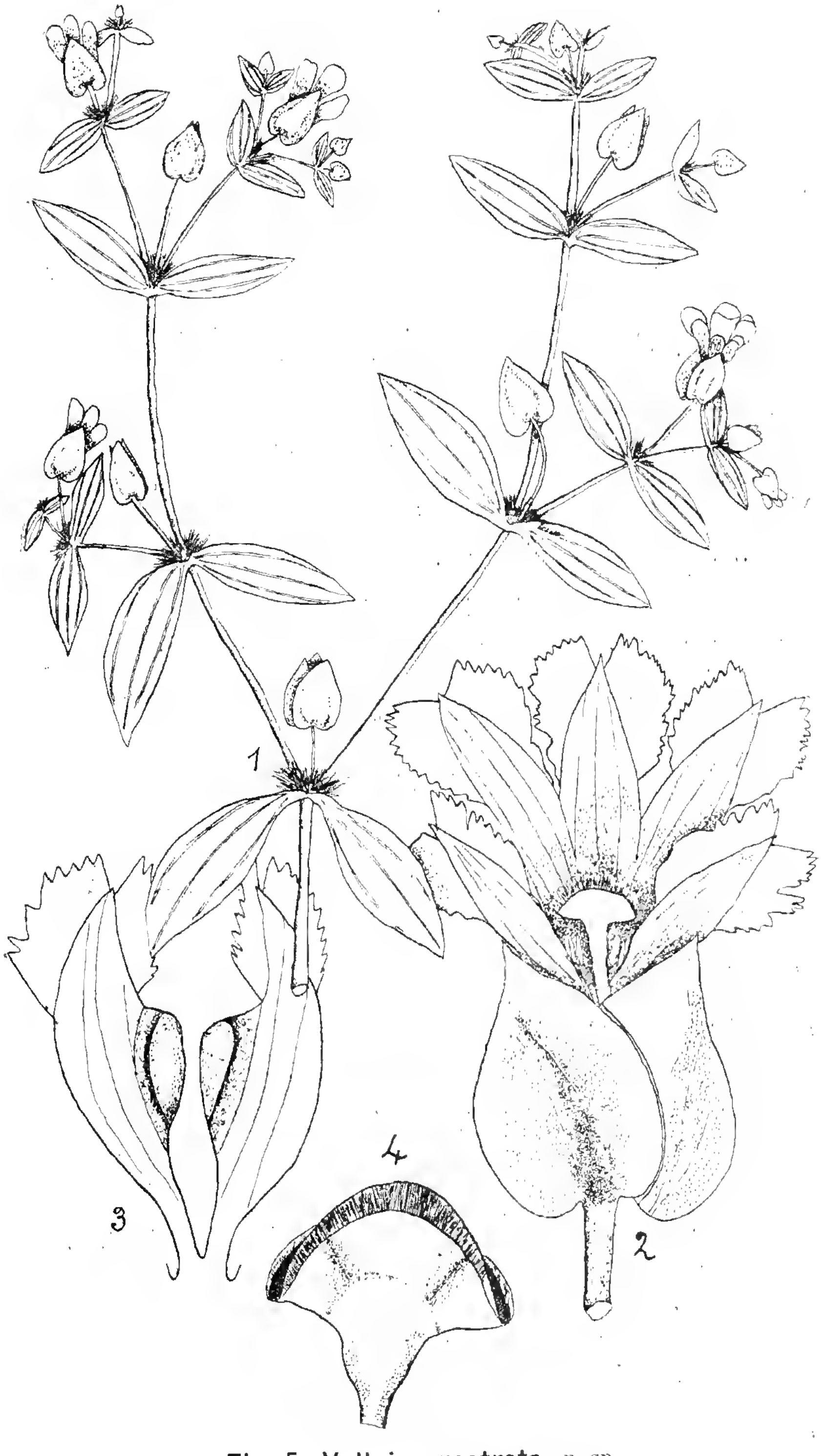

Fig. 5—Velleia prostrata, n. sp.

1, Flowering branch with leaves; 2, flower enlarged; 3, the two posterior petals showing frilled appendages and lateral auricles; 4, top of the style with folded indusium.

dichasium, with large, leafy bracts, and one or two flowers in the final forks. Flowers yellow, the calyx of three sepals coherent by their edges for more than two-thirds of their length, and separating as the fruit opens; corolla yellow, the three anterior petals longer than the posterior, the free lobes equal, with fringed bilateral appendages, and projecting beyond the calyx. The two posterior petals are free almost to their bases, the inner edges at the middle have each an auriculate appendage curled around the stigma, the terminal portion has membranous appendages similar to the other petals. Stamens 5, anthers free. Ovary superior, the dissepiment extending more than half way up. Seeds at least 17, small, thick, with a tubercular surface, and a narrow border. Indusium cup-shaped, with prominently hairy lips, closing when the flower opens and folding horseshoe fashion.

The nearest affinity is *V. perfoliata*, but the posterior petals are winged on both sides and the bracts are barely connate.

Additions or new localities from the Tate Herbarium, Adelaide, University.

The following are not given in the Flora of the Northern Territory, Ewart and Davies, or in the Horn Expedition Botany, R. Tate, 1896. The collector is R. Tate, if no name is given.

MONOCOTYLEDONEAE.

GRAMINEAE.

Eriachne obtusa R.Br.
Newcastle Waters and Fitzroy River, Calvert Exp., 1894.

Astrebla pectinata F.v.M.
Swallow Creek, 1894.

A. triticoides, F.v.M. var. *lappacea.*
Newcastle Waters.

Chloris barbata Sw.
Tennant's Creek and Barrow Creek, 1894.

Cynodon tenellus R.Br.
Fitzroy River, Calvert Exp., 1897.

Andropogon intermedius, R.Br.
Finke River. at Crown Point, 1894.

Perotis latifolia Ait. (*P. rara* R.Br.).
Newcastle Waters, Tennant's Creek, Barrow Creek, 1894; also Rev. Kempe, Finke River, 1882. This genus is given in Engler's Pflanzenfamilien as from the Old World tropics, and in the Kew Index from India, East Africa, Japan and Cuba.

Imperata arundinacea Cyr.
Illamurta Marsh, 1894.

Leptochloa subdigitata Trin.
Horseshoe Bend, 1894.

Elytrophorus articulatus Beauv.
Arnhems Land, F.v.M. This species is given in the Kew Index as from the E. Indies, and by Engler as from the whole of the Old World tropics.

Diplachne fusca Beauv.
Glen Helen Gorge, Finke River, 1894.

Eragrostis diandra Steud.
Pine Creek and Barrow Creek.

E. Dielsii Pilger.
Goyder River, 1894. (This was under the name of *E. falcata* Gaud.)

E. laniflora Benth.
Bagato Creek, R. Tate, 1894.

Anthistiria membranacea Lindl.
Swallow Creek, Central Australia, 1894.

Panicum argenteum R.Br.
Near MacDonnell Ranges, Rev. W. F. Schwartz, 1889 (ex Nat. Herb. Melb.).

P. reversum F.v.M.
Finke River, at Crown Point, 1894.

JUNCAGINACEAE.

Triglochin centrocarpum Hook.
Victoria Springs, Upper Arkaringa Valley, and Mt. Ilbillie, R. Helms, 1891, and Deering Creek, R. Tate (as *T. calcitrapa* Hook.).

NAJADACEAE.

Najas major All.
Palm Creek and Ilara Water, 1894.

CYPERACEAE.

Schoenus hexandrus F.v.M. and Tate.
Vict. Desert, Camp 57, 1891, R. Helms.

Cyperus alterniflorus R.Br. (labelled *C. fulvus* by Tate).
Finke River, at Horseshoe Bend; Glen Helen, 1894. It is doubtful whether *C. fulvus* occurs in the Northern Territory; the nearest recorded locality is one from Charlotte Waters, collected by Giles.

Scirpus lacustris L. (labelled *S. littoralis*).
Ilara Water, 1894.

S. supinus L.
Deering Creek, Central Australia, 1894.

Eleocharis acuta R.Br.
Deering Creek, 1894.

COMMELINACEAE.

Commelina agrostophylla F.v.M.
Pine Creek.

C. ensifolia R.Br.
Barrow Creek.

ORCHIDACEAE.

Dendrobium Foelschei F.v.M. (*D. canaliculatum* R.Br. var. *Foelschei.*)
Near Port Darwin, P. Foelsche, 1882.

[Proc. Roy. Soc. Victoria, 39 (N.S.), Pt. I., 1926.]

Art. II.—*New or Little-known Fossils in the National Museum. Part XXX.—A Silurian Jelly-fish.*

By FREDK. CHAPMAN, A.L.S.
(Palaeontologist to the National Museum.)

(With Plates I. and II.)

[Read 8th April, 1926.]

Introduction.

Probably hardly anything in the province of fossil discovery that has come within my ken during the past forty-five years equals in interest and wonder that of a beautifully preserved jelly-fish in the Silurian mudstone of Brunswick, Victoria.

It was at about the same spot, but on a higher horizon of the Silurian, that a marvellously preserved cast of a crinoid, *Helicocrinus plumosus* (1, p. 108, pls. xvii., xviii.) was found twenty-four years previously. Only for the care and interest of the two workmen who found these respective fossils are we able to include them among the treasures of the National Museum.

Description of the Fossil.

Class HYDROZOA.

Sub-Class SCYPHOMEDUSAE.

Order DISCOPHORA.

Genus **Discophyllum**, J. Hall, 1847.

Discophyllum mirabile, sp. nov.

(Plates I. and II.)

The Holotype.

The circular form of the umbrella is distinctly shown, and only a little distorted by pressure. The diameter of this portion is 118 mm. The total probable diameter, including the tentacles, is 168 mm., or about $6\frac{1}{2}$ inches.

The radials of the umbrella are seen as perfect ridges in the fossil, and therefore there has been the least amount of compression compatible with its preservation. The number of radial ridges on the umbrella is about 56. These are rounded to roundly depressed, and are crossed by strong, concentric ridges that bear a composite undulate ornament. The frilled ribs extend practically to the centre of the umbrella.

Where the external covering has been broken through, or is thin, there are seen the four gastro-genital pouches arranged in a cruciform manner just as in a modern *Aurellia.*[1] These pouches are more or less cuspidate in outline.

The tentacles are seen as a zone of delicate, threadlike, carbonaceous stains surrounding the umbrella, and appear to become more visible in a photograph. They are of two kinds, those which emanate from the termination of the ribs are strong, and seem to be grooved, whilst the interspace is filled in with multitudes of finer tentacles. The tentacles extend beyond the umbrella margin for about 25 mm.

The central part of the disc was apparently more strongly convex, so that the central diameter, of about 64 mm., is marked off as with a depressed ring. It is within this central zone that the pouches are confined. The concentric ridges are seen to interdigitate on the sides of the radials, so that there is left in the radial furrow a lenticular pit. This arrangement imparts a beautiful undulose ornamentation to the umbrella surface.

Note on the Paratype.

It was fortunate that the counterpart of the fossil was also secured (purchased by Mr. F. A. Cudmore), for this gives some details not seen in the holotype; and we are indebted to Mr. Cudmore for the loan of this specimen.

The central part of the disc in the paratype is perfectly shown by a fine impression of the radials emanating from a clear apical spot in the centre. This apical spot has a diameter of 4 mm. The surrounding ring of radials is very delicate, and the striate ridges, at a diameter of 11 mm., bifurcate into the stronger ridges that pass over the general area of the disc.

Towards one side of the paratype there appears to be distinct evidence of the impression of the manubrium. This is represented by a pendent cluster of divergent and crenulated ridges, which suggest a depressed tubular structure lying within the central disc.

Relationship of the Fossil.

So far, I have been unable to find more than one other described jelly-fish which can be compared with the present specimen. It is the *Discophyllum peltatum* of James Hall (2, p. 277, pl. lxxv., fig. 3). The resemblance of this species is so close to the Victorian specimen that it is clearly congeneric. Hall's species

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1.—Usually referred to as *Aurelia,* Agassiz, 1862. Correctly as *Aurellia,* Peron and Lesueur, 1809.

was found in the Trenton Series at Troy, New York State. When described, James Hall placed it with the corals. Scudder, in his Index, referred it to the graptolites (3). Later on, Dr. Chas. D. Walcott included it in his fine Monograph on "Fossil Medusae" (4, p. 101, pl. xlvii., figs. 1, 2), and not only replaced the original figure by a better, but figured an additional example from the same locality. These figures leave no shadow of a doubt that they and the Australian specimens are similar in every morphological particular, so far as the genus goes.

In re-describing the Trenton specimen, Dr. Walcott says (4, p. 101): "It is exceedingly difficult to determine whether *D. peltatum* is the impression of a medusa. There is no *a priori* reason why a gelatinous disc should not leave such an impression in the very fine arenaceous silt which now forms the slightly gritty layers embedded in the shales carrying the graptolitic fauna referred to the Trenton terrane. If *D. peltatum* be considered to be the cast of the impression of a medusa, it might be grouped with *Medusina princeps* as an acraspedote medusa."

The close affinities of the Victorian and American species leave little doubt that they both belong to the fringed Scyphozoa, but that the tenuity of the marginal tentacles accounts for their absence in the American specimens, which were preserved in a fine sandy matrix; whereas the Victorian occurs in an impalpable, blue mudstone.

Dr. C. D. Walcott has figured a second specimen of James Hall's species (*Discophyllum peltatum*), and this shows more of the distinctive characters than the original type. There are about 72 radial ridges as against 56 in the Victorian fossil, and they bear a similar ornamentation to each other. As in the Victorian fossil, the Troy specimen shows a distinct central area, although perhaps not so much in relief; it does not, however, afford any convincing evidence of gastro-genital pouches, although some irregular depressions on both the American specimens may indicate their position.

A. G. Mayer, in his "Medusae of the World" (5), does not refer to Hall's *Discophyllum peltatum*, when listing the fossil jelly-fishes, although he enumerates most of the species which have a claim to such origin. Incidentally we may note, however, that he accepts Walcott's interpretation of Torrell's fossil (*Medusina costata*), from the Lower Cambrian of Esthonia, as a probable *Aurellia*.

Occurrence and Age.

This fossil was found by Mr. R. Evans in the blue mudstone of the Silurian (Melbournian) series at Brunswick, north of Melbourne. It was very fortunate that it fell into the hands of a careful collector like Mr. Evans, who, by the way, had previously brought some very interesting fossils to the National Museum.

The bed in which this fossil was found is near the base of the clay pit, at a depth of about 100 feet. It is an exceedingly fine-grained mudstone, that has proved an ideal matrix for a delicate structure such as this. There is no difficulty, to my mind, why a soft body like a jelly-fish should have been preserved as a cast and impression in relief, for when the fine ooze settled down upon the gelatinous body, the latter would be sufficiently rigid to withstand complete pressure, and the succeeding layers would help to distribute the pressure over and away from that particular point. When once the matrix had been fairly compacted there would be no further compression. A noteworthy feature of the bed in which the fossil was found is its horizontality, or if folded, only in the slightest degree.

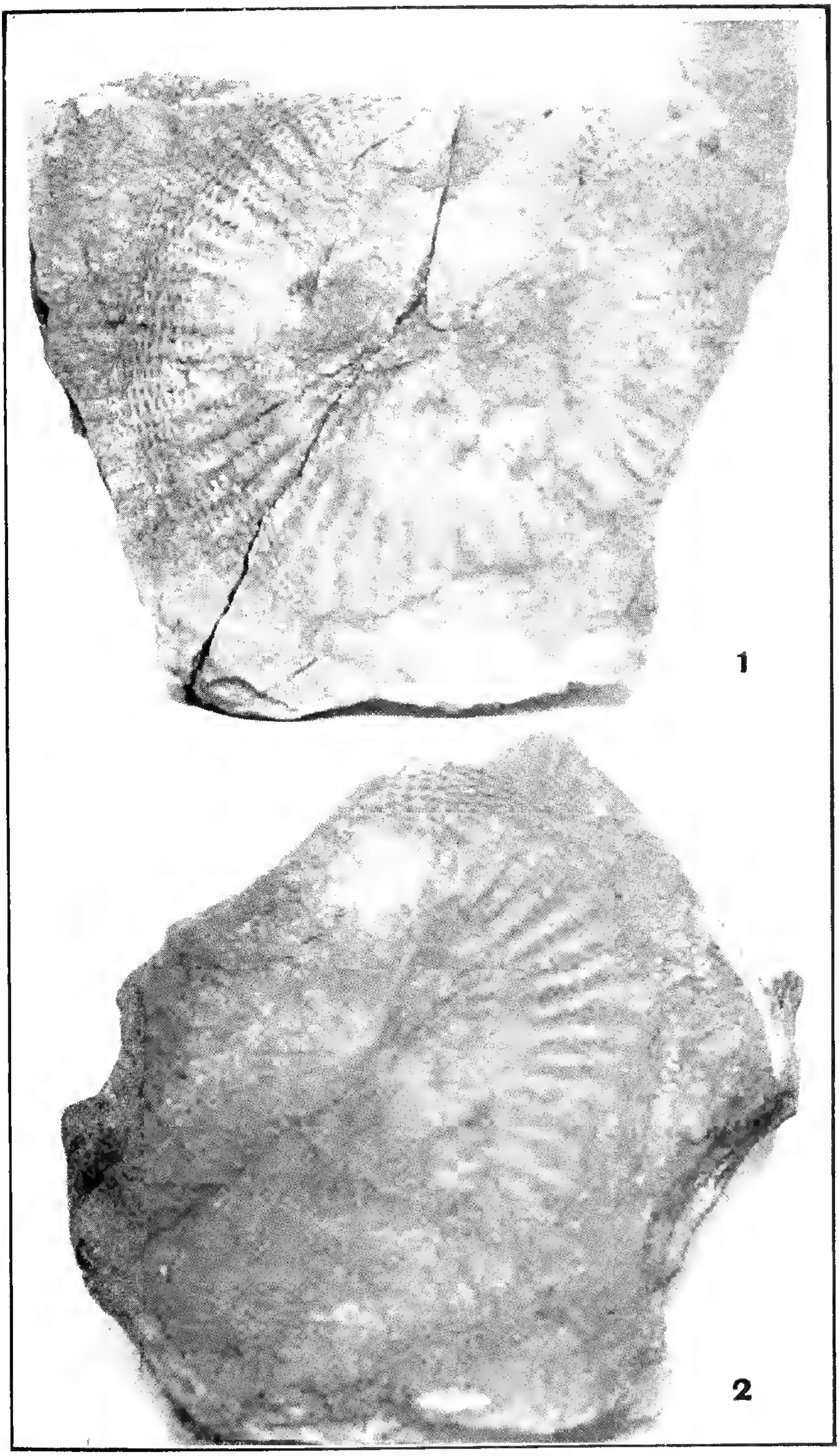
A face of the clay-pit shows 26 feet of Tertiary (Kalimnan) sand at the top, below which is the Silurian brown mudstone for about 45 feet. Beneath this, in the deepest part, is about 58 feet of blue mudstone and sandstone. It may be remarked that the upper brown bed is more typically Melbournian, and it is quite possible that the blue bed is one of the lowest zones of the Silurian yet reached. In this pit the stratification is almost horizontal, there being only a slight dip towards the boundary of the excavation, and at one end a dip of about 30°.

Associated Fauna and Flora.

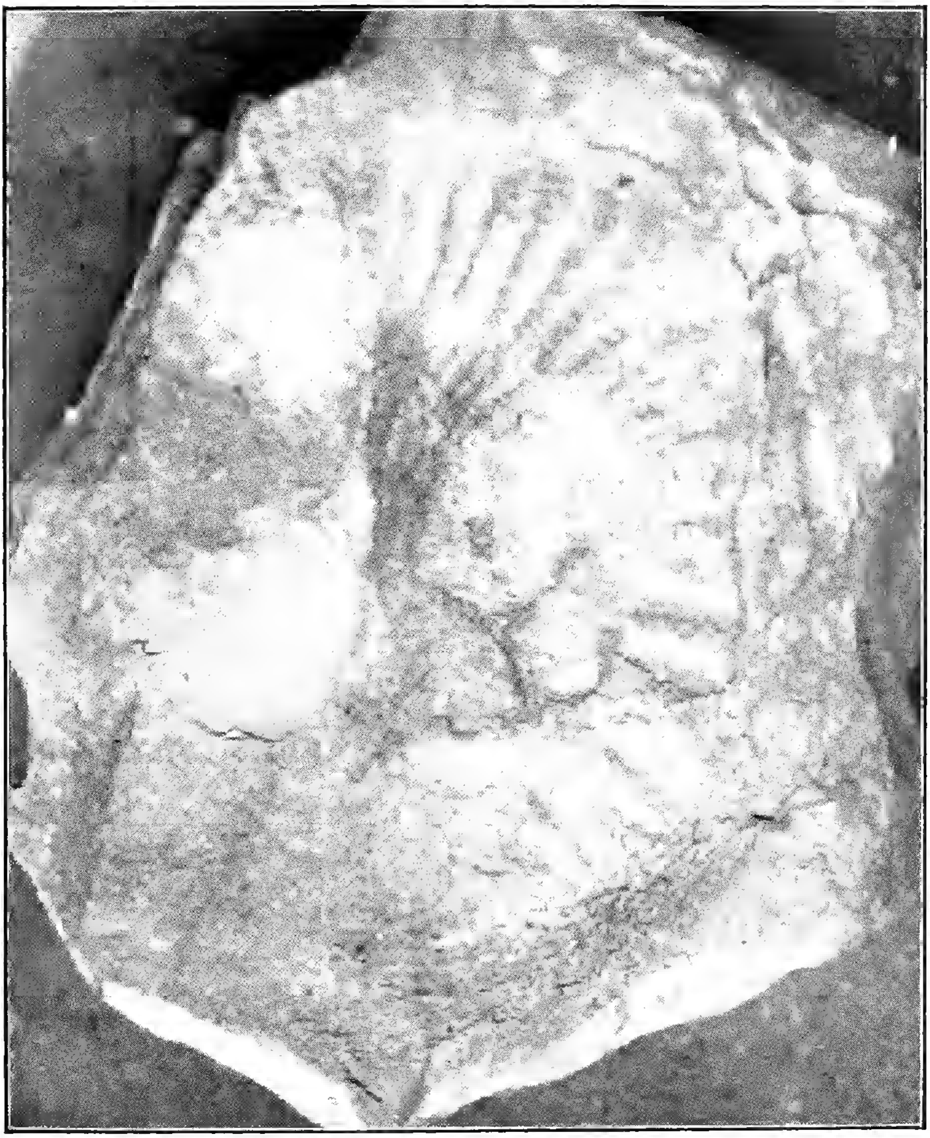
From a more sandy bed near the place where the jelly-fish occurred, there was obtained a beautiful specimen of the seaweed, *Bythotrephis gracilis* J. Hall. A description of this specimen is in course of publication, from the pen of Mr. A. J. Lucas. This well-known authority on algae is convinced of the true algal affinities of the fossil, and says that it differs very little from some forms found at the present day.

In other parts of the more sandy rock in this pit were found the remains of:—

Algae.	*Bythotrephis gracilis* J. Hall sp., and several other algae, not yet determined.
Brachiopoda.	*Camarotoechia* sp. *Nucleospira australis* McCoy.
Gasteropoda.	*Euomphalus* sp. *Bellerophon* sp. *Conularia* sp.
Cephalopoda.	?*Endoceras* sp. ?*Ooceras* sp.
Trilobita.	*Calymene* sp. *Encrinurus* sp.



F.C. photo **Discophyllum mirabile. Silurian. Victoria.** Circ. ⅔ nat. size.



F.C. photo. **Discophllyum mirabile. Silurian. Victoria** Circ. nat. size.

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2. J. Hall, Palaeontology of New York, i., 1847.
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4. C. D. Walcott. Fossil Medusae. *Mon. U.S. Geol. Surv.*, xxx., 1898.
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EXPLANATION OF PLATES.

Plate I.

Fig. 1.—*Discophyllum mirabile*, sp. nov. Holotype. Silurian. Hoffman's Clay-pit, Brunswick Circ. 2/3 nat. size.

Fig. 2.—*D. mirabile*, sp. nov. Paratype. Counterpart of Holotype. Silurian, Brunswick Circ. 2/3 nat. size.

Plate II.

D. mirabile, sp. nov. Paratype. Circ. nat. size.

[Proc. Roy. Soc. Victoria, 39 (N.S.), Pt. I., 1926.]

Art III.—*Distorted Pebbles from Goat Island, Tasmania.*

By E. J. DUNN, F.G.S.

(With Plates III.-VI.)

[Read 8th April, 1926.]

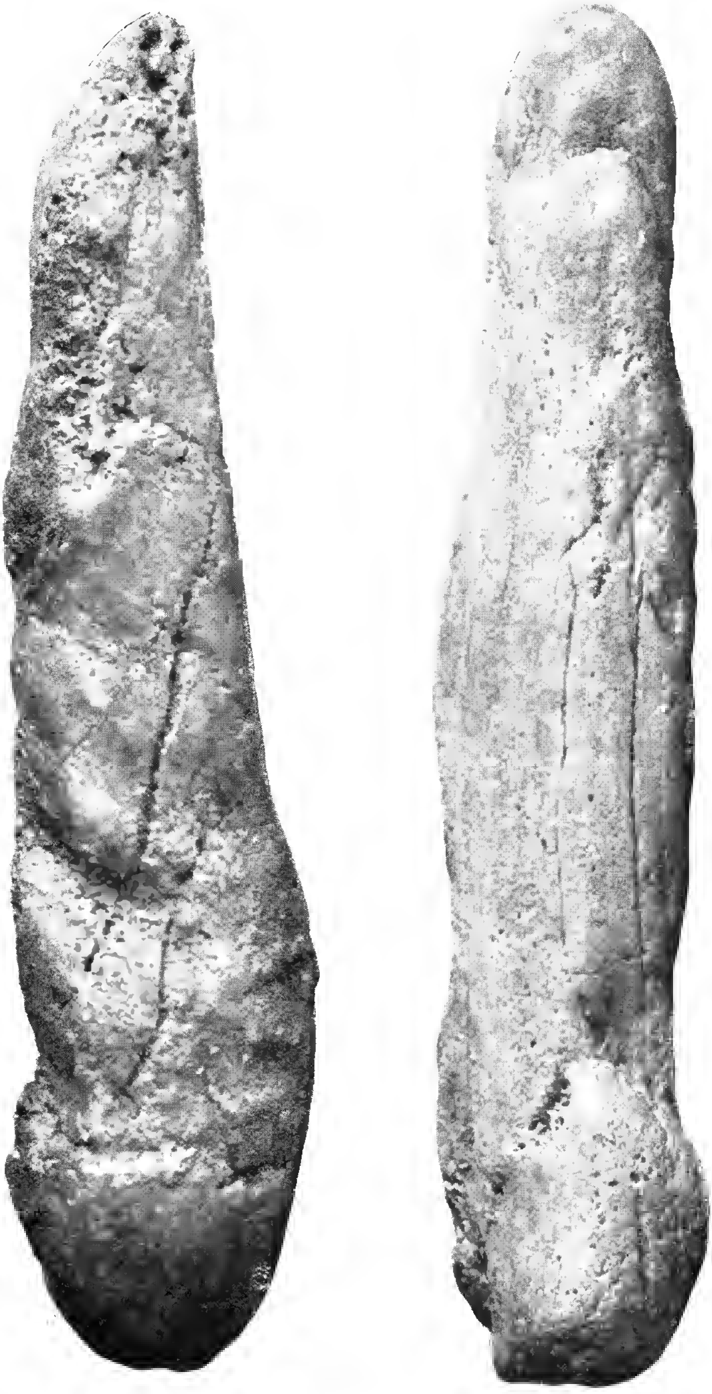
Near Ulverstone, on the North Coast of Tasmania, a small rocky peninsula juts out into the sea. At high water it becomes an island, known as Goat Island.

My attention was first directed to this locality by the late Mr. Twelvetrees, Government Geologist, who sent me a sample of the conglomerate. Since then I have visited the spot, where the conglomerate consists of quartz and quartzite pebbles of moderate size, embedded in a fine micaceous schist base. The only published reference to this locality that has come under my notice is in a paper by the late Mr. Twelvetrees, Government Geologist for Tasmania, entitled Outlines of the Geology of Tasmania, in Report of the Secretary for Mines for year 1908, published 1909, p. 118. Under the heading of Pre-Cambrian, locality Ulverstone and Forth, he states: "At the mouth of the River Leven, quartzitic and sericitic schists and schistose conglomerates, with beautifully stretched quartz pebbles, are well exposed along the beach eastward as far as Buttons Rivulet, where they are covered by basalt of Tertiary age, with a general strike of N.10°E.; and westward past Picnic Point to halfway across Barkworth's Bay, west of Goat Island, where their junction with the overlying Dundas and Leven Cambrians is hidden by a flow of lava. The striped slates and breccia a little further west appear with a strike of from N.15° to 25°W., showing their strongly unconformable position on the Algonkian schists The schistose conglomerates on Goat Island furnish classical examples of dynamically deformed pebble beds, the quartz pebbles being stretched into lenticles and narrow strips without fracture. The strike of the schists west of Goat Island ranges from N.12° to 30°E., with a north-westerly dip."

During the period the conglomerate has existed, it has been subjected to all manner of strains and stresses that have left their impress on the pebbles, as shown in the illustrations.

No. 1 is attenuated to probably more than twice its original length. It is flattened as well as elongated, showing that it has been subjected to both tension and compression. Length, $10\frac{1}{2}$ inches; breadth, 2 inches; thickness, $\frac{3}{4}$ inch.

No. 2 is a cylindrical pebble that has been elongated by tensile forces, but it has not been compressed like No. 1. On each end a small pebble of finer grained quartz is embodied. It was found



1 2

3

4

5

6

among some beach pebbles, and has been subjected to wave action since it was detached from its matrix. Length, 11 inches; thickness, 2 inches.

No. 3 is a flattened pebble that has been most affected by compression, and resembles the upper valve of an oyster shell. Length, 5 inches; breadth, 3½ inches; greatest thickness, 1 inch.

No. 4. Like No. 3, this pebble has been most affected by compressive forces. Length, 4¼ inches; greatest breadth, 2½ inches; greatest thickness, ¾ inch.

No. 5. This pebble does not appear to have suffered much deformation, except that it has been fractured and faulted. The exposed surface is covered with red lichen. Attached to the back of the pebble is fine micaceous schist matrix. Unlike the other pebbles, which are of quartz, this is of quartzite. Length, 6 inches; breadth 2¼ inches; thickness, 1½ inch.

No. 6. The feature in this pebble is the remarkable manner in which it has been torn apart. It does not appear to have been lengthened or flattened to any extent, but apparently tensile forces were so applied that fine fractures resulted, which have widened out to fissures, the widest of which is about ¼ inch. Within the fissures is a growth of small quartz crystals. Besides the actual tearing apart, there has been a little lateral displacement on the opposite sides of the fissures. Length, 5½ inches; width, 2½ inches; thickness, 2 inches.

[PROC. ROY. SOC. VICTORIA, 39 (N.S.), PT. I., 1926.]

ART. IV.—*Termites (Isoptera) from South Sea and Torres Strait Islands.*

By GERALD F. HILL.

(Entomologist, National Museum, Melbourne.)

[Read 13th May, 1926.]

The following notes and descriptions refer to a collection of Termites made by Mr. A. M. Lea during his entomological investigations in the South Sea and Torres Strait Islands in 1924.

Of the five species, representing three genera, obtained in Fiji, two are proposed as new, one is referred to a well-known Samoan species, one to a recently described (MS.) species contained in Dr. Buxton's Samoan collection, and one is indeterminable. So far as I am aware, there are no published records of Termites from Fiji. A number of immature *Calotermes* were obtained by Mr. Lea in New Caledonia, from which locality three species have been described previously (Holmgren, 1915). Rennel and Murray Islands, from which no Termites have been recorded previously, yielded one species of *Prorhinotermes* and one species of *Microcerotermes* respectively. The former is closely related to, if not identical with, the Samoan species *P. inopinatus* Silv., whilst the latter appears to be conspecific with a North Queensland species, the description of which is in course of publication in *Memoirs of the National Museum, Melbourne.* In each case the material is not sufficiently complete to enable a definite identification to be made.

The types of the new species and examples of the others are in the South Australian Museum; paratypes are in the National Museum, Melbourne.

CALOTERMES (?GLYPTOTERMES) TAVEUNIENSIS, n. sp.

Soldier.

Colour.—Head dark chestnut-brown, mandibles dark ferruginous, labrum, antennae, pronotum and legs buckthorn-brown, frons darker than labrum, but distinctly paler than remainder of head.

Head.—Long and narrow, parallel on the sides, broadly rounded behind; anterodorsal margin, except in middle, slightly elevated, frons concave and sloping to the base of the clypeus at an angle of 45 degrees; anterior one-third of head including frons and clypeus finely shagreened, remainder glabrous, with very scanty moderately large setae. Clypeus large, truncate in front, anterior half pale in colour, with a row of four setae. Labrum large, extending more than half way to the apex of the mandibles, convex and widest in middle, rounded at apex, with narrow impressed margin and a group of nine to twelve stout setae on anterior half. Antennae short and stout, extending very little beyond apex of mandibles, 10-jointed; 1st joint short and stout; 2nd about half as long as 1st, not much longer than wide; 3rd a little longer than 2nd, and narrower at base; 4th a little longer and stouter than 3rd; 5th to 9th a little longer than 4th and narrower at base, markedly swollen at apex; 10th much shorter and narrower than 9th. Gula long and narrow, with impressed lateral margins, the posterior half parallel-sided, widest part at anterior third, where it is a little less than two-thirds wider than narrowest part.

Pronotum.—Short and wide, as wide as head, broadly concave in front, narrowed slightly on the sides to the broad and faintly sinuate posterior margin, clothed with very scanty setae.

Legs.—Short and comparatively slender, with very few setae; claws small; spurs small and not serrate.

Abdomen.—Long and narrowed to the apex, the tergites with an apical fringe of minute pale setae and with very few long setae elsewhere.

Measurements.—

	mm.
Total length - - - - - - -	4·90 — 5·10
Head, with mandibles, long - - -	2·22 — 2·33
Head, without mandibles, long - -	1·65 — 1·71
Head, wide - - - - - - -	0·93
Head, deep - - - - - - -	0·85
Gula, at narrowest part, wide - -	0·45 — 0·57
Pronotum, long 0·51; wide - - -	0·91 — 0·97
Tibia iii. long - - - - -	0·68

Locality.—Fiji: Taveuni.

Described from three soldiers and several larvae; collected in May.

Allied Species.—Differs from *C.* (*?G.*) *perangustus* Hill (1926), *inter alia,* in having a much darker, smaller, and more setaceous head, relatively long and narrow labrum, different frons and reddish mandibles.

Calotermes (Calotermes) repandus Hill (MS.).

Mem. Nat. Mus. Melb., No. 7 (In Press).

A small colony comprising one dealated imago and several soldiers and workers, from Taveuni, Fiji, agrees very closely with the above species from Samoa. So far as comparison is possible, the imago differs only in its smaller size. The soldiers also agree very closely with the smaller examples of the Samoan species, from which they differ in having the head slightly darker and very little more setaceous, and the antennae 12- to 16-jointed

(13- to 15-jointed in *C. repandus*), As in the latter, some examples have the joints beyond the 5th or 6th relatively shorter and stouter than in others. The 3rd joint is not so well developed as in typical *Calotermes*, s. str., but it is more developed than is the case in any species of the sub-genus *Neotermes* known to the writer. Until more material is available for examination there would appear to be no reason to regard the Fijian insect as being distinct from the Samoan form.

Measurements of soldier—

	mm.
Head, with mandibles, long - - - - - -	4·00
Head, without mandibles, long - - - -	2·56
Head, wide - - - - - - - - -	1·71
Pronotum, long 1·14; wide - - - - - -	1·71

CALOTERMES (CRYPTOTERMES) ? sp.

Two damaged alate imagos from Viti Levu, Fiji (April) are very closely allied to *C. primus* Hill (from Townsville, N.Q.). The specific differences between imagos of the sub-genus *Cryptotermes* with markedly different soldiers are often difficult to detect.

CALOTERMES ? sp.

A series of larvae only from Noumea, New Caledonia, may be referable to one of the three species described by Drs. K. and N. Holmgren, in 1915, namely *C. rouxi*, *C. sarasini* and *C. canalensis*.

PRORHINOTERMES ? INOPINATUS Silvestri.

Die Fauna Südwest-Australiens, ii., 1909.

Soldiers and workers from Taveuni, Fiji, appear to be quite typical of the species originally described by Silvestri from Samoa, and more recently recorded from the Ellice Group (Hill, 1926). To the same, or a very closely allied, species also belongs a small colony found in a log on the beach on Rennel Island, Torres Strait. The soldier in this colony agrees with certain small sized examples in colonies collected recently by Dr. P. A. Buxton in the type locality, but the apterous adult king and queen differ from typical forms in their smaller size and paler colour, and in having a few very long setae on the thorax, and conspicuously long setae on each tergite of the abdomen. Until alate imagos are examined it cannot be stated whether these differences are specific or not. The genus comprises thirteen described species, all of which are more or less closely related and confined almost entirely in their distribution to islands within tropical and sub-tropical waters. Apart from the records referred to above, the only other references to the genus in the Australian Region is that of Snyder (1925), who described *P.*

manni and *P. solomonensis* from Santa Cruz Archipelago and Solomon Islands respectively. Both species are described in the soldier caste only, and are evidently closely allied to Silvestri's species. Many additional species or varieties will doubtless be discovered in the South Pacific Islands since their mode of life offers a ready means of dispersal by ocean currents.

Eutermes olidus, n. sp.

Soldier.

Colour.—Head and antennae hazel, rostrum and anterior half of pronotum chestnut, remainder of thorax and tergites of abdomen buckthorn-brown, legs somewhat paler.

Head.—Moderately short and deep, widest at posterior one-third and very little narrowed to the base of rostrum, the posterior half hemispherical in dorsal aspect, clothed with many rather short and stout reddish setae; rostrum a little less than one-third of the total length of head, wide at base. Antennae 13- or 14-jointed; 1st joint twice as long as wide, cylindrical; 2nd half as long as 1st, slightly narrowed at base; 3rd as long as 2nd but narrower; 4th to 6th equal, longer than 2nd and 3rd, or 3rd and 4th closely fused, the organ then appearing as 13-jointed, with 2nd joint shortest of all; 7th to 10th long and narrow, longer than 6th; 11th to 13th a little shorter than 7th to 10th; 14th as long as 13th, widest in middle, bluntly rounded at apex.

Pronotum.—Small, the anterior half bent up sharply, narrowed and deeply emarginate in the middle, the anterolateral angles narrowed, the sides sloping acutely to the obscurely emarginate posterior margin, the surface clothed moderately densely with long setae, as on abdomen.

Legs.—Of moderate length and stoutness, very setaceous.

Measurements.—

	mm.
Total length - - - - - - -	3·50 — 4·50
Head, long - - - - - - -	1·60 — 1·70
Head, wide - - - - - - -	1·08
Head, deep - - - - - - -	0·74
Antennae, long - - - - - -	1·80
Pronotum, long, 0·25—0·28; wide - -	0·61
Tibia iii, long - - - - - -	1·31

Worker.

Colour.—Head tawny-olive, somewhat paler on the sides and with large russet areas above on either side of the frontal suture; frontal and transverse sutures distinct, pale in colour; frons suffused with russet.

Head.—Large, a little longer than wide, widest across the middle, with rather scanty short setae; frons with a distinct impression on either side of the median line about midway between the transverse and clypeofrontal sutures. Postclypeus same colour as sides of head, small, about twice as wide as long. strongly convex, without distinct median suture, with three large and many minute setae on each side, the hindermost in the middle, the anteriormost in the anterolateral corner, and the third and smallest close to the latter on the inner side; anteclypeus nearly as long as postclypeus, markedly lengthened in the middle, a dark castaneous spot at the articulation of the mandibles. Labrum small, narrowest at base, widening to the anterior one-fourth, broadly rounded in front. Antennae 15-jointed; 1st and 2nd joints as in soldier; 3rd shortest and narrowest of all; 4th a little longer and wider than 5th; 3rd-6th usually more or less fused.

Pronotum.—As in soldier excepting that it is of uniform colour.

Legs.—Moderately long and slender.

Abdomen.—Large, moderately setaceous.

Measurements.—

	mm.
Total length - - - - - - - - -	6·00
Head, to apex of labrum, long - - - -	1·82
Head, to clypeofrontal suture, long - - -	1·08
Head, wide - - - - - - - -	1·53
Antennae, long - - - - - - - -	1·70
Pronotum, long, 0·45; wide - - - - -	0·80
Tibia iii, long - - - - - - -	1·60

Locality.—Fiji: Taveuni. Lea's No. 20844.

Allied Species.—The soldier appears to resemble most closely the Northern Territory species *E. longipennis* Hill, from which it is easily distinguished by its shorter rostrum, more setaceous head, thorax and body, longer 3rd antennal joint and deeply emarginate pronotum.

Microcerotermes ? taylori Hill (MS.).

Mem. Nat. Mus., Melb., No. 7 (in Press).

A few soldiers and workers of a small species of *Microcerotermes,* from Murray Island, Torres Strait, agree very closely with the above species (from North Queensland). Imagos are required for confirmation of this identification.

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[Proc. Roy. Soc. Victoria, 39 (N.S.), Pt. I., 1926.]

Art. V.—*New Australian Coleoptera, with Notes on some previously described Species, Part III.*

By F. ERASMUS WILSON.

[Read 8th July, 1926.]

PSELAPHIDAE.

Schistodactylus gracilis, n. sp.

♂ Flavous, in parts infuscated, this noticeably so on second, third, and apex of first dorsal segments of abdomen, and on the whole of undersurface, and less so on the three subapical segments of antennae; very sparsely clothed with a minute depressed pubescence.

Head subquadrate, with large, round, shallow punctures, evenly distributed, except on vertex and portion of base, where they become sparser and less clearly defined; with two small interocular foveae. Antennae with joint 1 cylindric, about equal to 2 and 3 combined, 2-8 gradually decreasing in length, 8 lightly transverse, 9 longer and much wider than 8, 10 strongly transverse, shorter than 9, 11 subovate, almost equal to the three preceding combined. Maxillary palpi with last segment furnished at apex with a spine and a shorter seta, together with a few fine hairs; sub-basal segment with spines of equal length. Prothorax about as long as wide, greatest width about apical third, thence gently rounded to base; puncturation as on head. Elytra strongly transverse, a little longer than prothorax, and with similar puncturation, but not so well defined; sutural striae entire, dorsal disappearing about middle, each arising in minute basal foveae. Abdomen about twice length of elytra, widest at apex of the large segment, at the base of this with a short longitudinal sulcus on each side. Metasternum lightly depressed, punctate. Prosternum with a small conical tubercule on either side, these surmounted with a long sharp seta. Anterior trochanters in middle, and anterior femora near base, armed with a long setigerous spine. Undersurface of abdomen lightly flattened along middle, subapical segment not interrupted in middle, apical segment with a fairly deep round fovea on its apical half.

Length, 1·75 mm.

♀ Similar, but without the abdominal fovea.

Habitat.—South Australia; Myponga (A. H. Elston). Sieved from moss.

This species is most closely allied to *foveiventris* Wilson (1, p. 124). It is however shorter, more slender, and lighter in colour, whilst its puncturation is a little more sparse, and much less coarse. It differs also in the conformation of the undersurface of its abdomen. In *foveiventris* the subapical segment only appears as a triangle on either side of the fovea, which is very large and cavernous. In *gracilis* the subapical segment is not interrupted in middle, and the fovea is much smaller and confined to the posterior half of the apical segment.

From *armipectus* Wilson (1, p. 123), it differs in its much more slender build (greatest width of *armipectus* 1 mm. and of *gracilis* 0·75 mm.), in its head not being impressed in front, in its more sparse, and much less coarse puncturation, in its shorter and more sparse clothing, and in its abdominal fovea being round and deep.

On the type specimen there are protruding two flattened claspers or forceps, very similar in form to those found in *Psalidura impressa* Boisd. of the Curculionidae.

In *Proc. Roy. Soc. Vic.*, n.s., xxxv. (2), p. 125, I commented upon the fact that each of the four described species of this genus had its habitat in a different State. The addition of this new insect from South Australia fills another gap, and leaves only Queensland without its representative. As, however, that State has up to the present been very imperfectly prospected for Pselaphidae, it is possible that a member of the genus may yet be discovered there.

Type in author's collection. Co-types in Elston's Collection.

NARCODES TERMITOPHILUS, n. sp.

♂ Dark castaneous, but mottled in appearance, due to the bicolouration of clothing; legs and antennae a little lighter; palpi lightly ferrugineus; clothing dense, squamose, mostly cream-coloured, but in places notably prothorax, blackish, this clothing becoming more subsquamose on first two or three joints of antennae, the other joints of which are furnished with somewhat short semidecumbent hairs.

Head lightly transverse, with disc raised, and precipitous sides, these from region of eyes to base becoming widely explanate, maximum width across base of eyes, where there is a rounded projection on the lateral border, sides behind projection gently arcuate to base, in front much constricted, and gently decreasing in width to apex; with a wide depression between antennal tubercles and two large shallow interocular foveae; with dense and somewhat coarse puncturation much concealed by clothing. Antennae thin, passing intermediate coxae, basal joint moderately stout, subcylindric, 2 oval, much shorter, 3-7 elongate, 3 nearly twice as long as 2, and a little longer than 4; 4, 5 and 7 subequal, 6 a little shorter, 8 about one half as long as 7, 9 equal in length to 8 but wider, 10 about as long as wide, 11 subovate, as long as the two preceding; the last three segments forming a somewhat inconspicuous club; palpi with joint 4 inserted near summit of swollen portion of joint 3. Prothorax, including lateral projections, about as wide as long, sides furnished at about apical fourth with a tubercular projection or tooth; from middle to base gently arcuate; with a shallow medio-basal impression, and puncturation as on head. Elytra short, about one-third wider than long, sides evenly rounded, apical margin of each elytron lightly produced near outer angle; dorsal striae widened basally and traceable to about apical fourth; with two somewhat prominent eminences near humeral angles; surface densely and rather coarsely nodular. Abdomen much wider than elytra, first and second segments widened posteriorly, third parallel sided, others decreasing in width, beyond second strongly declivous, surface much as on prothorax. Undersurface densely punctate. Metasternum raised and widely and somewhat deeply excavated. Abdominal segments only slightly flattened. Legs moderately long. Anterior trochanters armed in front with a somewhat flattened protuberance, this at its summit, bluntly dentate exteriorly. Anterior femora each with a minute tubercle near base. All tibiae curved apically.

Length, 4 mm.

♀ Differs in being much larger (4·5 mm.), and in having the undersurface of abdomen a little more convex.

Habitat.—Western Australia; Mundaring (J. Clark). Four males and one female taken in a colony of *Microcerotermes newmani* Hill MS.

This species is the largest of the known *Narcodes*, the only one approaching it in size being *crassus* Oke (2), the measurements given for which are 3·25—3·35 mm. It may, however, be readily differentiated from that species, among other things by its metasternum not being furnished with a lamelliform protuberance and in the undersurface of its abdomen not being excavate.

For the determination of the Termite host of this species I am indebted to my friend Mr. Gerald F. Hill, Entomologist of the National Museum, Melbourne.

Type in Author's collection.

Narcodes gramenicola, n. sp.

♂ Dark castaneous, prothorax, abdomen in parts, and antennal club, infuscated; palpi flavous; upper surface with clothing moderately dense, squamose, mostly whitish, but in parts fuscous; undersurface with a fairly long whitish adpressed subsquamose vestiture, this noticeably longer at apex of each abdominal segment.

Head including eyes, lightly transverse, raised on disc, with two shallow interocular foveae, and a large median impression in front, extending to front margin; hind angles produced; basal margin arcuate inwardly; with a coarse shallow round puncturation; antennae passing a little intermediate coxae, joint 1 cylindric, viewed from above not much longer than 2, but broader, 3 narrower and longer than 2, 4-7 subcylindric, shorter than 3, 8 much shorter than 7, about as long as broad, 10 strongly transverse, 11 widely and bluntly ovate longer than the two preceding combined. Prothorax transverse, anterior angles produced, posterior wanting, base rounded, sides each with a projection at about apical third, in front and behind these projections lightly arcuate; disc raised; with a shallow medio-basal fovea much obscured by clothing, and an impression on each side; with puncturation as on head. Elytra short, strongly transverse, sides gently rounded, with sutural and discal striae, the latter terminating at about apical third, surface much raised between dorsal and sutural striae, and with a prominent eminence near humeral angles; with puncturation much less clearly defined than on prothorax. Abdomen nearly twice as long as elytra; puncturation as on elytra; its ventral surface strongly flattened, and with a wide shallow excavation on ultimate segment. Metasternum widely and deeply excavate, with a prominent lamelliform protuberance immediately behind each intermediate coxa, these protuberances lightly deflected backwards and slightly overhanging the excavation. Anterior trochanters with a flattened projection in front, this bidentate. Legs with femora strongly inflated, but constricted before apex, the anterior ones each with a minute tubercle near base. Tibiae curved, bluntly spurred apically. Length, 3 mm. (*vix*).

♀ Similar, but with undersurface of abdomen not flattened, metasternum much less strongly impressed, and with no protuberances behind intermediate coxae.

Habitat.—South Australia; Mount Remarkable (F. E. Wilson and A. M. Lea). Sieved from grass tussocks.

The prominent lamelliform projections behind the middle coxae serve to easily distinguish this species from all other described species of the genus. *Crassus* Oke has its metasternum with a lamelliform projection, but in this case it is located between the posterior coxae.

Type in Author's collection.

Schaufussia mona, n. sp.

♂ Dark reddish castaneous, nitid; elytra except at extreme base and tips, and appendages, a little paler; clothed with rather short semidecumbent yellowish pubescence.

Head moderately long, broad, coarsely and frequently punctate, basal angles widely rounded, rather strongly constricted before eyes, vertex in front suddenly declivous, in centre of declivity with a bunch of golden hairs reaching across to antennal tubercle; with three shallow but sharply defined interocular foveae placed just at edge of declivity, the centre one very large, transverse, broadly rounded, the outer ones small, rounded, and each emitting from its centre a long and strong seta, these directed a little forward; antennal tubercle moderately wide at base, strongly elevated and directed a little backwards, its sides notched about middle, and its apex broadly rounded and almost reaching the level of vertex. Antennae moderately stout, reaching intermediate coxae, joint 1 cylindric, not quite equal to 2 and 3 combined, 2 cylindric, 3 lightly obconic, 4, 5, 6 cylindric, 2-5 subequal in length, 6 a little shorter, 7 quadrate, 8 a little shorter and a little broader than 7, 9, and 10 trapezoidal, longer than 8 and increasing in width, 11 irregularly ovate, truncated at base, bluntly pointed, a little longer than the two preceding combined. Palpi with second joint pedunculate on basal half and strongly swollen on apical half, its swollen portion dilated internally, third joint shorter, not so stout, fourth as long as third but a little narrower, thin at base, lightly dilated internally, and minutely truncated at apex. Prothorax about as long as broad, broader than head, convex, no medio-basal fovea, sides widely rounded, puncturation coarse and frequent. Elytra lightly transverse, sides evenly rounded, gently narrowed to base; dorsal striae feeble, barely attaining middle of elytra; puncturation similar to that on prothorax but not so conspicuous. Abdomen a little narrower than elytra, strongly depressed beyond first dorsal segment, which is longer than the rest, and which exhibits two feeble basal carinules enclosing a little more than a half part of the base, these difficult to see owing to a fringing effect of the pubescence on the elytral tips; puncturation much as on elytra. Metasternum widely and shallowly excavate, and ventral segments of abdomen slightly flattened along middle. Feet elongate. Anterior and intermediate femora a little more robust than posterior, the anterior armed with a small blunt tooth towards their bases. Four front tibiae rather strongly curved, hind almost straight. Anterior trochanters strongly produced over almost their entire width into a subparallel sided, square ended, plate; intermediate trochanters angularly produced.

Length, 2 mm. (*vix*).

♀ Unknown.

Habitat.—Victoria; Warrandyte (F. E. Wilson). Two examples sieved from moss.

Of the two species assigned to the genus *Schaufussia*, viz., *formosa* King (3), and *nasuta* Raff. (4), this insect comes nearest to the latter. From the former it differs in its strongly elevated antennal tubercle, different arrangement of interocular foveae, its very much more uniform, and more sharply defined puncturation, its more dense clothing, its much shorter and less well defined dorsal striae, etc. From the latter among other things, its elevated antennal tubercule, interocular foveae, and differently armed front trochanters, clearly define it.

Type in Author's collection.

PSELAPHUS STRIGOSUS, n. sp.

♂ Head and prothorax very dark castaneous, the rest much paler; very sparsely clothed with pale moderately long pubescence, this on elytra most noticeable at sides, and arranged in lines; elytral tips not fringed.

