Bernard C. Cotton

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CONTENTS

PART I

A RELATIONSHIP BETWEEN EVAPORATION AND TEMPERATURE

By J. A. PRESCOTT, Waite Agricultural Research Institute

Summary

In the formulation of climatic indices several attempts have been made to develop factors in which the effect of evaporation in controlling the efficiency of rainfall is expressed as a function of temperature without taking atmospheric humidity into account. Such indices include those of Lang, de Martonne, Emberger McKibbin for annual values and of Thornthwaite (1931) for monthly values. Reference may be made to a previous paper (1934) for a discussion of these indices.

TRANSACTIONS OF THE ROYAL SOCIETY
OF SOUTH AUSTRALIA INCORPORATED

A RELATIONSHIP BETWEEN EVAPORATION AND TEMPERATURE

By J. A. Prescott, Waite Agricultural Research Institute

[Read 12 November 1942]

In the formulation of climatic indices several attempts have been made to develop factors in which the effect of evaporation in controlling the efficiency of rainfall is expressed as a function of temperature without taking atmospheric humidity into account. Such indices include those of Lang, de Martonne, Emberger, McKibbin for annual values and of Thornthwaite (1931) for monthly values. Reference may be made to a previous paper (1934) for a discussion of these indices.

A more recent attempt is that of Baver (1937) who obtained a useful expression linking the ratio of rainfall to evaporation with rainfall and temperature.

It was later shown (1940) that although evaporation from a free water surface is roughly proportional to atmospheric saturation deficit, the amount is limited by the amount of solar energy which is available to supply the latent heat required for the evaporation and that an improved relation is obtained if both saturation deficit and radiation are taken into account.

In view of the fact that temperature is important in controlling saturation deficit and is in itself controlled by solar radiation, there appeared therefore to be a reasonable probability of being able to express evaporation from a free water surface as a function of temperature.

It has been previously noted (1942) that the relationship between mean monthly temperatures and solar radiation is essentially one of difference in phase, and an examination was therefore made by the methods of Fourier analysis then outlined of the phase relationship between temperature and evaporation for a number of Australian stations, about thirty in number, for which the mean monthly values over a reasonable term of years were available. The amounts of evaporation recorded appear to vary considerably from site to site, although the records at each site are usually consistent. The evaporation data used in the examination are given in Table I, temperature data were taken from the Commonwealth Year Book (1941) and from Pamphlet No. 42 of the Council for Scientific and Industrial Research. In Table I are also given the differences in phase between temperature and evaporation. As might be expected, the evaporation is intermediate in phase between radiation and temperature. The column giving the ratios of annual evaporation to saturation deficit gives a measure of the variability amongst the recording stations.

The phase relationships between meteorological elements may be illustrated from the records of the Waite Institute, Adelaide, which are given in Table II.

The probable radiation at the earth's surface is seen to be some eight days later than the solar radiation proper—this being due to a lag in relative sunshine of 26 days. The difference in phase between evaporation and saturation deficit is 4·7 days, and between evaporation and temperature it is 13·0 days.

Table I

EVAPORATION DATA FROM SOME AUSTRALIAN RECORDING STATIONS

Locality	Difference in phase between Temperature and Evaporation	Mean Evaporation for month of 30 days												Annual Evaporation	Annual Saturation deficit	Ratio E/s.d.	Length of Record
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.				
	days	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins	ins.	ins.	ins.	ins. of mercury		years
New South Wales and A.C.T.																	
Dubbo	7.4	10.91	9.85	7.11	4.31	2.15	1.36	1.40	1.92	3.17	5.17	7.84	10.18	66.1	0.21	315	20
Griffith	8.2	9.32	7.90	6.16	3.85	2.26	1.46	1.46	2.12	3.61	5.20	7.32	8.51	59.9	0.21	286	18
Leeton	8.2	8.58	7.37	5.45	3.12	1.90	1.23	1.13	1.43	2.56	4.03	6.34	7.61	51.4	0.21	246	24
Yenda	-	8.91	7.88	6.05	3.63	2.31	1.48	1.38	1.79	2.90	4.37	6.92	7.92	56.3	0.21	269	11
Trangie	5.4	10.40	9.89	7.01	4.39	2.55	1.83	1.68	2.15	3.50	5.44	7.44	9.16	66.2	0.25	266	10
Bathurst	8.8	7.21	6.41	5.09	3.22	1.87	1.23	1.18	1.77	2.95	4.06	5.66	6.61	47.8	0.13	368	27
Young	6.3	7.30	6.13	4.72	2.93	1.74	1.26	1.32	1.57	2.11	3.07	4.77	6.80	44.2	-	-	24
Canberra	8.3	8.75	7.64	5.58	3.38	2.01	1.28	1.25	1.79	3.08	4.65	6.31	7.67	54.0	0.14	386	12
Hume	6.2	7.19	6.24	4.71	2.88	1.35	0.88	0.81	1.11	1.94	3.06	4.77	6.43	41.9	0.13	322	18
Burrinjuck	9.0	5.80	5.29	4.07	2.40	1.13	0.70	0.69	1.02	1.92	2.91	4.30	5.18	35.8	0.15	239	28
Hay	8.2	6.84	6.21	4.53	2.80	1.57	1.14	1.07	1.44	2.30	3.71	5.62	6.54	44.3	0.23	193	24
Walgett	8.7	7.20	6.61	5.36	3.78	2.45	1.74	1.68	2.46	3.69	5.02	6.33	6.90	53.9	0.29	186	28
Wilcannia	6.7	9.20	8.42	6.94	4.96	2.82	1.86	1.87	2.81	4.47	6.14	7.54	8.69	66.5	0.32	208	34
Broken Hill	10.1	12.40	11.44	8.94	5.94	3.99	2.80	2.77	3.89	5.84	8.27	10.21	11.65	89.3	0.30	299	28
Lake Victoria	7.5	9.48	8.34	6.41	4.22	2.43	1.65	1.56	2.25	3.65	5.33	7.34	8.74	62.2	0.21	287	14
Sydney	20.9	5.20	4.51	3.54	2.64	1.79	1.45	1.49	1.91	2.75	3.79	4.66	5.24	39.6	0.17	233	58
Cataract River	15.8	4.89	4.33	3.32	2.33	1.50	1.11	1.14	1.63	2.46	3.25	4.20	4.89	35.5	-	-	34
Prospect Reservoir	18.4	5.59	4.90	3.94	2.95	2.06	1.60	1.57	2.11	3.11	4.12	5.05	5.58	43.1	0.19	227	34
Queensland																	
Brisbane	23.9	6.51	5.80	4.89	4.03	2.98	2.41	2.59	3.32	4.35	5.58	6.28	6.73	56.2	0.22	256	29
Biloela	11.4	8.60	7.72	7.37	5.76	4.23	3.26	3.07	3.90	5.31	6.76	8.20	8.90	74.1	0.24	309	9
Tasmania																	
Hobart	17.1	4.63	3.88	2.93	1.98	1.33	0.90	0.89	1.24	1.95	2.92	3.84	4.22	31.1	0.13	240	27
Victoria																	
Melbourne	14.0	6.20	5.35	3.88	2.41	1.45	1.13	1.05	1.45	2.32	3.24	4.54	5.55	39.1	0.15	261	65
Merbein	9.1	9.09	7.60	6.10	3.88	2.53	1.81	1.85	2.44	3.91	5.08	7.66	8.34	61.1	0.19	322	12
South Australia and N.T.																	
Waite Institute	13.0	8.49	7.59	6.46	4.14	2.86	1.86	1.78	2.32	3.30	4.63	6.64	7.87	58.7	0.22	267	14
Alice Springs	5.4	12.08	11.20	9.31	6.88	4.68	3.36	3.55	4.97	7.22	9.06	10.78	11.66	96.0	0.47	204	24
Western Australia																	
Marble Bar	23.1	11.00	9.49	9.52	8.28	6.60	5.36	5.60	6.42	8.65	10.80	11.93	12.04	107.2	0.57	188	8
Chapman	15.8	11.56	10.78	8.92	6.79	4.02	2.63	2.39	2.84	4.06	6.23	8.95	11.01	81.2	-	-	23
Perth	20.2	10.01	9.21	7.37	4.74	2.65	1.76	1.68	2.28	3.39	5.17	7.69	9.50	66.0	0.21	314	42
Narrogin	14.1	8.77	7.89	6.22	3.88	2.28	1.61	1.57	1.80	2.51	3.71	6.16	8.21	55.3	-	-	24
Merredin	11.0	12.74	11.52	9.04	5.98	3.52	2.29	2.03	2.53	4.01	6.32	9.75	11.88	82.6	-	-	24
Coolgardie	12.2	12.48	11.18	8.96	6.11	3.66	2.47	2.44	3.47	5.38	7.50	10.42	12.55	87.7	0.28	313	17
Eucla	29.0	6.75	6.45	5.53	4.12	3.06	2.56	2.49	3.28	4.53	5.64	5.80	6.69	57.7	0.24	241	6

TABLE II

Lag between Meteorological Elements and Solar Radiation at the Waite Institute, Adelaide

Meteorological Element	Days
Probable radiation at earth's surface	8·3
Relative humidity	17·5
Evaporation	21·2
Relative sunshine [1]	25·6
Saturation deficit	25·9
Temperature	34·2
Vapour pressure	50·6

For each of the stations, the next step was to calculate the temperature corresponding to a forward displacement in phase equal to the difference in phase between the curves for evaporation and temperature. It was then found that the relationship between mean monthly evaporation and the corresponding phase-displaced temperature could be represented by an equation of the form

$$E = a + bT + ce^{dT}$$

where E is the monthly evaporation expressed in inches
T is the corresponding monthly phase-displaced temperature expressed in degrees Fahrenheit,
and a, b, c and d are constants.

When evaporation is plotted directly against temperature a characteristic loop represents the relationship. The displacement of the temperature in phase by the calculated amount gives an excellent curve in all cases examined, and three of these are illustrated in fig. 1. It is interesting to note that the phase-displaced temperature when evaporation is nil is very close to the dew point of the coolest month.

The methods used for calculating the constants of the equations were in the main graphical, and it is not intended to quote them in full. These constants have been examined, however, by statistical methods in order to secure any generalisation that might prove useful later in attempting to secure estimates for the evaporation at any site in Australia, at least south of the tropic.

To simplify the handling of the data, logarithms were taken of the third term in the equation: $\log ce^{dT} = \log c + T.d \log e$

so that the constants to be examined became a, b, $\log c$ and $d \log e$ In view of the fact that it was considered undesirable to introduce humidity factors into the generalisations, the only other constants permitted were distance from the ocean and latitude.

The first generalisations attempted related to the phase relationships of the curves of temperature and evaporation. Both the lag of the evaporation curve behind solar radiation and the difference in phase between temperature and evaporation show a general relationship with distance from the ocean. These relationships vary, however, both with latitude and longitude, but the stations in New South Wales, Victoria and Tasmania appear to belong to a common group. In this group the lag of evaporation behind solar radiation reaches a maximum for stations about 170 miles from the ocean. For the Western Australian group this maximum period of lag occurs at a distance of about thirty miles from the ocean. The Queensland stations appear to belong to yet another group. These relationships are illustrated in fig. 2. The difference in phase between temperature and evaporation for stations in south-eastern Australia shows a maximum of

[1] Relative sunshine is the ratio of actual to possible sunshine in each month.

twenty-one days at the ocean coast and falls off rapidly to values of the order of seven days within 150 miles of the coast. This feature is illustrated in fig. 3.

With respect to the constants a, b, c and d, the main feature is a high correlation between values for a and b ($r = 0{\cdot}984$) and for $\log c$ and $d\log c$ ($r = 0{\cdot}950$).

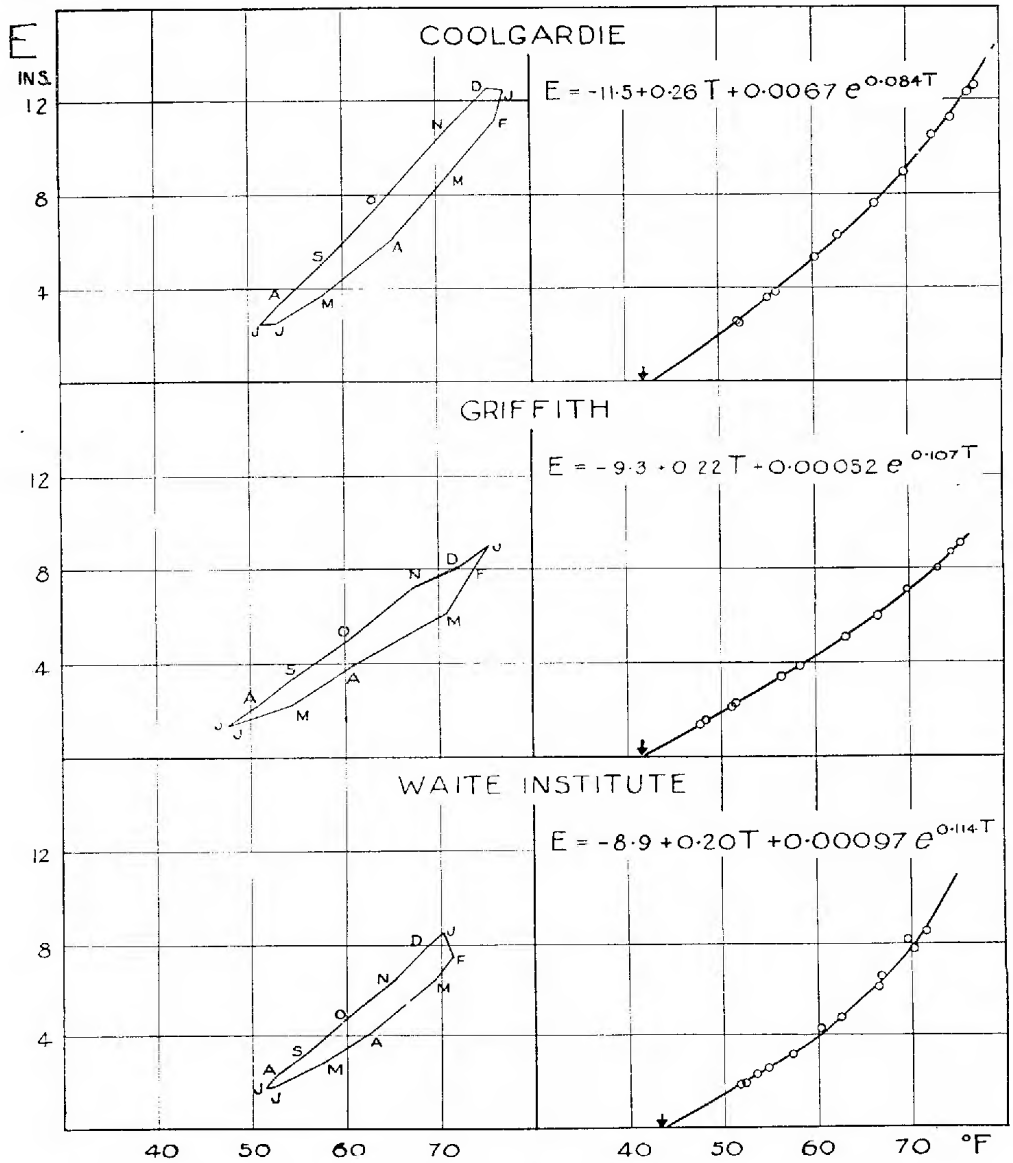

Fig. 1 Illustrating the relationship between mean monthly evaporation and temperatures at three stations. On the left the evaporations and temperatures are those actually observed; on the right the temperature curves have been displaced in phase by an amount corresponding to the difference in phase between evaporation and temperature. These differences are: for Coolgardie, W. Aust., 12·2 days; for Griffith, N.S.W., 8·2 days; and for the Waite Institute, S. Aust., 13·1 days. For example: the temperatures corresponding to the monthly evaporations at the Waite Institute are not those of the corresponding months but are read off from the temperature curves 13·2 days later. The relationship between evaporation and phase-displaced temperature can be expressed by an equation of the form $E = a + bT + ce^{dT}$. The arrows indicate the dew point of the coolest month.

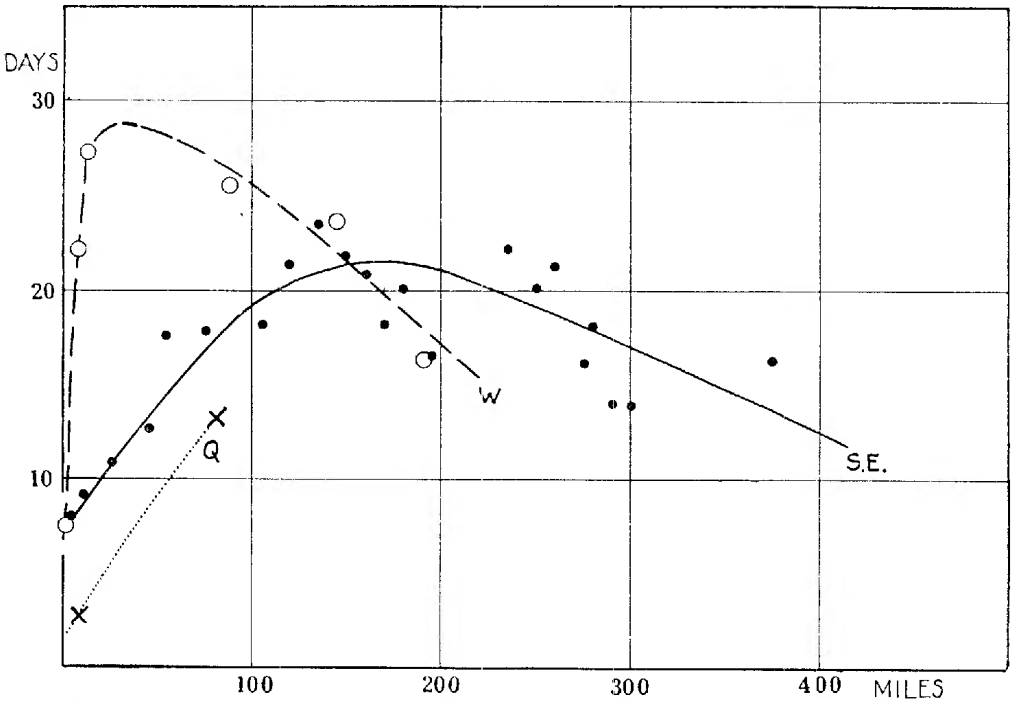

Fig. 2 Illustrating the relationship between the distance from the ocean and the lag in phase between evaporation and solar radiation at Australian stations. Line S.E. with solid circles: stations in south-eastern Australia; line W with open circles: stations in Western Australia; line Q with crosses, two stations in Queensland.

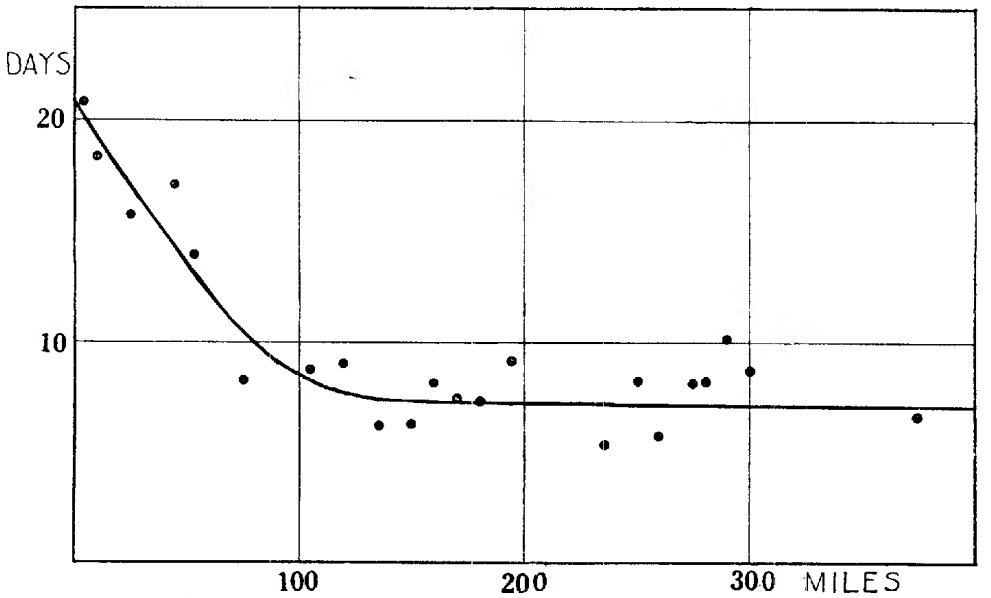

Fig. 3 Illustrating the relationship, for stations in south-eastern Australia, between the distance from the ocean and the difference in phase between temperature and evaporation.

In the latter case an improvement is to be observed by allowing for latitude ($R = 0{\cdot}981$). Corresponding regression equations are:

$$-a = 49{\cdot}0\ b - 0{\cdot}86$$

$$\text{and } -\log c = 1{\cdot}60 + 77{\cdot}1\ d\log c - 0{\cdot}0643\ \textit{Latitude}.$$

The constants a and b are related to the total annual evaporation. The correlation between annual E and b for example is 0·616 with the corresponding regression equation:

$$\text{annual } E = 155\ b + 31{\cdot}8.$$

There is a suggestion of some relationship between the values for $\log c$ and the difference in phase between temperature and evaporation, but the correlation is low.

Summary

The relationship between mean monthly evaporation and mean monthly temperature for a range of Australian stations can best be expressed in terms of a difference in phase which is a function of distance from the ocean. The relationship between evaporation and phase-displaced temperature can be satisfactorily expressed by an equation of the form

$$E = a + bT + ce^{dT}.$$

This equation has been fitted to some thirty sets of records and some correlations have been sought. The records are, however, not consistent enough to enable a general equation to be applied for all or part of southern Australia.

Acknowledgment:

Acknowledgments are due to Mr. E. A. Cornish for suggesting some aspects of the statistical treatment, and to Mr. W. H. Maze for securing and verifying some of the records from New South Wales.

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TWO INTERESTING UPPER PERMIAN HOMOPTERA FROM NEW SOUTH WALES

By J. W. EVANS

Summary

As by far the sweater part of the available knowledge of extinct insect forms is based on the study of wing venation, well-preserved remains of other insect parts are of extreme interest. In the present paper two fossil insects are described in which the principal features are head structure. In one of them wing venation is also preserved.

TWO INTERESTING UPPER PERMIAN HOMOPTERA FROM NEW SOUTH WALES

By J. W. Evans

[Read 8 April 1943]

Plate I

As by far the greater part of the available knowledge of extinct insect forms is based on the study of wing venation, well-preserved remains of other insect parts are of extreme interest. In the present paper two fossil insects are described in which the principal features are head structure. In one of them wing venation is also preserved.

The fossils were found in 1942 in Upper Permian strata, near Newcastle, New South Wales, by Mr. O. Le M. Knight. I am grateful to Mr. Knight for the opportunity to examine and describe these fossils and for making available the photographs which accompany the paper.

HOMOPTERA-AUCHENORRHYNCHA

Scytinopteridae

Permagra gen. nov.

The costal border of the tegmen is thickened. Sc is short and curved to meet R, and R_{2+3} extends in a straight line to the apex of the tegmen. M has only two branches, and both branches of Cu are short. An appendix is developed.

Permagra distincta sp. nov. (Genotype)

(Pl. 1, fig. 1; text fig. 1)

Length of the whole insect, 7 mm., of the tegmen, 5 mm. Head wider than long with a distinct epicranial suture posterior to the frons. Posterior margin of the face of the head as in text fig. 1. Tegmen rugose, venation as in text fig. 1.
Holotype—No. F39866, Australian Museum, Sydney.
Horizon—Upper Permian of Belmonth, N.S.W.

The single specimen on which this genus and species are based is fairly well preserved, and of interest because, as well as the outline of the head being visible, the shape of the frons, or more probably the fronto-clypeus, is well indicated. The anterior part of the head is not clear, though the impression of the labium remains. Posterior to the head, on each side, are a pair of indistinct impressions which are suggestive of pronotal paranota. Much of the segmentation of the thorax and abdomen is visible and the greater part of the venation of one tegmen; the other is somewhat obscured by the hind wing.

The venation has characteristics in common both with *Permoscarta belmontensis* Tillyard and with present-day Cercopids, such as species in the genus *Philagra* Don. It resembles *P. belmontensis* in the shape of the media and first cubitus and differs in having a radial sector with two branches. It resembles *Philagra* in the shape of the subcosta, radius and first cubitus, but differs in having a two-branched media; the media in *Philagra* is undivided.

Tillyard (1926), and others, have suggested that the Cercopidae are descended from the Scytinopteridae. The discovery of *Permagra distincta* lends support to this hypothesis. The possible retention by *P. distincta* of pronotal paranota, is not evidence of any very close relationship with the Peloridiidae, although this group is the only one among present-day Homoptera in which these structures are developed.

HOMOPTERA-PALAEORRHYNCHA

Archescytinidae

The insect described below is preserved in such a fashion that only the ventral surface is visible; the wings are completely concealed by the body. Its small size suggests it may belong to the genus *Permopsylla* Tillyard, or to a related genus. These genera have been placed by Carpenter (1939) in the Archescytinidae. The head is excellently preserved and, though undoubtedly Homopterous, is not of an insect belonging to any of the three present-day divisions of the Homoptera. It is therefore placed in the division Palaeorrhyncha, which Carpenter (1932) has suggested may well be ancestral to both the Auchenorrhyncha and the Sternorrhyncha. As *Eugereon boeckingi* Dohrn, is very doubtfully Hemipterous, the head described below is the first well preserved Hemipterous head to be discovered in Palaeozoic strata.

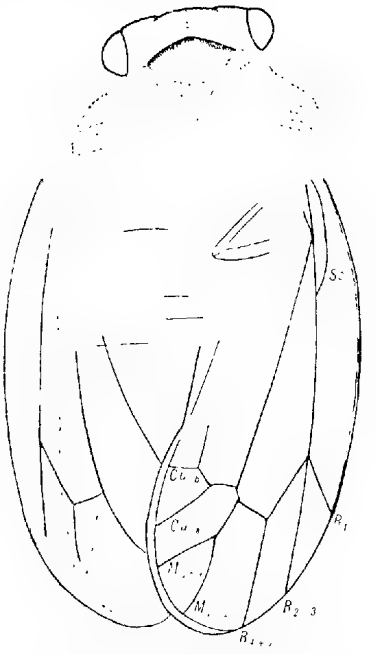

Fig. 1
Permagra distincta g. et., sp. n.

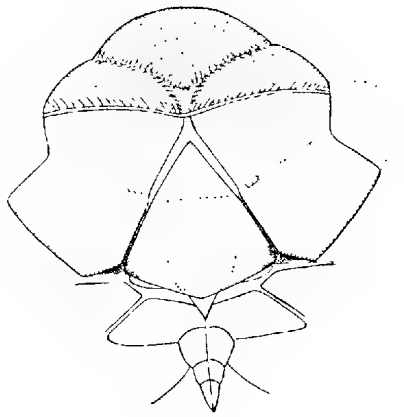

Fig. 2
Permocephalus knighti, head, g. et., sp. n.

Permocephalus gen. nov.

The head, which is nearly twice as wide as long, is divided by a transverse ridge into a posterior convex area and a more or less flat anterior area. The arms of the epicranial sutures join the genal sutures on each side. The genae are wide, the clypeus wider anteriorly than posteriorly, and the labium is short.

Permocephalus knighti sp. nov. (Genotype)

(Pl. 1, fig. 2; text fig. 2)

Length, of whole insect, 5 mm. Width of head, 1·3 mm. The head is illustrated in text fig. 2. Parts of the thorax are visible, abdominal segmentation is distinct, and there are faint indications of the presence of a saw-like ovipositor.

Holotype—No. F39865, Australian Museum, Sydney.

Horizon—Upper Permian of Belmouth, N.S.W.

That part of the head which lies posterior to the transverse ridge needs little comment, apart from noting that there is no trace of a coronal suture. The broken

Fig. 2 **Permocephalus knighti**, g. et., sp. n.

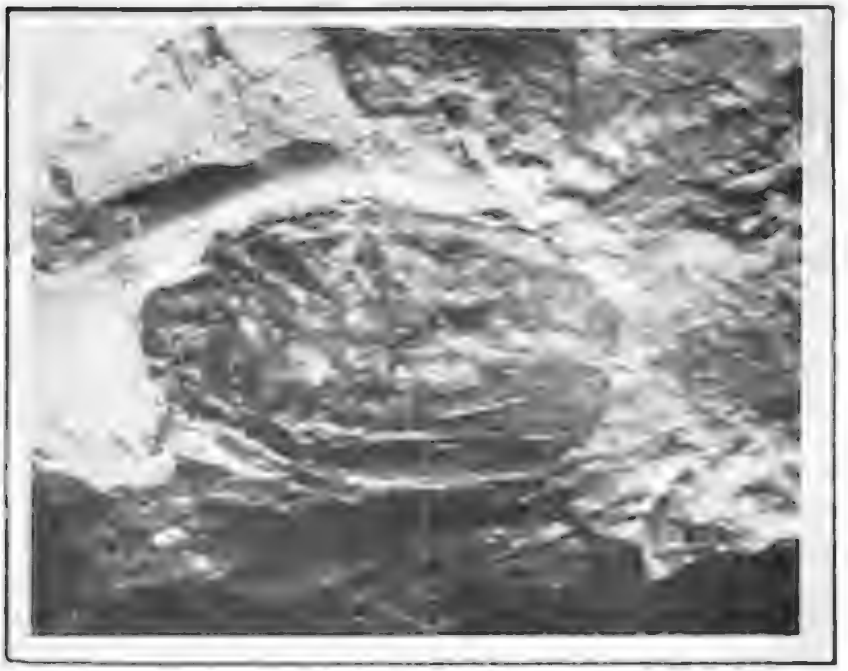

Fig. 1 **Permagra distincta**, g. et., sp. n.

line which connects the arms of the epicranial suture in text fig. 2 represents the epistomal suture. It is not distinct and can be seen only with careful lighting. The antennae appear to arise close to the ends of the epistomal suture. The genae are wide, and not connected facially with the maxillary plates. Narrow borders, anterior to the clypeus on each side of the labrum, may represent parts of these plates.

The clypeus is a single undivided sclerite, somewhat raised antero-medially. The lateral sutures bounding it on each side, which join the epicranial sutures, are genal and not clypeal sutures. It has been suggested earlier (Evans, 1938) that the lora of the Auchenorrhyncha are part of the clypeus, and that a progressive development can be traced from the Peloridiidae (Coleorrhyncha) through the Fulgoroida to the rest of the groups in the division. A comparison of the head of *P. knighti* with that of the head of a nymph of *Hemiodoecus fidelis* Ev. (Peloridiidae), lends support to this view. In *P. knighti* no trace of clypeal sutures occurs; in *H. fidelis* incipient clypeal sutures are present which do not reach to the hind margin of the clypeus. In the Homoptera-Auchenorrhyncha clypeal sutures divide the ante-clypeus into a central part and a lateral lora, and connect with the frontal sutures on each side of the head. Snodgrass (1938) has expressed contrary views and is of the opinion that the lora are part of the hypopharynx.

The labrum of *P. knighti* is distinct, also the three apical segments of a short labium. The proximal segment of the labium is not preserved, and the wide structure underlying this segment consists presumably of the entosternal arms of the prothorax.

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AUSTRALIAN SPECIES OF LISTROPHORIDAE CANEST (ACARINA) WITH NOTES ON THE NEW GENERA

By H. WOMERSLEY, F.R.E.S., A.L.S., South Australian Museum

Summary

No records of this family of Acarina from Australia appear to have been published since the original description of the following two genera and species:

AUSTRALIAN SPECIES OF LISTROPHORIDAE CANEST (ACARINA) WITH NOTES ON THE NEW GENERA

By H. Womersley, F.R.E.S., A.L.S., South Australian Museum

No records of this family of Acarina from Australia appear to have been published since the original description of the following two genera and species:

1 *Chirodiscus amplexans* Trt. and Neum. 1890 (Bull. Sci. Fr. Belg., **22**, 392, pl. 21) from *Podargus strigoides* (Tawny-shouldered Frog-mouth or Mopoke) from South Australia.

2 *Campylochirus chelopus* Trt. 1893 (C-R Soc. Biol. Paris, **45**, 699) from *Pseudocheirus convoluta* Oken 1816 = *cookii* Desm. 1818 (Ringtail Possum) from Tasmania.

Both these records are repeated in Canestrini and Kramer's monograph on the "Demodicidae and Sarcoptidae" in "Das Tierreich," Lfg. 7, 27 and 28, 1899, but the first is omitted from Rainbow's "Synopsis of Australian Acarina (Rec. Austr. Mus. **6**, (3), 1906). Canestrini and Kramer (*loc. cit.*, 29) regard the occurrence of *C. amplexans* on a bird (*Podargus strigoides*) as accidental and suggest that its true host was most probably a species of marsupial.

Recently C. Gunther (Proc. Linn. Soc. N.S.W., **67** (3 and 4), 109, 1942), in erecting a new genus *Neolabidocarpus* for his species (*Labidocarpus buloloensis* Gunther 1940 (*ibid* 65, (3 and 4), 353) has subdivided the family into a number of well-defined subfamilies and published a key to the subfamilies and genera based upon that of Ewing (Manual of External Parasites, 1929).

Unfortunately, several errors and omissions have crept into his paper which need to be corrected.

In the first place, in his key, in caption 3, the words "Body depressed" have been transposed with "Body compressed" in the next line. As given by Ewing 1929, however, these respective statements are in their correct place and the error in Gunther's key is probably one of transcription.

In this table of generic distribution and hosts, he is in error in giving the locality of *Listrophoroides* Hirst as Orange Free State, West Africa; that given by Hirst was Accra, Gold Coast. No reference is made to Ferris' record of a species attributed to *Listrophoroides* from the Marquesas (Marquesan Insects, (1), Bull. 98, B. P. Bishop Museum, 1932), nor does Gunther seem to have been aware of a species, also attributed to the same genus, described by Radford 1939 (Parasitology, **31**) from Cape Town. As will be shown later, however, the first of these species does not belong to this genus.

Ewing (1929) synonymises Hirst's *Chirodiscoides* 1917 with *Campylochirus* Trt. 1893, and although he is possibly correct in this, Troussart's original work is not available to me and Hirst, unfortunately, does not describe the dorsal surface and has only figured (in 1922) the ventral surface of the male of *Chirodiscoides caviae* from guinea pigs.

Listrophoroides aethiopicus Hirst 1923 is, so far, only known from the male, and here again in his original description he neither mentions nor figures the dorsal surface, so that it is not possible without reference to the type slide to say whether it has any dorsal scuta or not. Radford also (1939), in describing *Listrophoroides bathyergians* from a male from Cape Town ignores, both by description and figures, the dorsal surface, while his figures of the ventral surface of both sexes leave much to the imagination.

Ferris, however, in his paper gives some excellent detailed figures of his species *Listrophoroides expansus* showing both dorsal and ventral aspects. He was rather doubtful about the placing of his species in the genus, and it certainly does require a new genus, although one cannot point at present to the differences of the dorsal surface between this and *Listrophoroides* Hirst.

Key to the Subfamilies and Genera of Listrophoridae

1 Legs I and II modified as claspers.
Legs III and IV modified as claspers. *Myocoptinae* Gunth. 1942 9
Maxillae modified as claspers. *Listrophorinae* Gunth. 1942 10

2 Legs I and II with caruncles, not highly modified. Sometimes with accessory claspers. *Atopomelinae* Gunth. 1942 3
Legs I and II without caruncles, highly modified. Without accessory claspers. *Labidocarpinae* Gunth. 1942 6

3 Body compressed. Sternal region between coxae II and III with clam-like accessory claspers. Leg of ♂ very large. Gen. *Atopomelus* Trt. 1918
Body depressed. Sternal region without claspers. 4

4 All coxae widely separated medially. Palpi 2-segmented. Three dorsal scuta. Gen. *Marquesania* nov. for *Listrophoroides* Ferris 1932 nec Hirst 1923
Coxae I and II touching medially, large, inner areas striated. III and IV widely separated. 5
All coxae touching in medial line, without striations. Front legs not unduly flattened and incurved or hook-like. Leg IV shorter in ♂ than ♀, and thicker. Dorsally with a single anterior scutum. Palpi 2-segmented. Gen. *Austrochirus* nov.

5 Legs I and II strongly flattened and incurved hook like on apical segments; tarsus IV also incurved and hook-like. Dorsal scuta? Gen. *Campylochirus* Trt. 1893
= *Chirodiscoides* Hirst 1917
Legs I and II not flattened or markedly incurved; tarsus IV normal. Coxae II with stout blunt inner tooth. Dorsal scuta? Gen. *Listrophoroides* Hirst 1923
nec Ferris 1932

6 Body depressed. 7
Body compressed. 8

7 Legs I and II broadened distally into a truncate shovel-like shape. Gen. *Schizocarpus* Trt. 1896
= *Haptosoma* Kramer 1896
Legs I and II about same width for most of their length, 1-segmented, flattened, hollowed internally, curved and pointed distally. Legs III and IV normal with caruncle. Gen. *Chirodiscus* Trt. and Neum. 1890

8 Legs III and IV short and stumpy, without caruncles, 3-5-segmented almost vestigial. One anterior dorsal scutum. Gen. *Labidocarpus* Trt. 1895
= *Alabidocarpus* Ewing 1929
Legs III and IV long, slender with caruncles, 5-segmented, doubled forward beneath abdomen. One anterior dorsal scutum. Gen. *Neolabidocarpus* Gunth. 1942

9 Legs III and IV similar in both sexes and ending in a transverse disc, with 2 stout setae on distal segments. Gen. *Trichoecus* Canestri 1899
= *Trichobius* Can. 1897 pre. occ.
Legs III and IV dissimilar in two sexes, not as above. No dorsal scuta. Palpi 3-segmented, apparently. Gen. *Myocoptes* Clap. 1869

10 Coxae III separated. One anterior dorsal scutum. Gen. *Listrophorus* Pagenst 1861
Coxae III dilated and fused together. Gen. *Euryghiroides* n.n. for *Euryzonus* Trt. 1918 pre. occ.

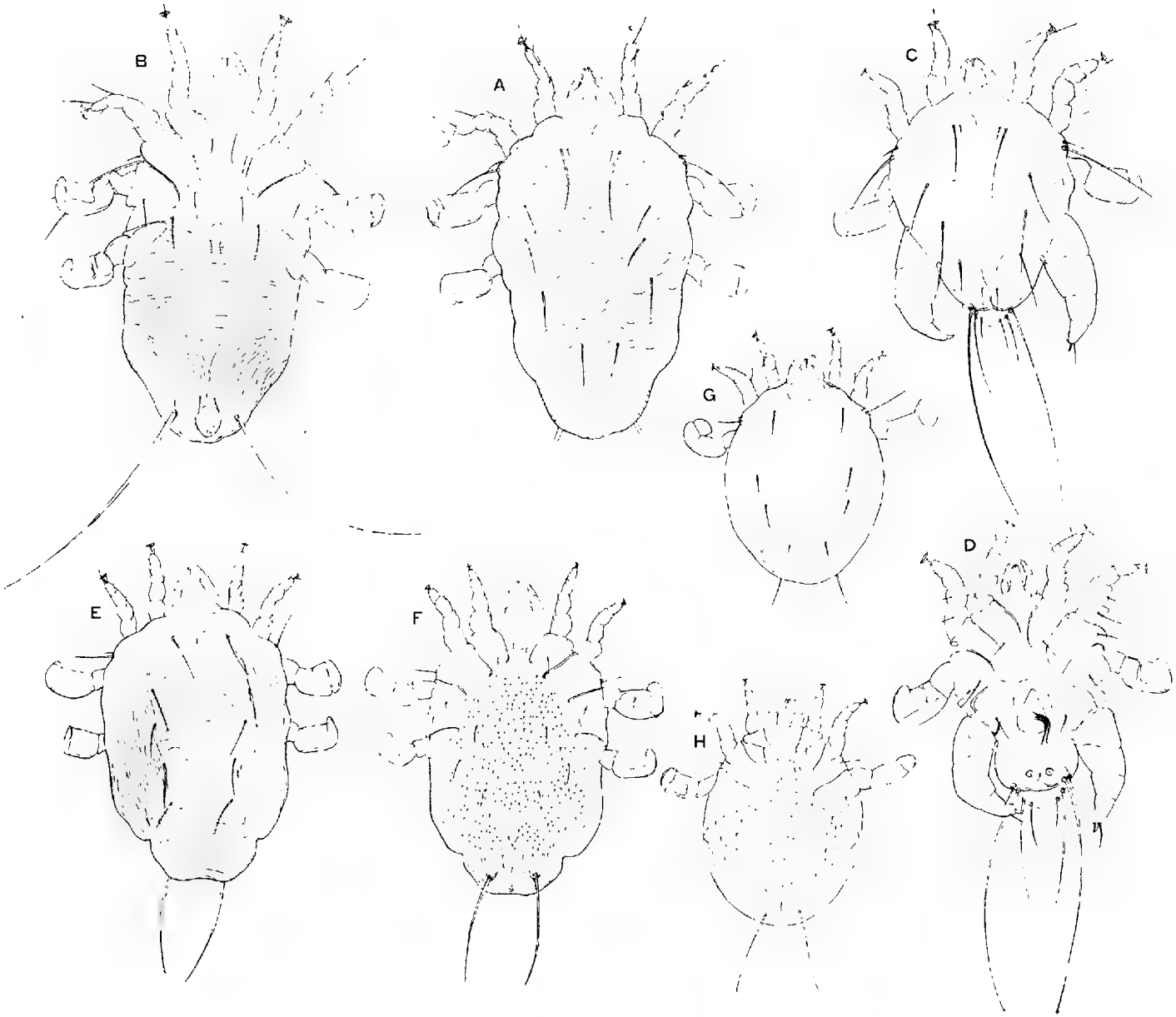

Fig. 1. *Myocoptes musculinus* Koch: A, ♀ dorsal; B, ♀ ventral; C, ♂ dorsal; D, ♂ ventral; E, nymph, dorsal; F, nymph, ventral; G, larva, dorsal; H, larva, ventral.

Subfamily MYOCOPTINAE Gunther 1942

Proc. Linn. Soc. N.S.W., **67**, (304), 109.

Genus Myocoptes Claparede 1869

Z. Wiss. Zool., **18**, 532.

MYOCOPTES MUSCULINUS C. L. Koch 1844

Sarcoptes musculinus C. L. Koch 1844. C.M.A., fasc. 5, fig. 13.

Myocoptes musculinus Can. and Kr. 1899, Das Tierreich, Lfg. 7, 25.

(Fig. 1, A-H)

Numerous specimens of this European species were found on laboratory white mice by Mr. H. B. Carter of the MacMaster Laboratory, Sydney. The mice were of a strain introduced from England, and the effect of the mites was to produce a type of mange for which Mr. Carter proposes the name of "Myocoptic Mange."

As far as I have been able to ascertain the adult stages only have been described or figured. In the material sent to me for study the larval and nymphal stages are represented, and the opportunity is taken to describe and figure the three stages in detail.

Description —Adult ♀ (fig. 1, A, B). Length 320 μ, width 160 μ. Dorsally with a pair of short setae on capitulum, on shoulders with a very long seta and anterior of this a short seta; on dorsum with 5 rows of 2 setae, the anterior row long and with a pair of short, fine setae inside; the other four pairs of setae moderately long. Ventrally with one fairly long seta on coxa I and III, a pair of about the same length between coxae III and IV, a short median pair between coxae IV, and also just anterior of anus; and a very long pair of setae subapically. The dorsal cuticle is transversly striated in the posterior fourth, anterior of which the striations become broken and roughly scaliform. Ventrally the cuticle is transversely striated but entirely lacks the fine points of the nymphs and larvae.

Adult ♂ (fig. 1, C, D). Length 210 μ, width 155 μ, rather more ovate than in ♀. Dorsal and ventral setae much as in ♀, but the cuticle is only coarsely marked with striations. Ventrally with the setae also as in ♀; posteriorly with a pair of anal discs and two pairs of long extra setae. Leg IV stout and thick and differing from III, which is similar to leg III and IV of ♀; penis bent and 2-pronged; no ventral striations.

Nymph, ♀ (fig. 1, E, F). Length 255 μ, width 160 μ. Dorsal and ventral chaetotaxy as in adult ♀. Dorsum longitudinally striated laterally and transversely so on posterior fourth, medially with broken transverse lines. Ventrally longitudinally striated narrowly laterally, and in between with transverse lines with numerous fine points.

Larva (fig. 1, G, H). Length 185 μ, width 130 μ, broadly oval, the third pair of legs modified for grasping hair. Dorsally the cuticle is longitudinally striated for a narrow width all round, and medially with broken curved transverse lines. Ventrally with lateral longitudinal and medial transverse lines, both with fine points, as figured. Leg IV is indicated by a slight tubercle (cf. fig. 1, H). Chaetotaxy simpler than in nymph.

Subfamily ATOPOMELINAE Gunther 1942

Proc. Linn. Soc. N.S.W., **67**, (3 and 4), 109.

Genus **Marquesania** nov.

Ferris, 1932, in describing his species *Listrophoroides expansus* from the Marquesas, was somewhat doubtful about the generic placing and had in mind

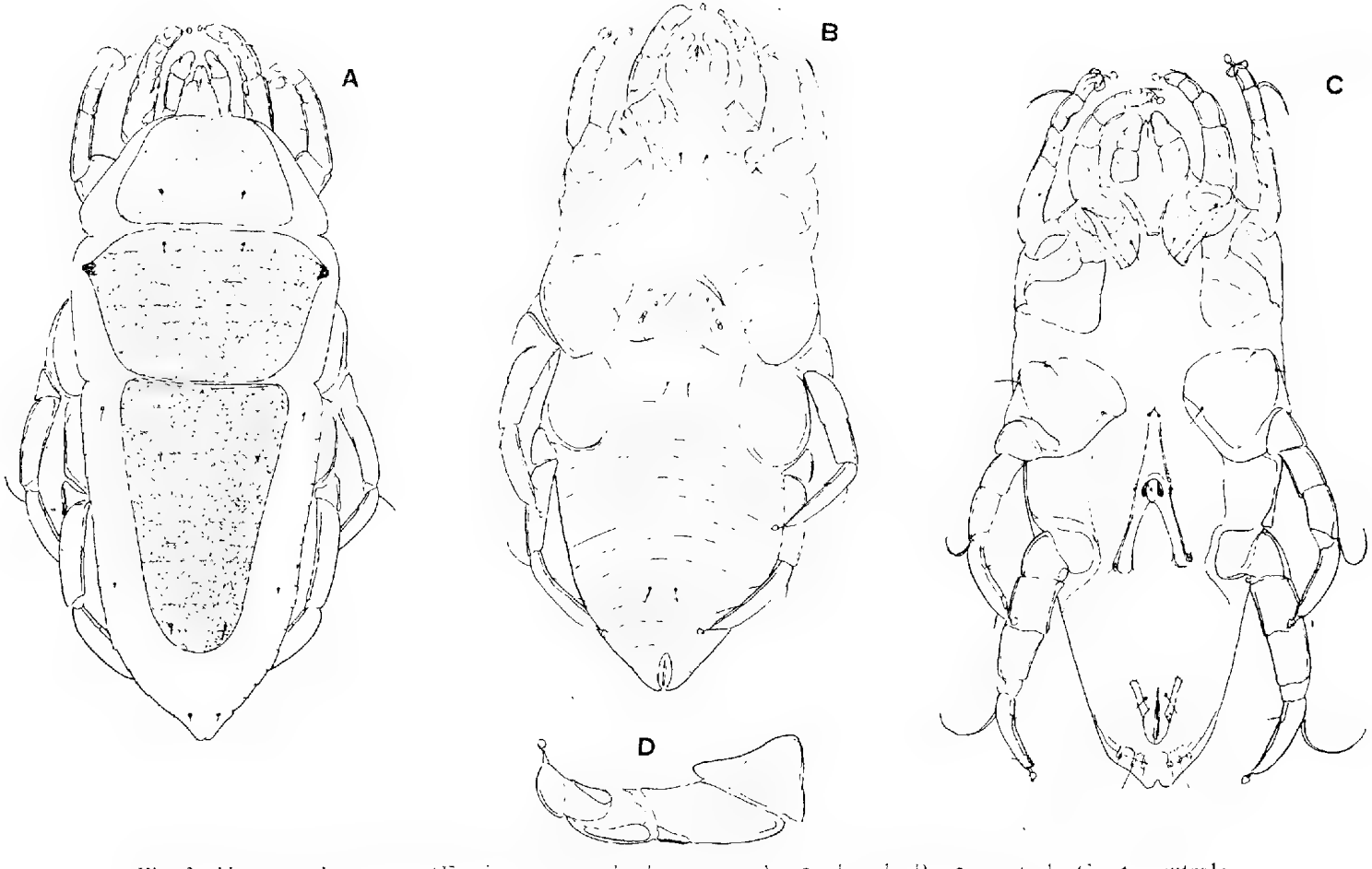

Fig. 2 *Macquesania expansa* (Ferris) v. *queensland.ca* nov.: A. ♀ dorsal; B. ♀ ventral; C. ♂ ventral; D. leg I of ♀.

the possibility of a new genus being required. There are many points of difference between his species and the genotype of *Listrophoroides* (*aethiopicus* Hirst 1923), and I propose the above new genus with *Listrophoroides expansus* Ferris as genotype. It is to be separated from *Listrophoroides* Hirst and the other genera of the subfamily as given in the key.

Marquesania expansa (Ferris 1932)

= *Listrophoroides expansus* Ferris 1932, B. P. Bishop Museum, Bull. 98.

The typical form of this species is discussed under the new variety *queenslandica*. It has been admirably figured and described by Ferris.

Loc. and Hosts—Three specimens, conforming entirely with the description and figures, were collected from the debris of a jar containing bats in the South Australian Museum collections, numbered M4443-53, 3576, 501 and 500. No locality is given and even the host is doubtful. Ferris' material was from rats, and it is quite possible that the spirit in which the bats were preserved may at some time have been poured off specimens of rats.

var. **queenslandica** nov.

(Fig. 2, A-D)

Description – ♀. Length 430 μ, width 170 μ, elongate, flattened dorsally, with three lightly chitinised finely pitted scuta (cf. fig. 2 A), second and third scuta with irregular transverse lines. Palpi 2-segmented, short and stout. Front legs modified for grasping hair; leg I with lateral sclerotisations, the outer sclerite on femur somewhat as in *M. expansa* f.p., but apparently not as pronounced and not free; leg II with the terminal segment ending in two lateral anchor-like hooks; legs III and IV long, cylindrical and fairly slender; all legs with small caruncles, and without claws. Eyes absent. Dorsal setae small and few, as in fig. 2 A. Ventrally the coxae are in two groups, large and finely pitted, not striated as given for coxae I and II of *expansa;* a pair of small setae between coxae I, a seta on each of coxae II, three setae on coxae III, and a pair between coxae IV, a median pair anterior of anus. Genitalia between coxae III.

♂. Length 345 μ, width 140 μ. Generally as in ♀ but legs III and IV much stouter and the subbasal seta on tarsi II, III and IV longer and stronger and recurved. Subapically on venter are six clavate processes from which arise fine setae, the median one of each three being the longest. Apex of abdomen slightly incised. Genitalia between coxae II and coxae IV (cf. fig. 2 C).

Loc. and Host—Many specimens of both sexes from rats, Queensland; Cowan Cowan, September 1938, on *Rattus youngi*, (Smith); Cairns, 1939, on rat (No. 6) (W. G. Heaslip).

Remarks—This form, which at the present time I am not relegating to more than a variety of *M. expansa* Ferris from the Marquesas and ? Australia, differs mainly in the lack of striations on coxae I and II and the apparent absence of a pronounced tooth on the femur of leg I.

Genus **Austrochirus** nov.

Elongate, dorsally compressed, with only an anterior chitinised scutum. Legs I and II curved inwards and modified for grasping hair. Coxae in two groups, epimera meeting in mid-line in all pairs. Leg IV of ♂ very much stouter than in ♀. Caruncles present on all tarsi. Genotype **Austrochirus queenslandicus** n. sp.

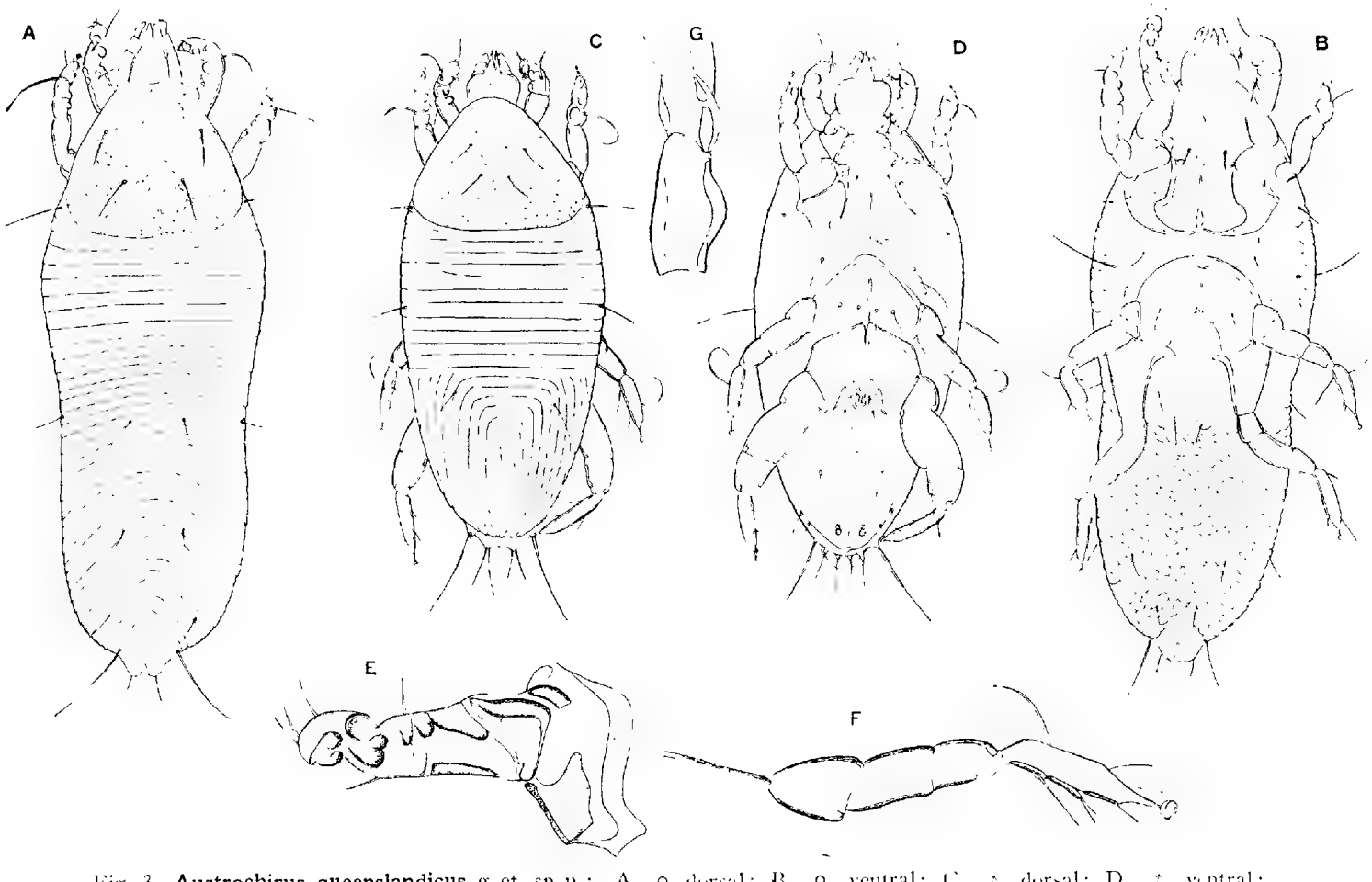

Fig. 3 **Austrochirus queenslandicus** g. et., sp. n.: A, ♀ dorsal; B, ♀ ventral; C, ♂ dorsal; D, ♂ ventral; E, leg I of ♀; F, leg IV of ♀.

Austrochirus queenslandicus n. sp.

(Fig. 3, A-G)

Description—♀. Length 515 μ, width 200 μ; elongate, slightly wider in anterior half. Palpi 2- (?3-) segmented (cf. fig. 3 G). Legs I and II fairly short, apical segments strongly sclerotised laterally to form rounded knobs for grasping hair, metatarsus (?) with long recurved seta; legs III and IV somewhat longer, segments cylindrical, tarsi apically rather tapering. Coxae large, touching medially and partially pitted, not striated. Genitalia between coxae IV. Dorsum anteriorly with a chitinised pitted scutum occupying the whole width of animal and extending posteriorly to end of coxae II, with two pairs of fine setae; rest of dorsum coarsely transversely striated. Ventrally as in fig. 3 B, a pair of setae on coxae I and III, a pair between coxae II and III and between coxae IV; on the venter the dorsal striations become scale-like. Apex of abdomen slightly incised and with two long setae and a pair of small ones.

♂. As in ♀ but a little smaller. Length 480 μ, width 170 μ. The transverse dorsal striations end at about the level of coxae III, thereafter they are longitudinal. Ventrally there are two pairs of setae on coxae III. Genitalia between coxae IV. Leg IV is very much stouter than in the female (fig. 3 D). A pair of small anal discs on each side of the anal opening.

Loc. and Hosts—A number of specimens from a possum. Brisbane, Queensland, 1938 (Smith).

Remarks—That this species will not fit into any known genus of Listrophoridae and requires a new one will be evident from the key to subfamilies and genera.

Subfamily LABIDOCARPINAE Gunther 1942

Proc. Linn. Soc. N.S.W., **67**, (3 and 4), 109, 1943.

Genus LABIDOCARPUS Trt. 1895

Bull. Soc. ent. France, 38, 1895. Type *L. rollinati* Trt. 1895).

= *Alabidocarpus* Ewing 1929, 188. (Type *L. megalonyx* Trt. 1895).

Labidocarpus recurvus n. sp.

(Fig. 4, A-C)

Description—♀. Laterally compressed. Length 620 μ, depth 205 μ. With an anterior chitinised scutum. Abdomen posterior of scutum strongly transversely striated. Legs I and II short and stumpy, modified for grasping hair, segmentation indistinct, thickened and flattened; legs III and IV long, 5-segmented, tarsus provided with a long curved claw, and two spurs on III, one spur on IV, tibia with a long apical recurved seta. Apically on the abdomen with a pair of long and a pair of short setae; on the shoulders between coxae II and III a long seta.

Loc. and Hosts—A single specimen from Bathurst, New South Wales, 15 March 1934 (A. S. Allman), on the hair of a bat.

Remarks—This species would come into Ewing's genus *Alabidocarpus* as differentiated by the presence of a pair of spurs on the tarsus of leg III, but this separation does not seem to be justified as suggested by Gunther, 1942. It comes nearest to *L. nasicolus* Lawrence 1938 from Natal, but differs in that the spurs of tarsus II are only one-fifth the length of claw instead of nearly one-half. Like

nasicolus it is intermediate in size between *megalonyx* Trt. and *minor* Trt. from the European horse-shoe bat. Gunther, in his key (1942), also separates *Neolabidocarpus* from *Labidocarpus* in that it has five- and not three-segmented legs III and IV. In both *nasicolus* and the above new species are these legs.

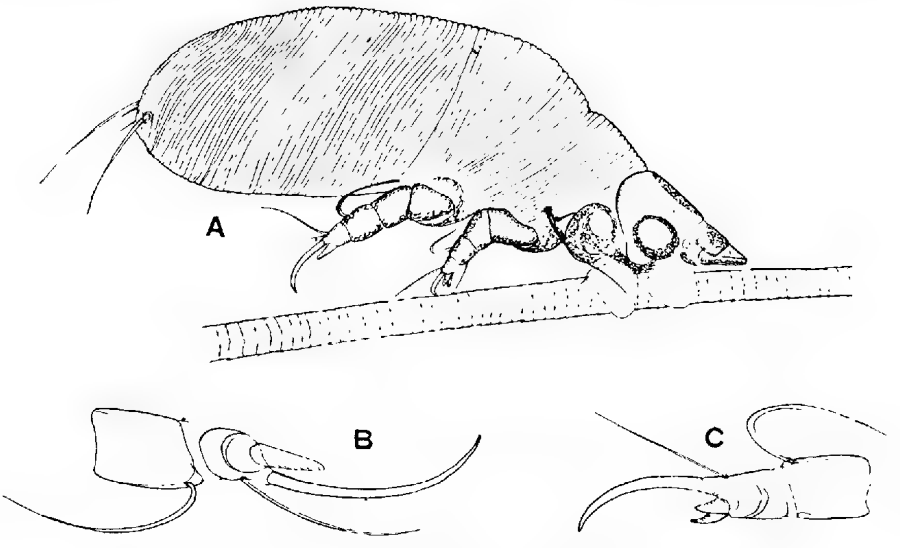

Fig. 4 **Labidocarpus recurvus** sp. n.: A, lateral view of ♀; B, tarsus IV; C, tarsus III.

although not slender and not provided with caruncles as in *Neolabidocarpus*, with five very distinct segments. In this respect they differ from the European species which, as figured by earlier workers, have only 3-segmented legs III and IV.

Subfamily LISTROPHORINAE Gunther 1942

Proc. Linn. Soc. N.S.W., **67**, (3 and 4), 109, 1942.

Genus LISTROPHORUS Pagenstecher 1861

Z. Wiss. Zool., **11**, 105, 156, 1861. (Genotype *L. gibbus* Pgst., 1861.)

LISTROPHORUS GIBBUS Pagenstecher 1861

loc. cit., 156, pl. 17. (Fig. 5, A-D)

Description—♀. Broadly oval, length 430 μ, width 275 μ. Dorsum with one anterior scutum (fig. 5 A), behind which it is strongly transversely striate, apex more or less rounded, apparently devoid of setae. Gnathosoma broadly truncate. Legs short, not specially modified, tarsi all with caruncles. Ventrally striated as in 5 B. Coxae non-striate.

♂. Rather narrower than in ♀, the dorsal scutum somewhat longer. Posteriorly produced in a more or less parallel-sided and apically bifurcate process (cf. fig. 5 C, D), with a pair of anal discs. Genitalia between coxae III and IV. Legs relatively longer and somewhat stouter than in ♀. All tarsi with caruncles; tibiae II with a long apical seta. Length 500 μ, width 205 μ.

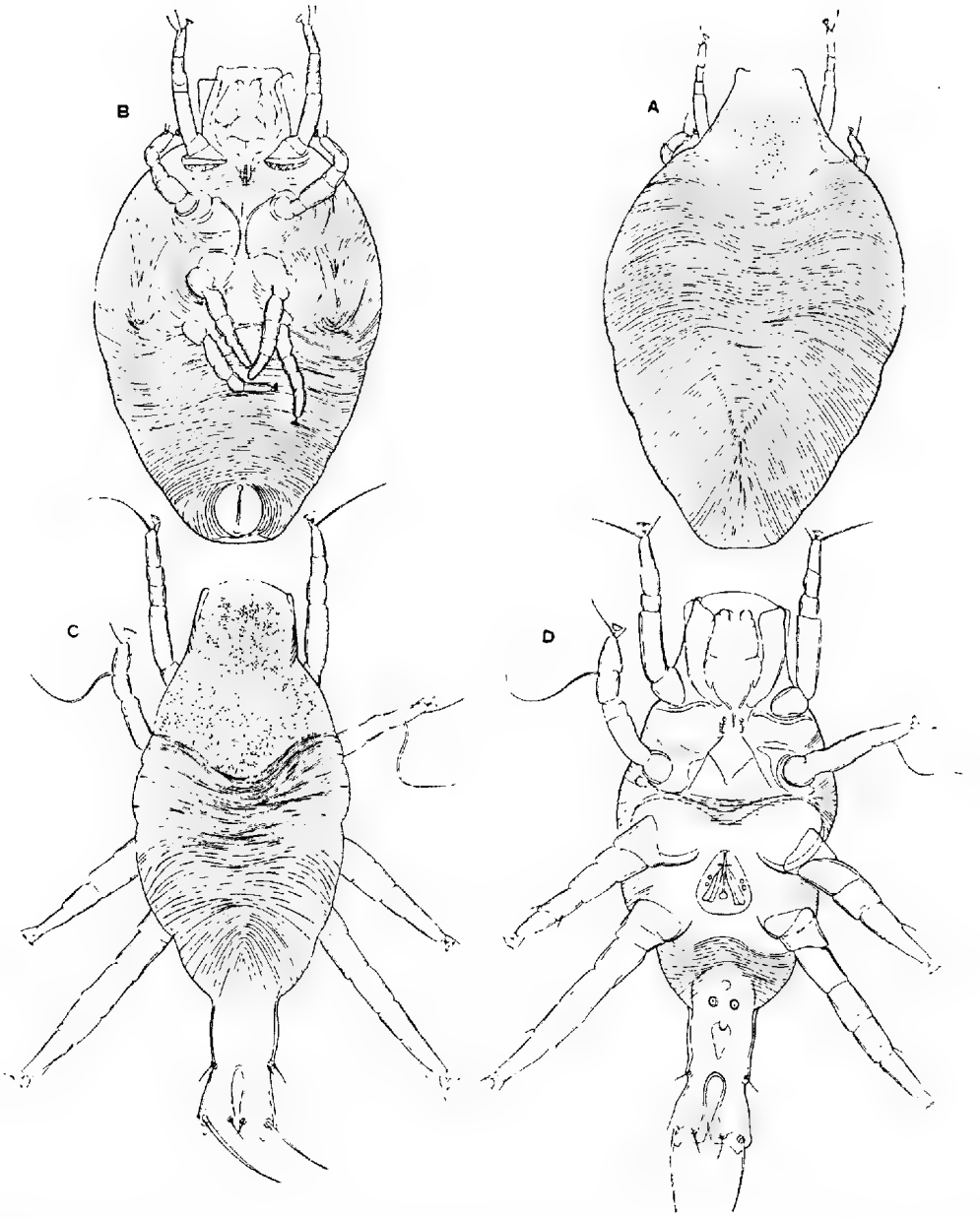

Fig. 5 *Listrophorus gibbus* Pgst.: A, ♀ dorsal; B, ♀ ventral; C, ♂ dorsal; D, ♂ ventral.

Loc. and Host—This species occurs in the fur of rabbits and is undoubtedly introduced from Europe. I have specimens as follows:—Australia: on rabbits, near Melbourne, Vict., Nov. 1941 (W. M. M.). New Zealand: on Angora rabbits, Ashburton, 1935 (L. M.).

Genus **Eurychiroides** nom. nov.

This name is proposed for *Euryzonus* Trt. 1918 (Bull. Soc. Zool., Fr., 42, 155), which is preoccupied by *Euryzonus* Attems, 1900 (Denskssk. Akad. Wiss., Wien, **68**, 265), for a Myriapod.

SOME ASCARID NEMATODES FROM AUSTRALIAN MARINE FISH

By T. HARVEY JOHNSTON and PATRICIA M. MAWSON, University of Adelaide

Summary

LIST OF HOSTS AND PARASITES

MUSTELUS ANTARTICUS Gunth. - Port Phillip, Vict.: *Capsularia marina* (Linn).
larva : *Acanthocheilus quadridentatus* Molin.

SOME ASCARID NEMATODES FROM AUSTRALIAN MARINE FISH

By T. Harvey Johnston and Patricia M. Mawson, University of Adelaide

[Read 8 April 1943]

List of Hosts and Parasites

Mustelus antarcticus Gunth.—Port Phillip, Vict.: *Capsularia marina* (Linn.), larva; *Acanthocheilus quadridentatus* Molin.

Thyrsites atun Euphr.—Port Jackson and Clarence River, N.S.W.; Derwent River, Tasm.; Apollo Bay, Vict.; Port Willunga, S. Aust.; Fremantle, W. Aust.: *Capsularia marina* (Linn.), larva.

Platycephalus macrodon Ogilby—Coast of N.S.W.: *Capsularia marina* (Linn.), larva; *Contracaecum* (*Thynnascaris*) *legendrei* Dollfus, larva.

Sciaena antarctica Castl.—Port Willunga, S. Aust., and coast of N.S.W.: *Capsularia marina* (Linn.), larva.

Istiompax australis Whitley—Port Phillip, Vict.: *Capsularia marina* (Linn.), larva.

Xiphias estara Phillips—Cronulla, N.S.W.: *Contracaecum* (*Thynnascaris*) *incurvum* (Rud.).

Thunnus maccoyi Castl. Off Green Cape, N.S.W., and Cape Everard, Vict.: *Contracaecum* (*Thynnascaris*) *legendrei* Dollfus. Port Willunga, S. Aust.: *Capsularia marina* (Linn.), larva.

Coryphaena hippurus Linn.—Jervis Bay, N.S.W.: *Capsularia marina* (Linn.), larva.

Upeneichthys porosus C. & V.—St. Vincent Gulf, S. Aust.: *Contracaecum* (*Thynnascaris*) *legendrei* Dollfus, larva.

We acknowledge gratefully the receipt of material from Professor J. B. Cleland, University of Adelaide; Associate Professor O. W. Tiegs, University of Melbourne; Dr. D. Serventy, of the Fisheries Division, C.S.I.R.; T. C. Roughley, Fisheries Branch, Chief Secretary's Department, Sydney; and R. Lynn, Melbourne (per National Museum, Melbourne). Unless otherwise stated, the parasites were collected by the senior author. The present investigation was assisted through the Commonwealth Research Grant to the University of Adelaide.

Contracaecum (Thynnascaris) legendrei Dollfus

(Fig. 1)

One adult male and one adult female were taken, one from each of two specimens of *Thunnus maccoyi* collected by Dr. Serventy in October and November 1919 while on the C.S.I.R. Fisheries Research Ship, "Warreen," in waters between Merimbula and Cape Everard. Immature specimens of the same species have been taken from the tiger flathead, *Platycephalus macrodon*, from the coast of New South Wales and from *Upeneichthys porosus* from St. Vincent Gulf.

The male is 26 mm. and the female 35 mm. in length. The parts of the body agree with the description given by Dollfus (1933; 1935), with the exception of the male tail, on which we are unable to recognise as many postanal papillae as shown in his figure.

The young worms from *Platycephalus* and *Upeneichthys* have the characteristic lips and ratios of parts of the alimentary canal as in the adult, but the reproductive organs are not developed.

Contracaecum (Thynnascaris) incurvum (Rud.)

(Fig. 2)

Several males and females were taken from *Xiphias estara* at Cronulla, New South Wales. They agree closely with the description of *C.* (*T.*) *incurvum* given by Dollfus. In our male specimens there appear to be a pair of adanal and four pairs of postanal papillae. Dollfus stated that he was unable to see the exact number in his material. The species was originally recorded (Johnston 1910 b. 310) as from *Xiphias gladius*, but Whitley (1934) now regards the Australian spearfish as *X. estara* Phillips.

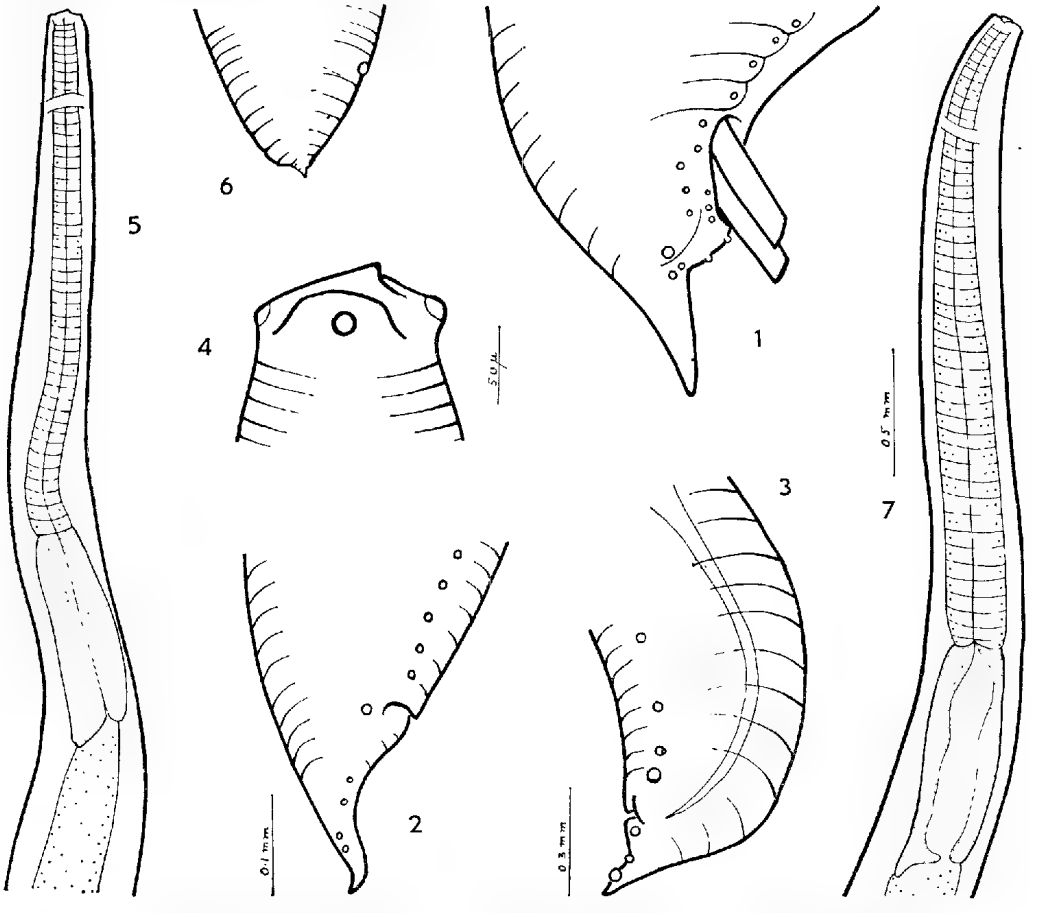

Fig. 1, *Contracaecum* (*Thynnascaris*) *legendrei*, male tail; fig. 2, *C.* (*T.*) *incurvum*, male tail; fig. 3, *Acanthocheilus quadridentatus*, male tail. Fig. 4-6—*Capsularia marina* larvae from *Thyrsites atun*: fig. 4, head; fig. 5, oesophageal region; fig. 6, tail. Fig. 7, *Capsularia marina*, oesophageal region of young worm from *Kogia breviceps*. Fig. 1 and 4 to same scale; 2 and 6; 5 and 7.

Acanthocheilus quadridentatus Molin

(Fig. 3)

A male, a female, and an immature worm were taken from *Mustelus antarcticus* from Port Phillip, and were forwarded to us by Professor Tiegs.

A description of the genus *Acanthocheilus* and the species, *A. quadridentatus*, has been given by Wülker (1930 a; 1930 b). Since the tail of his only male specimen was damaged, we are able to emend his account in this particular. There

are apparently at least nine pairs of preanal and three pairs of postanal papillae. The spicules of our 43 mm. long male are 1·1 mm. in length, but their tips are not distinct as they remain inside the worm.

A young specimen, obviously belonging to the same species, was coiled in a flat spiral. It is 21 mm. long, and its oesophagus and lips are similar to those of the adult.

The species had previously been recorded from the southern hemisphere by Baylis (1929), who gave an account of a young female from *Mustelus vulgaris* from South Africa.

Capsularia Zeder 1800

For reasons indicated later in this paper, we consider the following genera to be synonyms of *Capsularia*: *Stomachus* Goeze 1800, *Filocapsularia* Deslongchamps 1824, *Anisakis* Duj. 1845, *Peritrachelius* Dies. 1851, and *Conocephalus* Dies. 1861. The characters are those given by Yorke and Maplestone (1926) for *Anisakis*, to which we may add—larvae spirally rolled and enclosed in rather flat disc-like capsules, present chiefly in the mesentery and subperitoneal tissues of marine fish. The subfamily term Anisakinae will require to be altered to Capsulariinae.

Capsularia marina (Linn.)

(Fig. 4-7)

This widely distributed larval form has been identified by us from: (1) The barracouta, *Thyrsites atun*, from Port Willunga, South Australia; Fremantle Western Australia (coll. Professor Cleland); Apollo Bay, Victoria; Port Jackson and Clarence River, New South Wales; and Derwent River, Tasmania. (2) The tiger flathead, *Platycephalus macrodon*, from New South Wales (coll. T. C. Roughley, T. H. Johnston). (3) The mulloway, jewfish or butterfish, *Sciaena antarctica*, Port Willunga, South Australia. (4) The black marlin, *Istiompax australis*, from Mentone, Port Phillip, Victoria (coll. R. Lynn). (5) The blue-fin tunny, *Thunnus maccoyi*, from Port Willunga. (6) *Coryphaena hippurus*, from Jervis Bay, New South Wales (Prof. Cleland). (7) The "gummy" shark, *Mustelus antarcticus*, Port Phillip (Prof. Tiegs). Stead's larval *Ascaris* from the viscera of *Sciaena antarctica* from New South Wales (1914, 20) was *C. marina*.

The following account is based on material from the barracouta. The parasite was identified by Dr. Sweet (1909, 516-522) as *Ascaris marina*, her species coming from the same host species from Port Phillip, Victoria. Soon afterwards it was recorded under the same name by Johnston (1910, 711-712) who reported that masses of these spirally-coiled larvae were to be found along the whole of the mesentery of these fish (Sydney, Clarence River, Tasmania, Western Australia). Linstow (1906, 1-3) had previously described as *Ascaris sphyranurae* young worms from the body cavity of *Sphyranura barracuda* from Tasmania, sent by Jeffrey Bell, apparently from the British Museum. There has obviously been a mistake in the name of the host, as there is no fish genus *Sphyranura* but there is a genus of heterocotylean trematodes of that name. The true barracuda, a West Indian fish, is *Sphyraena barracuda*, and its ally in southern Australian waters is the snook, *Sphyraena novachollandiae*. Linstow's name is probably to be regarded as a lapsus for *sphyraenae*. Baylis (1916, 369) used the term *A. sphyraenae*, stating that he had examined worms from *Sphyraena* sp., the parasite being regarded as belonging to *A. capsularia*, a group name which, as we will indicate later, includes the barracouta worms. As we cannot find any other references to the specific name *sphyraenae* associated with a nematode, it seems probable that Baylis examined material (? Linstow's) from *Thyrsites*.

The term barracouta applied to our fish, *Thyrsites atun*, is due to confusion with the American fish but, though there is some similarity of form, they belong

to different families. Our barracouta occurs also in South African waters where, according to Waite (1923, 109), it is termed snoek. Gudger (1918, 81), in his paper on the West Indian barracuda, referred to Linstow's record of *Ascaris* from *Sphyranura barracuda* from Tasmania, and suggested that the generic name was probably a mis-spelling of *Sphyraena*.

Lord and Scott (1924) do not list the snook, *Sphyraena novaehollandiae*, as occurring in Tasmania. There is thus little doubt that Linstow's material (which agrees with our own) came from *Thyrsites atun*. Linstow's record was included by Miss Young (1939, 77, 113) in her catalogue of Australian helminth parasites.

Linstow (1908, 21) also described *Ascaris thyrsitis*, a larval form from *Thyrsites atun* off South-west Africa. The account is not available to us but the parasite very probably belongs to the same species as the Australian worm. Baylis (1929, 546) grouped larval worms from *T. atun* from Tristan da Cunha, as well as from other fish from the South Atlantic, under the heading "*Porrocaecum* or *Anisakis*," but he reported that they had a ventriculus (without an appendix) and that an intestinal caecum was absent. These remarks indicate that the larvae belonged to *Anisakis*, *i.e.*, to *Capsularia*, as also did the larva (from *Sebastes norvegicus*) which he figured in 1916 (pl. xiv, fig. 1) as that of *Porrocaecum*, to which his fig. 2 and 3 (from *Sciaena*) do belong. His figures (pl. xvi, fig. 1-2) of worms from *Clupea alosa* resemble ours so closely that we refer them to our species.

We recorded (1943) the parasite from the barracouta in southern New Zealand waters and identified it as the larval stage of *Anisakis simplex*. The mode of occurrence of the encapsuled worms is referred to by Sweet (1909, 517). Each capsule is 3-5 mm. in diameter and encloses the spirally rolled worm whose anterior end is less closely coiled than the remainder. The worms are active when released from the capsules. In one specimen the capsules formed a compact mass about 20 mm. in diameter and over 50 mm. long, surrounding the narrowed intestine of the fish.

Sweet's measurements of three individual larvae, 25, 27 and 30 mm. long respectively, indicate some degree of variability in the dimensions of the various structures. The following are our measurements in millimetres of four specimens:

	(1)	(2)	(3)	(4)
Length - - - -	18	25	27	28
Breadth - - - -	·28	·48	·48	·44
Oesoph. (muscular) - -	1·76	2·24	2·24	1·84
Ventriculus - - -	·6	·8	·88	·76
Oesoph.: ventriculus - -	1:3	1:2·7	1:2·7	1:2·4
Head to nerve-ring - -	·28	·36	·48	·44
Tail - - - - -	·1	·12	—	—

The characters of the head and tail ends are indicated in our figures. The lips are low and broad, the larval tooth prominent, and the head end narrower than the posterior.

Dr. Sweet has misinterpreted the ventriculus as an intestinal caecum, the lengths given for it by her agreeing with those mentioned by us. The ventriculus is nearly twice as wide as the muscular oesophagus and is slightly broader than that of the succeeding portion of the intestine which it enters obliquely. The posterior part of the ventriculus projects back further ventrally than it does on its dorsal side and in side view one may get the impression of a developing intestinal caecum. The difference in colour renders the ventriculus a conspicuous organ. The rather broadly rounded tail region, bearing a short, very narrow tip, is characteristic. Linstow's measurements for his *Ascaris sphyranurae* agree sufficiently with those given by Sweet and ourselves.

Cleland's reference (1914, 131) to *Ascaris* sp. from *Coryphaena hippurus* from Jervis Bay, New South Wales, was based on the identification by one of us (T. H. J.) of the parasites as immature nematodes resembling *Ascaris marina*. It can now be placed under *Capsularia marina*.

On the basis of the food relationship between the barracouta and dolphins, as well as of the similarity in appearance between the larvae from the former and the common ascarid, *Anisakis simplex*, of dolphins, we considered that the larva was the young stage of the latter worm and accordingly identified it as *A. simplex* in a recent paper (1943), at the same time placing *Ascaris filholi* Chatin and *A. nelsonis* Chatin (both based on similar larval worms from New Zealand or Campbell Island) under it as synonyms.

Since that paper went to press we have re-examined our cetacean nematodes and have searched literature more extensively. The smallest worm amongst our material from the pigmy sperm whale, *Kogia breviceps*, was 28 mm. long, ·64 mm. in maximum breadth, with a tail ·12 mm. long, a muscular oesophagus 2·4 mm. and a ventriculus ·8 mm. in length. The specimen agreed with the larvae from *Thyrsites* in all dimensions except breadth which had evidently increased after the worm had reached a suitable host. There is thus no doubt that "*Ascaris capsularia*" larvae are the young stages of the dolphin parasite.

Baylis (1929, 546) reported that larvae found in various fish, including *Thyrsites atun*, from the South Atlantic possessed a ventriculus, but had no caecum and that similar larvae were found in the stomach of the dolphin, *Steno rostratus*, near Cape Verde, but he did not suggest any relationship between the larvae and *Anisakis simplex*. It is of interest to note that Linstow (1880, 45) identified as *A. capsularia*, a larval form, 40 mm. long, with a boring tooth and undergoing ecdysis, found in the stomach of the porpoise, *Phocaena communis*. He stated that, since the larva was shedding its cuticle, presumably because of the presence of conditions favourable for further development, it was very probable that *A. capsularia* was the larval stage of *A. simplex*, but he had no opportunity to compare various larval measurements and characters with those of the latter.

Yamaguti (1935, 338) gave an account of a larval form occurring in numerous species of Japanese fish and identified it as *Anisakis salaris* (Gmelin), listing *Anisakis simplex* (Rud.) and *Capsularia salaris* as synonyms. His figure of the anterior end of the larva agrees with that of our own material. Yamaguti, as far as we are aware, is the only investigator who definitely associated the "*Capsularia*" type of larva with the parasite of dolphins.

Anisakis simplex (a term which we will use for the present) is now known to occur very widely as a parasite of the stomach of cetaceans, especially odontocetes. Its presence in the northern hemisphere has been referred to by many authors since Rudolphi named it *Ascaris simplex* in 1804 and described it in 1809, his material coming from *Phocaena*. There have been several records of the adult stage in the southern hemisphere. Krefft (1873, 212) recorded *Ascaris* sp. from *Delphinus forsteri* from New South Wales, and Cobbold (1879, 426; 1886, 177) suggested that the parasite was *Ascaris simplex*. We re-examined Krefft's specimen and reported it to be *Anisakis simplex* (1941, 433). Cobbold (1886, 177) identified the species from material collected by Darwin from a porpoise off Chiloe Island, Chili, and Monticelli (1889, 69) reported it from a dolphin from Patagonia.

Baylis (1929, 543) recorded *A. typica* from *Lagenorhynchus* off South-west Africa, and also published an account of *A. catodontis* from a sperm whale from Saldhana Bay, South Africa. The latter species appears to us to differ from *A. simplex* only in the number of papillae on the male tail, but Baylis stated that he was able to obtain only a lateral view, observing a single pair of papillae. We consider it probable that *A. catodontis* is a synonym of *A. simplex*.

We described *Anisakis kogiae* from the pigmy sperm whale, *Kogia breviceps*, from Spencer Gulf, South Australia, and from Moreton Bay, Queensland (Johnston and Mawson 1939, 263), but the detailed and emended account of *A. simplex* published by Lyster (1940) permitted us to synonymise *A. kogiae* (incorrectly indicated by Nicoll 1941, 96, as *A. kogianus*) with *A. simplex* which we also recorded from *Lagenorhynchus obscurus* from Cook Strait, New Zealand (Johnston and Mawson 1942, 183).