Head lightly elongate, not much narrower before than behind eyes; median groove not sharply defined, wide and shallow, widely open in front, and somewhat indistinctly carried back to neck; bigibbous and bifoveate between eyes, the foveae small, round, and placed beneath the gibbosities; the whole coarsely longitudinally strigose. Antennae passing a little middle coxae, club moderate. Palpi with fourth joint strongly arcuate, its club a little more than one-third total length of joint. Prothorax about as wide as long, sides lightly arcuate before base and apex; transverse furrow wide, not interrupted in middle and laterally not terminating in a small round fovea; the whole coarsely longitudinally strigose as on head, except behind furrow, where the strigosity is much finer and more or less transverse. Elytra transverse, sides evenly rounded; apex almost straight; suture not raised, with four striae on each elytron, one sutural, two parallel dorsal, and one diverging extra-dorsal; all except sutural terminating at apical declivity. Abdomen with first segment long, longer than the rest combined, and wider than elytra. Prosternum and metasternum more or less strigose. Second ventral segment of abdomen with a shallow longitudinal impression from base to near apex, and metasternum indistinctly impressed on disc. Legs with femora moderately stout, and hind tibiae rather strongly curved near apex.

Length, 2 mm. (*vix*).

♀ Differs in having undersurface of abdomen convex.

Habitat.—South Australia; Myponga (A. H. Elston). Sieved from moss.

This very fine species is one of the prizes obtained by my friend Mr. Elston, who, like myself, had devoted much time to the examination of mosses and tussocks. In all he secured ten examples—three males and seven females.

Its strigose head and prothorax render it one of the most distinct of the genus, as up to the present no other Australian species has been described having similar sculpture. The hairs, particularly on the elytra and abdomen, are strongly curved just before their apices.

Type in Author's collection. Co-types in collection of A. H. Elston.

Pselaphus niveicola, n. sp.

♂ Nitid, castaneous, palpi paler; sparsely clothed with moderately long, suberect, black, curved hairs; these arranged in lines on the elytra. Disc of metasternum, and base of abdomen ventrally, with short pale fasciculate clothing.

Head elongate, rather strongly attenuate before eyes; median longitudinal groove terminating between eyes, shallow, its sides in front suddenly converging and almost meeting; with two large rounded interocular foveae, these placed close to the hind margin of each eye; vertex convex; palpi with fourth joint of moderate length, strongly bent, its club somewhat exceeding one-third of its total length. Prothorax as long as broad, equal in length to head, maximum width at middle; transverse furrow except in centre, shallow, strongly interrupted in middle by a carinate sided longitudinal fovea, and terminating at each side in a roundish fovea; these rounded lateral foveae however are each connected with an irregular shallow longitudinal depression reaching back to the base of prothorax. Elytra lightly transverse, rather strongly narrowed to base, humeral angles acute, apical declivity naked and minutely striolate; the whole of base occupied by four deep longitudinal fossae, these becoming more and more shallow as they recede towards apex; inner fossa on each elytron bounded by the raised suture and a sharp-edged flattish-topped carina, occupying position of dorsal stria, outer bounded by this carina and another sharper one, near the lateral margin; outer edge of dorsal carina traceable to just beyond apical declivity, bent. Abdomen very much depressed beyond first segment, this very long, exceeding the rest combined. Metasternum much raised, shallowly excavated on disc, excavation narrowed to base. Second ventral segment of abdomen with a large, oval, longitudinal excavation extending from base to apex. Legs with femora robust, their surface at base beneath, scaly. Tibiae lightly arcuate, swollen on apical halves, each with an indistinct longitudinal channel, and carinate outer edge.

Length, 2·5 mm.

♀ Unknown.

Habitat.—Victoria; Mount Feathertop, altitude 6200 feet. Sieved from tussocks of snow grass kindly collected for me at the summit, by my friend, Mr. Chas. Barrett.

In Raffray's table, *Proc. Linn. Soc. N.S.W.*, xxv. (2), p. 194, this species would be associated with *pilosus* Raff. (5, p. 201), and *longcpilosus* Schaufuss (6). From the former it differs amongst other things in its non-tuberculate head, and from the latter, its carinated elytra serve to distinguish it. From *villosus* Lea (7, p. 750), it may be separated by reason of its more sparse clothing, its greater size, and by its median cephalic groove being almost closed in front. From *bryophilus* Lea (7, p. 751), the latter two characters also serve to differentiate it. *Foveiventris* Lea (7, p 748) is certainly allied to it, but in that insect the clothing is very different.

Type unique, in Author's collection.

Pselaphus metasternalis, n. sp.

♂ Reddish castaneous, palpi slightly paler; somewhat sparsely clothed with moderately long, pale pubescence, this where present on elytra arranged in lines; elytral tips not fringed. Undersurface with a narrow strip of pearly, subsquamose clothing on each side of mesosternum in front, and on base of abdomen; sides of metasternal and abdominal excavations fringed with pubescence, elsewhere more or less sparse.

Head elongate, median channel deep, moderately wide, and terminating between the eyes, where it becomes widened; with two small round interocular foveae. Antennae reaching about middle coxae, all joints elongate, ninth narrowly ovate, tenth wider but a little shorter, and eleventh equal to the two preceding, ovate acuminate. Palpi thin, about equal in length to antennae, fourth joint arcuate, its club a little more than one-third of its total length. Prothorax about as broad as long, greatest width in advance of middle, sides rounded; transverse furrow terminating in a small round fovea at each side, and lightly interrupted in middle by a minute carinate-sided fovea; surface behind furrow smooth. Elytra slightly broader than long, each elytron with a sutural and dorsal stria, these foveate basally. Abdomen wider than elytra. Metasternum with disc widely and deeply impressed from base to apex, this impression narrowed to middle coxae, and having its greatest width about middle, becoming increasingly deepened as it approaches hind coxae. Undersurface of abdomen with first, second, and ultimate segments, longitudinally impressed, impression on second segment widely oval, that on ultimate segment shallow and not very distinct.

Length, 2·3 mm.

♀ Similar but with metasternum convex, though somewhat depressed posteriorly, and with undersurface of abdomen convex.

Habitat.—Victoria; Mount Donna Buang, 4080 feet (F. E. Wilson). From tussocks of snow grass.

This species seems to fall nearest to *crassus* Raff. (5, p. 200). The author of that species does not state the sex of his type, though from the description, it seems probable that it is a female. *Metasternalis*, however, differs from the description of that species in having its head not bigibbose between the eyes, and in the proportional sizes of its antennal joints. From *elongatus* Raff. (5, p. 200), it may be distinguished by its larger size, in having its palpi not nearly straight, and in having the extreme base of its prothorax not minutely reticulated.

Mr. A. M. Lea states in *Proc. Roy. Soc. Vic.*, xxiii., p. 154, that in the male of *tuberculifrons* Raff., the metasternum is impressed, and that the impression is carried over on to the large segment of the abdomen, but the prominent interocular tubercles of that species, apart from anything else, preclude possibility of confusion with *metasternalis*. The metasternal impression of the latter species is indeed pronounced, and no described Australian species approaches it in this respect.

Type in Author's collection.

Pselaphus elstoni, n. sp.

♀ Reddish castaneous, palpi noticeably paler; uniformly clothed with moderately long pale pubescence; elytral tips fringed with blackish setae; with an oval patch on each side of mesosternum in front, and a narrow band on extreme base of abdomen dorsally and ventrally, of pale squamose clothing.

Head short and broad, slightly longer than wide; eyes very prominent and placed a little behind middle; median channel somewhat narrow and deep, widened between eyes, and continued back to neck; with two small round interocular foveae placed a little further from eyes than usual. Antennae moderately long, thin, joint 1 stout, wider than 2, which in turn is wider than 3, but of about equal length, 4-8 subequal, 10 a little longer and wider than 9, 11 about one and one-half longer than 10. Palpi not quite so long as antennae, fourth joint lightly arcuate, its club occupying a little more than half its total length. Prothorax of equal length and breadth, greatest width a little in advance of middle, sides lightly arcuate to base and apex; transverse furrow well defined, terminating at each side in a small round fovea, and interrupted in middle by an oval longitudinal sulcus, this carinate at sides, where it intersects the transverse furrow; surface behind transverse furrow smooth. Elytra lightly transverse, sides gently rounded, almost straight across apex, suture very little raised, each elytron with dorsal and sutural striae. Abdomen very little wider than elytra. Metasternum and ventral surface of abdomen strongly convex.

Length, 1·75 mm.

Habitat.—South Australia; Mount Lofty Ranges (A. H. Elston). Two examples taken in ants' nests. Hosts, *Iridomyrmex nitidus* and *Chalcoponera metallicum.*

This species is most closely allied to *mundus* Sharp (8), but differs from the description of that species in the following details. The channel on disc of head is not indistinct, the clothing is certainly not sparse, and the transverse furrow on prothorax is not entire. Otherwise it has much in common with that beetle.

Type in Author's collection.

Pselaphus otwayensis, n. sp.

♀ Reddish castaneous, tarsi and palpi a little paler; clothing consisting of fairly long, pale semi-decumbent pubescence, this sparse, and mostly confined to abdomen and sides of head, and a very short, dense subsquamose pubescence on dorsal and ventral surfaces of abdomen at base, on mesosternum at apex, and on apical declivity of elytra, except at outer edges.

Head rather broad and of moderate length; median channel a little narrowed in front but continuing back to neck, although considerably widened and somewhat interrupted between eyes; with prominent interocular tubercles, these somewhat hollowed out on their internal sides. Eyes prominent, placed centrally. Surface on either side of median excavation between tubercles, and base of head irregularly and shallowly, transversely sulcate. Antennae moderately long, joint 1 viewed from above equal to 2 and 3 combined, 3-8 subequal, a little narrower than 2, 9 and 10 longer and increasingly wider, their combined length equal to 11, which is subovate. Palpi of moderate length, fourth joint strongly curved, its club about equal to one-third of its total length, and furnished with an indistinct longitudinal sulcus. Prothorax very little wider than head including eyes, about as long as wide, maximum breadth in front of middle; transverse sulcus very wide, strongly arcuate and in places deep, lightly interrupted in middle by two minute carinae, and terminating at each side in a small round fovea, these latter situated in a wide sulcus running back to base of prothorax; surface behind transverse sulcus finely reticulate. Elytra wider than long, sides gently rounded from base to apex, sutural and dorsal striae moderately distinct, the latter on about basal third being represented by a broad, lightly raised, flat topped ridge, formed by the backward prolongation of the basal fovea, of which there are two on each elytron. Abdomen length of elytra, strongly depressed beyond first segment. Metasternum strongly convex. Ventral surface of abdomen convex and its second segment longer than the sum of the succeeding ones.

Length, 2·5 mm.

Habitat.—Victoria; Lorne, in moss (F. E. Wilson).

This *Pselaphus* apparently approaches nearest to *tuberculiventris* Lea (7, p. 749), and *longifrons* Raff. (9). From the description of the former it may be distinguished by reason of its very evident interocular tubercles, in having its cephalic surface on either side of median excavation sulcate, in its lack of dense white pubescence on apex of prosternum and middle of neck, in its abdomen not being longer than elytra, and in its elytra possessing four basal foveae. From the description of *longifrons* to which it appears most closely allied, it may be differentiated by the different shape of the apical joint of its antenna, in the possession of lateral longitudinal foveae on its prothorax, in its elytra, being not longer than broad, and in having four and not two basal foveae.

Type unique, in Author's collection.

PSELAPHUS BIARMATUS, n. sp.

♂ Castaneous, feet and palpi paler, with pale, moderately long subdepressed pubescence, this on elytra rather sparse and arranged in lines, on abdomen more frequent and evenly distributed, on prothorax sparse, and mostly confined to the sides; clothing of undersurface shorter, and most conspicuous on sides and apex of metasternal excavation, on sides of the excavation on second segment of abdomen, and where it forms a broad longitudinal line on ultimate segment; base of abdomen ventrally, narrowly clothed with a moderately thick, short subsquamose vestiture.

Head with median groove wide, dilated towards its termination between eyes; vertex convex and almost same width as apical extremity; eyes placed slightly behind middle; with two somewhat obsolete interocular elevations or tubercles; undersurface, on either side in region of eyes, armed with two strong outwardly deflected spines. Palpi rather long, fourth joint with club occupying about one-third of its total length, first joint armed at apex with a long bluntly pointed spine. Antennae with first joint much wider than second, and about equal in length to second and third combined, second lightly wider than third, all joints longer than wide, apical joint subovate, acuminate. Prothorax lightly longer than wide, widest slightly in advance of middle, with transversal impression well defined and strongly arcuate, this obsoletely interrupted in middle by two minute carinules, and terminating at the sides in a small roundish fovea. Elytra almost as long as wide, apical declivity naked and minutely striolate, dorsal striae strongly bent and terminating at beginning of apical declivity, bordering either side of the dorsal striae particularly on basal half, the elytral surface is somewhat raised thus forming two longitudinal ridges; also on apical half of elytra, midway between dorsal striae and lateral margins there are faint indications of still another stria on each elytron. Metasternum widely and deeply excavate. Abdomen with second ventral segment longitudinally excavate, apical segment with its surface minutely striolate and with an inconspicuous impression near its termination.

Length, 2 mm.

♀ Unknown.

Habitat.—Victoria; Belgrave, in moss (F. E. Wilson). Ferntree Gully (C. Barrett).

The armature of the undersurface of the head, and of the palpi, render this species by far the most distinct of any *Pselaphus* so far described from Australia.

Some entomologists might consider that this insect by reason of the armature of its palpi, should have a genus to itself, but apart from this matter of armature it is a typical *Pselaphus,* and I do not consider that any good purpose would be served by isolating it.

Type in Author's collection.

PSELAPHUS GEMINATUS Westw.

(Trans. Ent. Soc. Lond., 1856, p. 273, t.16, f.9.)

Habitat.—South Australia; Myponga, in nest of a small ant, *Iridomyrmex* sp. (A. H. Elston).

TYROMORPHUS VICTORIENSIS, n. sp.

♂ Dark reddish brown, but prothorax and joints 7-10 of antennae tinged with black, palpi and eleventh joints of antennae flavous; with moderately long pale semidecumbent pubescence.

Head, including eyes, about as wide as long, sides behind eyes evenly rounded to base, in front of eyes rather strongly narrowed to apex; somewhat widely-impressed between antennal ridges, and with two small but rather deep interocular foveae; with large round shallow punctures densely and evenly distributed. Antennae reaching about middle coxae. Joint 1, long, cylindric, about equal to 2 and 3 combined, 2 about equal in length to 3 but thicker, 3 to 8 slightly decreasing in length, 9 about twice as long and nearly twice as wide as 8, 10 transverse, 11 subovate, longer than the two preceding combined. Palpi long, second joint much swollen on its apical half, third about one-half length of second, fourth about twice as long as broad, somewhat excavated at base for the reception of third when folded back upon it, and bearing a longitudinal groove bordered by a carinate ridge, this latter only visible from some directions when palpi are extended, apical truncature of segment bearing a seta. Prothorax approximately as long as wide, widest about apical third, wider at base than apex, sides evenly rounded from apex to position of greatest width, thence almost straight to base; with a small round medio-basal fovea, and puncturation as on head. Elytra transverse, fairly convex, shoulders prominent, sutural striae entire, dorsal wide, and deep basally, and traceable to beyond middle; pucturation much less distinct than on prothorax. Abdomen with first and second dorsal segments subequal in width, the latter much shorter than the former, strongly depressed beyond second segment; first segment with a rather inconspicuous longitudinal impression on either side towards lateral border; ventral surface with a wide shallow impression commencing at base of second segment, and continuing to the apex of abdomen, apical segment strongly produced in middle. Metasternum widely and deeply excavate and with a well defined median longitudinal sulcus. Legs moderately long. Intermediate trochanters at base produced into a strong subtriangular tooth, posterior with a rounded projection or tooth in like location. Femora moderately stout, rather strongly constricted near apex. All tibiae curved from just beyond middle, this much more apparent on hind tibiae.

Length, 3 mm.

♀ Similar, but no armature on trochanters, ventral surface of abdomen convex and not strongly produced apically, and tibiae much less strongly curved.

Habitat.—Victoria; Beaconsfield (F. E. Wilson). Bacchus Marsh (C. Oke). Ferntree Gully (F. E. Wilson and Ejnar Fischer).

This species is fairly abundant and may usually be found beneath logs or stones in damp situations. It bears rather a strong superficial resemblance to *mastersi* Macl. (10), but may be easily distinguished from that species by the possession of armed trochanters. From *flavimanus* Lea (11), it differs by being larger, in its possession of armed trochanters, in its pubescence being not short and in its coarser puncturation.

In Raffray's table of species, *Proc. Linn. Soc. N.S.W.*, xxv. (2), p. 227, it would be associated with those species falling under the heading "Entirely punctate." A female from Bacchus Marsh collected by Mr. Oke apparently is referable to this species, but differs in having its antennae unicolorous and in its prothorax not being tinged with black.

Type in Author's collection.

Tyromorphus tibialis, n. sp.

♂ Dark reddish castaneous; head, abdomen and four apical joints of each antenna black or blackish, rest of antennae, palpi and legs light reddish-brown; the whole nitid; very sparsely clothed with short, pale, semidecumbent pubescence.

Head lightly broader than long, truncate in front, before eyes, lightly narrowed, behind, widely rounded to base; with two small interocular foveae, and a few scattered punctures. Palpi with second joint subtriangularly produced within, apical segment furnished with a moderately strong seta at summit. Antennae rather long, joint 1 as long as 2 and 3 combined, 2 subcylindric, 3-6 subequal and a little shorter than 2, 7 slightly wider than 6, 8 obconic, shorter than 7. 9 obconic, about one and one half times wider and longer than 8, 10 transverse lightly wider and shorter than 9, 11 subovate, equal in length to the sum of the three preceding joints. Prothorax about as wide as long, sides evenly rounded to their widest part situated about apical third, thence lightly arcuate to base; with a basal fovea, and puncturation much as on head. Elytra transverse, shoulders raised, sutural striae entire, dorsal traceable to about apical fourth, both sutural and dorsal striae widely and deeply impressed at their bases; with puncturation as on prothorax. Abdomen longer than elytra, very convex and depressed towards apex, first segment with a very short carina on either side. Undersurface of abdomen lightly impressed on disc. Metasternum widely and deeply impressed. Front trochanters in middle and front femora at base, armed with a short acute spine, each spine surmounted with a little bundle of setae; middle trochanters armed with a flattened protuberance, this rounded at apex. Femora moderately robust. Tibiae strongly sinuate on apical halves, the intermediate thickened to about middle, where they are furnished with a short tooth, their apical extremities also bluntly produced internally.

Length, 2 mm.

Habitat.—Victoria; Warburton, in flood debris (F. E. Wilson).

Raffray divided the Australian species of the genus *Tyromorphus* into two sections—(1) Entirely punctate, (2) Entirely smooth. This species belongs to the second section, and it appears to be somewhat closely related to *laevis* Raff. (5, p. 232), the male of which Mr. A. M. Lea tells us in *Proc. Linn. Soc. N.S.W.*, 1911, p. 452, has the intermediate tibiae dentate in the middle. It may, however, be differentiated from that species by reason of its armed intermediate trochanters, carinated first dorsal segment of abdomen, and by its smaller size.

Type in Author's collection.

Hamotopsis metasternalis Lea.

(Proc. Linn. Soc. N.S.W., xxxvi. (3), p. 454.)

Mr. Lea in his notes at the end of the description of this species states that on the type there is, on the apparent first dorsal segment of abdomen, a very narrow longitudinal carina, but as it is slightly oblique and not exactly median it may possibly not be typical. Before me are three specimens of this species collected by myself at Mount Lofty, South Australia, from nests of the ant *Amblyopone australis* Er. I find that in all of them the carina mentioned by Mr. Lea is present, but is median, and is continued to the apex of the apparent second segment. A specimen in the collection of Mr. A. H. Elston, also from the same locality and same host, has the carina placed centrally, but in this case it traverses little more than half of the apparent first segment. It therefore appears that this carination is a somewhat variable character in this species.

Tmesiphorus formicicola, n. sp.

♂ Reddish castaneous, elytra and palpi paler; moderately clothed with a pale, very short, decumbent pubescence, and with a prominent fascicle of golden hairs on either side of head at base.

Head about as broad as long, front impressed longitudinally between antennal ridges, with two not very prominent interocular foveae, and with a conical fascicle-clad tubercle behind each eye; with dense rounded punctures becoming somewhat rugose towards front; antennae long, reaching about middle of elytra; joint 1 cylindric, longer than 2 and 3 combined, 2 slightly broader than 3, 2-7 subequal in length, 8 shorter, 9 longer than 8, 10 shortest of all, 3-10 of equal width, 11 which alone forms the club longer than the five preceding, pyriform; palpi with the spine on second segment lightly, and on the third strongly, curved. Prothorax about equal in length and breadth, widest slightly in advance of middle, thence strongly arcuate to base which is wider than apex; with a small medio-basal fovea, and a large fovea on each side low down; puncturation as on head. Elytra strongly transverse, smooth, dorsal striae well defined, reaching about middle of elytra, each widely sulcate at base. Abdomen elongate, at broadest wider than elytra; with a well defined longitudinal carina on either side traversing the first and half of the second segments. Undersurface with metasternum deeply and widely sulcate on its apical half and second and third segments of abdomen lightly impressed.

Length, 2·75 mm.

♀ Unknown.

Habitat.—Western Australia; Mundaring (J. Clark). In nest of small black ant.

Differs from all other described Australian species of *Tmesiphorus* by its remarkable antennal club, consisting of one segment only.

Type in Author's collection.

ENDOMYCHIDAE.

Daulotypus gibbosipennis, n. sp.

Reddish flavous, tarsi paler, basal half of prothorax, scutellum palpi, legs, more or less, and antennae except two basal segments and apical two thirds of ultimate segment, black or deeply infuscated; moderately clothed with fairly long, erect setae, these interspersed with a shorter pubescence on sides of both head and prothorax.

Head lightly impressed between antennae, with only faint indications of puncturation. Clypeus without impressions. Antennae moderately stout, first joint a little more robust than second, third twice as long as fourth, and about one and one-half times longer than the second, 4, 6, 8 subequal, 5 and 7 longer, subequal, 9 about as long as 7 but wider, dilated from base to apex, 10 longer and wider than 9, 11 lightly longer than 10, bluntly pointed. Prothorax nearly twice as wide as long, widest near apex, sides finely margined; bluntly toothed at widest part and again at about apical third; hind angles acute; with a narrow transverse, sharply defined furrow close to base, this meeting on either side near lateral borders a longitudinal furrow, these latter a little wider and deeper than the transverse furrow and not quite attaining middle of prothorax; anterior half of prothorax strongly convex, posterior half strongly depressed; puncturation wanting. Elytra much wider than prothorax, widest a little in advance of middle, with four prominent elevations at base, two humeral and two nearer suture, with somewhat irregular rows of fairly large punctures, becoming less conspicuous posteriorly. Abdomen with first ventral segment about equal in length to the sum of the following three. Legs with femora thin, the posterior ones passing fourth segment of abdomen. Posterior tibiae curved.

Length, 2·75 to 3 mm.

Habitat.—Queensland; Goodna, in a rotten log (F. E. Wilson).

Two species have previously been assigned to this genus, viz., *picticornis* Lea (12), and *minor* Lea (13). From *picticornis* my species may be readily differentiated by its much smaller size, its non infuscate head, the different shape of the sides of its prothorax, by its hind femora passing the fourth abdominal segment, and in its possession of elytral elevations. From *minor* it may be separated by its head being not infuscated, its prothorax not more than twice as wide as long, its clypeus without impressions, and also by its possession of elytral elevations.

The shape of the two apical segments of the antenna vary according to the position of observation. From some directions the subapical segment is seen to be obtusely produced, and passes somewhat the base of the apical segment.

Type in Author's collection.

OEDEMERIDAE.

Techmessa ephippiatum, n. sp.

Reddish testaceous, nitid; head less muzzle and antennal joints 5-11, deeply infuscated; a black area occupying a little less than half the length of elytra, beginning at about one-sixth, this area gradually narrows towards, but does not quite attain the lateral margins.

Head strongly transverse, greatly decreasing in width towards base and apex; eyes placed laterally, protruding; with sharply defined round punctures, fairly evenly distributed, but becoming smaller in front. Antennae reaching about middle of elytra, joint 2 short, 3 about one and one half times longer than 2, 4-10 subequal, a little longer than 3, 11 longer than 10, pointed. Prothorax lightly narrower than head, evenly rounded to beyond middle, thence arcuate to base; with a large shallow depression on either side of disc a little behind middle; puncturation as on head, but if anything a little more sparse on median line, which is only very faintly indicated at apex. Scutellum more densely punctured than prothorax. Elytra nearly twice as wide as prothorax, shoulders evenly rounded, sides parallel to about two-fifths, thence gradually increasing in width to about three-fifths, from whence they are gently rounded to apex; shallowly depressed along suture near base; with punctures about the same size as those on prothorax. Prosternum less, mesosternum more, densely punctured. Metasternum with a discal area behind middle, and most of its posterior declivity impunctate. Abdominal puncturation less sharply defined.

Length, 4 mm.

Habitat.—Queensland; Blackall Ranges (F. E. Wilson).

This species differs from the description of *bifoveicollis* Lea (14), in its general coloration, unicolorous clothing, in the median line of prothorax being almost totally wanting, and in its elytra not being parallel sided.

Type in Author's collection.

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Art. VI.—*The Technique of the Nanson Preferential Majority System of Election.*

By J. M. BALDWIN, M.A., D.Sc., F.Inst.P.

[Read 15th July, 1926.]

I.

In 1925 a joint conference of the University Council, the Standing Committee of Convocation, and the University Association was appointed to consider the question of methods of voting at University elections. The Conference, having decided at its first meeting in favour of a system requiring election by a majority, considered that, of the different majority methods available, that devised by Professor Nanson (*Trans. Roy. Soc. Vic.*, xix., p. 197, 1882) was the best, but that the labour involved in the counting, except when the number of candidates was small, might be excessive.

Mr. Picken (Council) in a memorandum drew the attention of the conference to an alternative method of tabulating the votes given by Mr. G. Hogben (*Trans. N.Z. Inst.*, xlvi., p. 304, 1913), and at the second meeting Mr. Le Couteur (Association) and Dr. Baldwin (Standing Committee) both expressed the opinion that the Nanson method with the Hogben tabulation could be carried out without undue labour, provided that the number of candidates was not very large. A sub-committee was appointed to conduct a test election, and the result showed that this opinion was justified.

At the third meeting it was suggested that, as a first step in an election with a large number of candidates, the number should be reduced on a count of first preferences by the rejection of those at the bottom of the list or the election of those at the top or by both methods, and Dr. Baldwin was asked to draw up a memorandum embodying these suggestions.

This was considered at the fourth meeting, when it was resolved to recommend that the Nanson method of voting, with a generalized form of the Hogben tabulation, should be adopted for the next election, and Mr. Phillips (Standing Committee) and Dr. Baldwin were appointed to draw up the necessary Statute. This draft statute, with some verbal alterations suggested by Sir Leo Cussen, was finally adopted by the Council and the Standing Committee.

In the course of these meetings and elsewhere, a technique was evolved, which was tested at the University elections last December. The experience gained there has shown that the method is a thoroughly practical one, and does not involve an undue amount of labour provided the number of candidates does not exceed 10.

II.

No critical examination of the different methods of voting is here attempted—that has already been fully done in Nanson's paper cited above. The present paper is a detailed description of a method of carrying out Nanson's system in its most general form, allowing the voter to indicate preferences for as few or as many candidates as he pleases, and to bracket two or more candidates if he so desires. It is thus an extension of Hogben's paper, where the tabulation is for a single member electorate only and incomplete papers and bracketing are not considered. Actually such papers are dealt with almost as easily as other papers, so that any expression of preference by a voter will be recorded and have due weight in the final result.

In one detail only is the Nanson system departed from. In that system all candidates who are not above the average are rejected *en bloc;* here, as in the Trinity College Dialectic Society's elections (Nanson, *loc. cit.*, p. 217), the lowest only is excluded. In the original system this short cut meant a considerable saving of time, in the present method the extra time involved in carrying out the more rigorous procedure is quite negligible—a matter of a very few minutes only.

III.

RULES.

(*Melbourne University Calendar*, 1926, Statute 34, Division 1, Sections 21 to 26.)

1. The Voter shall indicate the order of his preference by writing numbers on his ballot paper opposite the names of all or some or one of the candidates. A number opposite the name of a candidate shall indicate a preference for that candidate over all candidates opposite whose names a higher number or no number is written, and the same number or no number opposite the names of two or more candidates shall indicate that the voter considers these candidates of equal merit.
2. The number of preferences for each candidate over each other candidate shall be ascertained. In each case where on a voting paper no preference is expressed as between two candidates, half a preference is to be credited to each of the two candidates. Where no preference is expressed as between more than two candidates, the candidates so bracketed shall be dealt with two at a time. The number of preferences shall be arranged in tabular form in which one column (ver-

tical) and one row (horizontal) are assigned to each candidate, the number of preferences (for instance) for candidate P over candidate Q being written down in column P, row Q.

3. The numbers in each column shall be summed. The column with the lowest sum and the corresponding row shall be excluded, and the remaining numbers in each column shall again be summed. The column with the lowest sum at this stage and the corresponding row shall be excluded, and this process of summing and exclusion shall be repeated until only two columns are left. Of the candidates to whom these columns refer that one who has the majority of preferences over the other shall be declared elected.
4. If a further vacancy is to be filled, the column and row assigned to each elected candidate shall be excluded, and the process of election carried out in precisely the same manner as before.
5. If at any stage two columns (for instance, those assigned to B and C) have the same sum, and there is no other column with a lower sum,[1] then the column C shall be excluded if B has a majority of the preferences as between B and C, but if B has exactly half of the preferences as between B and C, the Returning Officer shall decide which column is to be excluded. If, at any stage, three or more columns have the same sum, and there is no other column with a lower sum, the Returning Officer shall decide which column is to be excluded.
6. At any stage of the scrutiny the Returning Officer may adopt any modification which is the mathematical equivalent of the portion of the process for which it is substituted.

IV.

These rules may be used as they stand, but the labour of tabulation may be considerably shortened by a suitable arrangement of the work and by variations of the procedure which, however, can be shown by strict mathematical reasoning to lead to the same result, and are therefore allowable under Rule 6. Details of the procedure are given in the following instructions.

INSTRUCTIONS.

(The process described in a sentence or paragraph following an * is a mathematical equivalent of one laid down in the preceding rules.)

1.—An alteration has been made here, to provide more explicitly for the case where the equality occurs when all columns but those with equal sums have been excluded.

1. Sort the voting papers according to first preferences, and count the number of first preferences allotted to each candidate.

   *For each paper where any number, p, of candidates are placed equal with a preference ranking as first, 1/p is to be credited to each of the candidates so placed.

   *If the number of first preferences received by any candidate exceeds half the number of voting papers, that candidate is placed first at once, and is excluded from all further counts and tabulation.

2. If any candidate is elected under (1) redistribute the voting papers on which he is given first or equal first preference according to the preferences ranking as first preferences among the remaining candidates, and determine the total number of preferences ranking as first credited to each.

   *For each paper where any number q of candidates are placed equal with a preference which ranks as first at this stage, 1/q is to be credited to each of the candidates so placed.

   *If after the redistribution the number of preferences ranking as first preferences received by any candidate exceeds half the number of voting papers, that candidate is placed second, and is excluded from all further counts and tabulation. This process may be continued as far as possible.

3. (*For occasional use only.*) Sort the voting papers according to last preferences (candidates against whose names no number is written rank last), and count the number of last preferences allotted to each candidate.

   *For each paper where p candidates are placed equal last, 1/p is to be debited against each of the candidates so placed.

   *If the number of last preferences received by any candidate exceeds half the number of voting papers, that candidate is placed last, and is excluded from all further counts and tabulation.

4. To the candidates who remain after the completion of the above processes allot rows and columns[2] according to the count of first preferences, starting with the highest in the *top left-hand* corner, referred to the recording scrutineer.

5. The scrutineers work in pairs. Any pair, A and B say, deals first with a group of papers on each of which the first preference has been given to the same candidate, S say, and to no other. A has the voting papers

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2.—The size of the tabulation sheet should not exceed 24 inches by 20 inches. If each column is 2 inches wide, and each row 1½ inches wide, 200 preferences can readily be recorded in each space, and so 400 voting papers can be tabulated on the sheet.

and a number of strips. He fastens a strip over the row assigned to S, *and B writes the number of voting papers in the group in each of the spaces of the column assigned to S, above the diagonal through the top left-hand corner. Taking the first voting paper, A now calls out the name of the candidate with the second preference, and places a strip[3] on the corresponding row, *while B puts a stroke in each of the uncovered spaces above the diagonal in the corresponding column. The third, fourth, etc., preferences are dealt with in a similar way.

Where no preference is indicated as between two or more candidates, A calls out (in the order in which they appear in the tabulation) the names of such candidates. Taking the row of the first such candidate, B puts a dot in the columns corresponding to the second, third, etc., such candidates; then taking the row of the second such candidate, he puts a dot in the columns corresponding to the third, etc., such candidates; and so on. This having been done, strips are placed over the rows in turn, and strokes put in the uncovered spaces as before.

When all the rows have been covered, the strips are gathered by A, and a similar process is gone through with each of the voting papers in turn, until the group is finished. Another group is then dealt with in a similar manner, and so on until all the papers have been tabulated.

Where the remaining candidates are numbered on a voting paper in the order in which their names appear on the tabulation, it will be found that no further strokes will need to be put on the tabulation for that paper.

6. As the treatment of voting papers with bracketing and those that are incomplete is slightly different from that of other papers, it is well to have all such voting papers tabulated by a special pair of scrutineers. If A and B, dealing with papers on which S has first preference, transfer any voting papers to the special pair, B must be careful to see that these papers have not contributed to any of the entries in his tabulation. If the preferences on a voting paper have been partially recorded before the bracketing is noticed, it is inadvisable to transfer the voting paper to the special scrutineers.

7. At the close of the tabulation, the number of strokes in each space is counted. To this is added half the number of dots in the same space. The results from each

3.—This use of strips was suggested by Mr. Le Couteur. The strips should be of cardboard, stiff enough to be placed in position with one hand, somewhat narrower than the rows, and long enough to reach across the sheet.

pair of scrutineers are added together, and thus the total number of preferences of each candidate over each candidate before him on the tabulation is obtained. *These are written on a similar table, and the spaces below the diagonal are filled in by subtracting the number in the complementary space above the diagonal from the total number N of voting papers. This completes the tabulation.

Note.—If the counting be carried on at several centres, the third part of (1) and the whole of (2) and (3) are inapplicable. The order of columns and rows will probably be different for the different centres, but when the tabulations are all received at the head centre it will be a simple matter to combine them into a single tabulation for the whole electorate.

8. Inspect the table and ascertain—
   *(a) if in any column each number is greater than N/2. In such case the candidate to whom that column refers is placed first, and his row and column are covered with fastened strips.
   *(b) if now in any column each uncovered number is greater than N/2. In such case the candidate to whom that column refers is placed second, and his row and column are covered with fastened strips.
   *(c) if in any column each number is less than N/2. In such case the candidate to whom that column refers is placed last, and his row and column are covered with fastened strips.
   *(d) if now in any column each uncovered number is less than N/2. In such case the candidate to whom that column refers is placed second last, and his row and column are covered with fastened strips.

   *These processes may be continued as often as possible.

9. When as many candidates as possible have been placed by (8), the uncovered numbers in each column are summed. The column with the lowest sum and the corresponding row are covered with unfastened strips (see section 11 below), and the uncovered numbers in each column again summed. The column with the lowest sum at this stage and the corresponding row are then covered with unfastened strips, and this process of summing and covering is repeated until only two columns are left uncovered. Of the candidates to whom these columns refer that one who has the majority of preferances over the other shall be placed next in order of those elected. Removing all the unfastened strips, his row and column are now covered by fastened strips.

10. *Again inspect to see if any further candidates can be placed by inspection as in (8). If so, cover the corresponding rows and columns by fastened strips.

11. Proceed again by summing and covering to place another candidate, and so on until a sufficient number have been placed to enable the successful candidates to be determined.

    It is to be noted that as each candidate is definitely placed, his row and column are covered with *fastened strips*, but, when a row and column are to be temporarily excluded in the process of placing another candidate, they are covered with *unfastened strips.*

12. If at any stage it is necessary to discriminate between two columns (for instance, those referring to R and S) which have the same sum, then the column S shall be excluded if R has a majority of the preferences as between R and S, but if R has exactly half the preferences as between R and S, the Returning Officer shall decide which column is to be excluded. If it is necessary to discriminate between three or more columns which have the same sum, the Returning Officer shall decide which column is to be excluded.

13. The most complete check will be given by making an independent tabulation in precisely the same way as the first was done. The two are compared, and where any difference is found the voting papers are gone through, the preferences as between each pair of candidates for whom there is a difference being counted. If the result agrees with the result in one of the tables, it may be assumed that this result is correct. If, however, it agrees with neither, a second count for this pair of candidates may be made, and so on until reasonable certainty has been secured.

    As a general rule, however, it will probably not be necessary to carry out the complete retabulation, but a count of the preferences as between two candidates should be carried out wherever it appears possible that a slight error in the tabulation could affect the election. The most usual case will be where, when the candidates are reduced to two, each of them has approximately half the preferences over the other.

V.

Actually at the recent University elections there were 1550 voting papers and 6 candidates for the Council, and 688 voting papers and 9 candidates for the Standing Committee. Dealing with the papers occupied some 12 scrutineers about 13 hours, one-third of which was spent in opening the envelopes and checking the names of the voters.

None of those present except the Returning Officer (Mr. Bainbridge) and myself had had any previous experience of the tabulation. No difficulty whatever was found with the ordinary papers, but a little preliminary practice was shown to be advisable with voting papers which had bracketing or were incomplete, so that the treatment of them may become mechanical.

The above figures enable an estimate of the time necessary for obtaining the result of any election by this system to be made. In round numbers a pair of scrutineers without previous experience can deal with 1000 preferences per hour. The number of preferences on a voting paper is $n(n-1)/2$, where n is the number of candidates. If then N is the number of voting papers, and m the number of scrutineers, the time taken would be approximately $N.n(n-1)/1000m$ hours.

VI.

PROCEDURE WHERE NUMBER OF CANDIDATES IS LARGE.

It will be seen that the amount of work involved increases rapidly with the number of candidates, and when the number of candidates exceeds 10 may well become too great. When there are more than 10 candidates, the procedure described below will enable the result to be obtained with almost mathematical certainty, while at the same time reducing to 10 the number of candidates whose preferences are to be tabulated.

Since the object of the election is simply to elect a certain number of candidates, and not necessarily to place them in order, it will be found that for a candidate to be elected by the proposed short cut who would be rejected by Nanson's system, or vice versa, requires that the position of such a candidate must differ by *at least* six places from the position he would occupy if the Nanson system were adopted in its entirety. The likelihood of this happening is so infinitesimal that it may be disregarded. The procedure recommended is as follows:—

1. Whenever the number of candidates exceeds 10, and the number of vacancies exceeds 5, make use of the method[4] described in (2) below to elect a certain number of candidates. If the excess of the number of candidates over the number of vacancies—
   (a) is 5 or more, the number to be so elected is equal to to the number of vacancies in excess of 5;
   (b) is less than 5, the number to be so elected is equal to the number of candidates in excess of 10.
2. Determine the number of first preferences allotted to each candidate. For each paper where any number p of candidates are placed equal with a preference ranking as first, $1/p$ is to be credited to each of the candidates so placed.

4.—Ware's method, modified to allow of bracketing of candidates.

5

3. Exclude provisionally the candidate with the lowest number of first preferences so determined, and determine by the above rule the number of preferences ranking as first preferences allotted to each remaining candidate. Continue this process of provisional exclusion of the candidate with the lowest number of preferences ranking as first preferences and the determination of the number of preferences ranking as first preferences allotted to each remaining candidate until one only remains. This candidate is declared elected, and is excluded from further scrutiny.
4. Including those provisionally excluded, determine the number of preferences ranking as first preferences allotted to each remaining candidate, and proceed as in (3), excluding provisionally the candidates one by one until one only is left, who shall be declared elected, and excluded from further scrutiny.
5. Repeat the process in (4) as often as is necessary to elect the number of candidates given by (1).
6. At any stage a candidate who has an absolute majority of preferences ranking as first preferences shall be declared elected forthwith, and excluded from further scrutiny.
7. If, after the election of such candidates (if any) as shall be elected under (1), the number of remaining candidates is greater than 10, the number shall be reduced to 10 by the rejection of candidates as follows:—

   Determine by the rule in (2) the number of preferences ranking at this stage as first preferences allotted to each of the remaining candidates. Exclude provisionally the candidate with the highest number of preferences ranking as first preferences, and again determine the number of preferences, ranking as first preferences, allotted to each of the remaining candidates. Continue this process of provisional exclusion of the candidate with the highest number of preferences ranking as first preferences, and the determination of the number of preferences ranking as first preferences allotted to each remaining candidate until one only remains. This candidate is declared rejected, and is excluded from further scrutiny.
8. Including those provisionally excluded, determine the number of preferences ranking as first preferences allotted to each remaining candidate and proceed as in (7), excluding provisionally the candidates one by one until one only is left, who shall be declared rejected, and excluded from further scrutiny.
9. Repeat the process in (8) until the number of remaining candidates has been reduced to 10.

10. If at any stage under (3) to (9) it be necessary to discriminate between candidates with an equal number of preferences that rank as first preferences at that stage, the Returning Officer shall have a casting vote.

Note.—In the above, 10 and 5 may be replaced by 2n and n respectively, where 2n is the number of candidates that can be dealt with conveniently under the Nanson system.

VII.

As the technique of Ware's method is well established, it is unnecessary to give here any instructions for its use, and the method of dealing with bracketed votes is clear from Instructions (1) and (2) earlier in this paper. At each stage each group of papers should be labelled to show to which candidate or candidates first preference was given, and which candidates have preferences ranking at that stage as first. This will render the counting of bracketed preferences an easy matter, and also will facilitate redistribution.

When the number of candidates has been reduced to 10 as described above, further dealing with the voting papers will be facilitated by placing over the voting paper a card which has been cut so that only those portions of the paper referring to the 10 remaining candidates can be seen.

VIII.

In conclusion, it cannot be too strongly emphasised that the Nanson system is *not* a system of allotting *marks*. In it the voting paper is simply and solely a means of showing which one of each pair of candidates the voter prefers, and the method of tabulation adopted shows at a glance how many voters preferred P to Q. The candidates are eliminated one at a time, until two only, P and Q say, remain.

If a voter expressed no preference as between P and Q, either by bracketing them, or by not placing a number against their names, this has been indicated by a dot in column P, row Q, and a dot in column Q, row P. Each dot has been counted as half a preference, but as there is the same number of dots in each of the two spaces which show P's preferences over Q, and Q's preferences over P, the dots exactly balance, and it is immaterial what value is assigned to a dot as far as the contest between P and Q (or any other pair of candidates) is concerned.

When no candidate has a majority over each of the other candidates, it is necessary to adopt some criterion for the exclusion of a candidate. The criterion adopted in the above method is that the candidate with the lowest number of preferences shall be provisionally excluded. In order that each voting paper should have equal weight in this exclusion, it is necessary, where no preference has been expressed as between two candidates, to credit each of the two candidates with half a preference. Incidentally, the use of the dot reduces the work of tabulation to less than one-half, as with it the detailed tabulation need only be made on one side of the diagonal.

In Ware's method, the criterion is that the candidate with the lowest number of first preferences shall be provisionally excluded, and the rule adopted above for counting bracketed preferences is that necessary for giving equal power to each voter. Owing to this difference in the criterion adopted, Ware's method may lead to the anomalous result that a candidate may obtain a majority of preferences as against each other candidate, and yet not be elected. (Nanson, *loc. cit.*) Thus Ware's method does not fulfil the fundamental condition which a true majority system must fulfil. Under Nanson's method such a candidate would *always* be elected, so that Nanson's method is theoretically sound, and, if the scrutiny is carried out as described in this paper, is also a method which can be readily applied in practice.

END OF VOLUME XXXIX., PART I.

[PUBLISHED 11TH NOVEMBER, 1926]

[Proc. Roy. Soc. Victoria, 39 (N.S.), Pt. II., 1927.]

Art. VII.—*The Total Solar Eclipse of May 9th, 1929.*

By Z. A. MERFIELD, F.R.A.S.

[Read 21st October, 1926.]

On May 9th, 1929, a Total Solar Eclipse will take place, and ill be visible from Northern Sumatra, Malaya and Cochin hina. It seems worth directing attention to the fact that this is ıe only Total Solar Eclipse in the next ten years to exceed 160 ·conds duration, and therefore of any real use in the solution of ɔlar Physical problems.

No information regarding trigonometrical surveys of the ›untry has been received up to the present, so it is therefore ırdly possible to ascertain what places of importance lie on the ntre line. Special meteorological observations are in hand, and e result of these will be made available in due course.

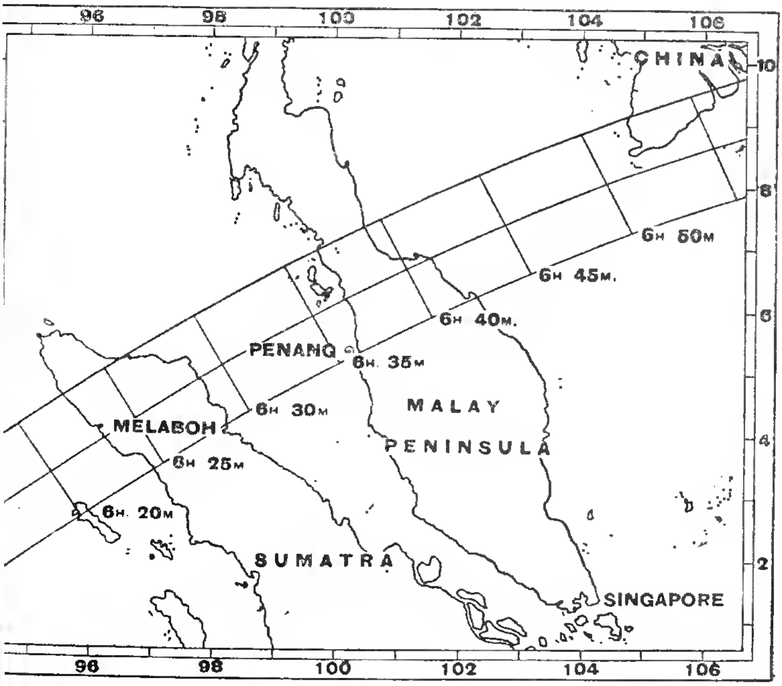

Fig. 1.

Track of Total Solar Eclipse of 9th May, 1929.

The following table gives the path of the shadow and the duration of totality at the centre line:—

G.C.T.	N. Limit Lat. N.	N. Limit Long. E.	Central Line Lat. N.	Central Line Long. E.	S. Limit Lat. N.	S. Limit Long. E.	Duration
H. M.							M. S.
6 15	3° 15.1′	93°32.1′	2°31.9′	94° 1.8′	1°48.5′	94°31.5′	5 7.3
20	4 10.9	94 53.4	3 27.1	95 22.6	2 43.1	95 51.7	5 7.2
25	5 4.3	96 16.6	4 19.9	96 45.2	3 35.4	97 13.7	5 6.5
30	5 55.0	97 42.2	5 10.1	98 10.2	4 25.2	91 38.1	5 5.0
35	6 43.2	99 10.8	5 57.8	99 38.1	5 12.4	100 5.3	5 2.7
40	7 28.6	100 42.8	6 42.8	101 9.3	5 57.0	101 35.8	4 59.7
45	8 11.3	102 18.8	7 25.0	102 44.4	6 38.7	103 10.0	4 55.9
50	8 51.0	103 59.3	8 4.3	104 24.0	7 17.6	104 48.7	4 51.2
55	9 27.5	105 45.2	8 40.5	106 8.8	7 53.5	106 32.6	4 45.7
7 0	10 0.5	107 37.4	9 13.2	107 59.9	8 25.9	108 22.7	4 39.4

ELEMENTS OF ECLIPSE.

		h.	m.	s.
G.M.T. of Conjuntion in R.A., May 9th		5	58	0.2
Right Ascension of Sun and Moon		3	2	36.7
Sun's hourly motion				9.73
Moon's hourly motion				144.02
Sun's Declination	+17° 14′ 1.9″			
Hourly Motion	+ 40.4″			
Moon's Declination	+16° 55′ 16.8″			
Hourly Motion	+ 13′ 31.2″			
Sun's Equatorial Horizontal Parallax	8.7″			
Sun's True Semi Diameter	15′ 50.3″			
Moon's Equatorial Horizontal Parallax	60′ 24.7″			
Moon's True Semi Diameter	16′ 26.9″			

CIRCUMSTANCES OF ECLIPSE.

			Longitude	Latitude
Eclipse begins	May 9th	3 hrs. 32.5m.	— 46°47′	−31°12′
Central Eclipse begins	May 9th	4 hrs. 30.2m.	— 34°57′	−36°46′
Centre of Eclipse at local apparent noon,	May 9th	5 hrs. 58.0m.	— 89°35′	− 0°54′
Central Eclipse ends	May 9th	7 hrs. 50.1m.	—153°03′	+ 4°48′
Eclipse ends	May 9th	8 hrs. 47.7m.	—140°28′	+10°30′

[PROC. ROY. SOC. VICTORIA, 39 (N.S.), PT. II., 1927.]

ART. VIII.—*A Note on Solar Radiation in the Lyman Region and Far Ultra Violet.*

By Z. A. MERFIELD, F.R.A.S.

(With Plate VII.)

[Read 21st October, 1926.]

The D_1 and D_2 lines, according to Mitchell (1) reach a height of 1000 kms. in the Chromosphere, and Saha subsequently showed that the ionization potential of sodium (5·11 volts) is so low that above this level no appreciable quantity of sodium would remain un-ionized. The characteristic absorption lines of the ionized atom lie in the far ultra violet and the height which such atoms attain cannot therefore be directly ascertained. In following up this subject, Milne (2) suggested that since solar radiation in the far ultra violet is probably too weak to exert any appreciable pressure, the sodium atoms which chance to become ionized will not be supported, and he concluded that 1000 kms., the limit of the neutral atoms, would also be the limit of the ionized atoms. The Earth's atmosphere begins to absorb strongly beyond λ 3000, and we have as yet little or no knowledge of continuous absorption in the solar envelope. According to Fabry and Buisson (3), and also H. H. Plaskett (4), the continuous spectrum of the Sun conforms closely with that of a black body. How far we are at liberty to extend these results into the ultra violet is difficult to say. The intensity of solar radiation in the extreme ultra violet is therefore largely a matter of conjecture.

Observations made by the author[1] at the Eclipse in Sumatra, 1926, show that D_1 and D_2 reached 3300 kms. and it is suggested that stripped sodium atoms cannot exceed this level because the L radiations of sodium, the longest of which is 376·5 A.U. (5), lie in the Lyman region, where the intensity of solar radiation is insufficient to support such atoms. It remains to show some jus-

1.—A full account of this work will be published in due course. The observations were made with a moving plate objective grating spectrograph. On the spectrogram reproduced the scale of heights is such that 1 mm. on the spectrogram is equivalent to 275 kms. in the chromosphere. Direct measures give Na 3300 kms., Ca 1500 kms., Ca 10,000 kms., Ba 1400 kms. These results are in good agreement with observations (unpublished), made in Australia at the Total Solar Eclipse, 1922. Corrections have still to be made for atmospheric and instrumental absorptions or losses, also spectral sensitivity of the plate emulsion. The combined effect of these, however, does not vary much over the range of the spectrum under consideration, so the relative heights as measured directly from the spectrogram will not be seriously in error. On the original spectrogram the precaution has been taken to impress a standard solar spectrum and standard squares, so that the above corrections may be ascertained.

tification for this suggestion, and also the assumption made by Milne regarding the intensity of solar radiation in the far ultra violet.

When the valency electron of the sodium atom is removed we are left with a "stripped atom," and there are then two possible alternatives:—

(*a*) The next absorption may be one of the L radiations, or

(*b*) One of the L electrons may be only lifted into one of the M levels, leaving the atom in the normal state for the absorption of the principal series of enhanced lines[2]. In such a state the atom is not likely to capture an electron—in fact, it is more easily ionized than before.

If any sodium atoms exist above 3300 kms., there is little doubt that they must be in an almost completely ionized state. Ionized calcium exists to 10,000 kms., and we will therefore have a mixture of stripped sodium, ionized calcium and free electrons. The ionization potential of calcium, 6·08 volts, is considerably higher than that of sodium, 5·11 volts, so there will be a tendency for the ionized calcium atoms to capture electrons and become neutral. In that case, we would expect to find some trace of λ 4227 neutral calcium above 3300 kms. In reality my observations show that λ 4227 only reaches 1500 kms. The inference to be drawn is that the existence of stripped, and hence ionized, sodium atoms above 1500 kms. is extremely unlikely, and as a corollary that solar radiation, in the extreme ultra violet and Lyman region, is very weak.

Before dismissing this subject, it might be mentioned that the ionization potential of barium, 5·12 volts (6), is almost identical with that of sodium, but in this case the principal lines of the ionized atom lie in the easily accessible region of the solar spectrum. A comparison of the heights of the ionized lines λ 4934 and λ 4554 of barium, and λ 4227 neutral calcium will, therefore, afford an admirable test (other things being equal) of the foregoing theory.

λ 4934 and λ 4554 not only lie in the observable region, but near F and between F and G respectively, in which region we know solar radiation can exert a very strong pressure. We might therefore expect λ 4934 and λ 4554 to reach heights commensurate with the H and K lines, which lines reach 10,000 kms. In reality λ 4934 only reaches 1400 kms., which is in keeping with the theory advanced. λ 4554, unfortunately, cannot be used to test the theory as this line appears as a blend with a line of zirconium.