All records of *Anisakis simplex* have been based on cetacean material, with the exception of that by Linstow (1888) who reported *Ascaris simplex* from a seal from Kerguelen. Baylis (1916, 365) re examined the Challenger specimens and identified them as belonging to *Porrocaecum decipiens*, a widely distributed parasite of seals. Stossich (1896), as well as Stiles and Hassall (1899), published long host lists for the adult stage, and the latter two authors also assembled in their Index Catalogue (1920) all the references to literature. Baylis (1932) brought the list up to date. Baylis (1936) has omitted reference to the presence of the parasite in Indian waters, though Dujardin (1945) recorded it as having been taken from a dolphin near the Maldive Archipelago. Synonyms of *Anisakis simplex* are *Ascaris dussumieri* Beneden 1870; *A. angulivalvis* Creplin 1851; *A. kükenthalii* Cobb 1888; *Conocephalus typicus* Dies. 1861; *Peritrachelius typicus* (Dies.) Jägersk. 1894; and probably *Anisakis catodontis* Baylis 1929.

Dujardin (1845, 150-1) subdivided *Ascaris* (after separating off *Heterakis*) into four subgenera, *Ascaris*, *Ascaridia*, *Anisakis* and *Polydelphis*. The first had, amongst other features, two equal spicules and the oesophageal region with or without a ventricle and "pyloric appendages"; and Dujardin showed that it was possible to subdivide it on the basis of these differences in the digestive tract. These differences are the main characters which are now used to distinguish genera of the Anisakinae. The subgenus *Anisakis* with the two species, *Ascaris distans* Rud. from monkeys and *A. simplex* from dolphins, was erected to include species whose males had two unequal spicules (as the name implies). Dujardin gave an account (p. 220) of *A. distans* based on Rudolph's description and of *A. simplex* (p. 220-221) based on material collected by Dussumier west of the Maldive Archipelago. The oesophagus of *A. simplex* was stated to be followed by a slender curved ventricle, while that of *A. distans*, according to Rudolphi, was succeeded by a spherical ventriculus. Though *A. distans* has page priority, *A. simplex* was selected subsequently as the type of *Anisakis*. *A. distans* was transferred by Railliet and Henry to *Subulura*.

Diesing (1851) did not utilise Dujardin's subgenera of *Ascaris* but he erected (1851, 209) *Peritrachelius* (type *P. insignis* from the Amazon dolphin), which is now regarded as a synonym of *Anisakis*. He also erected *Conocephalus* (1861), with *C. typicus* from a dolphin as type, and this too is synonyms with *Anisakis*.

The barracouta worms belong to the group of larval parasites to which the term *Ascaris capsularia* Rud. has been applied by various authors, more than one species having been included. Baylis (1916; 1919, 513) believed the true *A. capsularia* to be the larva of *Porrocaecum decipiens*, a widely distributed parasite of seals, but we have pointed out that he included larval *Anisakis* as well.

Linstow (1884, 127) suggested that *A. capsularia* was the larva of *Ascaris* (*i.e.*, *Contracaecum*) *incurva*. Wülker (1939 b, 14) recorded that larvae of *Anacanthocheilus* were found coiled on the viscera and under the peritoneum of marine teleosts, especially Gadidae, and were often referred to under the group names, *Ascaris capsularia* and *Filaria piscium*. This larva differs from that of *Anisakis* mainly in the modification of the dorsal portion of the oesophagus. Kahl (1938, 513) published further information regarding the larva of *Anacanthocheilus rotundatus* and its encystment, the parasite occurring as thick clusters of

spirally-rolled worms on the stomach of cod in the North Sea. The larvae of *Porrocaecum decipiens* are found especially in the musculature of fish (Kahl, 1938, 415; Wülker 1930 a; Martin 1920; Johnston and Mawson 1943), and will be considered later in connection with *Filaria piscium* and other larval forms. Encysted *Contracaecum* larvae occur curved, or more or less loosely coiled, in the subperitoneal regions of the digestive tract and coelome of marine fish. Those of *C. clavatum* (Rud., 1809) have been especially studied by Wülker 1930; Kahl 1936; and Martin 1920. Since *Ascaris clavata* was a renaming by Rudolphi of *Ascaris gadi* Mueller 1776, the name of this parasite of Gadidae should be *Contracaecum gadi* (Mueller). Linton referred frequently (1895, 1899, 1901, 1905) to various ascarid larvae in North American marine fish, his figures indicating those of *Anisakis, Porrocaecum* (rarely), and especially *Contracaecum*, though he usually called them *Ascaris* sp. and at times mentioned their resemblance to *A. capsularia* and *Agamonema capsularia* (1901).

Linnaeus in 1767 (Syst. Naturae, Ed. xii, p. 1075) gave the name *Gordius marinus* to worms occurring in Norwegian fish, especially in the viscera of *Clupea halecis*. In 1782 Bloch described *G. harengum*, also from a herring; Schrank in 1788, and Froelich in 1802, transferring it to *Ascaris*. Goeze (1782, 133-134) made reference to, and figured, an encapsuled spirally-rolled worm from the liver of a salmon and, though he regarded it as a new species, he did not name it. Gmelin in 1790 described *Ascaris halecis*, quoting *Gordius harengum* as a synonym, and also named *Cucullanus salaris* as a variety of *C. lacustris*, the host being the salmon (*Salmo salar*). In 1794 Fabricius transferred Gmelin's *halecis* to *Cucullanus* and gave an account of *Ascaris clupearum* (*A. harengum* Froelich).

Zeder (1800, 5-7) erected the genus *Capsularia* for the "capsule worms" of Goeze (1782) and gave a diagnosis—worms aciculate, but truncate at the ends, anterior end somewhat more slender, with a stumpy point at the tail end; digestive canal with a differentiated whitish stomach; worms enclosed in a special capsule. He included *Capsularia salaris* (based on Goeze 1782, 133, pl. viii, fig. 9-10) and *C. halecis* (based on Goeze l.c., 133; Bloch 1782; Schrank 1788). The figures of *C. halecis* (pl. i, fig. 1-6, especially fig. 4-5) indicate the same species as that from the barracouta. Zeder also referred to Goeze's remarks regarding the ventriculus, mentioning (p. 11) that Goeze had suggested the name *Stomachus albus* for the worm, on account of the "white stomach." Since *Capsularia* has page priority, *Stomachus* must be considered as a synonym.

In 1802 Rudolphi described as new species *Filaria capsularia* (syns. *Gordius harengum, Ascaris halecis, Capsularia halecis*) from the viscera of *Clupea harengus;* and *Ascaris capsularia* (syns. *Cucullanus salaris, Capsularia salaris*) from the salmon. We consider the two species synonymous.

In 1803 Zeder named *Ascaris trinodosa* from *Salmo salar*, but this was a renaming of *Capsularia salaris*. In 1809 Rudolphi gave an account of *Filaria capsularia* (p. 61), adding *Gordius marinus* Linn. to the synonyms mentioned above; also of *Ascaris capsularia* (p. 179) whose synonymy included *Capsularia trinodosa* in addition to those given above, the host being *Salmo salar*. He referred to Goeze's observations concerning the whitish organ behind the head region. He also mentioned (p. 203) *Ascaris clupearum* Fabricius 1794, and the account leaves no doubt that the species is the same as *A. capsularia*, though Rudolphi regarded them as distinct. His account (p. 134) of *A. constricta* suggests that it may be *A. capsularia*, as Linstow (1880, 45) and Stossich (1896) believed. Amongst the "species dubiae" Rudolphi described (1809, 74) *Filaria piscium* from several species of *Gadus* as well as from some other fish, and mentioned that Rathke in 1799 had reported it as *Filaria marina* from *Lophius* as well as from *Gadus* spp. Rudolphi stated that the parasite occurred encysted in a folded state in the muscular tissue as well as in the liver, and gave several synonyms; *Gordius*

marinus Linn., Houttuyn, Muller and Fabricius, in part; *Ascaris marina* Gmelin; *Fusaria marina* Zeder; and *Filaria marina* Rathke. Houttuyn's reference was to material from the liver of *Gadus* spp. The species has been listed by some authors (Creplin, Baird, Cobbold) as a synonym of *Ascaris capsularia*. Martin (1920), Kahl (1938) and others have shown that the ascarid larvae from the musculature of marine fish from northwestern European waters belong to *Porrocaecum decipiens*, and our own experience with "fleshworms" from various species of sub-antarctic fish (Johnston and Mawson 1943) confirms their identification.

In 1819 Rudolphi again referred to the parasites mentioned in his work of 1802—*Filaria capsularia* (p. 6) from *Clupea harengus; F. piscium* (p. 10, 218), *Ascaris capsularia* (p. 50) and *A. clupearum* (p. 303). He mentioned amongst "entozoa generis dubii" a number of nematodes from fish (p. 190-197, 560-567), listing them under the genitive of the generic and specific names of the host, but in the host-parasite list he indicated them as *Dubium nematoideum*, while in the index to his work they are arranged under *Dub.* (*i.e.*, *Dubium*). Many of these parasites probably were *Contracaecum* larvae, but a number of them can be listed under *Capsularia marina*, since Rudolphi stated, when briefly describing them (p. 190-197), that they belonged to Zeder's *Capsularia*. Amongst these latter are (*Dub. nemat.*) *Syngnathi pelagici; Gadi wachniae; Zenis fabri; Zenis apri; Sparorum* (p. 564), indicated also (p. 194) as *Spari boopis, mormyri, melanuri, alcedinis; Percae cirrosae; Percae marinae;* and *Triglae adriaticae*. Many other ascarid larvae, such as *Ascaris argentinae* and *A. atherinae*, were recorded by him as having been taken from the mesentery or peritoneum of marine fish, but further identification is not possible without re-examining material. Most of them are probably larvae of *Contracaecum*, though Stossich (1896) included many of them under the synonymy of *A. capsularia*.

In 1824 Deslongchamps definitely renamed *Capsularia* as *Filocapsularia* (p. 391), and his diagnosis (p. 398) included as a characteristic the rolled form of the parasite, enclosed in a disc-shaped capsule. He however stated that the worms were sometimes not rolled in a disc but were thrown into several irregular folds within the membrane. The presence of the white spot (= ventriculus) near the anterior end was noted. He reported that the parasite was found in a great number of fish belonging to different orders, genera and species. Since he failed to find any differences, except those of length, he included them all under the same name, *F. communis*, quoting as synonyms *Gordius marinus, G. harengum, Asc. marina, Asc. halecis, Asc. capsularia, Cucullanus salaris, Capsularia salaris, C. halecis, Filaria capsularia* and *F. piscium*, as well as seventeen of Rudolphi's "entozoa generis dubii," which he indicated by Rudolphi's numbers. Of these seventeen we have already mentioned eight which we consider to belong to *Capsularia*. The remainder were probably larval *Contracaecum*. From the foregoing remarks it is evident that *Filocapsularia* must fall as a synonym of *Capsularia*, and *F. communis* be accepted as a synonym (in part) of *C. marina*.

Bellingham (1844, 172) listed *Ascaris capsularia* from the peritoneum of fifteen species of fish from the Irish coast, amongst them being *Clupea harengus* (in which it was very commonly found) and *Salmo salar*. The characteristic ventriculus was referred to, as also was the presence of three very small "tubercules" around the mouth. He found that the parasite was very active and could live in fresh water for 29 days.

Dujardin (1845, 187) referred to *Ascaris capsularia*, quoting as synonyms, *Cucullanus salaris* Goeze, *Capsularia salaris* Zeder and *C. trinodosa* Zeder. He gave a list of the species of fish from which it had been recorded. His remarks concerning Bellingham's reference to the ventriculus and those made in referring to *A. culpearum* (p. 188) suggest that he had confused *Filaria piscium* (p. 205),

at least in part, with *A. capsularia*. The account of *Filaria piscium* (p. 60), for which a long host list was given by Dujardin, is that of an Anisakine worm, and the statement that there was an intestinal caecum lying beside the oesophagus indicates the larva of *Porrocaecum*. Amongst the hosts mentioned for *F. piscium* were various Gadidae, *Salmo salar* and *Clupea harengus*, and the lengthy synonymy quoted included *Gordius marinus* Linn., *G. harengum*, *Capsularia halecis* and *Filaria capsularia*. In 1840 Nordmann regarded *C. halecis* as a synonym of *Ascaris capsularia*, and in 1846 Creplin stated that *F. piscium* was a synonym of the latter. In 1849 Blanchard mentioned *Ascaris salaris* from *Gadus* and gave synonymy similar to that quoted by Dujardin for *Ascaris capsularia*.

Diesing (1851, 163) mentioned only a few hosts for *A. capsularia*, and his synonymy related chiefly to *C. salaris*. In another part of his work (p. 116-117) he dealt with *Agamonema capsularia* Dies. from numerous hosts, amongst them being *Clupea harengus* and Gadidae, his synonymy including *Gordius marinus*, *G. harengum*, *Capsularia halecis*, *Filaria capsularis* (*sic*) Rud., *Filocapsularia communis* Deslongchamps (*halecis*) and *Ascaris capsularia* of Bellingham. Diesing transferred *Filocapsularia communis* Deslg. (excluding *Capsularia halecis*) to *Agamonema* (p. 120), the synonymy quoted being that given by Rudolphi (1809, 74) under *Filaria piscium*, together with Rudolphi's species. The hosts mentioned are chiefly Gadidae, and the sites are liver, muscular tissue, subcutaneous tissue, peritoneum and mesentery. *Agamonema commune* (Deslg.) Dies. is probably, in part, a synonym of *Asc. capsularia*, but as described by Rudolphi (under *F. piscium*), it is quite distinct and, as we have indicated, is the larval stage of *Porrocaecum decipiens*. *Asc. clupearum* Fabr. (syn. *A. harengum* Fröl.) from *Clupea harengus* was mentioned by Diesing (1851, 204), and a reference was made under it to *Agamonema capsularia*, though he retained the species amongst sp. inquir.

Diesing mentioned, amongst others, the various nematodes of doubtful position (*Dubium nematoideum*) of Rudolphi 1819, quoting them as *Nematoideum dubium syngnathi pelagici* Rud., etc. In most cases the worms were placed under *Agamonema* (pp. 118-119), sometimes with a new specific name—thus *Ag. syngnathi pelagici*; *Ag. merlucci vulgaris* Dies. (syn. *Nemat. dub. gadi merluccii* Rud.); *Ag. wachniae* Dies. (syn. *Nemat. dub. gadi wachniae* Rud.) *Ag. fabri*. Dies. (syn. *Filaria zeuis* (sic) *fabri* Rud. (1819, 11); *Nemat. dub. zeuis fabri* Rud.); *Ag. triglae lineatae* Dies. (syn. *Dubium triglae adriaticae* Rud.); *Ag. apri* Dies. (syn. *Nemat. dub. zeuis* (sic) *apri* Rud.); *Ag. sparoidum* Dies (syn. *Nemat. dub. spari boopis, mormyri, melanuri* and *alcedinis* Rud.); *Ag. scorpaenae cirrhosae* Dies. (syn. *Nemat. dub. percae cirrhosae* (sic) Rud.; *Ag. serrani cabrillae* Dies. (syn. *Nemat. dub. percae marinae* Rud.); and *Ag. triglae lineatae* Dies. (syn. *Dubium triglae adriaticae* Rud.) *Ascaris argentinae sphyraenae* Rud. (*Asc. argentinae* Gmelin) was placed under *Nematoideum* (p. 341).

Baird (1853, 22)dealt with *A. capsularia* and gave the synonymy published by Rudolphi, as well as some later references. His material came mainly from Gadidae. He placed the species in that group of *Ascaris* spp. possessing a simple oesophagus, with or without a stomach (ventriculus), but without any pyloric appendages. He also referred to *Filaria ? marina* (p. 7), giving almost the same synonymy as that quoted by Rudolphi (1802) for *F. capsularia* and by Diesing (1851, 117) for *Agamonema capsularia*; adding *Filaria piscium* of Rudolphi, Creplin, Siebold and Dujardin, as well as *Ag. commune* Dies. (p. 106). Baird's material came from the liver of the cod and the peritoneum of *Clupea*, but his mention of the former worms being nearly straight seems to indicate that they belonged to some other species, perhaps *Contracaecum* larvae.

Siebold (1857, 26) mentioned that in many marine fishes the liver was covered with capsules, each containing a worm more than an inch long. Such

parasites were placed under *Ascaris capsularis* (sic), *Filaria piscium* and *F. cystica*. All were immature but they resembled strikingly certain adult ascarids such as *Asc. osculata*, *A. spiculigera*, etc., from seals, cormorants, gulls and predaceous fish. He suggested that the encysted worms were the larvae of some such adult ascarids.

Schneider (1862) referred to *Fil. piscium* (*Agamonema piscium*) as being a very common larval nematode found in the abdominal cavity and amongst the muscles of several species of marine fish. He stated that haddock were not eaten in Copenhagen during summer because of the abundance of these parasites in them. The oesophagus was said to have a caecal prolongation posteriorly. Probably more than one species was included under the name *F. piscium*.

In 1864 Cobbold published some synonymy of *Asc. capsularia* (1864, 406). He also mentioned (1879, 472) that sexually immature filariae were to be found in nearly every marine fish examined, and it was a very common occurrence to find the small *Filaria piscium* spirally coiled within the tissues of edible fish such as herrings, haddock, cod and whiting, all waiting passively to be transferred to their ultimate hosts, usually either fish, birds, cetaceans or seals.

Leuckart (1876) made a number of references to *F. piscium* (or *Asc. capsularia*), but he seems to have been dealing with two kinds of Ascarid larvae, *viz.*, *A. capsularia* and another form occurring sometimes in hundreds in the flesh of marine fish. This latter is, in our opinion, the true *Fil. piscium*, *i.e.*, the larva of *Porrocaecum decipiens*. He regarded the parasite as the young form of ascarids whose adult stage occurred in the intestine of dolphins, seals, swimming birds and predaceous fish (p. 98), the adult stages being mentioned (p. 124) as *Asc. acuta*, *A. spiculigera*, *A. osculata*, etc. In another place (p. 417, footnote), when dealing with *A. spiculigera*, he stated that the young form was *Fil. piscium*. He also used the latter term (p. 615) for the encapsuled ascarid larva occurring in the muscular part of the body ("muscle flesh") of numerous marine fish. From what we now know of larval ascarids from fish, Leuckart must have included several species (*Contracaecum*, *Porrocaecum*, *Anisakis* and perhaps others) under the term, but chiefly *Porrocaecum*.

Apart from references by Leidy (1856, 1878, 1888) little of importance relating to the species under review appeared until 1896 when Stossich's monograph on *Ascaris* appeared. In it *A. capsularia* was dealt with and a long list of fish hosts were added. Amongst its synonyms were given *A. salaris* Gmel., *A. clupearum* Fabr., *A. argentinae* Rud., *A sciaenae* Rud., *A. ophidii-barbati* Rud., *A. ophidii-imberbis* Rud., *A. lyrae* Rud., *A. linguatulae* Rud., *A. labri-luci* Rud., *A. gadi-minuti* Rud., *A. constricta* Rud., *A. centrisci* Rud., and *A. spicrae* Dies. With reference to *A. constricta* it may be mentioned that Linstow (1880, 45) had already stated that this larval form from *Trachinus* was indistinguishable externally from *A. capsularia*. Baylis (1916, 369) placed under the latter some worms from *Cottus* and *Sciaena*, previously identified as *A. constricta*.

Monticelli in 1889 recorded *A. capsularia* from *Merlucius* from Chile, this being probably the earliest record of the larval parasite from the southern hemisphere. In 1916 Seurat recorded *Fil. capsularia*, *F. marina*, *F. piscium*, *Filocapsularia communis* and *Agamonema commune* as synonyms of *Asc. halecis* (1916, 353). In 1899 Stiles and Hassall linked up *A. capsularia* with *A. decipiens* from seals, and in 1905 designated the former (= *salaris*) as type of *Capsularia* (1905, 37, 92). In 1920 was published their Index Catalogue (Nematoda), whose references to literature have been of marked assistance in our present inquiry. In 1932 Sprehn (p. 533) referred to *Ascaris capsularis* as being probably the larva of *Porrocaecum decipiens*.

Spiroptera hominis, which was described by Rudolphi (1819), was placed in the synonymy of *Filaria piscium* by Schneider (1862, 275), after a re-

examination of the original material, which was reported to consist of encapsuled *F. piscium*, along with fish viscera, the specimens having been, apparently, deliberately introduced into the urethra by the patient, and thus passed in the urine. Schneider's *F. piscium* was *Asc. capsularia*. Amongst the authors accepting this synonymy for *S. hominis* were Cobbold (1864, 406-409), Leuckart (1876, 151, 395, 611), Beneden (1878), R. Blanchard (1889), and Stiles (1907). The last-named (1907, 48) included as synonyms of *Ag. piscium*, not only *Sp. hominis* but also *S. rudolphi* Chiaje 1825, *S. rudolphiana* Chiaje 1825, and *S. rudolphii* Dies. 1851. Diesing (1851, 223) had previously listed *Strongylus gigas pullus* and *Sp. rudolphii* as synonyms of *Sp. hominis*.

Many of the "species" in the Dubium group of Rudolphi (1809, 561-567) and placed by Diesing (1851) under *Agamonema* and *Nematoideum*, sometimes with new names, obtained from fish and generally encapsuled, probably belong to *A. capsularia*, as Deslongchamps (1824) and Stossich believed. Brazier (P.L.S., N.S.W., 5, 1881, 629) exhibited specimens of a *Filaria* taken in Sydney from imported salt herrings, the reference being probably to *C. marina*. Leuckart (1876, 417) suggested that *A. capsularia* was the larva of *A.* (= *Contracaecum*) *spiculigera*, while Ciurea (1921, 532) thought it was the larva of *Eustrongylides* sp. Martin (1921, 13), as well as Baylis (1916), considered it to be the larva of *Porrocaecum decipiens*, while Schwartz (1925, 6) regarded it as a group name for larval stages of *Porrocaecum* spp. Yorke and Maplestone (1926, 279) listed *Capsularia* as ? synonym of *Porrocaecum*, and *C. salaris* as a synonym of *P. decipiens*.

McIntosh (1927) mentioned the names of many fish hosts (including *Clupea* and *Salmo*) of *A. capsularia* in Scottish waters. There are various references to the presence of *A. capsularia* in Mediterranean fish—Sigalas (1923), Riccardi (1931), Cercignani (1938), Romboli (1939), Remotti (1933), and Guiart (1938). Schmidt-Ries' paper (1939) relating to the parasites of *Phocaena phocaena* is not at present available to us, nor is Mégnin's work (1882) relating to the development of *A. simplex*.

Ascaris delphini Rud. 1819, from the dolphin of the Ganges (*Platanista gangetica*) was indicated as *A. delphini gangetici* Lebeck ? by Diesing (1851, 155) and placed as a synonym of *A. simplex*. Cobbold (1876, 297; 1879, 426; 1886, 177), Stossich (1896), and Stiles and Hassall (1899) accepted such synonymy, but Baylis (1920, 402; 1932, 402; 1936, 87) listed it as a probable synonym of *Contracaecum lobulatum* (Schneider 1866).

Stiles and Brown (1924, 1958) gave as a character of *Capsularia* the presence of an oesophagus with a distinct ventriculus. They stated that the genus seemed to belong to the Anisakinae and might possibly supplant one of the other genera such as *Anisakis* or *Porrocaecum*.

Our survey of the literature and our examination of material from marine fish and various odontocetes indicate that *Capsularia* must replace *Anisakis* Duj., other synonyms being *Stomachus* Goeze and *Filocapsularia* Deslongchamps. The true *Ascaris capsularia* is the larval stage of the dolphin parasite commonly known as *Anisakis simplex*. *A. capsularia*, together with *Capsularia salaris* and *C. halecis* are synonyms of *Gordius marina* Linn. (in part). The correct name of the parasite is *Capsularia marina* (Linn.). The name of the subfamily Anisakinae, as emended by Baylis (1920, 260), will require to be changed to Capsulariinae, of which we regard Acanthocheilinae Wülker to be a synonym.

From Linnaeus onwards many of the earlier names (referred to above) included at least two, probably more, species. In regions where seals are frequently met with *Porrocaecum* larvae would be included. The larvae of *Contracaecum*, *Anacanthocheilus* and probably *Acanthocheilus* may also have to

be included, since, as adults, they are parasites of fish-eating vertebrates. The known distribution of *C. marina* in its larval and adult stages is now extended very considerably. Its larva is now known to occur in a great number of marine fish. In the case of the barracouta, we know that the vast assemblages that occur at times off the southern Australian coasts are preyed on by dolphins and by sharks such as the "whaler," *Carcharinus brachyurus* Gnthr. It is of interest to note that the barracouta is commonly infested with species of tetrarhynch cestodes (Johnston, 1910, 711), whose adult stage probably occurs in such a shark.

As Baylis (1929) and Johnston (1938, 79) have pointed out, there are three main types of anisakine larvae found in marine fish. One kind is slender, without caecum or appendix, and contained in nearly flat lenticular capsules found chiefly in the subperitoneal and mesenteric tissues (*Anisakis* — *Capsularia*). The larvae of *Acanthocheilus* and *Anacanthocheilus* belong to the same general type as *Capsularia*. The second kind is larger, has an intestinal diverticulum and is usually folded in a larger capsule with one axis longer than the other, the worm being found mainly in muscular tissue (*Porrocaecum*). The third kind is variable in size and is contained in a loose capsule in which it may be merely bent or twisted or may be loosely rolled; this kind possesses an oesophageal appendix and an intestinal caecum. This last type (*Contracaecum*) occurs particularly in the mesentery, in the walls of the stomach and intestine and under the capsule or in the substance of the liver.

With the suppression of *Anisakis* the recognised species are now transferred to *Capsularia*—*C. similis* (Baird), *C. rosmari* (Baylis), *C. dionedeae* (Linstow), and *C. physeteris* (Baylis).

The synonymy of *C. marina* is now very lengthy and is quoted herewith, but no attempt is made to indicate all the literature relating to each synonym. We consider it probable that many of the synonyms recorded here may also relate, in part, to the larvae of *Acanthocheilus* and *Anacanthocheilus*, especially the latter, since Wülker (1930) reported that *A. rotundatus* was the commonest nematode occuring in German marine fish. The names marked with a query are amongst those quoted by other authors as synonyms of *A. capsularia* or some other of its many names, but the evidence available to us suggests that most of them belong, at least in part, to larval *Contracaecum* spp.

We have added a hyphen to the compound names used by Rudolphi and Diesing.

NAMES BASED ON THE LARVAL STAGE

Gordius marinus Linn. 1767 (in part); Bloch 1779; and others (in part). *G. harengum* Bloch 1782; Fabr. 1794. *Ascaris marina* Müller 1780 (in part); Gmelin 1790; Sweet 1909; Johnston 1910. *Ascaris* sp. (? *marina*) Johnston and Cleland 1914. ? *A. argentinae* Gmelin 1790; Rud. 1810, 1819; Duj. 1845. ? *A. atherinae* Rud. 1819; Duj. 1845; Dies. 1851. *A. capsularia* Rudolphi 1802, 1809, 1819; Bellingham 1844; Creplin 1846; Diesing 1851; Baird 1853; Leidy 1856; Linstow 1880; Stossich 1896; Stiles and Hassall 1899; Linton 1901; Baylis 1916 (in part). *A. capsularis* Siebold 1857; Sprehn 1932. ? *A. centrisci* Rud. 1819. *A. clupearum* Fabr. 1794; Rud. 1809, 1819; Dies. 1851. *A. constricta* Rud. 1809, 1819; Linstow 1880. *A. filholi* Chatin 1885. ? *A. gadi-minuti* Rud. 1819. *A. halecis* Gmelin 1790; Bloch 1782. ? *A. labri lusci* Rud. 1819. ? *A. linguatulae* Rud. 1819. ? *A. lyrae* Rud. 1819. *A. nelsonis* Chatin 1885. ? *A. ophidii-barbati* Rud. 1819. ? *A. ophidii-imberbis* Rud. 1819. *A. salaris* E. Blanchard 1849. ? *A. sciaenae* Rud. 1819. *A. sphyranurae* Linstow 1906; Young 1939. *A. sphyraenae* Baylis 1916. ? *A. spicae* Dies. 1851 (syn. *A. spari-spicae* Rud. 1819). *A. thyrsitis* Linstow 1908. *Agamonema apri* Dies. 1851. *Ag. capsularia* Dies. 1851. *Ag. commune* Dies. 1851 (in part). *Ag. fabri* Dies. 1851.

Ag. merlucii-vulgaris Dies 1851. *Ag. piscium* Schneider 1862. *Ag. scorpaenae-cirrhosae* Dies. 1851. *Ag. serrani-cabrillae* Dies. 1851. *Ag. sparoidum* Dies. 1851. *Ag. syngnathi-pelagici* Dies. 1851. *Ag. triglae-lineatae* Dies. 1851. *Ag. wachniae* Dies. 1851. *Anisakis salaris* Yamaguti 1935. *An. simplex* Johnston and Mawson 1943. *Capsularia halecis* Zeder 1800. *C. salaris* Zeder 1800. *C. trinodosa* Zeder 1803. *Cucullanus halecis* Fabr. 1794. *Cuc. lacustris* v. *salaris* Gmel. 1790. *Cuc. salaris* Gmel. 1790. ? *Dubium argentinae-sphyraenae* Rud. 1819. *D. gadi-merlucii* Rud. 1819. *D. gadi-wachniae* Rud. 1819. *D. percae-cirrosae* Rud. 1819. *D. percae-marinae* Rud. 1819. *D. spari-boopis, -mormyri, -melanuri, -alcedinis* Rud. 1819. *D. sparorum* Rud. 1819. *D. syngnathi-pelagici* Rud. 1819. *D. triglae-adriaticae* Rud. 1819. *D. zenis-apri* Rud. 1819. *D. zenis-fabri* Rud. 1819. *Filaria capsularia* Rud. 1802, 1809, 1819; Creplin 1846. *F. capsularis* Dies. 1851 (for *F. capsularia*). *F. piscium* (in part) of authors (non. Rud. 1809). *F. zenis-fabri* Rud. 1819. *F. zenis-fabri* Dies. 1851. *Filocapsularia communis* Deslongchamps 1824 (*halecis*). *Fusaria argentinae* Zeder. ? *Nematoideum argentinae-sphyraenae* Dies. 1851. *N. dubium gadi-merlucii* Dies. 1851. *N. d. gadi-wachniae* Dies. 1851. *N. d. percae-cirrhosae* Dies. 1851. *N. d. percae-marinae* Dies. 1851. *N. d. spari-boopis, -mormyri, -melanuri, -alcedinis* Dies. 1851. *N. d. syngnathi-pelagici* Dies. 1851. *N. d. zenis-apri* Dies. 1851. *Porrocaecum* or *Anisakis* larvae Baylis 1929 (in part). *Spiroptera hominis* Rud. 1819. *Sp. rudolphi* Chiaje 1825. *Sp. rudolphiana* Chiaje 1825. *Sp. rudolphii* Dies. 1851. *Stomachus albus* Goeze in Zeder 1800. *Strongylus gigas pullus* Dies. 1851 (based on Bremser 1819).

Names Based on the Adult Stage

Ascaris simplex Rud. 1809, 1819; Dujardin 1845; Diesing 1851; Cobbold 1886; Stossich 1896; Stiles and Hassall 1899, etc.: not *Ascaris simplex* Linstow 1888 (from seal, Kerguelen = *Porrocaecum decipiens*). *A.* (*Anisakis*) *simplex* Duj. 1845. *A. angulivalvis* Creplin 1851. *A. dussumieri* Beneden 1870; Stiles and Hassall 1899. *A. kükenthalii* Cobb. 1888. *A.* sp. (from dolphin) Krefft 1873. *Anisakis catodontis* Baylis 1920. *A. dussumieri* Baylis 1920. *A. kükenthalii* Baylis 1920. *A. kogiae* Johnston and Mawson 1939. *A. kogianus* Nicoll 1941. *A. simplex* Raill. and Henry 1912; Baylis 1920; Lyster 1940; Johnston and Mawson 1941, 1942, 1943; and other authors. *A. typica* Baylis 1920. *Conocephalus typicus* Dies. 1861. *Peritrachelius typicus* Jägersk 1894.

Porrocaecum piscium (Rud. 1809), J. and M. 1943

Rudolphi (1809, 74) included amongst his doubtful species one which he named *Filaria piscium*. He gave a number of references, including Houttuyn's *Gordius marinus* Linn. (which was figured) from the liver of Gadidae. Rudolphi stated that the parasite occurred in the musculature, abdominal cavity and liver of various marine fish. He used the term "membranis implicita," suggesting that the worm was rather intricately folded within the cyst. This would imply an obvious difference from his *Filaria capsularia* and *Ascaris capsularia* described in the same work, both of these being spirally rolled within their cysts. Rudolphi mentioned as hosts for *F. piscium* three species of *Gadus*, as well as representatives of other genera, and stated that Rathke had recorded it as *Filaria marina* from *Lophius* and *Gadus* spp. In a later work, Rudolphi (1819, 218) mentioned that many kinds of entozoa had been confused by authors under the name of *F. piscium*, and since his time the latter term has been applied very commonly to larval ascarids from fish, as has been indicated earlier in the present paper. *Filocapsularia communis* Deslg. 1824 is in part a synonym of it, as also is *Agamonema commune* Dies. 1851. Diesing's list of synonyms is essentially the same as that given by Rudolphi (1809) for *F. piscium* and the main hosts mentioned are species of Gadidae. Dujardin's account of *F. piscium* (1845, 60)

indicates that he was dealing, at least in part, with a larval *Porrocaecum*. Diesing's (1851, 347) *Dubium merlucii-vulgaris* was stated to have been obtained from the abdominal muscles of *Merlucius vulgaris*. Leuckart (1876, 98, 615) referred to the presence of *F. piscium* in the muscular tissue of numerous species of marine fish. Stiles and Hassall (1899) and Baylis (1916) believed that *Ascaris capsularia* was the larval stage of *Porrocaecum decipiens*, as we have already indicated. Martin (1920) wrote concerning the ascarid larvae occurring in the flesh of North Sea fish and gave an account of the larva of *P. decipiens;* and Wülker (1930 a) returned to the same subject. Kahl (1938) gave an excellent account of the larva of *P. decipiens*, and of the process of its encapsulation in various fish. The musculature was stated to be the chief site for infestation, though the parasites were found occasionally in the walls of the viscera, such situations probably indicating the invasion route to the body muscles.

We have investigated the "flesh worms" of fish from subantarctic islands (1943) and found them to be larvae of *P. decipiens*. We also regarded *Agamonema campbelli* Chatin as a synonym. Under *Capsularia marina* we have, in passing, drawn attention to other references in literature relating to larval *Porrocaecum*.

There is no doubt that the true *Fil. piscium* Rud. (1809) is the larva of *Porrocaecum decipiens* of seals, and consequently Krabbe's specific name must be superseded by that given by Rudolphi. The chief synonyms of *P. piscium* are *Fil. piscium* Rud. 1809; Dujardin 1845; and of many authors (in part). *Dubium merlucii-vulgaris* Dies. 1851. *Ascaris decipiens* Krabbe, 1878. *Porrocaecum decipiens* Raill. and Henry 1912. *Ascaris capsularia* Baylis and others (in part). *Ascaris capsularis* Sprehn 1932. *Agamonema campbelli* Chatin. 1885.

Additional synonymy for the larva was given by Rudolphi (1809) and Diesing 1851; and for the adult by Baylis (1937) and Johnston (1938).

Summary

1 *Contracaecum legendrei* Dollfus is recorded from *Thunnus maccoyi* (S.E. Australia), and its larval stage from *Platycephalus macrodon* (N.S.W.) and *Upeneichthys porosus* (S. Aust.).

2 *Contracaecum incurvum* (Rud.) is recorded from *Xiphias estara* (N.S.W.).

3 *Acanthocheilus quadridentatus* Molin is reported from *Mustelus antarcticus* (Vict.).

4 *Capsularia* Zeder 1800 is rehabilitated, with *Stomachus* Goeze 1800, *Filocapsularia* Deslongchamps 1824, *Anisakis* Duj. 1845, *Peritrachelius* Dies. 1851, and *Conocephalus* Dies. 1861, as synonyms, and with *C. marina* (Linn.), in part, as type.

5 Capsulariinae nom. nov. replaces Anisakinae; and Acanthocheilinae Wülker is a synonym.

6 *Capsularia marina* (L.) Johnston and Mawson is the larval stage of *Anisakis simplex*, a parasite of odontocetes, and occurs in a closely rolled condition in a flat capsule, especially in the subperitoneal tissue of the body wall and digestive tract of coastal and pelagic fish. It is now recorded from Australian fish:—*Thyrsites atun* (N.S.W., Vict., Tasm., S. Aust., W. Aust.); *Platycephalus macrodon* (N.S.W.); *Sciaena antarctica* (N.S.W., S. Aust.); *Istiompax australis* (Vict.); *Thunnus maccoyi* (S. Aust.); *Coryphaena hippurus* (N.S.W.); and *Mustelus antarcticus* (Vict.).

7 Extensive synonymy of *Caps. marina* is listed, more recent synonyms being *Ascaris sphyraenae* Linst., *A. thyrsitis* Linst., *Anisakis simplex* (Rud.), and *An. catodontis* Baylis.

8 New combinations are *Capsularia similis* (Baird), *C. rosmari* (Baylis), *C. diomedeae* (Linst.), and *C. physeteris* (Baylis) for valid species previously assigned to *Anisakis*.

9 The correct name for *Porrocaecum decipiens* (Krabbe) appears to be *P. piscium* (Rud. 1809), *Filaria piscium* Rud. being the larval stage occurring as "flesh worms," rather loosely folded in cysts in the body musculature of marine fish.

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ADDITIONS TO THE FLORA OF SOUTH AUSTRALIA NO 41

By J. M. BLACK, A.L.S.

Summary

GRAMINEAE

Stipa pubescens R. Br. nov var. maritima. Nonnulla folia caulina plana et 8-10 mm. lata; panicula densa; arista $5^1/_2$ cm. longa, columna $2\text{-}2^1/_2$ cm. longa. - Marino.

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No. 41

By J. M. Black, A.L.S.

[Read 13 May 1943]

Gramineae

Stipa pubescens R. Br. nov var. **maritima.** Nonnulla folia caulina plana et 8-10 mm. lata; panicula densa; arista 5½ cm. longa, columna 2-2½ cm. longa.—Marino.

Stipa semibarbata R. Br. nov. var. **gracilis.** Caulis gracilis; panicula circa 14 cm. longa, interdum laxula; arista 6-7 cm. longa.—Mount Lofty Range; Kangaroo Island.

Proteaceae

Grevillea biternata Meisn. Extreme western end of the Gawler Ranges, Eyre Peninsula, 1941, *C. W. Johns.* "Shrub up to 1 m. high, growing in dense communities and propagating itself by suckers."—Collector's note. This is the first record for South Australia, and the first species of the section *Manglesia* to be found here. This section is distinguished by the small straight glabrous flower, with a globular limb, the erect obtuse stigmatic cone, which is supported on a short style narrowed at both ends and swollen in the middle, so as to resemble an ovary; the real ovary is globular, glabrous, situated just below the style, and raised on a gynophore about as long as the style and stigmatic cone. In *biternata* the young branches and leaves are pubescent with small appressed basifixed hairs, the leaves bisect or trisect, usually more than once, ending in two or three needle-like segments. The peduncles of the short simple raceme are also pubescent with similar hairs. This species, like the others of the section, has hitherto been known only from Western Australia.

Cruciferae

Hymenolobus alatus, nov sp. Plantula annua, sparsissime appresso-pilosula; caules ascendentes, 2-8 cm. alti; folia obovata, circa 1 cm. longa, in petiolum

Hymenolobus alatus

A, septum and one sepal; *B*, pod; *C*, seed exuding mucus, which appears like a wing in the illustration; *D*, embryo; *E*, horizontal section of seed.

angustata, pleraque basilaria, integra vel apice obtuse lobulata; racemi fructiferi 3-5 cm. longi, pedicellis patentibus siliculas subaequantibus; sepala cymbiformia, patentia, 1 mm. longa, obtusa; petala nulla; stamina 4, filamentis basin versus dilatatis; silicula fere orbicularis, glabra, circa 4 mm. longa et lata, manifeste alata et emarginata, parte seminiferâ turgidâ, alâ 1-1½ mm. latâ, totam carinam valvularum marginante; septum oblongum, circa 3 mm. longum, 2 mm. latum; stylus nullus; semina ovoidea, brunnea, 1 mm. longa, in statu macerato valde mucosa, 4-5 in utroque loculo; cotyledones incumbentes.

In shady spots near Wudinna, Eyre Peninsula, 1941, *C. W. Johns.*

This little plant has the habit of *H. procumbens* (L.) Nutt., but differs in the absence of petals, in the pedicels shorter in relation to the pods, which are larger almost orbicular, distinctly winged and have fewer seeds. However, as winged and wingless pods are admitted in *Lepidium* and *Thlaspi*, it seems to me preferable to place the new species in *Hymenolobus*, rather than attempt to create a new and probably monotypic genus.

LEGUMINOSAE

Acacia gonophylla Benth. var. *crassifolia*, Benth. Finniss River, October 1929, J. B. Cleland. Agrees with specimens from Eyre Peninsula, except that the thick phyllodes are rather narrower (about 2 mm. broad). In all our specimens the peduncles are solitary in the axils, not twin. Until pods have been found the determinations are somewhat doubtful.

A. iteaphylla F. v. M. Western end of the Gawler Ranges, 1941, *C. W. Johns.* First record for Eyre Peninsula.

**Sutherlandia frutescens* R. Br. Heath country at Venus Bay, Eyre Peninsula, 1941, *C. W. Johns.* This handsome South African shrub (*Bladder Senna*) has hitherto been found wild only in the Flinders Range.

STERCULIACEAE

Rulingia craurophylla F. v. M. Poldinna railway siding, 5 miles north of Minnipa, Eyre Peninsula, 1941, *C. W. Johns.* First record for South Australia. Discovered by Alexander Forrest in 1871 near the present site of Southern Cross; in 1891 it was collected in the Victoria Desert and the Fraser Range by R. Helms. A silky-villous shrub about 1 m. high; leaves broad-linear, rigid and brittle, 2-4 cm. long by 2-4 mm. broad, obtuse, sessile, faintly crenate and puckered above by the numerous short impressed lateral nerves spreading almost at right angles to the midnerve; outer bracts of each cyme longer than flowers, ovate, stipitate; stamens and staminodes in two rows, the staminodes forming the inner row, all free or almost so.

GOODENIACEAE

Velleia cycnopotamica F. v. M. Near Wudinna, Eyre Peninsula, 1941, *C. W. Johns.* First record for South Australia -Western Australia.

The capsule is orbicular, white when ripe, rather thin in texture, faintly reticulate, 2-valved and not splitting into four valves as in our other two species (*paradoxa* and *connata*), and always longer than the sepals. The basal leaves are mostly obovate and sharply toothed, but a few are lyrate, with small spreading acute lobes decreasing in size downwards and a winged rhachis. In the capsules examined, I found only two orbicular seeds filling the cavity.

MYRTACEAE

Melaleuca eleutherostachya F. v. M. Along the road between Wudinna and Kimba, 1928, *C. W. Johns;* 30 miles north-east of Cowell, Eyre Peninsula, November 1936, *J. B. Cleland.* A tall shrub, with small decussate leaves and flowers and fruits in short oblong sessile lateral spikes, hitherto found only in Western Australia.

A NEW OCCURRENCE OF MONAZITE IN SOUTH AUSTRALIA

By ALLAN F. WILSON
(Communicated by Sir D. Mawson)

Summary

Early in 1942 when examining the area of hornfels and crystalline schists in the neighbouhood of Strathalbyn, monazite was discovered as occasional tiny crystals in irregular pegmatitic veins. Much more common in these veins is rutile, which is often in large and perfect crystals.

A NEW OCCURRENCE OF MONAZITE IN SOUTH AUSTRALIA

By Allan F. Wilson
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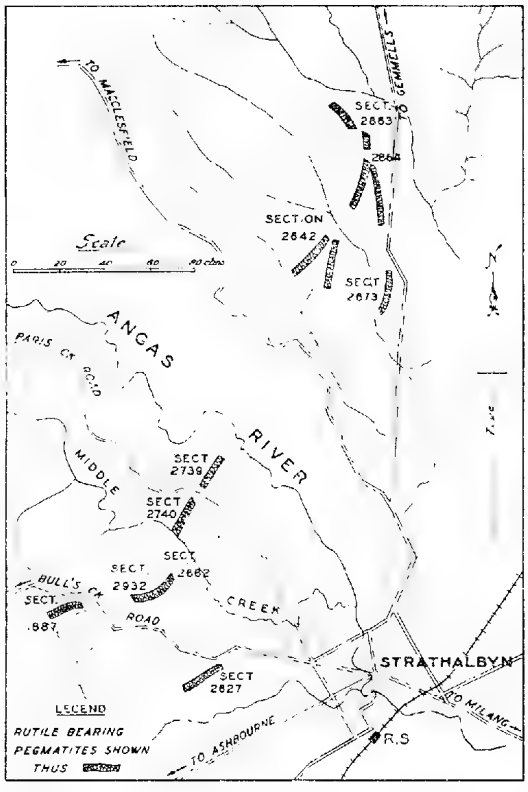
[Read 13 May 1943]

Early in 1942 when examining the area of hornfels and crystalline schists in the neighbouhood of Strathalbyn, monazite was discovered as occasional tiny crystals in irregular pegmatitic veins. Much more common in these veins is rutile, which is often in large and perfect crystals.

Rutile, in such formations, has been met with from place to place over a length of several miles in the belt of country extending between Section 1887 Kondoparinga and Section 2863 Macclesfield. Brilliant honey yellow crystals of monazite associated with the rutile were collected both in the neighbourhood of Section 2740, and on Section 2863 (Hundred of Macclesfield), which localities are distant some two miles apart.



One of the monazite crystals from the former locality measures 12 mm. across on the cleavage face. It was found difficult to secure complete crystals owing to the facile cleavage of the mineral: thus when breaking open the rock matrix the fracture planes often traversed the monazite. Several crystals from this area exhibit twinning.

At the second locality black tourmaline makes its appearance and the enclosing hornfels has suffered considerable bleaching in the vicinity of these mineralised stringers as a result of pneumatrolysis proceeding from the latter.

Crystals of rutile and monazite often make their appearance at the contact of the vein material with ingested country rock. In some cases the latter fragments are observed to have been in process of alteration to felspar and sericite.

The near-by water-courses yielded, on panning, both monazite and rutile, the latter mineral being much the more abundant.

The identity of the monazite has been established by qualitative chemical tests and a limited optical examination. Owing to lack of material, no quantitative analysis has been made. The radio-activity of the monazite was established by its action on photographic plates; in these tests the Strathalbyn monazite appears to have about the same radio-activity as the monazite from North Carolina.

NOTES ON FOSSILIFEROUS ROCKS FROM TERTIARY OUTCROPS TO THE SOUTH - WEST OF COONALPYN, SOUTH AUSTRALIA

By FREDK. CHAPMAN, A.L.S., F.G.S.

Summary

These notes arc based on three specimens [1] of limestones collected by Professor Sir Douglas Mawson. He kindly submitted them to me for detailed examination, as of particular interest on account of the absence of information concerning the nature of the Tertiary rocks in that particular district and the paucity of their outcrops. These fossiliferous limestones overlie, unconformably. massive granite.

NOTES ON FOSSILIFEROUS ROCKS FROM TERTIARY OUTCROPS TO THE SOUTH-WEST OF COONALPYN, SOUTH AUSTRALIA

By Fredk. Chapman, A.L.S., F.G.S.

[Read 13 May 1943]

These notes are based on three specimens[1] of limestones collected by Professor Sir Douglas Mawson. He kindly submitted them to me for detailed examination, as of particular interest on account of the absence of information concerning the nature of the Tertiary rocks in that particular district and the paucity of their outcrops. These fossiliferous limestones overlie, unconformably, massive granite.

One of the specimens is a dense red limestone of an unusual character; the others being more or less typical polyzoal rocks.

Specimen No. 5158

Locality—From a shallow well in limestone overlying granite at Cold & Wet Homestead, distant six miles due west-south-west by south from Coonalpyn.

Description—A soft, spongy, polyzoal limestone, of a yellowish to pink colour. Crushed material shows the component particles to have been re-crystallised on the surfaces, whilst the organisms themselves were largely corroded before consolidation.

Finest washings contain numerous minute elongated rhombs of aragonite or calcite, averaging 12 μ in length, together with abundant rods and plates of a calcareous nature, some iron stained.

Foraminifera—*Dentalina* ? *obliqua* d'Orb.; *Eponides repandus* (F. and M.); *E. scabriculus* Chapm.; *Cibicides lobatulus* (W. and J.); *C. ungerianus* (d'Orb.); *C. haidingerii* (d'Orb.); *Elphidium verriculatum* (Brady); *Textularia sagittula* Defr.

Polyzoa—cf. *Amphiblestrum* sp.; *Smittina tatei* (T. Woods); *Porina gracilis* (M. Edw.); cf. *Retepora* sp.

Crinoidea—*Antedon* sp. (arm ossicle).

Horizon and Age—A typical Polyzoan Limestone. Comparable in its faunal aspect with the bulk of the Mallee Borings below the Kalimnan (Chapman, 1916. Cainozoic Geology of the Mallee and other Bores. Rec. Geol. Surv. Vict., 3, (4)). It may also correspond with Tate's Middle Murravian Series—Calciferous sandstone with polyzoa (Tate, 1885, Notes on the Physical and Geological Features of the Basin of the Lower Murray River, Trans. Roy. Soc. S. Aust., 7, 24-46). This horizon is referred to by Singleton (The Tertiary Geology of Australia, Proc. Roy. Soc. Vict., **53**, (1), N.S., 1941) in his "Tentative Correlation Table' as the upper part of the Middle Miocene, in which he includes Balcombian with *Trillina* (at Muddy Creek), and incidentally the upper part of the Barwonian.

Specimen No. 5159

Locality—A thin formation on the west-facing slopes of the granite ridge at about $\frac{3}{4}$ mile north of Crottie's Knob. The latter is some 9 miles due west-south-west by south of Coonalpyn.

[1] The specimen numbers refer to the rock collection, University of Adelaide.

Description—Very hard, pinkish, fine-grained, gritty and sandy limestone, with organic remains. These include fragments of calcareous algae (chiefly Lithothamnion); foraminiferal tests; echinoid spines and test fragments; polyzoa indet.; also fragments of molluscan shells (gasteropods and bivalves). The foraminifera are well rolled and embedded in a calcitic paste.

The component particles of the rock are often coated with a dense concentric growth, suggesting algal (cyanophyaceous) structure, but not so well preserved as to be identified. This appearance might almost introduce an æolian or littoral element into the question of conditions of accumulation of the deposit.

The foraminifera are abundant. The species, as far as they can be determined, in the various slices (numbers 1 to 8) examined, are as follows:

Marginulina glabra d'Orb. (1); *Guttulina* sp. (2); cf. *Sigmoidella* sp. (4, 6); *Bolivinopsis* sp. (2); *Patellinella annectens* Parr and Collins (5); *Discorbis* sp. *a* (6); *Discorbis* sp. *b* (2); *Eponides repandus* (F. & M.) (1, 2, 7); *Rotalia verriculata* Parr (1, 2, 3, 4, 5, 6, 7); *Anomalina* sp. (2); *Cibicides lobatulus* (W. and J.) (3); *Acervulina* sp. (2); *Gypsina globulus* (Rss.) (6); *Carpenteria* sp. (3, 4, 8); *Amphistegina* sp. (2, 6, 8); *Globorotalia truncatulinoides* (d'Orb.) (4); *Elphidium chapmani* Cushman (3, 4, 6, 7); *Elphidium verriculatum* (Brady) (4, 6, 7, 8,); *Quinqueloculina* sp. (1); *Sigmoïlina* sp. (4); *Spiroloculina* sp. (1); *Miliola* (*Pentellina*) sp. (5); *Triloculina tricarinata* d'Orb. (1, 3); *Textularia* sp. (7); *Dorothia* sp. (4).

Horizon and Age—This facies, as well as the characters of the rock itself, is strikingly like that of the Batesford Limestone, where, at the type locality, it appears as a shore-line detritus. At Batesford, in the neighbourhood of the Dog Rocks, the detrital material has been derived from granite. Here it is more of a fine quartzitic nature.

The shallow marine conditions under which this rock (5159) was deposited is partly responsible for the sub-tropical aspect of its associated foraminifera, as distinguished by the deeper water and cooler aspect of the typical polyzoal deposits of the associated rocks in this locality—Coonalpyn.

The redundant and thickened tests of *Elphidium* and *Rotalia* seen in these rock sections remind one of similar forms found in the shallow water gatherings on the Great Barrier Reef, Queensland, at the present day, although of different species.

In slide No. 5 there occurs a very nice section of *Patellinella*, cut through the vertical axis. It has a thicker and lower test than the Recent and Post-Tertiary species, *P. inconspicua* (Brady). There is little doubt that this example from Coonalpyn can be identified with the Lower Miocene form described some years ago by Parr and Collins from Muddy Creek, Victoria (Proc. Roy. Soc. Vict., 43, (1), 1930, 91, pl. iv, fig. 6).

The living *Patellinella inconspicua* (Brady), Rep. Chall., 1884, 9, 357, pl. xlii, fig. 6 *a-c* (as *Textularia*), has a wide distribution at the present day. It includes E. Monceeur Island, Bass Strait; Nares Harbour, Admiralty Island; south of Japan; Malay Archipelago; off New Zealand; and off Portuguese East Africa. The Post-Tertiary example was found by W. J. Parr in a boring near Boneo, Victoria, at 177-184 feet.

So far as examined in thin slices, the specimen 5159, Coonalpyn, has yielded no evidence of *Lepidocyclinae* nor *Cycloclypeus*, which are characteristic of the Batesfordian at the Dog Rocks, near Geelong. The association of *Rotalia verriculata* Parr in abundance, with *Gypsina globulus* (Reuss) and probably *Elphidium chapmani* Cushman, whose type locality is Neumerella, East Gippsland, with marls and limestones containing a general facies is in many respects comparable with the Batesfordian, though not entirely similar lithologically.

Specimen No. 5160

Locality—From a shallow well about 1 mile east of Binnie's Water, which is about 11 miles due west of Coonalpyn.

Description—A somewhat coarse-textured polyzoal and shelly limestone. White weathering to grey. Numerous fronds of sea-mats and pecten shells visible on the surface.

The finest washings contain fragments of shells and crystals of calcite or aragonite, with an average diameter of 24 μ.

The crushed material yields fragmentary organisms, generally corroded. Polyzoa fairly abundant. Foraminifera scarce and small.

Foraminifera—*Discorbis pileolus* (d'Orb.); *Eponides scabriculus* Chapm.; cf. *Cibicides ungerianus* (d'Orb.); *Globigerinoides* cf. *conglobatus* (Brady); *Quinqueloculina seminulum* (L.); *Textularia sagittula* Defr. var. *fistulosa* Brady.

Polyzoa—*Cellaria* sp.; *Amphiblestrum* sp.; *Membranipora marginata* McG.; *Crisia scalaris* McG.; *Crisia gracilis* McG.; *Hornera* sp.; *Idmonea semispiralis* McG.

Pelecypoda—cf. *Austrolima bassi* (T. Woods); *Notochlamys* cf. *consobrina* (Tate); *Callanaitis cainozoica* (T. Woods).

Horizon and Age—This shelly polyzoal rock indicates a typical Gambierian facies. Both the polyzoa (restricted spp.), and some of the foraminifera, would relegate it to an horizon not older than the top of the Lower Miocene (Batesfordian) and the lowest part of the Middle Miocene (cf. Balcombian).

CRITICAL NOTES ON THE GRAMINEAE AND CYPERACEAE OF SOUTH AUSTRALIA WITH DESCRIPTIONS OF NEW SPECIES

By S. T. BLAKE, M.Sc., Department of Biology, University of Queensland
(Communicated by J. M. BLACK)

Summary

Since the publication of Black's Flora of South Australia during the years to 1922-1929, a large amount of intensive work on the flora of Australia has been carried out, both in Australia and overseas. This has resulted in the discovery of a number of new species and in the recognition of many other species as undescribed which had previously been misidentified with more or less well-known species. Bibliographical research into the validity of names has been responsible for many name-changes. This is particularly the case in the Cyperaceae and Gramineae, two families which have especially engaged my attention for some years past, and for the study of which Mr. Black has kindly loaned me very many specimens from his Herbarium.

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[Read 13 May 1943]

Since the publication of Black's Flora of South Australia during the years 1922-1929, a large amount of intensive work on the flora of Australia has been carried out, both in Australia and overseas. This has resulted in the discovery of a number of new species and in the recognition of many other species as undescribed which had previously been misidentified with more or less well-known species. Bibliographical research into the validity of names has been responsible for many name-changes. This is particularly the case in the Cyperaceae and Gramineae, two families which have especially engaged my attention for some years past, and for the study of which Mr. Black has kindly loaned me very many specimens from his Herbarium.

When, towards the end of 1940, Mr. Black asked me to assist him in the revision of the Gramineae and Cyperaceae for the Second Edition of the Flora, I willingly undertook what proved to be quite a lengthy task. This paper is offered as an explanation of the many changes found necessary, most of which could not be adequately discussed within the limits of the Flora.

To avoid overloading the text with lengthy citations, a Bibliography of the more frequently cited papers is given at the end of the paper, and this is referred to as is commonly done in non-taxonomic papers.

Thanks to the courtesy of the Directors of the National Herbaria of Victoria and New South Wales, I have been able to examine the types or duplicate-types of many species, some of which were specially loaned for this work. The following abbreviations have been used to indicate herbaria, those in small capitals being in accordance with the international system proposed by Lanjouw in Chronica Botanica, **5**, 142-150 (1939):

Tate Herbarium, University of Adelaide	AD
Black Herbarium	Bl
Cleland Herbarium	Cl
National Herbarium of Victoria, Melbourne	MEL
National Herbarium of New South Wales, Sydney	NSW
Queensland Herbarium, Brisbane	BRI

Gramineae

The genera of the subfamily Panicoideae have been the subject of intensive study during recent years, and the tendency has been to recognise numerous small more homogeneous genera instead of the large unwieldy heterogeneous aggregations of species frequently included in such genera as *Andropogon* and *Panicum*. These smaller genera are not always sharply definable, though, as a rule, they are at least as sharply marked as *Andropogon* and *Panicum* in the broad sense.

The South Australian species of the Andropogoneae were re-arranged under the smaller genera by Black (1936), but further study has necessitated more changes. *Hemarthria uncinata* R. Br. replaces *Rottboellia compressa* L.f. of the First Edition. The genus *Rottboellia*, as now understood, is restricted to tropical

species with fragile cylindrical racemes (so-called "spikes") and the spikelets of each pair dissimilar. *Hemarthria* has tough, decidedly compressed racemes with the spikelets of each pair similar or nearly so; all the Australian specimens appear to belong to the one species.

The South Australian species referred to as *Andropogon* in the First Edition are now distributed between the genera *Dichanthium*, *Bothriochloa*, *Sorghum*, *Cymbopogon*, and *Chrysopogon*. Species of these and other genera are being fully discussed elsewhere (Blake, 1943). Three species of *Bothriochloa* are known from South Australia, but unfortunately some confusion has arisen as the result of a misidentification in Black's paper cited above. The description there given of *B. inundata* (F. Muell.) J. M. Black refers to *B. Ewartiana* (Domin.) C. E. Hubbard, a species widely spread in the drier parts of the continent. The basis of the combination, however, *Andropogon inundatus* F. Muell., was founded on a small specimen of what is now known as *B. intermedia* (R. Br.) A. Camus, collected by Mueller at Crystal Brook in October 1851, and is the only known record of *B. intermedia* for South Australia. The South Australian specimens referred to *B. decipiens* (Hack.) C. E. Hubbard belong to the closely allied *B. ambigua* S. T. Blake.

The plant commonly passing as *Andropogon bombycinus* R. Br. or *Cymbopogon bombycinus* (R. Br.) Domin differs from the plant originally described by Brown from the eastern coast of Queensland in the reflexed racemes and more numerous nerves on the lower glume of the sessile spikelet, and has to receive a new name, *C. obtectus* S. T. Blake. It is widely spread over the Australian mainland. Likewise, the Australian specimens generally referred to *Andropogon Gryllus* L. or *Chrysopogon Gryllus* (L.) Trin. have been found to represent an hitherto undescribed species, *C. fallax* S. T. Blake.

The species of *Iseilema* have been discussed elsewhere by Black (1933, 1938).

Isachne australis R. Br. The Australian species of *Isachne* require further study, and until this has been carried out the above name should be used for the South Australian form. Henrard (1940, p. 464) seems to imply that *I. australis* is conspecific with *I. globosa* (Thunb.) O. K. which was originally described from Japan, but the specimens so far seen from the southern half of Australia do not agree with the characters given by Henrard as being distinctive of *I. globosa*.

Eriochloa pseudoacrotricha (*Stapf ex Thell.*) *C. E. Hubbard* in herb. Brisbane, comb. nov. *E. ramosa* var. *pseudoacrotricha* Stapf ex Thell. in Viertelj. Naturforsch. Gesellsch., Zurich, 64, 697 (1919). *E. ramosa* var. *acrotricha* Stapf ex Thell. l.c. *E. annulata* (Fluegge) Kunth var. *acrotricha* Benth. Fl. Austral., 7, 463 (1879) as to the description and specimens cited, not *Helopus acrotrichus* Steud.

Thellung, when publishing *E. ramosa* var. *pseudoacrotricha* Stapf, gave no description, merely referring to "*E. annulata* var. *acrotricha* Bentham Fl. Austral. (excl. syn.)." This appears to constitute valid publication, in spite of the fact that Bentham's combination, based on a misidentification, is a synonym of *Helopus acrotrichus* Steud., another species. The reason advanced is that Thellung has definitely excluded Bentham's synonymy when publishing Stapf's combination, thus leaving the description and the specimens on which it was based. In herbarium Melbourne are representatives of the collections of Woolls and Mrs. Calvert cited by Bentham; these are certainly conspecific, and one must therefore be part of the type-collection. Leichhardt's specimens may be excluded, as they are mentioned as if it were an after-thought—"also in *Leichhardt's* collection." The sheet in herbarium Brisbane determined by Hubbard as *Eriochloa pseudoacrotricha* (Stapf) C. E. H. is a duplicate of a collection sent to Kew and evidently matched by Hubbard with Stapf's type there.

The species, which occurs in parts of Queensland, New South Wales and South Australia, is characterised chiefly by the lanceolate spikelets 4·75-5·5 mm. long being broadest at about one-third from the base, thence acuminate upwards, tapering into a rather long bristle-like point. An amplified description, based chiefly on *Blake 10147* from Yelarbon, Darling Downs District, Queensland, which is a particularly good match for the Melbourne material, is as follows:

Gramen perenne, caespitosum, viride, plerumque 50-100 cm. altum; innovationes intravaginales. *Culmi* erecti, basi leviter geniculati vel stricti, 2-5-nodes, ramosi, molles, striati saepe etiam plus minusve sulcati, laeves, glabri vel prope nodos pubescentes. *Vaginae foliorum* striatae, laeves, praecipue ad nodos pubescentes vel omnino glabrae, arctae vel solutae, infimae internodiis saepe longiores, ceterae breviores; collum pubescens; ligula ad seriem ciliorum circa 0·7 mm. longorum redacta; laminae anguste lineares sensim acutissimae, plus minusve involutae raro planae, prope ligulam pubescentes, ceterum glabrae vel subtus breviter pubescentes, usque ad 30 cm. longae, usque ad 4 mm. latae, nervis 11 primariis percursae. *Inflorescentia* angusta, 10-18 cm. longa, e racemis 3-7 constructa; axis communis compresso-triquetra, circiter 0·5 mm. lata, glabra vel nodis pubescens vel parce pilosa, scaberula, striata. *Racemi* breviter pedunculati, erecti vel suberecti, 2-6 cm. longi, axis communis internodiis saepissime longiores, densi; rhachis scaberula, axillis pubescens vel etiam pilosa, ceterum glabra; pedicelli 0·5-2·5 mm. longi, clavato-filiformes, scaberuli et praecipue prope apicem longe pilosi (pilis usque ad 3 mm. longis). *Spiculae* 4·75-5·5 mm. longae, circiter 1·4 mm. latae, dilute virides vel purpureo-variegatae, lanceolatae, a tertia parte inferiore longiuscule setaceo-acuminatae, parte majore longiuscule pilosae. *Gluma inferior* minute denticulata, saepe purpurea vel atro-violacea, 0·3-0·45 mm. longa. *Gluma superior* spiculae formam congruens et ejus apicem attingens, explanata ovato-lanceolata, acuta, aristulata (aristula 0·5-0·8 mm. longa), $\frac{1}{3}$-$\frac{2}{3}$ inferiore pilis longis plus minusve appressis dense pilosa. *Lemma inferum* gluma superiore paullo brevius, explanatum ellipticum, acutum, mucronatum, marginibus anguste hyalinis prope apicem ciliolatum, dorso parte majore pilosum; palea 0. *Anthoecium superum* ellipticum, 2·5 mm. longum, 1·1-1·2 mm. latum, acutum vel subacutum et mucrone circiter 0·7 mm. longa terminatum, stramineum, minute punctulatum. *Antherae* 1·1-1·5 mm. longae. *Caryopsis* oblongo-elliptica, utrinque obtusa, dilute olivacea, circiter 2 mm. longa, circiter 1 mm. lata.

E. australiensis Stapf ex Thell., l.c., was published with an extremely scanty description, but which is nevertheless sufficient to differentiate the species, which is characterised by the crisped margins of the rather short and relatively broad leaves as compared with the former species, the more numerous shorter racemes, the narrow long-acuminate spikelets 6-8 mm. long, and the relatively short fertile floret. The third South Australian species, *E. longiflora* S. T. Blake (1941 b, p. 18), has still larger spikelets, 9·3-11 mm. long, and short broad leaves.

Several smaller genera have now been segregated from the older concept of *Panicum*. These were used on pp. 665-667 of the First Ed. and later discussed by Black (1935, 1939). The genera *Paspalidium* and *Digitaria* are badly in need of a thorough revision; the latter genus was being studied by Henrard when war broke out. *Urochloa* is now to be omitted from the Flora, the indigenous Australian species assigned to it by Miss Hughes (1923) now being placed under *Brachiaria*. *Brachiaria* is distinguished from *Urochloa* by the adaxial position of the spikelets, so that the lower glume is turned to the axis of the raceme, not away from the axis as more commonly the case. In species with divided racemes, such as *B. praetervisa* (Domin) C. E. Hubbard, this orientation is often difficult to observe, but it has been shown by Gardner and Hubbard (1938) that if the tips of the branches be examined, the orientation is readily seen; further, that the orientation can also be determined from the lower spikelets on the lateral branchlets.

The genus *Spinifex* has now been divided into two. The genus *Zygochloa* S. T. Blake with one species, *Z. paradoxa* (R. Br.) S. T. Blake (1941 c, p. 7) has been erected for *Spinifex paradoxus* (R. Br.) Benth. The inflorescences of the two genera are very complicated in structure, but the chief differences between the genera are that the male spiklets of *Zygochloa* are paniculate in the head, not spicate as in *Spinifex*, the female heads are not spiny but provided with prominent winged "bracteoles" under the spikelets, while the upper lemma of the latter is distinctly hardened with firm more or less involute margins. *Spinifex hirsutus* Labill. remains the correct name for the coastal species, though Black (1933, p. 143), following Domin (1915, p. 333), has used the combination *S. inerme* Banks & Sol. ex Hook. f. for this plant. The latter combination is based on *Ixalum inerme* Forst., but both Mr. C. E. Hubbard and Dr. H. H. Allan have informed me that the latter is a *nomen nudum*.

Tragus australianus S. T. Blake (1941 b, p. 12) replaces *T. racemosus* All. The latter is a native of Europe introduced into many countries though not yet into Australia; it differs in that the spikelets are borne in little clusters of three or more along the main axis, not in pairs as in our plant.

The species of *Aristida* were fairly recently discussed by Black (1933, pp. 144-147) on the basis of Henrard's monumental work. Further study of the Australian forms with the aid of a greater range of material has compelled yet another arrangement of the South Australian forms.

Though he does not definitely say so, Black implies that he would prefer to regard *A. Muelleri* Henr. as synonymous with *A. Browniana* Henr., and I have been forced to the same conclusion. As in most species of the genus, the dimensions of the spikelet-parts vary considerably, and in the *A. Browniana*—*A. Muelleri* complex there is undoubtedly a complete intergrade between the dimensions as given by Henrard for the two species. The variation in one character is frequently independent of the variation in another or of differences in habit or facies. Henrard's suggestion that *A. Browniana* may be the result of hybridism between *A. Muelleri* and *A. arenaria* Gaud. cannot be accepted on field evidence. *A. Browniana* is not uncommon along the east coast of Queensland and on the adjacent islands, a very long way from the known eastern limit of *A. arenaria* or of any forms referred by Henrard to *A. Muelleri*. It may be noted that the type locality of *A. Browniana* is decidedly coastal, in the North. *A. Muelleri* appears to be an extreme form of *A. Browniana*, and there are comparable forms of *A. arenaria* with spikelet-parts larger than usual. It is not suggested that hybridism does not occur between *A. Browniana* (as understood here) and *A. arenaria*.

A. latifolia Domin. var. *minor* J. M. Black has been sunk under the type, since its dimensions come well within the usual variation of the species.

Aristida echinata Henr. and *A. muricata* Henr. are confined to a relatively small area in South Queensland and Western New South Wales, about midway between the South Australian border and the east coast. The South Australian specimens referred to these belong to a group of closely allied forms, hitherto quite inadequately understood, one of which, strangely enough, was placed by Henrard under *A. calycina* R. Br. as var. *strigosa* Henr., in spite of the fact that it has a tubular lemma, not furrowed as in *A. calycina*. This form is described below as a new species, as is also the South Australian material referred to *A. echinata* and *A. echinata* var. *nitidula*. The Mount Goolwa specimen referred by Black to the last is a duplicate type of *A. capillifolia* Henr.

Aristida strigosa (*Henr.*) *S. T. Blake*, species nova. *A. calycina* R. Br. var. *strigosa* Henr. in Meded. Herb. Leid., No. 58 A, 297 (1932) (descr. ang.); No. 54 C, 708 (1933) (descr. lat.). — Affinis *A. echinatae* Henr., sed culmis plurinodibus, foliis longis persistentibus, lemmatibus parce strigosis vel. glabrescentibus haud spinosis differt. Descriptio hic emendata et ampliata.

Gramen perenne, caespitosum, subglaucum, ca. 60-100 cm. altum. *Culmi* subrobusti, erecti vel inferne geniculatim adscendentes, 5-8 nodes, simplices vel raro e nodis superioribus parce ramosi, teretes, leviter striatuli, etiam vel punctulati vel scaberuli vel laeves, omnino glabri. *Folia* pro genere bene evoluta, persistentia; vaginae internodiis breviores vel infimae longiores, teretes, arctae vel infimae plus minusve hiantes, crebre striatae, minute asperulo punctatae vel plus minusve scaberulae, glabrae; ligulae brevissimae dense ciliatae; auriculae prominulae, incrassatae, plus minusve barbatae; collum linea angusta plus minusve incrassata notatum, pubescens; laminae diu persistentes, strictae vel curvulae, longae, usque ad 20 cm. longae et usque ad 3·5 mm. latae, plus minusve involutae vel prope basem saepe subplanae, apice setaceo-attenuatae, nervis pluribus crebre percursae quorum 5-7 primariis aliis admodum validioribus, supra scabrae, subtus et marginibus (prope apicem exceptis) laeves, vel subtus scaberulae. *Panicula* exserta, plerumque 15-25 cm. longa et (aristis inclusis) 2-3 cm. lata, densiuscula sed interrupta; rhachis plerumque visibilis, glabra, striatula, inferne subteres plus minusve laevis, sursum plus minusve angulata scabra vel scaberula; rami singuli vel subbini, rhacheos internodiis plerumque breviores, a basi divisi, cum ramulis erecti, appressi, fere filiformes, scaberuli; ramuli breves, a basi spiculigeri, saepe unispeculati; pedicello anguste clavati, trigoni, scaberuli, laterales 0·9-2 mm. longi, terminales usque ad 6 mm. longi. *Spiculae* pallidae vel atroviolaceo suffusae. *Glumae* lanceolatae, subacutae, firme membranaceae, subhyalinae, 1 nerves, rectae, cuspidatae, glabrae, 6-8·5 mm. longae, subaequales sed superior 0·7-1·5 mm. longior; inferior acuminata, carina omnino parce scabra, lateribus laevis; superior haud acuminata, altius biloba, inter lobos lanceolatos acutos aristulata, carina prope apicem et aristula scaberula, ceterum laevis. *Lemma* fusco-maculatum, glumis subbrevius, lanceolato-lineare, tubulosum, superne leviter carinatum, a lateribus leviter compressum, minutissime punctulatum, carina plus minusve scabrum et lateribus superioribus pilis albidis tenuibus appressis e tuberculis minutis ortis parce strigosum, cum callo angusto obtusiusculo 1-1·25 mm. longo breviuscule barbato 7-11 mm. longum, 0·5-0·6 mm. latum. *Columna* nulla. *Aristae* subsimiles, oblique patulae, scabrae, tenues, basem versus conspicue applanatae, 12·5-15 mm. longae.

QUEENSLAND—Gregory North District: Tulmur, 22° 30′ S., 142° 25′ E., on stony creek bank amidst *Triodia* sp., ca. 680 feet, 11 May 1936, *Blake 11451* (BRI). Gregory South District: Mount Margaret Station, near Eromanga, on stony creek bank and bed, ca. 780 feet, 3 July 1936, *Blake 11906* (BRI).

CENTRAL AUSTRALIA—Hermannsburg, 16 August 1929, *Cleland K. 21* (Cl, BRI); Horseshoe Bend, Finke River, 23 August 1931, *Ising 2355* (Bl); Maryvale, 8 January 1927, *Cleland H. 503* (Cl, BRI); Pinta Spring, 7 August 1932, *Cleland L. 13* (Cl, BRI).

SOUTH AUSTRALIA—Far North: Swallow's Creek,[1] 5 May 1942, *Tate* (AD); Arkaringa Creek, 15 May 1892, *Helms* (AD, MEL, BRI, Bl; Type; duplicate types of *A. calycina* var. *strigosa*); Aldinga, in sandy soil, 15 May 1937, *Clarke* (Bl); Cordillo Downs in watercourse, May 1924, *Cleland* (Cl, Bl).

Aristida nitidula (*Henr.*) *S. T. Blake*, species nova. *A. echinata* Henr. var. *nitidula* Henr. in Meded. Herb. Leid. No. 58 A, 285 (1932) (descr. angl.); No. 54 C, 714 (1933) (descr. lat.).—Affinis *A. platychaetae* S. T. Blake, sed culmis plurinodibus, internodiis a vaginis obtectis, foliis plus minerosis longioribus rigidioribus vaginarum ore densius barbatis, lemmatum callo aristisque brevioribus differt; ab *A. echinatae* Henr. culmis minus ramosis, foliorum laminis longioribus persistentibus eorum vaginis arctis internodiis longioribus, spiculis brevioribus, glumis laevibus nitidulisque, aristis brevioribus latioribus differt.

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[1] So reads the label; according to J. M. Black (1933, 146) the locality is probably Swallow's Waterhole, 10 miles north of Oodnadatta.

Gramen perenne, caespitosum, foliosum, subglaucum, 20-40 cm. altum. *Culmi* erecti, stricti, graciles, glabri laevesque, simplices vel ramosi, 3-6-nodes, internodiis brevibus summo longo excepto. *Folia* plura, longa, subsetacea, subglaucescentia; vaginae arctae vel basales tandem patentes, internodiis (summo excepto) longiores, obscure pauci-striatae, asperulae, ore barbatae ceterum glabrae; auriculae obscurae, glabrae; collum glabrum; laminae flexuosae, setaceo-involutae vel -convolutae raro basi planae, 9-13 cm. longae (summa vix abbreviata) et 0·6-0·8 mm. latae (explanatae usque ad 2 mm. latae), supra hirtellae subtus scabridae vel sublaeves. *Panicula* tandem longe exserta, linearis, 13-25 cm. longa, circiter 1·5 cm. lata (aristis inclusis), sparsiflora; rhachis inferne angulata laevis, sursum plus minusve applanata et scaberula, omnino glabra striatula visibilis; rami bini erecti, rhacheos internodiis breviores et ad ea appressi, sparse divisi vel simplices, angulato-filiformes, scaberuli, a basi fere spiculigeri; pedicelli filiformes, scaberuli, apice vix incrassati, terminales usque ad 9 mm. longi, laterales brevissimi vel subnulli. *Spiculae* erecti, pallidae vel plus minusve atroviolaceae. *Glumae* tenuiter membranaceae, 1-nerves, nitidae, subaequales, normales vel interdum inversae; inferior lanceolato-linearis, acuta, cuspidata, carina nonnunquam scabra ceterum laevis, 7·1-10·3 mm. longa; superior linearis, anguste obtusa, saepe emarginata, mucronulata, laeves, 7·9-10·1 mm. longa, inferiore usque ad 0·8 mm. longa vel ad 0·2 mm. brevior. *Lemma* anguste lineare sursum vix vel haud angustatum, tubulosum marginibus convolutum, dorso prominule carinatum, atro-maculatum, basem versus punctulatum, ceterum pilis crassis conicis hyalinis albidis saepe creberrimis antrorsim spinulosum, basi in callo abruptius angustato, cum callo 6·5-9·4 mm. longum, glumis brevius; callos angustus haud pungens (basi late rotundus) 0·9-1·1 mm. longus, pilis brevibus usque ad 1·1 mm. longis barbatus. *Columna* nulla. *Aristae* similes, subaequales obliquae, rigidae, rectae sed saepe leviter tortae, tenues sed latae, planae vel leviter concavae, scabrae et scaberulae, supra basem versus fere hirtulae, 11-18 mm. longae, medialis lateralibus usque ad 1 mm. longior.

WESTERN AUSTRALIA—Eastern Division: Victoria Desert, on sandstone, 4 September 1891, Helms (AD, BRI, MEL, NSW). Central Division or Eucla Division: Fraser's Range, on gneissic formation, 23 October 1891, *Helms* (AD, MEL).

CENTRAL AUSTRALIA—Lander's Creek near Mount Thomas, 10 August 1931, *Cleland H. 312* (Cl, Bl); Alice Springs, 7 August 1929, *Cleland K. 22* (Cl), July 1922, *Allen 566* (NSW, BRI), Heavitree Gap, 29 May 1935, *Cleland* (Cl); Hermannsburg, 11 August 1929, *Cleland H. 103* (Cl); Haast's Bluff, 20 August 1932, *Cleland L. 12* (Cl, BRI; TYPE); John's Creek (AD).

SOUTH AUSTRALIA—Far North-west: Ernabella, Musgrave Range, 16 August 1933, *Cleland* (Cl, Bl, BRI); rock-hole 10 miles north of Ernabella, 16 August 1933, *Cleland* (Bl); near Mount Goolwa, south of Musgrave Ranges, on diorite rock, 18 June 1891, *Helms* (AD). Far North: Finniss Springs, 21 December 1926, *Warren* (Bl); 7 miles south-west of Maree, 26 August 1934, *Cleland* (Bl, BRI); Mount Parry Gap, April 1883, *Tate* (AD); Aroona Range, stony hill slopes (AD); Moolooloo, October 1915, *S. A. White* (Bl); Mount Chambers Gorge, 30 May 1937, *Cleland* (Cl); north of Baretta, 3 December 1930, *Cleland H. 8* (Cl, BRI).

QUEENSLAND—Burke District: Selwyn, on stony ground, ca. 1,250 feet, 25 June 1934, *Blake 6405* (BRI). Gregory North District: Elderslie, west of Winton, on upper part of Mount Booka Booka, among quartzitic rocks, ca. 750 feet, 29 October 1935, *Blake 10050* (BRI).

While I have not seen a representative of the type collection of Henrard's variety, there are several specimens in the Cleland Herbarium determined by Hubbard and apparently compared with the duplicate-type; one of these, from near

the original locality, has been chosen for the type of the species. The spikelets are very similar to those of *A. echinata* Henr., except that the glumes are shining, smooth or nearly so, and the lemmas are shorter with shorter and broader awns. In vegetative characters, however, the species is very distinct in being less branched, more leafy, and with the leaf-sheaths longer than the internodes.

The three species, *A. capillifolia*, Henr., *A. nitidula* (Henr.) S. T. Blake, and *A. strigosa* (Henr.) S. T. Blake, are closely allied and sometimes resemble one another to some extent. *A. capillifolia* is distinguished particularly by the extremely slender culms, leaves, lemmas, and awns; the culms are usually fastigiately branched from the lower nodes; the lemma is scabrous on the keel and sometimes also on the sides with small slender hairs; the callus, only $\frac{3}{4}$ mm. long, is the shortest of all South Australian species and is also only shortly bearded. *A. strigosa* is the tallest and stoutest species; in spikelet-characters it resembles the former, but the lemma is stouter, bearing appressed tubercle-based hairs which are sometimes reduced to the tubercles, and the considerably longer callus (1-$1\frac{1}{4}$ mm. long). *A. nitidula* is especially distinguished by the usually simple or nearly simple culms densely covered with leaf-sheaths, the sheaths and blades more or less scabrous and sometimes strongly so, in the stout, very spiny lemmas not perceptibly narrowed in the upper part, and by the extraordinarily broad and flat awns; elongated specimens sometimes approach *A. capillifolia* in appearance.

Most of the Australian species of *Sporobolus* have been discussed elsewhere (Blake 1941 b, p. 3-12 and p. 22). *S. Mitchellii* (Trin.) C. E. Hubbard (1941, p. 26) replaces *S. virginicus* var. *pallidus* Benth., being a species quite distinct from *S. virginicus* (L.) Kunth in habit, foliage, and detailed structure of inflorescence and spikelet. *S. capensis* Kunth replaces *S. indicus* (L.) R. Br., which name is properly applied to a species not known to occur in Australia. *S. Caroli* Mez has to replace *S. Lindleyi* (Steud.) Benth.; the latter is based on *Vilfa Lindleyi* Steud., a name-change for *Sporobolus pallidus* Lindl., which was described from a specimen of *Eragrostis japonica* (Thunb.) Trin.

The Australian species previously referred to *Pappophorum* are now placed under *Enneapogon* (see Black, 1938, p. 352) and have recently been revised in an excellent paper by Burbidge (1941). I am indebted to Miss Burbidge for a type-written copy of her key and notes and other assistance while engaged in working up the South Australian forms before her paper was published. Nineteen species are now recognised as occurring in Australia, of which seven occur in this State, though none are restricted thereto.

Plectrachne Helmsii C. E. Hubbard (1941, p. 29) replaces *Triraphis bromoides* F. Muell., which is *Plectrachne bromoides* (F. Muell.) C. E. Hubbard. *Plectrachne* differs from *Triraphis* in the *Triodia*-like habit and firmer, several-nerved, 3-awned lemmas; it is close to *Triodia*, but the lobes of the lemma are elongated and awn-like, while the upper lemmas are sterile and reduced to a bunch of awns as in *Triraphis*.

The genus *Eriachne* includes a large number of species, chiefly restricted to Australia; it was being studied by Mr. W. Hartly, of the C.S.I.R., Canberra, who has kindly given permission to use his manuscript name *A. Benthamii* for the form previously placed as a variety of *E. ovata* Nees.

E. scleranthoides F. Muell. has been omitted from the Second Edition, as an examination of the type in herbarium Melbourne has convinced me that this species has not been collected since its original discovery at Mount Olga, Central Australia, by Giles in 1875. The specimens generally referred to *E. scleranthoides* represent reduced or stunted states of *E. mucronata* R. Br. with short, closely-branched culms densely covered by leaf-sheaths and with inflorescences of few

spikelets. This state is very different from typical *E. mucronata* which has longer less-branched culms with exserted nodes, but the two are connected by a complete series of intermediate forms. *A. scleranthoides* var. *elongata* Benth., of which I have seen duplicate-types, is also a form of *E. mucronata*. The true *E. scleranthoides* is a very distinct species of different habit with villous intricately-branched culms, tiny leaves more or less flat in their lower part, and smaller spikelets with the lemmas acute, not acuminate in profile. *E. Helmsii* Domin is a species allied to *E. mucronata*, but differs therefrom in that the base of the plant is prominently woolly as are usually also the lower internodes, the leaves are flatter, the spikelets are larger on shorter pedicels, and the lemmas are longer than (not subequal to) the glumes, acute and not abruptly acuminate in profile. The type was collected by Helms on sandstone in the Victoria Desert, camp 40, Western Australia, on 4 September 1891, and is represented in the Tate Herbarium. The same form was also described by Domin (1915, p. 359) as *E. mucronata* var. *villicalmis* Domin, and on p. 361 as *E. mucronata* var. *Helmsii* Domin. *E. ovata* var. *pedicellata* J. M. Black (1922, p. 565) is also based on a specimen of *E. Helmsii;* the other South Australian specimens were included under *E. mucronata* in the First Edition.

The shape of the lemma in profile and its length relative to the glumes are very useful characters for distinguishing species in the genus.

Eragrostis Clelandii *S. T. Blake;* species nova, affinis *E. lanipedi* C. E. Hubbard, sed culmis 4-8-nodibus, vaginis internodiis plerumque longioribus, laminis angustioribus, lemmatibus brevioribus differt.