2.—A sodium atom which has lost its valency electron is referred to as a stripped atom. In such a state the atom is capable of absorbing and subsequently emitting a series of radiations in the Lyman region, the longest of which is 376·5 A.U. The term "ionized sodium atom" is used to denote a sodium atom with its valency electron removed to infinity as before, but with one of its L electrons raised to one of the M levels. In this state the atom is capable of absorbing, and subsequently emitting the well-known, many-lined, enhanced spectrum.

Bearing on Terrestrial Phenomena.

The electrical state of the Earth's upper atmosphere is of considerable importance in connection with the transmission of wireless waves, and was the subject of a recent discussion of the Royal Society (7). The evidence obtained from Radio work indicates that the upper air is considerably ionized or may contain a moderate number of free electrons. Appleton and Barnett (8) have assigned 10^5 as the lower limit to the number of free electrons per cubic cm. at 80 kms. above the Earth's surface, but there is ample evidence to show that the concentration is considerably greater. The electrical state of the upper air has been ascribed to various causes, but mainly to direct ionization by ultra violet light in the Sun's rays, and also to the formation of ozone by wave lengths shorter than 1800 A.U.(7) and its subsequent decomposition into ions. The pertinent question is whether sunlight contains the ultra violet radiations necessary for either (or both) of these processes.

In discussing this subject it seems desirable to distinguish between two kinds of radiation, bright line emission and continuous emission. The latter we have already seen to be weak in the far ultra violet and Lyman region, and need not be considered any further at present.

According to Russell (6), the percentage of calcium remaining un-ionized in the Sun's reversing layer at a height where the pressure falls to 10^{-6} Ats. is 0·007 and of ionized calcium 83·6. These figures if correct show that even at moderate elevations an appreciable quantity of calcium (approximately 16·4%) is doubly ionized, and it has been suggested to me by Professor Grant that if the high level calcium atoms eventually become doubly ionized there would be a copious emission of just those short wave lengths requisite for ionization of the Earth's upper atmosphere.

We have already seen that the reason why the ionized and stripped sodium atoms are not supported is because of the Sun's poverty in continuous radiation in the far ultra violet and the Lyman region. These are also the radiations necessary to support the doubly ionized calcium atoms, so we are faced with the conclusion that if the calcium atoms become doubly ionized they will not be supported, and will fall inwards towards the Sun until they capture an electron with which to absorb. The intensity of the short wave length radiations from this source will depend on how quickly the doubly ionized atom can find an electron, and climb up into the high levels again. St. John (9) gives the velocity of ascent of ionized calcium as 2 kms. sec. $^{-1}$. If a mobile equilibrium is established, it is plain that the intensity of the doubly ionized radiations will not be very strong. On the other hand, in spite of the low pressure at great heights, Milne (10) has given good reasons for believing that there will scarcely be an appreciable amount of the second stage ionization.

When all these matters are taken into account it seems that the theory of the formation of ozone at great elevations and the hypothesis of photo-electric ionization of the upper atmosphere by ultra violet radiations between say λ 3000 and the region of long X-rays are rather unsatisfactory. Nevertheless, the small intensity of these radiations in the Sun's rays may suffice and the ionization products may accumulate with time, but the hypotheses of very penetrating radiation (11) and swift-moving charged particles (12) seem on the whole preferable.

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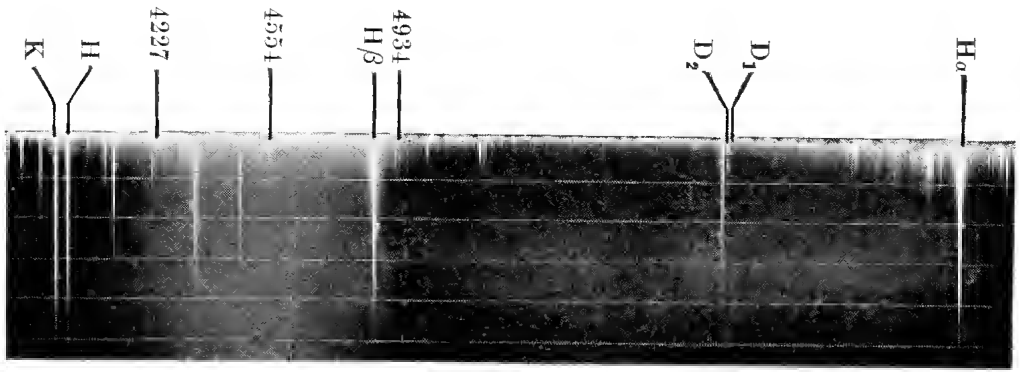
12. E. A. Milne, *M.N., R.A.S.*, lxxxvi., p. 467.

EXPLANATION OF PLATE VII.

Flash Spectrum. Total Solar Eclipse, Sumatra, January 14th, 1926.



Flash Spectrum. Total Solar Eclipse, Sumatra, January 14th, 1926.

[Proc. Roy. Soc. Victoria, 39 (N.S.), Pt. II., 1927.]

Art. IX.—*On the Bad Lands Deposits of Coburg, Victoria, and their Mapping by Elutriation Methods.*

By R. B. PRETTY, M.Sc.

(With Plates VIII., IX.)

[Read 11th November, 1926.]

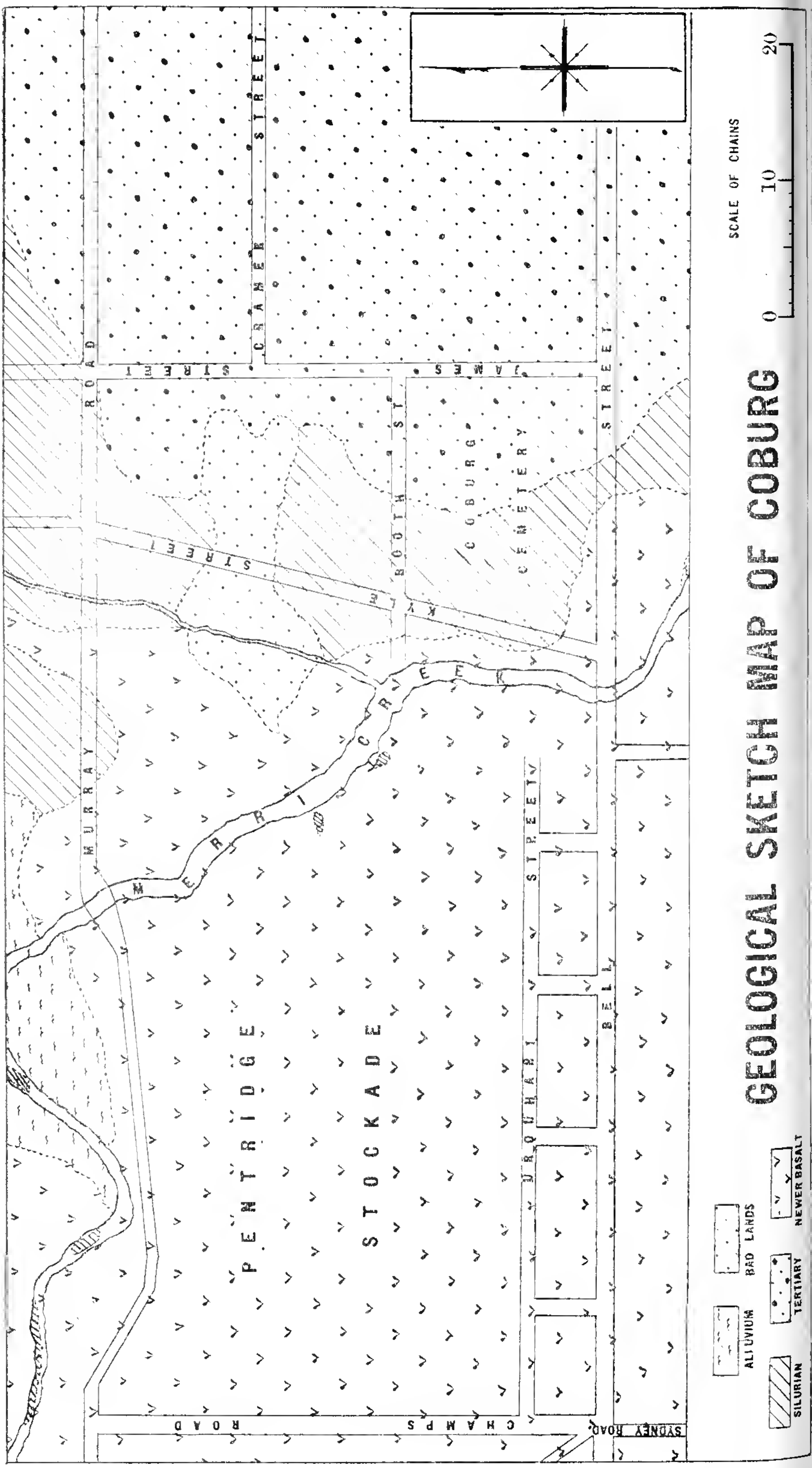
Contents.

I. Introduction.

The work described in this paper was undertaken with a view to elucidating the relations existing between the normal marine Tertiary series and a deposit (hereafter referred to as the "Bad Lands" deposit) associated with it at Coburg.

The locality lies some six miles to the north of Melbourne, to the east of Pentridge Stockade, and occupies a limited area on the western slope of the rising land to the east of the Merri Creek. The Bad Lands area lies to the north of the Coburg Cemetery, to the west of James Street, and to the south of Murray Road.

In passing along Kyle Street, between Bell Street and Murray Road, the locality is easily distinguished by the canyon-like formation due to scouring out of the soft Bad Lands material by running water. This is its most characteristic feature, and has led to its being called the "Bad Lands."
making out some boundaries on account of the paucity of the
In spite of the ease with which the two series may be separated
actual rock exposures, the soil being often the only indication.
In spite of the ease with which the two series may be separated when forming solid rock faces, as in cuttings, the actual surface indications on both the Silurian and Tertiary were surprisingly alike when examined together.


GEOLOGICAL SKETCH MAP OF COBURG
SCALE OF CHAINS
0
10
20
SILURIAN
ALLUVIUM
TERTIARY
BAD LANDS
NEWER BASALT
MURRAY ROAD
CRAMER STREET
JAMES STREET
BOOTH ST
KYLE STREET
COBURG CEMETERY
MERRI CREEK
PENTRIDGE STOCKADE
URQUHART STREET
BELL STREET
CHAMPS ROAD
SYDNEY ROAD

In addition, to the west of Kyle Street particularly, there is a thin mantle of hill wash material as a result of the scouring of the canyons in the Bad Lands nearer the top of the hill. Such hill wash can only be regarded as a thin film, and insufficiently thick to be represented as a distinct deposit in plan.

Physiographically the area consists of two parts. On the west is a comparatively level area which is almost wholly composed of basalt and which is mainly within the bounds of the Penal Establishment. To the east is an area consisting mainly of Silurian and Tertiary sediments. These two areas are separated roughly by the course of the Merri Creek, which drains both slopes and flows in a southerly direction to meet the Yarra.

The Silurian underlies all the rocks in this locality, and is the basement rock in the Melbourne district. The Silurian consists mainly of sandstone and shales, and specimens from the Coburg area have been already examined and described (*7*).

The next horizon to be found in this area is the aqueous Tertiary series. Two types of aqueous deposits may possibly be included here: the definite Tertiary such as occurs at Royal Park, Kew, Essendon and Keilor among other localities around Melbourne, and the Bad Lands deposit, which may perhaps be included here as an upper member, though the weight of evidence favours a post-Tertiary age for the Bad Lands.

It is with respect to the origin and relative age of the Bad Lands deposit and its relation to the definite Tertiary, and the use of the elutriation method to distinguish these two, that this paper is mainly concerned.

Several hypotheses[1] have been put forward assigning to the Bad Lands deposit different modes of origin, and different ages, but all hypotheses agree in calling the deposit not older than Tertiary.

The normal Tertiary is best seen at the top of the hill between Murray Road and Bell Street, and immediately south of the poultry farm which faces James Street. Here on the E. and N.E. of the Bad Lands area the Tertiary occurs as a coarse ferruginous gritstone, cemented into a fairly hard rock by dark brown limonite. This type appears to fringe the Bad Lands area on the E., N.E. and N., and then becomes masked by soil and vegetation as it passes over north-westwards to the Silurian.

The Bad Lands deposit consists of much finer-grained material than the Tertiary, and is quite unconsolidated, the limonitic cement of the Tertiary being typically absent. However, there is a characteristic hard capping forming the surface of the Bad

1.—The sources of all but two of these hypotheses are obscure, and they have not been published. The Leaching Hypothesis was a tentative one, used by the writer during field work in 1921. The Basalt-barrier Lake Hypothesis is a personal communication from Dr. H. S. Summers.

Lands area. This is about nine inches in thickness, and immediately under this caked surface capping the Bad Lands material is quite soft and friable, being easily attacked by running water. Three causes may be responsible for this capping, namely:—

1. The concentration of mineral salts by evaporation as a result of percolating waters again reaching the surface by capillarity.
2. The binding action of the matted roots of vegetation.
3. The baking action of the sun at the surface.

Thus for a depth of about nine inches there is a relatively hard and resistant crust, under which, when pierced, the rock is very susceptible to the attack of erosive forces as in the manner suggested by Leach (8).

II. Preliminary Survey of Previous Hypotheses.

Regarding the mode of formation and hence the relative age of the Bad Lands material there has been some diversity of opinion. Quite a number of different hypotheses have been put forward but without much in the way of facts to justify them, and before outlining the work done on the actual Bad Lands material, it may be relevant to mention some of them for testing by actual facts discovered.

The author of one hypothesis states the age as being post-Basaltic, another makes it Tertiary.

A peculiar feature of the Tertiary around Melbourne has led to another hypothesis—the Leaching Hypothesis.[2] It has been noticed in places such as road cuttings, that when the Tertiary is exposed to the subaerial forces, it almost always shows bleaching to some extent at least, and is deprived of its ferruginous cement which has the characteristic brown colour. The material after the leaching out of the iron loses its compact character, becomes soft and friable and of a distinctly lighter colour—light brown to even white. This process has led to the view that the Bad Lands formation was essentially of the same age as the Tertiary marine series, and part of that series which has suffered unduly under the subaerial forces that have been greatly aided in their work of destruction by the agency of Man himself. In support of this hypothesis it was pointed out that the Bad Lands formation differed from the normal Tertiary in the almost complete absence of ferruginous material, the deposit being quite light in colour and correspondingly soft and friable, as a result of the lack of this cement, which makes the Tertiary usually hard and compact. The effective ferruginous cement is pictured as being leached out by percolating waters, which gained considerable assistance by the breaking through of the hard capping (which naturally protects

2.—See footnote page 61.

the Tertiary from denudation) by the construction of plough furrows during the land boom in the 'eighties. At that time it is said that the land on the site of the Bad Lands was subdivided and, to mark the boundaries, plough furrows were run down the slope of the hill, and that the run-off waters naturally sought these depressions, utilising them as channels. Since the hard capping and the binding of grassy vegetation were of no further avail in protecting the Tertiary below, the waters were able to scoop out deep channels in a comparatively short space of time. As then the subaerial agencies were allowed free access to a soft material, they soon leached out a large quantity of iron. In corroboration of this type of action due to weathering, attention is called to road cuttings around Melbourne which have been made comparatively recently, e.g., at La Rose, North Essendon. Here the face of the cutting is furrowed deeply and the material is bleached and looks similar in lithological character to that in the Coburg Bad Lands. It is notable that such alteration by weathering (which is almost certainly the case in these instances) gives rise to light coloured rubbly material; to some extent at least.

This hypothesis postulates that the Bad Land formation is merely the result of weathering of the normal Tertiary, such weathering being due to, and in the first instance promoted by, Man's influence in disturbing Nature's nicely balanced condition of equilibrium when the subdivisional furrows were put in during the land boom days. By upsetting this equilibrium, Man thus gave the erosive forces an opportunity to produce the great scouring out that has taken place. The subaerial forces are still extending their conquest towards the hilltop by a process of headward erosion.

The description and map given in Cook's paper (4) leads one to the conclusion that he regarded the Bad Lands as being portion of the Tertiary Marine Sands.

Another hypothesis is based upon the accumulation behind a temporary barrier. It suggests that the deposit was produced by interruption of the drainage by a basalt flow.[3] Such a condition would give rise to a small lake on the site of the present Bad Lands, and in it there would be deposition of material derived from the Tertiary and Silurian.

III. Nature of the Present Investigations.

The work done in connection with this area includes the making of the mechanical analyses of the Bad Lands material and of the Tertiary associated with it and the microscopical examination of the grades so obtained, together with a field survey of the locality, based in large measure upon the results of the mechanical analyses. The mapping was rendered difficult on account of the surface being covered with grass, and the great

3.—Personal communication from Dr. H. S. Summers, Melbourne University.

scarcity of actual rock exposures. The boundaries to the E., N.E., and S. of the Bad Lands gave less trouble, but the western boundary of the Bad Lands material is exceedingly difficult to place with accuracy on account of the fact that with every rain the Bad Lands material is being washed down-hill to the west and deposited as thin hill wash, completely obliterating the junctions.

Two maps are given: one on a large scale showing the environment of the Bad Lands themselves, and a small locality plan showing the exact position of the area which has been mapped in detail. For geological boundaries outside this area I have relied upon modifications of G. A. Cook's map (4), taken from an unpublished map lent me by Mr. Singleton.

A description of the method used for the mechanical analyses is given as an appendix to this paper.

IV.—Results and Discussion of the Mechanical Analyses.

The outstanding fact brought out by the mechanical analyses is the distinctness between the normal marine Tertiary and the Bad Lands material. The figures show predominance of the silt and clay grades in the Bad Lands deposit, whereas in the Tertiary the coarse grades are dominant. The average cumulative percentage above the lowest limit of the sand grade, i.e., the sum of percentages of all material over 0·1 mm. in diameter, for the Tertiary is 86%, whereas the corresponding figure for the Bad Lands is only 25% approx. This is best brought out by the means of a graph.

The method of plotting the results of the mechanical analyses is that outlined by Holmes (6, p. 216), except that the horizontal scale adopted is not proportional to the logarithms of the diameters, but directly proportional to the square roots of the diameters. The use of the logarithm of the diameter requires the zero of diameter to be represented at infinity. The use of the square roots of the diameters gives the zero of the diameter a finite position on the graph.

Baker (2) has graphed elutriation curves by plotting the actual grade diameters. This method gives a finite zero, but where the particles differ widely in their grade sizes the length of the graph becomes far too great, so that this method is not satisfactory except in cases where the sample shows comparatively small variation in the diameters of its particles, i.e., is well graded. For the purposes of graphing, the cumulative percentage weights were added up from the tables of analyses, and these are given in Table II.

The curves for the Tertiary were found to take up their position as a distinct group on the graph, while the analyses of typical Bad Land material gave a series of curves in an area of the graph quite distinct from the Tertiary. Both series show considerable uniformity, and as the whole area under consideration is small, it was found that the position of the curve in either of these two

		I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Clay	<0·01 mm.	35·8	36·4	36·5	5·6	6·3	3·5	3·1	3·1
Silt	0·01 to 0·1 mm.	43·5	36·5	43·7	6·8	6·5	9·3	11·1	13·2
Sand	0·1 to 1·0 mm.	15·4	18·7	13·1	39·9	40·9	42·2	41·8	38 3
Gravel	>1·0 mm.	5·3	8·5	6·7	47·7	46·3	45 0	44·0	45·5
	Total	100·0	100·1	100·0	100·0	100·0	100·0	100·0	100·1%

		IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII
Clay	<0·01 mm.	43·5	34·4	23·1	32·5	36·2	32·5	59·8	16·6	51·3
Fine Silt	0·01 to 0·05 mm.	28·3	32·6	30·1	28·0	24·8	38·4	17·7	29·8	35·5
Coarse Silt	0·05 to 0·10 mm.	24·6	19·5	13·9	14·0	12 9	17·9	6·4	13·0	6·9
Sand	0·10 to 1·0 mm.	2·5	7·2	21·1	23·3	20·4	10·2	10·2	26·8	5·9
Gravel	>1·0 mm.	1·0	6·3	11·8	2·2	5·7	1·2	5·9	13 8	1·3
	Total	99·9	100·0	100·0	100·0	100·0	100·2	100·0	100·0	100·0%

TABLE II.

		I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Clay	<0·01 mm.	100·0	100·1	100·0	100 0	100 0	100·0	100·0	100·1%
Silt	0·01 to 0·1 mm.	64·2	63·7	63·5	94·4	93·7	96·5	96·9	97·0%
Sand	0·1 to 1.0 mm.	20·7	27·2	19·8	87·6	87·2	87·2	85·8	83·8%
Gravel	>1.0 mm.	5·3	8 49	6·7	47 7	46·3	45·0	44·0	45·5%
Maximum Size of Gravel		2·69	3·23	2·02	4·28	4·02	3·97	4·08	4·16 mm.
Square Root of Diameter		1·64	1·79	1·42	2·07	2·00	2·00	2·02	2·04

TABLE II. (*Continued*).

		IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.
Clay	< 0·01 mm.	99·9	100·0	100·0	100·0	100·0	100·2	100·0	100·0	100·0°/o
Fine Silt	0·01 to 0·05 mm.	56·4	65·6	76·9	67·5	63·8	67·7	40·2	83·4	48·7°/o
Coarse Silt	0·05 to 0·1 mm.	28·1	33·0	46·8	39·5	39·0	29·3	22·5	53·6	13·2°/o
Sand	0·1 to 1·0 mm.	3·5	13·5	32·9	25·5	26·1	11·4	16·1	40·6	6·3°/o
Gravel	> 1·0 mm.	1·0	6·3	11·8	2·2	5·7	1·2	5·9	13·8	1·3°/o
Maximum Size of Gravel		2·68	4·15	3·21	2·81	5·29	2·00	2·95	3·54	4·13 mm.
Square Root of Diameter		1·64	2·04	1·79	1·68	2·30	1·42	1·72	1·88	2·03

I.—Bad Lands about 15 inches below surface immediately beneath the hard capping.
II.—Bad Lands about 6 feet below I.
III.—Bad Lands about 10 feet below I.
IV.—Tertiary East of Bad Lands.
V.—Tertiary N.E. of Bad Lands.
VI.—Tertiary South of All-White Poultry Farm.
VII.—Tertiary S.E. of Bad Lands.
VIII.—Tertiary North of Bad Lands.
IX.—Bad Lands 18 inches below surface on slope between Kyle and James Streets.
X.—Bad Lands 18 inches below surface on slope between Kyle and James Streets.
XI.—Bad Lands 18 inches from surface in Creek Section West of Kyle Street.
XII.—Bad Lands 2 feet below XI.
XIII.—Bad Lands 4 feet below XI.
XIV.—Bad Lands 4 feet below XI.
XV.—Bad Lands on hillside between Kyle and James Streets.
XVI.—Bad Lands West of Kyle Street, 80 feet West of Creek.
XVII.—Bad Lands near the contact with basalt.

groups indicated the series to which the sample belonged. It was stated earlier in the paper that great difficulty was experienced in the separating of the two series in the field. The junctions are grass-covered for the most part, and it became necessary to be able to distinguish between the Tertiary and the Bad Lands by examination of the loose detrital material. The usual methods of mapping in the field were found ineffectual. It became necessary to use some method to separate the two series in some systematic manner in the laboratory. To this end the mineral suites in both series were examined, but they showed great similarity, and so no satisfactory distinction could be made on mineral composition except in the few places where the solid ferruginous Tertiary could be found. The only distinction found to hold for the systematic mapping was that provided by the mechanical analyses, and this led to a considerable number of analyses being made with a view to determining the lateral extent in plan of the already known Bad Lands area.

The mapping problem thus resolved itself into that of making the analysis, obtaining the curve for the particular sample and noting the group to which it belonged, and then mapping the locality in accordance with the data so obtained.

Prior to this work being undertaken, the Bad Lands were considered to exist only as far west as the neighbourhood of Kyle Street, but this work has resulted in this deposit being extended across the small tributary valley, and right over to the basalt. This further information lends colour to the last and most probable hypothesis for consideration—namely, that the deposit was formed by a deposition in a lake dammed back by the basalt.

Since the work has been completed, the writer has had the view strengthened that the westerly extension is considerably west of Kyle Street by hearing from an old resident that he remembers the time when there were canyons to the west of Kyle Street exactly similar to those now restricted to the east of Kyle Street, and that he was employed by the landowner to shift the greater amount of the deposit by means of drays.

V. Results of the Microscopical Examination.

The disintegrated material obtained from the elutriator was examined under the microscope using clove oil as a mounting medium, its index of refraction being similar to that of Canada balsam, 1·544. The results of the microscopical examination showed the similarity in mineral content of the Tertiary and Bad Lands. The mineral assemblage is found to be largely identical also with that of the Silurian as given in Langford's paper (7).

It was found early that the mineral content showed an overwhelming preponderance of the minerals quartz and felspar, so much so as to make the discovery of the less common minerals difficult. To facilitate the search for these accessory minerals large samples were treated (9) with bromoform (S.G. 2·84) in order to float off the lighter quartz and felspar and leave the heavy residue concentrated for closer examination.

The most striking essential difference between the Tertiary and the Bad Lands material, however, lies in the presence of the limonitic cement in the Tertiary, while the Bad Lands are distinctly lacking in this constituent.

The minerals common to both the Tertiary and Bad Lands are as follow:—

Quartz.—In great abundance, occurring in irregular grains without crystal boundaries. Low refractive index, no cleavage and many showing 1st order yellows under polarized light. Many good uniaxial interference figures and of positive sign.

Felspar.—Also greatly abundant, but showing much cloudiness due to weathering. Biaxial, R.I. low, and showing low polarization colours. A few show somewhat vague indications of lamellar twinning, and may be plagioclase.

Tourmaline.—This is a fairly abundant accessory, occurring in rectangular grains, with refractive index higher than quartz. Pleochroism strong, and with straight extinction. Uniaxial figures and negative sign. The grains are quite free from alteration.

Topaz.—R.I. higher than quartz, straight extinction. Biaxial and with basal cleavage. Occurs in rounded grains.

Zircon.—Many grains show crystal faces. High R.I., and showing whites of high order. Uniaxial. This mineral is common as an accessory.

Rutile (probably).—Reddish brown, rounded grains, with high R.I., and with high polarization colours. Uniaxial.

Iron Ores.—Occurring as minute black opaque grains of irregular shape, probably magnetite and ilmenite.

Micas.—Biotite occurs rarely, as crystals with frayed ends and basal cleavage, markedly pleochroic and with high polarization colours. There are also colourless, ragged-ended crystals, with characteristic cleavage of the micas, high colours and biaxial figure, and hence probably muscovite.

Andalusite.—Occurs in rounded prismatic grains, with inclusions present. The mineral was colourless, and so showed no pleochroism. Cleavage present, but not very distinct. R.I. fairly high, low polarization colours. Biaxial and showing straight extinction.

Of the minerals mentioned quartz is by far the most important in quantity, the felspar being very common but subordinate to the quartz. Of the minerals present in small amounts the most conspicuous is the tourmaline, although zircon is quite common, the others mentioned being quite subordinate, while the micas are only rarely found.

The limonite in the Tertiary occurs as a brown cementing material coating the grains of other minerals. The friable nature of the Bad Lands may be attributed to the lack of this ferruginous cement.

VI. Summary of the Evidence obtained at Coburg.

1. All three series (Silurian, Tertiary, and Bad Lands) have similar mineralogical composition with the notable exception of the presence of limonitic cement in the Tertiary. When this limonite becomes leached out, as it does on weathering, the Tertiary assumes the appearance of the Bad Lands.

Minerals present include quartz, felspar (perhaps including plagioclase), tourmaline, rutile, topaz, zircon, iron ores, micas, and probably andalusite.

2. The mechanical analyses show the Bad Lands and Tertiary to be distinct, i.e., the Tertiary is coarse and the Bad Lands fine.

3. The Bad Lands material is homogeneous in grain size in vertical sections excepting for the presence of the thin basal conglomerate and the immediate surface soil.

4. The Bad Lands material is visibly unconformably overlying the Silurian, but no section can be seen at Coburg showing Tertiary and Bad Lands in stratigraphic contact, although the mapping demonstrates their unconformable relations.

5. The Silurian occurs close to the surface near the top of the hill, but further down the hill the thickness of the Bad Lands deposit becomes 12-15 feet.

6. The Bad Lands material shows bedding, and may be considered to be *in situ*.

7. The Tertiary is ferruginous: the Bad Lands not ferruginous.

8. The Bad Lands material is unconsolidated, while the Tertiary normally is consolidated.

9. No fossils have so far been obtainable from either series at Coburg. A doubtful sponge spicule was noted in the microscopical examination of the sands from the Bad Lands.

In examination of the Bad Lands material under the microscope organic remains were found. These were diatoms belonging to the genera *Fragillaria*, *Melosira* and *Synedra*, but it was found that they came in with the water during the elutriation process and are therefore valueless as fossil evidence concerning the Bad Lands.

10. Pebbles in the basal conglomerate of the Bad Lands include some of the material belonging to the marine Tertiary. It follows that the Bad Lands are post-Tertiary in age.

11. The Bad Lands material is notably free from basaltic detritus. There is an absence, as far as it is observable, of basaltic pebbles associated with the Bad Lands, although there is a great abundance of pebbles from both Tertiary and Silurian. However, near the western limit of the deposit the material includes detritus derived from the basalt.

VII. Discussion of Hypotheses in the Light of New Evidence.

With this evidence it is possible to review the two hypotheses mentioned at the beginning of this paper. The first is the hypothesis which postulates that the Bad Lands material was produced by leaching from the original Tertiary *in situ*, aided by Man's influence in piercing the hard protective capping. Although the mechanism whereby the water got down below the hard capping is given as due to the putting in of plough furrows along subdivisional boundaries in the boom period, yet such procedure is not likely. What probably happened and realised the same ultimate result even more effectually was that the upper surface was shovelled off and carted away on account of the builders' great demand for this particular kind of material constituting the hard capping. There is abundant surface indication that such illicit practices occurred before the subdivisional survey was made. The building boom was flourishing in 1885-6, and this hard capping was probably removed at this time. The fact that the survey took place subsequently in 1888 is in accord with these considerations.

Certain of the evidence obtained at Coburg agrees with the leaching hypothesis, e.g., the mineralogical similarity between the Tertiary and the Bad Lands deposit, the absence of limonite in the latter being pictured as due to the leaching out of the cementing medium. This accords also with the unconsolidated friable nature of the Bad Lands, the absence of fossils and the persistency of its faint bedded nature.

The objections are mainly those appearing on inspection of the mechanical analyses. There should be no basal conglomerate containing rounded Tertiary pebbles. If the Tertiary marine deposit were the parent rock undergoing leaching, the coarser grades should still be present. The simplicity of this hypothesis is commendable, but while it is on this account interesting, the facts shown by the mechanical analyses are difficult of explanation. The lack of the sand grade (1·0—0·1 mm.) in the Bad Lands is considered to show the distinctness between the Bad Lands material and the Tertiary. The question may well be asked, why is it that the Bad Lands deposit lacks the coarse sand grade percentage which characterizes the Tertiary? The mechanical analyses show the percentages down to the lower limit of the sand grade to be 25% and 86% for the Bad Lands and Tertiary respectively.

The other hypothesis for consideration is that which postulates that the Bad Lands material was deposited in a lake formed subsequently to the Newer Basalt, behind a barrier caused by one of these flows. Such a mechanism would readily accord with the mineralogical similarity between the three series—the limonite probably disappearing in solution as in the last hypothesis. The reason that there is a lack of the coarser grades in the Bad Lands may be that the Silurian material and only the *finer* grades of the Tertiary were carried into the lake, the currents being not strong enough to transport the coarser grades. This would give a higher sand percentage in the Tertiary than in the Bad Lands.

The site of the lake was probably determined by the presence of the old valley mentioned by Cook (4). This old valley must have been cut down right through the Tertiary to the Silurian beneath, before the deposition of the Bad Lands material commenced. This is shown by the fact that the Bad Lands is clearly resting directly on the Silurian, and the basal conglomerate of the Bad Lands Series contains pebbles unmistakably belonging to the Tertiary.

Such a deposit as the Bad Lands is like a recent lake deposit, being unconsolidated, since it has never had compression due to superincumbent rock. The uniformity with the Silurian is readily explained, and so also is the basal conglomerate with its rounded pebbles of the Tertiary. The homogeneity of the Bad Lands material in vertical section is satisfied, and so also is the slight bedded nature of the deposit.

VIII. Conclusion and Acknowledgments.

It is concluded, so far as can be gleaned from the evidence at present obtained at Coburg, that the Bad Lands are certainly younger than the marine Tertiaries, and also very probably the result of deposition of detrital material from the neighbouring Tertiary and Silurian in a lake formed in post-Newer Basaltic times.

In conclusion, the writer wishes to gratefully acknowledge his indebtedness to Prof. Skeats for much valuable criticism of the work in its various stages; to Dr. Summers, for much helpful discussion of the problems which have arisen from time to time; and to Mr. Singleton, M.Sc., and Dr. Stillwell, for useful suggestions in the laboratory work.

IX. Appendix.—Description of the Apparatus and Method used in making the Mechanical Analyses.

The mechanical analyses were done by the method of elutriation for the three finest grades, viz., clay, fine silt and coarse silt (i.e., below 0·1 mm.), while coarse grades, gravel and sand, were separated by wet sieving in a circular mesh sieve.

The form of elutriator used first was similar to that described by Crook (5), but this was later discarded in favour of a single-vessel on account of the difficulties in working the particular vessels in use. The single-vessel type used is similar to that described by Holmes (6), where Prof. Boswell's description (3) is quoted. Two of these elutriators were used; one of large diameter, about 8 inches, for estimation of the clay grade, and another of approximately 3 inches diameter for the fine silt and the coarse silt grades.

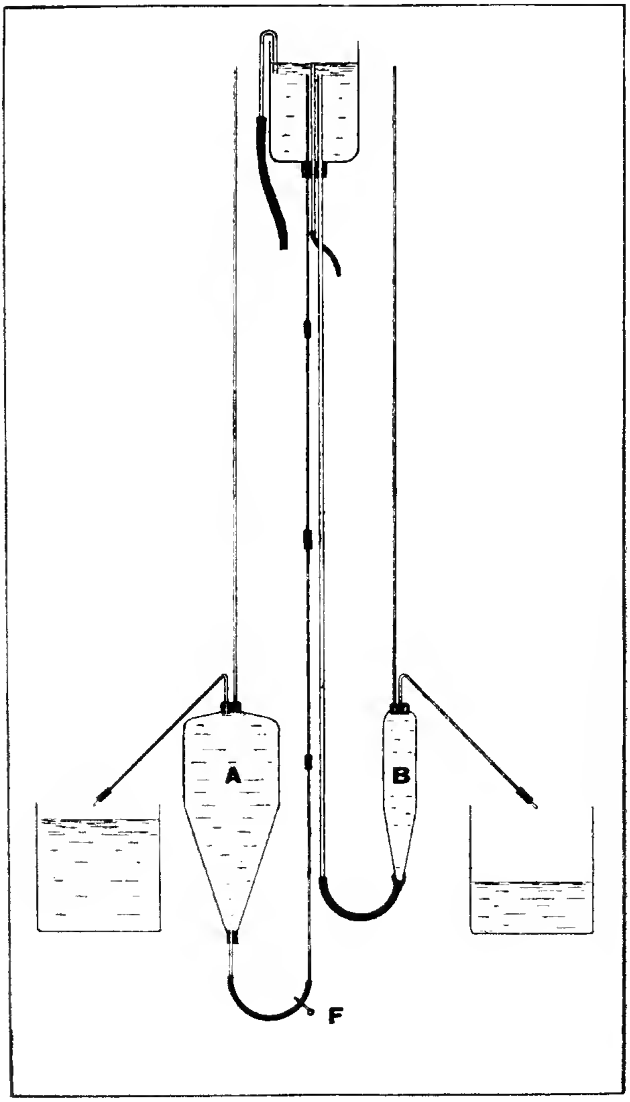


Fig. 2.

The internal diameter of the vessel B (about 3 inches) was determined by measuring the volume of water discharged while the level of the water in the vessel fell through a known height. Then the diameter thus found was used to determine the rate of outflow from the vessel in order to give the required velocity of upward flow within the vessel (1·79 mm. per sec. for fine silt between the limits 0·01 and 0·05, and 7 mm. per sec. for coarse silt between 0·10 and 0·05 mm.). Having a reservoir supplying water under constant head and a jet of suitable size, about 1 mm., the screw clip is opened and adjusted by trial and error until the calculated rate of outflow is obtained for one particular jet. To find the required height in the manometer the method of graphing used by Baker (1) was found to be very satisfactory. The height of the column in the manometer is then marked so that for future determinations all that is necessary to obtain that particular rate of flow is to use the same jet and open up the screw clip until the manometer column reaches this point. In this way two different rates were marked—one to run off the fine silt and the other to run off the coarse silt. The larger clay elutriator A (about 8 inches diameter) was treated in the same way and adjusted to give an upward flow of 0·15 mm. per sec. The height of the water level in the manometer was then marked as before to facilitate regulation for the same flow in future determinations.

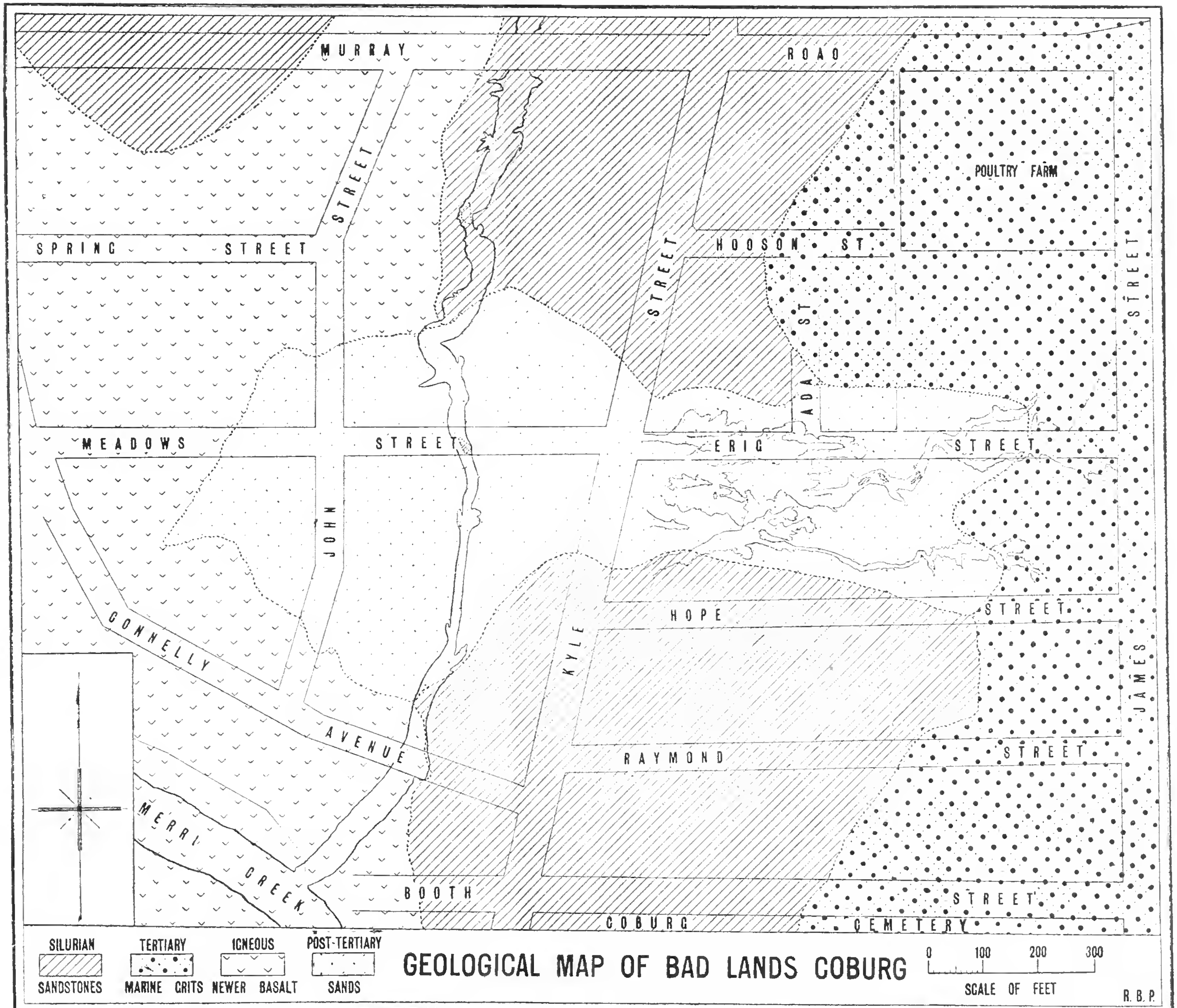
It was found that though the height in the manometer tube appeared stationary, yet after a space of two or three hours the level would show movement. As it is desirable to be able to allow the elutriation process to go on without attention, any such variation is unsatisfactory. This variation was overcome by using a small outlet feed pipe, the maximum capacity of which was scarcely greater than that required by elutriation at 0·15 mm. per sec. through the vessel A. Under these circumstances the controlling clip F needed only slight adjustment, and the flow was found to remain steady. A rubber inlet pipe was first used, but was discarded in favour of glass of similar bore. Under these conditions the manometer level was found to be quite stable for long periods.

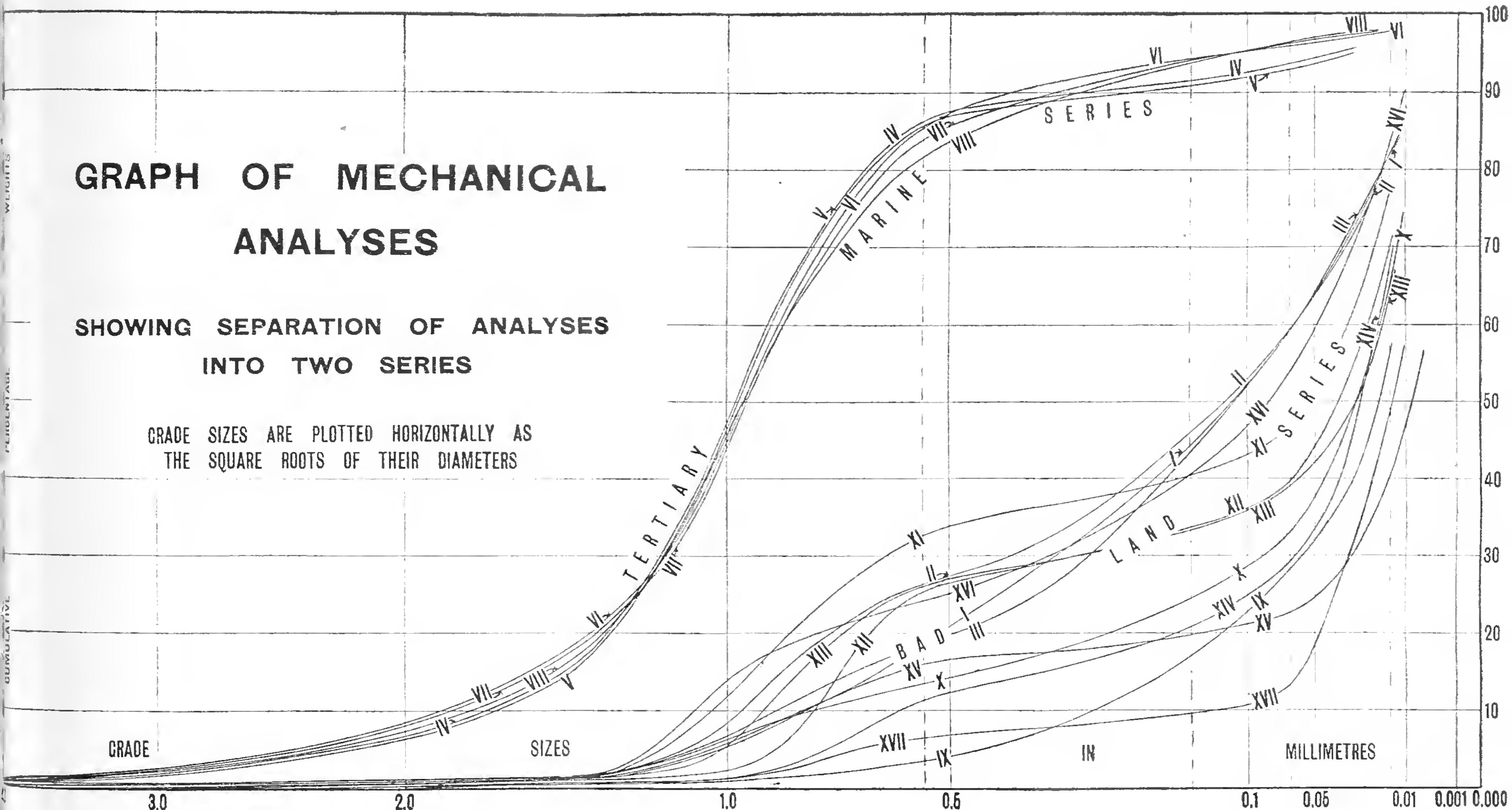
The method of calculating the required rate of flow from the figures 0·15 mm. per sec. for fine clay up to 0·01 mm. in diameter, 1·79 mm. per sec. for fine silt up to 0·05 mm., and 7 mm. per sec. for coarse silt up to 0·10 mm. diameter, gives rates of flow which bring over grades which are only approximately of the stated diameter. The maximum diameter of the particles actually coming over for each grade was measured under the microscope, and the corrections made for each of the grades were applied in the plotting of the curves in the graph. For example, it will be noted on Plate IX. that the ordinate representing the actual grade run off, is displaced a little from the ordinate representing the grade calculated to run off, and the plotting is done on these displaced ordinates, which are shown in broken lines. Having thus calibrated the particular apparatus in use the mechanical analysis may be proceeded with.

A sample of the Bad Lands material weighing several kilograms, after being air-dried on a tray, was quartered down to a sample of 15 to 25 gms., and this was placed in a tared weighing bottle and dried as far as possible at 110°C. A weighing bottle must be used on account of the hygroscopic nature of the fine clay forming part of the material. After weighing, the sample must be prepared for elutriation by disintegration into the grain sizes in which it was laid down in the original sediment. On this account no hard pestling is permissible. It was found satisfactory to plunge the weighed material at 110°C. into a beaker of cold water, whereupon the small clods fall away into powder. Complete disintegration is promoted by warming gently to a boil, and, after cooling, by the addition of a little ammonia to deflocculate the clay.

Then with the clay elutriator A half full of water, wash the prepared sediment into it. Fill the elutriator completely, allowing time to elapse for all grades but the clay to settle below the uniformly wide part of the vessel. Start the water flowing at the required speed according to the manometer, as calibrated with the particular jet for running off the finest grade, namely, the clay (less than 0·01 mm.). The clay will be run off continually, leaving behind the three other grades, sand, silt and gravel. The conclusion of the running off of any particular grade is known to be complete when the outlet water is clear and quite free from suspended particles. Difficulty was experienced in estimating the clay. Three methods, all more or less direct, were tried, but none was completely satisfactory. The first was by evaporating down the complete volume of clay water. This was a very tedious, long and messy process requiring much attention, and thus found to be very unsatisfactory. An alternative tried was to evaporate down an aliquot part of the whole volume of clay water. This involves accuracy in measuring the volumes, as the clay water may be 15-20 litres or more, and such a bulk introduces error. The third method was that of precipitating all the clay by the addition of the electrolyte (ferric chloride) and subsequent filtration. The very large volume of liquid is too much to deal with, and the precipitation is not as complete as could be desired. After trying these methods it was found more expedient to estimate the clay indirectly.

The weights of gravel, silt and sand were added together, and subtracted from the weight of the sample, thus giving the weight of the finest grade (clay). As a check against this the elutriator was discharged at the conclusion of running off the clay and the weight of (sample minus clay) directly found by weighing. After making this check the (sample minus clay) was returned to elutriator B, and the flow regulated for fine silt. After the fine silt had been completely run off the elutriator was discharged, and the coarse silt, sand and gravel weighed together. This coarse silt, sand and gravel is then placed in elutriator B, and the flow regulated for coarse silt. This runs the coarse silt off, and leaves the sand and the gravel in the elutriator. The elutriator is then discharged into a 1·0 mm. circular mesh sieve, and the


MURRAY ROAD
POULTRY FARM
SPRING STREET
STREET
HOOSON ST
STREET
ADA ST
STREET
MEADOWS STREET
ERIC STREET
JOHN
CONNELLY AVENUE
HOPE STREET
KYLE
JAMES
RAYMOND STREET
MERRI CREEK
BOOTH STREET
COBURG CEMETERY
SILURIAN SANDSTONES
TERTIARY MARINE GRITS
IGNEOUS NEWER BASALT
POST-TERTIARY SANDS
GEOLOGICAL MAP OF BAD LANDS COBURG
0 100 200 300
SCALE OF FEET
R. B. P.


GRAPH OF MECHANICAL ANALYSES
SHOWING SEPARATION OF ANALYSES INTO TWO SERIES
CRADE SIZES ARE PLOTTED HORIZONTALLY AS THE SQUARE ROOTS OF THEIR DIAMETERS
TERTIARY MARINE SERIES
BAD LAND SERIES
GRADE SIZES IN MILLIMETRES
3.0
2.0
1.0
0.5
0.1
0.05
0.01
0.001
0.000
10
20
30
40
50
60
70
80
90
100

sand passes through, leaving the gravel on the sieve. These two grades were then dried and weighed separately. In the case of the estimation of the silt and the sand there is no difficulty experienced since these two grades will subside relatively quickly to the bottom of the vessels, and the supernatant liquid can be decanted off quickly. After all the liquid possible is removed by decantation and siphoning, the tared beaker is dried in the oven, cooled and weighed.

Analyses were made of the Bad Lands material in this way, but the ferruginous Tertiary had to be treated with acid for the removal of iron, which cements the grains together, before the mechanical separation in the elutriator.

The apparatus described above has been used successfully in the Geological Department of the University of Melbourne for the systematic separation into grades of the abrasive powders used in the preparation of polished surfaces of opaque minerals for microscopical examination by reflected light, and for grinding of thin rock sections.

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[PROC. ROY. SOC. VICTORIA, 39 (N.S.), PT. I., 1927.]

ART. X.—*Australian Curculionidae of the Subfamily Gonipterides.*

By ARTHUR M. LEA, F.E.S.

[Read 9th December, 1926.]

This subfamily of weevils appears to be confined to Australia, where most of the species feed on eucalyptus twigs and leaves. As adults many of them drop on the least alarm, but others cling so tightly that some force is needed to detach them, not infrequently one or more legs being broken in the operation. *Iptergonus cionoides* is abundant in some years near Sydney, but specimens seldom fall into the umbrella from plants beaten over it. Two characters appear to be constant in the subfamily.

1. A dense pad-like mass of clothing at the base of the prothorax, normally concealed when that part is closely applied to the elytra.
2. Each side of the metasternum abruptly vertical over the hind coxa, appearing as if with a conspicuous tubercle from the side.

All the genera contain species that are more or less densely covered with a meal, that is often of a rusty-red or ochreous colour. The meal often becomes greasy, and the grease holds dust, so that specimens often have a dirty appearance, and normal markings become obscured; occasionally the meal becomes caked, and conceals both derm and scales. On washing with chloroform, benzine, or other grease-absorbing liquids, the grease and meal are easily removed, but cleaned specimens often look very different from those on which the meal is in perfect condition. Washed specimens usually have more prominent eyes, owing to the removal of the meal that is normally present behind them. It is in fact difficult to keep the meal in good condition, and it is often left only in the punctures and other depressed spaces. I have often found it impossible to remove the grease without at the same time removing the meal. Where the necessary specimens are available it is always desirable to select two, agreeing as closely as possible, and to wash one of them with chloroform, etc. Scales and fascicles that on many specimens appear more or less rusty, after washing usually become snowy-white or silvery.

On most species of the subfamily the middle of the third and fourth segments of the abdomen is polished and glabrous. The second joint of the funicle appears to be usually longer than the adjacent ones.

In *Gonipterus*, *Oxyops* and *Iptergonus* many of the species (probably all of them) may be found in four apparent forms:—

1. Densely covered with a meal varying with the species from almost white to yellow, red, and muddy-brown, and partly or entirely concealing the derm and scales. Such specimens are usually in perfect condition when taken, but are especially liable to become greasy with age.
2. Irregularly covered with meal, mostly in depressed parts. These are usually specimens killed without being placed in liquids, and which, owing to a certain amount of rubbing have meal partly removed. With age they tend to become greasy, and the grease may discolour the meal.
3. No meal present, usually specimens that have been in alcohol for some time, when the whole of the meal is removed. Such specimens seldom become greasy, and the sculpture (but not the clothing, which is sometimes affected) is generally in perfect condition for examination. In weak alcohol, or after prolonged immersion, the scales may be stained or largely abraded.
4. No meal present, and often no scales on the upper surface, but the derm with a varnished or leaden appearance. This is apparently due to old age, and living specimens may be seen with it, sometimes in copulation with mealy ones. It occurs in *Catasarcus* and other weevils; and is not altered by washing with chloroform. In *Syarbis* a somewhat similar incrustation may be occasionally noticed, but may be removed. I have not seen it in *Pantoreites* or *Prophaesia,* although mealy specimens of both genera may be taken.