Gramen perenne, caespitosum, viride, erectum, 20-30 cm. altum, basi bulbosa-incrassatum lanatum. *Culmi* teretes, simplices, graciles, stricti vel inferne leviter geniculati, plerumque 4-8 nodes, tenuiter striati, glabri, laeves vel admodum asperuli, basi squamis pallidis multis dense breviterque lanatis obtecti. *Foliorum vaginae* arctae, striatae, scaberulae vel fere laeves, ore pubescentes nonnunquam etiam sparse barbatae, marginibus plerumque ciliolatae, ceterum glabra, internodiis longiores vel interdum eis breviores, inferiores in squamis basalibus mutatis; laminae oblique patentes, curvulae, breves sed interdum usque ad 10 cm. longae, inferiores brevissimae, plerumque arcte setaceo involutae, explanatae 1-1·5 mm. latae, supra hirtellae, subtus scaberulae. *Panicula* tertiam partem plantae occupans, oblonga vel anguste pyramidalis, laxa; rhachis inferne teres sursum complanata vel angulata, glabra, majore parte laevis; rami solitarii distantes, patentes vel dellexi, rigidi, admodum flexuosi, sursum scaberuli, inferiores usque ad 3 cm. longi, a basi divisi; ramuli pauci, brevissimi. *Spiculae* sessiles, patulae, purpureae, singuli vel 2-4-ni glomerati, late oblongae, obtusae, compressae, vix sulcatae, 3-5 mm. longae, 2-3 mm. latae, 7-12-florae; rhachilla fere recta, robusta, haud articulata, internodiis ca. 0·5 mm. longis. *Glumae* subaequales, ca. 1·25 mm. longae, obtusissimae, 1-nerves, ciliolatae, superior mucronata. *Lemmata* arcte imbricatae admodum patulae, 1·75-2 mm. longae, a latere visae fere semiorbiculares, explanatae suborbiculares obtusissimae, mucronatae, lateribus laeves, marginibus inferioribus longiuscule ciliatae, nervis subtenuibus sed prominulis, carina sursum scaberula, nervis lateralibus inter carina marginibusque aequidistantibus admodum curvulis. *Palea* obovata fere truncata, ¾ lemmatis aequilonga, carinis et margine superiore pilis tenuibus mollibus longiusculis densiusculis ciliata. *Stamina* 3; antherae 1 mm. longae. *Caryopsis* ignota.

South Australia—Far North-west: Ooldea Soak, 17 August 1939, *J. B. Cleland*, (BRI, CI).

This species, dedicated to its discoverer, is easily distinguished by the short broad spikelets scattered or in distant small clusters, and the very broad mucronate lemmas bearded along the margins in the lower part. There is, unfortunately, no

ripe grain in the fine series of specimens collected by Prof. Cleland. Amongst South Australian species, it seems closest to *E. eriopoda* Benth. and *E. laniflora* Benth., differing from both in the shape of spikelet and lemma and the less densely woolly base of the plant, and from the former also in the densely bearded lemmas.

Twenty-one species of *Eragrostis* are now known to occur in South Australia, some of which have been discussed by Black in various papers (1924, p. 253; 1931, p. 136-7; 1933, p. 147-148; 1935, p. 252). The species are very difficult to discriminate and circumscribe, and the usual arrangement based on the shape of the spikelets proved impracticable. The degree to which the lemmas spread varies considerably in some species, sometimes even on the same specimen, and this results in a corresponding variation in the tereteness or flattening and often in the presence or absence of furrowing of the spikelet. The lemma itself provided very useful characters, and the shape of this organ, either flattened or in profile, taken in conjunction with the nervature, served to distinguish two difficult groups. As a general rule lemmas which were broadest at or about the middle were very obtuse and had the lateral nerves midway between the midnerve and the margins, whereas those broadest distinctly below the middle are much narrowed towards the more or less acute tip and have the lateral nerves close to the margins. Doubtful cases were eliminated earlier in the key. The shape of the grain is, on the whole, very constant, but as it is rarely seen in *E. setifolia* and allied species and is unknown in *E. Clelandii* and *E. infecunda*, it cannot be used as a leading character. The length of the anthers is usually a very constant character for each species, though for obvious reasons it has not been used in the key. But for reference purposes it might be interesting to mention that small anthers, 0·25 mm. long or less, are characteristic of *E. japonica* (Thunb.) Trin., *E. confertiflora* J. M. Black, *E. Kennedyae* Turner, *E. leptocarpa* Benth., *E. parviflora* (R. Br.) Trin., *E. Basedowii* Jedwabnik, *E. elongata* (Willd.) Jacq., *E. lacunaria* F. Muell. ex Benth., and *E. Barrelieri* Daveau; medium-sized anthers, 0·4-0·6 mm. long, are confined to *E. falcata* Gaud., *E. Dielsii* Pilger, and *E. ciliaenensis* (All.) Link ex Lutati; large anthers, mostly 0·75 mm. long or more and up to 1·5 mm. long are found only in *E. Clelandii* S. T. Blake, *E. laniflora* Benth. *E. eriopoda* Benth., *E. setifolia* Nees, *E. xerophila* Domin, *E. infecunda* J. M. Black and *E. australiensis* (Steud.) C. E. Hubbard. *E. speciosa* (R. & S.) Steud. has anthers 0·25-0·4 mm. long, intermediate between the first and scond groups.

In the Second Edition, *E. parviflora* (R. Br.) Trin. replaces *E. pilosa* (L.) Beauv. with which it was united in the Flora Australiensis, but *E. pilosa* differs in having hairs in the axils of the lower panicle branches, longer pedicels, more prominently nerved and more acute lemmas and more compressed grain. It is a native of the Mediterranean region, whence it has been introduced to many countries but not yet to South Australia. *E. elongata* (Willd.) Jacq. and *E. Brownii* (Kunth) Nees are often difficult to distinguish. Unfortunately Domin (1915, p. 399) misidentified *E. elongata* with *E. Brownii* and accordingly sunk the latter under the former, at the same time keeping as distinct *E. diandra* (R. Br.) Steud. This treatment was followed by Black (1933, p. 147). Mr. C. E. Hubbard has recently studied the types of these species, and he has informed me that *E. diandra* is conspecific with *E. elongata* and must therefore be regarded as a synonym of the latter, while *E. Brownii* is a distinct species. The latter, as at present understood, is quite a variable species, but the description in the Second Edition is based on South Australian specimens.

The group of species including *E. trichophylla* Benth., *E. falcata* Gaud., *E. lacunaria* F. Muell. ex Benth., *E. Rankingii* F. M. Bail. and *E. Dielsii* Pilger seems frequently to have caused considerable difficulty. In the Flora Australiensis, *E. falcata* embraced the form described many years later by Pilger (1904) as *E. Dielsii*. Domin (1915, p. 392) placed *E. lacunaria* and *E. Rankingii* as

synonyms of *E. falcata*. Miss Vickery had become convinced that *E. falcata* and *E. lacunaria* were distinct species with distinct areas of distribution, and kindly placed at my disposal her notes and the specimens in the Sydney Herbarium. There seems no doubt that Miss Vickery is correct, and that these species are quite distinct. *E. falcata* is especially characterised by the obliquely spreading spikelets with subtruncate lemmas broadest about the middle with the nerves equally distributed, anthers 0·5-0·65 mm. long, and dorso-ventrally compressed grain; it is confined to Western, Central, and South Australia. *E. lacunaria*, on the other hand, has the spikelets nearly divaricately spreading with the lemmas broadest distinctly below the middle and distinctly narrowed upwards with the lateral nerves approaching the margin, anthers about 0·25 mm. long, and prominently laterally compressed grain; it occurs along the River Murray, but is otherwise restricted to the Eastern States. Both species may be glabrous or with hairy culms and leaves. *E. trichophylla* was described from specimens collected north of Fowler's Bay by Giles in 1875, and to judge from a piece of the type in herbarium Sydney and a duplicate type in herbarium Melbourne, it is a hairy form of *E. falcata*, and is here formally reduced to a synonym of the latter species. *E. Rankingii*, described from Queensland specimens, is conspecific with *E. lacunaria*. *E. Dielsii* is closely allied to *E. falcata*, but has more nearly sessile and often coarser spikelets, rather larger, much thinner concavo-convex grain, a different appearance, and is usually an annual. The lemmas are commonly tightly imbricate and the spikelet is then terete, but frequently they become looser with the spikelet then somewhat compressed or even furrowed. Small specimens with such spikelets constitute *E. Dielsii* var. *Pritzelii* Pilger, l.c., to judge from duplicate types in herbarium Sydney, but individual specimens may show such a range of variation in this respect that it seems impracticable to uphold the variety.

The name *E. major* Host has been shown by Sprague and C. E. Hubbard (1933) to be illegitimate. There are two other rival names for the species, *E. megastachya* Link, Hort. Berol. i, 187 (1827), and *E. ciliaiensis* (All.) Link ex Lutati in Malpighia, 18, 386 (1904), based on *Poa ciliaiensis* All. Fl. Pedem. 2, 246, t. 91, f. 2 (1785). According to authors who have seen Allioni's work, this species was published with a poor description and a worse figure. Henrard (1940, p. 420-422) argues, but not very convincingly, that they refer to a true *Poa*, and suggests that the type specimen has been lost and that the name should be rejected as a *nomen ambiguum*. But according to F. T. Hubbard (1913), Lutati saw the specimen in the Herbarium of Balbis who acquired Allioni's herbarium after the latter's death. Under these circumstances, and following the advice of C. E. Hubbard, the name *E. ciliaiensis* (All.) Link ex Lutati has been taken up for the Flora.

Glyceria ramigera F. Muell. ex Benth. has been transferred to *Eragrostis* as *E. australasica* Steud. Syn. Glum. 1, 286 (1854). *Poa ramigera* F. Muell. in Trans. Vict. Inst., 45 (1855) is another synonym. Its shrubby habit gives this grass a peculiar appearance, but it agrees with *Eragrostis* in the 3-nerved lemmas, in the structure of the grain, and in the anatomy of the leaf. Mr. Hubbard tells me that in habit it resembles some African species.

Glyceria Fordeana F. Muell. has been referred to *Poa* as *P. Fordeana* F. Muell. because the free lodicules, the grain adnate to the palea, and the indumentum of the lemma appear to accord better with this genus. The Australian species of *Poa* are badly in need of a revision, but the lack of time and inaccessibility of many types has prevented this being accomplished for the Flora. There seem to be several species in South Australia. True *P. caespitosa* Forst. is probably confined to New Zealand.

No revisional work on *Stipa* or *Danthonia* was done by me. *Deyeuxia* and *Agrostis* have been recently revised by Vickery (1940, 1941).

CYPERACEAE

So many changes in this family were found to be necessary, that the whole account has been re-written. The order of the genera in the First Edition has been retained, though it differs from that usually accepted at the present day.

The genus *Cyperus* has recently been monographed by Kükenthal (1935), and in this work the genus *Kyllinga* has been united with *Cyperus*. This seems a logical act, for although characteristic species of *Kyllinga*, such as those found in Australia, are very well marked off from those of characteristic *Cyperus*, there is a large proportion of intermediate species. The single South Australian species affected is *C. brevifolius* (Rottb.) Suringar, based on *K. brevifolia* Rottb. *K. intermedia* R. Br. is sometimes regarded as distinct and has been kept up as a variety by Kükenthal as *C. brevifolius* var *stellulatus* Suringar, but the alleged differences between the two are so inconstant and occur in so many combinations, that it seems quite impracticable to distinguish the two forms.

C. exaltatus Retz. var. *minor* J. M. Black was based on a starved specimen and has been sunk under the typical form of the species.

C. rotundus L. and its allies have been the subject of a recent paper (Blake, 1942), in which it has been shown that this name has been used for many different species in Australia. *C. rotundus* is purely a weed of agricultural areas, but two distinct inland species occur in this State, namely, *C. victoriensis* C. B. Clarke and *C. bulbosus* Retz. The last is noteworthy on account of the irregularly corymbose inflorescence; the record of *C. subulatus* R. Br. in the First Edition, taken from the Flora Australiensis, refers to this species.

C. vaginatus R. Br. and *C. gymnocaulos* Stend. have frequently been considered to be conspecific (as in the First Edition) or else the latter has been considered to be a subspecies (*C. vaginatus* R. Br. subsp. *gymnocaulos* (Steud., Kükenth.)) or variety (*C. vaginatus* var. *densiflorus* Benth.) of the former. In general, the two species are readily distinguishable as the following table indicates:

	C. vaginatus	*C. gymnocaulos*
Stems - - -	Cylindrical, only faintly striolate.	More or less trigonous, at least at top, rather distinctly striate.
Bracts - - -	Numerous, mostly 5-8, firm but not particularly rigid, not pungent, flat, 2-6 mm. wide, up to 15 cm. long, always more than 5 cm. long.	3-4, usually less than 5 cm. long, very rigid and pungent with incurved margins.
Inflorescence - -	Umbel-like with elongated rays bearing digitate clusters of spikelets.	Capitate or umbel-like with 1-4 short rays bearing globose heads of spikelets.
Spikelets - -	Linear or oblong-linear, 8-18 mm. long, 2-2¾ mm. wide.	Ovate to lanceolate-ovate, 3-5½ mm. long, 2½-3 mm. wide.
Glumes - - -	About 2 mm. long, rigid.	2-2¾ mm. long, thinner and less rigid.
Nut - - - -	¾ mm. long.	1-1¼ mm. long.

However, particularly from South Australia, several specimens seen are intermediate in appearance; the species may hybridise to some extent, but definite

field evidence is lacking and the specimens seen are mostly too immature or otherwise imperfect for critical study. Kükenthal (1935, p. 190) has described a *C. vaginatus* var. *pseudotextilis* Kükenth. but the specimens I have seen from the collections cited agree exactly with R. Brown's description.

C. flabelliformis Rottb., a native of Africa but cultivated in many parts of the world, has been found naturalised at Waterfall Gully by J. B. Cleland on 9 April 1942.

C. congestus Vahl, a native of South Africa but introduced to Western Australia and New South Wales, has been found in South Australia as a garden weed at Burnside by J. B. Cleland, February 1940. It has sometimes been mistaken for *C. rotundus*, but no tubers are produced and the stems are usually tufted.

C. clarus S. T. Blake (1940a, p. 44) has been added on the evidence of an imperfect specimen in a very young flower collected by Miss Staer at Oodnadatta in June 1914. The specimen is too poor for certain determination and comes from a locality far distant from any other known for the species, but looks more like this than any other.

C. rutilans C. B. Clarke replaces the record of *C. alterniflorus* R. Br. The latter species is known only from a very few specimens from widely separated localities in Western Australia, Western New South Wales, and Queensland, and is a much coarser, densely tufted plant with differently shaped spikelets, glumes, and nuts.

C. rigidellus (Benth.) J. M. Black has been discussed elsewhere (Blake, 1940a, p. 43); it includes the specimens referred in the First Edition to *C. enervis* R. Br. and *C. enervis* var. *laxus* R. Br. What may be a duplicate-type is in the Tate Herbarium.

The name *C. laevigatus* L. has now been used to cover all Australian forms which have been referred to this species and to *C. distachyus* All. After studying authentic specimens of these species from the Mediterranean region, I can find little difference between them and the Australian specimens seem to be intermediate.

The Australian plant frequently known as *C. Eragrostis* Vahl (1806) not of Lam. (1791) has now to be called *C. sanguinolentus* Vahl. Like so many annual species of *Cyperus* this species varies greatly in stoutness and degree of development according to the amount of available water. In wet places the plants are often above 30 cm. high with rather stout stems and well developed umbel; in places which dry out rapidly the plants are often quite tiny with very slender stems and inflorescences reduced to a single cluster of very few spikelets. It was on such plants as these that *C. Eragrostis* var. *pauperata* J. M. Black was based; the variety is not upheld in the Second Edition.

The genus *Schoenus* has also recently been revised by Kükenthal (1938), but several species were scarcely known to him. Some species have still more recently been discussed by Black (1939, 1940) and Blake (1940a).

Specimens of two species hitherto unrecorded for South Australia were found in the Tate Herbarium. One of these, *S. humilis* Benth., is without label, but is presumably from South Australia; otherwise the species is restricted to Western Australia. The second species is *S. nanus* (Nees) Benth., collected at Golden Grove in June 1878, presumably by Tate; this species ranges from Western Australia to Victoria.

S. Carsei Cheesem. was originally described from New Zealand specimens in Man. N. Zeal. Fl. 781 (1906), and its discovery in South Australia is only one of the many interesting finds of Professor J. B. Cleland. Cleland's specimens were first described by Black (1928, p. 225) as *S. monocarpus* J. M. Black; he

later (1929, p. 261) transferred the species to *Cladium*, and as such it appeared in the First Edition, p. 678, and still later (1934, p. 168) transferred it to *Tetraria*. The rhachilla of the spikelet is elongated and curved over the fertile flower but not conspicuously so, and the other characters are also those of *Schoenus*. Kükenthal, l.c., p. 69, treated the South Australian form as *S. Carsei* var. *monocarpus* (J. M. Black) Kükenth., but I can find no difference between the specimens from South Australia and those from New Zealand.

Without having seen the specimens Kükenthal (1938, p. 88) suggested that the South Australian record of *S. sculptus* Boeck. might really refer to the closely allied *S. latelaminatus* Kükenth. from Victoria and New South Wales, but my examination of the specimens has convinced me that Black is correct in referring them to the western *S. sculptus*.

S. Tepperi F. Muell. is regarded by Kükenth. as a var. of *S. breviculmis* Benth. I have seen no specimen of the latter, but the description suggests that it is distinct.

The curious and distinctive little *S. discifer* Tate had not been collected since the original discovery on Dudley Peninsula, Kangaroo Island, in November 1883, until Prof. Cleland found it at Mount Compass on 26 October 1940.

On the grounds of priority, *S. subaphyllus* Kükenth. (1938, p. 179) replaces *S. aphyllus* Boeck. (1874) non Vahl (1806).

Tetraria capillaris (F. Muell.) J. M. Black (1934, p. 169) replaces *Cladium capillaceum* (Benth.) C. B. Clarke. The glumes distichous or nearly so, the lower flower alone barren when the spikelets are more than 1-flowered, and the occasional presence of minute hypogynous bristles are characters at variance with *Cladium*, and together with the prominent style-base persistent on the ripe nut agree better with *Tetraria* than with any other genus, though the habit does not. The species extends at least from Tasmania to the high mountains of North Queensland; it occurs apparently also in Western Australia and New Zealand, but the specimens so far seen from these places are often stouter than the others.

In the genus *Scirpus* six additional species now appear, while one, *S. supinus* L., has been omitted since there is still no record of this species or its poorly understood immediate allies from the State. The genus has been the subject of recent work by A. A. Beetle (1941, 1942) and myself (1937, 1940 b). Beetle's work has been of the greatest importance in fixing the identity of the larger Australian species and their relationships with the American forms. It is now evident that the Australian plant commonly known as *S. lacustris* L. or *S. lacuster* L. is really *S. validus* Vahl. The former species is restricted to Europe with a variety extending into Asia, while the latter is restricted to the countries bordering on the Pacific Ocean. *S. validus* differs from typical *S. lacustris* in the smooth, not scabrous outer involucral bracts, non-reddish glumes, and constantly 2-fid styles; and from *S. lacustris* var. *tabernaemontani* (Gmel.) Doll. (= *S. tabernaemontani* Gmel. to which Kükenthal refers the Australian plant in Engl. Bot. Jahrb., **59**, 51, 1924) in the stouter stems, usually more numerous spikelets with less viscid glumes and distinctly scabrous rays. Further, the plants referred to *S. maritimus* L. are recognised as belonging to two distinct species, namely, *S. maritimus* L. and *S. fluviatilis* (Torr.) A. Gray. The description of *S. maritimus* in the First Edition refers to the latter species. True *S. maritimus* is a smaller and more slender plant with narrower leaves, fewer spikelets, 2-branched style and larger strongly compressed nut with only two hypogynous bristles. It is more characteristic of saline ground than in *S. fluviatilis*.

My papers cited above deal with the section *Isolepis* as understood by Bentham (1878, p. 323), which is represented in Australia and New Zealand by a bewildering series of closely allied species, most of which are very small and

some of which are not yet satisfactorily understood. The eleven South Australian species are (relatively) fairly easily distinguishable, provided ripe fruit and a good lens are both available, but the determination of flowering specimens requires particularly careful observation and some considerable experience in the group. *S. nodosus* Rottb. stands out from the others by reason of its stout rigid habit. *S. productus* C. B. Clarke has been admitted as distinct from *S. fluitans* L., and with ripe fruit the species are readily distinguishable, the former having a distinctly thickened edge to the nut while that of *S. fluitans* thins from the middle to the edge. Well-prepared specimens of *S. productus* are strongly coloured with purple, particularly on the leaf sheaths and glumes, while in *S. fluitans* these parts are green or pallid, but it seems that the differences in colour are not quite constant. Terrestrial forms of *S. fluitans* occur (= *S. fluitans* var. *terrestris* E. Mey.) which differ greatly from the floating forms in being tufted with short stems and frequently the lower-most glume bract-like and longer than the spikelet. *S. lenticularis* (R. Br.) Poir. is probably this form. Some of Prof. Cleland's specimens show the variation from the terrestrial to the aquatic forms. No special terrestrial form of *S. productus* has been observed.

S. calocarpus S. T. Blake is the Australian representative of the European *S. setaceus* L. *S. platycarpus* S. T. Blake is very similar in appearance and has often been found mixed in collections with *S. calocarpus*, but the markings on the nuts are quite different. *S. congruus* (Nees) S. T. Blake and *S. australiensis* (Maid. & Betche) S. T. Blake have very delicate glumes and characteristically shaped nuts but have been confused with *S. cernuus* Vahl.

One very interesting introduced species is *S. hamulosus* (M. Bieb.) Steven, here recorded from Australia for the first time. The specimens seen are from the Far North (Ross's Waterhole, *J. B. Cleland*, 2 January 1927) and Central Australia (*Horn Expedition*). It is indigenous to Southern Russia and Southern Siberia, to Turkestan and Afghanistan, and has probably been introduced with camels. Kükenthal (1935, p. 502) places it under *Cyperus* (*C. hamulosus* M. Bieb.) next to *C. aristatus* Rottb., to which it bears a close superficial resemblance and of which it has the characteristic curry-like scent. But the glumes are certainly spirally arranged and the stem frequently bears a leaf above the base, characters quite at variance with those of *Cyperus*.

Very few of the numerous Australian species of *Fimbristylis* appear to occur in South Australia, and of those previously recorded, *F. Neilsonii* F. Muell. has been omitted from the Second Edition. No specimens have been seen from this State, nor indeed from anywhere near its boundaries. No specimen of *F. ferruginea* has yet been collected in South Australia, but as the species is known from the Finke River just within Central Australia, it has been retained in the Second Edition. *F. diphylla* (Retz.) Vahl, as usually understood, is a very polymorphic species, and in this sense it should be known as *F. dichotoma* (L.) Vahl. But in a preliminary paper on the genus (Blake, 1940 c) I have suggested that several distinct entities are involved, and until these are thoroughly worked out it seems best to use the commonly accepted name *F. diphylla* as the collective name for the Australian forms. The South Australian specimens so far collected have all been too immature to permit of a satisfactory comparison with other Australian forms.

The generic name *Bulbostylis* Kunth has now been conserved against *Stenophyllus* Raf. (see Kew Bull., 1940, p. 91). Accordingly *Bulbostylis barbata* (Rottb.) C. B. Clarke replaces *Fimbristylis barbata* (Rottb.) Benth. and *Stenophyllus barbatus* (Rottb.) Cooke of the First Edition (p. 92 and 677). *B. turbinata* S. T. Blake (1941 a, p. 56) replaces *S. capillaris* (L.) Britton; the South Australian specimens differ from the typical Queensland and Central Australian specimens in having slightly larger nuts and glumes, but the specimens are too old for critical examination. *B. capillaris* (L.) C. B. Clarke differs in having prominently

bearded leaf-sheaths, glabrous stems, muticous glumes and an asymmetric brown nut, and has a wide range within the tropics.

The original spelling *Eleocharis* has to be used instead of *Heleocharis* (see Kew Bull., 1940, p. 81). The Australian species were recently revised (Blake, 1939). *E. nigrescens* (Nees) Steud. is included in the Second Edition on the authority of a single collection in the Melbourne Herbarium labelled as being collected by F. von Mueller at cataracts on Mount Lofty, December 1850. The species undoubtedly occurs in North Australia and North Queensland, but otherwise is known chiefly from Tropical America and Tropical Africa. *E. pusilla* R. Br. replaces *E. acicularis* (L.) R. & S. (cited as *H. acicularis* (L.) R. Br. on p. 92). *E. pusilla* is restricted to Extra-tropical Australia and New Zealand, while *E. acicularis* has a wide range in Europe, Asia, and America, differing from the Australian plant in a number of minor points, such as the more slender rhizome, unthickened base of the stem, less obtuse glumes, and narrower, less prominently ribbed nut. The Australian and New Zealand *E. gracilis* R. Br. is also considered to differ from the European *E. multicaulis* Sm. in the well-developed creeping rhizome, the more slender harder stems, the more rigid orifice to the leaf-sheath, and in details of the nut and bristles. *Heleocharis halmaturina* J. M. Black is not a species of *Eleocharis;* the type specimens are very young, but possibly are small specimens of *Tetraria capillaris* with the inflorescence reduced to a single spikelet.

The species of *Lepidosperma* are very difficult to define, and the genus is badly in need of a thorough revision. Up to the present it has been possible only to study the South Australian species and those most closely allied thereto. In many species a good series of fruiting specimens has not been available.

L. concavum R. Br. has been omitted from the Second Edition, as no specimen of this species has been seen from anywhere near South Australia. Specimens of several species have been referred to this species, which is characterised chiefly by the flat or slightly concave very thin stems and dense, more or less pyramidal, panicle. The South Australian specimens referred to here were found to belong to either *C. congestum* R. Br. or *L. laterale* R. Br.

L. exaltatum R. Br. (1810) has been united under *L. longitudinale* Labill. (1804), as it was found impossible to distinguish two species from among the large number of specimens examined, which ranged from Western Australia to Queensland, including Tasmania.

L. laterale R. Br., as at present understood, varies widely in the Eastern States, but the South Australian specimens so far seen have not been sufficient to allow of a critical comparison.

L. viscidum R. Br. appears also to vary greatly; var. *angusticaule* J. M. Black is of uncertain status, for though it differs widely from some specimens left under the species, it appears to be connected with these by various intermediates. As in nearly all species, series of good complete fruiting specimens are required before anything approaching a final decision can be reached.

L. tortuosum F. Muell. is admitted to the Flora on the evidence of a few immature specimens collected by J. B. Cleland at Breakneck River, Kangaroo Island, on 26 January 1940. These appeared to be conspecific with specimens from New South Wales which were later matched with the type. *L. lineare* var. ? *depauperatum* Benth. (1878, p. 395) is a synonym.

L. semiteres F. Muell. ex Boeck., *L. canescens* Boeck. and *L. filiforme* Labill. constitute a series of closely allied species. As the lectotype of *L. semiteres* I have chosen specimens in the Melbourne Herbarium collected by F. Mueller "in arenosis sterilissimis versus Lacum Alexandrinae" on 28 April 1848, because the label bears the name "Lepidosperma semiteres Ferd. Muell." in Mueller's writing, and

agrees best with the description published by Boeckeler, particularly in that the leaves are short; in most specimens the leaves are rather long, though shorter than the stems. The species is best distinguished by the slender leaves and stems, with the latter not much compressed and the former nearly flat. *L. canescens* was described by Boeckeler from specimens communicated by F. Mueller; a duplicate type is in the Melbourne Herbarium. The specimens were collected at Sondbug (?), apparently by Behr, and were originally labelled by Mueller as *Schoenus macrophyllus* Ferd. Muell., a manuscript name cited by Boeckeler but never otherwise published. *L. filiforme* appears to be restricted to Tasmania and the eastern half of Victoria; it differs from *L. canescens* in the more slender stems with very slender leaves and bracts hooked at the tip and the constantly reduced unbranched inflorescence.

L. caephoides F. Muell. ex Benth. is very distinctive on account of the short dense blackish inflorescence. Of the three collections in the Melbourne Herbarium so labelled by Mueller, a sheet of two specimens collected by Mueller at Lake Alexandrina has been chosen as the lectotype, as the specimens agree best with the published descriptions.

Cladium procerum *S. T. Blake*; species nova, affinis *C. Mariscо* (L.) R. Br., sed culmis robustioribus ramos gerentibus, spiculis minoribus, nuce apice obtusa haud rostrata differt.

Herba dura maxima, caespites densissimos magnos virides efformans, 2-3·5 m. alta; rhizoma squamosum, semper ut videtur breve. *Culmi* robusti usque ad 1 cm. crassi, duri, fistulosi, inferne subteretes, sursum obtuse trigoni, striolati, laeves, glabri, multinodes, e nodis superioribus vel gemmas vel ramos foliosos breves gerentes. *Folia* multa, longa, glabra, viridia; laminae planae, lineares, in apicem setaceum triquetrum longe attenuatae, tenuiter multinerves, subtus anguste carinatae, carina marginibusque sursum dense serrulato-scabrae, usque ad 2·5 m. longae, longiores 5-15 mm. latae. *Bracteae* foliis breviores angustoresque, inferiores paniculis partialibus longiores. *Panicula* linearis vel oblonga, 15-55 cm. longa, 3·5-9 cm. lata, e corymbis paucis vel pluribus constructa; rami primarii (corymborum pedunculi) solitarii, compressi; corymbi compositi vel decompositi, densi vel densiusculi, plerumque 3-7 cm. lata; ramuli ultimi filiformes trigoni, alte striati, laeves, usque ad circiter 6 mm. longi. *Spiculae* rubro-brunneae vel fulvo-brunneae, sessiles, 3-10ni (plerumque 5-8ni) in capitulis conglomeratae, supra glumis 2 vacuis parvis (vel prophyllis) deciduae, ovoideae, sub anthesi acutae sub fructu plus minusve hiantes 3·5-4·25 mm. longae, 2-florae; flores bisexuales, superior plerumque sterilis. *Glumae* ovatae vel suborbiculares, obtussissimae, concavae, 1-nerves, membranaceae, 5-6 persistentes, summa vacua majuscula, penultima maxima, inferiores 2-3 gradatim breviores vacuae. *Stamina* plerumque 2 (raro 3). *Stylus* brevis; stigmata 3 longa. *Nux* subdrupacea, ovoidea, basi rotundata, apice obtusa vel fere obtusa plus minusve rotunda nec rostrata nec acuminata, 2-2·5 mm. longa, 1·5-2 mm. lata, tandem fuscobrunnea, nitens, laevis; stylo basis cum exocarpio spongioso fusa; endocarpium durum.

WESTERN AUSTRALIA—North-West Division: Nickol Bay district, *McRae* (MEL.).

QUEENSLAND—Mitchell District: Bowen Downs, in 1874, *Birch* (MEL.). Port Curtis District: Near Mount Wheeler, on banks of creeks amongst *Pandanus*, *Thozet 815* (MEL.). Wide Bay District: Fraser Island, dominant in middle of swamp, 15 October 1930, *Hubbard 4195* (BRI.). Moreton District: Buderim, in 1907, *Wedd* (BRI.); Peel Island, December 1904, *Soutter* (BRI.); Moreton Island, in 1924, *White* (BRI.); Stradbroke Island, in open fresh-water swamps, 12 December 1934, *Blake 7137* (BRI.); Stradbroke Island, near Myora in fresh-water swamps, ca. 0 ft., 5 December 1940, *Blake 14306* (TYPE in BRI.). Darling Downs District: Wyberba, at edge of creek, 23 January 1933, *Blake 1631* (BRI.).

NEW SOUTH WALES—North Coast: Richmond River, in 1874, *Hodgkinson* (MEL.); Raymond Terrace, January 1883, *Betche 26* (MEL.). Central Districts: Duck Creek, Clyde, March 1909, *A. A. Hamilton* (BRI.); Parramatta, *Woolls* (MEL.).

VICTORIA—Gippsland: Orbost, January 1904, *Grove in herb. Pescott* (MEL.). Central District: Bank of River Yarra, near mouth, rare, January 1853, *Mueller* (MEL.). Western District: Near Cape Otway, March 1877, *Walter* (MEL.); Tower Hill near Warrnambool, January 1873, *Sullivan* (MEL.), and April 1875, *Mueller* (MEL.); Lower Glenelg River, in 1891, *Eckert* (MEL.).

SOUTH AUSTRALIA—Southern Districts: Mount Lofty Range, on streamlets, December 1847, *Mueller* (MEL.); Clarendon, December 1881 (AD.); Bridgewater, January 1904, *Black* (BI.); Blackwood, in bed of creek, 10 April 1910, *Black* (BI.); Encounter Bay, in 1895, Hussey 354 (MEL.). South-East: Mosquito Creek, 25 November 1882, Tate ? (AD.).

NEW CALEDONIA—Rio des Pirogues, in swamps, 31 October 1923, *White 2279* (BRI.); Prony, on banks of streams, in 1913, *Franc* (BRI.).

This is the plant commonly referred to *C. Mariscus* (L.) R. Br., a species which has been generally considered to be almost cosmopolitan in distribution. A recent study by V. M. Conway, in Journ. Ecol., 30, No. 1, 211-216 (1942), suggests that true *C. Mariscus* is more or less confined to Europe, East Asia, and parts of Africa, with a possible extension to South Africa, while the other forms included in it are distinct. Consequently, a more detailed study of all material available was undertaken, with the result that the Australian and New Caledonian plant is described above as a new species. It seems distinguishable from all members of the group by the branched stem and obtuse (neither beaked nor acuminate) nut. The culm, at least in its upper part, produces at the nodes vegetative buds which break through the base of the surrounding leaf-sheath and ultimately grow out into short leafy branches. So far as observed it has only a very short rhizome, very distinct from the long creeping one described for *C. Mariscus* (seen in a few specimens!) and other species.

Specimens from Hawaii have not been seen. To judge from the description in Hillebrand Fl. Hawaii 478 (1888), the Hawaiian plant, *C. leptostachyum* Nees and Meyen, differs from all other species in the group in that the stigmatic branches are 4-6 in number, due to division.

The following key will serve to show the relationships of the Australian plant:

Stigmatic branches 4-6; spikelets rather pale-coloured. *C. leptostachyum* Nees & Meyen
Stigmatic branches 2-3; spikelets brown to rusty or dark brown.
  Nut smooth, shining; partial panicles dense.
    Nut acuminate or beaked; culms not branched; rhizome long creeping. *C. Mariscus* (L.) R. Br.
    Nut obtusely rounded at tip; culms with leafy branches in upper part; rhizome short (always?). *C. procerum* S. T. Blake
  Nut rather prominently tessellately rugose; partial panicles often loose.
    Nut acuminate; common rhachis of panicle deeply canaliculate with scabrous margins; a rather slender plant from China and Japan. *C. chinense* Nees
    Nut acute but scarcely acuminate; common axis not channelled, smooth; a stout American plant. *C. jamaicense* Crantz

Possibly other species occur in America allied to *C. jamaicense*, but the specimens seen have been insufficient to determine this.

Cladium glomeratum R. Br. (1810, p. 237) is the correct name for the species so called in the First Edition, p. 95. On p. 678, following Domin (1915, p. 476), the combination *C. rubiginosum* (Forst.) Domin is used, which is based on *Schoenus rubiginosus* Soland. ex Forst. Prodr. 89 (1786). Dr. H. H. Allan, of

Wellington, New Zealand, who greatly assisted me in the study of species alleged to be common to Australia and New Zealand, has kindly sent me a copy of the relevant passage in Forster's Prodromus, a work unavailable to me. I agree with him that *Schoenus rubiginosus* is a *nomen nudum*, and therefore the combination *C. rubiginosum* is invalid. Domin cites in synonymy *Fuirena rubiginosa* Spreng. Fl. Hal. Mant., **1**, 29 (1807), of which I have been unable to obtain a copy, and so cannot determine whether this has any bearing on the question. H. Pfeiffer (1927, p. 349) has further complicated the position by making a new combination *C. glomeratum* (Gaud.) H. Pfeiff. based on *Baumea glomerata* Gaud. in Freycin. Voy. 46, t. 29 (1826), a plant of the Moluccas, but this is illegitimate because of Brown's earlier name for the distinct plant, and the Moluccan plant is properly known as *C. globiceps* C.B. Clarke in Kew Bull., Add. Ser., **8**, 46 (1908).

Pfeiffer has also (1927, p. 350; 1929, p. 261) made the combination *C. punctatum* for the plant known as *C. Gunnii* Hook. f. In 1927 the combination was based on *Schoenus punctatus* R. Br., but, as he recognised in 1929, this is a true *Schoenus* with nothing in common with *C. Gunnii*. In correcting his former treatment in 1929, Pfeiffer based the combination on "*Schoenus punctatus* Kth. Enum. **2**, 336 (1837), nec. R. Br. (Descriptio iuxta Sieber Agrosth. 19:)." Now this is wrong for three reasons: firstly, Kunth evidently misidentified Sieber's plant with Brown's species, and although his description is drawn from Sieber's plant, this does not give his description the status of that of a new species (cf. International Rules, Art. 54); secondly, even if it could be accepted that Kunth's description is that of a new species, the name is illegitimate on account of the earlier homonym of Brown, and must not be taken into account in matters of priority when a legitimate name is available (International Rules, Art. 67); and thirdly, the combination *C. punctatum* (Kunth) H. Pfeiff. (1929) (if legitimate) woud be antedated by the earlier homonym *C. punctatum* (R. Br.) H. Pfeiff. (1927).

Other synonymy cited by Pfeiffer is as follows:

Lampocarya tenax Hook. f., Fl. N. Zel., **1**, 277 (1855); *Schoenus nudus* Steud. Syn. Glum., **2**, 165 (1855); *Cladium Gunnii* and *C. laxiflorum* Hook f., Fl. Tasm., **2**, 95 (1856); *C. nudum* Boeck. in Linnaea, **38**, 236 (1874); *Gahnia sulcata* F. Muell. First Gen. Rep., **20**, (1879); *C. tenax* Druce in Rep. Bot. Exch. Cl. Brit. Isles, 1916, p. 615 (1917).

Lampocarya tenax Hook. f. was founded on New Zealand material; the specimens which I have seen from New Zealand do not match the Australian material, so this and the combination *C. tenax* (Hook. f.) Druce based on it can be eliminated from the discussion. *Gahnia sulcata* F. Muell. appears in a list only, is a *nomen nudum*, and can also be eliminated. *Cladium nudum*, to judge from a duplicate type in the Melbourne Herbarium and from Boeckeler's description, with which it agrees, is a distinct though closely allied species from the extreme south-east part of Queensland and North-east New South Wales. *C. Gunnii* Hook. f. and *C. laxiflorum* Hook. f. certainly appear to be conspecific, and were published simultaneously. Since these two species were first united by Bentham (1878, p. 408), his choice of name, *C. Gunnii* is the correct name for the southern Australian species generally known by this name.

Pfeiffer has also (1929, p. 259) treated as a new combination *C. tetragonum* H. Pfeiff. based on *Lepidosperma tetragona* Labill., but this combination was made seven years earlier by Black; the correct citation for the species is *C. tetragonum* (Labill.) J. M. Black, Fl. S. Aust., **1**, 95 (1922).

C. Huttonii T. Kirk is an addition to the Flora. The species was originally described from New Zealand, and it was Dr. Kükenthal who first drew my attention to the identity of some Queensland specimens with this species. The South

Australian specimens match those I have seen from New Zealand very closely, but the Queensland ones differ in a few very minor points. The species probably occurs in Victoria and New South Wales, but I have not yet seen specimens from these States.

C. gracile J. M. Black appears to be conspecific with *C. laxum* (Nees) Benth. and must be reduced to synonymy under the latter. It was described (Black, 1929, p. 261) from small, poorly developed specimens collected at Breakneck River, Kangaroo Island, by J. B. Cleland, 5 March 1929, but larger well-developed specimens collected more recently are indistinguishable from specimens of the type-collection of *C. laxum* in the Melbourne Herbarium, originally described as *Chapelliera laxa* Nees in Pl. Preiss., **2**, 76 (1846-1847). The spikelets in specimens from both Western Australia and South Australia appear to be either 1- or 2-flowered, whereas those of *C. laxum* was originally described as being 2-3-flowered, and those of *C. gracile* as 1-flowered.

Gahnia hystrix J. M. Black is a very curious little species from Kangaroo Island and has the shortest stems and smallest inflorescence of the genus. The spikelets are sometimes 2-flowered, though given as only 1-flowered in the original description. The large flowering glume is peculiar for *Gahnia*, but the other spikelet-characters are those of this genus.

In *Carex* I have had very great assistance from Mr. E. Nelmes, of the Royal Botanic Gardens, Kew, who has been making a special study of the Australian species of this large and difficult genus. *C. chlorantha* R. Br. has been omitted from the Second Edition, and *C. fascicularis* Boott is admitted as distinct from *C. pseudocyperus* L. of the Northern Hemisphere. *C. Bichenoviana* Boott is treated as being distinct from *C. pumila* Thunb., differing chiefly in the usually taller stems, the more numerous male spikes, the shorter, differently-shaped utricles, and the usually differently-coloured glumes; no specimen with mature nuts has yet been seen. The South Australian specimens of *C. pumila* differ from the prevailing form of this species in the elongated stems, and approach *C. Bichenoviana* in appearance. The group of forms allied to *C. inversa* R. Br. is still not satisfactorily understood, but *C. inversa* and var. *major* Boott are recorded for the State. A form allied to *C. inversa* but with nearly nerveless utricles has been collected by Cleland in the National Park, 30 December 1939, and perhaps represents another species, but the specimens are incomplete, and until the group is better understood the collection has been included with *C. inversa*.

In accordance with modern practice, the term "spike" is used instead of "spikelet"; the partial inflorescence in this genus is now considered to consist of spikes of 1-flowered spikelets.

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THE HYDROLOGY OF THE HUNDRED OF BELALIE, COUNTY VICTORIA, SOUTH AUSTRALIA, AND ITS SIGNIFICANCE IN SOIL CONSERVATION AND FLOOD CONTROL

By C. G. STEPHENS, M.Sc., A.A.C.I.

Summary

During 1941 a survey of the soils, erosion position and land-use in the eastern half of County Victoria was carried out by members of the Soils Division of the Council for Scientific and Industrial Research. Aerial photographs with a scale of 1" == 20 chains were used as working plans in the field and on these were marked the data collected, including the stream pattern and the positions of the watersheds. On the accompanying map (fig. 1) is shown the stream pattern and the watersheds of the Hundred of Belalie.

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[Read 10 June 1943]

During 1941 a survey of the soils, erosion position and land-use in the eastern half of County Victoria was carried out by members of the Soils Division of the Council for Scientific and Industrial Research. Aerial photographs with a scale of 1″ = 20 chains were used as working plans in the field and on these were marked the data collected, including the stream pattern and the positions of the principal watersheds. On the accompanying map (fig. 1) is shown the stream pattern and the watersheds of the Hundred of Belalie.

From the location of the watersheds as shown on the map and from the contour map (fig.2), it is apparent that physiographically the Hundred of Belalie is composed of alternate ridges and valleys which are orientated approximately in a north-south direction. The ridges of which the Bundaleer Hills and the Brown Hill Range are the highest are up to 1,000 feet above the valley floors, with an average difference in elevation of about 400 feet. Jamestown and Belalie North are respectively 1,495 and 2,024 feet above sea level. The floors of the valleys are covered by alluvial and colluvial material derived from the adjacent ridges. This deposited material has been transported by a series of east to west and west to east consequent streams of intermittent flow and high gradient. These streams either join the north to south subsequent streams of lower gradient or are absorbed in the alluvium of the valley floors in systems of distributaries. The east and west orientation of the consequent streams, of which Dillowie Creek is one of the largest, and the north to south flow of the subsequent streams, namely Freshwater Creek, Belalie Creek, Baderloo Creek and other un-named streams, is very evident on the map. The subsequent streams are either absorbed in distributaries or are tributaries of the Broughton River or its tributaries.