The punctures especially vary in appearance with the density of the meal and clothing, and on greasy and mealy specimens even large ones are often completely hidden. It is not always easy to connect the various forms, and in consequence some synonymy has resulted. With greasy, dirty or badly abraded specimens, it is often difficult or impossible to determine the species, and in collections it is desirable that many such should be left unnamed. Many specimens, however, may be improved in appearance by washing with chloroform.

Although some of the species, especially of *Gonipterus,* are very unsatisfactory, the genera (except that a few species are intermediate between *Gonipterus* and *Oxyops*) are easy of recognition, as is evidenced by the following table:—

A. Tarsi without claw-joint .. .. *Syarbis*
AA. Tarsi with claw-joint.
B. Club continuous with funicle .. .. *Bryachus*
BB. Club much wider than funicle.
C. Rostrum long and comparatively thin .. *Prophaesia*
CC. Rostrum short or comparatively short.
D. A conspicuous posthumeral tubercle on the submarginal interstice on each elytron
Gonipterus

DD. Without such a tubercle.
E. Eyes not prominent .. .. .. *Pantoreites*
EE. Eyes very prominent.
F. Intercoxal process of mesosternum pointed in front .. .. *Oxyops*
FF. Process rounded in front *Iptergonus*

Notes on Table.

D. The posthumeral tubercle is occasionally absent from *Gonipterus,* but on such species the intercoxal process of the mesosternum is not subacutely produced as it usually is in *Oxyops.* On many species of *Oxyops* there is a cluster of granules at the position of the tubercle of *Gonipterus,* but not a strong isolated tubercle. Pascoe considered that *Oxyops* and *Gonipterus* were not both needed, but there are many species of both that may be readily identified generically.

EE. On several species of *Oxyops* the eyes are but little more prominent than in *Pantoreites,* but the two genera are abundantly distinct.

Minia not included as unknown to myself, and its subfamily doubtful.

Following is a list of the species, with their known geographical distribution.

Oxyops, Schon.

alphabetica, Lea	Q.. S.A., C.A.
amplipennis, Lea	N.S.W.
arcifera, Pasc.	Q.
aulica, Pasc.	Q., N.T.
interrupta, Blackb.	
bilunaris, Pasc.	Q.. N.S.W., V., S.A.
calida, Pasc.	N.W.A.
clathrata, Boh.	S.A.
concreta, Pasc.	Q.. N.S.W.
crassirostris, Pasc.	V., S.A., W.A.
crassicornis, Mast.	
decipiens, Lea	Q.
excavata, Boi.	Q.. N.S.W.
favosa, Boh.	
farinosa, Pasc.	V., S.A., W.A.
fasciata, Boi.	Q.. N.S.W., V.. T., S.A., W.A., N.W.A., N.T., C.A.
obliquata, Boh.	
parallela, Blackb. var.	
fasciculata, Redt.	Q., N.S.W., V., S.A.
maculata, Blackb.	
florea, Pasc.	W.A.
frenchi, Lea.	Q.
gemella, Pasc.	V., S.A., W.A.
griffithi, Lea	Q.
grisea, Lea	Q.
hopei, Boh.	Q., S.A.
hyperoides, Pasc. (*Gonipterus*)	Q.
simplex, Lea	
irrasa, Pasc.	Q.. N.S.W.

marginalis, Pasc.	Q., N.T., N.W.A.
armata, Blackb.	
mastersi, Pasc.	N.S.W., S.A., N.W.A.
meles, Pasc.	W.A.
memnonia, Pasc.	W.A.
modesta, Lea	N.S.W., V.
modica, Blackb.	N.T.
mucronata, Lea	Q.
multidentata, Lea	N.W.A.
niveosparsa, Pasc.	Q.
nodicollis, Lea	Q.
pallida, Lea	N.W.A., N.T.
parvicollis, Lea	Thursday I.
pictipennis, Blackb.	V., S.A., W.A.
serricollis, Lea	
placida, Blackb.	N.S.W.
posticalis, Lea	S.A., W.A., C.A.
pruinosa, Pasc.	Q., N.W.A.
reticulata, Boi. (*Gonipterus*)	N.S.W., S.A.
cancellata, Boh.	
rufa, Lea	N.S.W., V.
rutila, Pasc.	W.A.
scabra, Lea	Q.
scabrosa, Boi. (*Gonipterus*) .	Q., N.S.W.
squamulosa, Boh.	
scoparia, Lea	V., S.A., W.A.
sepulchralis, Pasc. (*Gonipterus*)	S.A.
sicca, Blackb.	N.T.
soror, Lea	Q., N.W.A., C.A.
sparsuta, Pasc.	W.A.
spencei, Blackb.	N.T.
tuberculata, Perr.	Australia
turbida, Pasc. (*Gonipterus*)	N.S.W., V., S.A., N.W.A., N.T., C.A.
obscura, Blackb. (*Medicasta*)	
minuscula, Lea	
uniformis, Lea	
vacillans, Lea	Q., S.A., W.A.
vitiosa, Pasc.	Q.

Gonipterus, Schon.

balteatus, Pasc.	Q., N.S.W., V., S.A.
cinnamomeus, Pasc.	Q.
citriphagus, Lea	W.A.
crassipes, Lea	Q., N.S.W.
exaratus, Farhs.	Australia
excavifrons, Lea	Q., N.S.W., S.A.
ferrugatus, Pasc.	Q., N.S.W.
geminatus, Lea	N.S.W.
gibberus, Boi.	N.S.W., V., T., S.A.
lateritius, Blackb. (*Oxyops*)	W.A., N.W.A., N.T.
lepidotus, Gyll.	Q., N.S.W., V., T.
notographus, Boi.	Australia
pulverulentus, Lea	N.S.W., V.
rufus, Blackb.	Q., N.S.W., V., T.
scutellatus, Gyll.	Q., N.S.W., V., T.
suturalis, Gyll.	N.S.W., V., S.A.
xanthorrhoeae, Lea	N.S.W.

Bryachus, Pasc.

squamicollis, Pasc.	Q., N.S.W., V., S.A., W.A., N.W.A., C.A.

Iptergonus, Lea.

aberrans, Lea (*Oxyops*) . . .	W.A.
bifurcatus, Lea	Q.
cionoides, Pasc. (*Gonipterus*)	N.S.W.
niveopictus, Lea	N.S.W.

Pantoreites, Pasc.

P. breweri has been transferred to *Lycosura.*

arctatus, Pasc. (*Oxyops*) . .	V., S.A., W.A., C.A.
brevicollis, Lea	
cretatus, Pasc.	W.A.
illuminatus, Lea	V., T., S.A.
major, Lea	V., S.A.
micans, Lea	W.A.
scenicus, Pasc.	N.S.W.
trilinealbus, Lea	N.S.W.
trivirgatus, Lea	W.A.
virgatus, Pasc.	S.A., W.A.
vittatus, Pasc.	N.S.W.

Prophaesia, Pasc.

albilatera, Pasc.	S.A.
Pantoreites longirostris, Lea.	
florea, Pasc.	W.A.
confusa, Pasc.	T.
cretata, Pasc.	V., S.A.

Syarbis, Pasc.

alcyone, Lea	N.S.W., V., T.
deyrollei, Roel. (*Acroteriasis*)	Australia
emarginatus, Roel. (*Acroteriasis*)	W.A.
eucalypti, Lea	N.T.
fasciculatissimus, Lea . . .	N.W.A.
gonipteroides, Pasc.	W.A., N.W.A., C.A.
goudiei, Lea	V., S.A.
haagi, Roel. (*Acroteriasis*) .	N.S.W.
plumbeus, Lea	
sciurus, Pasc. var.	
nervosus, Pasc.	Q., N.S.W.
niger, Roel. (*Acroteriasis*) .	N.S.W.
plumbeus, Lea	
nubilus, Roel. (*Acroteriasis*)	Q., N.S.W., V., N.T.
brevicornis, Lea	
pachypus, Pasc.	Q.
porcatus, Lea	N.S.W., S.A., W.A.
pulchellus, Lea	W.A.
pulchripennis, Lea	N.W.A.
punctipennis, Roel. (*Acroteriasis*)	Australia

sciurus, Pasc.	W.A., N.W.A.
semilineatus, Pasc.	W.A.
simulans, Lea	N.S.W.
subnitidus, Roel. (*Acroteriasis*)	Australia

Minia, Pasc.

opalescens, Pasc.	N.S.W.

I have to thank Mr. Gilbert J. Arrow and Dr. G. A. K. Marshall, of the British Museum, for information as to some types in that Institution.

Oxyops reticulata, Boi.

Two specimens of this species, from the Blue Mountains, are slightly smaller (9 mm.) than usual, and have the elytra with thin scales forming a fairly distinct fascia at the summit of the apical slope; on many specimens this fascia is not traceable, and it is usually very feeble. Two specimens of normal size, from Sydney, have the prothoracic granules and elytral punctures larger than usual, and the elytra have two subapical tubercles that are hardly indicated on others.

Oxyops scabrosa, Boi. (*Gonipterus*).

O. squamulosa, Boh.

The description of *O. scabrosa*, an unusually lengthy one for Boisduval, makes it practically certain that it was founded upon the same species as *O. squamulosa*, over which it has precedence.

Oxyops fasciata, Boi.

O. parallela, Blackb. var.

The type and a co-type of *O. parallela* are in the South Australian Museum, and I think they should be regarded as representing a variety of *O. fasciata;* they differ from most specimens of that species in the derm being of a dingy reddish-brown, instead of jet black (when the meal has been removed), and the third interstice is more strongly ridged, or with an elongated tubercle, near the base, and again about the summit of the apical slope. It has been already noted (1) that the length given in the original description should have been four lines, not two. A specimen from Queensland (Somerset), probably represents another variety; it is smaller (7 mm.) than usual, and has the tips of elytra more conspicuously mucronate; is of a dingy brown (except that the pronotum is blackish), and has a greater area about the scutellum clothed with whitish scales; but the postmedian fascia is normal. In the Queensland Museum there are three specimens, from Brisbane, that are decidedly wider than is usual in *fasciata.* In the South Australian Museum there is a specimen of *fasciata* from Charters Towers, in which the colour is almost identical with the types of *parallela*, but the third interstice is normal. A specimen from Oodnadatta is normally dark, but has the elevations of the third interstice even more pronounced than on *parallela*. The scales composing the postmedian fascia also vary; on some they are shorter and fully twice as wide as on others. Cleaned specimens, with snowy-white scales, look very different from others densely covered with a rusty-looking meal, although this seems to be more easily lost than on many other species.

Oxyops clathrata, Boh.

The description of this species, except for the rostrum, reads as if it might have been founded upon a specimen of *O. farinosa*, from which the meal had been entirely removed (by immersion in alcohol, etc.). The rostrum, however, was described as unicarinate, and in *farinosa* it is tricarinate, the median carina well-defined, the others feeble and oblique. If the names are synonymous *O. clathrata* has priority. I have seen the name applied to *O. reticulata*, but that can hardly be correct, as each elytron has two tubercles on the apical slope.

Oxyops pruinosa, Pasc.

Specimens of this species in perfect condition are so densely covered with ochreous-grey or ashen meal that the derm is concealed, except that a few granules and the median carina are visible on the pronotum; on being partly removed the alternate interstices of the elytra show up conspicuously, but the punctures usually remain full; on washing the elytra to remove the meal, the alternate interstices are seen to be distinctly elevated and granulate, although not throughout; the basal half has large punctures, often ringed with granules, and in places there are slight granulate elevations connecting the raised interstices; posteriorly, however, the elevations (except for a tubercle on the fifth interstice) decrease, and the punctures become smaller; there are numerous minute scales on the elytra that are normally concealed. Of this species I wrote to Mr. Arrow that " Blackburn and I separately identified the same species as *pruinosa* Pasc.; his specimens were almost completely covered with meal, mine were partly cleaned, and I washed one with chloroform to remove the whole of the meal. These specimens look very different. Do you think from comparison of the types, that it is the same as *calida?* Both are large, from Nicol Bay, and from the descriptions I imagined they might be the same with the clothing and meal differently preserved." In reply Dr. Marshall wrote: " The differences between *calida* and *pruinosa* are not due merely to the efflorescence. The unique type of *calida* is a female, and differs from the unique male of *pruinosa* in being distinctly broader; the elytra have more prominent humeral angles, and on each there are two slightly raised oblique lines, one at about the middle and the other behind;

on the dorsal surface all the scales are slightly but constantly narrower; the mesosternal process is longer and sharper; and the apical mucro on the hind tibiae is shorter. These may all be individual or sexual differences, but it would be unwise to unite the species until this has been confirmed by examination of more material. A female in the British Museum from Alexandria, identified by you as *pruinosa*, has the elytra somewhat more elongate than in *calida*, with the humeral angles much sharper, and the scales are much longer and thinner, being practically setiform. This seems less likely to be the true female of *pruinosa* than is *calida*. If not a distinct species, it must be at least a well marked subspecies. But it is difficult to reach a decision without much more material." In an additional note Dr. Marshall wrote, "*O. calida*, female, is extremely close to *pruinosa*, male, and may be only the other sex; the sculpture is coarser, the raised areas being rather more raised; the scales on the elytra are rather narrower, the scales on the venter are uniformly narrow, whereas in *pruinosa* there are narrow and broad scales intermingled."

Oxyops farinosa, Pasc.

In previously commenting on this species (2) I stated that the tibiae were "entirely without the numerous small teeth so common in the subfamily." This is incorrect: there are some small teeth there, but they are normally almost or quite concealed by the clothing. On washing with chloroform the meal may be entirely removed, when the body is seen to be entirely deep black, and clothed with rather long setae, except on the elytra, where the clothing is very short. On cleaned specimens (as on many others of the genus) the true fourth joint of the tarsi appears as a minute basal portion of the claw-joint. The species occurs in many parts of Western Australia, South Australia (including Kangaroo Island), and Victoria.

Oxyops aulica, Pasc.

O. interrupta, Blackb.

A large species, extending to 18 mm., although usually somewhat smaller. When in perfect condition the surface is almost completely concealed by meal. This is of one colour on the individual, but varies from a bright ochreous to dark brick-red or a muddy-brown (the latter probably discoloured). On removing the meal the elytra are seen to be clothed with small scales, and the raised interstices to have numerous granules; the larger punctures are also ringed with granules. From most of the large species it is distinct by the prominent humeral tubercle, which is often subacute, although less acute than in *O. marginalis* (a much smaller species). *O. pruinosa*, in which the shoulders are somewhat similar, is without a distinct tubercle between each shoulder and the suture. Three specimens of *O. aulica*, in the Blackburn collection, were placed as *O. excavata*, but the latter species, as identified in my collection, differs in the rostrum, pronotum, and particularly in the elytra.

The type of *O. interrupta*, in the South Australian Museum, in 1926 was so greasy and dirty that it was necessary to wash it with chloroform; on this being done it became evident that it was a small specimen of *aulica*.

Oxyops gemella, Pasc.

In general appearance many specimens of this species approach those of *O. crassirostris*, and the appearance of both is considerably altered by immersion in alcohol., partial abrasion, etc.; but they may be readily distinguished, *inter se*, by the rostrum, that of *gemella* being parallel-sided, or slightly narrowed to the apex, and that of *crassirostris* being shorter and slightly dilated in front; specimens of the latter species often have, when in perfect condition, a long ridge of white setae on the third interstice, crowning the apical slope, and a shorter one on the fifth (the two sometimes connected), as they are depressed they can hardly be regarded as fascicles. In *gemella* there is usually an irregular patch of scales crowning the apical slope, but it is more oblique, and composed of shorter scales. Two specimens doubtfully identified by Blackburn (3) as *O. florea* belong to *gemella*.

Oxyops bilunaris, Pasc.

Two specimens in the National Museum, from Victoria, are densely covered with a pale ochreous or chalky meal, concealing most of the clothing or derm, but leaving two large round blackish spots on the elytra, behind which the semilunar white marks, typical of the species, may be traced. From other specimens the meal is entirely absent, the round patches are deep black and very conspicuous, and the semilunar marks are of a snowy whiteness. Even on badly abraded specimens the round spots can be traced, and the semilunar white marks are seldom completely absent.

Oxyops marginalis, Pasc.

O. armata, Blackb.

Dr. Marshall, from comparison of the types, confirmed my conjecture that these names are synonymous.

Oxyops turbida, Pasc. (*Gonipterus*).

Medicasta obscura, Blackb.

O. minuscula, Lea.

O. uniformis, Lea.

This species is one of the most widely distributed of the genus; specimens before me are from South Australia (Ardrossan, Murray Bridge, Tanunda, Blanchetown, Lyndoch, Ooldea, Oodnadatta, Hergott); Victoria (Sea Lake, Grampians), New South Wales (Mulwala, Tamworth); North Western Australia (Fortescue River and Murchison). The average size is about 6 mm., but it varies from 5 to 7. Fresh specimens are more or less covered with a rusty coloured meal, that partially conceals the clothing and derm; on many such specimens, however, a vague dark cross may be seen on the elytra. On removing the meal the scales are seen to be white, and to form three vittae on the pronotum and irregular fasciae on the elytra; a vague white cross on the elytra may often be noted. On the elytra the third and fifth interstices are but slightly elevated, more noticeably so at the summit of the apical slope, where the third often has a subfasciculate appearance. Specimens differ greatly in appearance with the partial removal of the meal and scales. *O. minuscula* has already been noted as a synonym, and *O. uniformis* has now to be added.

The above note was prepared recording *O. minuscula* and *O. uniformis* as synonyms of *obscura*. Dr. Marshall now informs me that they are synonyms of *Gonipterus turbidus*, which is an *Oxyops*.

OXYOPS SPARSUTA, Pasc.

Black, squamose and mealy.

Rostrum distinctly transverse, in front with rather small naked punctures, becoming larger and partly concealed elsewhere, with a short flat median carina, beginning immediately in front of an interocular groove. Antennae moderately thin, no joint of funicle distinctly transverse. Prothorax moderately transverse, sides rounded, base distinctly wider than apex; with large punctures, margined with granules, and with a short median carina. Elytra much wider than prothorax, shoulders somewhat thickened, beyond these parallel-sided to apical third, with rows of large, oblong, jagged punctures, becoming smaller posteriorly; interstices densely granulate. Mesosternal process well produced. Tibiae multidenticulate. Length, 7·5-9 mm.

Western Australia: Cunderdin, in September and October, Kellerberrin, Kalgoorlie, Mullewa and Ankertell.

Very distinct from all other species before me. The body parts appear to be always deep black, but the joints of the funicle are sometimes obscurely diluted with red. The meal varies from a muddy-yellow to yellowish-brown, and when dense, greasy or caked, fills many of the punctures and obscures the scales. The latter are really snowy-white; on the upper surface they are all pressed close to the derm, and are mostly rather wide; on the under parts they are mostly thinner. On the pronotum they form five feebly defined lines; on each elytron they appear as wide margining lines of black spots; four close to the suture, and four towards the side, the largest one is postmedian, and is sometimes connected with one on the side; occasionally there are ten spots on each elytron. On specimens in

Oxyops pictipennis, Blackb.

O. serricollis, Lea.

Two specimens, from Victoria and Kangaroo Island, appeared to agree with the description of *O. pictipennis;* they are bright red, with jet-black markings on the prothorax and elytra. They were seen subsequent to my description of *O. serricollis*, but considering that they were really immature specimens of that species, I asked for specimens to be compared with the type, and in reply Dr. Marshall wrote: " The darker specimen of *O. serricollis* from Kangaroo Island agrees well with the type of *pictipennis*, except that the latter is smaller and the setae on the elytra are slightly narrower. *O. irrasa* Pasc. (a female) is closely allied but distinct; Pascoe had actually associated with the type a black specimen of *pictipennis*. In *irrasa* the antennae are black, proportionately shorter and stouter, joint 2 of the funicle being shorter than 3+4 (equal to 3+4 in *pictipennis*); the frontal fovea is much larger and deeper, and the vertex is clothed with broad flat scales; the punctures and granules on the prothorax are somewhat fewer and larger; the elytra are broader and more quadrate, with the sculpturing very similar, but there are several dense tufts of long, ribbon-like erect scales; the bare impunctate patch in the middle of the venter is much larger, occupying one-third of the width on ventrites 3 and 4, and extending forwards to the middle of ventrite 2; the clothing of the lower surface consists of large broad flat scales, alternating with stout suberect setae." Fresh specimens are moderately covered with a brick-coloured meal. The derm on mature specimens is usually deep black, but on many is of a more or less dingy brown; in many the elytra appear to be black, irregularly mottled with red, or red mottled with black. On washing with chloroform all the scales are seen to be white. Several specimens have some loose fascicles of long setae on the elytra.

Oxyops sicca, Blackb.

A co-type of this species, in the National Museum, is fairly close in appearance to some specimens of *O. fasciata*, but the post-median fascia instead of extending forwards from the suture, is extended backwards from it; each elytron, as viewed from the side, appears to have two black spots, due to absence of clothing, one at the middle (filled with large punctures; from above this appears as an obtuse-angled triangle, forming, with its mate on the other elytron, an arrow-head), the other on the apical slope. A partly abraded specimen, without locality label, also in the National Museum, possibly belongs to the species, but the third interstice is strongly elevated at the base, again at the summit of the apical slope and moderately between, the fifth and seventh are somewhat elevated from beyond the middle to near the apex. On the co-type the third is only moderately elevated in parts, and the fifth and seventh are scarcely elevated above the adjoining ones.

good condition, but which have been soaked in chloroform, the spots are quite sharply defined, they vary somewhat in extent but not in disposition; even on old and greasy examples they are usually sufficiently distinct. On clean ones the granules are very distinct, especially on the bald parts. The body parts appear to be always deep black, but the joints of the funicle are sometimes obscurely diluted with red.

The above description was drawn up under the impression that the species was a new one, with a very short rostrum as in *O. sparsuta,* but differing from it in not having the scales of the upper surface "very slender bristle-like." Some specimens that were sent for comparison Dr. Marshall labelled "*Oxyops sparsuta* Pasc. var," and wrote of them, "Agrees with *O. sparsuta* Pasc., except that in your insect the scales are more elongate and less regularly elliptical, and the pattern is more sharply defined." Commenting on the species in a list, Mr. Arrow wrote, "Extremely like *O. florea* Pasc., but with roundish scales."

Oxyops sepulchralis, Pasc. (*Gonipterus*).

The original description of this species is insufficient for its certain identification, and implies ("squamulis griseis rarissime dispersis") that the type was badly abraded. Dr. Marshall writes that, "The type is a much abraded and dirty specimen. The posthumeral tubercle is absent, but there is a small conical projection on the mesosternal process, so that it should be transferred to *Oxyops.* In general form it looks like a small specimen of *O. crassirostris* Pasc., but the rostrum is longer than broad, the pronotum is not flattened, and sculpturing of the elytra less coarse, the basal tubercles being much reduced."

Oxyops florea, Pasc.

I wrote to Mr. Arrow, "Blackburn identified, with doubt as *florea,* the species you sent to me as *gemella.* I shall be glad if you will compare the types, particularly in the rostrum and third and fifth interstices of elytra, and let me know if you consider them synonyms." In reply, Dr. Marshall wrote, "*O. florea* and *O. gemella* are quite distinct.

"*O. florea.*—Longitudinal dorsal outline of rostrum strongly convex; eyes nearly flat; joint 3 of funicle nearly as long as 4; scales above and below comparatively long and narrow, most of them more or less raised, and some even subcrect; the dorsal surface more rugose and with conspicuous shining granules.

"*O. gemella.*—Dorsal outline of rostrum flat; eyes strongly convex; joint 3 of funicle much shorter than 4; scales above and below much shorter and broader, all closely recumbent; the dorsal surface less rugose, the granules much flattened and nearly obliterated. A distinctly smaller insect."

Oxyops soror, Lea.

Fresh specimens of this species are densely covered with a pale ochreous (almost stramineous) meal, in parts completely concealing the scales and derm; on being washed with chloroform the surface is seen to be almost evenly clothed with snowy-white scales, somewhat smaller on the elytra than on the pronotum.

Oxyops modesta, Lea.

Victorian specimens of this mountain species, in the National Museum, vary in length from 7 to 10 mm.

Oxyops decipiens, Lea.

Some specimens of this species, from Brisbane, are in better condition than the types; two of them are rather densely covered with a sooty-brown meal; a third has evidently been in alcohol, and is without meal, its clothing is almost snowy-white; its elytra have very large punctures in about ten rows, three or four deep, from about the basal third to beyond the middle, then there is a zigzag fascia with a lichenous appearance, beyond which part of the surface is again covered with large punctures.

Oxyops parvicollis, Lea.

Numerous specimens, recently taken on Thursday Island (the original locality), are rather densely covered with a snuff-coloured meal; to the naked eye each elytron appears to have two large, rusty-brown or blackish, transverse spots, one on the shoulder, the other just before the middle, the first extending to near the suture, the second to near the side. On removing the meal with chloroform the derm is seen to be intensely black, irregularly clothed with snowy-white scales. These are absent from a space on each elytron, resembling a C (commencing on the shoulder) on the right, or, on some specimens almost like an irregular O; behind it there is a conspicuous curved fascia of white scales (wider and less regular than on *O. bilunaris*, from which it also differs in many other respects). After washing, the prothorax appears to have four oblique black lines, due to granules showing through the scales, in addition to the median carina.

Oxyops scoparia, Lea.

The derm of this species is usually of a dark reddish-brown, but it and the scales and fascicles are often partly obscured by a snuff-coloured meal. Some South Australian specimens, that were in alcohol for some months, are completely free from meal, two of them are of normal colour, but the other is much paler (almost castaneo-flavous); their punctures are all deep and sharply defined, and are close together, although nowhere confluent. Five specimens, from Western Australia, are much darker (two of them have the derm of the prothorax and elytra entirely deep black, and two are black except that most of the pronotum and the sutural region are reddish), and the fascicles crowning the tubercles are decidedly shorter (the five are alike in this respect, so it is evidently not due to abrasion). Specimens from which the scales and fascicles are abraded, are, in general appearance, close to those of *O. fasciculata* similarly abraded, but may be readily distinguished by the decidedly larger and sparser granules surrounding the elytral punctures.

Oxyops vacillans, Lea.

On fourteen fresh specimens of this species, from Western and South Australia and Victoria, the intercoxal process of the mesosternum is produced as on many species of *Oxyops*, but on ten of them the latero-posthumeral tubercle is quite that of a normal *Gonipterus*, so that quite justifiably it might be referred to either genus. The whitish sutural vitta has numerous short projections on each side, and as the suture itself is usually blackish, it has a quite characteristic appearance.

Oxyops areolicollis, n. sp.

Dark reddish-brown. Densely clothed, multifasciculate and mealy.

Rostrum slightly longer than its subapical width, with a median depression obscured by clothing. Antennae rather short, fourth to seventh joints of funicle transverse, club short, its greatest width not twice that of the preceding joint. Prothorax about as long as wide, sides strongly rounded, granulate and strongly punctate. Elytra much wider than prothorax; with closely set rows of large punctures, each surrounded by small granules; fascicles supported on multigranulate elevations, especially those on the third interstice. Mesosternal process moderately produced and obtusely pointed. Tibiae with numerous small, but almost concealed teeth. Length (excluding rostrum), 7-8 mm.

Western Australia: Ankertell (H. W. Brown); Queensland: Cunnamulla (H. Hardcastle).

A rough strongly fasciculate species, allied to *O. fasciculata* and *O. scoparia*, but readily distinguished from both by the considerably wider funicle, which at first glance appears to be continuous with the club, although not as in *Bryachus squamicollis*. Fresh specimens are covered with an ochreous or brickdust-like meal, which causes the clothing to appear somewhat similarly coloured; but after washing with chloroform the clothing is seen to be almost snowy-white; on the under surface and legs it consists of stout setae or thin scales. On the pronotum there are three conspicuous lines of white clothing (the median one wider than the others), traversed by a line at the apex and another at the middle, so that the disc appears divided into four small squares, in addition a small square (partly visible from above) is marked off on each side of the base. The scutellum is densely clothed. The elytral clothing is rather sparse, except for the fascicles; of these there are from twelve to about fifteen on each elytron, the largest of all crowns the apical slope on the third interstice, and the longest is near its base. The clothing, however, is easily disarranged. The prothorax before abrasion appears slightly transverse, and the clothing obscures most of the punctures and granules, the latter on the sides are rather large and pointed; on the elytra there are numerous granules on the suture, but they are normally concealed, the meal also obscures many of the granules ringing the punctures, the granules being nearer those of *O. scoparia* than of *O. fasciculata.*

Oxyops multiarmata, n. sp.

Dark reddish-brown. Squamose, fasciculate and mealy.

Rostrum slightly longer than the subapical width; punctures distinct in front, but partly concealed elsewhere. Antennae rather short, three apical joints of funicle transverse, and about half the width of club at its widest. Prothorax slightly longer than wide, sides strongly rounded; with large punctures and large subconical granules. Elytra much wider than prothorax; with rows of large punctures, ringed with small granules, in addition with numerous subconical tubercles; shoulders conspicuously armed. Mesosternal process moderately produced. Tibiae multidentate. Length, 7·5 mm.

Australia (J. Clark). Unique.

Readily distinguished from all the other fasciculate species by the numerous subacutely conical tubercles on the elytra, averaging about six on the odd interstices, from the third to the ninth. On *O. scoparia* there are many small pointed granules, all below the level of the tubercles supporting the fascicles; but on this species the tubercles are conspicuously above the support of the fascicles; these are also differently disposed and the shoulders are different. The fascicles, although conspicuous, have less elevated supports than those of the preceding species. The type being unique, was not washed with chloroform, but most of the meal (apparently of a muddy-yellow colour) has been removed and the clothing is seen to be white; on the under-surface and legs it consists of stout and fairly wide scales intermingled. From the prothorax the clothing appears to be partly abraded, but it was evidently dense in parts. On the elytra there are many small and several fairly large fascicles, of the latter four form a transverse series beyond the middle.

Oxyops insignis, n. sp.

Black. Densely clothed with white scales and setae, mixed with a pale brownish meal.

Rostrum slightly longer than its apical width, with a shining median carina, most of its surface concealed by clothing. Prothorax moderately transverse, surface very uneven, and with a distinct median carina. Elytra much wider than prothorax; with rows of large punctures; apex mucronate; each elytron with seven large tubercles, and with a conspicuous granulated ridge below the shoulder. Mesosternal process acute. Denticulations of tibiae concealed by clothing. Length, 14 mm.

Queensland: Townsville in August (F. P. Dodd). Type (unique) in British Museum.

The type being in almost perfect condition as regards its meal and clothing, was not washed with chloroform to enable the derm to be clearly seen, as the species is a very distinctive one by the seven large tubercles on each elytron; of these there are three on the third interstice, the largest of all subbasal, the second median, and the third crowning the apical slope; on the fifth interstice there are also three slightly posterior to those on the third, but in addition there is a fairly distinct but small one, halfway beween the first and second; the other large tubercle is humeral.

OXYOPS TESSELLATA, n. sp.

Black, parts of antennae and of tarsi, obscurely diluted with red. Upper surface with small, round, glittering white scales, under surface with similar scales, mixed with thinner ones.

Rostrum strongly transverse; with comparatively small punctures, becoming larger near eyes. Antennae rather long and thin. Prothorax distinctly transverse, sides strongly rounded; with large punctures surrounded by distinct granules; median carina fairly long. Elytra much wider than prothorax; with rows of large, deep punctures, the interstices multigranulate; tips feebly mucronate. Mesosternal process well produced. Tibiae with close set but obscured denticulations. Length, 9 mm.

Western Australia: Kellerberrin, in January, on spearwood (J. Clark). Unique.

The rostrum is even shorter than on *O. sparsuta,* and its punctures are decidedly smaller. The scales on the elytra appear like small discs of mother-of-pearl, closely applied to the derm or inlaid. Many are quite circular; to the naked eye they cause the surface to appear speckled; on the pronotum they are usually less rounded, although mostly wide; and appear to form several feeble lines. A small amount of muddy-yellow meal was present on the type.

OXYOPS LEUCOPHOLA, n. sp.

Black, parts of antennae and of legs obscurely reddish. Clothed with white scales and setae.

Rostrum slightly longer than subapical width; with coarse, crowded, partially concealed punctures, except in front, where they are smaller and naked. Antennae moderately stout. Prothorax slightly shorter than the base, but distinctly longer than apex, sides rounded; with crowded granules and a short median line. Elytra much wider than prothorax, sides decreasing in width almost from base; with rows of large, deep punctures, almost evenly decreasing in size posteriorly; interstices narrow and multigranulate, the odd ones slightly elevated; the third more noticeably near base than elsewhere (but not tuberculate), where the granules are unusually large and dense, shoulders thickened and with crowded granules. Mesosternal process acutely pointed. Tibiae multigranulate. Length, 9·5 mm.

New South Wales: Grenfell (Dr. E. W. Ferguson). Unique.

A speckled species due to numerous small clusters of snowy scales on the elytra. It is near *O. irrasa* and *O. pictipennis*, but the elytra are slightly more triangular in appearance, and are non-fasciculate (although the scales are not all placed singly), the pronotum has smaller granules and the rostrum is somewhat different. The type is without meal. The scales are white (on mealy specimens they would, no doubt, appear different); on the elytra they are of two kinds: stout and rather large ones, sloping at an angle of about 45°, and usually placed behind the punctures; and minute ones, closely applied to the derm; on the pronotum the scales are fairly large and form feeble lines; on the under parts the clothing consists of fairly stout setae interspersed with scales. The prothoracic granules are of several sizes intermingled, they appear to arise from an impunctate surface, or at least not to encircle punctures as on several other species.

Oxyops carinirostris, n. sp.

Black, antennae and tarsi obscurely reddish. With white clothing.

Rostrum slightly longer than wide; apex with dense and minute punctures rapidly becoming coarser, but still glabrous to about middle, thence to base still coarser, but partly concealed by clothing; with a median carina from interocular groove to middle, where it ends in a cross piece. Antennae moderately thin. Prothorax slightly shorter than the base, which is distinctly wider than apex, sides rather strongly rounded; densely punctate and granulate, and with a short median carina. Elytra much wider than prothorax; with rows of large, deep punctures, becoming smaller posteriorly; interstices rather narrow and multigranulate, the alternate ones feebly elevated in parts, the third more noticeably near base, but not tuberculate there; tips scarcely mucronate. Mesosternal process well produced. Tibiae conspicuously multidenticulate. Length 8·5-9·5 mm.

South Australia: Kangaroo Island (A. H. Elston and J. G. O. Tepper).

In general appearance the three specimens taken are like small rubbed ones of *O. reticulata*, slightly less parallel-sided than usual; but they differ from that species in having the elytral punctures smaller, more regular, and more evenly ringed with granules, and the rostral carina in the form of an elongated T. All the specimens have some dark brown (almost black) meal. The clothing on the under surface is not very dense, and consists of long, thin, white setae, becoming denser on the legs; on the pronotum similar setae are fairly dense along the middle, and form two inconspicuous lines on each side; the elytra are glabrous, except for a few setae at the base and sides.

OXYOPS SEMICIRCULARIS, n. sp.

Dark brown, some parts paler. Densely clothed with white scales, and heavily covered with pale meal.

Rostrum slightly longer than wide; apical half naked, and with dense punctures, basal half with coarser, partly concealed punctures, and with a thin median carina starting from the interocular groove. Antennae moderately long, no joint of funicle transverse, club rather long. Prothorax slightly transverse, sides rounded and slightly wider at base than at apex; densely granulate-punctate. Elytra much wider than prothorax, subparallel-sided to beyond the middle; with regular rows of large punctures, becoming smaller posteriorly; interstices mostly wider than punctures, the third somewhat elevated near base, with numerous minute granules. Mesosternal process moderately produced. Tibiae short, with numerous partly concealed denticulations. Length, 5·5-6·5 mm.

New South Wales: Bogan River (J. Armstrong); South Australia (National Museum), Ardrossan (J. G. O. Tepper).

Specimens in good condition are so densely covered with scales and meal that the derm is concealed, and the punctures, even on the elytra, are often completely filled; on all such specimens, however, there is a conspicuous black semicircle at the base of the elytra, enclosing a subquadrate, whitish scutellar patch; there may also be noticed three vague lines on the pronotum, where the scales are more condensed ,and a line of white scales on the apical half of the suture. On removing the meal with chloroform, the scales are seen to be white throughout, and the basal semicircle of the elytra (which then becomes ill-defined), is seen to be due to sparsity of clothing. On the pronotum the scales are dense, rather long and almost evenly clothe the surface, except that they are denser along the middle than elsewhere. On the elytra the scales are smaller than on the prothorax, and most of them project backwards from minute granules; on the suture and about the scutellum they are larger than elsewhere. Washed specimens, compared with washed ones of *O. obscura*, are seen to differ in having the clothing sparser (except on the suture), the antennae are longer and the club decidedly thinner; unwashed specimens are at once distinctive by the black semicircle.

OXYOPS MICROLEPIS, n. sp.

Dark reddish-brown, antennae and tarsi (the claws black) paler. Densely squamose and mealy.

Rostrum slightly longer than wide; with small naked punctures in front, coarse and dense elsewhere. Antennae rather short, several joints of funicle transverse; club unusually short, being not much longer than its greatest width. Prothorax slightly transverse, base distinctly wider than apex; closely and evenly granulate-punctate. Elytra much wider than prothorax, feebly diminishing in width from shoulders to beyond the middle, tips scarcely mucronate; with rows of large deep punctures, becoming smaller posteriorly; interstices evenly convex, but the odd wider than the even ones, with numerous small granules; shoulders somewhat thickened and multigranulate. Mesosternal process moderately produced. Tibiae multidenticulate; basal joint of tarsi unusually short. Length, 5·5-6 mm.

South Australia: Oodnadatta; Northern Territory: MacDonnell Ranges (Blackburn's collection).

A small species, structurally close to *O. obscura,* but fifth interstice not elevated above the adjacent ones even near the base, and elytral scales uniformly disposed, except that they are denser about the scutellum than elsewhere. On washing with chloroform the elytra are seen to be nowhere subfasciate (as on *obscura*) or maculate. The elytral scales are individually much smaller and shorter than those of *obscura,* or the preceding species, being so short that (except a few near the suture) it would take several of them, placed end to end, to reach across the interstice on which they rest, whereas on those species most of the scales are at least as long as the interstices supporting them are wide; this is very conspicuous on washed specimens; on other part of the body the scales and setae are not so short. The scales are dense on most parts (less on the elytra than elsewhere), but they are so obscured by grease and meal on the only unwashed specimen in the collection, that on the pronotum no compacted lines are evident. The sutural interstice on each elytron is distinctly wider than the adjacent row of punctures, but many of these are wider than the adjacent interstices; their true sizes are normally concealed. The antennae are nearer those of *obscura* than the preceding species. *O. modica* has more prominent shoulders, less uniform elytral punctures and different clothing.

Oxyops parvoscabra, n. sp.

Black, antennae and tarsi reddish. Moderately clothed with thin scales or setae, denser on under surface and legs than on upper surface; meal rather dense and snuff-coloured.

Rostrum with coarse, crowded and partly concealed punctures, except in front, where they are much smaller and naked. Prothorax slightly transverse, sides rounded and increasing in width to base; densely granulate-punctate. Elytra much wider than prothorax, subparallel-sided to beyond the middle; with rows of large, deep, rough punctures, becoming smaller posteriorly; interstices narrower than punctures except near apex, the alternate ones feebly elevated in parts, and all rather coarsely multigranulate. Mesosternal process moderately produced. Tibiae multidenticulate. Length, 6-7 mm.

South Australia: Ardrossan (J. G. O. Tepper).

A small species, slightly wider than *O. turbata;* comparing washed specimens together, those of the present species are seen to have larger elytral punctures with narrower interstices, the granules of which are larger, so that the general appearance is rougher; the basal joint of the front tarsi, although short, is distinctly longer than in *turbata*, the antennae are also longer, only the sixth joint of the funicle being feebly transverse. From *O. semicircularis*, *O. modica* and the preceding species, it is distinct by the much larger and rougher punctures and granules, and the narrower interstices. The scales and setae are really white, but the meal causes than to appear darker; on the pronotum a median line of clothing is fairly distinct, and one or two others on each side are sometimes traceable. On most parts of the elytra the setae are sparse and thin, but about the summit of the apical slope and near the middle the clothing is stouter than elsewhere, and forms feeble spots on the third and fifth interstices, it is also fairly dense about the scutellum. Each prothoracic granule contains a seta directed forwards or inwards, the containing punctures being quite distinct on washed and abraded specimens. The tarsi are usually, but not always, darker than the antennae.

Oxyops platyodonta, n. sp.

Dark reddish-brown. Moderately clothed with rather long, thin, white setae, becoming denser on the under surface and legs.

Rostrum slightly longer than wide; with fairly coarse punctures becoming small in front; with a rather short carina starting from a deep interocular groove. Antennae moderately long, sixth and seventh joints of funicle feebly transverse. Prothorax almost as long as wide, sides parallel except near apex; with a short median carina and with dense granules, each containing a setiferous puncture. Elytra much wider than prothorax, feebly diminishing in width from near shoulders, with rows of large, deep, suboblong punctures, becoming smaller posteriorly; interstices usually wider than punctures, with numerous granules, third slightly elevated above the adjacent ones, near base thickened, more elevated and multigranulate, junction of third, fourth and fifth marked by a preapical callus. Mesosternal process acutely produced. Legs longer than usual; tibiae thin, denticulations inconspicuous; claws very wide and flat, suddenly becoming pointed at the tips. Length, 8 mm.

Northern Territory (Blackburn's collection from Dr. Bovill).

Readily distinguished from all other known species by the claws. The clothing consists entirely of thin setae.

Gonipterus gibberus, Boi.

There are before me nearly one hundred specimens of a species that is common in many parts of New South Wales, Victoria, and South Australia, and which vary in length, 7-10 mm., the average size of Tasmanian specimens being about a millimetre longer than mainland ones, but the smallest before me is from Tasmania. They all, unless badly abraded, have a conspicuous triangle of white clothing on each side of the elytra, wide on the sides and narrowing to the suture, which they may or may not reach, close behind the scutellum. They all have the posthumeral tubercle conspicuous. Some of them were named in my collection for many years as *G. exaratus,* but probably in error, as Fahraeus in his lengthy description of that species does not mention a white fascia or triangles. They are probably *G. gibberus,* of which Boisduval in unusually lengthy descriptions says, "*lateraliter obsolete albido fasciatis*"; also "*une bande blanchâtre, oblique et laterale*"; and "*une bande blanchâtre, large qui, partant du côté remonte sur l'élytre un peu au-delà du milieu.*" Boisduval also describes the elytra as having the first four rows of punctures, counting from the suture, as more distinct than the others, but their distinctness is dependent upon the scales and meal; he gives the length as four (French) lines, and the locality as New Holland. Fresh Tasmanian specimens are covered with a pale ochreous or almost stramineous meal, but it is lost in alcohol, and is seldom in good condition on old specimens, especially greasy ones, on which it is usually confined to the punctures. On washing specimens with chloroform the whole of the clothing is seen to be white, with the triangles conspicuous on account of the density of their clothing. On complete abrasion the derm, where the triangles used to be, is seen to be paler than the adjacent parts, and to have smaller punctures. I cannot satisfy myself as to the limits of the species, specimens of which range towards *G. balteatus,* and *G. pulverulentus,* either of which may be a variety; in *balteatus,* however, the fascia on each side is narrower than usual, and fresh specimens of it certainly look very different from ones with wide triangles; on *pulverulentus* the white markings always terminate some distance from the suture, and are widest about the middle instead of on the sides, and on fresh specimens the meal is of a dark dingy red. Some specimens also vary towards the species here regarded as *scutellatus,* but on that one the posthumeral triangles are usually inconspicuous, and often not traceable.

Gonipterus notographus, Boi.

The original description of this species is quite useless. M. Lesne, from examination of the type, was able to supplement it with particulars (4), making it certain that it is a true *Gonipterus,* but even these are insufficient for its reasonable determination.

Gonipterus suturalis, Gyll.

Typical specimens of this species, in good condition, may be readily recognised by a conspicuous line of white scales, or stout setae, continuous from between the eyes to the tips of the elytra, but wider on the prothorax than elsewhere. It was named originally from New Holland; specimens now under observation are from New South Wales, Victoria and South Australia. Three specimens from Tasmania, identified by Blackburn as *G. scutellatus,* and two in Simson's collection similarly identified, agree perfectly in structure with normal specimens of *G. suturalis,* but the white line stops abruptly a short distance behind the scutellum. There are also many other specimens from Queensland, New South Wales, Victoria, and Flinders Island (Bass Straits), agreeing with the Tasmanian ones, or with the sutural vitta intermediate between them and typical *suturalis.* Many of them are covered with a rusty-red meal (probably all are normally so covered when young). I am satisfied that these specimens are not the *scutellatus* as identified by Dr. Marshall from South African specimens, but really represent *suturalis,* with the vitta not continuous.

GONIPTERUS LEPIDOTUS, Gyll.

The description of this species might very well have been founded upon specimens of *G. suturalis,* with the white vitta stopping abruptly behind the scutellum. In the description the expressions "*humeris alte elevatis prominulis*" and "*callum humeralem*" might be regarded as not applicable of *suturalis,* one of the few species of which typical specimens may be identified with certainty; yet of *suturalis* itself Gyllenhal says, "*humeris alte elevatis prominulis,*" and "*pone callum humeralem.*" The shoulders of *suturalis* are almost square, and three striae terminate at each of them; they are also densely granulate (as is most of the surface), so that they appear somewhat thickened, but when viewed either from the sides, or directly from above, they do not appear to be strongly elevated above the adjacent parts; although when viewed obliquely from behind they certainly appear tuberculate. The type was from New Holland. If the names are synonymous *G. lepidotus* has precedence, although specimens with the sutural vitta continuous to apex might well be considered as var. *suturalis.* Specimens that I refer to the species are from Queensland, New South Wales, Victoria, Tasmania and South Australia.

GONIPTERUS SCUTELLATUS, Gyll.

As instancing the difficulty that has occurred in connection with the correct name of a species of this genus that has unfortunately been introduced to South Africa, South America and New Zealand, reference may be made to an article appearing in *The Journal of the Department of Agriculture* at Pretoria, for November, 1924 (5), when not less than six specific and three generic names were considered in connection with it as follows:—

Oxyops reticulata, Boi. (formerly *Gonipterus*).
O. cancellata, Boh.
Bryachus squamicollis, Pasc.
Gonipterus scutellatus, Gyll.

G. exaratus, Fhs.
G. rufus, Blackb.

The species is a most difficult one to place from the original descriptions, but in the article Dr. Marshall is quoted as positively identifying it as *G. scutellatus,* from comparison with a co-type in the Oxford Museum. I do not think it wise to go beyond this identification, unless proved erroneous by examination of the type itself, although the description applies to several other species, quite as well as the one occurring in South Africa.

There are now before me twenty-five specimens, all taken on the same day at Rosebank, South Africa. They all have a wide median line of white setae on the pronotum, continued on to the scutellum, and for a short distance beyond it, a large and pale but vague triangle on each elytron, commencing behind the basal asperities, and continued on each side to slightly beyond the middle, the surface close to the triangle has somewhat sparser clothing than elsewhere, so that it is slightly accentuated; immediately beyond it, to the naked eye, there appears a feeble oblique dark stripe, but the triangles and dark stripes are often scarcely traceable even on nonabraded specimens; on some a feeble line of white clothing may be seen between the median one and each side of the pronotum. The base of each elytron (as seen obliquely from behind) appears to be conspicuously trituberculate, the tubercles covered with small black granules, the first on the third instertice, the second (and smallest) on the fifth, and the third the shoulder, with the conspicuous posthumeral tubercle typical of the genus. These tubercles, however, are much as on most species of the genus. The size ranges 6-8 mm. Other specimens before me are from Queensland, New South Wales, Victoria and Tasmania; the type was from New Holland.

Of the other names mentioned:—

Oxyops reticulata was originally referred to *Gonipterus,* but is a true *Oxyops.*

O. cancellata has been recorded as a synonym of *reticulata.*

Bryachus squamicollis has distinctive antennae.

Gonipterus exaratus.—For years I had in my collection specimens identified as belonging to this species, but which now are regarded as probably belonging to *G. gibberus.* In the original description no mention is made of white elytral triangles, or a fascia, and the description might well have been drawn up from specimens here regarded as *G. lepidotus.* It was compared with *G. scutellatus,* but the differences mentioned would be quite consistent with the type being a partly abraded specimen of that species; if synonymous *scutellatus* has precedence.

G. rufus.—Small specimens with the triangles ill-defined are difficult to distinguish from specimens of *rufus,* that have been in alcohol and are without meal, but on such specimens of that species the elytral clothing is uniform, and there are never even vestiges of triangles.

Of other species with which it might be confused—

G. lepidotus.—The species here so regarded is consistently larger and is without a pale triangle on each elytron, but the clothing of the prothorax and scutellum is much the same.

G. gibberus.—The species here so regarded, when in good conditon, has conspicuous triangles, but small and partly abraded specimens are often difficult to distinguish from *G. scutellatus.*

Gonipterus cinnamomeus, Pasc.

A beautiful species, varying in appearance with the condition of the meal; when this is removed the clothing appears of a snowy whiteness, forming five lines on the pronotum, and the elytra are seen to have some nude black or blackish irregular spaces (including the elevations), about the base and on the apical slope, these, however, being well indicated on fresh specimens. It appears to be confined to Queensland.

Gonipterus balteatus, Pasc.

Specimens of this species in good condition are covered with a rusty meal, through which a conspicuous vitta of white clothing shows on the scutellar region, shortly behind which it bifurcates to near the middle of the sides; the base of the elytra appears blackish, as also behind where the white stripes diverge, between each of these and the dark base, to the naked eye, the surface appears gradually paler. Specimens without meal are deep black, with white scales and a conspicuous oblique line of white on each side, often disconnected with the scutellum. The pronotum has fairly dense white scales, but not forming a distinct vitta.

Gonipterus ferrugatus, Pasc.

Fresh specimens of this species have a conspicuously rusty appearance. The four prothoracic vittae noted by Pascoe are due to the irregularity of granules and punctures, and disappear when the scales are exposed through the removal (in alcohol, etc.) of the rusty meal; there is also a feeble median carina. A co-type, from the British Museum, has the intercoxal process of the mesosternum distinctly produced and pointed, much as on many species of *Oxyops,* but the general appearance and the strong, subconical, posthumeral tubercle are those of a normal *Gonipterus.* Some specimens from Brisbane and the Blue Mountains agree well with the co-type.

Gonipterus lateritius, Blackb. (formerly *Oxyops*).

The type of this species is in the South Australian Museum, and is certainly a small *Gonipterus,* having the conspicuous posthumeral tubercle typical of the genus. The intercoxal process of its mesosternum is feebly produced, but is not pointed (as it is in most species of *Oxyops*). Its rostrum is exceptionally short, being (near the apex) distinctly wider than long. It was very dirty, but, on being washed with chloroform, proved to belong to a species taken by Mr. W. D. Dodd at Derby, and of which forty specimens were preserved in alcohol for several months, thus removing all the meal. These specimens are almost uniformly clothed with depressed white setae, forming a median line on the pronotum, dense on the scutellum, and moderately dense on the shoulders. To the naked eye the elytra appear to have six nude spots, due to the clothing there being sparser than elsewhere; two at the base, and four on the apical slope, the latter forming the corners of a square; occasionally there are four feeble spots at the base or none, sometimes the upper two of the four apical spots are very feeble, and occasionally the two outer ones are almost conjoined. Two specimens were not placed in alcohol by Mr. Dodd, and have their meal in almost perfect condition; it is dense, dark stramineous or yellowish, and completely conceals the punctures, and much of the clothing, several dark spots being indicated on the elytra; they were pinned, and were rather greasy twelve years after capture. A specimen that was sent and agreed with them was washed with chloroform, and proved to be identical with the type and the other specimens sent. It is about the size of *G. cinnamomeus,* and is structurally close to that species, except that the shoulders are less prominent, and that the tubercle on the third interstice near the base is less conspicuous; the clothing also is different. A specimen from the Swan River probably belongs to the species, but its setae are shorter (more nearly approaching scales) and denser on the elytra.

Gonipterus rufus, Blackb.

Fresh specimens of this species are densely covered with a rusty-red meal, becoming dark brown with age, or when greasy. The clothing is almost concealed, except that a white line is conspicuous from apex of prothorax to apex of scutellum. On complete abrasion the derm is seen to be red, or at most of a rather dark brown, so that such specimens, to the naked eye, almost resemble fresh ones. Those that have been in alcohol for some time, or that have been washed with chloroform, are seen to have white elytral clothing, moderately and evenly distributed, except that on the basal elevations it is sparser than elsewhere, and is nowhere condensed into spots; on the pronotum five rather feeble white lines may often be seen, but the sublateral ones are never sharply defined, and are often not traceable; on many even the median one is scarcely traceable. It is common in Tasmania and the mountain parts of Victoria and southern New South Wales.

Three specimens from Wyreema (Queensland) probably represent a variety of the species, but each posthumeral tubercle appears as a faint swelling only. On typical examples it is unusually prominent and conical, but it varies considerably on Tasmanian specimens, on some of which it is scarcely more prominent than on the Wyreema ones.

Four specimens from Launceston (Tasmania) probably represent another variety; they have the elytral clothing and punctures less uniform, the punctures being larger and many of them slightly encroaching upon the interstices, behind many of the punctures the setae are slightly condensed, causing a faint multimaculate appearance. The posthumeral tubercles are of normal prominence. The base of the head is black, as on most specimens of the species. They have not been in alcohol, and most of the meal is present on them. A specimen from the Victorian Alps evidently belongs to the same variety, but having been in alcohol the meal has been removed, and the multimaculate appearance of the elytra is more pronounced.

Gonipterus crassipes, Lea.

Of two types of this species one is slightly, and the other badly abraded. There are now before me seven specimens in perfect condition as regards the clothing (but they are without meal). They have a conspicuous white triangle of clothing on each elytron, but the triangle is larger than on the species here regarded as *G. gibberus,* and its point is aimed at a considerable distance behind the scutellum (about the middle of the suture, instead of near the scutellum or even conjoined with it), the punctures about it are much larger than on that species (although on *gibberus* they are decidedly larger about the triangles than elsewhere), and the elevations are consistently black; the clothing of the pronotum is practically uniform throughout, certainly not condensed along the middle. A specimen from the Blackburn collection was identified with doubt as *G. exaratus,* but it is badly abraded, and the triangles are but little evident, much as on the type. One of the fresh specimens is from Mackay (Queensland), the others are without locality labels.

Gonipterus xanthorrhoeae, Lea.

A male from Australia, in the Blackburn collection, and another from Queensland, in the National Museum, may belong to this species, but they differ from the type (a female) in having the derm black, except that parts of the elytra are obscurely diluted with red, and the clothing is somewhat different. On the type, behind many of the large elytral punctures, there is a small cluster, not a fascicle, of white scales, giving a speckled appearance to the surface that is absent from the others. The type, however, has the elytra in perfect condition and densely mealy, which is not the case with the others.

Gonipterus humeralis, n. sp.

Dark reddish-brown, some parts almost or quite black. Moderately densely clothed with thin scales or setae, and covered with ochreous or snuff-coloured meal.

Rostrum about as long as wide. Prothorax about as long as the basal width, sides feebly diminishing in width from base to apical third, and then more strongly to apex; densely granulate-punctate. Elytra much wider than prothorax, tips obtusely mucronate, shoulders very prominent; with rows of large deep punctures, becoming smaller posteriorly; interstices multigranulate, the third with a conspicuous and moderately long tubercle near base, fifth with a small tubercle, between the one on third and shoulder; posthumeral tubercle very prominent. Mesosternal process not produced. Length, 7-8 mm.

New South Wales (National Museum and G. Masters); Queensland: Brisbane in January and February (Queensland Museum from H. Hacker).

The clothing consists of thin scales or setae, and is white (although normally obscured by meal) and rather dense on head and part of rostrum, along middle of protonum, on scutellum, on a subquadrate space on basal fourth of elytra, and on under parts. Seen from the side each elytron appears to have an oblique dark line (due to the setae there being smaller and sparser than elsewhere) from the suture to near the apex; as a result most of the elytron appears to be occupied by a large pale triangle, separated by the dark line from a very narrow apical triangle, and with the elevated basal parts dark. The elevated parts of the elytra appear to be always darker than the adjacent surface, although on several specimens the entire derm of the body parts appears to be blackish. The shoulders, and the tubercles behind them, are unusually prominent, the width across the former being almost twice that of the base of the prothorax; although each shoulder is not itself tuberculate, when seen from behind it appears as an even larger and more prominent tubercle than the one on the third interstice, and much larger although less acute, than the posthumeral one. *G. gibberus, crassipes*, and *pulverulentus* have much less prominent shoulders, and much smaller and more conspicuous triangles on the elytra; *G. scutellatus* has also much less prominent shoulders, with the triangles smaller and less defined. *G. cinnamomeus* has prominent shoulders, but they slope back from the base at an angle of about 45°; on the present species the base (except for the parts produced over the base of the prothorax) is almost straight; the clothing also is very different.

Gonipterus inconspicuus, n. sp.

Black or dark brown, antennae and tarsi (claws excepted) reddish. Moderately densely clothed with stout setae, becoming denser on under surface and legs; and covered with rusty or snuff-coloured meal.

Rostrum and prothorax as described in preceding species. Elytra much wider than prothorax, tips mucronate, shoulders rounded; with rows of large deep punctures, becoming smaller posteriorly; interstices multigranulate; third with a rather long obtuse tubercle, connected with base by a feeble ridge, fifth with a smaller tubercle between the one on third and shoulder; posthumeral tubercle large. Length, 7-8 mm.

Queensland: Gympie (Aug. Simson).

A rusty-looking, inconspicuous species, of which nineteen specimens were obtained, and which differ but little in size and appearance (allowing for post-mortem alterations in the meal and clothing). In general appearance they are much like *G. ferrugatus,* on a reduced scale, but on that species the intercoxal process of the mesosternum is distinctly produced (much as on *Oxyops*); on the present species it is decidedly shorter, and rounded in front. Structurally it is close to *G. scutellatus,* but the elytra are without the least traces of lateral triangles, and the median vitta of the pronotum is wider and less conspicuous. From the preceding species it differs in having elytra less narrowed posteriorly, shoulders rounded and less prominent, tubercle on third interstice near base smaller, and in the clothing. The clothing normally appears somewhat stramineous or pale brown (except on the under surface where it is mostly whitish), but on being washed with chloroform all the meal is removed, and it becomes white or almost so. On the pronotum it forms a wide median vitta and two narrow ones on each side, but the vittate arrangement is feeble and easily obscured; on the elytral interstices the clothing is almost uniform, but behind many of the punctures there are small clusters of scales (not fascicles) so that the surface appears feebly maculate.

Var. BIMACULATUS, n. var.

There are before me seven specimens that appear to belong to this species, and which have similarly speckled elytra; but, in addition, they have a distinct dark spot on each elytron, slightly beyond the middle, on the third and fourth interstices; each spot is due to sparsity of clothing, and partly to the clothing itself being black, the elevated parts at the base and the shoulders are also partly clothed in black, this being very noticeable on washed specimens.

Queensland (National Museum), Mackay (R. E. Turner), Bowen (Aug. Simson), Dalby (Mrs. F. H. Hobler); New South Wales: Tooloom in January (Queensland Museum from H. Hacker).

GONIPTERUS PARALLELICOLLIS, n. sp.

Black or blackish, antennae and parts of legs reddish. Setose, squamose and mealy.

Rostrum as long as its subapical width; with a feeble median carina, on each side of which is a shallow groove, bounded externally by an oblique ridge. Prothorax about as long as basal width, sides parallel to apical fourth, thence oblique to apex, with a short median carina; densely granulate-punctate. Elytra much wider than prothorax, tips very feebly mucronate, shoulders rounded and thickened; with rows of large, deep punctures, becoming smaller posteriorly; interstices multigranulate, third with a large obtuse tubercle near base, fifth with a smaller one; posthumeral tubercle large. Length, 7·5-9 mm.

South Australia (National Museum), Kangaroo Island (Blackburn's collection and A. M. Lea), Mount Lofty Ranges (J. G. O. Tepper).

A fairly large rough, rusty-looking species, in appearance close to *G. ferrugatus*, but the intercoxal process of mesosternum normal. Structurally it is close to *G. geminatus*, but the metasternum is without longitudinal tubercles. A large suddenly elevated tubercle, near the base of the third interstice distinguishes from *G. xanthorrhoeae;* on that species the third interstice is moderately elevated there, but more as the highest part of a gentle elevation, which is continued almost to the middle. It is also structurally close to *G. crassipes*, but that species has a conspicuous pale triangle on each elytron, on specimens in good condition. The prothorax is longer in proportion than on *G. inconspicuus,* and the rostrum is different. The meal is present although not very dense on four specimens, but absent from the others; on the basal and apical thirds of elytra it is of a rather dark red, on the median third and all other parts it is ochreous. The clothing (which is white when not obscured by meal) consists mostly of rather thin scales, on the elytra mixed with stouter ones, along the middle of the pronotum it becomes more setose in character. As on *inconspicuus* the elytra have a speckled appearance, owing to the compaction of scales behind many of the large punctures, the prothoracic clothing on some specimens seems to be in three or five obscure vittae. On the pronotum there is a faint depression on each side of the median carina, and another towards each side; as a result there appear to be four feebly elevated spaces, along which the granules are more conspicuous than elsewhere; but this appearance is obscured on washed specimens.

Gonipterus conicollis, n. sp.

Blackish-brown, muzzle, antennae and legs paler. Moderately clothed with white scales and setae, becoming dense on the under parts.

Rostrum scarcely as long as the subapical width, apex red, shining and with small crowded punctures, with coarse, crowded, partially concealed ones elsewhere; with a basal furrow continued on to head. Prothorax about as long as the basal width, gently diminishing in width from base to apex, with a feeble median carina, densely granulate-punctate. Elytra as described in preceding species. Length, 9-9·5 mm.

Victoria: Fernshaw. Type in National Museum, co-type, I. 16119, in South Australian Museum.

Close to the preceding species, but rostrum without a median carina or oblique grooves, and its tip red; the prothorax is also less parallel-sided, and the median carina is thinner and less defined; in these respects it is close to *G. xanthorrhoeae,* but the tubercles on the third and fifth interstices near base are more conspicuous. The derm of the pronotum is obscurely reddish in the middle, and this part is rather densely clothed with setae, towards the sides the clothing is sparser but stouter, and lineate in arrangement; on the elytra the clothing is fairly dense on the apical slope, elsewhere it has a spotted appearance owing to the compaction of a few scales behind the large punctures. The three specimens before me were evidently preserved in alcohol, as they are entirely without meal.

Gonipterus intermedius, n. sp.

Blackish; muzzle, under surface, antennae and legs more or less reddish. Moderately clothed with white setae and scales, becoming denser on under surface and legs.

Rostrum slightly longer than wide; muzzle red, glabrous, and with dense and small punctures, elsewhere with crowded and coarser ones. Prothorax about as long as the basal width, almost evenly decreasing in width from base to apex; densely granulate-punctate. Elytra much wider than prothorax, tips feebly mucronate, shoulders somewhat rounded; with rows of large punctures, becoming smaller posteriorly; interstices near base and apex wider than punctures, in middle parts about as wide, third with an obtuse tubercle near base, connected with base itself by a slight ridge, fifth with a small one near base; posthumeral tubercle represented by an obtuse swelling. Mesosternal process not produced. Length, 7-8 mm.

New South Wales: Dorrigo (W. Heron), Brooklana (W. W. Froggatt); Queensland: Mount Tambourine, in December (H. Hacker, in Queensland Museum).

With the general appearance of *G. inconspicuus*, but with the conspicuous posthumeral tubercle of that species represented by a feeble swelling that disappears posteriorly (as on many species of *Oxyops*); one specimen from Dorrigo, however, has it slightly more prominent than on the others. *Oxyops vacillans*, which may be considered a *Gonipterus*, has the suture with white clothing throughout, and the mesosternal process more produced. *G. excavifrons*, with the posthumeral tubercle feeble, is larger, elytra more parallel-sided, rostrum more largely excavated, and with different clothing. The specimen from Mount Tambourine and one from Dorrigo, have most of the derm of a livid brownish-yellow, probably from immaturity, the former specimen has the appearance of a spiracle on each side of the subapical segment of the abdomen, but it is almost certainly accidental. The clothing along the middle of the prothorax consists of stout setae, but about the coxae it becomes true scales; on the elytra it is fairly even on the interstices, but it has a spotted appearance, owing to a few scales becoming compacted behind many of the large punctures; the preapical callosities, although feeble, are indicated by small white spots. The median carina of the pronotum is ill-defined. Two of the specimens are rather densely covered with a chocolate coloured meal, partly obscuring the derm and clothing.

IPTERGONUS ABERRANS, Lea.

A specimen from Three Springs (Western Australia) possibly belongs to this species, but differs from the type, and many other specimens, in having the median vitta occupying about one-third of the width of the pronotum (except close to the apex, where it is very narrow), instead of scarcely wider than the scutellum at the base; the medio-lateral patch on each elytron is larger, and the fascicles are larger; the third interstice is more elevated at the basal fifth, more conspicuously clothed with white scales, and at the apex of its elevated part is connected with the suture by a transverse patch of white scales.

PANTOREITES ARCTATUS, Pasc.

Fresh specimens of this species are covered with a brick-dust-like meal; owing to the irregularity of the disappearance of this material, or to its becoming greasy, many specimens look very different from others that have been in spirits. Some specimens from the Northern Flinders Ranges (S. Australia) have the white scales on the pronotum much denser than usual, so that the median vitta, although quite as large as on ordinary specimens, is less conspicuous.

PANTOREITES FUSIFORMIS, n. sp.

Black or blackish, antennae and tarsi obscurely reddish. Clothed with scales and setae, partly obscured by a yellowish or stramineous meal.

Rostrum evenly dilated from base to near apex, where the width is about two-thirds of the length; with crowded, partially concealed punctures, except about apex, where they are dense and small. Prothorax slightly longer than the basal width, almost evenly decreasing in width from base to apex; densely granulate-punctate. Elytra about one-fourth wider than prothorax, shoulders rounded, sides gently decreasing in width almost from base; with rows of large punctures, normally almost concealed; interstices wider than punctures, and densely and finely granulate. Length, 8-9 mm.

Western Australia: Cue (H. W. Brown).

About the average size of *P. major*, but that species has five conspicuous vittae on the elytra, all conjoined at apex, the intermediate ones commencing acutely near the shoulders; on the present species a semi-double one commences immediately behind a dark spot, due to naked punctures. Before washing mealy specimens the setae appear to be distinctly yellowish, but after washing with chloroform both setae and scales are seen to be snowy-white. The scales are dense on the head, scutellum, under surface and legs, form three conspicuous lines on the pronotum, on the elytra clothe the suture, fifth and sixth interstices from about the basal third, shoulders and sides; but on two unwashed specimens the upper surface appears clothed with white scales, except for a stramineous vitta on each side, extending from apex of prothorax to near apex of elytra. Although the elytra are distinctly wider than the prothorax, to the naked eye their outlines seem almost continuous with those of the latter. A specimen from Fortescue River (W. D. Dodd), appears to belong to this species; it was in spirits for some months, hence all the meal has disappeared; its upper surface has white clothing throughout, but the clothing being partly dense scales and thin setae, the parts clothed with the latter have a vittate appearance, the vittae placed as on the two unwashed Cue specimens; as on all the others, it has three naked punctures, about the middle at the basal third. A similar specimen is in the British Museum from Cossack.

Prophaesia.

Referred by Pascoe to the Hyperides, but stated to be "very near *Hypera* and *Pantoreites*." Of the latter he wrote, "I have no hesitation in referring it to the Gonipterinae." It appears to belong to the Gonipterides, and to differ from *Pantoreites* by the rostrum being longer. All the species known to me have the base of the prothorax bisinuate, with the concealed part densely padded, the mesosternum overlaps the hind coxae on each side (to about the same extent as in *Pantoreites*, but less than in other genera), the tibiae are strongly denticulate, and the specimens when fresh are all mealy; a combination of characters apparently confined to the Gonipterides.

Prophaesia albilatera, Pasc.

Pantoreites longirostris, Lea.

At the time I named *P. longirostris* I was not aware that *Prophaesia* really belonged to the Gonipterides, and although the long rostrum certainly seemed out of place in *Pantoreites*, the other characters agreed so well that it appeared desirable to refer it to that genus. Dr. Marshall informed me that specimens of *longirostris*, sent for comparison, agreed with the type of *albilatera*.

Prophaesia alba, n. sp.

Reddish, claws black. Densely clothed with white scales, the elytra with some naked punctures.

Rostrum about as long as prothorax, almost straight, with a feeble concealed median carina, and with crowded concealed punctures, except about muzzle, where they are small. Antennae rather thin. Prothorax about as long as the apical width, sides gently dilated to base; with crowded, concealed punctures. Elytra about one-third wider than prothorax, each side with a feeble posthumeral swelling; with rows of large punctures, mostly normally concealed. Length, 5-5·5 mm.

South Australia: Lucindale (B. A. Feuerheerdt).

Allied to *P. cretata*, but larger, prothoracic clothing thinner (approaching setae), elytra with scales only, and these more uniformly clothing the surface, so that (except on abraded specimens) only individual punctures appear naked, instead of large spots; on abrasion the punctures are seen to be large and in regular series, but they are mostly the width of or narrower than the interstices, and these are densely and minutely granulate. Seven specimens have the clothing in perfect condition, and on them the naked punctures are in irregular transverse series at the basal third, in the middle, and at the apical third, with a few near apex, but a slight amount of abrasion considerably alters their appearance; the entire pronotum is covered, but the clothing is denser along the middle than elsewhere. The seven specimens mentioned have the rostrum clothed almost to the tip, on two others with abraded elytra it is clothed only near base, but the difference may be sexual. They have probably all been in alcohol, but on one of them there is a slight amount of yellowish pubescence.

Prophaesia tenuirostris, n. sp.

Dull reddish, claws black. Densely clothed with white scales and with a yellowish meal; each elytron with two large, oblique, bald spots.

Rostrum long, thin, cylindrical and slightly curved; with a thin carina on basal half; with crowded punctures, towards the base partially concealed. Antennae thin, inserted in middle of sides of rostrum. Prothorax about as long as basal width, which is considerably wider than apex; punctures normally concealed. Elytra elongate-cordate, about one-third wider than prothorax; with rows of large, round, deep punctures, much wider than interstices, but, except on the naked spots, almost or quite concealed. Length, 5-5·5 mm.

Western Australia: Cue (H. W. Brown).

About the size of the preceding species, but rostrum decidedly longer, prothoracic scales stouter, elytra with larger punctures and narrower interstices, and each with two large bare spots. These are obliquely placed at the basal and apical thirds, and (except for the sutural clothing) form a feeble cross, which is traversed by an irregular white fascia. From *P. cretata*, to which it is closer, it differs in being larger, each elytron with but two large naked spots, and the apical slope densely and uniformly clothed; the elytral clothing consists of scales only (although these vary in size), not of scales and setae. Specimens are normally covered with a yellowish meal, but on washing with chloroform this is removed, and the scales are seen to be snowy-white.

Syarbis.

Specimens of this genus are often covered with a leaden-white kind of varnish, possibly due to some change in the meal; it is not due to old age, as the scales on such specimens are of normal density, even on some that have the upper surface completely covered by it.

SYARBIS NIGER, Roel.

S. plumbeus, Lea.

Specimens before me are all from New South Wales: one agrees perfectly in structure and clothing with normal specimens, but is entirely reddish. I am now satisfied that the type of *S. plumbeus* is a varnished one of *S. niger;* a second specimen agrees perfectly with it, and both have the clothing of *niger;* a third agreed with them (except that it is somewhat paler), and on being washed with chloroform the varnish disappeared, leaving the typical clothing of *niger*.

SYARBIS PORCATUS, Lea.

All the many specimens that I have seen of this species have five lines of scales on the pronotum. Three of it were standing in the Blackburn collection as *S. nubilus*, but of that species Roelofs says, "*Prothorace . . . vitta media lateribusque pallidis,*" and again, "*Prothorax . . . formant trois lignes parallelès.*"

SYARBIS NUBILUS, Roel.

S. brevicornis, Lea.

Occurs in many parts of South Australia. Many specimens have a more or less conspicuous leaden "varnish" in parts. One (evidently immature) is of a bright pale chestnut-brown, without a trace of meal or varnish, but with normal clothing. Another from Queensland (Charters Towers) probably belongs to the species, but has the oblique fascia of scales on each elytron approaching more closely to the suture than is usual. With an extended series of specimens of *S. brevicornis* it is evident that they belong to *S. nubilus*.

SYARBIS GOUDIEI, Lea.

A specimen of this species, from South Australia, was almost entirely covered with a leaden-white "varnish." On this being removed with chloroform the clothing was seen to be as on many others from South Australia and Victoria.

SYARBIS ALCYONE, Lea.

On specimens of this species, in good condition, the elytra have no compacted scales except those forming a conspicuous whitish line on the suture. It appears to be possible that it is the same as *S. subnitidus*, if the type of that species had the sutural scales abraded; at least there are two specimens from the Blue Mountains that agree with the description of *subnitidus,* and appear to be *alcyone,* with the sutural scales abraded. A Victorian specimen without elytral scales, but evidently belonging to *alcyone,* was identified by Blackburn as "*?deyrollei,*" but it can hardly be that species, which was described as of the shape of *S. niger* (a considerably narrower species).

SYARBIS SCIURUS, Pasc.

A specimen from Mount Squires (Elder Expedition) identified by Blackburn, without comment, probably belongs to this species, as it has an oblique postmedian spot on each elytron, but the base is hardly darker than the adjacent parts. Its pronotum is densely covered with whitish scales, and with fairly large punctures, each of which contains a large scale.

SYARBIS HAAGI, Roel.

Some specimens in the Macleay Museum, from North-Western Australia, were identified as *S. sciurus.* They have the base of the elytra conspicuously dark, and about one fourth of the apex (less at the suture and sides), but are without the postmedian spot noted as on that species. A specimen of the same species, from Onslow, in the National Museum, was identified as *S. sciurus* in the writing of Mr. C. French, Jr., but is in better condition, the dark base of the elytra being margined with strong scales: the dark apical part is partly covered with snowy scales, but a spot on each side of it is glabrous, margined with a ring of snowy scales. I believe these specimens represent a variety of *S. haagi,* the typical form of which has a much greater amount of both base and apex dark, leaving a conspicuous pale median fascia.

The ordinary length of Queensland specimens of *haagi* is about 5 mm. (as the type), but one from Magnetic Island is only 4 mm., and two from Charters Towers are 7 mm.

A specimen from Cape York, in the Queensland Museum, agrees so closely in structure with specimens of *haagi* that it does not appear to be distinct from that species. It is, however, of a rather pale castaneous, the elytra very slightly darker at base and apex than in the middle; its pronotum has three conspicuous lines of white scales, the median one of which is continued on to the scutellum.

SYARBIS POSTHUMERALIS, n. sp.

Castaneous, a large median blotch on each elytron paler. With small white scales forming five lines (two of them feeble) on pronotum, dense on scutellum, forming many small transverse or oblique lines on elytra, and fairly dense elsewhere.

Rostrum slightly longer than wide, with a rather shallow groove, beginning at a conspicuous interocular fovea, apical third depressed and with smaller punctures than elsewhere. Antennae short, six apical joints of funicle transverse. Prothorax about as long as the basal width, evenly decreasing in width from base to apex; with fairly numerous large and small, irregularly distributed punctures. Elytra much wider than prothorax, about twice as wide as long; with rows of large, round, deep punctures, much wider than interstices, even posteriorly; with a conspicuous posthumeral tubercle interrupting a row of large punctures. Legs short, tibiae with a few strong denticulations. Length, 4·5-5 mm.

Western Australia: Swan River (J. Clark and A. M. Lea).

The only species of the genus with a conspicuous posthumeral tubercle, as on most species of *Gonipterus*. *S. gonipteroides* is without such a tubercle, but has a conspicuous one between each shoulder and the suture. The two specimens obtained differ somewhat in depth of colour, the blotch on each elytron of the smaller specimen being almost flavous; but otherwise they are in close agreement.

SYARBIS ALBIVITTIS, n. sp.

Reddish, clothed with white scales, on the upper surface lineate in arrangement.

Rostrum slightly longer than wide, with a shallow median groove beginning at a deep interocular fovea. Antennae short, six apical joints of funicle transverse. Prothorax about as long as the basal width, evenly decreasing in width from base to apex; with crowded punctures, many of large size. Elytra about twice the width of prothorax, shoulders slightly thickened, a feeble posthumeral swelling; with regular rows of large, round, deep punctures, wider than interstices; of these the third is somewhat elevated on the basal half. Legs short, tibiae with strong denticulations. Length, 4-4·5 mm.

Queensland, Brisbane (J. H. Boreham). Type in Queensland Museum; co-type I. 16121, in South Australian Museum.

On the pronotum the clothing is somewhat as on *S. porcatus*, but it is very different on the elytra. On the pronotum the white scales form three distinct and two feeble lines; on the elytra they clothe the suture throughout, the third interstice to the middle, the fifth from the middle to near apex, the fourth for a short distance connecting the markings on the third and fifth, and near the sides from the shoulders to the suture; there are minute scales on most of the other parts of the elytra, but they do not interrupt the vittate appearance to the naked eye.

The description was drawn up from three Brisbane specimens: two others from Herberton (C. J. Wild) differ in being slightly more robust; the markings appear to be the same, but are somewhat obscured by chocolate or muddy-brown meal, of which there is not a trace on the Brisbane specimens.

MINIA OPALESCENS, Pasc.

Referred with doubt by Pascoe to the Gonipterides; as its right to a position there seemed very doubtful, I asked for some information as to the type, and Dr. Marshall replied: " Unfortunately there is only one specimen of the species. The genus does not present to me any very obvious affinities. In Lacordaire's system it runs down to his Cleonides, being excluded from the Hyperides by its connate claws. I am, however, of opinion that in spite of this latter character it had better be placed temporarily in the Hyperides."

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[Proc. Roy. Soc. Victoria, 39 (N.S.), Pt. II., 1927].

Art. XI.—*Descriptive Notes on Tertiary Mollusca from Fyansford and other Australian Localities, Part I.*

By F. CHAPMAN, A.L.S., and F. A. SINGLETON, M.Sc.

(With Plates X., XI.)

[Read 9th December, 1926.]

The following notes deal in the main with species contained in the Tertiary molluscan fauna of the Orphanage Hill beds at Fyansford, near Geelong, now under revision by the present authors. A few species not occurring in that fauna, but of interest as allied forms, are also included.

Class PELECYPODA.

Family NUCULIDAE.

Genus **Nucula** Lamarck.

Nucula obliqua Lamarck.

Nucula obliqua Lamarck, 1819[1], p. 59. Hedley, 1902, p. 292. Chapman and Gabriel, 1914, p. 301.
Nucula tumida T. Woods (*non* Phillips *nec* Hinds), 1877, p. 111. Tate, 1886, p. 127, pl. vi., figs. 6*a,b*.
Nucula tenisoni Pritchard (*nom. mut.*), 1896, p. 128.

Observations.—In studying a long series of fossil shells from the various Tertiary horizons, we have reconsidered the question of their identity with the Recent *N. obliqua,* as affirmed by Pritchard, Hedley, and other authors. Upon comparison with Recent shells dredged by Mr. C. J. Gabriel in 8 fathoms off Point Cook, Port Phillip Bay, we observe that Lower Tertiary (Balcombian and Janjukian) shells tend to be somewhat produced anteriorly, and in some cases to be less inflated than is usual in the Recent shells. Upper Tertiary (Kalimnan and Werrikooian) examples commonly attain a rather larger size and are notably heavier in build.

After much consideration as to the relative stability of variations in the fossil forms, we cannot but consider that they all belong to one species, for the reason that although the general tendency in the fossils is towards a more elongate valve, a long series always contains some examples which are inseparable from the generally shorter and more convex Recent type, and conversely among living shells individual valves are more elongate than the average.

1.—Full references are cited in the list at the end of this paper.

NUCULA ATKINSONI (Johnston).

Portlandia Atkinsoni Johnston, 1880, p. 39.
Nucula Atkinsoni, Johnston: Tate, 1886, pp. 127, 128, pl. iv., figs. 3*a-c*. Johnston, 1888, pl. xxxi., figs. 16, 16*a*.

Observations.—In this species a great range of surface ornament is apparent, when a fair series is examined. The ordinary reticulated ornament, as a rule best developed towards the ventral region, often varies in the direction of suppression of the radial striae; the shell having in the extreme forms, a corrugated rather than a reticose ornament. A feature hitherto unnoted is the presence in most cases of a discrepant ornament, in which a divarication of the concentric riblets is developed on the anterior side of the shell, but not, however, so well developed as in the genus *Acila*, H. and A. Adams.

The divarication varies in strength on the different geological horizons. Thus at Balcombe Bay and Muddy Creek (Balcombian) it is represented only by a slight corrugation on the extreme anterior border, whilst the valve-surfaces are nearly smooth. Most of the Janjukian variations are in the direction of a strongly corrugated shell, usually with pronounced divarication. Those from Beaumaris (Kalimnan) are smoother shells like the oldest representatives, and without divarication, but with a more trigonal shape.

This divaricate ornament is more constant in the New Zealand Tertiary species *N. sagittata*, Suter (1917, p. 65, pl. vii., fig. 6), a close relative of the Australian species. Compared with examples of Suter's species from Ardgowan, near Oamaru, our shells differ in their uniformly smaller dimensions, greater tumidity, less conspicuous resilifer and finer denticulation of the inner ventral margin, while in ornament the Australian species, though variable, always shows much deeper concentric ribbing but weaker radial striations.

NUCULA BREVITERGUM, sp. nov.

(Plate X., Figs. 1*a,b*.)

Description.—Holotype, left valve. Shell moderately thin, smooth, somewhat depressed, very inequilateral, subovate in outline. Umbo subacuminate; posterior margin short, straight, nearly at right angles to dorsal margin and meeting ventral border in a wide curve; anterior extremity sharply curved. Shell surface marked with fine concentric lines of growth of varying strength, more irregular in the ephebic stage. Interior of shell smooth, ventral margin flattened, without denticulations. Cardinal line having about 18 slightly uncinate teeth anteriorly and 6 oblique teeth posteriorly, separated by an acutely angular elongate resilifer. Lunule long, linear; escutcheon semilunate, bounded by a slight angulation with shell surface.

Length 8·75 mm.; height 6·5 mm.; thickness of valve 2 mm.

Observations.—The shortness of the posterior margin and the lengthened valve, with its generally depressed surface, separate this species from certain variants of fossil forms of *N. obliqua.* We have compared the present form with the Recent *N. superba,* Hedley (1902, p. 292; 1912, p. 131, pl. xl., figs. 1, 2), and although at first sight it appears to be comparable in outline, the latter species has a more strongly arcuate dorsal margin, whilst the shell surface is strongly concentrically ridged on the posterior region; moreover the inner margin of *N. superba* is finely denticulate, whereas in *N. brevitergum* it is smooth. The resilifer is deeper and wider in the recent than in the fossil species.

Occurrence.—Balcombian (Oligocene). Lower beds at Muddy Creek, Victoria (holotype in Dennant Coll., Nat. Museum).

Kalimnan (Lower Pliocene).—Jimmy's Point, Gippsland Lakes, Victoria. A solitary specimen occurs with *N. obliqua* from this locality in the Dennant Coll., but we feel some doubt as to its authenticity.

Family NUCULANIDAE.

Genus Nuculana Link.

Nuculana chapmani Finlay.

Leda apiculata Tate (*non* J. de C. Sowerby), 1886, p. 132, pl. ix., figs. 4*a*,*b*.

Nuculana chapmani Finlay (*nom. mut.*), 1924, p. 107.

Observations.—We are unable to include in the synonymy of the above species the Balcombian *N. acuticauda* (Pritchard), (1901, pp. 27, 28, pl. iii., figs. 4, 4*a*), as suggested by Dennant and Kitson (1903, p. 122, footnote). The latter species appears to be slightly variable in its degree of rostration, the type representing an extreme form (which can, however, be matched) in which the shell is posteriorly " drawn out into a very acutely pointed end " (Pritchard, *loc. cit.*). Of the other differential characters cited by Pritchard, the most ready means of distinction lies in the absence of the regular raised concentric ornament typical of *N. chapmani.*[1]

1.—While this paper was passing through the press we have seen a statement by Mr. H. J. Finlay (*Trans. N.Z. Inst.*, lvii., p. 523, 1927) that "*N. chapmani* does not occur at Balcombe Bay (nor probably in the Balcombian at all), being represented by *N. acuticauda* Pritch., and a variety of it." We have examined examples in the Dennant Coll. (Nat. Mus.) of *N. chapmani* Finlay [=*Leda apiculata* Tate] from the lower beds at Aldinga Bay, the type locality subsequently selected by Finlay, which agree well with Tate's description and figure. The two Mornington examples labelled as *N. apiculata* in the Dennant Coll. we identify as *N. acuticauda* (Pritchard), but of a series of 177 *Nuculanae* collected at Balcombe Bay by Mr. F. A. Cudmore, the great majority agree closely with the Aldingan topotypes of *chapmani,* the 28 exceptions being referable to *acuticauda.* The horizon of Finlay's type locality (Lower Aldingan) is, by the way, generally correlated with the Janjukian, and is certainly not Eocene.

Genus **Sarepta** A. Adams.

SAREPTA OBOLELLA (Tate).

(Plate X., Figs. 2-7).

Leda obolella Tate, 1886, p. 130, pl. v., figs. *3a,b.*
Sarepta? tellinaeformis Hedley, 1901, pp. 26, 27, fig. 8.
Sarepta obolella, Tate sp.: Hedley, 1902, p. 295.
Ovaleda tellinaeformis Hedley: Iredale, 1925, p. 250.

Observations.—Iredale (1925, p. 250) has proposed the new generic name *Ovaleda*, citing as genotype Hedley's *Sarepta? tellinaeformis*, which the latter author finally regarded as conspecific with the fossil shell. Iredale states that "the recent forms are generally higher, deeper, with coarser sculpture, the beaks a little more angulate, and the hinge teeth fewer." At the same time he admits the relationship to be "very close and of disputable value," and proposes to indicate this by the use for the recent shell of the trinomial *Ovaleda* [*obolella*] *tellinaeformis* Hedley.

We have had on loan from the Australian Museum four virtual topotypes of Hedley's species, one of which we figure (Pl. X., Fig. 5), from 33-56 fathoms, Botany Heads, as well as a series of eight, illustrating growth stages, from off Cape Three Points, both in New South Wales. Fossil material in the National Museum used for comparison included a fine series of topotypes of Tate's species from the lower beds at Muddy Creek (Dennant Coll.), as well as many examples from Fyansford (G.S.V. Coll.).

At first sight the recent and the fossil specimens appear to show some differences that might be of specific value, such as in outline and inflation, but these features can be exactly matched, as illustrated on Pl. X., Figs. 6, 7, in a long series of the fossils, and these again pass insensibly into the commoner, more elongate form, which is illustrated by Figs. 2-4. We find the sculpture variable in both, while the hinge teeth appear to us to be equally numerous, but more salient in the fossil shells, a feature evidently due to loss of area resultant on dissolution of the inner conchiolitic margin. We are thus unable to find any specific break, nor can we see reason for the removal of the species from *Sarepta*.

SAREPTA PLANIUSCULA (Tate).

(Plate X., Figs. 8-12.)

Leda planiuscula Tate, 1886, p. 131, pl. v., fig. 2.

Note on Tate's Syntypes.—The tablet bears five specimens from the Adelaide bore, of which all but the two smallest are imperfect. Tate has labelled as types the whole series, and from the dimensions given has evidently figured the largest example, which we here designate as lectotype (Pl. X., Fig. 8). This, the uppermost shell on the tablet, is $5\frac{1}{4}$ mm. long, $4\frac{1}{4}$ mm. high, and 1 mm. in thickness, which agrees fairly well with Tate's 5 x $4\frac{1}{2}$ mm. and his figure, drawn by Chidley, measuring 5 x 4 mm.

Observations.—Tate (*loc. cit.*) states: "Shell minute, similar to *L. obolella:* comparing equal-sized specimens of each, *L. planiuscula* is more deepened and the outline approaches more to the circular."

In addition, we note that *S. planiuscula* possesses a less prominent umbo and, if the lectotype be an adult shell, is a much smaller species than *S. obolella.* Nevertheless, owing to the paucity and unsatisfactory nature of the available material, we are unable to feel entirely satisfied as to its specific validity.

Family PECTINIDAE.

Genus **Propeamusium** Gregorio.

PROPEAMUSIUM ATKINSONI (Johnston).

(Plate X., Figs. 13-19.)

Amusium Atkinsoni Johnston, 1880, p. 41. Idem, 1888, pl. xxxi., figs. 15, 15*a*.

Pecten Zitteli, Hutton: Tate, 1886, pp. 115, 116, pl. vii., figs. 3*a-c* (*non* Hutton).

Amusium atkinsoni Johnston: Marwick, 1924, p. 318.

Observations.—Marwick (*loc. supra cit.*) has recently discussed the supposed identity of the Australian shell with the New Zealand *Pecten zitteli* Hutton, as affirmed by Tate. We accept Marwick's conclusion that "specific identity is not established, and until better New Zealand material is available the Australian species should be called *Amusium atkinsoni* Johnston." We further agree with Marwick in referring our shell to *Propeamusium*, but consider Gregorio's name worthy of generic rank.

Johnston in his original description of a Table Cape shell appears to have regarded both valves as having a similar concentric ornament. Tate (*loc. cit.*) has commented upon this and given a full description of the discrepant ornament of the right valve, based apparently on Balcombian examples from Muddy Creek, from which locality we figure further specimens. The type of *Amusium atkinsoni* should be contained in the Johnston collection, now in the Tasmanian Museum, Hobart, but has not yet come to light.

The only topotype available to us is a right valve (Pl. X., Fig. 13) collected by Mr. F. A. Cudmore at Table Cape, Tasmania. This shell, though considerably obscured by matrix, shows the radial ribs and concentric ornament, which constitute a fenestrate pattern, to be of equal strength. The dorso-ventral diameter is relatively greater than in the Muddy Creek examples, which approach more to the orbicular in outline. The well-preserved right valves from this locality show in addition to a primary series of radial costae, continuous over the whole valve excepting on the embryo, a secondary series, much shorter and extending over the ventral region to about one-third to one-half of the valve.

Family CARDITIDAE.

Genus **Venericardia** Lamarck.

VENERICARDIA GRACILICOSTATA (T. Woods).

(Plate XI., Figs. 20, 21.)

Cardita gracilicostata T. Woods, 1877, p. 112. Tate, 1886, p. 152, pl. ii., figs. 6, 8.

Note on Tate's Plesiotypes.—The tablet bears four valves from Table Cape (R. M. Johnston coll.), of which the two on the left are marked as figured. The upper of these agrees in dimensions with Tate's description and figure (*loc. cit.*, pl. ii., fig. 6), but the other measures 21¼ mm. long by 18¼ mm. high, whereas the illustration (Fig. 8) has been enlarged to 29 x 25 mm. Both are right valves, Chidley's drawings having been reversed in lithographing, and are here refigured.

Observations.—The number of ribs is given by Woods as 30 to 34; by Tate as about 30; and we find 31 in each of Tate's figured specimens and 32 in the other two on his tablet. The five largest topotypes in the Dennant Coll. (National Museum), exhibit 31, 35, 31, 31, 34, giving a mean for nine examples of 32 ribs.

V. gracilicostata attains much larger dimensions than *V. scabrosa*, and is matched in size only by a *Venericardia* common in the Janjukian of Spring Creek, hitherto identified as *V. polynema* on Tate's authority, but herein described as a new species, *V. janjukiensis*.

V. latissima is closely allied in number of ribs and in ornament, but is wider posteriorly and suborbicular rather than suboval in outline. The young forms of the above four species are almost impossible to separate.

VENERICARDIA LATISSIMA (Tate).

(Plate XI., Figs. 22, 23.)

Cardita latissima, Tate, 1886, p. 153, pl. ii. (not pl. x., as in text), fig. 5.

Note on Tate's Metatypes.—Of the eleven examples on the tablet, from the Adelaide-bore, none is marked as figured, but the left valve in the top left-hand corner agrees in dimensions with Tate's description and the accompanying reversed figure. It is here refigured and regarded as holotype. This specimen (the largest) is 31½ mm. long and 29 mm. high, and bears 34 ribs, of which the three anterior are very small. Another, of nearly equal dimensions, has 30 ribs, and the next four smaller examples 32, 28, 28 and 28 respectively, giving an average of 30 ribs, the number given in Tate's description. The first of these smaller shells, measuring 21 mm. long and 19 mm. high, and bearing 32 ribs, we also figure. The juvenile series bear 27, 23, 21, and 14 ribs in a very minute shell.

Observations.—Tate compares this shell in ornament with juveniles of *V. gracilicostata,* but notes the difference in shape. This ornament of erect scales is, however, also characteristic of the other members of this group, *scabrosa, polynema* and *janjukiensis,* as well as of other species. The outline to some extent recalls that of *V. polynema* (regarded in this paper as a variety of *V. scabrosa*), but this is more numerously ribbed and narrower anteriorly, as well as being a smaller shell in the adult stage.

Venericardia scabrosa (Tate).

(Plate XI., Figs. 24-26.)

Cardita scabrosa Tate. 1886, p. 152. pl. ii., fig. 4. Pritchard, 1896, pp. 132, 133.

Note on Tate's Metatypes.—Tate's original tablet bears fifteen examples, of which the top row of three is marked as from the Murray Cliffs, the locality given for his figure, but none is indicated as the type or as having been figured. The central specimen, here illustrated, would agree quite well with Tate's figure by Chidley, were it not that other illustrations on the same plate are known to have been reversed. It is, moreover, of smaller dimensions than those given by Tate ($18\frac{1}{2}$ x 15, as against 21 x 16 mm.). The tablet, however, is the only one of this species in the type collection of the Tate Museum, University of Adelaide, and we therefore designate the shell now figured (Pl. XI., Fig. 24), as lectotype of the species, while indicating the discrepancies above noted.

Counting the minute anterior ribs, we find in Tate's Murray River shells 32, 32 and 29, averaging 31 ribs; in his Muddy Creek series 31, 34, 29, 28 and 33, also averaging 31. Of these latter we have excluded the middle shell in the third row, here figured (Pl. XI., Fig. 29), as being better referable to *polynema,* with which it agrees in outline. It bears 34 ribs. Another of somewhat similar outline is the left-hand shell in the second row (Pl. XI., Fig. 25), having 31 ribs, and retained by us in *scabrosa* (*s.str.*). We are inclined to refer the juvenile Cheltenham [=Beaumaris] shell with 21 ribs, in the bottom row of the tablet, to *V. spinulosa* (Tate) rather than to *V. scabrosa.*

Tate's original diagnosis of the species well fits the lectotype, from which, indeed, it may have been drawn, and there is therefore no necessity to give any further description if the smaller dimensions (length $18\frac{1}{2}$ mm., height 15 mm., and thickness of valve $5\frac{1}{2}$ mm.) be borne in mind, as well as the fact that the lectotype is a right valve.

Observations.—The distinctive characters of the lectotype of *V. scabrosa* seem to be its long quadrate outline, its steeply sloping posterior margin, not very salient umbones, and squarely keeled costae, 32 in number. We indicate hereunder our belief that both in outline and in costation this species runs into *polynema,* which we reduce to varietal rank, and under which heading we discuss their differential characters.

Venericardia scabrosa, var. polynema Tate.

(Plate XI., Figs. 27-29).

Cardita polynema Tate, 1886, p. 153, pl. ii., fig. 7.

Note on Tate's Metatypes.—The tablet labelled *Cardita polynema* from the type collection in the Tate Museum, University of Adelaide, bears ten examples, all from Schnapper Point [=Balcombe Bay], the only locality cited in Tate's original description. While none is marked as figured, the left valve in the top left hand corner is the only one agreeing with the dimensions (18 x 15 mm.) and number of ribs (37) given by Tate, and is identified by us as the holotype (Pl. XI., Fig. 27). Chidley's figure is reversed and also enlarged, and does not satisfactorily represent the outline.

Of the remainder, shells comparable with the holotype bear 35, 32, 34 and 36 ribs, the last of which we also figure (Pl. XI., Fig. 28). Smaller examples have 33(?), 32, 32, and 30, and a juvenile 15 ribs respectively.

Observations.—Tate appears to have selected an extreme form for his diagnosis of *V. polynema,* and in a long series we have not seen another example so numerously costated as the holotype. We suggest that the definition of *V. polynema* be extended to include shells of 34 to 37 ribs having also a subovate outline, and that the 32-ribbed shell of Tate's series be referred to *V. scabrosa,* to whose more subquadrate outline it approximates.

The close relationship of the above species is emphasized by our belief that each of Tate's type tablets contains an example of the opposite species. These two names appear to us to have been applied to extreme members of a very variable form, in which the costation ranges between extreme limits of 28 to 37 ribs, and the outline from subquadrate to suboval, and since *scabrosa* has page priority we accord to *polynema* only varietal rank. If the shape be taken as a criterion, then *polynema* must be extended to include shells (e.g., Pl. XI., Fig. 25), with only 31 ribs, which can hardly be reconciled with Tate's diagnosis and name. It appears preferable to utilize the costation, referring shells with less than 34 ribs to *scabrosa, s.str.,* and to var. *polynema,* the more numerously ribbed forms. These latter (Figs. 27-29) are typically suboval in outline, narrowed anteriorly, while the less numerously costate shells are usually subquadrate (Fig. 24), but occasionally approximate to the suboval (Fig. 25).

Venericardia janjukiensis, sp. nov.

(Plate XI., Figs. 30*a,b,* 31.)

Cardita polynema auctorum, *non* Tate, 1886.

Description of Holotype.—Right valve, roundly subquadrate in outline, anterior beneath the beak not so produced as in *V. gracili-*

costata, so that the umbo is placed more anteriorly than in that species; lunule ovate, valve deep, giving a more tumid profile than in *V. gracilicostata,* in which the ventral region is more depressed. Costae 36, rather sharply V-shaped, with erect scales, developing into spines on the last four or five posterior ribs; interspaces wider than ribs and marked by distinct lines of growth, which are stronger when confluent with the scales of the ribs. Interior margin strongly denticulate, crenulations sharply pointed.

Observations.—This, the commonest species of the genus in the Spring Creek beds, has always been listed as *polynema,* and we figure (Pl. XI., Fig. 31), an example so identified in the Tate collection. It resembles Balcombian topotypes of *polynema* only in the number of ribs, but is a very much larger shell of heavier build, with the umbo placed less anteriorly than in typical *polynema.* The affinities of the Spring Creek shells, however, lie rather with *V. gracilicostata,* which is of similar heavy build and large dimensions. The former, as stated by Tate, are less produced anteriorly and usually more numerously ribbed. The holotype of *V. janjukiensis* bears 36 costae as against 31 in Tate's plesiotype of *V. gracilicostata,* while series of each average 34½ and 32 respectively, with limits of 34-37 and 31-35 ribs, the costation in neither case being dependent purely on size. In the ephebic stage the Spring Creek shell has a characteristic humped appearance due to steepening of the umbono-ventral profile towards the latter margin, but this is lost again during geronticism. In *V. gracilicostata* the posterior region of the shell is more depressed and the denticulae of the internal margin are rounded and not pointed, as in the present species.

Although topotypes of these two species may readily be separated, there occur in the Dennant Coll., Nat. Mus., shells labelled C. Otway, Br. Ck. and Picnic B. (probably Brown's Creek, on the Aire Coast, and Picnic Point on the Aire River), bearing 34, 31 and 30 ribs respectively. While the three shells exhibit minor differences, yet they combine the general shape of the Spring Creek shell with a less degree of costation, and may be regarded as annectant forms between *V. gracilicostata,* the Table Cape representative, and *V. janjukiensis,* the Spring Creek equivalent. In the absence of a continuous series linking the two forms at the one locality, as obtained in the case of *scabrosa* and *polynema,* we prefer to keep *gracilicostata* and *janjukiensis* at present as distinct species.

Occurrence.—Janjukian (Miocene).—Common at Spring Creek (Bird Rock Cliffs), Torquay, Victoria. Holotype coll. and pres. to Nat. Mus., Melb., by F. A. Singleton.

Acknowledgments.

We are again under deep obligations to Sir Douglas Mawson and Mr. C. T. Madigan for the loan of types from the Tate Collection, in the Geological Department of the University of Adelaide.

To the Director of the Australian Museum (Dr. C. Anderson) and the Conchologist (Mr. T. Iredale) we are indebted for the loan of recent mollusca from New South Wales.

Mr. F. A. Cudmore has kindly lent and subsequently presented to the National Museum a specimen of *Propeamusium atkinsoni* from the type locality of Table Cape.

Our best thanks are also due to Mr. C. J. Gabriel for giving us on many occasions his valued aid in regard to recent allied species and for the loan of material from his collection.

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EXPLANATION OF PLATES.

(Numbers in brackets refer to registered specimens in the National Museum, Melbourne.)

PLATE X.

All figures 1·8 *times natural size.*

Fig. 1.—*Nucula brevitergum*, sp. nov. Balcombian (Oligocene). Muddy Creek, lower beds, Vic. Holotype, left valve. Dennant Coll., Nat. Mus., Melb. (*a*) exterior; (*b*) interior. [13461]

Figs. 2-4. *Sarepta obolella* (Tate). Balcombian. Muddy Creek, lower beds, Vic. Plesiotypes, adult left and juvenile right valves. Dennant Coll., Nat. Mus. [13462-4]

Fig. 5.—*S. obolella* (Tate) (=*S. tellinaeformis* Hedley). Recent. Botany Heads (33-56 faths.), N.S.W. Plesiotype, right valve. Reg. No. 48115 in Aust. Mus., Sydney. (*a*) exterior; (*b*) interior.

Fig. 6.—*S. obolella* (Tate). Balcombian. Muddy Creek, lower beds, Vic. Plesiotype, right valve. Dennant Coll., Nat. Mus. (*a*) exterior; (*b*) interior. [13465]

Fig. 7.—*S. obolella* (Tate). Barwonian. Orphanage Hill, Fyansford, Vic. Plesiotype, right valve. G. S. V. Coll., Nat. Mus. (*a*) exterior; (*b*) interior. [13466]

Figs. 8-12.—*S. planiuscula* (Tate). Janjukian (Miocene). Adelaide Bore, S.A. Syntypes. Tate Coll., Adelaide University.

Fig. 13.—*Propeamusium atkinsoni* (Johnston). Janjukian. Table Cape, lower beds. Tas. Plesiotype, right valve, exterior. Nat. Mus. Coll., pres. F. A. Cudmore. [13467]

Figs. 14-19.—*P. atkinsoni* (Johnston). Balcombian. Muddy Creek, lower beds, Vic. Plesiotypes. Fig. 14, right exterior [13468]; Fig. 15, right interior [13469]; Fig. 16, left exterior. [13470]; Fig. 17, right exterior [13471]; Fig. 18, left interior [13472]; Fig. 19, left exterior, unusually large specimen [13473]. Dennant Coll., Nat. Mus.

Plate XI.

All figures natural size.

Figs. 20, 21.—*Venericardia gracilicostata* (T. Woods). Janjukian. Table Cape, Tas. Plesiotypes, right valves. Tate Coll. (coll. R. M. Johnston), Adel. Univ.

Fig. 22.—*V. latissima* (Tate). Janjukian. Adelaide Bore, S.A. Holotype, left valve. Tate Coll., Adel. Univ.

Fig. 23.—*V. latissima* (Tate). Adelaide Bore, S.A. Metatype, left valve. Tate Coll., Adel. Univ.

Fig. 24.—*V. scabrosa* (Tate). Janjukian. R. Murray Cliffs, S.A. Lectotype, right valve. Tate Coll., Adel. Univ.

Fig. 25.—*V. scabrosa* (Tate). Balcombian. Muddy Creek, lower beds, Vic. Ideotype, right valve. Tate Coll., Adel. Univ.

Fig. 26.—*V. scabrosa* (Tate). Balcombian. Balcombe Bay, Vic. Plesiotype, left valve (from Tate's tablet of *polynema*). Tate Coll., Adel. Univ.