Howchin (1) considered that the present topography of the area is due, at least in part, to older and larger north to south rivers which were at some elevation above the present valley bottoms. These ancient streams predate the Peterborough-Olary upwarp and the Lake Frome downthrow. He traced their courses by means of the location of beds of conglomerate and silicified stream gravels. Quite a number of these beds are to be found in the Hundred of Belalie and the adjoining Hundreds. However, Fenner (2) considers Howchin's conclusions to be erroneous, and more recent work by Langford-Smith (3) indicates that synclinal folding and erosion of anticlines have been involved in the production of the alternate ridge and valley structure. Another feature related to the topography is the unusual direction from south to north of the headwaters of Baderloo Creek and some of its tributaries, and another un-named stream lying to the west across the valley in the Bundaleer Hills. These streams, after running north for some distance, turn around the end of minor watersheds (at Y and Z on the map) and then take up a north to south direction, the same as the other subsequents.

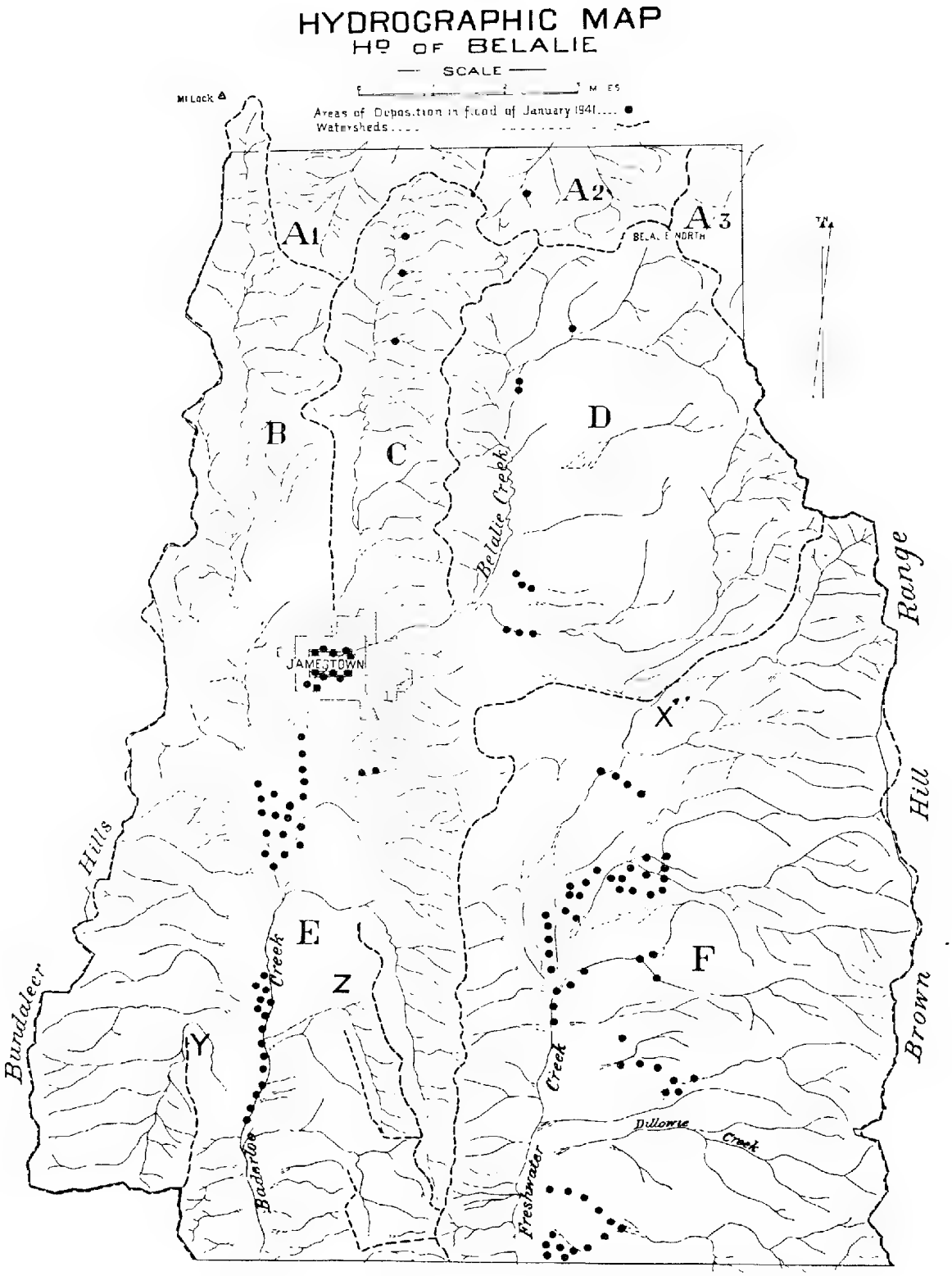
HYDROGRAPHIC MAP
HD OF BELALIE
SCALE
MILES
Milock
Areas of Deposition in flood of January 1941....
Watersheds....
A1
A2
A3
BELALIE NORTH
B
C
D
E
F
X
Y
Z
Belalie Creek
JAMESTOWN
Range
Hill
Brown
Hills
Bundaleer
Badnaloe Creek
Freshwater Creek
Dullorie Creek

Fig. 1

The catchment areas delineated by the watersheds have been labelled A (1, 2 and 3), B, C, D, E and F on the plan. The areas of these as estimated by planimeter are shown in Table 1.

TABLE I

Areas of Catchments in the Hundred of Belalie

CATCHMENT		AREA IN SQ. MILES	
A	(A1	2·9)	
	(A2	3·5)	8·0
	(A3	1·6)	
B			13·2
C			10·5
D			28·5
E			37·4
F			48·7
Total			146·3

The position of the watershed between catchments D and F is not easy to discern in the field. In fact, some of the water from the creek just to the south of the watershed crosses it in times of flood by means of an overflow watercourse (at X on the map), and a little further south the drainage pattern of the creeks has been easily and extensively altered and interlaced by artificial ditching. This has been made possible in this neighbourhood by the poised position of the creeks on the very low divide between the catchments. It is quite apparent that catchments D and F were formerly a single catchment area, but that Belalie Creek, which drains catchment D, and formerly part of Freshwater Creek, has been captured by drainage to the west. Now, in times of flood, it overruns its distributaries and discharges through Baderloo Creek in catchment E. Further south in this valley, in the Hundred of Reynolds, Baderloo Creek in turn is captured by Bundaleer Creek. Again in the neighbourhood of the junction of catchments C, D and A2, part of the headwaters of Belalie Creek has been captured by the drainage of catchment C.

This junction lies on the watershed that traverses the northern portion of the Hundred from Belalie North to the vicinity of Mount Lock. This watershed is important geographically as it is part of the crest of the Peterborough-Olary upwarp, and hence the interfluve between the endoreic drainage towards Lake Frome and the exoreic drainage via the Broughton River to Spencer's Gulf. The alteration of the direction of the headwaters of Baderloo Creek and the other adjacent streams mentioned above may indicate a former more southerly position of the interfluve now passing through Belalie North.

As mentioned above, some of both the consequents and subsequents end in distributary systems, the surface drainage of the area being only partly integrated. Thus the drainage pattern is partly areic in character, and as such is typical of country lying in the transition belt between arid and humid climates. The annual average rainfall at Jamestown is 17·63 inches, and at Bundaleer Forest, some six miles to the south, it is 21·92 inches. On the highest part of the ranges precipitation probably reaches 25 inches. As is indicated in Table II and in fig. 3, showing monthly averages of the rainfall at Jamestown, the climate is divided fairly sharply into two seasons, namely, winter rain and summer drought. What rains fall in the summer are frequently of high intensity. The difference in intensity between summer and winter rain is shown to some extent in Table II by the average number of points of rain per wet day for each month. However, the difference is greater than can be demonstrated by data based on daily observations. Much of the summer rain falls during thunderstorms of brief duration, whereas a high

proportion of the winter rain is due to showery days frequently recording only a few points.

TABLE II

Climatic Data for Jamestown, South Australia

	Jan.	Feb.	Mar.	Apl.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Av. rainfall (inches)	0.79	0.70	0.82	[illegible].25	1.71	2.22	2.03	2.27	2.03	1.60	1.14	1.07	17.63
Av. number of wet days	3.4	3.1	3.4	6.3	9.0	12.0	12.4	11.8	9.6	7.8	5.1	4.3	88.2
Number of points of rain per wet day	23	23	24	20	19	18	16	19	21	21	22	25	20

On 24 and 25 January 1941, Jamestown recorded 338 points of rain, and in the neighbourhood there were recordings up to 600 points. The town was flooded

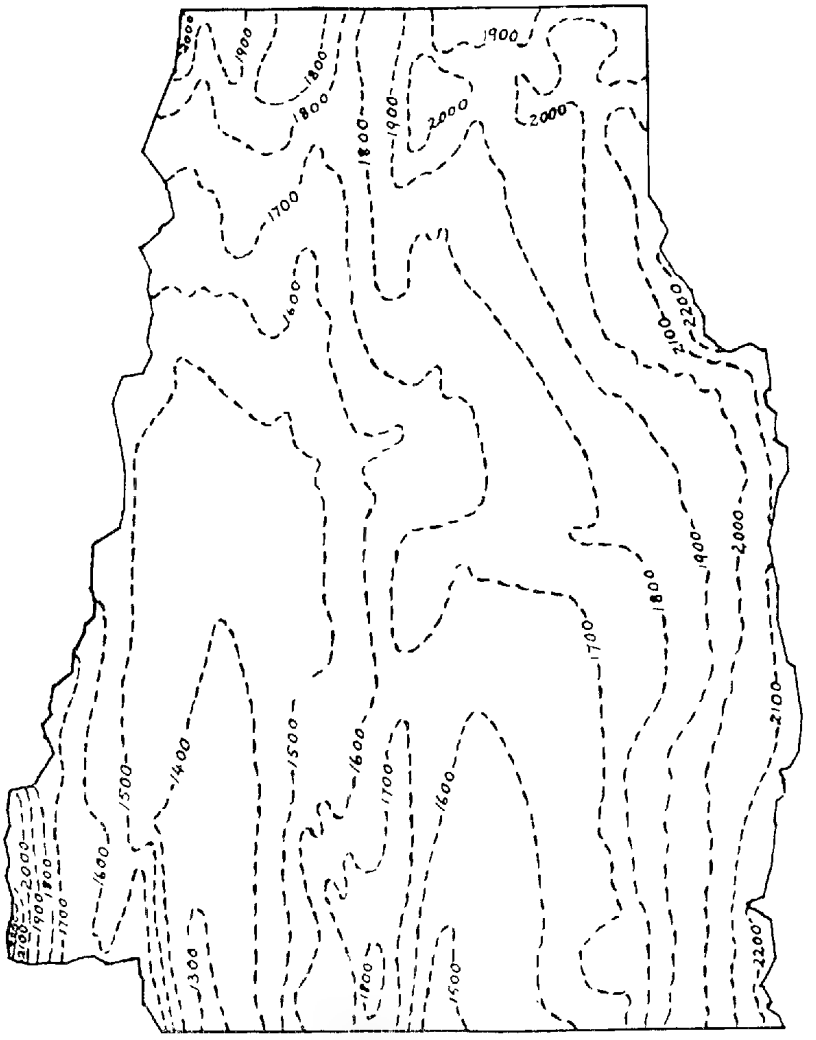

Fig. 2

Contour Map of the Hundred of Belalie

(After T. Langford Smith) Intervals of 100 feet

to a depth of two or three feet and much silt was deposited in the town. The water rose and subsided very rapidly, the duration of the flood being between one and two hours. On fig. 1 is shown in the town and other localities where significant

deposition of silt and other water-borne material occurred. These areas of deposition are located principally in catchment F where there is a fairly abrupt break of slope between the hills of the watershed and the valley floor, and at Jamestown and south of the town where the floodwaters of Belalie Creek join the headwaters of Baderloo Creek. As is evident from the drainage pattern on the map, Jamestown lies in a locality which, in times of normal rains and run-off, has some of the characteristics of a place of internal drainage. Salt accumulations in the soil occur to the south and west of the town and, although there are no actual playa lakes the area is very like that near Whyte-Yarcowie some 20 miles to the east and where the average rainfall is 13·44 inches per annum. In the Jamestown

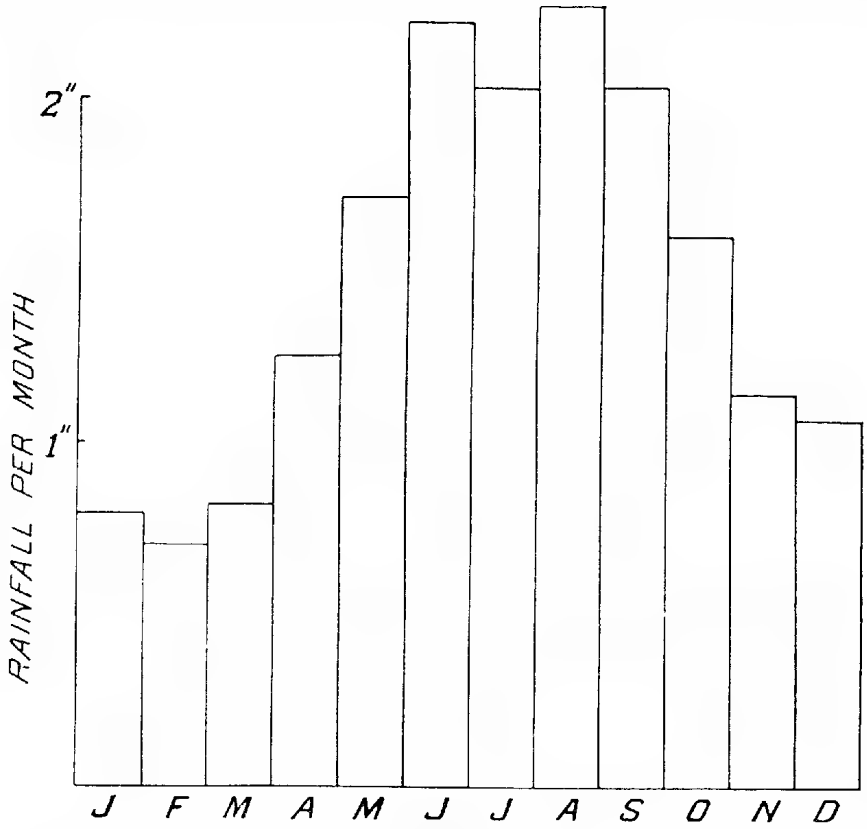

Fig. 3

Distribution of the monthly average rainfall at Jamestown, South Australia

locality and further south along Baderloo Creek the flooding was widespread and somewhat extensive areas of lucerne in the valley opposite the Bundaleer Hills may have aided in causing deposition in that area.

Jamestown directly receives the run-off drainage from catchments C and D (39 square miles), the town being situated on the distributary and absorption system of Belalie Creek and the creek which collects the run-off from catchment C. Furthermore, run-off from catchment B (13·2 square miles), in times of flood, joins the waters from C and D just south of the town. Thus Baderloo Creek, under flood conditions, has to handle water due to the running of the creeks draining catchments B, C and D, as well as the run-off water from its own catchment area E (37·4 square miles). Apart from that due to overflow at X, water from catchment F does not affect the position at Jamestown, as its floodwaters are delivered directly into the Broughton River by way of Freshwater Creek. The

deposition of silt south of Jamestown will further aggravate the flooding by restriction of the surface drainage to that part of Baderloo Creek which runs south from where it receives the floodwaters from Belalie Creek.

It is obvious that floods will recur in Jamestown every time rain comparable with that of January 1941 falls in the summer months. Unless surface conditions, particularly in catchments C and D, are considerably improved so as to restrict the present rapid run-off, floods will in all probability be more frequent. In the Hundred of Belalie some 35% of the land is used for permanent grazing, principally on the hills where the watersheds lie, and the other 65% is almost entirely wheat-growing land, very largely worked on the two-year wheat fallow rotation system. With over-grazing of the hill pastures generally, and nearly all cultivated land lying bare or in stubble over the summer months, conditions favour rapid run-off. In short, the agriculture of the Hundred is such that it has radically upset the delicately balanced drainage system. In this connection, it is probably typical of large areas of wheat-growing country throughout southern Australia. An instance of the upset to individual streams is shown by the consequent stream in the middle of catchment D. This creek has an abnormally enlarged distributary system which now involves several hundred acres, which it has scarred by gully and sheet erosion. In general, most of the deeper gully erosion of the area is associated with the areic streams which, under the more rapid run-off now prevailing, are cutting channels across formerly smooth land in an attempt to deliver their water directly into the subsequent streams of the valley bottoms, thus tending to make the drainage of the area south of the main divide completely exoreic in character.

Restriction of flooding and the minimising of soil erosion can be attained in the Hundred of Belalie and adjacent areas by controlled grazing of the watersheds, widening the wheat-growing rotation to include a period under pasture, by growing more lucerne in suitable localities, and by the installation of erosion control structures such as contour furrows and terraces on grazing and agricultural land respectively.

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THE TROMBICULINAE (ACARINA) OR ITCH-MITES OF THE AUSTRO-MALAYAN AND ORIENTAL REGIONS

By H. WOMERSLEY A.L.S., F.R.E.S., South Australian Museum,
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Summary

The economic importance of this group of mites lies in the fact that, as larvae, they are external parasites of vertebrates, including man, and that in the above regions certain species have been incriminated as the vectors of the form of typhus, commonly known as "tsutsugamushi" fever, from the primary hosts, rodents and small marsupials, to man. This disease occurs throughout the area covered in this study.

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Plates II-XIII, Text Fig. 1-18

[Read 10 June 1943]

Introduction

The economic importance of this group of mites lies in the fact that, as larvae, they are external parasites of vertebrates, including man, and that in the above regions certain species have been incriminated as the vectors of the form of typhus, commonly known as "tsutsugamushi" fever, from the primary hosts, rodents and small marsupials, to man. This disease occurs throughout the area covered in this study.

The adults, of which few species are known, are small, eight-legged, white to cream or reddish creatures, usually elongate, with a medial constriction giving them the shape of a figure 8. They are clothed with a dense mat of ciliated hairs, from which the popular name of "velvet mites" is derived.

Little is known of the feeding habits of the nymphs or adults, but they are probably vegetarian. They may be found under stones, in the soil, or under logs amongst the herbage in damp gullies, etc.

The eggs of the genus *Trombicula* s. str., as far as is known, are laid in clusters in the soil or other habitat favoured by the adult. The genus *Guntherana* is remarkable in that the eggs are found attached to the hairs of the host, a fact which suggests that the adult, for a time at least, lives in the fur of the hosts. The larvae are small microscopic six-legged creatures which, in the case of some genera at least, lurk or move amongst the herbage until they are able to attach themselves to a passing host. On the hosts they are frequently to be found in colonies in the ears, in the axillae or on the genitalia.

These mites have for long been known in many parts of the world as the cause of intense irritation to workers in the fields at harvest time, and to workers in the scrub of tropical and subtropical parts. In Europe, America and Australia they are popularly known as "harvest mites," and in America as "chiggers"; in Surinam as "batatas" or "bête rouge"; in Mexico as "tlasahuate"; in Japan and Formosa as "akamushi" or "kedani"; as "itch mites" or "ti-tree itch" in Australia and as "scrub itch" in Malaya and New Guinea.

The first mention in scientific literature of these mites was in 1758 when Linnaeus described the "bête rouge" of Surinam under the name of "*Acarus batatus*." Sambon, L. W., 1928, Annals, of Trop. Medicine and Parasitology, **22**, 67, states that the association between mites and the disease has been known for over 1,000 years. Palm, Th. A., 1878, described the disease in the Edinburgh Med. Journal, **24**, 128. In 1879 Baetz, E., and Kawakami, Archiv. für Path. Anat. und Physiologie, und für Klin. Med. (Virchow's Archiv., **78**, 373) recognised the suspected vector as a larval mite resembling *Leptus autumnalis* but discounted its importance. Tanaka, 1899, attributed the "tsutsugamushibo" or "river fever" of Japan to a minute red mite locally called "Kedani" (hairy mite), and in this connection figured three larval mites, but none of the figures correspond with Brumpt's *T. akamushi* (1910), a species which occurred on field mice in Japan and attacked man as well as domestic animals. The matter was followed up by other Japanese workers and it is now definitely accepted, both in Japan and

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Formosa, that this mite is the vector in the transmission of the disease. In 1924 Walch and Keukenschrijver showed that another species, *T. deliensis*, was probably the vector of a "tsutsugamushi"-like fever in Sumatra, the primary hosts being various species of *Rattus*. Later, 1928, Fletcher, Lesslar and Lewthwaite suggested a similar larval Trombid mite as the vector of tsutsugamushi as well as of "tropical typhus" in the Federated Malay States, and, in 1932, Gater made a survey of the Trombidiid larvae of the Federated Malay States and of their primary hosts. Fletcher, 1928, showed that *T. deliensis* Walch, and its Sumatran hosts were present in the Federated Malay States. Gater also added *T. akamushi* (Brumpt), *T. hirsti* Sambon and *T. acuscutellaris* Walch as being found on man. In the present paper the first of these is shown not to be the Japanese form but a new species (*T. fletcheri*). In New Guinea C. Gunther, 1938 - 1940, has investigated the "endemic typhus" of that region and incriminated a species of mite, which he called *T. hirsti* v. *buloloensis*, as the probable vector. He also found *T. deliensis* (= *vanderghinstei* Gunther) on rats, but not so plentifully. Mehta (1937) records *T. deliensis* as associated with scrub typhus in the Simla Hills, India.

In 1927 Sambon described from Innisfail, Queensland, a "scrub itch mite" under the name of *T. hirsti* from human beings; a species which Walch thought synonymous with *T. pseudoakamushi* Hatori 1919. This has now been shown to be the same as *T. minor* Berl. Heaslip, 1939-41, in investigating the typhus-like fevers of Queensland, has found *T. deliensis* to be the probable vector of K-typhus. He also found that *T. hirsti* was not present amongst some 2,500 larval mites collected from the natural animal reservoirs. The rats from which the North Queensland material was collected were identified and comprised seven species, *viz.*, *Rattus conatus* Thomas 1923, *R. rattus* (Linn. 1758), *R. assimilis* (Gould. 1858), *R. norvegicus* (Erxleben 1777), *Melomys littoralis* Lomberg 1916, *Hydromys chrysogaster reginae* Thomas and Dollman 1908 and *Uromys caudimaculatus* Krefft 1867. As each species of rat harboured many species of mite, and no species of mite showed any definite preference for any one species of host, the specific species of rat from which the individual species of mite were collected have not been detailed.

While species of *Eutrombicula*, *Schöngastia*, *Neoschöngastia* and *Leeuwenhoekia* are also known to bite humans, it is only with species of *Trombicula* s. str. that we can as yet connect the occurrence of disease. Nevertheless, to completely understand and appreciate the importance of these mites to mankind it is highly desirable to know all we can of their life-history, and also to be able to identify the known larval forms and link them up with their respective adults when discovered. This work should be carried out by well designed and checked breeding experiments. Most such experiments so far have endeavoured to rear the nymphs and adults from larvae. Apart from the difficulty of satisfactorily identifying the larvae in life (the specific identification requires high power microscopy), most workers have used a number of specimens in a tube, ignoring the fact that rarely does a colony on a host consist of a single species.

The only satisfactory procedure is to start with the gravid female and hatch out the larvae; in this way the female is also available after oviposition for microscopic examination.

Of the 19 genera of Trombiculinae recognised as valid in the present paper only *Blankaartia* Oudms. and *Trombicula* Berl. are definitely known from the adults or nymphs as well as larvae, all the others being larval genera only.

In addition to the new species described, *Neoschöngastia novae-hollandiae* (Hirst) and *Neoschöngastia perameles* Wom. are now recorded for the first time from North Queensland.

The most important specific characters are to be found, firstly, in the shape and dimensions of the dorsal scutum and its attendant setae, both normal and

sensillary, and secondly in the number and arrangement of the dorsal setae. Other workers have tried to find specific differences in the number and nature of the setae on the tarsus of the palp, and in the bi- or trifurcation of the palpal claw. These latter characters, however, are sometimes difficult to see clearly, while it is doubtful whether the arrangement of the setae is of more than generic value. On the other hand, in well mounted specimens, the characters of the dorsal scutum and the dorsal setae are comparatively easy to determine. The actual size of the whole creature is of very little importance and largely depends upon whether it has fed or not. Generally it is easier to make out the arrangement of dorsal setae from a fully gorged specimen. On the ventral surface the setal pattern of the coxae is of some value but the arrangement of setae behind the third pair of coxae is usually more irregular and less important than on the dorsum.

The chaetotaxy of the legs is generally fairly uniform and offers little variation of specific value within a genus.

For critical identification high power magnification is essential, as stated above, and to ensure this proper clearing and mounting of the specimens is necessary. In the first place, only a single specimen should be mounted on a slide, even from what appears to be a colony of the same kind, for only rarely can a single species be found on one host. For examination and drawing, a specimen is temporarily mounted straight from alcohol into a drop of glacial lactic acid on a slide and covered with a cover glass. The mount is then gently heated over a spirit lamp until it just bubbles. This ensures perfect clearing and details of both dorsal and ventral surfaces can usually be readily seen and drawn or measured. For a permanent mount, the cover glass is carefully lifted off and the specimen transferred to a drop of gum-choral [1] on another slide, covered and heated as for the temporary mount.

The careful measuring of a standard series of data from the scutum [2] of the different species and a comparison of the arrangements of the dorsal setae have shown that these can be used to distinguish specifically the many species of larvae. The various dimensions used are indicated by abbreviations, and quoted in microns in a definite order as follows:

AW = width between the bases of the antero-lateral scutal setae.
PW = width between the bases of the postero-lateral scutal setae. [3]
SB = distance between centres of sensillae bases.
ASB = distance from anterior margin to sensillae bases.
PSB = distance from posterior margin to sensillae bases.
A–P = distance between antero-lateral and postero-lateral setae.
AM [4] = length of antero median setae.
AL [4] = length of antero-lateral setae.
PL [4] = length of postero-lateral setae.
Sens. = length of sensillary setae.
DS = length of dorsal setae.
SD = depth of scutum = ASB + PSB.

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[1] With the older formulae for gum-chloral, experience shows that in course of time considerable crystallisation takes place and renders the mounts opaque. This is apparently due to the loss of acetic acid, and in the medium now recommended this is replaced by the less volatile and more viscous glacial lactic acid.

[2] The figures of the scuta given in this paper are all drawn to scale from standard data and to magnification of 500 diam.

[3] It is to be noted that PW as used here is aways slightly less than the greatest width as used by earlier workers.

[4] In the genus *Leeuwenhoekia* there are two AM of equal length; in *Walchia* and *Gahrliepia* AM is entirely wanting. In *Trombiculoides* AL setae are triplicated and the most posterior pair is regarded as the PL, but in *Gahrliepia* the first pair behind the sensillae bases is the PL, any posterior of these being members of the DS embraced by the backwardly extended scutum.

The arrangement of dorsal setae is usually constant and easily discernible, at least in the anterior rows. The setae in each row are quoted in order of rows from front to back, making due allowance for curvature of the rows.

While within the larval species, as here recognised, the measurements of the standard data appear to give sound differentiation of the species, there does, in some, at least where a good number of specimens have been measured, appear to be a rather wide though limited range of variation of any one character. It would therefore be worth while, when sufficient material is available, to treat the measurements statistically with a view to verifying the validity of each species.

The DS are normally in rows, generally transverse, and often anteriorly curved. Usually the first or anterior row consists of two setae, one on each side of the scutum; it may occasionally consist of none or four setae.

The total number of species recognised in this paper is 92, together with 4 varieties, as follows:

Trombicula - -	30 and 1 variety	*Paraschöngastia* -	5 and 1 variety
Myotrombicula -	1	*Guntherana* - -	1
Trombiculoides -	1	*Walchia* - -	6
Schöngastia -	7 and 1 variety	*Gahrliepia* - -	6
Neoschöngastia -	34 and 1 variety	*Leeuwenhoekia* -	1

Lastly, this paper has largely been rendered possible and its value increased by the generous help of colleagues from elsewhere than Australia. To the following we are particularly indebted and desire to express our sincere thanks. From Prof. Dr. M. Takenouchi of the Institute of Bacteriology, Imperial University of Tokyo, we have received authentic material of Japanese species. From Prof. J. E. Dinger, Director, Koningin Wilhelmina Institute, Batavia, Java, we have received specimens of certain of Walch's species. Valuable preparations of some of Gater's species have also been forwarded by Mr. Hodgkin from the Institute for Medical Research, Kuala Lumpur, through the kindness of Lieut.-Col. B. A. R. Gater and Dr. R. Lewthwaite. In addition Mrs. Dr. Walch, of Samarang, graciously forwarded reprints of some of her late husband's papers.

For Australian material we have had access to large numbers of specimens from Queensland collected by Mr. D. J. W. Smith, Dr. E. H. Derrick and one of us (W. G. H.), as well as all the material in the S.A. Museum, reported upon in earlier papers.

To Prof. Harvey Sutton, School of Tropical Medicine and Public Health, University of Sydney, we are indebted for the loan of the type slides of Gunther's species and to Dr. Gunther for paratype material now in the South Australian Museum collections.

SYSTEMATICS

Key to the Genera of Larval Trombiculinae

1 With two median dorsal scuta. Eyes two on each side, anterior larger than posterior. Numerous small platelets behind second dorsal scutum. Tarsi I and II with two, III with three claws. Gen. *Blankaartia* Oudms. 1911

With only one median dorsal scutum. All tarsi with three claws. — 2

2 Anterior margin of dorsal scutum with one median or two medial setae. 5

Anterior margin of dorsal scutum without median or medial setae. 3

3 Tarsi with two unequal claws. Sensillae simple. Setae on legs and dorsum simple. Gen. *Hemitrombicula* Ewing 1938

Tarsi with three claws. Sensillae clavate or capitate. 4

4 Dorsal scutum with only four setae, antero- and postero-lateral. A-P = or > ½ SD. Sensillae clavate. Gen. *Walchia* Ewing 1931

Dorsal scutum with four or more setae, due to posterior prolongation of scutum to take in two or more of the median setae of one or more of the dorsal rows; A P always $< \frac{1}{2}$ SD. Sensillae globose or clavate. Gen. *Gahrliepia* Oudms. 1912
incl. *Schöngastiella* Hirst 1915
incl. *Gateria* Ewing 1938

5 With two medial setae on anterior margin of dorsal scutum. 6

With one median seta on anterior margin of dorsal scutum. 8

6 Scutum longer than wide, lateral margin produced well in front of AL, apex truncate. Traces of crista present. Sensillae filamentous. Coxae I with two, II and III with one seta; none between coxae I Gen. *Heterothrombidium* Verd. 1909

Lateral margins of scutum not produced in front of AL. Scutum wider than long. 7

7 Anterior margin of scutum with a median forwardly directed process. Coxae I with two, II and III with one seta; no setae between coxae I. Chelicerae serrate. Sensillae filamentous. Gen. *Leeuwenhoekia* Oudms. 1911

Anterior margin of scutum without above process; otherwise similar.
Gen. *Hannemannia* Oudms. 1911

8 Mandibles and palpi modified for grasping hair. Sensillae lost, probably filamentous. On bats. Gen. **Myotrombicula** nov.

Mandibles and palpi normal. 9

9 Sensillae filamentous, with more or less distinct ciliations. 10
Sensillae globose, clavate or lanceolate, nude or ciliated. 14

10 With nine scutal setae in addition to sensillae. Scutum broader than long, without posterior angles, evenly rounded from anterior angles. Chelicerae with a very large inner subapical tooth. Gen. **Trombiculoides** nov.

With five scutal setae in addition to sensillae. 11

11 AL or AL and AM scutal setae stout and spine-like. Gen. *Fonsecia* Radford 1942
The above setae normal. 12

12 Chelicerae not serrate dorsally, with a single apical tooth; ventral tooth always present. 13

Chelicerae with three equal or subequal dorsal teeth. Dorsal scutum well developed or vestigial. AM seta simple or pectinate. Gen. *Odontacarus* Ewing 1929
= *Endotrombicula* Ewing 1931

13 Palpal claw trifurcate. Dorsal setae > 30. Gen. *Trombicula* Berlese 1905
inc. *Pentagonella* Sig. Thor. 1936

Palpal claw bifurcate. Dorsal setae < 30. Gen. *Entrombicula* Ewing 1938

14 All coxae multisetose. Scutum roughly triangular with apex directed forwards.
Gen. *Doloisia* Oudms. 1910

Coxae I and II always unisetose, III sometimes multisetose. Scutum trapezoidal, pentagonal or hexagonal. 15

15 Middle claw thickest and distally lanceolate. Eyes absent? All coxae unisetose. Sensillae globose. Gen. *Reidlinea* Oudms. 1916

Middle claw not lanceolate. 16

16 Body definitely constricted medially. Dorsally with a rounded caudal plate, generally longitudinally divided and bearing three pairs of fine setae. Gen. **Guntherana** n.n.
for *Guntheria* Wom. 1936 preocc.

Body not so. No caudal plate. 17

17 Chelicerae serrate. Sensillae globose or clavate. Gen. *Schöngastia* Oudms. 1910
Chelicerae not serrate, with only a single small subapical tooth. 18

18 Scutum with a raised transverse crest forming a wall in which the sensillae arise. Coxae III with one, two or three setae. Sensillae globose.
Gen. *Paraschöngastia* Wom. 1939

Scutum without above crest. Coxae rarely with two to four setae. Sensillae globose, clavate or lanceolate. Gen. *Neoschöngastia* Ewing 1929

Genus Trombicula Berlese 1905

Acari Nuovi, Manipl. IV, p. 155, in Redia II, fasc. 2, 1905. Genotype *T. minor* Berl. 1905, *loc. cit.*

Although this name was first used in 1905 for *Trombicula minor* from Java, Berlese does not appear to have given a generic description until the publication in 1912 of his monograph on the Trombidiidae in Redia VIII, fasc. 1, p. 83. The two specimens described by Berlese are now generally considered to be nymphs and to be the same as *T. mediocris* Berlese 1912, also described from Java as the adult.

The larval form of this genus was unknown until 1916, when Japanese workers, Miyajima and Okumara, and Nagayo and his co-workers established by breeding that the larval species *Trombidium akamushi* Brumpt developed into a *Trombicula*-like nymph and adult, very closely resembling *T. minor* Berl. In this paper 30 larval species of *Trombicula* s. str. are recognised from the Austro-Malayan and Oriental Regions, together with a variety of one of them.

The genus can be characterised as follows:

Adult and nymph: shaped like a figure 8, white to reddish in colour, with clothing of close ciliated setae. Crista present with posterior sensory area and a pair of long filamentous sensory setae. Eyes 1 + 1, closely adjacent to sensillary area, or none. Larvae: with a single anterior dorsal scutum with five normal setae and two sensory setae which are long and filamentous and ciliated or not; chelicerae not serrate dorsally, with a single apical tooth and a ventral tooth. Palpal claw trifurcate.

Key to the Species of Larval Trombicula of the Austro-Malayan and Oriental Regions.[5]

1 Scutum almost rectangular, with well-defined posterior angles. PL about midway between anterior and posterior angles. 2

Not entirely as above. 3

2 Anterior and posterior margins of scutum rectilinear. Scutal setae tapering to a point. AM 48, AL 44, PL 50, AW 64, PW 50, A-P 20, SD 38, DS 2.12.4.10.4.8.8.4. (After Walch.) *T. keukenschrijveri* Walch 1923

Anterior margin of scutum sinuous; posterior margin making a very slight obtuse medial angle. Scutal setae stout, bushy and apically blunt. AM 44, AL 40, PL 50, AW 60, PW 66, A-P 18, SD 38, DS 2.12.14.12.10.8.6.4.2. *T. pallida* Nagayo et al. 1919

3 AW greater than 45. 5

AW less than 40. 4

4 Sensillae with only two or three cilia on each side in apical half. AW 33, PW 47, A-P 17, DS 2.6.6.4.4.2. *T. munda* Gater 1932

Sensillae with numerous cilia on apical half. AW 38, PW 51, A-P 20, DS 2.6.4.4.4.4.2. *T. spicea* Gater 1932

5 Scutum roughly pentagonal. Tarsus III with long sensory seta. 6

Scutum not pentagonal. 7

6 AW and PW about equal. PL much longer than AM or AL. AW 75, PW 80, A-P 27, Sens. 78, DS 2.6.6.6(4).4(2).2(0). *T. acuscutellaris* Walch 1923

AW less than PW. PL not much longer than AM or AL. AW 80, PW 97, A-P 33, Sens. 92, DS 2.8.6(8).6(8).4.4.6 (probably 2.8.6.6.4.4.2). *T. japonica* (Tanaka 1916)

7 AW much less than PW, so that anterior angles of scutum are widely obtuse. AW 60, PW 87, A-P 19, SD 39, Sens. in line of PL, DS 2.8.6.6.4.2. **T. quadriense** n. sp.

AW not much less than PW. Anterior angles of scutum not or only slightly obtuse. 8

[5] Excluding *T. cerrulicala* Ewing 1931, from India.

8 Scutum practically rectangular and posterior margin almost rectilinear between PL. Sens. near to posterior margin of scutum. AW 72, PW 78, A-P 38, DS. 2.8.9.12.11.6.4.4.2. (After Walch.) *T. densipiliata* Walch

Scutum not rectangular. Posterior margin more or less curved. 9

9 Scutum relatively small, less than 3,000 μ^2; posterior margin extending not more than 12 μ behind line of PL. 10

Scutum relatively larger, more than 4,000 μ^2; posterior margin extending more than 15 μ behind line of PL. 21

10 Posterior margin of scutum an even shallow curve. 11

Posterior margin of scutum not an even curve. 13

11 Scutum rugose. AW 47, PW 69, SB 14·5, SD 34, A-P 21, AM 27, AL 27, PL 43, Sens. 51, DS 2.8.6.6.4.2. **T. chiroptera** n. sp.

Scutum smooth. 12

12 AW 60, PW 65, A-P 26, SD 40, DS 2.8.8.8.6.4.2. (After Hirst). *T. gliricolens* (Hirst 1915)

AW 57, PW 67, A-P 28, SD 39, DS 2.8.6.6.4.2. **T. walchi** sp. no.

AW 49, PW 59, A-P 22, SD 42, DS 2.6.6.6.4.2. (After Sugimoto.) *T. issikii* Sugimoto 1938

13 Posterior margin of scutum shallow, extending only slightly behind line of PL, almost straight. 14

Posterior margin of scutum deeper, extending more than 10 μ behind PL. 17

14 AM longer than AL or PL. AW 58, PW 69, A-P 30, DS 2.8.6.8(10).8.4.2. *T. akamushi* Brumpt 1910

AM shorter than PL. 15

15 Sensillae anterior of line of PL. 16

Sensillae in line of PL. DS 2.12.8.8.4.2. AW 73, PW 82, SB 27, SD 38, A-P 28, AM 25, AL 28, PL 47, Sens. 41. (After Gunther 1941.) *T. robusta* Gunther 1941

16 DS 2.8.6.6.6.4. AW 56, PW 64, A-P 27. *T. bodensis* Gunther 1940

DS 2.10.8.6.4.2. AW 62, PW 75, A-P 26. **T. fletcheri** n. sp.

17 DS 2.8.6.6.4.2. AW 63, PW 77, A-P 28, AL 44, PL 63. *T. deliensis* Walch 1924 = *vanderghinstei* Gunther 1940

DS 2.10.+. 18

18 A-P greater than half SD. 19

A-P less than half SD. 20

19 Sens. 58, ciliated only on basal half. PW 85, SD 37, Sens. 8 in advance of line of PL. DS 2.10.10.16.12.10.8 and 45 μ long. Eyes 1 + 1. On birds. *T. corvi* Kaw. and Yam. 1921

Sens. 70, ciliated to tip, bases in line with or slightly behind line of PL. AW 57, PW 69, A-P 26, AM 51, AL 43, PL 53, SD 43, DS 2.10.10(12).10(8).6.4. *T. scutellaris* Nagayo et al. 1920

20 Sensillae bases well behind line of PL. DS 2.10.10.+. AW 60, PW 66, A-P 17, SD 37, AM 45, AL 37, PL 48, Sens. 56. *T. palpalis* Nagayo 1919

Sensillae bases only slightly behind PL. DS 2.10.8.8.6.4.2. AW 53, PW 60, A-P 18, SD 36, AM 53, AL 41, PL 57, Sens. 65 (After Nagayo) *T. intermedia* Nagayo 1920

21 Sensillae well in advance of midline of scutum, much nearer line of AL than PL. Scutum almost as deep as wide, 75 μ by 100 μ. AM 40, AL 33, PL 40, SD 74, AW 85, PW 100, A-P 40, DS 2.4.4.4.2. (in text) 2.6.2.4.4.2. (in figure). (After Walch.) *T. rara* Walch

Sensillae much nearer to line PL than AL. 22

22 Posterior margin of scutum sinuous or flattened medially. 23

Posterior margin of scutum an even curve. 27

23 AW/AP greater than 3. Scutal setae parallel-sided almost to tip, serrated rather than ciliated. DS 2.14.16.12.+. AW 100, PW 110, A-P 31, SD 63. *T. rioi* Gunther

AW/AP less than 3. Scutal setae tapering and ciliated. DS 2.6.+. 24

24 Sens. in midline of scutum, *i.e.*, ASB = PSB. 25

Sens. anterior to midline of scutum, *i.e.*, ASB < PSB. 26

25 AW 79, PW 92·5, A-P 31·5, AM 43, AL 46·5, PL 58, Sens. 63, DS 2.6.6.4.2.2. Posterior margin of scutum medially flattened or slightly sinuate.
T. reichmanni Oudms. 1905

AW 72, PW 85, A-P 27, AM 36, AL 36, PL 50, Sens. 55, DS 2.6.6.4.2. Posterior
T. hatorii n. sp.
= *pseudoakamushi* Kaw. and Yam.

26 AW 75, PW 86, SB 41, ASB 24, PSB 35, A-P 35, AM 42, AL 46, PL 52.
T. minor Berlese 1904
= *hirsti* Sambon 1927

AW 84·5, PW 99·5, SB 44·5, ASB 26·5, PSB 38·5, A-P 34·5, AM 48, AL 53, PL 58·5.
T. minor v. *deliensis* Walch 1923
= *hirsti* v. *buloloensis* Gunther 1939

27 Sensillae slightly behind PL, about 95 long. AW 71, PW 96·5, A-P 35, SD 62, DS 2.6.6.6.4.2.
T. novae-hollandiae Hirst

Sensillae in front of PL, 65-70 long. 28

28 Sens. with only three branches. DS 2.6.6.4.2., AW 78·5, PW 87, A-P 30, SD 60.
T. samboni Wom. 1936

Sens. with many branches. DS 2.8.6, plus a cluster of about 30. AW 76, PW 82, A-P 30, SD 56.
T. macropus Wom. 1936

Trombicula keukenschrijveri Walch 1923

Trans. Vth. Bien. Congr. Far East. Assoc. Trop. Med., p. 583, Singapore, 1923 (publ. 1924).

(Pl. ii, fig. 1)

In the almost rectangular dorsal scutum with well-defined postero-lateral angles and the PL setae placed midway between the antero- and postero-lateral angles, this and the following species *T. pallida* Nagayo form a well-defined group.

From *T. pallida* it is to be distinguished as given in the key to species of the genus.

We have not been able to obtain any authentic material of this species. The figure of the dorsal scutum given in pl. ii, fig. 1, is drawn to scale from our standard data as derived from Walch's figures and details. The standard data are:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
64	70	32	24	14	20	48	44	50	—	45

The species was described from a solitary specimen found on man at Deli, Sumatra. It is to be noted that in his table Walch gives the arrangement of DS as 13.4.6.8.11.8.4, whereas from his figure the arrangement is 2.12.4.10.4.10.8.4. In the type specimen the sensillae were missing but the species is probably correctly placed in *Trombicula* s. str.

Trombicula pallida Nagayo et al 1919

Verhdl. d. jap. pathol. Gesellsch., Tokyo, **9**, 107, 1919; Amer. J. Hygiene, **1**, (5-6), 569, 1921.

(Pl. ii, fig. 2)

Allied to the preceding in the form of the dorsal scutum, but distinguished therefrom as in the key to species.

Only the second of Nagayo's papers has been available to us, but through the great help of Prof. Dr. Takenouchi of the University of Tokyo we have been able to examine two microscopic preparations of this species from the Yamagata Prefecture, Japan.

The figure of the dorsal scutum which we give (pl. ii, fig. 2) is to scale from Nagayo's figures and details, aided by the two specimens studied. Our standard data for these specimens are as follows:

Loc. and Date		AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Yamagata, 28/6/19	-	65	70	32	23	18	18	53	36	48	60	32–45
„ 18/8/19	-	63	73	32	22	17	18	50	37	47	—	32–45

The arrangement of DS was, in the first, 2.13.12.14.+, and in the second 2.11.12.+.

Nagayo gives little data beyond that the sensillae measured 64·8 long and that the first row of dorsal setae was 10-11 (13).

In his breeding experiments Nagayo, 1921, claims to have reared the larvae to adults, and to have obtained larvae from captured adults. He was unable, however, to detect any definite differences between the adults and nymphs of this species and those of *akamushi, palpalis, intermedia* and *scutellaris*.

We have also received from Prof. Dr. Takenouchi a preparation of an adult caught in the field in Yamagata Prefecture, Japan, in July 1920, which he states in his letter is "probably *Trombicula pallida*." Whether it is this species or one of the other Japanese forms it is briefly described here as follows:

Length 775 μ, width of propodosoma 395 μ, of opisthosoma 400 μ. Eyes, if present, invisible in the preparation. Crista 130, sensillary area transverse, dumb-bell-shaped as figured for *T. deliensis* by Walch 1923; SB 48 apart, sensillary setae hard to see and apparently broken, only 40 long. Tarsus I ovate, 202 by 91, metatarsus 130 long. Body thickly covered with long, slender, non-tapering setae, 55 to 80 in length, with short outstanding ciliations along whole length.

If this specimen is correctly placed, then it will not fit into the *akamushi-palpalis* group as given later in the key to the nymphs and adults of *Trombicula*. It will instead come between *deliensis* Walch and *tindalei* Wom. in the form of the sensillary area and the SB, and be nearer the latter in that the DS are not knobbed, although not pointed as in *tindalei*. It also differs from this last species in the longer DS and the different proportions of the front tarsi.

Trombicula munda Gater 1932

Parasitology, **24**, 143-174, 1932.

(Pl. ii, fig. 3)

This and the following species, *T. spicea* Gater, in the small size of the dorsal scutum (AW < 40) constitute a second fairly distinctive group of species.

From *spicea* it differs in the proportions of the scutum, the fewer ciliations on the sensillae and in the arrangement of the DS, as well as in other characters given in the key to species.

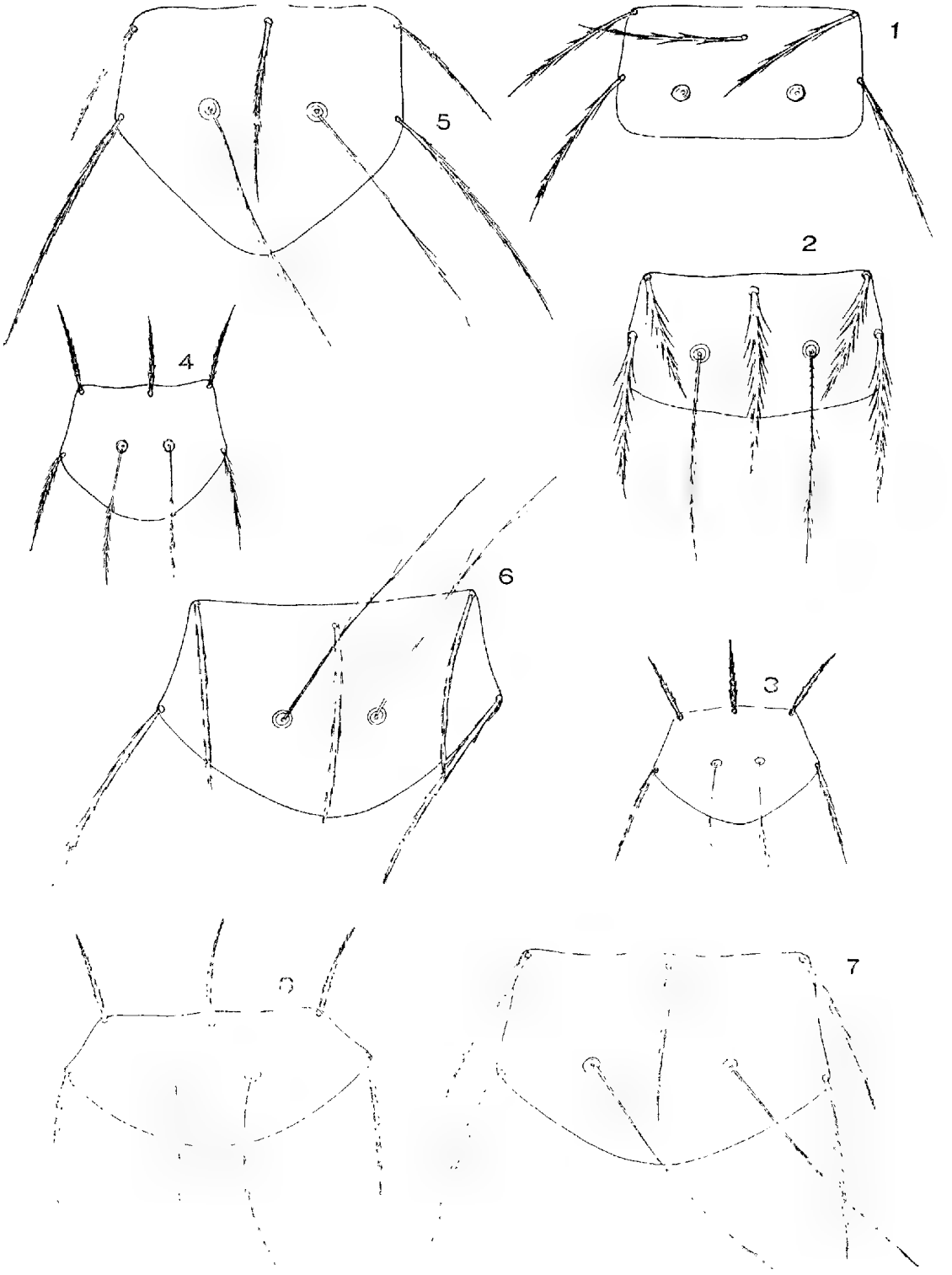
In addition to Gater's original description and figures we have been able to examine specimens from the original type locality and host. The specimens were labelled as from *Rattus rattus diardi* or *jaloreuse*, Kuala Lumpur, Selangor 1929. Gater also reorded it from *R. mulleri validus* (Miller) and from *R. malaisia* Kloss, from Sungei Buloh, Selangor.

The standard data for the two specimens measured are:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
32·5	46·5	11·5	16	16·5	16·5	20	20	30	30	20–25
33	48	14	17·5	17·5	18	22	20	30	30	20–25

The DS are arranged 2.6.6.4.4.2.

Gater gives the scutal width as 48, and the length as 35, SB as 13, and the arrangement of DS as 2.6.6.2.4.4.2. It should be noted that his drawing of the scutum is not entirely in agreement with ours from the above specimens; he shows SB as very much nearer to the anterior margin, whereas they are about equidistant between anterior and posterior margins. The AW is also shown as rather too wide, and the lengths of the scutal setae are not to scale.



1. *Trombicula keukenschrijveri* Walch; 2. *T. pallida* Nagayo et al.; 3. *T. munda* Gater; 4. *T. spicea*; 5. *T. acusertelloris* Walch; 6. *T. japonica* (Tanaka); 7. *T. autumnalis* (Shaw); 8. **T. quadriense** n. sp.

Trombicula spicea Gater 1932

Parasitology **24**, 143-174, 1932.

(Pl. ii, fig. 4)

This species was described from *R. malaisia* Kloss from Sungei Buloh, Selangor, Federated Malay States, and Gater also recorded it from *R. mülleri validus* (Miller) from the same locality.

We have been able to examine an authentic specimen from the latter host kindly forwarded from the Institute of Medical Research, Federated Malay States.

It differs from the previous species as discussed thereunder and as given in the key to species.

The figure of the dorsal scutum given here (pl. ii, fig. 4) is from the specimen examined, and drawn to scale. The standard data are:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
38	51·5	13	18	21·5	20	23	25	30	38	25–35

Arrangement of DS 2.6.4.4.4.4.2.

Gater gives the width of dorsal scutum as 55, and its length 41, and SB 15. As with his figure for the preceding species, this is not exactly to scale, but there seems no reason to doubt that the specimen before us is correctly determined.

Trombicula (Pentagonella) acuscutellaris Walch 1923

Kitasato Archives, **5**, (3), 78, 1923; Gater, B. A. R., Parasitology, **24**, 143-174, 1932; Sig Thor, Zool. Anz., 114, 30, 1936.

(Pl. ii, fig. 5)

In his original paper Walch only briefly described this species but gives a table of dimensions and detailed figures. He had originally but a single specimen from a rat from Deli, Sumatra. Gater 1932, however, records having compared Malayan material with specimens forwarded to him by Walch. Gater also recorded the species from *R. rattus diardi* from Sungei Buloh, Federated Malay States, from August 1929 to January 1930; once only on the same host from Kuala Lumpur, August 1929, and from Raub, Pahang, in March 1930. The only record from a human being (a woman school teacher) is by Gater from Setapak, Selangor.

To Prof. Dr. J. E. Dinger, of the Koningin Wilhelmina Institute, Batavia, we are indebted for an authentic specimen of this species, and we have also been able to examine another specimen from the Institute for Medical Research, Federated Malay States. We can therefore affirm Gater's identification of the Malayan and Sumatran specimens.

The standard data for the material before us are as follows:

Locality		AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
F.M.S.	-	75	78	30	31	42	27	52	36	74	—	60–70
Batavia	-	76	82	32	29	40	27·5	54	40	76	78	60–75

Dorsal setae arranged 2.6.6.6.4.2.

Walch gives the following data: scutal width 77, length 68, AL 42, sensillae 77.

The figure of the dorsal scutum given in this paper is from the above two specimens, drawn to scale.

Sig Thor, 1936 erected the genus *Pentagonella* for this and other species on the pentagonal form of the dorsal scutum. As a similar form of scutum occurs in a number of otherwise well-defined genera it does not seem to be a valid character, and we do not accept *Pentagonella* as more than a subgenus at most.

TROMBICULA JAPONICA (Tanaka 1916)

Leptus autumnalis japonica Tanaka 1916, Igakkai Zasshi (in Jap.), **30**, (22); 1918, Ikai Jiho (in Jap.), No. 1,228.

Trombicula autumnalis japonica (Tanaka et al.), Zentrbl. Bakt., Abt. 1, Orig, **116**, 361.

(Pl. ii, fig. 6)

We have been able to study only Tanaka's description and figures in the last reference, the others not being available to us.

Because of its close similarity in the form of the dorsal scutum, Tanaka placed the Japanese form as a subspecies of the European *Trombicula autumnalis* (Shaw). To try to elucidate the status of Tanaka's species, we give comparative drawings to scale of the scutum of each form, that of the Japanese from the author's data and figures, and that of the European (pl. ii, fig. 7) from that of Hirst (Arachnida and Myriopoda injurious to Man, Brit. Mus. (N.H.), Econ. Ser. 6, pl. ii, 1917), but as no dimensions are given by Hirst for the dorsal scutum or are elsewhere available it is assumed for comparison that its AW = 80, as in the Japanese species.

From these drawings the comparative standard data are:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
japonica -	80	97	27	34	28	33	57	56	62	92	—
autumnalis -	80	94	40	34	29	36	50	50	55	80	—

The arrangements of the dorsal setae respectively are 2.8.6.6.6.4.2 and 2.6.6.6.4.4.2.

The more important differences are therefore that in *japonica*—sensillae bases nearer together and slightly posterior of line of PL; sensillae longer and with fewer longer ciliations; the sides of scutum more divergent posteriorly; the different arrangement of dorsal setae.

Although the above differences are small they are yet significant, and it is obvious that Tanaka's form is not the same as *autumnalis* and must be raised to specific rank. Both species are closely allied to *acuscutellaris* in the pentagonal scutum and would come within the genus *Pentagonella* of Sig Thor. All three species have a similar long plain sensory seta on the tarsus of the third leg.

Trombicula quadriense n. sp.

(Pl. ii, fig. 8; text fig. 1, A-E)

Description—Shape subrotund to subquadrate. Length to 340 μ, width to 300 μ. Dorsal scutum much wider than long (pl. ii, fig. 8), posterior margin strongly crescentic, anterior angles widely obtuse. Sensillae slightly in advance of line of PL, bases rather wide apart, setae filamentous, ciliated in distal half. Normal scutal setae as in standard data. Eyes 2 + 2. Chelicerae and palpi as in text fig. 1, D, C. Dorsal setae fairly long to about 40, pointed and shortly ciliated, arranged 2.8.6.6.4.2. All coxae with a single seta, a pair of setae between coxae II and between coxae III, ventral setae arranged thereafter 2.6.2.4.2, to 27 long. Legs comparatively short, I 204, II 170, III 220, tarsi with two claws and a longer median claw-like pulvillus.

The standard data for three specimens are as follows:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
	62	92	24	19	23	19·5	32	26	43	—	27–38
	62	87	23	19	20	19·5	29	27	40	—	29–38
	56	81	22	16	20	18	—	25	44	—	27–38
Mean -	60	87	23	18	21	19	30·5	26	42	—	27–38

The sensillae in pl. ii, fig. 8, and text fig. 1, A, were drawn from the specimens before permanently mounting. They afterwards became lost.

Loc. and Hosts—On rat, Cairns, Queensland, 1939 (W. G. H.); on *Rattus assimilis*, Intake, Queensland, 1940 (W. G. H.); on *Hydromys chrysogaster*, Intake, Queensland, 1940 (W. G. H.).

Remarks—A very characteristic species in the shape of the dorsal scutum, and the arrangement of the DS.

Text fig. 1

Trombicula quadriense n. sp.: A, dorsal view; B, ventral view; C, palp; D, chelicera; E, tarsus I.

TROMBICULA DENSIPILIATA Walch 1923

Kitasato Archives, **5**, (3), 79, 1923.

(Pl. iii, fig. 1)

This species was described by Walch from a single specimen from a rat at Deli, Sumatra. We have not seen any material of this species and for our drawing of the dorsal scutum (pl. iii, fig. 1) and the standard data we have had to go entirely by Walch's figure and details. The species does, however, appear to be well differentiated as given in the key. The data given by Walch is: scutal width 81, length 51, AL 51, Sens. 45, DS arranged 2.8.9.12.11.6.4.4.2. From these we compute the standard data as follows:

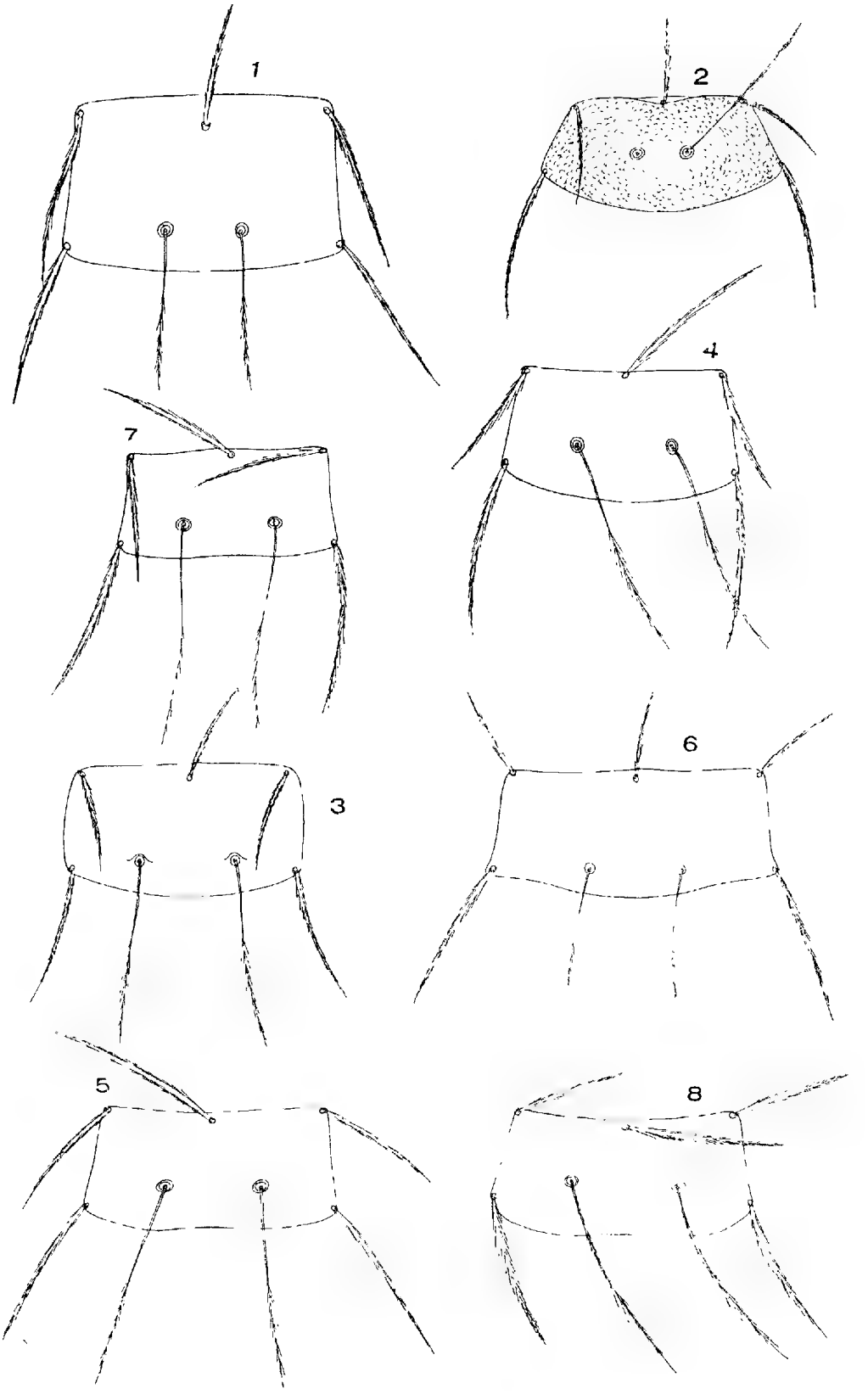
AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
72	80	22	40	11	39	37	51	50	45	50

Arrangement of DS 2.8.8.12.12.6.4.4.2.

Trombicula chiroptera n. sp.

(Pl. iii, fig. 2; text fig. 2, A–C)

Description—Shape an elongate oval, with a suture behind the scutum. Length 350 μ, width 210 μ. Eyes 2 + 2, large and subequal and placed on lateral margins. Dorsal scutum as in pl. iii, fig. 2, wider than long, with shallowly convex



1, *Trombicula densipilifata* Walch; 2, **T. chiroptera** n. sp; 3, *T. gliricolens* (Hirst); 4, **T. walchi** n. sp.; 5, *T. akamushi* (Brumpt); 6, *T. robusta* Gunther; 7, *T. bodensis* Gunther; 8, **T. fletcheri** n. sp.

posterior margin and strongly rugose surface. Sensillae filamentous, ciliated on distal half. Ordinary scutal setae pointed and shortly ciliated. AM and AL about equal and much shorter than PL. DS fairly long and tapering and shortly ciliated, arranged 2.8.6.6.4.2. Chelicerae as in text fig. 2, C. Palpi normal, tibial claw apparently bifurcate. All coxae with 1 seta, a pair of setae between coxae I and between coxae III, thereafter ventral setae arranged 4.4.4.4.2. Legs normal, I 160, II 160, III 180, tarsi with two claws and a longer claw-like pulvillus, I and II with the usual dorsal rod-like seta.

Text fig. 2

Trombicula chiroptera n. sp.: A, ventral view; B, dorsal view; C, chelicera.

The standard data for two specimens are:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Type [6] -	48	76	14·5	24	17·5	32	25	19+	22+	—	20
Parat. -	48	69	14·5	16	17·5	31	27	27	43	51	19

Loc. and Hosts—Type from residue in jar containing bats (unnamed and unlocalised but probably South Australian), in the South Australian Museum Collections. Paratype similarly with *Chalinolobus gouldi*, probably South Australian.

Remarks—Can be separated from other species as in the key and by the strongly rugose scutum.

Trombicula gliricolens (Hirst 1915)

Microtrombidium gliricolens Hirst 1915, Bull. Entom. Res., 6.

(Pl. iii, fig. 3)

Hirst described this species from a single specimen taken from the ear of *Mus rattus* (sic.) from Calcutta, India, March 1915.

His description is, however, rather vague and lacking in detail. The figure of the dorsal scutum given in this paper (pl. iii, fig. 3) is re-drawn to scale from Hirst's figure and details. The AW and PW are nearly equal and the sides con-

[6] Crushed and scutum damaged with broken setae.

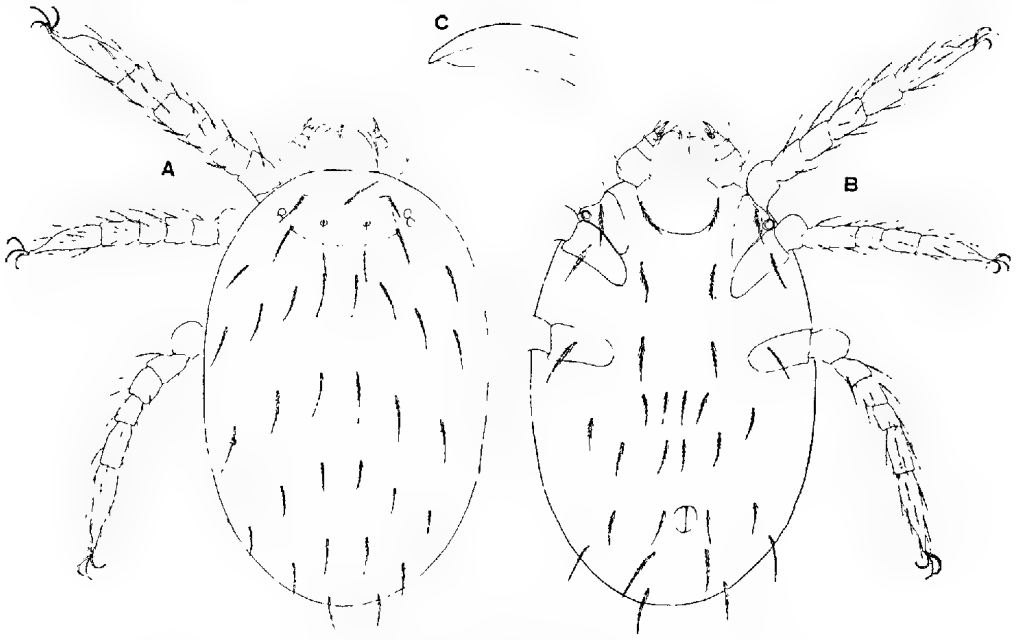
sequently almost parallel. The arrangement of DS is 2.8.8.8.6.4.2., and the standard data calculated from Hirst's figure and the few details he gives are:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
60	65	28	28	11	25	30	30	40	55	—

Trombicula walchi n. sp.

(Pl. iii, fig. 4; text fig. 3, A-C)

Description Shape an elongate oval. Length 320 μ, width 210 μ. Eyes 2 + 2, equal and about two diameters from side of scutum. Dorsal scutum wider than long with slightly concave anterior margin and more convex posterior margin, AM and PL longer than AL, all tapering and shortly ciliated. Sensillae filamentous, ciliated on apical half, bases wide apart. Chelicerae as in text fig. 3, C. Palpi normal. Dorsal setae 45-50, long, pointed and ciliated and arranged 2.8.6.6.4.2. Coxae with a single long ciliated seta, a pair between coxae I and between coxae III, thereafter the ventral setae are arranged 6.4.4.4.2., the last two rows as long as the dorsal setae. Legs normal I 210, II 190, III 240, tarsi with paired claws and longer claw-like pulvillus, I and II with the usual dorsal rod-like seta.



Text fig. 3

Trombicula walchi n. sp.: A, dorsal view; B, ventral view; C, chelicera.

The standard data are as follows:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Type - -	57	67	27	22	17	28	52	37	54	—	45–50
Parat. - -	57	67	27·5	22	16·5	27	51	38	53	65	45–50

Loc. and Hosts — Type, on a slide (IA, 1 C, I) from Prof. Dinger, of the Institute for Bacteriology, Batavia. In his letter Prof. Dinger refers to this slide as *T. deliensis*, but on the slide it is marked "as very close to *akamushi*." A study of the figures given and the key to species will show the relationships of this species. The paratype is on a slide from the Institute for Medical Research, Federated Malay States, labelled *T. deliensis* and stated in writing to be from *R. rattus diardi* (Jk.) from Sardang, Selangor, 21 April 1932.

TROMBICULA ISSIKII Suginoto 1938

J. Jap. Soc. Vet. Sci., 1938, **17**, (1), 57-62, fig. 1-3.

(Text fig. 18 B)

This species was described in Japanese from *Capella hardwickii* (Gray), from Formosa. From Suginoto's figures and the few dimensions he gives, the following standard data are interpolated:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
49	59	20	22	20	22	44	38	60	56	45–48

Dorsal setae arranged 2.6.6.6.4.2.

TROMBICULA AKAMUSHI (Brumpt 1910)

? *Trombicula coarctatum* (Berl. 1888), in Kitashima and Miyajima 1918, cited Walch Tr. Vth. Bien. Congr. Far East. Assoc. Trop. Med., 1923 (1924).

Kedani tanakai Kishida 1909,* cited Tanaka et al., 1930, Zentralblt. Bakt., Abt. I. **116**, Orig., 353.

Trombidium akamushi Brumpt 1910, Précis de Parasit., 2nd ed., 506.

Microtrombidium akamushi, Hirst 1915, J. Econ. Biol., **10**, 79.

Leptothrombium akamushi, Nagayo et al. 1917, J. Exper. Med., **25**, 255.

Trombicula akamushi, Hirst 1917, Arachnida injurious to Man (B. Mus. N. H.) Econ. Ser., No. 6; Nagayo et al. 1921, Amer. J. Hygiene, **1**, (5-6), 569; Walch, 1923 (1924), Tr. Vth. Bien. Congr. Far East. Assoc. Trop. Med.; Gater, 1932, Parasitology, **24**; Brumpt 1936, Précis de Parasitologie.

Microtrombidium brumpti Hirst, 1915, J. Econ. Biol. **10**; syn. Ewing, 1925, Ann. Ent. Soc. Amer., **13**, 381.

(Pl. iii, fig. 5)

This species, which is one of those indicated as vectors of the Japanese river fever or tsutsugamushi disease, was originally recorded from Japan. There, at certain seasons of the year, it occurs very plentifully upon voles.

Under the generic name of *Microtrombidium*, it was fully re-described and figured, although few dimensions were given, by Hirst 1915 (J. Econ. Biol., p. 78), also from Japanese material.

In 1916 (Ikai Jiho, No. 1,164, 1,701) (cited by Nagayo et al. 1921) Tanaka considered that two species of mites occurred upon voles in Japan. One, which was known to attack man, he regarded as the Kedani or Akamushi tsutsugamushi; the other he called the Yasodani or vole mite, or Pseudoakamushi.

In 1919 Nagayo et al. (Jap. J. Exper. Med., **3**, 265) claimed to distinguish three species, and in 1921 (Amer. J. Hygiene, **1**, (5-6), 569) brought the number of known Japanese species up to five, viz., *akamushi* (Brumpt 1910), *pallida* Nagayo et al. 1919, *palpalis* Nagayo et al. 1919, *intermedia* n. sp. and *scutellaris* n. sp. In this last paper the authors considered that *akamushi* (Brumpt 1910) was the same as Tanaka's "Kedani," the same as Miyajima and Okamura's "thin-haired type" and the same as Kawamura's "type A"; that *pallida* Nagayo was the same as Tanaka's "Pseudoakamushi," the same as Miyajima and Okamura's "type D"; that *palpalis* Nagayo 1919 was the same as Kawamura's "type C," and that *scutellaris* Nagayo 1921 was the same as Kawamura's "type B."

In 1930 (Zentralblt. Bakt. Abt. I. **116**, Orig., 353) Tanaka et al. reviewed the Japanese species. The Kedani mite he again referred to *akamushi* Brumpt but cited this as synonymous with *Kedania tanakai* Kishida 1909.* His *pseudo-*

* This reference seems important but is not available to us.

akamushi of 1916 he separated into A and B; the first he synonymised with *pallida* Nagayo 1919, and the second with *palpalis* Nagayo 1919.

As the name *pseudoakamushi* is therefore a complex of at least two species for which valid names, *pallida* and *palpalis*, are available, it should be dropped from literature.

In addition, Tanaka in 1930 described another species under the name of *Trombicula autumnalis japonica*, which has already been discussed.

In 1928 Fletcher, Lesslar and Lewthwaite recorded specimens from the Federated Malay States which "resemble *T. akamushi* even more closely than *T. deliensis*," and in 1932 Gater recorded *T. akamushi* from Selangor on *R. rattus diardi*, *R. r. jalorensis* and *Trichys fasciculata fasciculata* Shaw. The latter author also stated that it was common on man. Some of his material was examined by H. E. Ewing in America, who was also of the opinion that the specimens belonged to the Japanese *akamushi*. Through the kindness, however, of Dr. Takenouchi of the University of Tokyo, and of the Director of the Institute of Medical Research, Federated Malay States, we have been able to compare two slides of supposed *akamushi* from the Federated Malay States with authentic Japanese material. From this study we are able to satisfy ourselves that the specimens from the Federated Malay States do not agree with the Japanese material, nor with the figures and descriptions given by Nagayo and by Hirst. They are a new species, described in this paper as *T. fletcheri* n. sp. Whether Gater's and Fletcher's original material, however, was true *T. akamushi* still remains somewhat uncertain, but in all probability the Japanese species does not occur other than in Japan and Formosa.

The standard data, as used in this paper for the Japanese material before us are as follows:

Locality	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Yamagata, 20/8/19 -	63	75	28	22	13	30	58	38	52	64	42–65
" " -	62	70	28	22	11	28	58	37	54	60	45–65
Yamagata, 27/7/19 -	66	74	30	22	11	28	—	—	—	58	45–65
" " -	62	70	27	22	13	30	58	38	48	62	45–65
Mean - - - -	63	72	28	22	12	29	58	38	51	61	42–65

The dorsal setae are arranged 2.8.6.8.6.+. In Hirst's figure they are shown as 2.8.6.10.8.4.2, but it would appear that some of the latero-ventral setae may have been included in the drawing as the result of too much depression of the specimen in mounting.

Nagayo (1921) claims to have reared this species through from the larvae to the nymph and adult, and also to have obtained larvae from captured adults. Beyond a slightly redder colour in the nymph and adults of *akamushi* than in *pallida*, he was unable to point to any very definite specific differences between either of these species or between these and *palpalis*, *intermedia* and *scutellaris*.

Trombicula robusta Gunther 1941

(Pl. iii, fig. 6)

This was described from birds, *Pitta mackloti* Temminck and *Microeca* sp. from Bulolo, T. N. G. The species, which is very close to the two following, can be separated as given in the key. The drawing of the dorsal scutum (pl. iii, fig. 6) and the following standard data are derived from Gunther's original drawings and descriptions. We have not seen any specimens.

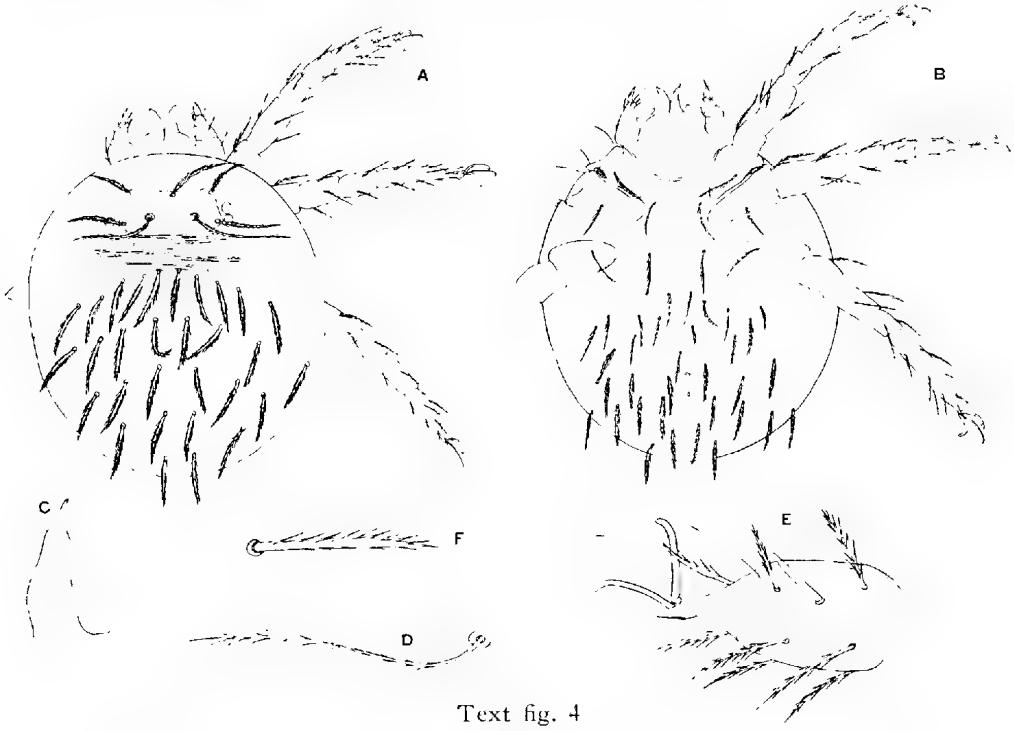
AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
73·5	82·5	27	29	8·5	28	25	28	47	41	—

Arrangement of dorsal setae, 2.12.8.8.4.2.

Trombicula fletcheri n. sp.

(Pl. iii, fig. 8; text fig. 4, A-F)

Description—Shape almost circular. Length 283 μ, width 235 μ. Dorsal scutum (pl. iii, fig. 8) pitted, wider than long, posterior margin shallowly convex and medially extending 8 μ behind line of PL, scutal setae moderately long, and fairly bushy; sensillae rather thick, ciliated as in text fig. 4, D. Eyes 2 + 2, not far removed from sides of scutum. Dorsal setae fairly stout and coarsely ciliated, arranged 2.10.8.6.4.2.2 and 32-50 long. Venter: all coxae with 1 long (40) seta, a similar pair between coxae I and between coxae III, thereafter anterior of anus 8.8.8, posterior of anus 6.4.4.2; those behind the anus are 40 and of similar structure to the dorsal setae, the others are more slender and finer. Legs, palpi and chelicerae normal. Cuticle finely, transversely, striated.



Text fig. 4

Trombicula fletcheri n. sp.: A, dorsal view; B, ventral view; C, chelicera; D, sensilla of scutum; E, tarsus I; F, dorsal seta.

The standard data for the type and paratype are:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Type - -	62	74	32	20	15	27	52	35	48	65	32–50
Parat. -	62	75	30	20	14	25	50	35	48	62	32–50

Loc. and Host—Two specimens permanently mounted sent from the Institute of Medical Research, Federated Malay States, and labelled as *Trombicula akamushi* (Brumpt), from *Rattus rattus* (*diardi* or *jalorensis*), Sungei Buloh, Selangor, 14 October 1930.

Remarks—From the key to species, the figures, and descriptions it will be seen that the above specimens do not agree with *akamushi* or any other known species. We have pleasure in naming it after Dr. W. Fletcher.

Trombicula bodensis Gunther 1940

Proc. Linn. Soc. N.S.W., **65**, (5-6), 479, 1940.

(Pl. iii, fig. 7)

Of this species which was described from specimens taken on the mouse deer, *Tragulus borneanus* Miller, from the Bode River near Sandakan, British North Borneo, we have been able to examine the type slide from the School of Public Health, University of Sydney, as well as three paratypes.

The standard data for these specimens are as follows:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Type - -	55	63	27	20	11	25	45	40	48	60	40–50
Parat. -	55	62	27	21·5	10	25	45	38	50	—	40–50
,, -	60	65	27	22	10	27	44	39	49	—	40–50
,, -	56	65	27	23	10	28	40	40	50	65	40–50
Mean - -	56·5	64	27	22	10	26	44·5	39	49·5	62·5	40–50

The posterior margin of the dorsal scutum reaches 3 μ behind the line of PL, and the arrangement of the DS is 2.8.6.6.6.4.

There are some slight differences between certain of the above measurements and those given by Gunther, *e.g.*, the scutum is given by him as 75 wide and 37·5 long, whereas allowing for the fact that PW is somewhat less than the real maximum width, the latter value is only about 66-67. Similarly our values for the length of the scutum (ASB + PSB) are nowhere greater than 33 as against 37·5 given by Gunther.

Trombicula deliensis Walch 1923

Kitasato Arch. Exper. Med., **5**, (3), 63, 1923; Tr. Vth. Bien. Congr. Far East. Assoc. Trop. Med., Singapore, 1923 (publ. 1924).

= *vanderghinstei* Gunther 1940. Proc. Linn. Soc. N.S.W., **65**, (3-4), 252.

(Pl. iv, fig. 1)

This species was originally recorded from Deli, on the east coast of Sumatra, where Walch found it on man and rodents and considered it to be the vector of the pseudotyphus of that region. It was apparently confined to the lower altitudes, up to 300 metres.

In 1940 Gunther described *T. vanderghinstei* from rats at Bulolo and considered that it might possibly be only a local variant of *deliensis*. From the comparison of our figures of the dorsal scutum of these two species and the data given for both it will be seen that Gunther's *vanderghinstei* is only a synonym of the Sumatran species.

Heaslip (Med. J. of Aust. 1941, 380) in his investigations into the "tsutsugamushi" fever of North Queensland (Cairns district) has shown that *T. deliensis* is the commonest species of larval *Trombicula* of that area, but he did not find it around Brisbane. It occurred plentifully on rats and the bandicoot, *Isoodon torosus*, and out of 2,500 specimens from these hosts 90% were *T. deliensis*. It is apparently the vector of "tsutsugamushi" fever in North Queensland.

Of the material that we have examined in detail we give the following data:

Queensland:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Cairns -	63	81	32	21·5	13·5	27	55	46	60	62	50–55
,, -	62	76	30	23	13·5	29	56	46	65	62	50–55
,, -	62	76	30	23	13·5	27	54	43	60	60	50–55
,, -	65	76	30	23	13·5	28	54	43	65	65	45 55
,, -	60	73	27	22	13·5	27	54	43	62	- -	45 55

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Cairns -	60	73	28	22	13·5	30	60	43	60	65	50–60
,, -	62	75	30	22	13·5	30	55	43	60	62	50–60
,, -	65	75	30	24	16	30	54	41	60	65	55–55
,, -	65	77	30	24	13·5	27	56	43	63	65	50–60
,, -	62	70	26	21	13·5	27	52	41	57	60	45–55
,, -	60	73	30	22	13·5	30	56	40	62	60	45–60
,, -	60	75	30	24	13·5	28	56	43	62	60	45–60
,, -	65	81	32	23	15	30	60	46	65	—	50–60
,, -	67	82	32	23	15	28	56	43	65	—	48–55
,, -	65	78	32	24	15	28	57	46	62	65	50–55
,, -	65	82	30	25	16	27	56	46	65	62	50–60
,, -	65	78	30	23	16	28	54	48	62	65	48–55
,, -	65	81	30	22	13·5	30	60	46	67	65	50–60
,, -	65	76	29	25	16	30	57	43	65	62	45–55
,, -	60	81	31	23	13·5	27	—	40	65	—	45–60
Mean - -	63	77	30	23	14	28	56	44	63	62	45–60

New Guinea—Type and three paratypes of *T. vanderghinstei:*

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Type - -	65·5	75	30	22	13·5	26·5	50	43	60	65	45–60
Parat. - -	65	76	31	25	13·5	30	53	42·5	61	65	45–60
,, - -	—	—	—	—	—	27	60	42	64	65	48–60
,, - -	64	71	27	26	14	26	54	43	62	65	45–55
Mean - -	65	74	29·5	24	13·5	27	54	42·5	61	65	45–60

In all the above the arrangement of dorsal setae is 2.8.6.6.4.2. as given by Walch and by Gunther. The other data given by Walch are: scutal width 74, length 37; AL 39, Sens. 61, and by Gunther: scutal width 84·4, length 50; AM 50, AL 46, PL 56, SB 28; these latter, however, are not quite in agreement with our measurements of his material.

Trombicula corvi Kawamura and Yamaguchi 1921

Kitasato Archiv. Exper. Med., 1921, **4**, 169.

(Text fig. 7 A)

Hatori (1919), Ann. Trop. Parasitol., **13**, 233, referred to a species of *Trombicula* on fowls in Formosa, but while regarding it as new did not describe or figure it.