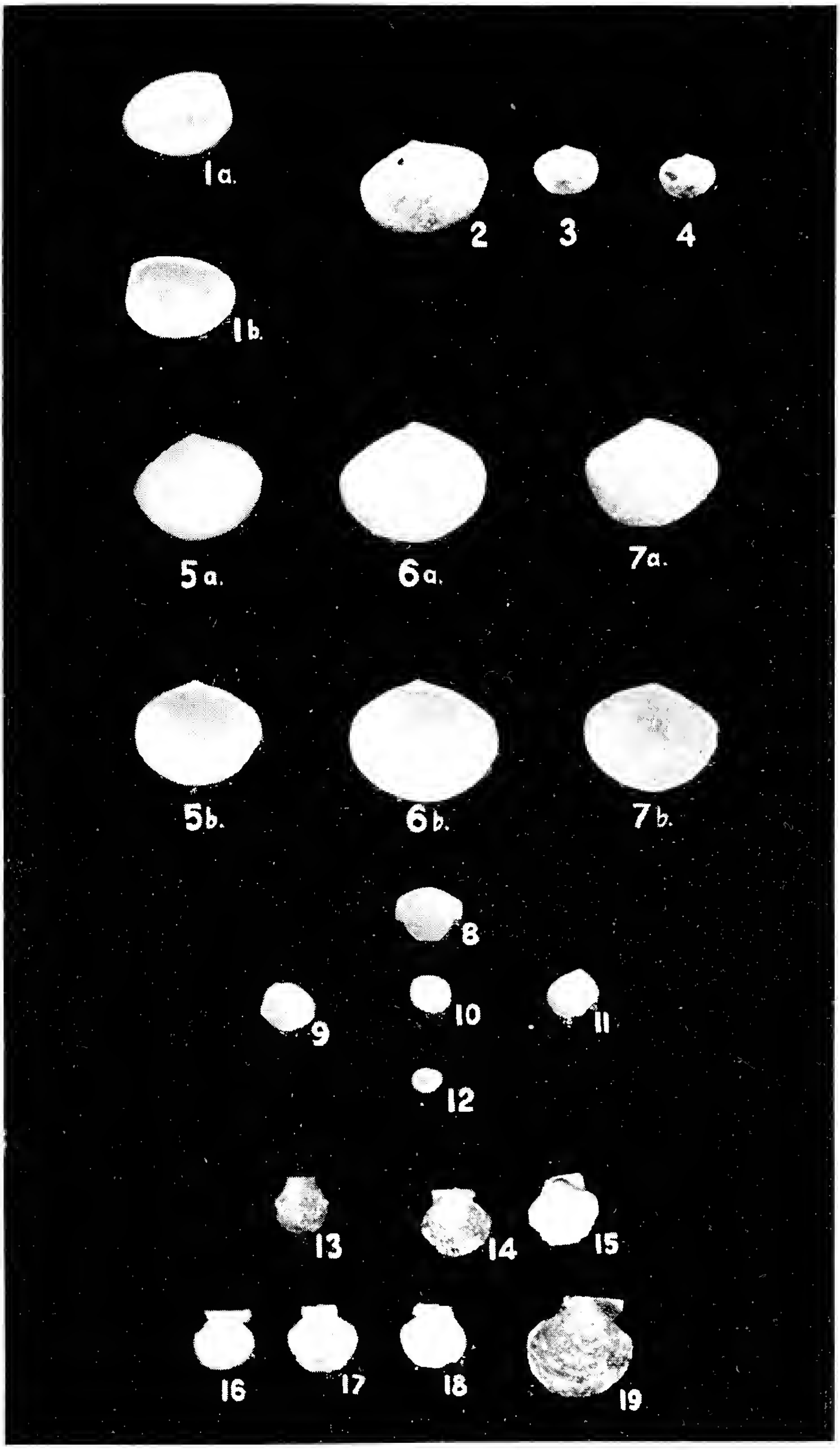
Fig. 27.—*V. scabrosa*, var. *polynema* (Tate). Balcombian. Balcombe Bay, Vic. Holotype, left valve. Tate Coll., Adel. Univ.

Fig. 28.—*V. scabrosa*, var. *polynema* (Tate). Balcombian. Balcombe Bay, Vic. Metatype, right valve. Tate Coll., Adel. Univ.

Fig. 29.—*V. scabrosa*, var. *polynema* (Tate). Balcombian. Balcombe Bay, Vic. Plesiotype, left valve (from Tate's tablet of *scabrosa*). Tate Coll., Adel. Univ.

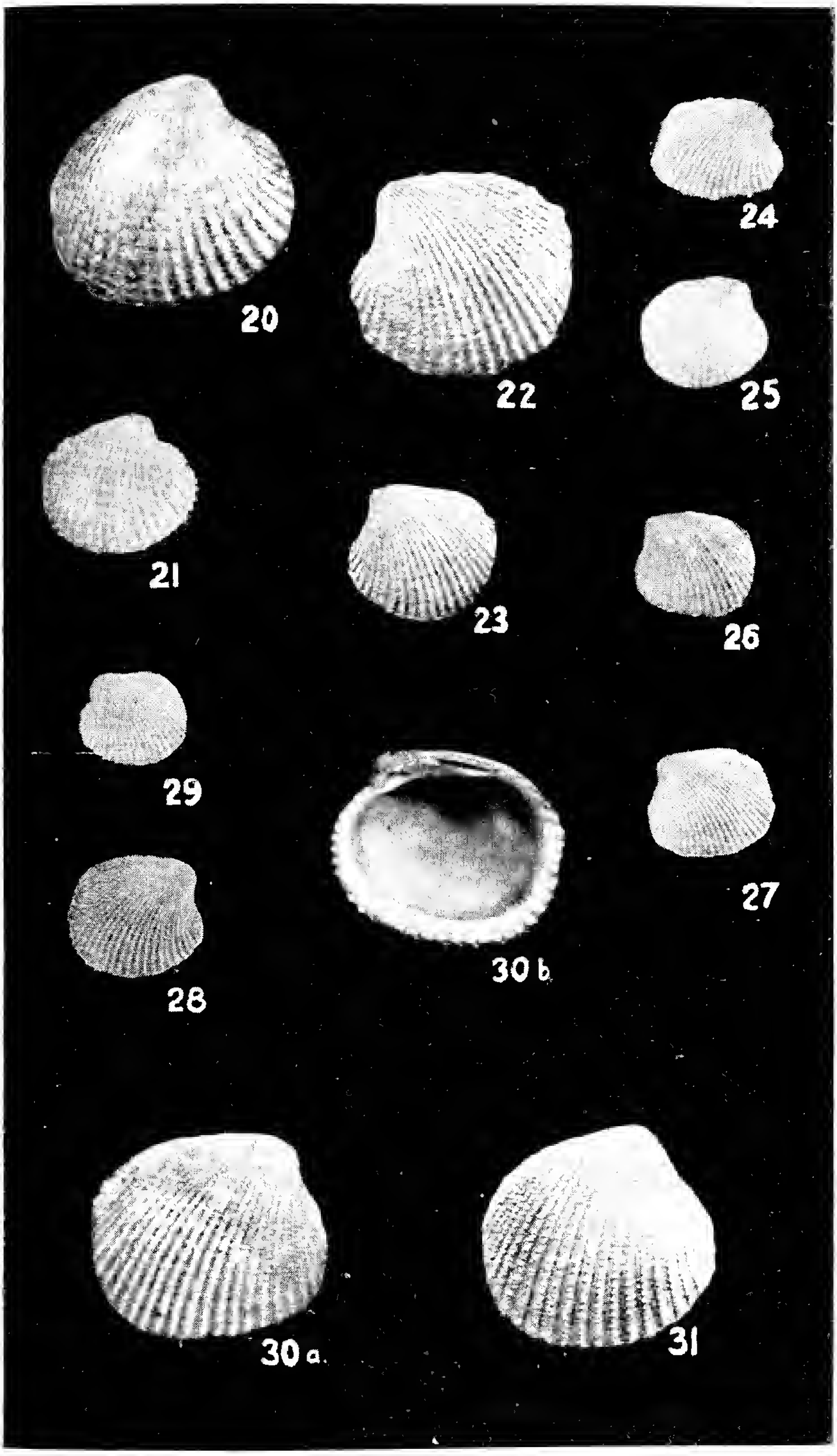
Fig. 30.—*V. janjukiensis*, sp. nov. Janjukian. Bird Rock Cliffs, Torquay, Vic. Holotype, right valve. Nat. Mus.; coll. and pres. F. A. Singleton. (*a*) exterior; (*b*) interior. [13474]

Fig. 31.—*V. janjukiensis*, sp. nov. Janjukian. Bird Rock Cliffs, Torquay, Vic. Paratype, right valve (from Tate's tablet labelled *polynema*). Tate Coll., Adel. Univ.



F.C. Photo

Australian Tertiary Mollusca



F.C. Photo.

Australian Tertiary Mollusca.

[Proc. Roy. Soc. Victoria, 39 (N.S.), Pt. II., 1927.]

Art. XII.—*On a Limestone containing Lepidocyclina and other Foraminifera from the Cape Range, Exmouth Gulf, W.A.*

By FREDERICK CHAPMAN, A.L.S., F.R.M.S., &c.

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(With Plate XII.)

[Read 9th December, 1926.]

Contents.

I. Introductory Remarks.

Although various species of the genus *Lepidocyclina* are well-known components of Australian Tertiary limestones, there have hitherto been no records of *Lepidocyclina dilatata* Michelotti, a species which belongs to the group having a tangential embryonic megasphere. It was, therefore, extremely interesting to receive from Mr. W. S. Dun, of the Department of Mines, Sydney, several specimens of limestone containing these and other foraminifera which had been collected from cliffs of whitish or cream-coloured limestone from the Tertiary rocks of the "Cape Range," south from North West Cape, 25 miles N.W. of Exmouth Gulf Station Homestead, in a deep gorge.

Dr. F. G. Clapp, who collected the specimens, has already published a valuable and extremely interesting paper entitled "A Few Observations on the Geology and Geography of North-West and Desert Basins, Western Australia" (Clapp, 1925). His remarks on this particular limestone deposit may here be quoted with advantage (loc. cit., pp. 64, 65):

"The 'Cape Range' Formation.

"The most unexpected discovery of any relation to the Tertiary system was in the 'Cape Range,' extending south from North-West Cape, where white limestones and interstratified chalky beds form a great anticline rising from below sea-level on the west side of Exmouth Gulf to a height of over 1000 feet in the centre of the Range . . . . intersected by deep gorges extending back miles into it. Some beds of the chalky material are full of foraminifera, as yet unidentified, and only surmised to be of Tertiary age."

Then follows a footnote dated 29th March, 1925;—"Word has just been received from Professor Sir T. W. E. David that Mr. F. Chapman states emphatically that these foraminifera are Oligocene types of *Lepidocyclina* and *Cycloclypeus*. The above is therefore an important discovery of raised and flexed Oligocene limestones in Western Australia.—Ed."

Dr. Clapp continues his description as follows:—

"The east dips vary from nil on top of the Range to 8 degrees on the lower east flank. Far up a gorge in the range, at a point 15 miles south of North-West Cape, I saw the dip flatten out and then dip toward the west at an angle of 2 degrees; but the Gorge was not followed farther west. Rocks are also reported to dip seawards at Pt. Cloates, 75 miles south of North-West Cape, on the west side of the Range." Dr. Clapp adds: "East of the anticline of Cape Range other anticlines were found, one of which, on Giralia Station, 20 miles east of Cape Range, has a height of at least 300 feet and a breadth of 10 miles."

From the above notes by Dr. Clapp it will be seen that the Oligocene formation is quite extensively developed on the West Coast of Australia, the discovery of which came too late to incorporate in the text of the paper on "The Tertiary Deposits of Australia" by F. A. Singleton and myself, published in the *Proceedings of the Pan-Pacific Science Congress*, Australia, 1923, where we remark (p. 991): "In the absence of palaeontological evidence, however, it is not always possible to make a distinction between Tertiary strata and the formation known as the Coastal Limestone, consisting of consolidated sand-dunes of Post-Tertiary age, which is extensively developed along the western and south-western coasts of Western Australia." The approximate location of the present occurrence was, however, inserted in the accompanying map, facing p. 991.

II. Description of the Rock.

This limestone is, in most samples submitted, moderately friable, but in others too hard to be disintegrated by immersion or crushing in water. It breaks with a ragged surface. The colour varies from a pale cream to yellowish, or sometimes pink, on the older weathered surfaces. The larger foraminifera are conspicuous throughout the rock, and are exposed by fracture of the surface.

An examination of the finer constituents of the limestone shows coccoliths to be fairly abundant; they measure 16 μ in diameter. There is a small dark nuclear spot in the middle of the disc, a wide, clear or radiately striate zone and a thin outer ring. Rhabdoliths are also numerous, appearing as rod-like bodies, either fusiform or with swollen ends; they measure circ. 30 μ. Flakes of shelly material are abundant, also rhomb crystals of secondary calcite or perhaps dolomite, circ. 20 μ in diameter.

Fragments of echinoid tests and spines are recognisable in these washings.

The finer washings also contain many minute foraminiferal tests, which have otherwise escaped corrosion.

The medium or coarser washings show abundant foraminiferal remains, but many, especially those belonging to the more coarsely perforated genera, as *Gypsina* and *Lepidocyclina*, have been corroded. This partial solution of the organisms has given rise to the secondary calcite crystals so freely scattered through the mud or finer portions of the limestone.

The larger foraminifera, as *Lepidocyclina* and *Cycloclypeus*, appear to occur in certain bands, especially in the finer, cream-coloured limestone; whilst the yellowish limestone is more prolific in the smaller kinds of foraminifera, as *Anomalina*, *Truncatulina* and *Discorbina*.

III. Conditions of Deposition.

The assemblage of foraminifera met with in this limestone or marly limestone of Exmouth Gulf, indicates a sub-tropical to tropical phase of deposition and comparable to that of a moderately deep water coral sand formation.

The conspicuous element in this fauna consists of abundant tests of the discoidal kinds of foraminifera, and this indicates shallow to moderately deep water. This type of foraminiferal deposit is comparable to that prevailing round coral islands at the present day, as, for example, at Funafuti, in the South Pacific, where *Cycloclypeus* was similarly abundant at about 50 to 200 fathoms.

The smaller foraminifera here present include numerous *Miliolinae*, the minute arenaceous forms such as *Spiroplecta*, *Bolivina* and *Cassidulina*, and the lagenids, as *Nodosaria* and *Cristellaria*, which are usual concomitants of clear water at fair depths. The open water character of the deposit is also indicated by the presence of the pelagic forms, as *Globigerina*.

IV. Systematic List and Description of the Fauna.[1]

Phylum **PROTOZOA.**

Class RHIZOPODA.

Order FORAMINIFERA.

Fam. MILIOLIDAE.

Sub-fam. MILIOLININAE.

Genus **Biloculina** d'Orbigny.

BILOCULINA BULLOIDES d'Orbigny.

Biloculina bulloides d'Orbigny, 1826, p. 297, pl. xvi., f. 1-4. Schlumberger, 1887, p. 120, pl. xv., f. 10-13. Chapman, 1907, p. 13, pl. i., f. 3, 4.

1.—My best thanks are due to Mr. W. J. Parr for much painstaking work in selecting a large part of the smaller foraminifera herein recorded.

Observations.—This well-known recent species has a geological range in Australia extending down to the Oligocene (Muddy Creek and Port Phillip). The tests vary in outline from slightly elongate or sub-oval to sub-circular.

Occurrence.—Frequent; small.

Genus **Miliolina** Williamson.

Miliolina oblonga (Montagu).

Vermiculum oblongum Montagu, 1803, p. 522, pl. xiv., f. 9.
Triloculina oblonga (Mont.), Cushman, 1917, p. 69, pl. xxvi., f. 3.

Observations.—This species has a long geological range. It is found in various Tertiary deposits in Victoria, notably at Muddy Creek and Port Phillip (Balcombian). It is also a well-known recent species.

Occurrence.—Frequent; rather small.

Miliolina pygmaea (Reuss).

Quinqueloculina pygmaea Reuss, 1850, p. 384, pl. i., f. 3*a,b*.
Miliolina pygmaea (Reuss), Brady, 1884, p. 163, pl. cxiii., f. 16*a,b*.
Miliolina oblonga Chapman (*non Serpula oblonga,* Mont.), 1907, p. 17, pl. ii., f. 26.

Observations.—This is a minute species of the *M. seminulum* type, but with more numerous chambers. It is trigonal in cross section. As a recent form it inhabits deeper water than other miliolines, as was remarked by Dr. H. B. Brady. It has occurred as a fossil in the Miocene of the Vienna Basin and in the Oligocene of Port Phillip, Victoria.

Occurrence.—Very rare.

Miliolina seminulum (Linné).

Serpula seminulum Linné, 1767, No. 791. Id., 1788, p. 3739, No. 2.
Miliolina seminulum (L.), Brady, 1884, p. 157, pl. v., f. 6*a-c*. Chapman, 1907, p. 19, pl. ii., f. 34.

Observations.—A common, fairly shallow water form. It occurs abundantly in the Victorian Mid-Tertiary series.

Occurrence.—Frequent; small.

Miliolina trigonula (Lamarck).

Miliolites trigonula Lamarck 1804, p. 351, No. 3; 1822, p. 612, No. 3.
Miliolina trigonula (Lamarck), Chapman, 1907, p. 18, pl. ii., f. 30.
Triloculina trigonula (Lam.), Cushman, 1917, p. 65, pl. xxv., f. 3.

Observations.—This species has already been recorded fossil from the Australian Tertiary beds of Port Phillip (Oligocene).
Occurrence.—Rare, typical.

Fam. LITUOLIDAE.

Subfam. LITUOLINAE.

Genus **Reophax** Montfort.

REOPHAX SCORPIURUS Montfort.

Reophax scorpiurus Montfort, 1808, p. 330, 83me genre. Cushman, 1910, p. 83, text-figs. 14-16 (p. 84).
Observations.—A commonly distributed species, both fossil and recent.
Occurrence.—Very rare; a stout, obtuse form.

Genus **Haplophragmium** Reuss.

HAPLOPHRAGMIUM ROTULATUM Brady.

Haplophragmium rotulatum Brady, 1884, p. 306, pl. xxxiv., f. 5, 6. Cushman, 1910, p. 104, text-figs. 156, 157.
Observations.—This species was hitherto known only as a recent form. It is interesting to note the present occurrence in beds as far back as the Oligocene.
Occurrence.—Very rare.

HAPLOPHRAGMIUM SUBGLOBOSUM (G. O. Sars).

Lituola subglobosa G. O. Sars, 1872, p. 253.
Haplophragmium latidorsatum Brady (*non* Bornemann), 1884, p. 307, pl. xxxiv., f. 7, 8, 10, ?14.
Haplophragmium subglobosum (G. O. Sars), Cushman, 1910, p. 105, text-figs. 162-164 (p. 106).
Observations.—This is a common species, both fossil and recent.
Occurrence.—Very rare.

Fam. TEXTULARIIDAE.

Sub-fam. TEXTULARIINAE.

Genus **Textularia** Defrance.

TEXTULARIA GRAMEN d'Orbigny.

Textularia gramen d'Orbigny, 1846, p. 248, pl. xv., f. 4-6. Chapman, 1907, p. 25, pl. iii., f. 53. Cushman, 1911, p. 8, text-figs. 6-8. Chapman, 1926, p. 30, pl. ii., f. 19; pl. v., f. 20*a-c*.
Observations.—The solitary specimen found has the aboral end slightly damaged, but, so far as can be seen, it shows no indi-

cation of a spiroplectine commencement. It is a well distributed form, both recent and fossil.

Occurrence.—Very rare.

Genus **Spiroplecta** Ehrenberg.

Spiroplecta nussdorfensis (d'Orbigny).

Textularia nussdorfensis d'Orbigny, 1846, p. 243, pl. xiv., f. 17-19.

Spiroplecta nussdorfensis (d'Orb.), Chapman, 1907, p. 28, pl. iii., f. 62.

Observations.—This form occurs in the Miocene of the Vienna Basin and the Oligocene of Grice's Creek, Port Phillip. The present example is typical.

Occurrence.—Very rare.

Genus **Verneuilina** d'Orbigny.

Verneuilina triquetra (Münster).

Textularia triquetra Münster, 1838, p. 384, pl. iii., f. 19.

Verneuilina triquetra (Münst.), Brady, 1884, p. 383, pl. xlvii., f. 18-20.

Observations.—In the fossil condition this species occurs both in the Cretaceous and Tertiary. As a living form it inhabits fairly deep water.

Occurrence.—Rare.

Genus **Guembelina** Egger.

Guembelina polystropha (Reuss).

Bulimina polystropha Reuss, 1845-6, p. 109, pl. xxiv., f. 53.

Guembelina polystropha (Reuss), Egger, 1899, p. 34, pl. xiv., f. 31-34, 40. Chapman, 1917, p. 21, pl. ii., f. 19.

Observations.—The example found here is rather more elongate than usual; otherwise it is typical. It occurred in some abundance in the Gingin Chalk of W.A., and it is here evidently a survival of that faunula.

Occurrence.—Very rare.

Sub-fam. BULIMININAE.

Genus **Bulimina** d'Orbigny.

Bulimina elegans d'Orbigny.

Bulimina elegans d'Orbigny, 1826, p. 270, No. 10; Modèles, No. 9. Cushman, 1911, p. 82, text-figs. 134*a-c*.

Observations.—A small but otherwise typical specimen occurs here. It is a Cretaceous and Tertiary fossil species, and was found in Victoria in the Tertiary (Janjukian) beds of the Mallee Bores (Bore 11, 442-444 feet).

Occurrence.—Very rare.

Genus **Bolivina** d'Orbigny.

Bolivina nobilis Hantken.

Bolivina nobilis Hantken, 1875, p. 56, pl. xv., f. 4. Chapman, 1892, p. 516, pl. xv., f. 11. Cushman, 1911, p. 39, text-fig. 64*a,b*.

Observations.—The first appearance of this form seems to be in the Cretaceous. It has been found in the Oligocene of Hungary and in succeeding beds in Europe, and also in the Miocene of the Victorian Mallee Bores. As a recent form it, curiously, is confined to the South Pacific.

Occurrence.—Very rare.

Bolivina spiroplectiformis, sp. nov.

(Plate XII., Fig. 4.)

Description.—Test small, elongate, depressed, with sharp but not carinate margins. The first third of the test is a coiled spiral of about six chambers, including a small central sphere, and this is succeeded by five alternate chambers as in *Bolivina limbata*. The spiral series and the next chamber show re-entrant angulation at place of contact, the angulation directed distally.

Dimensions.—Length, 0·42 mm.; width, 0·173 mm.

Observations.—The resemblance of this form to *B. limbata* is very close, but it differs materially in the coiled commencement. It appears to link up the hyaline bolivine forms with the strictly arenaceous *Spiroplecta*, to a species of which, *S. biformis* (Parker and Jones) (see Brady, 1884, pl. xlv., f. 25-27), it bears some resemblance.

Bolivina punctata d'Orbigny.

Bolivina punctata d'Orbigny, 1839, p. 63, pl. viii., f. 10-12. Chapman, 1907, p. 32, pl. iv., f. 80. Cushman, 1911, p. 32, text-figs. 53*a,b*. Chapman, 1926, p. 40, pl. i. f. 7.

Observations.—A typical specimen was found in the finer washings, which shows the slight curvature at the aboral end, seen in other specimens. It occurs in the Oligocene of Victoria and in the Upper Eocene and Lower Miocene of New Zealand.

Occurrence.—Very rare.

Bolivina textilarioides Reuss.

Bolivina textilarioides Reuss, 1862, p. 81, pl. x., f. 1. Brady, 1884, p. 419, pl. liii., f. 23-25. Chapman, 1907, p. 31, pl. iv., f. 79. Idem, 1926, p. 41, pl. ix., f. 8.

Observations.—This species commences its geological history, so far as recorded, in the Lower Cretaceous. It is found in the Oligocene of Victoria and the Upper Eocene, Miocene and Pliocene of New Zealand.

Occurrence.—Very rare.

Sub-fam. CASSIDULININAE.

Genus **Cassidulina** d'Orbigny.

CASSIDULINA CALABRA (Seguenza).

Burseolina calabra Seguenza, 1880, p. 138, pl. xiii., f. *7a,b*.
Cassidulina calabra (Seg.), Brady, 1884, p. 431, pl. cxiii., f. *8a-c*. Chapman, 1926, p. 42, pl. ix., f. 12.

Observations.—The original geological horizon for this species is Upper Miocene. I have since recorded it from the Upper Eocene and the Lower Miocene of New Zealand.

Occurrence.—Frequent.

CASSIDULINA SUBGLOBOSA Brady.

Cassidulina subglobosa Brady, 1884, p. 430, pl. liv., f. *17a-c*. Chapman, 1907, p. 33, pl. iv., f. 84. Idem, 1926, p. 42, pl. ix., f. 14.

Observations.—The range of this species in fossil deposits commences in the Lower Cretaceous. It is a common form in the Victorian Oligocene and Miocene, and I have lately described it from the Upper Eocene and Lower Miocene of New Zealand.

Occurrence.—Very rare.

Fam. LAGENIDAE.

Sub-fam. LAGENINAE.

Genus **Lagena** Walker and Boys.

LAGENA HISPIDA Reuss.

Lagena hispida Reuss, 1863, p. 335, pl. vi., f. *77-79*. Chapman, 1926, p. 45, pl. x., f. 1.

Observations.—Fossil specimens date from the Lias. It is found in the Oligocene of Victoria, and in the Upper Eocene and Upper Miocene of New Zealand. It is a fairly deep water form.

Occurrence.—Very rare.

Sub-fam. NODOSARIINAE.

Genus **Nodosaria** Lamarck.

Sub-genus **Dentalina** d'Orbigny.

NODOSARIA (D.) CONSOBRINA (d'Orbigny).

Dentalina consobrina d'Orbigny, 1846, p. 46, pl. ii., f. 1-3.
Nodosaria (Dentalina) consobrina (d'Orbigny), Brady, 1884, p. 501, pl. lxii., f. 23, 24. Chapman, 1926, p. 48, pl. i. f. 1-3; pl. iii., f. 27, 33, 34.

Observations.—Common throughout the Cretaceous and Tertiary, this species occurs in the Oligocene and Miocene of Victoria, and in the Upper Eocene and Miocene of New Zealand.

Occurrence.—Very rare.

NODOSARIA (D.) OBLIQUA (Linné).

Nautilus obliquus Linné, 1767, p. 1163.
Nodosaria (*Dentalina*) *obliqua* (L.), Brady, 1884, p. 513, pl. lxiv., f. 20-22. Chapman, 1917, p. 26, pl. iv., f. 39. Idem, 1926, p. 49, pl. iii., f. 23, 24, 37-39.

Observations.—This is quite a common species in the Oligocene and Miocene of Victoria. It has lately been recorded as of Upper Eocene and Lower Miocene ages in New Zealand.

Occurrence.—Very rare.

NODOSARIA SUBTERTENUATA Schwager.

Nodosaria subtertenuata Schwager, 1866, p. 235, pl. vi., f. 74, Brady, 1884, p. 507, pl. lxii., f. 7, 8. Howchin, 1894, p. 364. Chapman, 1917, p. 27, pl. xii., f. 117.

Observations.—Schwager's original specimens came from the Pliocene of Kar-Nicobar. Subsequently it was obtained off Japan by the "Challenger" (Brady); and later it was discovered in Cretaceous beds in South and West Australia (Howchin and Chapman). It therefore appears to have originated in the Australian area and to have persisted here until Oligocene times.

Occurrence.—Very rare and small.

NODOSARIA LONGISCATA d'Orbigny.

Nodosaria longiscata d'Orbigny, 1846, p. 32, pl. i., f. 10-12. Sherborn and Chapman, 1889, p. 486, pl. xi., f. 17, 18. Chapman, 1926, p. 51, pl. xi., f. 7.

Observations.—This is a Tertiary species, dating from the Eocene. It has lately been found in the Upper Eocene of New Zealand.

Occurrence.—Rare; typical.

Genus **Frondicularia** Defrance.

FRONDICULARIA cf. DECHENI Reuss.

Frondicularia decheni Reuss, 1860, p. 191, pl. iv. f. 3. Perner, 1897, p. 67, pl. iii., f. 3; pl. v., f. 6, 15. Chapman, 1917, p. 30, pl. vi., f. 53.

Observations.—The present example is of somewhat irregular growth, but it agrees in the almost parallel edges and the striate surface. This species has hitherto been known as a Cretaceous fossil, both in Europe and Australia. Here it therefore persists to the Oligocene.

Occurrence.—Very rare.

Genus **Trifarina** Cushman.

TRIFARINA BRADYI Cushman.

Rhabdogonium tricarinatum Brady (*non* d'Orbigny), 1884, p. 525, pl. lxvii., f. 1-3.

Triplasia tricarinatum (d'Orbigny), Cushman, 1913, p. 62, pl. xxxix., f. 2.
Rhabdogonium tricarinatum (d'Orbigny), Heron-Allen and Earland, 1923, p. 158.
Trifarina bradyi Cushman, 1923, p. 99, pl. xxii., f. 3-9.

Observations.—It has been pointed out by Cushman that the recent species resembling *Rhabdogonium* of the Cretaceous, in general aspect, are distinct from d'Orbigny's generic type in having affinities with *Uvigerina*. The present Oligocene occurrence compares with the recent rather than the Cretaceous form, and it has also been met with in the Oligocene of Port Phillip, Victoria.

Occurrence.—Rare; typical.

Genus **Marginulina** d'Orbigny.

Marginulina bullata Reuss.

Marginulina bullata Reuss, 1845-6, p. 29, pl. xiii., f. 34-38. Chapman, 1926, p. 56, pl. iii., f. 48.

Observations.—This form is an inflated modification of *M. glabra*. It is common in the Cretaceous and Lower Tertiaries, and has occurred in the Upper Eocene, in New Zealand.

Occurrence.—Very rare.

Marginulina costata (Batsch).

Nautilus costatus Batsch, 1791, pl. i., f. 1*a-g*.
Marginulina costata (Batsch), Brady, 1884, p. 528, pl. lxv., f. 10-13. Sherborn and Chapman, 1889, p. 487, pl. xi., f. 28. Chapman, 1917, p. 26, pl. vii., f. 63, 64. Idem, 1926, p. 56, pl. iii., f. 49, 51, 54.

Observations.—This species occurs in all formations from the Lias upwards. It has been found in the Cretaceous of Gingin, W.A.; in the Oligocene of Port Phillip, Victoria; and in the Upper Eocene of New Zealand.

Occurrence.—Very rare.

Marginulina glabra d'Orbigny.

Marginulina glabra, d'Orbigny, 1826, p. 259, No. 6; Modèles, No. 55. Brady, 1884, p. 527, pl. lxv., f. 5, 6. Chapman, 1917, p. 33, pl. vii., f. 65. Cushman, 1923, p. 127, pl. xxxvi., f. 5, 6. Chapman, 1926, p. 57, pl. iii., f. 46*a,b*, 47*a,b*.

Observations.—The present example is a large and stout form. It is comparable with specimens found in the Oligocene and Miocene of Victoria. In New Zealand it occurs fossil in the Upper Eocene. It was also recorded from the chalk of Gingin, W.A.

Occurrence.—Very rare.

Genus **Vaginulina** d'Orbigny.

VAGINULINA LEGUMEN (Linné).

Nautilus legumen Linné, 1767, p. 1164, No. 288.
Vaginulina legumen (L.), Chapman, 1917, p. 33, pl. viii., f. 67. Idem, 1926, p. 58, pl. i., f. 2.

Observations.—The vaginuline forms of this roundly depressed smooth type are common in Mesozoic and Lower Tertiary strata, and found more rarely in later deposits. It occurs with more frequency in the Oligocene and Miocene of Victoria, and in the Upper Eocene of New Zealand; also in the Cretaceous of Gingin.

Occurrence.—Common.

Genus **Cristellaria** Lamarck.

CRISTELLARIA BRONNI (Römer).

Planularia bronni (Römer), Reuss, 1862, p. 70, pl. vii., f. 13*a,b*. Chapman, 1894, p. 649, pl. ix., f. 12*a,b*, 13*a,b*. Idem, 1917, p. 36, pl. viii., f. 77.

Observations.—This species is another of the hitherto Cretaceous types which has persisted into Oligocene times. It is closely comparable to the Gingin examples.

Occurrence.—Very rare.

CRISTELLARIA WETHERELLII (Jones).

Marginulina sp., Sowerby, 1834, p. 134, pl. ix., f. 12.
Marginulina wetherellii Jones, 1854, p. 37. Parker and Jones, 1859, p. 350.
Marginulina fragraria Gümbel, 1870 (1868), p. 635, pl. i., f. 58*a-c*.
Cristellaria wetherellii (Jones), Chapman, 1926, p. 66, pl. iv., f. 4*a,b*, 5*a,b*.

Observations.—*C. wetherellii* is a well-known species in the Lower Eocene (London Clay) in the Oligocene of Hungary, and the Middle Eocene of Bavaria. In New Zealand it is found in the Upper Eocene. In recent soundings it has been dredged at 155 and 350 fathoms.

Occurrence.—Common.

CRISTELLARIA ACULEATA d'Orbigny.

Cristellaria aculeata d'Orbigny, 1826, p. 292, No. 14. Brady, 1884, p. 555, pl. lxxxi., f. 4, 5. Chapman, 1926, p. 58, pl. xii., f. 6.

Observations.—The present form is of the similar tuberculate variety found in the Upper Eocene of New Zealand. It was originally recorded from the Pliocene of Siena, and is a living species in West Indian Seas.

Occurrence.—Very rare.

Cristellaria gibba d'Orbigny.

Cristellaria gibba d'Orbigny, 1826, p. 292, pl. xxiii., f. 14*a,b*. Chapman, 1917, p. 37, pl. ix., f. 82. Idem, 1926, p. 61, pl. iv., f. 14*a,b*.

Observations.—The history of this species commences in the Lower Cretaceous (Aptian) of Surrey, England; it occurs at the base of the Upper Cretaceous (Hils) in Germany; and in the Gingin Chalk of W. Australia. In New Zealand *C. gibba* is a fairly common form in the Upper Eocene. Its range extends through the Tertiary, and it is a living form in shallow to moderately deep water.

Occurrence.—Very rare.

Cristellaria ovalis Reuss.

Cristellaria ovalis Reuss, 1845-6, p. 34, pl. viii., f. 9*a,b;* pl. xii., f. 19*a,b;* pl. xiii., f. 60*a*-63*b*. Howchin, 1907, p. 42. Chapman, 1917, p. 35, pl. viii., f. 75.

Observations.—This is one of the *C. gibba* type, but having a more depressed shell. It has hitherto been regarded as a Gault and Cenomanian fossil, but was also found in the Chalk of Gingin.

Occurrence.—Very rare.

Cristellaria orbicularis (d'Orbigny).

Robulina orbicularis d'Orbigny, 1826, p. 288, pl. xv., f. 8, 9.
Cristellaria orbicularis (d'Orb.), Brady, 1884, p. 549, pl. lxix., f. 17. Howchin, 1907, p. 42. Chapman, 1926, p. 63, pl. iv., f. 20*a,b*.

Observations.—Professor Howchin found this species in the Chalk of Gingin, W.A. It occurs throughout the Cainozoic series, and is also an Upper Eocene form in New Zealand.

Occurrence.—Very rare.

Cristellaria cultrata (Montfort).

Robulus cultratus Montfort, 1808, p. 215, 54^{me} genre.
Cristellaria cultrata (Montf.), Brady, 1884, p. 550, pl. lxx., f. 4-8. Chapman, 1926, p. 61, pl. i., f. 6; pl. iv., f. 9*a,b,* 15*a,b,* 27*a,b,* 30*a,b,* 31.

Observations.—This species is found in almost all fossil deposits, from the Lias to the present day. It is found in shallow to moderately deep water. The Australian occurrences are in the Cretaceous (Gingin), and in Oligocene beds (Port Phillip). In New Zealand *C. cultrata* was found in the Upper Cretaceous, Upper Eocene and Miocene.

Occurrence.—Common.

Genus **Flabellina** d'Orbigny.

FLABELLINA RUGOSA d'Orbigny.

Flabellina rugosa d'Orbigny, 1840, p. 23, pl. ii., f. 4, 5, 7. Reuss, 1845-6, p. 33, pl. viii., f. 31-34; pl. xiii., f. 49, 53. Perner, 1897, p. 72, pl. v., f. 10, 16, 17, 19. Chapman, 1917, p. 39, pl. x., f. 90.

Observations.—This is a most interesting survivor of the Cretaceous fauna. It was met with in the Cretaceous of Gingin, where it is moderately common.

Occurrence.—Very rare.

Sub-fam. POLYMORPHININAE.

Genus **Polymorphina** d'Orbigny.

POLYMORPHINA COMMUNIS d'Orbigny.

Polymorphina (Guttulina) communis d'Orbigny, 1826, p. 266, pl. xii., f. 1-4; Modèle, No. 62.

Polymorphina communis d'Orbigny, Brady, 1884, p. 568, pl. lxxii. f. 19. Chapman, 1917, p. 41, pl. x., f. 95. Idem, 1926, p. 67, pl. v., f. *7a,b*.

Observations.—This species has an extended geological range. In Australia it occurs in both Oligocene and Miocene, as well as in the Cretaceous. In New Zealand it has been noted from the Eocene and Miocene.

Occurrence.—Frequent.

POLYMORPHINA OBLONGA d'Orbigny.

Polymorphina oblonga d'Orbigny, 1846, p. 232, pl. xii., f. 29-31. Cushman, 1913, p. 88, pl. xxxvii., f. 6. Chapman, 1926, p. 68, pl. xiv., f. 2.

Observations.—This form is quite a common one in the Oligocene and Miocene of Victoria. It has also occurred in the Oligocene of Kakanui, New Zealand.

Occurrence.—Frequent.

Genus **Siphogenerina** Schlumberger.

SIPHOGENERINA COLUMELLARIS (Brady).

Sagrina columellaris Brady, 1884, p. 591, pl. lxxv., f. 15-17.

Siphogenerina columellaris (Brady), Egger, 1893, p. 316, pl. ix., f. 28, 31, 33. Cushman, 1913, p. 104, pl. xlvii., f. 2, 3.

Observations.—The occurrence here of this species places it much further back in the geological record than hitherto, since it has not before been found in the Australian Tertiaries.

Occurrence.—Very rare.

SIPHOGENERINA BIFRONS (Brady).

Sagrina bifrons Brady, 1884, p. 582, pl. lxxv., f. 18-20.
Siphogenerina (Sagrina) bifrons (Brady), Egger, 1893, p. 317, pl. ix., f. 25, 26, 29.
Siphogenerina bifrons (Brady). Cushman, 1913, p. 105, pl. xlv., f. 1, 2, 5-7.

Observations.—This seems to be the first fossil occurrence of the above species. It is well distributed in the Pacific and along the Australian Coast. The present examples are megalospheric.

Occurrence.—Rare.

Fam. GLOBIGERINIDAE.

Genus **Globigerina** d'Orbigny.

GLOBIGERINA BULLOIDES d'Orb.

Globigerina bulloides d'Orbigny, 1826, p. 277, No. 1, Modèles, Nos. 17, 76. Cushman, 1914, p. 5, pl. ii., f. 7-9, pl. ix. Chapman, 1917, p. 43, pl. xii., f. 1-3. Idem, 1926, p. 72, pl. v., f. 35*a-d*.

Observations.—The examples found here are well-developed. *G. bulloides* is common in many Australian Tertiary deposits.

Occurrence.—Rare.

Genus **Sphaeroidina** d'Orbigny.

SPHAEROIDINA BULLOIDES d'Orbigny.

Sphaeroidina bulloides d'Orbigny, 1826, p. 267, No. 1, Modèles, No. 65. Cushman, 1914, p. 18, pl. x., f. 7; pl. xii., f. 1. Chapman, 1917, p. 45, pl. xii., f. 127. Idem, 1926, p. 74, pl. xv., f. 2.

Observations.—This species is also of common occurrence in Cretaceous and Tertiary deposits, both in Australia and New Zealand.

Occurrence.—Frequent.

Genus **Pullenia** Parker and Jones.

PULLENIA QUINQUELOBA (Reuss).

Nonionina quinqueloba Reuss, 1851, p. 47, pl. v., f. 31*a,b*.
Pullenia quinqueloba (Reuss), Brady, 1884, p. 617, pl. lxxxiv., f. 14, 15.

Observations.—The related *P. sphaeroides* is the commoner form of the genus in Australian fossil deposits, but I have also recorded *P. quinqueloba* from the borings in the Mallee.

Occurrence.—Very rare.

Fam. ROTALIIDAE.

Sub-fam. ROTALIINAE.

Genus **Discorbina** Parker and Jones.

DISCORBINA GLOBULARIS (d'Orbigny).

Rosalina globularis d'Orbigny, 1826, p. 271, pl. xiii., f. 1-4; Modèle, No. 69.
Discorbina globularis (d'Orb.), Brady, 1884, p. 643, pl. lxxxvi., f. 8, 13.

Observations.—*D. globularis* is a well-known Tertiary fossil, and in recent soundings usually affects shallow waters.

Occurrence.—Very rare.

DISCORBINA ARAUCANA (d'Orbigny).

Rosalina araucana d'Orbigny, 1839, p. 44, pl. vi., f. 16-18.
Discorbina araucana (d'Orb.), Brady, 1884, p. 645, pl. lxxxvi., f. 10, 11.

Observations.—As a living species this form is well known in southern waters. It has been found in Tertiary beds in the Mallee Bores.

Occurrence.—Very rare.

DISCORBINA VILARDEBOANA (d'Orbigny).

Rosalina vilardeboana d'Orbigny, 1839, p. 44, pl. vi., f. 13-15.
Discorbina vilardeboana (d'Orb), Brady, 1884, p. 645, pl. lxxxvi., f. 9, 12; pl. lxxxviii. f. 2. Howchin, 1889, p. 12. Chapman, 1926, p. 77, pl. xv., f. 10.

Observations.—This species dates from Cretaceous times (Aptian of England), and is also known from the Oligocene of W. Victoria and from the Upper Eocene of New Zealand.

Occurrence.—Very rare.

Genus **Planorbulina** d'Orbigny.

PLANORBULINA LARVATA P. and J.
var. INAEQUILATERALIS Heron-Allen and Earland

Planorbulina larvata P. and J., var. *inaequilateralis*, Heron-Allen and Earland, 1924, p. 174, pl. xii., f. 85-90.

Observations.—This interesting variety of *P. larvata* was discovered by Heron-Allen and Earland in the marls of the Filter quarries at Batesford, Victoria, which deposit is of Miocene (Burdigalian age), and therefore later than the present one from Exmouth Gulf.

Occurrence.—Very rare.

Genus **Truncatulina** d'Orbigny.

TRUNCATULINA LOBATULA (W. and J.).

Nautilus lobatulus Walker and Jacob, 1798, p. 642, pl. xiv., f. 36.
Truncatulina lobatula (W. and J.), Brady, 1884, p. 660, pl. xcii., f. 10; pl. xciii., p. 78, pl. xv., f. 12.

Observations.—One of the most abundant rotalines in Australian Tertiary and Recent deposits. The present examples are typical.

Occurrence.—Common.

TRUNCATULINA REFULGENS (Montfort).

Cibicides refulgens Montfort, 1808-10, p. 122, 31me genre.
Truncatulina refulgens (Montfort), Brady, 1884, p. 659, pl. xcii., f. 7-9. Chapman, 1926, p. 78, pl. xv., f. 13.

Observations.—This is a common fossil in the Australian and New Zealand Tertiary deposits.

Occurrence.—Rare; typical.

TRUNCATULINA MUNDULA Brady, Parker and Jones.

Truncatulina mundula Brady, Parker and Jones, 1888, p. 228, pl. xlv., f. 25.
Planorbulina mundula B., P. and J., Goës, 1896, p. 71.
Truncatulina mundula, B., P. and J., Cushman, 1915, p. 41, pl. xiii., f. 4 (text-fig. 45*a-c*).

Observations.—*T. mundula* is a common species in Australian Tertiary marls, and is well represented living in Pacific faunas. The specimens here met with are perhaps rather more sharply keeled than usual.

Occurrence.—Frequent.

TRUNCATULINA WUELLERSTORFI (Schwager).

Anomalina wuellerstorfi Schwager, 1866, p. 258, pl. vii., f. 105, 107.
Truncatulina wuellerstorfi (Schw.), Brady, 1884, p. 662, pl. xciii., f. 8, 9. Chapman, 1917, p. 46, pl. xi., f. 106. Idem, 1926, p. 79, pl. xvi., f. 3.

Observations.—This species was found in the Gingin Chalk of W. Australia, and it is also a common fossil in the Tertiaries. In New Zealand it was found in the Upper Eocene and Miocene.

Occurrence.—Frequent.

Genus **Siphonina** Reuss.

SIPHONINA RETICULATA (Czjzek).

Rotalina reticulata Czjzek, 1848, p. 145, pl. xiii., f. 7-9.
Truncatulina reticulata (Cz.), Brady, 1884, p. 669, pl. xcvi., f. 5-8.

Siphonina reticulata (Cz.), Cushman, 1921, p. 322, pl. lxx., f. 3*a-c*.

Observations.—This is one of the regular components of the microzoic fauna of the Australian Tertiaries, and ranges from the Oligocene upwards. The present examples are well developed.

Occurrence.—Rare.

Genus **Anomalina** Parker and Jones.

Anomalina ammonoides (Reuss).

Rosalina ammonoides Reuss, 1845-6, p. 36, pl. viii., f. 53; pl. xiii., f. 66.

Anomalina ammonoides (Rss.), Brady, 1884, p. 672, pl. xciv., f. 2, 3. Chapman, 1926, p. 79, pl. v., f. 31*a-c*, 34*a-c*.

Observations.—One of the most abundant of the Tertiary Foraminifera in Australia, this species is here represented by well grown examples.

Occurrence.—Frequent.

Anomalina grosserugosa (Gümbel).

Truncatulina grosserugosa Gümbel, 1870, p. 660, pl. ii., f. 104.

Anomalina grosserugosa (Gümbel), Cushman, 1915, p. 45, pl. xx., f. 1. Chapman, 1926, p. 80, pl. xvi., f. 5.

Observations.—This fairly deep water form is a common species in the Tertiary deposits of Australia and New Zealand.

Occurrence.—Common. Rather small.

Genus **Carpenteria** Gray.

Carpenteria proteiformis Goës.

Carpenteria balaniformis Gray, var. *proteiformis* Goës, 1882, p. 94, pl. vi., f. 208-14; pl. vii., f. 215-219.

Carpenteria proteiformis Goës, Brady, 1884, p. 679, pl. xcvii., f. 8-14. Chapman, 1926, p. 81, pl. xvi., f. 7.

Observations.—This is a common Oligocene species in Australia and New Zealand. It also occurs in the Miocene of the Victorian Mallee Bores and Batesford.

Occurrence.—Rare.

Genus **Rotalia** Lamarck.

?Rotalia calcar (d'Orbigny).

Calcarina calcar d'Orbigny, 1826, p. 276, No. 1, Modèle, No. 34.

Rotalia calcar (d'Orbigny), Brady, 1884, p. 709, pl. cviii., f. 3, ?4.

Observations.—There is a worn test of a foraminifer in these washings, which is referred, provisionally, to this species. *R. calcar* is a well known form in the Australian Tertiary limestones.

Occurrence.—Very rare.

Genus **Calcarina** d'Orbigny.

CALCARINA DEFRANCII d'Orbigny.

Calcarina defrancii d'Orbigny, 1826, p. 276, No. 3, pl. xiii., f. 5-7.
Rotalia calcar Chapman, 1909, (*non* d'Orb.), p. 289, pl. iii., f. 2.
Calcarina defrancii d'Orb., Heron-Allen and Earland, 1924, p. 182.

Observations.—This is a common species in the Miocene of Batesford, Victoria. Although there accompanied by *Rotalia calcar*, my figures were erroneously referred to the latter species, as pointed out by Heron-Allen and Earland.

Occurrence.—Rare. Rather worn examples.

Genus **Baculogypsina** Sacco.

BACULOGYPSINA SPHAERULATA (Parker and Jones).

Orbitolina sphaerulata Parker and Jones, 1860, p. 33, No. 8.
Tinoporus baculatus Carpenter (*non* Montfort), 1861, p. 577, pls. xviii., xxi.
Baculogypsina sphaerulatus (P. and J.), Cushman, 1919, pl. xliv., f. 6. Idem, 1921, p. 359, pl. lxxv., f. 6.

Observations.—This is an abundant species in all warm waters of Australia and the Pacific. It is extremely interesting to find it fossil and so far down in the Tertiary series.

Occurrence.—Very rare; small, but otherwise typical.

Genus **Gypsina** Carter.

GYPSINA GLOBULUS (Reuss).

Ceriopora globulus Reuss, 1847, p. 33, pl. v., f. 7.
Gypsina globulus (Reuss), Heron-Allen and Earland, 1924, p. 183, pl. xiv., f. 117, 118.

Observations.—*G. globulus* is quite an abundant form in Australian Tertiary deposits, and as a recent form it affects coral zones.

Occurrence.—Rare; typical.

Fam. NUMMULITIDAE

Sub-fam. POLYSTOMELLINAE.

Genus **Polystomella** Lamarck.

POLYSTOMELLA CRATICULATA (Fichtel and Moll).

Nautilus craticulatus Fichtel and Moll, 1798, p. 51, pl. v., f. *h-k*.
Polystomella craticulata (F. and M.), Brady, 1884, p. 739, pl. cx., f. 16, 17. Howchin, 1889, p. 16.

Observations.—This is also a coral reef species. It occurs in the Oligocene and Lower Pliocene of Muddy Creek, and in the basal Miocene of the Mallee Bores, both in Victoria.

Occurrence.—Very rare.

Sub-fam. NUMMULITINAE.

Genus **Amphistegina** d'Orbigny.

Amphistegina lessonii d'Orbigny.

Amphistegina lessonii d'Orbigny, 1826, p. 304, No. 3, pl. xvii., f. 1-4; Modèle. No. 98. Chapman, 1926, p. 90, pl. i., f. 19.

Observations.—*A. lessonii* is a universally distributed and abundant form in the Australian and New Zealand Tertiaries.

Occurrence.—Very rare.

Genus **Operculina** d'Orbigny.

Operculina complanata (Defrance).

Lenticulites complanata Defrance, 1822, p. 453.

Operculina complanata (Defr.), Brady, 1884, p. 743, pl. cxiii., f. 3-5, 8. Chapman, 1926, p. 91, pl. xviii., f. 1; pl. xix., f. 3.

Observations.—This is a common Tertiary foraminifer. Several fragments of this form were found in the washings from the Cape Range limestone.

Occurrence.—Frequent.

Genus **Heterostegina** d'Orbigny.

Heterostegina depressa d'Orbigny.

Heterostegina depressa d'Orbigny, 1826, p. 305, No. 2, pl. xvii., f. 5-7; Modèle No. 99. Chapman, 1910, p. 295. Idem, 1926, p. 92, pl. xviii., f. 2.

Observations.—This is one of the fairly common forms in the Miocene of Australia and New Zealand.

Occurrence.—Frequent.

Sub-fam. CYCLOCLYPEINAE.

Genus **Cycloclypeus** Carpenter.

Cycloclypeus pustulosus Chapman.

(Plate XII., Figs. 1, 3.)

Cycloclypeus pustulosus Chapman, 1905, p. 271, pl. v., f. 1; pl. vi., f. 2; pl. vii., f. 2. Idem, 1909, p. 295, pl. lii., f. 6; pl. lv., f. 4. Id., 1926, p. 92, pl. xviii., f. 3*a,b*.

Observations.—This species appears to have a somewhat extended range, from Oligocene to Miocene. The present examples are very large, sometimes measuring as much as 20 mm. in diameter. The holotype, from the New Hebrides, measures only 6 mm. in diameter. Both are probably microspheric.

Occurrence.—Common.

Genus **Lepidocyclina** Gümbel.

Sub-genus **Eulepidina** H. Douvillé.

LEPIDOCYCLINA (EULEPIDINA) DILATATA (Michelotti).
(Plate XII., Figs. 1, 2.)

Orbitoides dilatata Michelotti, 1861, p. 17, pl. i., f. 1, 2.
Orbitoides (Lepidocyclina) dilatata Mich., Gümbel, 1870, p. 681, pl. iv., f. 45*a,b*, 46, 47.
Lepidocyclina dilatata (Mich), A. Silvestri, 1910, p. 139, pl. xxv., f. 9*a-c;* pl. i., f. 4-10. Chapman, 1926, p. 93, pl. xviii., f. 4*a,b;* pl. xx., f. 1.

Observations.—The present examples average about 12 mm. in diameter, and are thus more than twice as large as the New Zealand specimens from North Auckland and Titirangi.

The distribution of *L. dilatata* in East Borneo, as recently given by Van der Vlerk (1925, Table), shows this species to be there characteristic of the Oligocene (that is, " Post-Eocene Naintoepo Beds ") above which succeed the *Lepidocyclina tournoueri* beds (the " Poeloe-Balang Beds ").

Occurrence.—Frequent.

Genus **Miogypsina** Sacco.

MIOGYPSINA cf. IRREGULARIS (Michelotti).

Nummulites irregularis Michelotti, 1841, p. 296, pl. iii., f. 5.
Miogypsina irregularis (Mich)., Schlumberger, 1900, p. 328, pl. ii., f. 1-7, 9, 10; pl. iii., f. 17. Chapman, 1926, p. 93, pl. xviii., f. 5*a,b;* pl. xx., f. 3, 4.

Observations.—Fragmentary specimens of this or an allied form occur in the washings. It may belong to an earlier type of foraminifera, or if referable to the above, shows, as in New Zealand, a commingling of Oligocene and Miocene forms.

Occurrence.—Frequent.

Phylum **MOLLUSCOIDEA.**

Class POLYZOA.

Order CYCLOSTOMATA.

Fam. CRISIIDAE.

Genus **Crisia** Lamouroux.

CRISIA GRACILIS MacGillivray.

Crisia gracilis MacGillivray, 1895, p. 118, pl. xvi., f. 5.

Observations.—The original and only locality for this species is the Oligocene beds at Clifton Bank, Muddy Creek, Western Victoria.

Occurrence.—Very rare.

Phylum **MOLLUSCA.**

Class PELECYPODA.

Fam. DIMYIDAE.

Genus **Dimya** Roualt.

Dimya dissimilis Tate.

Dimya dissimilis Tate, 1886, p. 100, pl. iii., f. 9*a-c*. Harris, 1897, p. 306.

Observations.—A right valve of a subcircular form, with fine radial and undulate concentric ornament, occurs here. The inside of the valve is quite smooth, and thus precludes it from a comparison with *D. sigillata* Tate. This species has an extensive geological range within south-eastern Australia, from the Oligocene to Lower Pliocene.

Occurrence.—One valve.

Phylum **ARTHROPODA.**

Super Order OSTRACODA.

Fam. CYPRIDAE.

Genus **Aglaia** G. S. Brady.

Aglaia clavata G. S. Brady.

Aglaia clavata G. S. Brady, 1880, p. 34, pl. vi., f. 4*a-d*.

Observations.—This is the first time that *A. clavata* has occurred fossil. It only shows, in common with many other Australian recent species of ostracoda, that the living fauna was established in southern waters in early Tertiary times.

Occurrence.—Very rare.

Fam. CYTHERIDAE.

Genus **Cythere** O. F. Müller.

Cythere lactea G. S. Brady.

Cythere lactea G. S. Brady, 1865, p. 377, pl. lx., f. 3*a-c*. Idem, 1880, p. 91, pl. xxii., f. 1*a-d*. Chapman, 1914, p. 36, pl. vii., f. 15.

Observations.—The present examples are small but typical valves belonging to the above species. *C. lactea* occurred in the Janjukian (Miocene) of the Mallee Bores, and it persists to the present day round the Australian coast.

Occurrence.—Two opposite valves.

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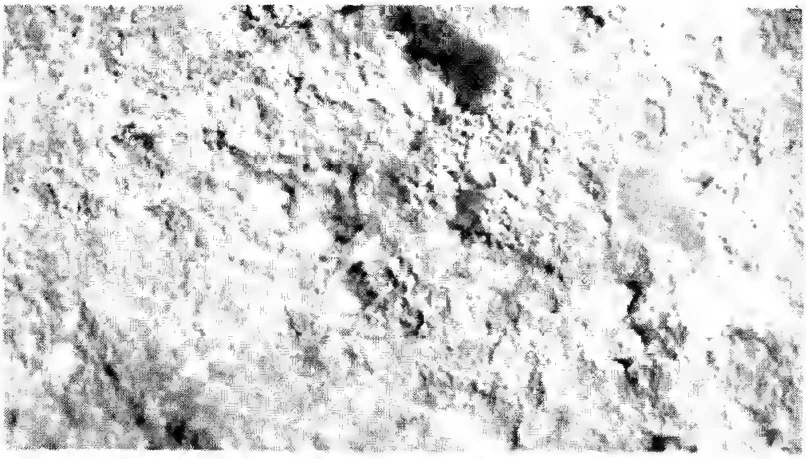
EXPLANATION OF PLATES.

Fig. 1.—Photograph of naturally fractured limestone from Exmouth Gulf, showing abundance of tests of *Cycloclypeus* and *Lepidocyclina*. Slightly reduced.

Fig. 2.—Horizontal section through test of *Lepidocyclina dilatata* (Michelotti); showing primordial and circumambient chamber in median section. The inner chamber has a diameter of 42 micra, the outer 77 μ. ×28.

Fig. 3.—Section of the limestone, with a portion of the test of *Cycloclypeus pustulosus* Chapm., seen in median aspect. The chamberlets measure 27 by 13μ. ×28.

Fig. 4.—*Bolivina spiroplectiformis*, sp. nov. Test. × 104.



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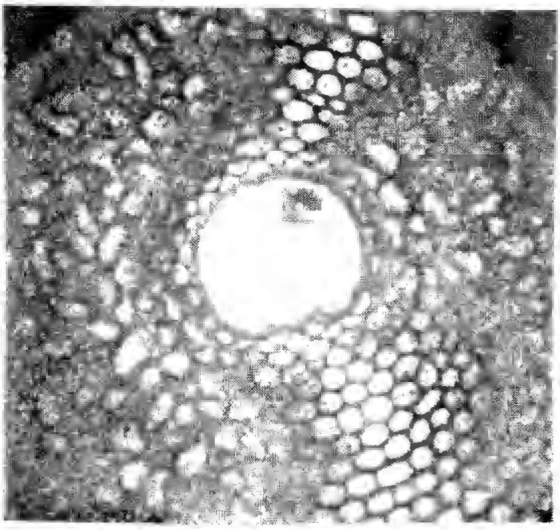

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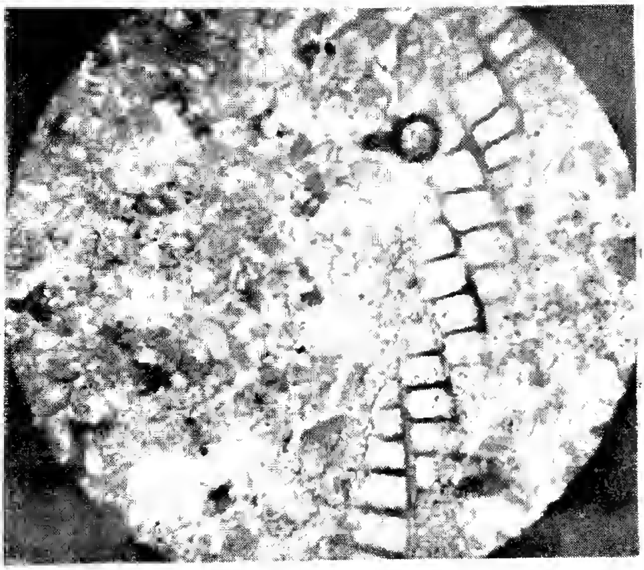

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F.C. photo.

Lepidocyclina Limestone—Exmouth Gulf, W.A.

[PROC. ROY. SOC. VICTORIA, 39 (N.S.), PT. II., 1927.]

ART. XIII.—*The Leaf of Grewia polygama and its Tannin Content*

By ALICE M. COVERLID, B.Sc.

(Communicated by Professor A. J. Ewart.)

[Read 9th December, 1926.]

Dried leaves of *Grewia polygama,* which belongs to the Natural Order Tiliaceae, were sent down by Captain Bishop, Veterinary Surgeon at Darwin. A decoction of the leaves is considered, throughout the Northern Territory and Queensland, to be an admirable bushman's remedy for cases of diarrhoea and dysentery, and *Grewia polygama* is recorded in Bailey's " Queensland Plants " as a " valuable remedy " for dysentery.

The decoction is made by pouring boiling water on to the leaves. Decoctions made in this way in the laboratory showed that quantities of a mucilaginous material, which gathered in the form of a cloudy precipitate, were present; also, judging by colour and taste, tannins. The mucilaginous material gave a stringy precipitate with alcohol, and could thus be isolated from the decoction. It was dissolved in weak alkali, and gave a positive Fehling's reaction. The positive furfural reaction and colour with the orcinol test proved that it is a pentose. The tannin is readily soluble, even in cold water. The test with ferric acetate showed a green colour, indicating the presence of pyrocatechol tannins, but further work was sufficient to show that the solution probably contains a mixture of tannins.

Several estimations of the percentage of tannin present were made by the Lowenthal-Schroeder method, and by Proctor's modification of this method (1). This depends on the reducing power of the tannin, and as this varies for each tannin, the method cannot give an exact result, but since the amount of tannin in the leaves varies according to the time of the year, and also according to the age of the leaves, an average result is all that can be hoped for.

First the dried leaves were ground up finely in a mincer, a large amount being ground at one time, so that each sample for estimation was taken from a well-mixed supply. It was noted that all the leaves in the quantity sent were mature; no young leaves or buds were present.

The moisture content of a weighed amount of the air-dried leaves (5·157 grams) was determined, and found to be 11·7%. From this, the dry-weight of each sample taken could be calculated. In the Lowenthal and Schroeder method, the use of a solution of indigo-carmine is necessary to control the oxidation of the tannin by the permanganate, otherwise the oxidation is too slow, and a definite end-point is not reached. The acid solution required by the permanganate oxidation method is supplied by the sulphuric acid in which the indigo-carmine is dissolved.

Since the infusion contains other oxidisable matters besides tannins, it is necessary to separate these and titrate a second time, in order to ascertain the volume of permanganate actually required by the tannin present. This is done by digestion with hide-powder. As the permanganate has to be standardised also, and the amount of permanganate used up by the indigo-carmine solution alone has to be found, there are four titrations required for each estimation, each of which must be repeated more than once.

For each estimation a known weight of leaves is treated with successive quantities of boiling water, sufficient to give a litre of infusion. Preliminary titrations were done to find approximately the weight of leaves which would give an infusion containing 0·4% tannin (the strength recommended for this method).

Estimations showed that only about 4% tannin was present in the particular leaves submitted. In tea leaves, there is often more than 10% tannin present, so that if the tannin is the active principle, in the form of an astringent, as was supposed, it must be a very active form of tannin.

The presence of resorcinol in the decoction is indicated by the positive result of a test on a pine-wood shaving, using the decoction and strong hydrochloric acid. A pale mauve colour was produced: such a test as this cannot be held a proof of its presence, and another specific test for resorcinol which was tried did not give a positive result. If resorcinol is proved to be present, it must be in such minute quantities that its therapeutic value as an antiseptic would be negligible.

Only dried material was available for sectioning. To soften and expand the leaf-tissues, before proceeding to imbed the leaves for sectioning, the quicker method of boiling in water was used, since it was found to give results quite as good as the use of glycerine with long soaking.

Sections of the leaf showed a rather interesting structure. The tannin is apparently not localised in special cells of the leaf. Mucilage-canals traverse the leaf, some running in the parenchymatous tissue below the main vascular bundle, and some near the upper leaf-surface. The upper epidermal layer contains mucilage, the presence of which is brought out very well in sections stained with ruthenium red. These upper epidermal cells are unusually large, and the cuticle is quite thin. The presence of mucilage in the epidermal cells undoubtedly delays transpiration to some extent, and is probably a xerophytic adaptation, although less effective than the formation of a thick cuticle. Cannon, in his paper on the Vegetation of the more arid portions of South Africa (2), refers to this fact.

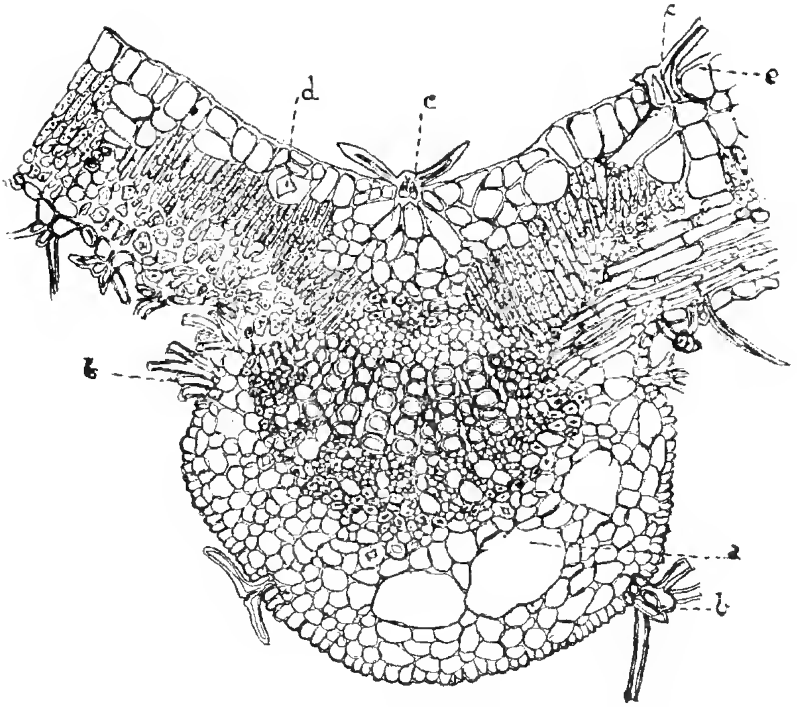

Fig. 1.—Vertical Section of leaf in region of midrib.

(a) Mucilage canals in parenchyma below vascular strand.
(b) Hair of lower epidermis.
(c) Thickly cuticularized hairs of upper epidermis.
(d) Crystal cell.
(e) Large epidermal mucilage-cell.

At definite points, just below the upper surface of the lamina, sometimes in the upper epidermis itself, there occur large crystal cells, each containing a single rhomboidal crystal, which, when tested microchemically, proved to be calcium oxalate. A few smaller crystals occur scattered through other parts of the leaf. The large crystals always show noticeably concave faces; this would be due to their formation in a mucilaginous medium, such as is evidently present in the enlarged crystal cells.

There are multifid cuticularised hairs present on both the upper and lower epidermal surfaces, although it is only on the lower epidermis that the hairs form what could be called a covering. Even there, the protruding ribs below the leaf-trace bundles are very sparsely covered with hairs.

On the upper surface the appearance is strongly suggestive of a connection of some kind between the mucilage ducts and the hairs. The ducts appear to run up towards the upper epidermis at the points where the hairs are inserted. The hairs are even more cuticularised than those on the lower epidermis, and it is hard to understand of what importance such a connection would be, for

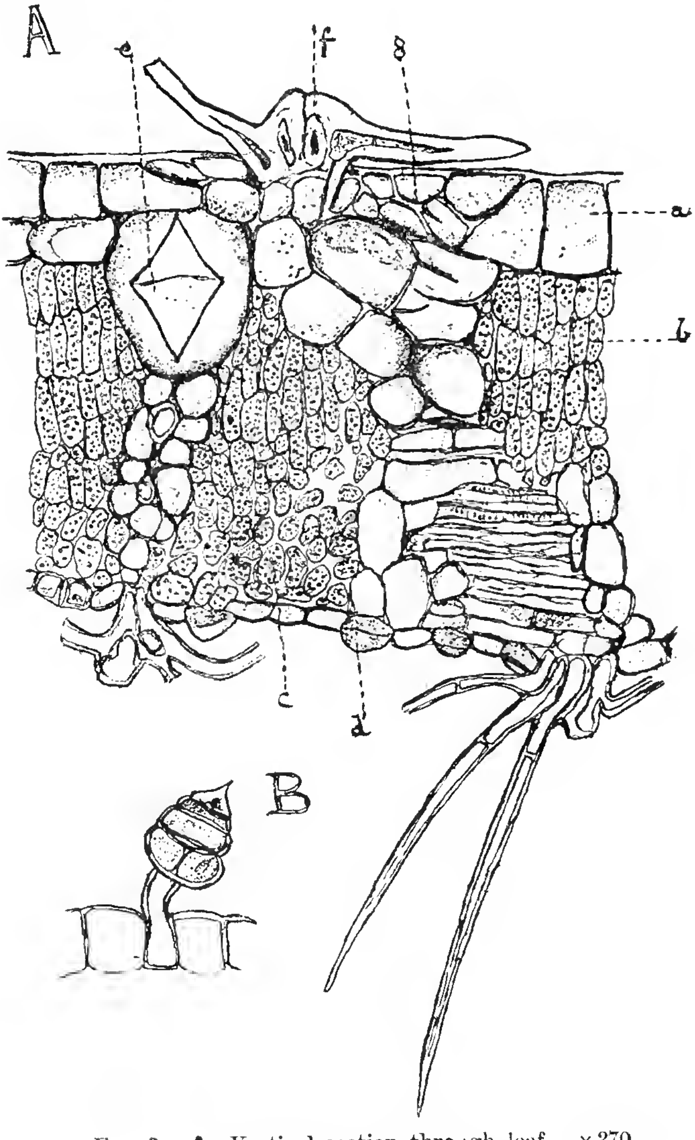

FIG. 2.—**A.** Vertical section through leaf. ×270.
(a) Large mucilaginous cell of normal epidermis.
(b) Palisade layer of mesophyll.
(c) Spongy mesophyll.
(d) Large stoma, surface view.
(e) Crystal of calcium oxalate in enlarged cell with mucilage.
(f) Hair of upper epidermis cut vertically.
(g) Multiple epidermis at insertion of hair.
B. Glandular Hair. ×270

the cell-walls of the hair are cuticularised right down to those cells which form, as it were, the "root" of the hair. Some indication of the same appearance of a connection has also been seen occasionally between hairs of the lower epidermis and mucilage ducts.

Other hairs, shortly stalked, and apparently glandular, occur on both surfaces of the leaf.

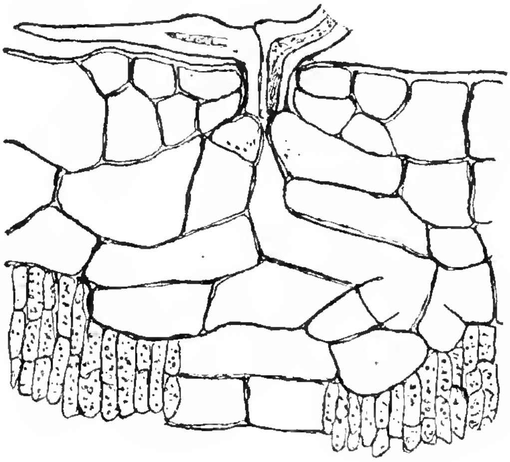

Fig. 3.—Vertical Section through insertion of an upper epidermal hair, to show the typical multiplication of epidermal cells, and the canal-like arrangement of mucilage-containing cells curving up towards the hair. ×270.

The stomata present an unusual appearance; they are large, distinctly projecting from the main epidermal level, and stain intensely with ruthenium red. They may occur in rather large and shallow stomatal pits, but are not confined to these.

A remarkable fact about the use of this plant as a medicine is that the aborigines do not know of it, and they are always credited with knowing all the plants in the North that have any important medicinal value.

This investigation has shown no basis for the belief that this decoction is of any special use in cases of dysentery as compared with specifics already known.

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[Proc. Roy. Soc. Victoria, 39 (N.S.), Pt. II., 1927.]

Art. XIV.—*Contributions to the Flora of Australia, No. 33.* Additions to the Flora of the Northern Territory and Locality Records.*

By ALFRED J. EWART, D.Sc., Ph.D., F.L.S., F.R.S.
(Professor of Botany and Plant Physiology),

and

PHYLLIS H. JARRETT, B.Sc.
(Howitt Research Scholar in Botany, University of Melbourne).

[Read 9th December, 1926.]

The present paper completes the identification of the collections made by the senior author in 1924. It also contains information derived from Mr. C. E. F. Allen's collection and from the Tate Herbarium, Adelaide. In addition it has been possible to append notes on the economic value of several species from information derived from Mr. Allen of Darwin, and from Sergeant Stott of Alice Springs. A small collection of plants from the Barrow Creek area was also received from Miss Crook of Wycliffe Well.

In the Northern Territory we find the most extreme degree of specialisation of the Australian flora. Over a large portion of the Territory, conditions are very arid, and the consequent xerophytic adaptations to these conditions are highly complex. From this point of view the origin of the flora and its evolutionary history is a subject of special interest; and perhaps ultimately it may be possible to apply such conceptions as Willis's Age and Area hypothesis to this problem. In the Northern Territory we have a large area in which the struggle for existence is severe, the environment is fairly uniform, and barriers to migration are almost absent—conditions peculiarly favourable for confirming the conclusions derived from a hypothesis of this kind.

CONIFERAE.

Callitris robusta R.Br.

Buxstone and MacDonnell Ranges, C. E. F. Allen (No. 374), July, 1922.

GRAMINEAE.

Rottboellia exaltata Linn.

Stapleton, C. E. F. Allen (No. 717), December, 1922.

*No. 32 in *Proc. Roy. Soc. Vic.*, n.s., xxxix. (1) p. 1., 1926.

Themeda triandra Forst.
Roper River Flats, C. E. F. Allen (No. 733), May, 1924.

Panicum sanguinale Linn.
Arltunga gold fields, C. E. F. Allen (No. 614), July, 1922.

Eriachne stipacea F.v.M.
Low coast lands, Darwin, C. E. F. Allen (No. 518), March, 1922.

Pappophorum nigrum R.Br.
Alice Springs, C. E. F. Allen (No. 567), July, 1922. Mr. Allen states that this plant is a good fodder.

Eragrostis Dielsii Pilger (= *E. falcata* Benth.).
Near Darwin, C. E. F. Allen (No. 441), January, 1920.

CYPERACEAE.

Cyperus concinnus R.Br.
Near Darwin, C. E. F. Allen (No. 519), March, 1922.

C. Iria Linn.
Barrow Creek, Miss Crook, July, 1926.

Schoenus sparteus R.Br.
Near Darwin, C. E. F. Allen (No. 520), March, 1922.

CASUARINACEAE.

Casuarina Decaisneana F.v.M.
MacDonnell Ranges, G. F. Hill, May, 1911.

ULMACEAE.

Trema aspera Blume.
Simpson's Gap, Mrs. Dutton, July, 1924.

T. cannabina Lour.
MacDonnell Ranges, F. W. Schwarz, 1889; Alice Springs, R. Tate, 1894.

PROTEACEAE.

Grevillea agrifolia A. Cunn.
Near MacDonnell Ranges, R. Tate, 1889; Attack Creek, E. C. S., May, 1891.

G. angulata R.Br.
Hamilton Down Station, near Alice Springs, Sergeant Stott, September, 1926.
This species is very plentiful throughout Central Australia and is recorded as a good fodder, being an excellent stand-by during drought.

G. pterospermum F.v.M.
Bagot's Creek, Ralph Tate, 1894.

G. refracta R.Br.
South Northern Territory, E.C S., May, 1891; (also Fitzroy River, N.W. Australia, Calvert Expedition, 1897).

G. stenobotrya F.v.M.
Chamber's Pillar, MacDonnell Ranges, Ralph Tate, 1894.
G. stricta R.Br.
Horse-shoe Bend, Mrs. Osborne, 1924.
Hakea intermedia Ewart and Davies.
MacDonnell Ranges, Ralph Tate, 1894 (labelled *H. lorea* in Tate Herbarium).
Banksia dentata R.Br.
Wet land eight miles from Darwin, C. E. F. Allen (No. 549), March, 1922.

LORANTHACEAE.

Loranthus sanguineus F.v.M.
Stapleton, C. E. F. Allen, (No. 547), December, 1922.

POLYGONACEAE.

Emex spinosa Campd. Rum.
Alice Springs, Sergeant Stott, April, 1926.
This plant has not previously been recorded from the Northern Territory.

CHENOPODIACEAE.

Hemichroa diandra, R.Br.
Taylor Creek, A.J.E., June, 1924.
Rhagodia spinescens R.Br.
MacDonnell Ranges, Ralph Tate, 1889.
Atriplex nummularia Lindl.
Alice Springs, Sergeant Stott, September, 1926.
This is an excellent fattening fodder for sheep and cattle.
Bassia divaricata F.v.M.
Ryan's Well, C. E. F. Allen (No. 575), July, 1922.
This species has not previously been recorded from the Northern Territory.
Kochia aphylla R.Br.
Alice Springs, C. E. F. Allen (No. 621), July, 1922, and Sergeant Stott, September, 1926.
This species which is an excellent cattle fodder is plentiful in various parts of Central Australia.
K. triptera Benth.
Ryan's Well, C. E. F. Allen (No. 576), July, 1922; Wycliffe Well, C. E. F. Allen (No. 644), July, 1922.
K. villosa Lindl.
Alice Springs, Sergeant Stott, September, 1926. A good fodder.
Enchylaena tomentosa R.Br.
Alice Springs, Ralph Tate, 1894.
Salsola Kali Linn., var. *strobilifera.*
Barrow Creek, Miss Crook, July, 1926.

AMARANTACEAE.

Trichinium macrocephalum R.Br.
Alice Springs, Sergeant Stott, September, 1926.
Grows prolifically on stony ridges. A good stock fodder procurable throughout Central Australia.

T. obovatum Gaud. var. *grandiflorum* Benth.
Burt Plain and Mount Gillen, Alice Springs, Sergeant Stott, September, 1926.
A good fodder common in Central Australia.

Gomphrena canescens, R.Br.
Emily and Burt Plains, Alice Springs, Sergeant Stott, September, 1926.

AIZOACEAE.

Mollugo cerviana Ser.
Barrow Creek, Miss Crook, July, 1926.

Glinus (*Mollugo*) (Aizoaceae).

Wycliffea, Ewart and Petrie, Contrib. Flora of Austr. No. 31, *Proc. Roy. Soc. Vic.*, n.s., xxxviii., 1926 (Caryophyllaceae).

Glinus spergula Linn. (=*Wycliffea obovata* Ewart and Petrie).

G. spergula Linn. var. *rotundifolia* n. var. (=*Wycliffea rotundifolia* Ewart and Petrie).
The two species of *Wycliffea* are merely highly cleistogamic forms of *Glinus spergula* adapted to arid conditions. The boundary between the Aizoaceae and Caryophyllaceae is not well defined, and it is possible that this section of the Aizoaceae is more closely allied to the Caryophyllaceae than to the order in which it is placed.

LEGUMINOSAE.

Caesalpineae.

Cassia leptoclada Benth.
Kelly's Well, C. E. F. Allen (No. 609), July, 1922.

Papilionaceae.

Mirbelia oxyclada F.v.M.
Tablelands south of Renner Springs, C. E. F. Allen (No. 674), July, 1922.

M. daviesioides Benth (=*M. aphylla* F.v.M.).
Bagot's Creek Gorge and Gill's Range, Ralph Tate, 1894, labelled *M. oxyclada.*

Crotalaria incana Linn.
In the sandy country near the coast, Darwin, C. E. F. Allen (No. 413), October, 1921.
This species has not previously been recorded for Northern Territory.

C. linifolia Linn.

In the sandy country south of Darwin, C. E. F. Allen (No. 632), July, 1922.

C. trifoliastrum Willd. var. *angustifolium.*

No. 2 Bore, Northern Wells, C. E. F. Allen (No. 633), August, 1922.

Wycliffe to Taylor, A.J.E., June, 1924.

This variety has not previously been recorded for Northern Territory.

Tephrosia sphaerospora F.v.M.

Ooramina, Central Australia, Ralph Tate, 1894.

T. eriocarpa Benth.

On the rocky ridges east of Taylor Range, A.J.E., June, 1924.

Swainsona Burkei F.v.M.

MacDonnell Ranges, C. E. F. Allen (No. 612), August, 1922.

Alice Springs, Sergeant Stott, September, 1926.

This species is plentiful throughout Central Australia and is an excellent fodder plant.

S. phacoides Benth.

Alice Springs, Sergeant Stott, September, 1926.

This species is plentiful throughout Central Australia and has a high fodder value.

S. microphylla A. Gray.

Wycliffe Creek, C. E. F. Allen (No. 596), July, 1922.

This is the first definite locality record for this species.

Glycine falcata Benth.

Alice Springs and Stuart, A.J.E., June, 1924.

ZYGOPHYLLACEAE.

Tribulus angustifolius Benth.

Barrow Creek, Miss Crook, July, 1926.

EUPHORBIACEAE.

Phyllanthus maderospatanus F.v.M.

Taylor Range, A.J.E., June, 1924.

This plant is greedily eaten by stock.

Petalostigma quadriloculare F.v.M. var. *nigrum* Ewart and Davies.

Wycliffe, A.J.E., June, 1924.

This plant is locally known as Quinine Bush on account of its very bitter fruits.

TILIACEAE.

Grewia polygama Roxb.

Near Darwin, Captain Bishop, April, 1926.

MALVACEAE.

Sida rhombifolia Linn.
Stuart to Alice Springs, A.J.E., June, 1924.
Hibiscus cannabinus Linn.
Barrow Creek, Miss Crook, July, 1926.

BIXINEAE.

Cochlospermum Fraseri Planch.
Macadam Ranges, Mt. Victoria, Fitzmaurice River, Dr. Basedow, 1922.
This plant has not previously been recorded for Northern Territory.

VIOLACEAE.

Ionidium suffruticosum Ging. (=*Hybanthus enneaspermus* F.v.M.)
Barrow Creek, Miss Crook, July, 1926.

MYRTACEAE.

Eugenia Holteana F.v.M.
Near Darwin, C. E. F. Allen, (No. 540), June, 1922.
This is the first definite locality record for this species.
E. Jambolana Lam.
Near Darwin, C. E. F. Allen, (No. 403), August, 1919.
This species has not previously been recorded for Northern Territory.
Eucalyptus grandifolia R.Br.
Stapleton, C. E. F. Allen (No. 461), December, 1922.

CONVOLVULACEAE.

Cuscuta epithymum Murr. Syst.
Alice Springs, Sergeant Stott, April, 1926.

BORAGINACEAE.

Heliotropium paniculatum R.Br.
Wycliffe, A.J.E., June, 1924.
Trichodesma zeylanicum R.Br.
Barrow Creek, Miss Crook, July, 1926.

LABIATAE.

Mentha australis, R.Br.
Neiles' Creek, Oodnadatta, S. Australia, A.J.E., April, 1924.
This species has not been recorded for the Northern Territory, but approaches the boundary.

SOLANACEAE.

Solanum echinatum R.Br.
Alice Springs, C. E. F. Allen (No. 627), July, 1922.

S. nigrum Linn.
Roper River, C. E. F. Allen (No. 738), May, 1924.

S. quadriloculatum F.v.M.
Near Alice Springs, C. E. F. Allen (No. 680), August, 1922.

RUBIACEAE.

Dentella repens Forst.
Barrow Creek, Miss Crook, August, 1926.

Gardenia edulis F.v.M.
Near Darwin, C. E. F. Allen (No. 406), August, 1919.

CUCURBITACEAE.

Momordica myriocarpus Linn.
Taylor's Flat, A.J.E., June, 1924.

Melothria maderospatanus Cogn.
Barrow Creek, Miss Crook, July, 1926.

CAMPANULACEAE.

Lobelia dioica R.Br.
Near running water, Banka Banka Station, South of Powell's Creek, C. E. F. Allen, (No. 663), August, 1922.

L. stenophylla Benth.
On lowlands near Darwin, C. E. F. Allen (No. 521), March, 1922.

Isotoma petraea F.v.M.
On wet country near Darwin, C. E. F. Allen (No. 524), March, 1922.

GOODENIACEAE.

Goodenia Haverlandi Maiden and Betche.
Between Wycliffe and Taylor, A.J.E., June, 1924.
This species has not been previously recorded for Northern Territory.

G. heterochila F.v.M.
Barrow Creek, Miss Crook, July, 1926.

G. mollissima F.v.M.
Barrow Creek, Miss Crook, July, 1926.

G. Strangfordii F.v.M.
Barrow Creek, Miss Crook, July, 1926.

Scaevola microcarpa Cav.
Barrow Creek, Miss Crook, July, 1926.
This species has not previously been recorded for Northern Territory.

COMPOSITAE.

Helipterum incanum D.C.

Alice Springs, Sergeant Stott, September, 1926.

This is the first definite locality recorded for this species though it is common throughout Central Australia; it is a good fodder plant.

[PROC. ROY. SOC. VICTORIA, 39 (N.S.), PT. II., 1927.]

ART. XV.—*Variation of Wind with Height at Melbourne when Geostrophic Winds are Northerly.*

By H. M. TRELOAR, B.Sc.

[Read 9th December, 1926.]

The geostrophic wind is an ideal wind blowing along the isobars with, in the Southern hemisphere, low pressure on its right. Its velocity G is defined by the equation—

$$2\omega \sin\phi . G = \frac{1}{\rho}\frac{dp}{dn} \qquad . \quad . \quad . \quad . \quad . \qquad A$$

where ϕ is the latitude,

ρ is the density of air,

ω is the angular velocity of rotation of the earth,

$\frac{dp}{dn}$ is the pressure change per unit distance normal to the isobars.

It has been shown that in other parts of the world the surface geostrophic wind is usually a good approximation to the actual wind at a height varying from about 1500 ft. to 3000 ft. The equation shows that the surface geostrophic wind can be computed from the surface isobars. Using data for 1922, G was calculated for Melbourne when the geostrophic wind direction was between N.22½°E. and N.22½°W., only those days being used for which a good determination of the pressure gradient could be made, and for which pilot balloon observations of the wind up to at least a kilometre were available. The accuracy of the wind determinations in the first half kilometre is high since distances are determined directly by rangefinder, thus avoiding the assumption of a uniform rate of ascent of the balloon. Both the 9 hour and 15 hour daily pressure charts were utilised, but the 9 hour determinations were by far the more numerous. The interval of time separating pressure and wind observations amounted to only half an hour.

The investigations of this paper are confined to geostrophic winds of less than 13 metres per second. Since two-thirds of the values lie between 7·4 and 10·5 metres per second the conditions are fairly homogeneous. For higher velocities the conditions are more complex and their investigation has not been completed. Means of the actual and geostrophic winds are exhibited in Table I. and Figure 1. This paper is concerned with the explanation of the average actual wind distribution from near the surface up to about 1000 metres in terms of the eddy diffusivity and geostrophic wind.

TABLE I.

Height above Theodolite	Variation of Wind with Height			
	Observed		Computed	
	V	θ	V	θ
m	m/s	°	m/s	°
50	5·5	18·6	5·6	18·5
150	7·3	16·2	7·2	16·6
300	8·8	11·0	8·6	11·3
450	9·3	7·0	9·2	6·5
750	9·7	2·2	9·3	0.9
1000	9·0	− 7	9·1	− 0·4
1300	10·0	− 17		
1500	9·4	− 21		
2000	10·4	− 26		
Mean Geostrophic Wind	8·9 m/s.	θ is the deviation of the wind from the surface isobars.		

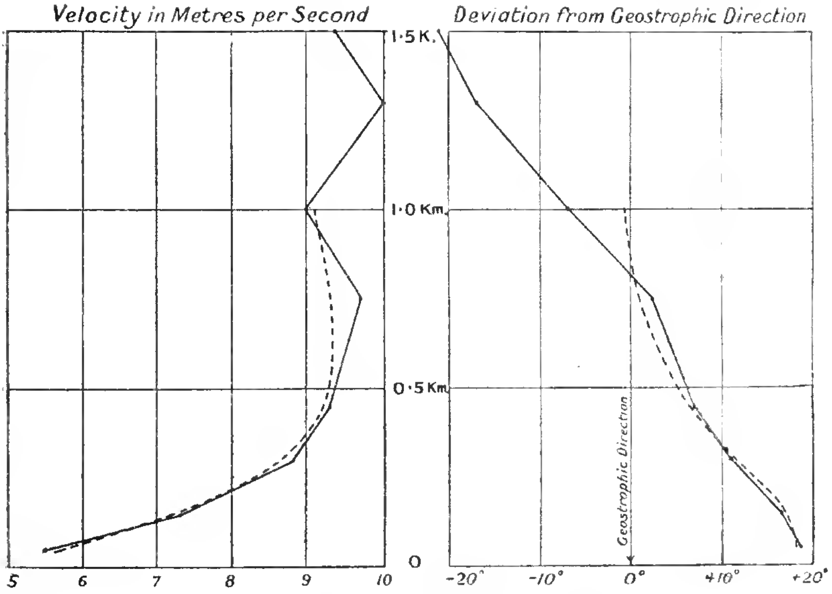

FIG. 1.—Variation of Wind with Height.

Air in uniform horizontal motion is under balanced forces due to gravity, pressure, friction and the earth's rotation. The equations of motion (1) referred to rectangular axes rotating with the earth are:—

$$-K\rho\frac{d^2u}{dz^2}=2\omega v\rho\sin\phi \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{B}$$

$$-K\rho\frac{d^2v}{dz^2}= -2\omega u\rho\sin\phi+2\omega G\rho\sin\phi \quad . \quad . \quad . \quad \text{C}$$

The motion at any height z is indicated in Figure 2, where OX is parallel to the surface geostrophic wind and OY is in the direction of decreasing pressure. The angle GOE is the angle between the actual wind and the geostrophic wind. The component wind velocities u and v are along OX, OY respectively.

Brunt simplified the treatment of the equations by using a vectorial notation, representing the horizontal velocity by W where $W = u + iv$.

Then regarding K and G as constants the solution, after neglecting that part which leads to an indefinite increase of velocity with height, is given by him (2) as

$$W - G = Ce^{-(1+i)Bz + i\gamma} \quad . \quad . \quad . \quad . \quad . \quad D$$

where C and γ are real constants to be determined from boundary conditions and $B^2 = \omega \sin\phi / K$.

Brunt, following Taylor and others, assumes that at the ground the up-gradient of velocity is in the direction of motion. In theory this condition is applied at the surface, but in practice $z = 0$ is taken to be some indefinite height "near the surface." This is equivalent to applying at a height near the surface the determining condition that there the up-gradient of velocity is in the direction of motion.

Three objections may be raised to these conditions:—

1. They are based upon an assumption which certainly does not always hold. Richardson (3) for instance gives a number of examples showing that the stress on the ground has a direction differing from the wind near the surface.
2. The height at which they are applied is too indefinite. This objection is important since the velocity changes rapidly near the surface.
3. It is now known that near the surface the eddy diffusivity decreases rapidly in disagreement with the assumption used in solving the equations.

An improvement would therefore be made if a condition for determining the constants could be found which was applicable at a definite height and required no additional assumption regarding frictional forces. It would be a further gain if this height were such that the condition as to constancy of eddy diffusivity was approximately fulfilled. Equation D leads to the following result:—

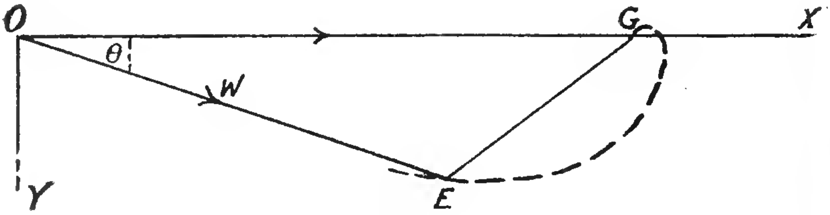

Fig. 2.

Referring to the explanatory diagram, Fig. 2, OG represents the geostrophic velocity along OX, and OE the vector velocity W. It has been pointed out that as W varies with height the solution indicates that the end of the vector GE traces out an equiangular spiral. Now if at any height z_1, the vector representing the wind is a tangent to that spiral, then at that height the direction of shear is in the direction of motion. The usual conditions will then be applicable at z_1, no additional assumption being needed. Since Brunt used the same conditions for different reasons as applying at the surface, his results can be used by substituting $z-z_1$ for his z. Hence the final solution is (2)—

$$W-G=\sqrt{2}G\sin\theta_1 e^{-B(z-z_1)+i\{\theta_1+\frac{3}{4}\pi-B(z-z_1)\}} \qquad . \quad . \qquad E$$

and at z_1, the well-known relation holds

$$\sqrt{u^2+v^2}=V=G(\cos\theta_1-\sin\theta_1) \qquad . \quad . \quad . \quad . \qquad F$$

θ_1 is the deviation of the wind from the geostrophic direction at the height z_1.

The value of K may be obtained from the wind data by the use of the formula

$$B^2=\frac{\left(\frac{du}{dz}\right)^2+\left(\frac{dv}{dz}\right)^2}{2\{(G-V)^2+2G(V-u)\}} \qquad . \quad . \quad . \quad . \qquad G$$

This follows immediately from equation D, and the constancy of G and K is therefore assumed. For the intervals 50-150 metres, and 150-300 metres, the magnitudes of K were found to be $3{\cdot}1.10^4$ and $3{\cdot}7.10^4$ respectively. Beyond that height reliance cannot be placed on the results as the quantities involved become too small. With the same assumption that G and K are constant, the latter can also be obtained from the relations given by Taylor (4)—

$$BH_d=\tfrac{3}{4}\pi+\theta_1 \qquad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad H$$

$$e^{-BH_v}=\frac{(1+\tan\theta_1)\cos BH_v-(1-\tan\theta_1)\sin BH_v}{\tan\theta_1} \qquad \ldots \qquad I$$

where

H_d=height at which the geostrophic direction is reached.

H_v=height at which the geostrophic velocity is reached.

For the winds dealt with here H_d=825m, H_v=340m, $\theta_1=18{\cdot}6°$.

The resulting values of K are $4{\cdot}8.10^4$ and $4{\cdot}2.10^4$ respectively. The eddy diffusivity thus appears to be approximately constant over the range of height considered and a good average value is $4{\cdot}0.10^4$.

Theoretically, since θ_1 is the maximum value of θ, the deviation from the geostrophic direction, it should be possible to determine θ_1 and consequently z_1, directly from the observations. Since θ_1 varies very slowly with height near z_1, and owing to various sources of irregularity, the results so obtained would be rather indefinite. The approximate value of θ_1 from the observations is 18·6°. Now it can be shown that

$$\text{Angle OGE (Fig. 2)} = B(z-z_1) - \theta_1 + \pi/4$$

Hence knowing θ_1, z_1 can be computed from the observations at various heights. Using the above approximate value of θ_1, we obtain the following results:—

$z =$	50	150	300	450	750 metres.
$z_1 =$	54	40	15	34	80 metres.

These give a mean value of 45 m. for z_1.

The value 50 m. will be adopted for z_1. It is near that determined above from the 50 m. observations for which the probable error is least, and also near the mean value. Furthermore it is the height at which θ_1 is a maximum and the equation F is fulfilled by the observations at that height. At 50 m. above the ground the effect of the decreasing eddy diffusivity will be less than at the lower heights usually taken as "near the surface."

We now have for the theoretical distribution the constants—

$$\theta_1 = 18{\cdot}6^\circ,\ z_1 = 50 \text{ m., } G = 8{\cdot}9 \text{ m/s and } K = 4{\cdot}0.10^4.$$

The values of V and θ derived from equation E are shown for stated heights in Table I. and graphed in Fig. 1 along with the actual winds, with which they are in remarkable agreement. Most of the calculations in this paper were made with a M.O. Pilot Balloon Slide Rule.

In conclusion I wish to thank Mr. H. A. Hunt, Commonwealth Meteorologist, for facilities for writing this paper.

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[Proc. Roy. Soc. Victoria, 39 (N.S.), Pt. II., 1927.]

Art. XVI.—*The Tasmanian Tektite—Darwin Glass.*

By SIR T. W. EDGEWORTH DAVID, D.Sc., K.B.E., F.R.S., H. S. SUMMERS, D.Sc., and G. A. AMPT, B.Sc.

(With Plate XIII.)

[Read 9th December, 1926.]

Contents.

I.—Introduction.

Considerable interest has been excited for many years past through the scientific world in the small bodies known as Tektites, the origin of which is still a mystery. Quite an extensive literature already exists dealing with the Moldavites of the Moldau River area, the Billitonites of the Netherlands East Indies, the Australites of the Commonwealth, and the Schonite of Scandinavia.

The remarkable variety of tektite known as Darwin Glass, has, as yet, hardly attracted the attention which its importance seems to the writers to deserve. Darwin Glass, so far, has been received only from the area of the Jukes-Darwin mining field. This area is situated to the east of Macquarie Harbour on the West Coast of Tasmania, and commences at a point about 12 miles south of the Mount Lyell Mine. A full account of its original discovery through Mr. V. Bruscoe, M. Donohue and Mr. Hartwell Conder, M.A., Assoc.R.S.M., is given in the original paper describing this glass by Professor Franz Suess (1). In it he quotes from a detailed letter describing the occurrence by Loftus Hills and Twelvetrees. This is reviewed in still more detail by Dr. Loftus Hills (2).

One of the writers, Professor Sir Edgeworth David, recently was so much impressed with the importance of this discovery that he made a special visit to the principal locality and had the good fortune to be accompanied by Mr. Hartwell Conder, the engineer who was chiefly responsible for bringing the matter before the scientific world. He desires specially to acknowledge the invaluable help and advice of Mr. Conder, and the generous assistance given him by Mr. R. M. Murray, General Manager of the Mount Lyell Mine, Mr. H. J. Clarke, Engineer of Works, Mr. D. Lumsden, Secretary of the Mount Lyell Company, Sir John Grice, Chairman of Directors of the Emu Bay Railway Company, and to the Tasmanian Government for travelling facilities. Lastly he is specially indebted to Dr. Loftus Hills for details in regard to mode of occurrence, etc., of the Darwin Glass, suggested by the latter's extensive personal local knowledge.

II.—Bibliography.

Reference has already been given to the two and only papers hitherto dealing with the subject of Darwin Glass.

In Professor Suess's paper the Darwin Glass, as it was originally named by the late W. H. Twelvetrees, former Government Geologist of Tasmania, is named Queenstownite—Queenstown being the largest settlement in its vicinity. Professor Suess would have named it Tasmanite, but for the fact that the term is already bespoken for the spore-bearing oil shale of the Latrobe area in Tasmania. The term Darwinite is also already appropriated to a mineral. It is proposed in this paper to adhere to Mr. Twelvetrees' original name of Darwin Glass. An objection to Queenstownite is that there are at least four towns within the British Empire of that name. Professor Suess has given such an excellent description of the Darwin Glass, together with chemical analyses, that we have little to add to his classic paper. Nevertheless some new observations have come to light which seem worth recording. Dr. Loftus Hills has well summarised all that was known about Darwin Glass up to the year 1915. His account should be read in conjunction with his work on the Jukes-Darwin mining field, forming Bulletin No. 16 of the Geological Survey of Tasmania.

III.—Mode of Occurrence.

The area where Darwin Glass seems to be most abundant is at the Ten Mile on the spur of Mount Darwin, trending down to the railway cutting at ten miles up from Kelly's Basin on Macquarie

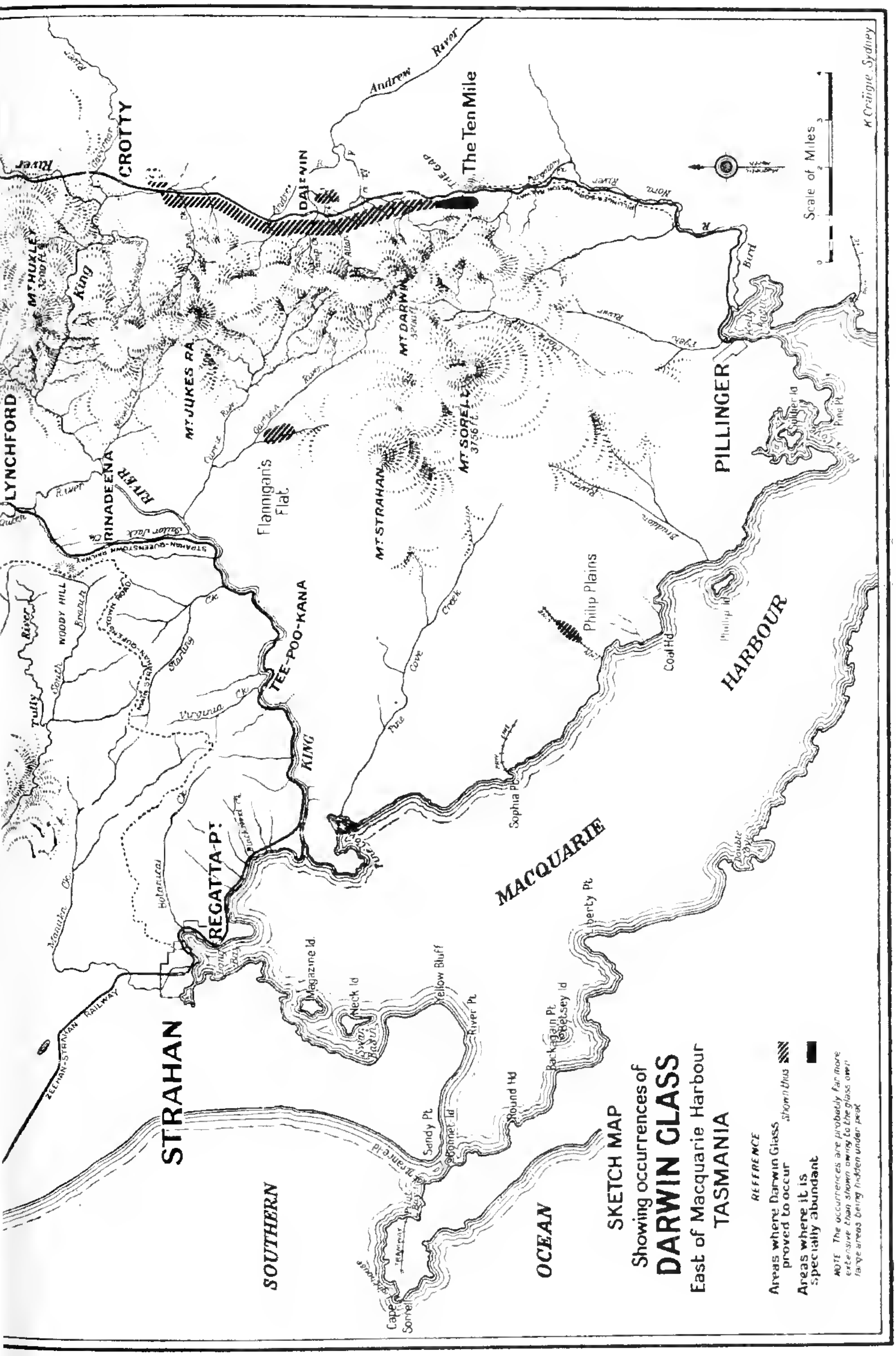

SKETCH MAP
Showing occurrences of
DARWIN GLASS
East of Macquarie Harbour
TASMANIA
REFERENCE
Areas where Darwin Glass proved to occur
Shown thus
Areas where it is specially abundant
Scale of Miles
STRAHAN
REGATTA-PT
TEE-POO-KANA
RINADEENA
LYNCHFORD
CROTTY
DARWIN
The Ten Mile
PILLINGER
MT. STRAHAN
MT. SOREL
MT. DARWIN
MT. JUKES RA.
MT. HUXLEY
Flannigan's Flat
Philip Plains
SOUTHERN
OCEAN
MACQUARIE
HARBOUR
KING
RIVER
Magazine Id.
Neck Id
Yellow Bluff
River Pt.
Round Hd
Sandy Pt.
Liberty Pt.
Sophia Pt.
Coal Hd.
Cape Sorell
K. Craigie Sydney

FIG. 1.

Harbour northwards, on the North Lyell Railway. The Darwin Glass is abundantly found in the cutting itself, and up the hill slope to a height of about 1300 feet above sea level. Strange to say, above the level of 1300 feet, the Darwin Glass has nowhere been met with, either on Mounts Darwin, Jukes, or Sorell. An ingenious explanation of the restriction in altitude of the occurrence of the Darwin Glass has been offered by Mr. Hartwell Conder. It is well known that this West Coast of Tasmania was heavily glaciated in Pleistocene time, and Mounts Darwin, Jukes, Sorell, and adjacent areas, show abundant evidence of the snow fields and glaciers having come down to within about 1000 feet of sea level. Indeed, during the maximum glaciation in early Pleistocene time, the glaciers in the Henty area came to within 200 feet or less of sea level. Conder assumes that, on the theory that the Darwin Glass was of meteoritic origin, as will appear most probable in the sequel, the hailstorm of small meteorites fell uniformly over the whole area of Mount Darwin for some twelve miles north of the Ten Mile, about ten miles east of the railway line, and four miles west, on the western slopes of Mount Sorell, and at Flanagan's Flat, west of Mount Darwin. In the case, however, of portion of this area which may have still been capped with ice and névé, the meteorites would become lodged in the ice, and would be gradually transported by it towards the ice margin, which at that particular time Conder argues would, on this hypothesis, be about at the top limit at which Darwin Glass is now found, namely 1300 feet above sea level.

If this view is correct, later investigation should show that the top limit of occurrence of the Darwin Glass on the western side of Mounts Darwin and Sorell is probably a little lower than that on the eastern, as the fall of the ice was chiefly westwards. This is an interesting point for detailed future investigation. We verified the statement that the Darwin Glass did not occur above the 1300 feet contour on Mount Darwin, and Conder, as well as Dr. Loftus Hills, is convinced that the glass is really absent from the higher levels. For example Donohue was much engaged in prospecting the higher levels of Darwin in search of gold, and although he was constantly on the look-out for Darwin Glass, with which he was particularly familiar, he never discovered a single specimen at the higher altitudes. At the Ten Mile the Darwin Glass occurs mostly immediately under a superficial covering of peat, which mostly forms the surface of this part of the hill slope. The peat is from 9 inches to about 18 inches in thickness. Immediately under the peat is fine rock rubble, from an eighth of an inch up to over an inch in diameter, the layer being from two to four inches in thickness, formed of pinkish sandstone or quartzite. This belongs to the West Coast Conglomerate Series of Silurian age. The Darwin Glass does not occur in the peat, which is of post-glacial origin, but only in the top two or three inches of rock rubble. Underneath the rubble is a foot or so of very fine pinkish grey sand. In places this sand thins out and even the rock rubble also, in which case the Darwin Glass is found resting on a surface of pink quartzite. In places the covering of peat has been removed by erosion, so that the Darwin Glass is exposed at the surface. It can most easily be collected from the beds of small rills coming down the mountain side, and particularly along the line of partly washed out track going up from the Ten Mile to Mount Darwin. The fragments appear to be present at the rate of from one quarter to one half ounce per square foot of the rock rubble. If this proportion is maintained even approximately over the greater part of the area within which the Darwin Glass has been found, it is evident that in the aggregate this material would amount to probably several hundreds of tons.

A further test of Conder's theory would be the probable local enrichment in Darwin Glass near to, and just below, the assumed contours of the old ice cap, for this zone would have received the dumpings from the large area of Mount Darwin between the 1300 foot level and its summit, 3340 feet above sea level. Near Crotty, about five miles north of the Ten Mile, i.e., fifteen miles north of Kelly's Basin, the Darwin Glass is found reposing on a surface of Silurian limestone. This fact weakens the argument that the glass is of fulguritic origin, for obviously the fusion of the limestone would not produce a glass of a chemical composition like that of the Darwin Glass, which has from $88\frac{1}{2}\%$ to nearly 90% silica. In the letter by Twelvetrees to Professor Suess, the former states that "they (the mysterious pieces) have been found on the east side of Mount Darwin and at a third locality to the south of it, one and a half miles inland from Macquarie Harbour. At the last-mentioned place they were found in gravel under the grass." Possibly Twelvetrees is here referring to the occurrence three miles west of Mount Sorell, but this is nearly six miles inland from the eastern shore of Macquarie Harbour. Obviously much yet remains to be done in the way of delineating correctly the limits horizontally and vertically of the Darwin Glass, and particularly the relations of its occurrence to the gravel sheets between Strahan and Kelly's Basin, if the deposit extends as far westwards as this.

There can be little doubt but that these gravel traces are outwash apron gravels from some of the Pleistocene ice sheets. So far no traces of Darwin Glass have been met with in the oldest and earliest Pleistocene morainic deposits.

IV.—Form and Surface.

The larger fragments are rarely found in an absolutely unbroken condition. If, as supposed before, they are of meteoritic origin, and the fall dates back to Pleistocene time, they must have been subjected to frost weathering, as well as water erosion, and these two factors would certainly have largely contributed to splintering the glass. Occasionally, however, one finds a perfectly unbroken specimen, particularly among the smaller examples. These latter are frequently of the tear-drop type. Between their two extremities these drops are generally curved. In the longer ones a small shelf or flange is developed on the concave side of this curve. Stalactitic forms often showing a spiral twist, are very common. These have a longitudinally striated appearance, something like that of pulled out and twisted toffee, owing to the considerable elongation of the gas pores parallel to the principal axis of the stalactite. Some of these types show a spiral twist of over 90°. Frequently such stalactites are bent irregularly. Occasionally one sees one of these types formed of greenish-brown glass with a droplet of clear translucent green glass firmly adhering to it. In many cases groups of small drops are closely aggregated together in many forms. They were apparently extruded, probably by gas pressure, from the molten interior of a larger fragment. More rarely the fragments are disc-shaped slightly thinned towards the centre, the disc being flattened so as to resemble a very small biscuit. More rarely still fragments are met with approaching in shape a somewhat flattened sphere. Only in some cases among the many hundreds of specimens collected has one been found (in this case by our party last April) showing a definite, though only slightly developed, ri n, analogous to the rim so characteristic of Australites. This specimen is figured, Plate XIII., Fig. 1.

V.—Physical Characteristics.

(a) *Specific Gravity.*

The specific gravity of the Darwin Glass is recorded by Loftus Hills (2) as ranging from 1·874 to 2·180, the variation being due to the number of vesicles present. One of us, G. A. Ampt, has made a careful determination of the specific gravity of the powder used in an analysis and records it as 2·296 at 14·2°C. Suess (1) also records two determinations by E. Ludwig of the specimens analysed by him. These are given as 2·2921 and 2·2845 with water at 4°C=1·0. The specific gravity varies very definitely with the silica percentage, as can be seen by the following table:—

	SiO_2	Sp. Gr.	Analyst.
No. 1	86·34	2·296	Ampt
No. 2	88·764	2·2921	Ludwig
No. 3	89·813	2·2845	Ludwig
Average	88·30	2·2909	———

(b) *Hardness.*

Loftus Hills records the hardness as being 7 on Mohs' Scale. In many cases the determination of hardness is impossible as the material is too brittle owing to the number of vesicles. The more solid specimens tested were just scratched with difficulty by quartz, so that the hardness of these was slightly below 7.

(c) *Colour, Lustre and Transparency.*

The colour of the Darwin Glass varies considerably. Some forms are dark smoky green to almost black and only translucent in very thin fragments. Others are greyish green, fairly free from vesicles and translucent in fairly thick fragments. Occasional pieces are almost white in colour and somewhat resemble pumice owing to the extremely vesicular nature of the material. Other colours observed were grey, olivine green and yellowish green.

In thin sections all the glasses are quite transparent, but as noted above the dark coloured forms and also the whitish forms are practically opaque in thick fragments, and only translucent in thinner fragments.

The lustre of the specimens on the weathered surfaces is dull, but ranging from vitreous to dull on freshly broken surfaces. Polished surfaces show a high vitreous lustre.

(d) *Microscopic Structure.*

All the thin sections examined showed that the material consisted of light greyish to greenish transparent glass. Some specimens showed a number of minute black specks. Flow lines were present in some specimens and absent in others. The denser forms showed a moderate number of vesicles, most of which were approximately circular. Occasional vesicles drawn out parallel to the flow lines were observed. The whitish forms when sectioned were found to be quite glassy with very numerous vesicles. In polarized light no definite trace of devitrification was found.

(e) *Refractive Index.*

The refractive index of two specimens was determined by a Herbert Smith refractometer, using sodium light, the results being:—

No. 1.—1·486.
No. 2.—1·497.

In addition the specific refractivity (3) of the three specimens analysed of which the specific gravity was determined was calculated from the specific refractivity of the minerals in the norm, and from this the refractive index, with the following results:—

K (Specific Refractivity)		Density	Ref. Index.
No. 1	0·2065	2·295	1·474
No. 2	0·2088	2·2921	1·479
No. 3	0·2087	2·2845	1·477

(f) *Radio-activity.*

One specimen was ground up and tested by Mr. J. S. Rogers for radio-activity and a completely negative test was obtained.

(g) *Melting Point.*

The microscopic examination of the material showed that it was wholly glassy so that no definite melting point would exist. The apparatus at our disposal would not allow of even a moderately accurate determination of the temperature at which crystallization of the thoroughly fused material would commence, so that no tests have been made.

VI.—Chemical Composition.

L. Hills (2) and E. Suess (1) both record analyses by Dr. Ludwig of Darwin Glass. Two additional analyses have been made by one of us, G. A. Ampt, and the following is a description of the methods employed and precautions taken to ensure a high degree of accuracy.

The analyses were carried out on the general lines prescribed by Washington and Hillebrand with certain modifications demanded by the exigencies of the cases, or shown by past experience to possess advantages in rationale and technique.

The material submitted for analysis was, from the point of appearance alone, of two qualities: I. dull, smoky-grey, glassy fragments in abundant quantity, II. pale, greenish-grey, clear, glassy fragments of which somewhat less than four grammes were available. Both qualities contained large numbers of vesicles, and the determination of specific gravity in the massive state was regarded therefore as futile. The determination of the specific gravity in the finely powdered form was, however, made in the case of I, all precautions being taken to remove entangled air from the powder by gently boiling with water under reduced pressure, in the specific gravity bottle used for the determination.

The specific gravity of the powder, referred to water at 14·2°C., was found to be 2·296.

The preparation of samples for analysis presented no difficulties whatever, since the glassy material shatters with the greatest ease. Moreover, the rapidity of attack of the usual reagents rendered it unnecessary to grind any portion to an impalpable powder. Crushing in a steel mortar was carried on only until the whole of the selected fragments had passed through a 90-mesh sieve.

As with all very siliceous rocks, fusion with sodium and potassium carbonates yielded nice clear melts, and in neither case did the colour of the solidified cake give any suggestion of the presence of manganese. The fused mass, after disintegration with hydrochloric acid, was evaporated to dryness on the water bath and then baked in an air oven at 130° C. for 1-2 hours. This procedure has been found to reduce the non-insolubilized silica to a practical minimum of about 2 milligrammes. The successive evaporations recommended in the treatises on the subject, while they may reduce this amount still further, do not result in the dehydration of the whole of the silica. reliance being placed on the ammonia precipitation for the recovery of the small amounts of silica still remaining in solution. Considerable economy in time is thus effected without in any way sacrificing accuracy. The complete removal of the last traces of insolubilized silica from the evaporating basins is a matter of great difficulty; a visible film remains after the most painstaking efforts of wiping with pieces of damp filter paper. The extent of the loss thus involved was investigated subsequently, using a platinum basin from which this film could be removed chemically with hydrofluoric acid; the adhering silica amounted to slightly less than 1 milligramme (=0·1% on a 1 grm. sample). This refinement could be introduced with advantage in certain special cases and if facilities were available.

Metals of the H_2S group were absent from I and the test was therefore not applied in II.

The separation of the ammonia precipitate calls for the greatest care. for it is in this operation that so many things can go wrong. A fruitful source of error lies in the ammonia itself. Long storage in bottles leads to the solution from the glass of both silica and alumina, and quite frequently the ammonia in reagent bottles has absorbed sufficient carbon dioxide to carry down in this group some calcium as carbonate. The commercial ammonia is therefore redistilled and kept in a heavily waxed bottle for use in all high class work.

The tendency of magnesium to be partially precipitated in this group is greater than is usually appreciated, and herein lies the fundamental necessity for dissolving and re-precipitating this group. No separation of aluminium and iron from calcium and magnesium will be complete unless the ammonia precipitate has been dissolved and re-precipitated at least once.

Precipitates of aluminium and ferric hydroxides should always be washed with a 2% solution of ammonium nitrate to suppress the formation of colloidal solutions; even so, the recovery of "dissolved" alumina from the filtrates should be made as a matter of course, and is best carried out after concentration to small bulk.

The addition of filter paper pulp prior to the precipitation with ammonia confers advantages quite out of proportion with the simplicity of the operation. Though it increases the bulk of the already voluminous precipitate still further, the fibres impart to it a porosity which makes for easy filtration and washing, both of which operations are extremely tedious with the ordinary gelatinous precipitates produced by ammonia. The subsequent ignition of these "pulp" precipitates yields a light porous mass which dissolves with great readiness in the pyrosulphate fusion. This is in marked contrast with the slow attack of the hard gritty nodules obtained by the older method.

To prepare the pulp, a 9-cm. ashless filter paper is torn into small fragments and drenched with about 5 c.cs of strong hydrochloric acid in a small flask. After a few minutes, water is added and the mush violently shaken to separate the fibres. The pulp is then strained off on a Gooch crucible, and washed once or twice, when the pad is removed to the precipitation vessel and disintegrated with a stirring rod.

The author of this section, G. A. Ampt, has adopted the practice of co-precipitating both manganese and nickel with the usual Group IIIA elements by adding a little bromine water to the hot ammoniacal liquid. The use of ammonium persulphate for this purpose is generally admissible, and is equally effective, but where appreciable quantities of lime are present it may lead to the precipitation of some calcium sulphate. The manganese and nickel thus find their way into the ignited "mixed oxides," as Mn_3O_4 and Ni_3O_4, and may be determined in aliquots of the solution of the pyrosulphate melt, the manganese colorimetrically after oxidation with sodium bismuthate, and the nickel by the glyoxime method. Both methods are capable of great accuracy, and even unweighable amounts of these oxides are readily detected. As a rule, the solution of the pyrosulphate melt is made up to 250 c.cs and used in the following manner: (i.) 100 c.cs for determination of total iron by reduction with zinc sulphide emulsion and titration with standard permanganate (4); (ii.) the same aliquot used for the glyoxime test for nickel, (iii.) 50 c.cs for the determination of manganese by the bismuthate process, (iv.) 50 c.cs for the determination of phosphoric anhydride, (v.) 10 c.cs for the colorimetric determination of titanium dioxide.

Neither manganese nor nickel was detected in either sample of Darwin Glass; a perceptible, though very minute precipitate of the yellow phospho-molybdate was obtained from I, indicating the presence of a trace of P_2O_5, while in II the test gave an absolutely negative result.

Ammonium sulphide produced a slight precipitate in both filtrates from the ammonia group; it was found to be mainly sulphur with a little platinum sulphide (from the crucibles), but it contained no cobalt.

Lime was present in minute amount (0·05%) in I, but could not be detected in II. This is interesting, and probably significant, in view of the distribution of P_2O_5.

Total water was determined by heating half-gramme portions in a small furnace and collecting the vapour in weighed absorption tubes. Control tests were made both with pure sodium bicarbonate (0·1 grm.) and with minute glass bulbs holding from 0·005 to 0·01 grm. of water, before the tests on the rock were undertaken. The weight of water collected, viz. I—0·46%, II—0·36%, showed remarkable agreement with the loss in weight suffered by the samples after correcting for oxidation of FeO to Fe_2O_3, viz. I—0·43%, II—0·33%.

The determination of ferrous oxide was made by dissolving the sample in a mixture of hydrofluoric and sulphuric acids, the apparatus employed resembling that advocated by Treadwell (5, p. 207). The platinum crucible was supported within a small leaden chamber through which carbon dioxide was circulated, and which was heated to 120°C. by immersion in an oil bath. Darwin Glass, obsidianites, and similar highly siliceous and homogeneous materials yield readily to HF, and it is not necessary to grind them to impalpable powders with the consequent danger of oxidizing some ferrous oxide.

The following method has been adopted for many years for the alkalies in preference to that of Lawrence Smith. The mineral is disintegrated in a platinum dish on a water bath with a mixture of alkali-free hydrofluoric and sulphuric acids, whereby the whole of the silica is expelled as volatile SiF_4. The solution is finally evaporated on a sand bath till fumes of SO_3 cease to be evolved and the residue is dry, but the heating should not be continued until the sulphates decompose, or sparingly soluble basic alums may be formed and alkalies lost. The sulphates after solution in water are treated with an excess of the purest solid barium hydroxide. This results in the complete precipitation of the sulphate radicle as $BaSO_4$ and of all the bases except calcium, the alkalies, and of course the excess barium, as hydroxides. The precipitate is filtered off and thoroughly washed (this is the only difficult operation in the process), and the filtrate is saturated with CO_2 and boiled down to small volume. Ba and Ca are thus thrown out as carbonates and are removed by filtration, while in the filtrate the alkalies are converted into chlorides and weighed. A few milligrammes of Ba invariably escape separation, and a series of small scale treatments with purest ammonium carbonate, filtrations and evaporations must be undertaken until the weight of the alkali chlorides is constant. It has never been found necessary to do this more than twice.

Potassium is separated as the platinichloride according to the usual procedure, but the final evaporation is made in a porcelain crucible with the addition of a little aqua regia to reoxidize any platinochloride formed by filtering the platinichloride through paper. The alcoholic filtrate containing the sodium platinichloride may be examined for lithium by means of the spectroscope.

The search for zirconium is now never omitted and is conveniently made on the same sample used for the detection of barium and sulphur. The determination as basic zirconium phosphate is somewhat tedious on account of the tendency of this salt to carry down others from which it must be purified by re-treatment. The presence of zirconia in sample II could not be definitely established, but barium, and sulphur in all forms, were absent from both specimens.

Owing to lack of material, further tests on II had to be abandoned. No. I was examined for carbonate in a miniature baryta-vacuum apparatus capable of detecting less than half a milligramme of CO_2 (6, p. 251)—none was found. The examination for chlorides was unsatisfactory and inconclusive. Owing to the inability to obtain chlorine-free sodium carbonate, a blank test yielded an amount of chlorine many times greater than that which it should be possible to detect. If present, however, the amount would not exceed 0·05%.

The complete analyses together with those of Ludwig are given in the following table:—

Analyst	Ampt		Ludwig	
	I.	II.	III.	IV.
Appearance	Smoke grey, full of vesicles	Pale greenish grey, many vesicles	Olivine green	Dirty white
SiO_2 -	86·34	87·00	88·764	89·813
Al_2O_3 -	7·82	8·00	6·127	6·207
Fe_2O_3 -	0·63	0·19	——	0·258
FeO -	2·08	1·93	1·238	0·895
MnO -	nil	nil	tr.	tr.
MgO -	0·92	0·82	0·575	0·727
CaO -	0·05	nil	0·174	——
Na_2O -	0·15	0·14	0·129	0·010
K_2O -	0·87	0·99	1·363	1·054
H_2O + -	0·43	} 0·36	——	——
H_2O — -	0·03			
CO_2 -	nil	nil	——	——
TiO_2 -	0·52	0·51	1·240	0·867
P_2O_5 -	tr.	nil.	——	——
ZrO_2 -	0·11	tr. (?)	——	——
Cr_2O_3 -	nil	nil	——	——
NiO, CoO -	nil	nil	——	——
BaO, SrO -	nil	nil	——	——
SO_3 -	nil	nil	——	——
Cl -	nil (?)	nil (?)	——	——
	99·95	99·94	99·610	99·821
Sp. Gr.	2·296	——	2·921	2·845

These four analyses have been classified according to the Quantitative Classification with the following results. The analyses are given in the same order as before.

	I.	II.	III.	IV.
Quartz - -	79·80	80·28	81·24	84·78
Orthoclase - -	5·00	5·56	8·34	6·12
Albite - -	1·05	1·05	1·05	——
Anorthite - -	0·28	——	·83	——
Corundum - -	6·53	6·73	4·08	5·10
Hypersthene - -	4·43	4·61	1·76	1·80
Magnetite - -	0·93	0·23	——	0·46
Ilmenite - -	1·06	0·91	2·28	1·67

All the analyses fall into Class 1 Persalane and Order 1 Perquaric. Rangs and sub-rangs are not considered necessary in this group. Only three analyses are quoted by Washington (7) in Class 1 Order 1.

VII.—Correlation with kindred Bodies, such as Moldavites, Australites, Billitonites, Schonite.

It has been shown by one of the authors (8) that all the other forms of Tektites of which analyses have been made fall into rangs and sub-rangs in the Quantitative Classification in which very few examples of normal igneous rocks are found. This is now shown to be equally true in respect to the Darwin Glass, so that rocks having compositions at all comparable with those of the Tektites are extremely rare among the igneous rocks of the earth's surface. At the same time, however, the strong similarity in composition of the various Tektites to one another is well shown by their relative positions in the Quantitative Classification.

The analyses of Australites, Billitonites and Moldavites have been compared by one of us (9) by means of variation diagrams. Suess (1) has also used a somewhat different form of variation diagram which includes in addition Ludwig's two analyses of Darwin Glass (Queenstownite). Variation diagrams are usually compiled either from the percentages of oxides as given by the analyses or from the molecular ratios determined from these percentages. The second form is that used by Suess. The summations of analyses and the percentages of water present vary. In some cases TiO_2 is not determined and in other cases the ferrous and ferric oxides have not been separated. If the molecular ratios are determined the totals for different analyses will vary greatly, so that in either case the analyses are not strictly comparable.

The molecular ratios give a better conception of the relative proportions of the oxides than do their percentages by weight. In order to obtain more satisfactory graphing, the molecular ratios of the various types have been determined from the analyses and then reduced to percentages. The water, both combined and hygroscopic, has been omitted and the TiO_2 reduced to Ti_2O_3. This latter is quite open to question, but the amount of titanium is small and the effect is practically negligible. The reduced analyses are given in the following table:—

	* Australite Uralla N. S. Wales	† Australite Uralla N. S. Wales	Australite Uralla N. S. Wales	Billitonite Tebrung Dendang	Australite Upper Weld Tasmania	Australite Bet. Everard Range & Fraser Range S. Aust.	Billitonite Lura No. 13 Dendang
	I.	II.	III.	IV.	V.	VI.	VII.
SiO_2	70·8	71·1	74·1	74·5	74·9	75·4	75·9
Ti_2O_3	—	—	0·1	—	0·3	—	—
Al_2O_3	10·8	10·9	9·7	7·6	9·4	8·5	7·5
Fe_2O_3	0·3	0·3	0·2	0·4	0·2	0·3	—
FeO	6·0	6·1	4·5	4·9	4·4	5·0	5·1
MgO	4·3	4·3	4·0	4·1	4·0	3·8	3·8
CaO	4·5	4·5	4·5	4·3	3·7	4·0	3·3
Na_2O	1·3	—	1·2	2·5	1·4	1·5	2·5
K_2O	2·0	2·8	1·7	1·7	1·7	1·5	1·9
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0

	Australite Coolgardie W. Aust.	Australite Kalgoorlie W. Aust.	Australite Mt. Elephant Victoria	Australite Pieman Tasmania	Australite Hamilton Victoria	Australite Peake Statn. S. Aust.	Moldavite Trebilsch Bohemia
	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.
SiO_2	76·0	77·0	77·5	78·6	81·3	82·0	82·2
Ti_2O_3	0·4	—	0·3	0·3	0·3	0·4	—
Al_2O_3	8·5	7·5	8·3	7·8	7·1	6·2	7·6
Fe_2O_3	0·3	0·4	0·2	0·1	0·1	0·1	0·1
FeO	4·4	4·7	4·1	3·5	3·5	3·3	3·2
MgO	3·9	3·4	3·0	2·9	2·3	2·5	2·3
CaO	3·6	3·5	3·7	4·3	2·9	2·7	2·2
Na_2O	1·4	1·8	1·6	1·1	1·3	1·4	0·6
K_2O	1·5	1·7	1·3	1·4	1·2	1·4	1·8
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0

* Iron and alkalies recalculated to accord with other specimens from Uralla.

† Iron recalculated to accord with other specimens from Uralla.

	Moldavite Skrey in Dukovan Mähren	Moldavite Trebilsch Bohemia	Moldavite Radomiltz Bohemia	Moldavite Radomiltz Bohemia	Australite Curdies' Inlet Victoria	Moldavite Budweis Bohemia	Moldavite Radomiltz Bohemia
	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.
SiO_2	82·7	83·0	82·5	83·8	84·4	86·2	86·3
Ti_2O_3	0 6	—	—	—	0·2	—	—
Al_2O_3	7·3	7·5	8 1	8·1	6·6	5·9	6·2
Fe_2O_3	—	0·1	—	0·8	0·3	—	—
FeO	2·4	2·9	2·3	1·3	2·8	1·1	1·7
MgO	2·5	2·2	0·4	1·9	2·2	2·4	1·6
CaO	1·5	1·8	3·6	1·4	1·7	2·3	2·5
Na_2O	0·7	0·4	0·3	0·8	1·0	0·6	0·3
K_2O	2·2	2·1	1·8	1·9	·8	1·5	1·4
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0

	Darwin Glass Tasmania (Anupt)	Darwin Glass Tasmania (Anupt)	Darwin Glass Tasmania (Ludwig)	Darwin Glass Tasmania (Ludwig)
	XXII.	XXIII.	XXIV.	XXV.
SiO_2	90·7	91·1	92·5	93·2
Ti_2O_3	0·2	0·2	0·5	0·3
Al_2O_3	4·8	4·9	3·8	3·8
Fe_2O_3	0·3	0·1	—	0·1
FeO	1·8	1·6	1·1	0·8
MgO	1·4	1·3	0·9	1·1
CaO	0·1	0·0	0·2	0·0
Na_2O	0·1	0·1	0·1	0·0
K_2O	0·6	0·7	0·9	0·7
Total	100·0	100 0	100·0	100·0

The percentages of molecular ratios have been graphed. In text-figure 2 the sums of the R_2O_3, RO and R_2O oxides are shown and for comparison those of some average compositions of the common more acid plutonic rocks are also given. Undoubtedly it would have been preferable to use average volcanic rocks rather than plutonic but up to the present similar averages of analyses of volcanic rocks have not been worked out.

In testing Daly's (10) averages for granites, quartz-monzonites, granodiorites, quartz-diorites, diorites, gabbros and norites by means of variation diagrams it was found that the various points for the percentages of the molecular ratios of the R_2O_3, RO and R_2O molecules fell practically on straight lines. Following this up all the better analyses of the above mentioned rocks quoted by Washington (7) were reduced to percentages of molecular ratios and graphed. Some analyses showed considerable deviation from the general average and were rejected as being probably not true to name. A series of averages was then calculated and the averages of the more acid types are shown on the diagram by crosses.

In text-figure 3 the graphs of the percentage molecular ratios of the individual oxides of the Tektites are given.

These variation diagrams strongly support the contention that the Tektites are all genetically related to one another and clearly show the close relationship in composition of the Darwin Glass to the remaining forms.

A comparison of the graphs for the Tektites with those for the common acid plutonic rocks shows that the two series are quite distinct in composition.

VIII.—Distribution of Tektites on the same Great Circle.

What is probably an extremely significant fact about Darwin Glass, in common with other Tektites, is that they all lie approximately on the same great circle.

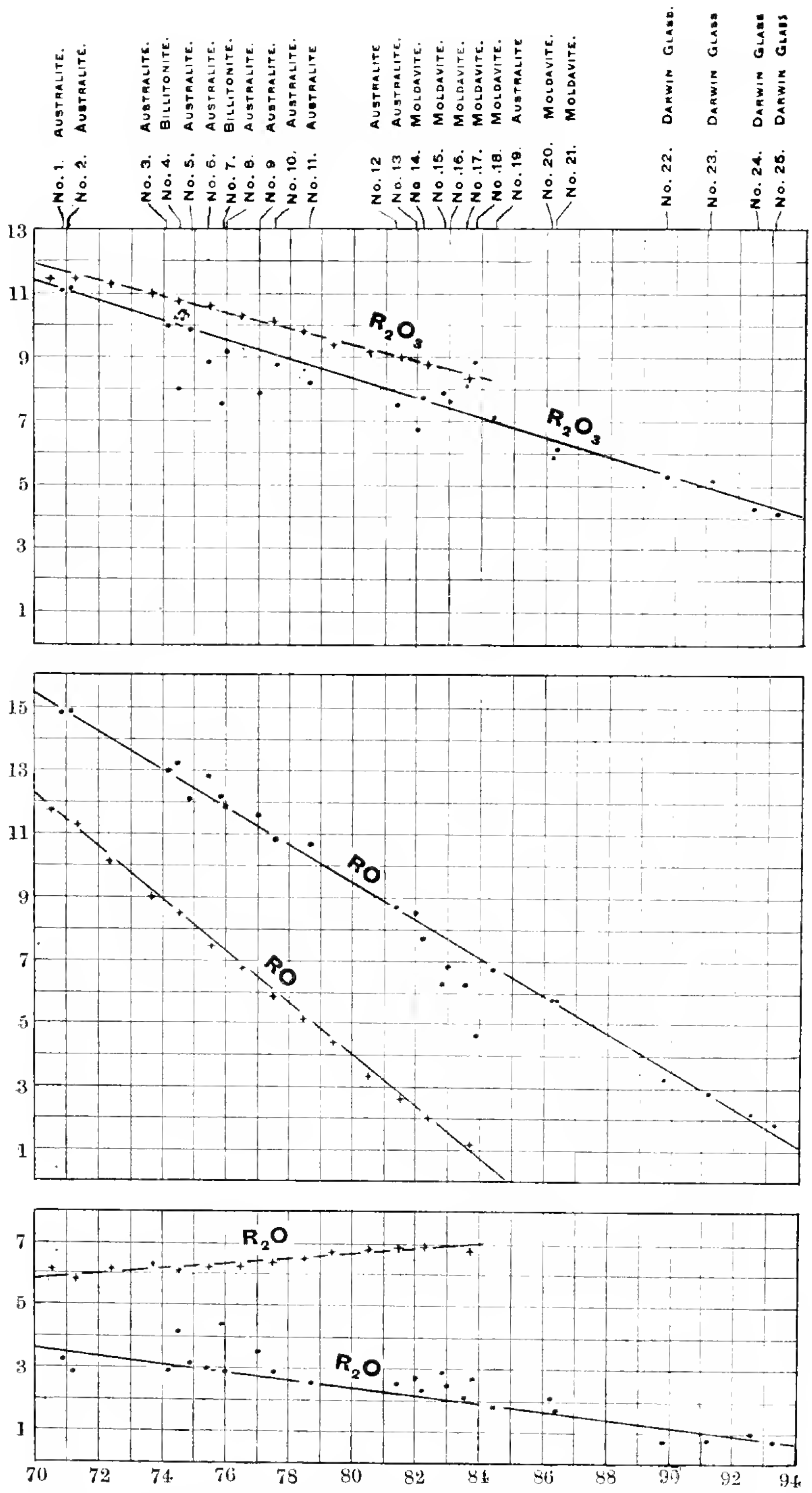


Fig. 2.—Graphs of sums of R_2O_3, RO and R_2O oxides in Tektites.

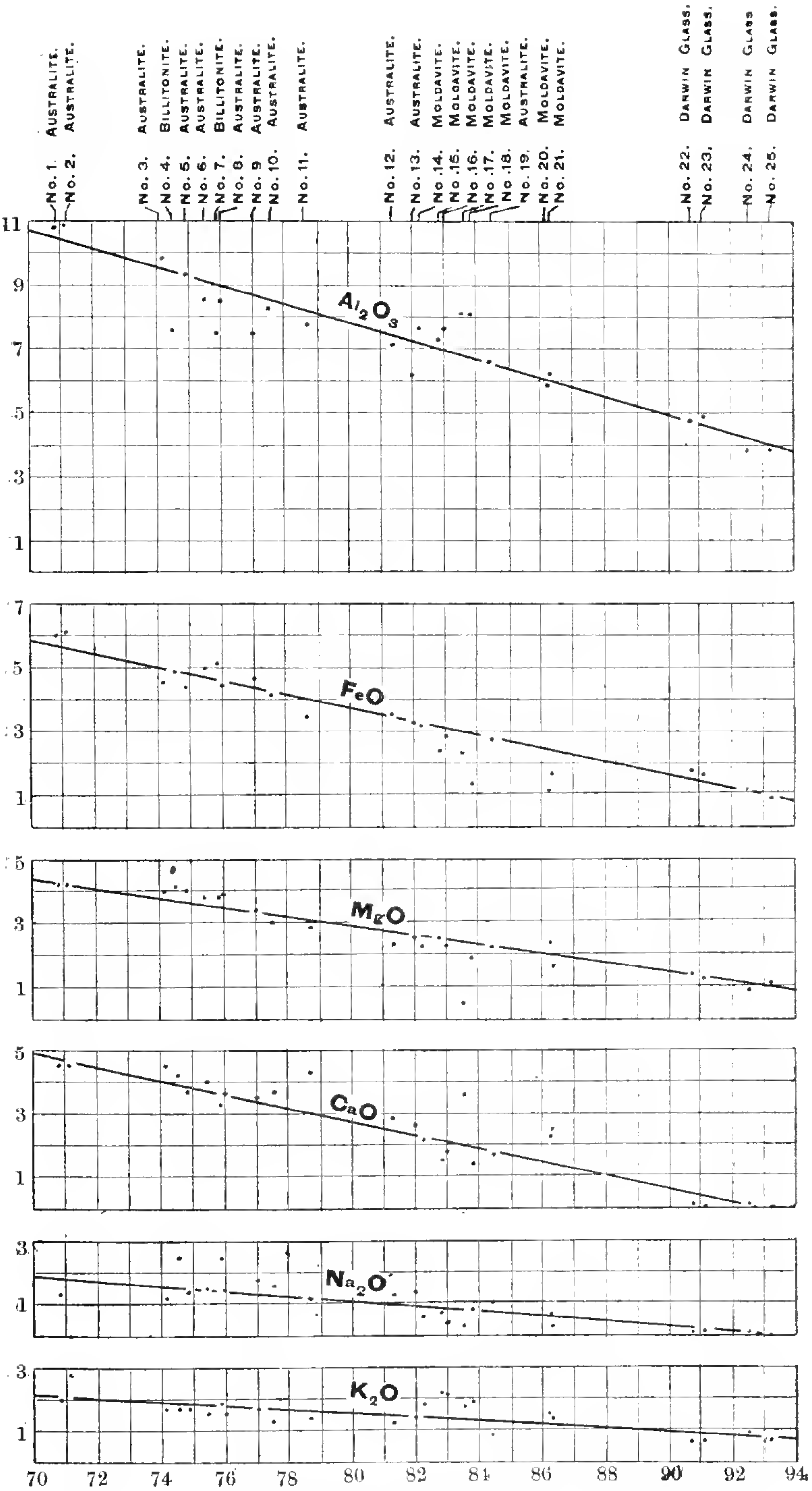
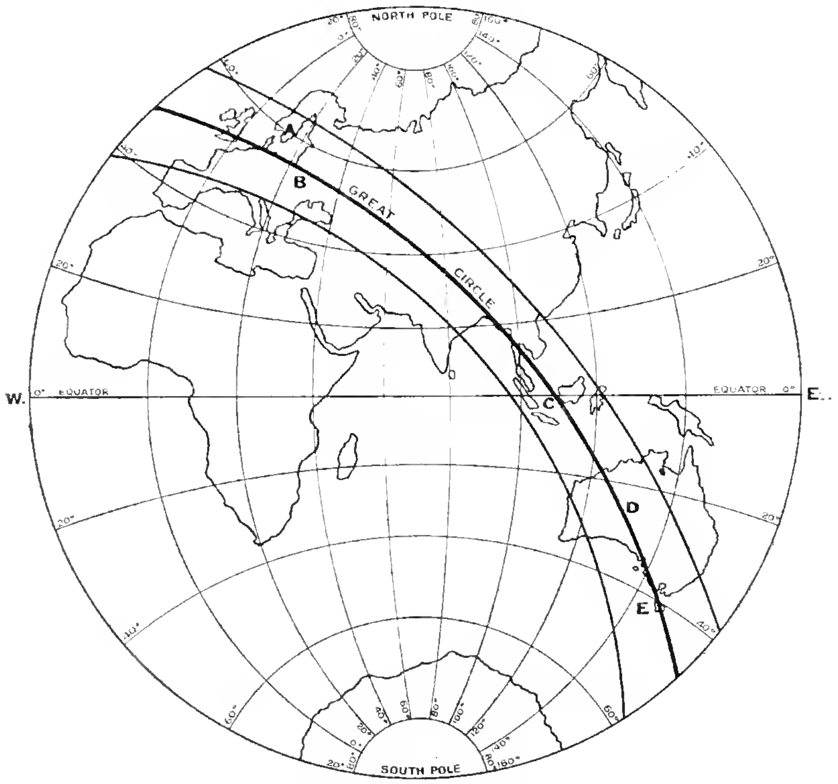


FIG. 3—GRAPHS OF PERCENTAGE MOLECULAR RATIOS OF INDIVIDUAL OXIDES IN THE TEKTITES.

If Tasmania be taken first it has Darwin Glass very plentifully, but also very locally, distributed, over a region in the south-west, upon and around Mount Darwin. No Australites, so far, have been found in this part of the island. Further north Australites occur, frequently several together in one group. The shower of Australites spread over Victoria, New South Wales, the southern

Map on Stereographic Projection
showing Great Circle $\frac{\nwarrow}{20}$ with belt on each side of it 10° wide, indicating that all the known tektites of the World lie approximately on the same Great Circle.



A. *Schonit of Sweden*
B. *Moldavites of Moldau River, etc.*
C. *Billitonites of Banca, Billiton and S. Borneo.*
D. *Australites of Australia.*
E. *Darwin Glass and Australites of Tasmania.*

Fig. 4.

extremity of Queensland, South Australia, and Central Australia, to beyond Charlotte Waters, and as far north west as the Tanami goldfield, Western Australia, where they appear to be specially abundant in the neighbourhood of the Coolgardie-Kalgoorlie goldfield. Northwards they have been traced to about half way between Wiluna and Hall's Creek on the Canning Stock Route. They have also been found a few miles inland from the coast near Wallal. They are thus strung out over an area about 2000 miles in length, from about E.40°S. to W.40°N. If this bearing be now followed on a great circle, it leads to Java, the south-eastern portion of Borneo. Banca and Billiton where the kindred bodies, Billitonites, occur somewhat plentifully. Following the same great circle, one finds, after a long interval, that one reaches Moldavia, where, of course, the closest allies of Darwin Glass, Moldavites, are very abundant and somewhat widely distributed. Again, on the same great circle, we find an isolated occurrence, in Scandinavia, of Schonite. In view of this remarkable distribution, there would seem to be a high probability that all these five bodies of Tektites belong to one and the same group of meteorites. They seem to have been either discrete swarms of small meteorites, or represent the scorification products of separate, larger bodies, which became, to a great extent, disrupted probably in their passage through the Earth's atmosphere. The distribution of the ultra-acid glasses, Moldavite and Darwin Glass, at the two extremities of the belt occupied by the Tektites (with the solitary exception of the Schonite) suggests an original gravitational separation of the meteoritic swarm into more siliceous portions on the periphery, and more basic types towards the centre. Though one is not sure of the sense of the movement, it may be assumed that as the swarm approached the earth, it became so greatly elongated towards the earth that the ring of acid meteorites was more or less disrupted into a vanguard and rearguard. The vanguard arrived in Tasmania, the main body fell over Northern Tasmania, Australia, and the Netherlands East Indies, and the rearguard, separated by a considerable distance, fell in Moldavia.

IX.—Hypotheses as to Origin.

Hypotheses as to the origin of the Tektites other than Darwin Glass have been discussed at length by many authors (see bibliographie lists by Suess (1) and Summers (8). The origin of the Darwin Glass has also been discussed by Suess and Loftus Hills (2). The hypotheses may be summarised as follows:—

(a) *Artificial.*

As recorded by Loftus Hills, this glass was not at first recognized as something unique owing to the material being found in the vicinity of copper smelting works at Crotty. Thus the glass was presumed to be simply a furnace slag. The analyses of course disprove this and the mode of occurrence and distribution also show that such an origin is impossible, as white men had only penetrated the area for about seventeen years at the time of the first discovery of Darwin Glass and the area had never been settled. The Tasmanian aborigines cannot be seriously considered as a factor in the distribution of a substance which does not occur naturally as a volcanic product and which they were incapable of producing artificially.

(b) *Volcanic.*

The Darwin Glass is certainly not earlier than the late Tertiary period. The principal volcanic rocks of this period in Tasmania and Victoria were basalts with occasional andesites and trachytes. The undevitrified nature of the glass precludes the possibility of this material being derived from any pre-Tertiary glassy igneous rocks. Therefore the only volcanic sources to which this material could be ascribed produced either basic or intermediate volcanic rocks only. The silica percentage in the Darwin Glass, approximately 88%, makes it even more difficult than in the case of the Australites, silica percentage 65 to 76, to suggest a local volcanic source. So far those holding the view that Australites are of volcanic origin have failed to suggest an Australian source which can be reasonably accepted. This led to the suggestion that the possible source was New Zealand or the East Indies. No rocks from these areas have been shown to be comparable in composition with the Australites, although some show a sufficiently high silica percentage. Even granting the possibility that the volcanoes from these areas might have produced material of the requisite composition, the transport of the material over such great distances cannot be ascribed to normal volcanic agencies. E. J. Dunn (11, 12, 13) has postulated the bubble hypothesis for the transport of Australites but it seems quite impracticable to extend this idea to cover the case of the Darwin Glass, even if it were accepted as a possible explanation of the distribution of Australites. If we are to believe that the Darwin Glass is of volcanic origin we must also believe that there exists in the neighbourhood a volcano which produced the glass.

If we consider the composition of the Darwin Glass we find that the hypothetical volcano would be required to produce a unique volcanic glass. The highest percentage of silica in an obsidian recorded by Washington is Dunn's so-called marekanite from New Zealand, with approximately 77% SiO_2. The Darwin Glass averages approximately 88% SiO_2. Richards (14) records an analysis of a rhyolite from Blackall Ranges, Queensland, with 83·13% SiO_2, and also quotes examples of other highly siliceous rocks. In all these cases, however, evidence of secondary silicification is noted and the compositions as given do not represent the original compositions at the time of extrusion. In the case of the Darwin Glass, if secondary silicification were accepted as a possible explanation of the high silica percentage, it would be necessary to assume that subsequently refusion of the material had taken place, to account for the absence of devitrification and absence of evidence of the presence of secondary silica. Taking into account the absence in the neighbourhood of evidence of contemporary volcanoes producing even normal acid rocks, and also the abnormal composition of the Darwin Glass, we have no hesitation in rejecting the hypothesis of a volcanic origin for these Tektites.

(c) *Fulguritic.*

(i.) *From fusion of siliceous sands at surface of ground.*

The records of the occurrence of fulgurites are comparatively few, and the plentiful distribution of the Darwin Glass has no parallel in such records. An examination of a fulgurite from New South Wales presented to us by Mr. Card shows that an open tube about 3/16″ in diameter runs throughout the specimen. Surrounding this tube the material is for the most part quite glassy but towards the margin the vitreous appearance is lost and this portion consists of only partially fused material. This is confirmed by an examination of a cross section of the fulgurite under the microscope. The central area is glassy but the outer portion affects polarized light and similates incipient devitrification. This appearance is, however, probably due to incomplete fusion of the original particles rather than to subsequent alteration from an isotropic glass.

This specimen of course cannot be taken as being typical of all fulgurites but shows that in this case there is very marked dissimilarity between the fulgurite and the Darwin Glass. According to Loftus Hills the Tektites are found lying directly on limestone in soil wholly composed of peat and the residuum from the decomposition of the limestone, and also in other places resting directly on quartzite. Since, as pointed out by Loftus Hills, a fulgurite must necessarily correspond approximately in composition with the surrounding material of which it is a fused portion, it is inconceivable that fulgurites of similar composition and appearance could be formed under such different conditions. The evidence therefore is distinctly against a fulguritic origin for the Darwin Glass.

(ii.) *From fusion of dust clouds in a thunderstorm.*

Fusion of dust clouds by lightning discharge has been suggested as a possible explanation of the formation of Australites. This idea while suggesting a possible source of the Australite does not explain their distribution or similarity in composition. This hypothesis postulates an exceptionally dense dust cloud and the production from this by means of lightning discharge of moderate sized pieces of a perfectly fused glass, a phenomenon which has never been recorded in any part of the world. A large proportion of the Australites are found in places in which dense clouds are by no means uncommon but the Darwin Glass is only found in an area, at the present time of heavy rainfall, and in which dust storms similar to those of Central Australia are impossible. There is no evidence to show that arid conditions existed in this area during Pleistocene times, but rather the reverse, as it has been shown earlier that the Darwin Glass was probably contemporaneous with the Pleistocene glaciation of Western Tasmania. Should such a fusion of dust take place one would expect the product obtained to be more related to the fulgurites than to a perfectly homogeneous glass, i.e.. the mass would consist of fused material together with a considerable amount of only partially fused dust particles. No evidence of such fritted material has been seen.

(d) *Meteoritic.*

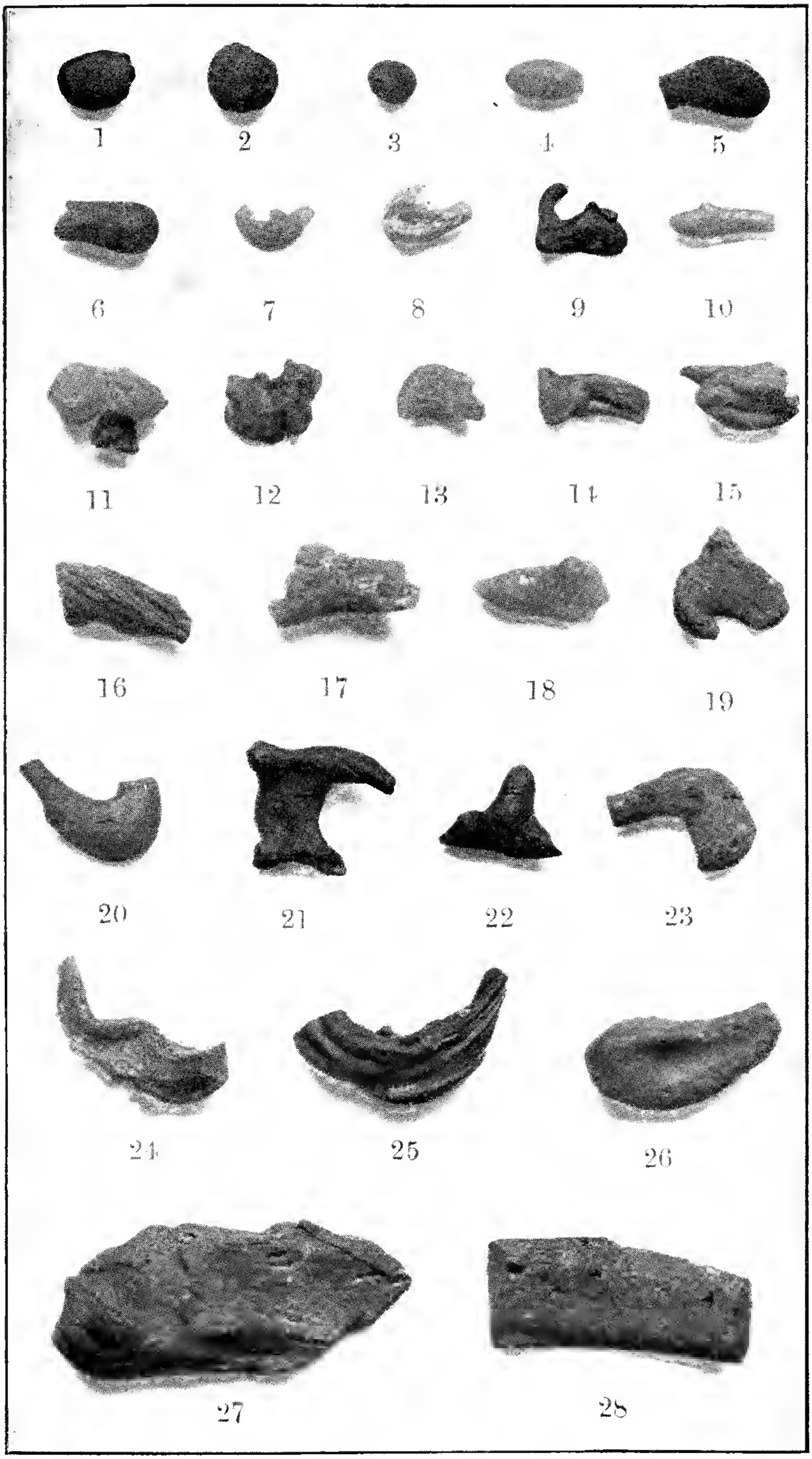
As other hypotheses have failed to account for the composition, form and distribution of the Darwin Glass, the meteoritic origin of this material must be considered. The majority of those who have seriously investigated the origin of the earlier known tektites are convinced that they are of extra-terrestrial origin. The composition and mode of occurrence show that the Darwin Glass is closely related to the Moldavites, Australites and Billitonites and we infer that they had a common mode of origin. Unfortunately no positive evidence of a meteoritic origin of the Tektites has been found and such evidence could only be obtained by the actual observation of a similar shower in the future. On the other hand no unanswerable arguments have been advanced against this hypothesis as being able to explain the source, form, composition and distribution of the Tektites.

Conditions must have been somewhat different in the different areas as the forms vary greatly. All are isotropic glass, so that they must have cooled rapidly from a molten state. In the case of the Australites, the characteristic forms are believed to be due to rotation of liquid bodies modified by the resistance of the atmosphere.

A similar explanation of the forms of the Moldavites is not possible, as they are quite irregular and the characteristic forms of the Australites seem to be entirely absent. The fusion surfaces on certain Moldavites described by Weinschenk (15) suggest that only partial fusion of these bodies took place during their flight through the atmosphere.

This explanation would assume that the Moldavites were glassy bodies before entering the earth's atmosphere. Alternatively the Moldavites may represent fragments of some larger body or bodies which exploded fairly close to the earth's surface and consequently the fragments had not sufficient time to assume the forms developed by rotating fluids. Some portions may have had their flight sufficiently checked by the explosion to solidify and partial refusion of the surface may have been due to their subsequent reacceleration under the action of gravity.

In the case of the Darwin Glasses their fragmental nature is apparent and is most satisfactorily explained as the result of the



Darwin Glass, Tasmania.

rupturing of some larger body or bodies. The majority of the specimens are somewhat analogous to forms produced by the violent ejection of molten lava from volcanoes, and thus the explosion of a molten mass, meteoritic in origin, might well produce the varying types which have been observed. The vesicular nature of most specimens of the Darwin Glass indicates that such explosion could be due to the expansion of the included gases.

It has been stated that all authentic meteorites are either metallic or ultrabasic in composition; therefore such acid material as the Tektites cannot be meteoritic in origin. Since the meteorites are probably derived from the disruption of a larger body, if such body had a composition at all comparable with that of the Earth we should expect to find a very large proportion of metallic meteorites a fairly large proportion of ultrabasic meteorites and comparatively few acid meteorites.

As pointed out earlier there is no positive evidence at present to support the meteoritic hypothesis of the origin of the Darwin Glass, but as all other hypotheses have been shown incapable of explaining their composition, distribution, etc., whereas the meteoritic hypothesis apparently is capable of so doing, we have no hesitation in accepting the meteoritic hypothesis as having the balance of evidence in its favour.

X.—Summary and Conclusions.

A full description of the distribution, with map, and the occurrence of the Darwin Glass is given and the explanation due to Mr. Hartwell Conder of their non-occurrence on the upper part of Mount Darwin is recorded. This explanation, if correct, is very important, as it fixes the age of the Darwin Glass as contemporaneous with the Pleistocene glaciation of Tasmania.

The form and general physical characteristics of the Darwin Glass are given in some detail.

Two fresh analyses of Darwin Glass are recorded and the methods used to obtain a high degree of accuracy are described.

The correlation of the various Tektites is discussed and by means of variation diagrams etc. it is shown that they are all genetically related to one another.

The interesting fact that all the Tektites recorded occur either along or close to the same Great Circle is recorded and this distribution is shown on the map of the Eastern Hemisphere. This map suggests that further discoveries of Tektites may be made in South-Western Asia.

The various hypotheses as to the origin of the Tektites is discussed and by a process of elimination the conclusion is reached that they are meteoritic in origin.

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Keartland, Miss B., M.Sc., Cramer-street, Preston ... 1919
Keble, R. A., c/o Mr. W. Baldry, "Wildwood," Flinders, Vic. 1911

Lambert, C. A., Bank of N.S.W., Melbourne 1919
Leslie, J. R., 99 Toorak-road, South Yarra 1923
Lewis, Miss R. M., 52 Campbell-road, East Kew. ... 1925
Limborn, R. M., 98 Highett-street, W. Richmond. ... 1924
Long, Miss M. E., Physiology School, University, Carlton. 1924
Luly, W. H., Department of Lands, Public Offices, Melb. 1896

Macdonald, B. E., Meteorological Bureau, Melbourne 1920
Mackenzie, G., 1 High-street, Prahran 1907
Maclean, C. W., 56 Cole-street, Elsternwick 1879
McInerny, Miss K., M.Sc., Geology School, University, Carlton. 1918
McLennan, Ethel, D.Sc., Botany School, University, Carlton. 1915
Melhuish, T. D'A., M.Sc., Port Pirie, South Australia 1919
Mollison, Miss E., M.Sc., Royal-crescent, Camberwell 1915
Moore, F. E., O.B.E., Chief Electrical Engineer's Branch, P.M.G's. Dept., Treasury Gardens, Melbourne. 1920
Morris, P. F., National Herbarium, S. Yarra 1922

Nelson, Miss E. A., M.A., M.Sc., University, Carlton. 1924
Newman, B. W., Meteorological Bureau, Melbourne ... 1927
Nicholson, Miss Margaret G., 59 Murray-street, Elsternwick. 1920

Oke, C., 56 Chaucer-street, St. Kilda. 1922
Orr, D., B.Sc., 860 Mount Alexander-road, Essendon ... 1927

Parr, W. J., 17 Bokhara-road, Caulfield 1927
Pern, Dr. Sydney, M.R.C.S., L.R.C.P., 16 Collins-street, Melbourne. 1920
Petersen, Miss K., B.Sc., 56 Berkeley-street, Hawthorn 1919
Pitman, Prof. E. J. G., M.A., B.Sc., University, Hobart, Tasmania. 1924
Pretty, R. B., M.Sc., Technical School, Wonthaggi, Vic. 1922

Raff, Miss J. W., M.Sc., F.E.S., University, Carlton ... 1910
Richardson, Sidney C., 21 Whitehall-street, Footscray 1923
Rosenthal, Newman H., B.A., B.Sc., 49 Odessa-street, St. Kilda. 1921
Ross, Miss D. J., M.Sc., Merton Hall, Anderson-street, South Yarra. 1924
Rossiter, Captain A. L., M.Sc., High School, Shepparton, Vic. 1913

Salier, D. G., B.Sc., Queen's College, Carlton 1924
Sayce, E. L., B.Sc., Research Laboratories, Maribyrnong. 1924
Scott, T. F., M.A., Teachers' College, Bendigo 1917
Sharman, P. J., M.Sc., "Glenalvie," 9 Daphne-street, Canterbury. 1916
Shearer, J., B.Sc., Queen's College, Carlton 1924
Shiels, D. O., M.Sc., Ph.D., Chemistry School, University, Carlton. 1927
Showers, Allan F., B.Sc., Brewster-street, Essendon ... 1922
Smith, J. A., 25 Collins-place, Melbourne 1905
Stickland, John, 433 Brunswick-street, Fitzroy 1922

Stillman, Miss E. G., B.Sc., "Taiyuan," 5 Grange-road, East Kew. 1919
Sutton, C. S., M.B., B.S., Education Dept., Melb. ... 1908

Tattam, C. M., M.Sc., 1 Miller-street, Essendon 1924
Thomas, R. G., B.Ag.Sc., State Farm, Rutherglen, Victoria. 1922
Thompson, Mrs. G. R., 26 Fawkner-street, St. Kilda 1922
Thorn, Wm., 37 Chrystobel-crescent, Hawthorn 1907
Traill, J C., B.A., B.C.E., "Myoora," Toorak-road, Toorak. 1903
Treloar, H. M., Meteorological Bureau, Melbourne ... 1922
Trüdinger, W., Gerald-street, Murrumbeena 1918
Turner, A. H., M.Sc., Natural Philosophy Dept., University, Carlton. 1927
Turner, A. W., M.V.Sc., Veterinary School. Parkville 1925
Wilcock, E. L., B.Sc., Dookie College, Dookie, Vic. ... 1925

Williamson, H. B., F.L.S., "The Grange," Corner Waverley-road, East Caulfield. 1919
Wilson, F. E., F.E.S., 22 Ferncroft-avenue, E. Malvern. 1921
Wilson, Major H. W., O.B.E., M.C., C.de G., B.Sc., 630 Inkerman-road Caulfield. 1923
Withers, R. B., 10 Nicholson-street, Coburg 1926
Woodward, J. H., Queen's Buildings. No. 1 Rathdown-street, Carlton. 1903

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The names of new genera and species are printed in italics.

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