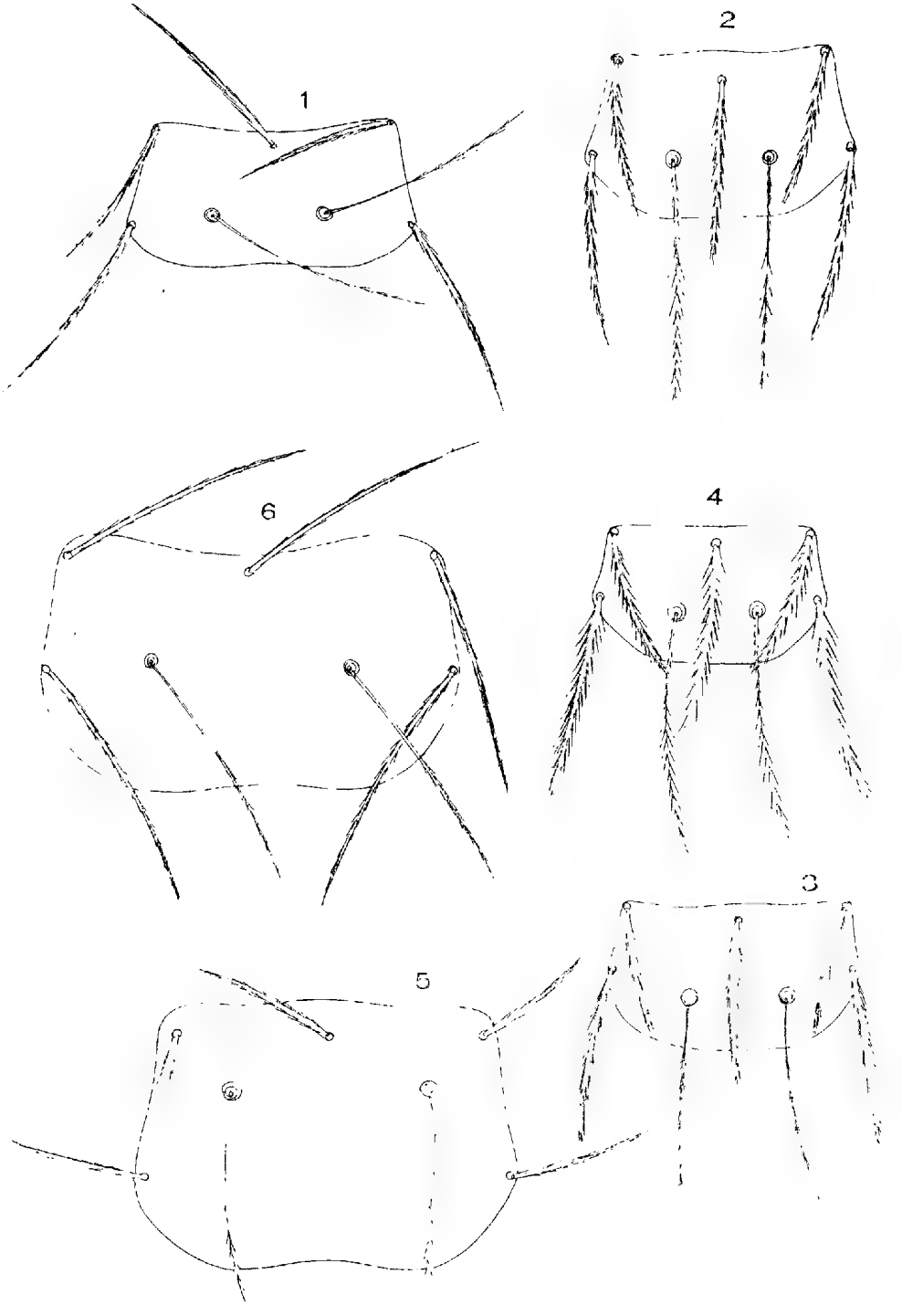
Later, in 1921, Kawamura and Yamaguchi, having received a slide of this species from Hatori himself, published a number of details and referred to it as *Trombicula corvi* Hatori. As we can find no reference to this specific name having been published by Hatori, it would seem that the species should be known as *T. corvi* Kawamura and Yamaguchi 1921. These authors give only a few details as in the key, and from these the figure of the dorsal scutum has been constructed. It must be remembered, however, that except for the values given by Kawamura and Yamaguchi it is hypothetical.

Trombicula scutellaris Nagayo 1920

Verhandl. d. jap. pathol. Gesellsch., Tokyo, **10**, 471, 1920; Amer. J. Hygiene, **1**, (5, 6), 569, 1921.

(Pl. iv, fig. 2)

Of this species we have not seen any authentic material. It is very close to *palpalis* Nagayo and may possibly be synonymous with it. The first reference has not been available to us, but the standard data and figure of the dorsal scutum



1, *Trombicula deliensis* Walch; 2, *T. scutellaris* Nagayo; 3, *T. palpalis* Nagayo; 4, *T. intermedia* Nagayo; 5, *T. rara* Walch; 6, *T. rioi* Gunther.

given here is from Nagayo's 1921 figure and data. The figure is to scale and the data as follows:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
57	69·5	26·5	28·5	15	26·5	51	43	53	70	—

The arrangement of dorsal setae is 2.10.10(12).10(8).6.4. According to Nagayo's figure the scutal setae are thick and strongly ciliated and the sensillae with very short ciliations on the basal third and thereafter with long ones. It also differs from the closely allied species *palpalis* and *intermedia* in that A-P is very much greater than SD.

Trombicula palpalis Nagayo et al. 1919

Verhandl. d. jap. pathol. Gesellsch., Tokyo, **9**, 107; Amer. J. Hygiene, **1**, (5, 6), 569, 1921.

(Pl. v, fig. 3)

We have only been able to refer to Nagayo's second paper, but have examined two authentic specimens from Yamagata, Japan (coll. July 1920).

Nagayo (1921) gives the following details: scutal length 37·7, width 71·7, Sens. 61·4. Our standard data for the two specimens examined are:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
62	67	28	26	13	17	47	36	48	56	35–50
58	66	25	22	13	17	45	38	48	—	—

Dorsal setae arranged 2.10.10.+.

Nagayo (1921) claims to have reared this species through from larvae to adult, and to have obtained larvae from the adult. He was unable, however, to point to any very definite specific differences between the nymphs and adults of this species and those of *akamushi*, *pallida*, *intermedia* and *scutellaris*.

Trombicula intermedia Nagayo 1920

Verhandl. d. jap. pathol. Gesellsch., Tokyo, **10**, 471, 1920; Amer. J. Hygiene, **1**, (5, 6), 569, 1921.

(Pl. iv, fig. 4)

Of this species, which is very close to the preceding two species, we have only been able to refer to Nagayo's second paper. Our figure is from his figure and data and drawn to scale. Our standard data, also from his details, are as follows:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
53	60	22·5	23·5	23	18	53	41	57	65	—

Arrangement of dorsal setae, 2.10.8.8.6.4.2.

Nagayo states that he has reared the larvae of this species as far as the nymph, but fails to find any definite morphological distinctions between the nymph of this and the other Japanese forms, *akamushi*, *pallida*, *palpalis* and *scutellaris*.

Trombicula rara Walch 1924

Tr. Vth. Bien. Congr. Far East. Assoc. Trop. Med. Singapore, 1923 (publ. 1924).

(Pl. iv, fig. 5)

This species was recorded from man from Sumatra. We have not been able to obtain any authentic material but Walch gives the following data: width of scutum 104, length 74, AL 33, Sens. 57. DS in text 6.4.4.2, in fig. 2.6.2.4.4.2, and 34 μ long. From his figure and the above data we give the following standard data on the basis of ASB + PSB, i.e., depth or length of scutum (SD) = 74.

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
85	104	54	25	49	40	40	33	40	57	34

From Prof. Dr. J. E. Dinger of the Koningen Wilhelmina Institute v. Bacteriologie, Batavia, we have a slide, I A. l.c. II., unnamed, which on examination proves to be this species. The standard data are:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
92	110	47	27	47	40	40	47	55	60	40

Arrangement of DS, 2.6.6.4.2.

Trombicula rioi Gunther 1939

Proc. Linn. Soc. N.S.W., **64**, (1-2), 80, 1939.

(Pl. iv, fig. 6)

Gunther described this species from *Megapodius duperreyi*, the bush fowl of New Guinea.

In his description he gives the following data: scutal width 120, length 69, AM 66, AL 68, PL 75, SD 50, Sens. 75, DS 2.14.12.4.6.8.10.8.4.

We have been able to examine the type and three paratypes, which gave the following data:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Type -	99	111	53	28	33	31·5	60	70	75	70	35–70
Parat. -	99	110	55	28	33	33	61	70	73	—	—
,, -	102	110	56	30	35	32	60	67	70	70	35–65
,, -	100	110	54	30	35	30	60	72	72	68	35–70
Mean -	100	110	54·5	29	34	31·5	60	70	72·5	69	35–70

Dorsal setae arranged, 2.14.16.12.+.

Trombicula wichmanni (Oudms. 1905)

Trombidium wichmanni Oudms. 1905, Ent. Ber., **1**, (22), 217; 1906, Nova Guinea, **5**, 106, 132, pl. iv, fig. 67-68; 1908, Tijds. Entom., **51**, 25; 1909, *ibid.*, **52**, 38.

Allotrombidium wichmanni Oudms. 1906, Ent. Ber., **2**, (28), 58-59.

Trombidium (*Heterotrombidium*) *wichmanni*, Verdun 1909, Cr. Soc. Biol., Paris, **67**, 246.

Microtrombidium wichmanni Oudms. 1909, Ent. Ber., **3**, (50), 20; 1912, Zool. Jahrb. Suppl., 14, 9.

Trombicula wichmanni, Gunther 1940, Proc. Linn. Soc. N.S.W., **65**, (5, 6), 480, 4-6.

(Pl. v, fig. 1)

This species was originally described from New Guinea from *Goura coronata*, and also from man from the North Celebes. Gunther records it from the mouse deer (*Tragulus borneanus* Miller 1902) from Bode River, British North Borneo, 1939.

We have been able to examine Gunther's type as well as three other specimens, all from the same series from British North Borneo. From these our standard data are as follows:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Type - -	79·5	93	40	25	27	31·5	43	48	58	63	45–65
Parat. - -	76·5	91·5	38	25	26	31·5	43	46	58	63	—
,, - -	79·5	93	38	23	25	31·5	—	46	58	63	—
,, - -	80	93	40	24	27	31·5	43	46	59	—	—
Mean - -	79	92·5	39	24	26	31·5	43	46·5	58	63	45–65

Arrangement of dorsal setae, 2.6.6.4.2.2.

Trombicula hatorii sp. nov.

Trombicula pseudoakamushi Hatori (nec. Tanaka) in Kawamura and Yamaguchi, Kitasato Archives Exper. Med., **4**, 169, 1921.

(Pl. v, fig. 5)

Hatori (Ann. Trop. Med. Parasitol., **13**, 233, 1919) described a species of larval *Trombicula* from Formosa under the above name, and claimed to have reared from these larvae the nymphs and adults which were identified with *T. mediocris* Berl. (= *minor* Berl.). Kawamura and Yamaguchi 1921 also worked on the Formosan species and described and figured what they considered Hatori's form in much detail. They agreed with the correlation of the larvae and adult with *mediocris*. The drawing of the dorsal scutum given herein is based to scale on Kawamura and Yamaguchi's figure and data, from which the following standard data are deduced:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
72	85	37	27	27	27	37	37	50	55	45

Dorsal setae arranged, 2.6.6.4.2.

This species is closely related to *T. wichmanni* Oudm., as will be seen by a comparison with the standard data. It differs in that the SB are only slightly in advance of the line of PL, that the posterior margin of the scutum is not flattened medially, and in the different lengths of the normal scutal setae.

Trombicula minor Berlese 1904

Trombicula minor Berl. 1904, Acari nuovi Manip. IV, 135, pl. xv, fig. 4; Womersley 1939 (July), Trans. Roy. Soc. S. Aust., **63**, (2), 152; Gunther 1939 (December), Proc. Linn. Soc. N.S.W., **64**, (5, 6), 466.

Trombicula mediocris Berl. 1912, Redia 8, fasc. 1, 94; Gunther 1940, Proc. Linn. Soc. N.S.W., **65**, (5-6), 477.

Trombicula hirsti Sambon 1927, Ann. Mag. Nat. Hist., (9), 20, 157; nec Hirst 1929, Ann. Mag. Nat. Hist., (10), **3**, 564; nec Womersley 1934, Rec. S. Aust. Mus., **5**, (2), 212.

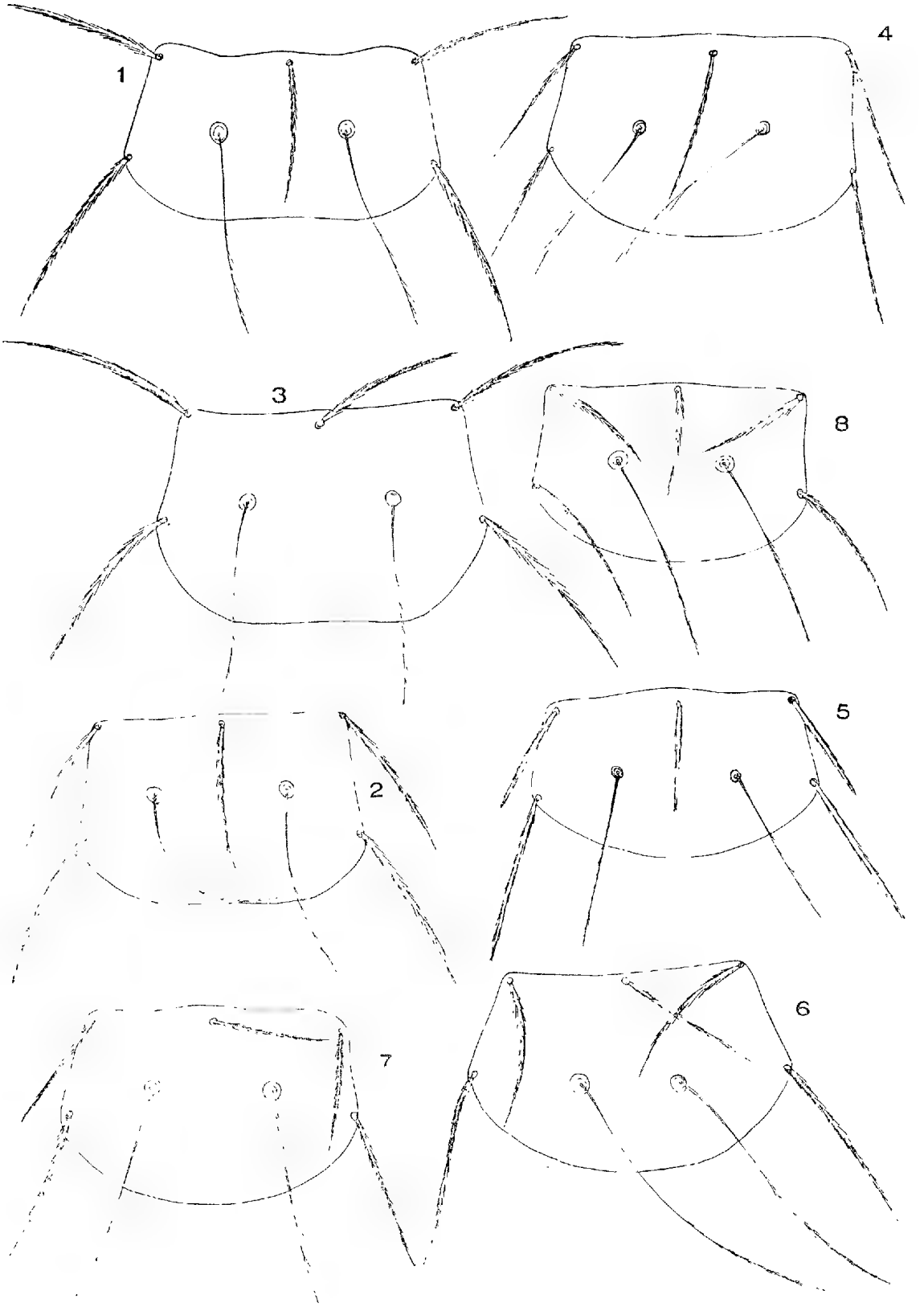
(Pl. v, fig. 2)

Although Berlese in his description and figure of *T. minor* from Java makes no reference to the presence or absence of eyes, yet his species (specimen imperfect) is probably, as suggested by Kitashima and Miyajima 1920, the nymph of *T. mediocris* Berl. 1912, also from Java, which has a very well developed eye closely adjacent to and on each side of the sensillary area of the crista.

Gunther's nymphs in size, dimensions of front tarsi and metatarsi, and in the dorsal setae agree with *minor*, but also possess a single eye on each side of the crista as in *mediocris*. An adult female from Innisfail, Queensland (1939, W. G. H.), agrees in size and all other characters with *mediocris* and, except in size and presence of eyes, also with *minor*.

This species as the larvae is the common "itch mite" of the Queensland scrub, at high altitudes. Heaslip (Med. J. Aust., 1941, p. 380), in his studies of "tsutsugamushi" fever in North Queensland, records it from man at Lake Barrine at 1,500 feet, and although he collected adults from near sea level, the larval form was not found amongst 2,500 specimens from rats and bandicoots. The usual hosts of the larvae appear to be birds (*vide* Gunther 1939, C).

T. minor Berl. (larvae) occurs on rats and on the bandicoot, *Isoodon torosus*.



1, *Trombicula wickmanni* Oudms.; 2, *T. minor* Berl. f.p.; 3, *T. minor* v. *deliensis* Walch (from Gunther's material from N.G.); 4, same from Walch's material; 5, **T. hatorii** n. sp.; 6, *T. novae-hollandiae* Hirst; 7, *T. samboni* Wom.; 8, *T. microfus* Wom.

We give the following data from two specimens from Innisfail, and one from Lake Barrine.

	AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	Sens.	DS
Innisfail -	73	85	40	23	35	35	43	46	53	—	50–55
,, -	73	85	40	24	35	35	—	45	52	—	50–55
Lake Barrine	79	89	43	25	35	36	41·5	46·5	52	—	50–55
Mean - -	75	86	41	24	35	35·5	42	46	52	—	50–55

Arrangement of dorsal setae, 2.6.6.4.2.

TROMBICULA MINOR v. DELIENSIS Walch 1923

Trombicula pseudoakamushi v. *deliensis* Walch 1923.
Trombicula hirsti Gater 1932.
Trombicula hirsti v. *morobensis* (nom. nud.) Gunther 1938.
Trombicula hirsti v. *buloloensis* Gunther 1939.

(Pl. v, fig. 3, 4)

This form appears to be but a variety of the larvae of *Trombicula minor* Berl. The differences, as will be seen from the key to species and from the figures, lie only in the size of the scutum and the longer scutal setae. Walch described it as a variety of Hatori's Formosan species *T. pseudoakamushi* (non Tanaka), from Deli, Sumatra. Gunther records it as common in the somewhat higher altitudes of New Guinea from many hosts, bandicoots, bush fowl, bush pig, bush turkey, cassowary, pigeon, and as a casual on rail, swamp hen and man. It was from this variety that he bred his nymphal *T. minor* Berl. It also occurs at Selangor, Federated Malay States. We have examined the following 21 specimens from New Guinea, and also a single specimen from Selangor, Federated Malay States, 1929, labelled as *T. hirsti*, with the following results:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	DS
F.M.S. -	85	106	41·5	23	35	33	43	50	56·5	41–58

Dorsal setae, 2.6.6.4.2.

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Type slide, N.G. -	83	99·5	44	30	40	38	48	53	56·5	60	—
,, ,, ,, -	83	99·5	44	26·5	40	33	53	51·5	58	60	—
,, ,, ,, -	83	98	44	28	38	33	—	50	55	60	—
,, ,, ,, -	83	96	44	26·5	36·5	35	—	50	56·5	60	—
,, ,, ,, -	80	96	41·5	23+	36·5	31	48	51·5	58	60	—
,, ,, ,, -	83	99·5	43	23+	36·5	35	48	53	58	60	—
,, ,, ,, -	83	99·5	44	25	36·5	33	48	53	60	61·5	—
,, ,, ,, -	84	101	46·5	25	36·5	33	50	55	60	63	—
,, ,, ,, -	83	95	43	26·5	38	35	50	54	60	60	—
,, ,, ,, -	84·5	103	44	26·5	38	35	50	55	60	60	—
,, ,, ,, -	84·5	96	43	26·5	38	33	—	55	58	60	—
Slide 2, N.G. - -	81·5	96	41·5	25	40	35	45	49	55	58	—
,, ,, - -	83	98	43	25	41·5	35	45	49	55	53	—
,, ,, - -	91	103	46	26·5	41·5	33	45	58	64	56	—
,, ,, - -	83	96	44	25	40	33	43	48	56	50	—
Slide 3, N.G. - -	83	99	46	25	40	35	50	53	50	60	—
,, ,, - -	83	96	45	26·5	38	33	50	53	61	60	—
,, ,, - -	83	104	46·5	25+	40	38	50	58	62	51	—
Slide 4, N.G. -- -	86	103	47	28	40	38	50	58	54	—	—
,, ,, - -	91	106	45	28	38	35	46·5	53	58	—	—
,, ,, - -	91	103	45	28	38	33	47	53	58	—	—
Mean - - - -	84·5	99·5	44·5	26·5	38·5	34·5	48	53	58·5	58·5	50–60

Arrangement of dorsal setae, 2.6.6.4.2.

That Walch's description and figures agree with the above is apparent, when the standard data deduced from them are compared. These data are as follows:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
82·5	93·5	36	28	33	33	46	48	56	58	44

He gives AL = 46 and shows the other setae as almost equal.

Trombicula novae-hollandiae Hirst 1929

Proc. Zool. Soc. London, 1929, 172; Womersley 1934, Rec. S. Aust. Mus., **5**, (2), 213.

(Pl. v, fig. 6)

Of this species we have measured 14 specimens from Kangaroo Island, South Australia (including 9 co-types), 9 specimens from Tasmania and 4 specimens from Cairns, Queensland.

The maximum, minimum and mean data of this material are as follows:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Maxima -	78	102	32	38	29	38	62	54	78	100	—
Minima -	62	90	27	32	24	32	49	46	57	90	—
Mean - -	71	96·5	31	35	27	35	53·5	51	68	95	50–80

The arrangement of dorsal setae is, 2.6.6.6.4.2.

Trombicula samboni Wom. 1936

(Pl. v, fig. 7; text fig. 5)

Womersley 1939, Trans. Roy. Soc. S. Aust., **63**, (2), 153.

= *Trombicula hirsti* Hirst 1929, nec Sambon 1927; Womersley 1934 nec Sambon 1927.

This is the "ti-tree itch" mite of South Australia. We have measured 10 specimens from Robe, the type locality, and 8 specimens from Port McDonnell.

The following are the standard data from all this material:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Highest -	81	91	38	26	39	32	41	44	52	72	—
Lowest -	75	84	34	23	31	27	37	38	43	65	—
Mean -	78·5	87	36	24	36	30	38	42	48	68·5	30–58

Dorsal setae, 2.6.6.6.4.2.

While this paper was in preparation two visits were made by one of us (H. W.) to the Robe district of South Australia to ascertain the prevalence of the larvae of this species at that time of the year (April) for certain experimental reasons.

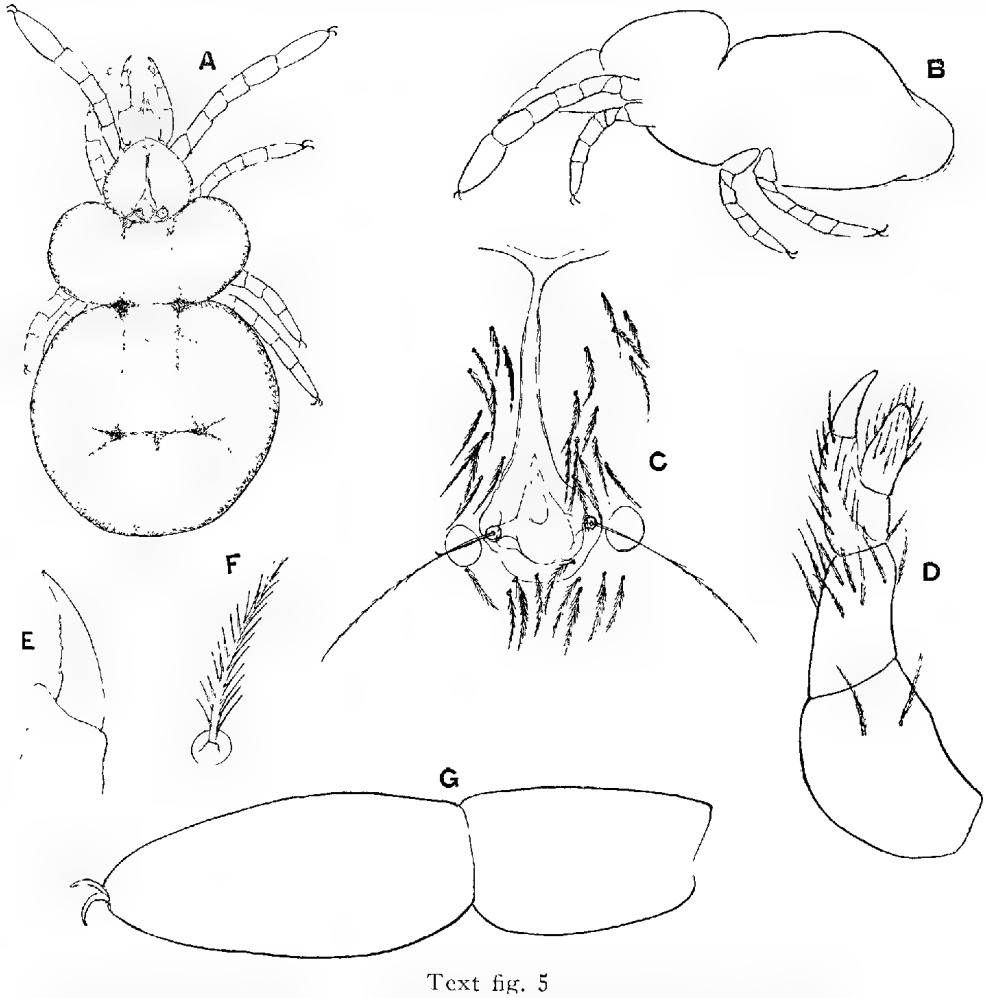
Inquiries showed that the larvae, locally known as "red spider" or "ti-tree itch," were well known to residents throughout the coastal area from Policeman's Point on the Coorong to Port McDonnell. The mites occur mainly on open grassy patches amongst the ti-tree scrub, frequented by campers and duck shooters. Walking amongst the scrub or lying on the grass invariably leads to infestation of the person, and any objects on the ground, such as one's boots, a gun or handkerchief, soon become covered with numerous specimens of these tiny yellowish active mites. They are more prevalent on warmer days, particularly from September to January but occur throughout the year, and even on the occasion of our visits they were abundant although the weather was cold and wet.

In the Robe district at the present time they occur on the introduced rabbit, which abounds, as small yellowish clusters in the ears and around the eyes. Almost any rabbit seemed to carry some. Old residents stated that they could remember the "itch" from their earliest days, 70 to 80 years ago, although rabbits did not appear in the district until about 50 years ago. Before rabbits became common, native animals such as wallabies and bandicoots were abundant, but are now extinct. It appears reasonable, therefore, to assume that the mites were carried by such native animals, and that as these were replaced by rabbits the mites transferred themselves to the latter.

The mites commonly attack cattle, horses and sheep, causing severe irritation and even bleeding, with subsequent loss of condition; in fact, one person informed us that he had lost cattle as a result.

On cattle and man the mites attach themselves singly and not in clusters as on the rabbits or on the hocks of sheep. On man they do not, as believed by local residents, burrow under the skin, but attach in the normal way by the mouth parts only, and are probably soon detached by scratching or rubbing of the clothing.

The bites are very irritating and some people seem to suffer a slight feverish reaction, although as far as known this particular species is not a vector of disease,



Text fig. 5

Trombicula samboni Wom. Adult: A, dorsal outline; B, lateral outline; C, crista and eyes; D, palp; E, chelicera; F, dorsal seta; G, tarsus and metatarsus I.

as are some allied species from Japan, New Guinea and Queensland. The site of attack on man is chiefly on the legs, around the waistline where clothing fits tightly and frequently on the scrotum. During the first visit nymphs or adults were not found, but intensive search on the second visit discovered numerous specimens of both stages in the black soil, chiefly in the top inch, and especially near spots where rabbits had been scratching and stamping. While finding of adults in the field is not absolute proof of their association with the larvae, the fact that in this area only the one larval species is known, strongly supports the view that

the larvae and adults are of the same species. Nevertheless, breeding experiments are being made to check this conclusion.

Adult of *Trombicula samboni* Wom. — Colour in life red except the propodosoma which is colourless except for deeply pigmented eyes. Shape a figure of 8, with the posterior portion broader than the anterior portion. Length (excluding gnathosoma) 1,200; width, anterior portion 690, posterior portion 860. Crista distinct, 170, sensillary area roughly triangular with paired sensillae, 118 long, and shortly finely ciliated on distal half, SB 47. Eyes 1 + 1, large and closely adjacent to sensillary area, deeply red pigmented in life, but difficult to observe after death except in freshly mounted specimens. Legs short, except I; I 775 long, II 520, III 600, IV 680, tarsus I conspicuous, 206 long by 86 wide, metatarsus 137 long. Clothing of thickly placed, ciliated, pointed setae, 40 long, with the ciliations long and outstanding, all setae uniform. Genital opening with three pairs of discs.

Nymph Similar to adult in all details except size and having only two pairs of genital discs. Length 1,000, width, anterior portion, 600, posterior portion 720.

Trombicula macropus Wom. 1936

Womersley 1936, J. Linn. Soc., London, (Zool), **40**, (269), 112.

(Pl. v, fig. 8)

The mean, maximum and minimum data for seven specimens of this species are as follows:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Maxima -	80	85	35	24	35	30	33	38	52	65	—
Minima -	72	78	30	22	30	27	30	30	46	65	—
Mean -	76	82	33	24	32	30	32	35	50	65	30–50

Dorsal setae arranged 2.8.6.4 .

Trombicula cervulicola Ewing 1931

Proc. U.S. Nat. Mus., 1931, No. 2,908, **80**, Art. 8, 13, pl. i, fig. 3.

(Text fig. 18, A [7])

This species was described from specimens from the Barking Deer (*Cervulus aureus*) from Muktesar, Kumaun, India.

Ewing's descriptions give no dimensions beyond the length and width of a "slightly engorged larva."

He regards the species as near to *acuscutellaris* Walch, differing in the scutum not being so angulate posteriorly and in the fewer setules on the sensillary setae. The dorsal setae are given as 26 in number.

From the details available it is not possible to place this species in the key. But from Ewing's figure of the dorsal scutum and assuming AW at 56, we get the following standard data:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
56	64	26	20	22	24	34	32	52	44	?

On the Correlation of the Larvae with the Nymphs and Adults of Trombicula

Although a large number of larval species of Trombiculinae are known, only a very few of these are also known from either the nymph or adult or both stages. Because of the importance of the larvae of these mites as vectors of disease to man from animals, it is of the utmost importance that an intensive study of their life histories should be made with a view to clearing up the whole question.

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[7] To no definite magnification.

In America, according to Ewing, nymphs and adults of the itch mite or "chigger" have been reared and it has been shown that the adult, *T. cinnabaris* Ew., is synonymous with the larva known as *Trombicula irritans* (Riley), which name has priority. In England the common "harvest mite," *Trombicula autumnalis*, has also been reared by Hirst to the nymphal stage.

Within the area covered by this paper, out of 30 recognised larval species of *Trombicula* s. str., at the most only four can be definitely correlated with nymphs or adults; these are *akamushi* Brumpt, *deliensis* Walch, *minor* Berlese, and *samboni* Wom. In addition two other species, *signata* Wom. and *tindalei* Wom., are known as nymphs from captured material but are unknown as larvae or at least uncorrelated with any known larvae. The life-cycle of *T. akamushi* seems to have been fairly definitely established by a number of Japanese workers since 1916, the principal of whom were Nagayo et al., Kawamura and Yamaguchi, and Miyajima and Okumura. None of these workers, however, appear to have identified the nymphal and adult stages with any known species.

In 1917 Hatori studied the tsutsugamushi disease of Formosa, and besides claiming to have reared the nymphs and adults from the larvae of *akamushi*, recorded another larval species under the name of *pseudoakamushi* (non Tanaka) (= **hatorii** n. sp. The adults of this second form he found living free in the soil, and considered it might be synonymous with Berlese's *mediocris* (= *minor* Berl.) from Java.

In 1921 Kawamura and Yamaguchi also studied the Formosan species and confirmed Hatori's rearing of both species, also referring *pseudoakamushi* to *mediocris* Berl.

In 1939 Gunther, in New Guinea, reared nymphs from the larvae, then known as *T. hirsti* v. *bulolocusis* Gunther, which one of us (H. W.) was able to identfiy with *T. minor*, and in Queensland W. G. Heaslip collected an adult of this species. The third species to be reared through is *T. deliensis* Walch, of which Walch himself reared and described the nymph and adult. This species cannot yet be referred to any known adult species. In the present paper the nymph and adult of the "ti-tree itch" of South Australia are also described.

In 1921 Nagayo et al. also claimed to have reared nymphs and adults from four other species from Japan, namely *palpalis, pallida, intermedia* and *scutellaris*. They were unable, however, to point to any specific differences between any of these nymphs or adults and those of *akamushi*, hence the validity of these species is uncertain at present, although the larvae seem to be well differentiated as in the key.

The nymphal and adult stages of those species known as such from the area under review can be separated as follows:

1 Eyes 1 + 1, closely adjacent to the sensillary area. 2
Eyes apparently absent. 5

2 Colour in life creamy white. 3
Colour in life red. Size 1·2 mm. long, width of opisthosoma 860 μ. DS pointed, 40 long, uniform, with long ciliations. Sens. 118 long, with short inconspicuous ciliations on distal half. SB 47. Tarsus I 206 μ by 86 μ. (Adult.) *T. samboni* Wom.

3 DS long, thick, pointed, with only a few adpressed ciliations or serrations. Length 1·2 mm. Sens. 170, SB 37. Tarsus I 237 μ by 97 μ. (Nymph.) *T. signata* Wom.
DS finer, with fine outstanding ciliations. 4

4 Length 1,100 μ, width 860 μ. DS 30-50 long. Sens. 160, SB 57. Tarsus I 260 μ by 105 μ. (Adult.) *T. minor* Berl.
Length 1,670 μ width. DS to 70 long. Sens. 160, SB 42. Tarsus I 275 μ by 67 μ (Adult.) *T. elegans* Wom.

5 Sens. area transverse and wider than long. 6

Sens. area more or less triangular, about as long as wide. *T. akamushi* (Brumpt.)
T. palpalis Nagayo
T. pallida Nagayo*
T. intermedia Nagayo
T. scutellaris Nagayo

6 Sens. 111, with short cilia along whole length, those on basal third very small, SB 25. Tarsus I in ratio of width to length = 1 : 1·7. DS 21-56, apically knobbed. (Nymph.) *T. delicnis* Walch.

Sens. 160, with few long branches on distal half. SB 71. Tarsus I 132 μ by 53 μ. DS 26-40 pointed with long outstanding ciliations. (Nymph.) *T. tindalei* Wom.

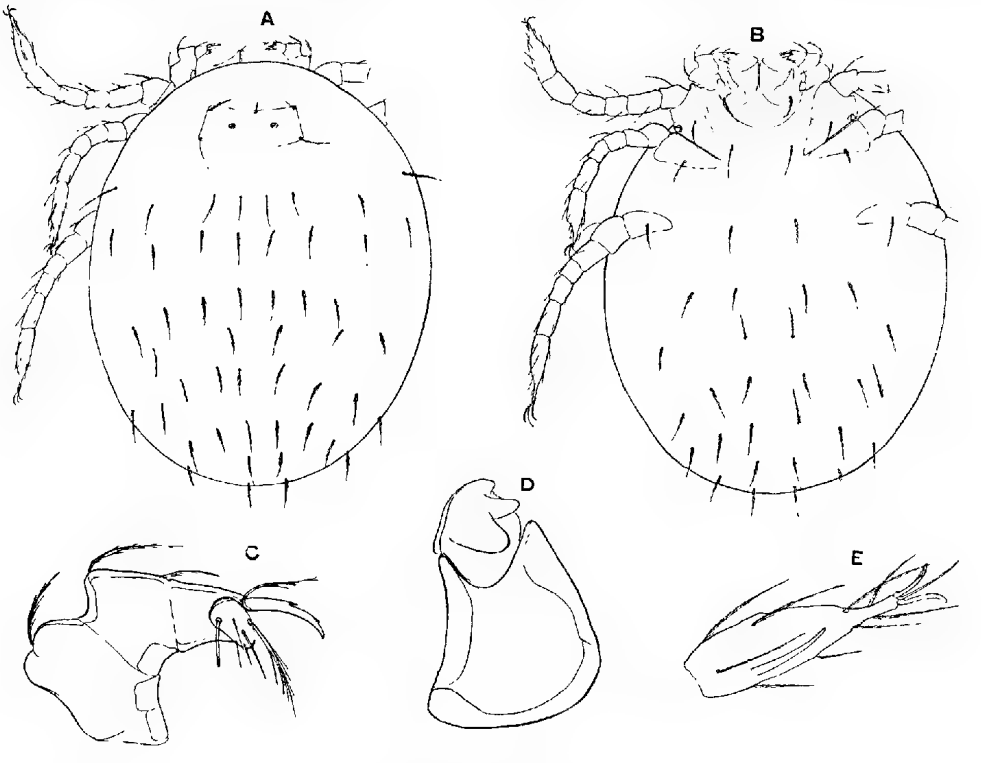
Gen. **Myotrombicula** nov.

Mandibles and palpi modified for grasping hair. One dorsal scutum as in *Trombicula,* with five normal scutal setae and a pair of sensillae. Claws three on all legs, the inner claw longer and finer than the laterals. Genotype **M. vespertilionis** n. sp.

Myotrombicula vespertilionis n. sp.

(Text fig. 6, A-E; text fig. 8, B)

Description—Shape almost rounded. Length 275 μ, width 220 μ. Legs long and slender, I 170, II 145, III 145. Dorsal scutum transversely rectangular (cf. text fig. 8, B), AW 62·5, PW 65·5, SD 24, ASB 16, PSB 11, A-P 16, AM 23, AL 19, PL 27, Sens. —, DS 23. Dorsal setae arranged 2.6(8).2(6).8.4.8.6.4.2, pointed, with short ciliations. Eyes absent. Mandibles (text fig. 6, D) with stout short stipes, and short broad chelicerae with two large blunt teeth, adapted more for



Text fig. 6

Myotrombicula vespertilionis n.g. et n. sp.: A, dorsal view; B, ventral view; C, palp; D, mandible; E, tarsus I.

* See under larval form of this species.

grasping hair. Palpi as in text fig. 6, C, strongly bent over as if to help in grasping hair, details as in figure. Venter with setae as shown, one on each coxae, a pair between coxae I and between coxae III, thereafter 2.4.4.6.6.4.2. Tarsus I (text fig. 6, E) with a long stout dorsal seta.

Loc. and Hosts.—This very interesting species was found among the debris of a jar of spirit containing bats, No. M 4443-53, 3576, 501, and 500 in the collections of the South Australian Museum, probably from South Australia.

Text fig. 7

Trombiculoides gateri n. g. et n. sp.: A, dorsal view; B, ventral view; C, palp; D, chelicera; E, tarsus I.

Remarks—The modifications of the palpi and chelicerae suggest the adaptation for grasping hair, although the modifications are not as pronounced as in some genera of Listrophoridae.

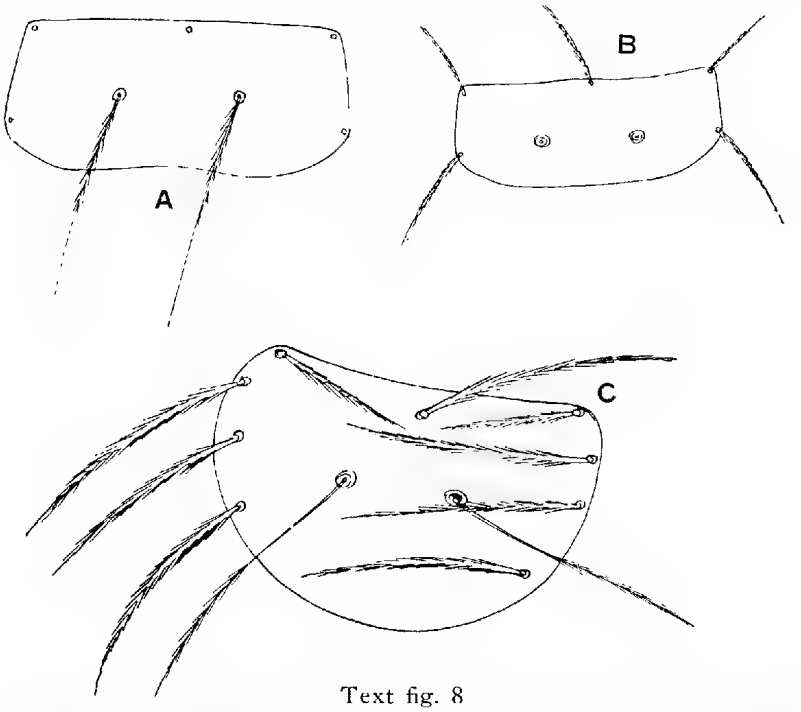
Genus **Trombiculoides** nov.

With a single dorsal scutum carrying nine normal setae and a pair of long filamentous sensillae. Eyes 2 + 2. Chelicerae large and strong with a strong apical and strong inner subapical tooth. Genotype *T. gateri* n. sp.

Trombiculoides gateri n. sp.

(Text fig. 7, A-E; 8, C)

Description—Shape subrotund. Length 690 μ, width 395 μ. Legs I 310, II 275, III 340. Eyes, two on each side. Dorsal scutum with a slightly incurved front margin, and then uniformly curved so that there is no demarcation between the lateral and posterior margins; with strongly ciliated setae, one anterior



Text fig. 8

A, dorsal scutum of *Trombicula corvi* K. & Y., x 500; B, dorsal scutum of **Myotrombicula vespertilionis** n. sp., x 500; C, dorsal scutum of **Trombiculoides gateri,** n. sp., x 500

median, one at each antero-lateral corner and one where each postero-lateral corner should be, and then two on each side between the AL and PL setae; two long sensillary setae, ciliated on apical half, their bases slightly in advance of the middle of scutum. Mandibles large and strong, with large prominent apical and inner subapical teeth. Dorsal setae long, 80, pointed and strongly ciliated in rows of 2.12.8.4.2.8.10.10.10.6.4, rows four and five from front with the setae sublateral. Palpi normal as figured, tibial claw bifurcate. Venter; all coxae with a single ciliated seta, a pair of setae between coxae II and between coxae III, thereafter 11.6.11.8.6.4.2.2., gradually lengthening posteriorly. Tarsi with three claws, the middle one about twice as long as laterals, tarsus I as in text fig. 7, E, tarsus III with a long outer simple seta. Standard data as follows:

AW	AW^1	AW^2	PW	Max. W	SB	ASB	PSB	A–P	AN	AL	AL^1	AL^2	PL	Sens.
76	91	85	78	95	27	27	33	42	65	28	38	70	60	75

(N.B. — AL_1 and AL_2 are the second and third lateral scutal setae, and AW^1 and AW^2 the width of the scutum between these; Max. W is the greatest width of the scutum.)

Loc. and *Hosts*—The type and two paratypes from *R. rattus argentiventer* Chase from Selinsing-Gunong, Semanggel. Perak, 15/3/32, were sent to us for study by the Institute for Medical Research, Federated Malay States.

Remarks—This genus, in the peculiar and strong chelicerae and the extra scutal setae, is obviously distinct from its allies. In the latter character it might show some relationship to *Gahrliepia* and its associates, but from a study of the figures it is clear that the extra scutal setae are not homologous with the extra scutal ones in *Gahrliepia;* they do not belong to the dorsal rows and are not taken into the scutum by any posterior prolongation.

Genus Schöngastia Oudemans 1910

Entom. Ber., **3**, (54), 86. Genotype *Trombidium vandersandei* Oudms. 1905; *ibid.* **1**, (22), 216.

Trombiculinae with the sensillary setae of the single anterior dorsal scutum clavate or capitate. Dorsal scutum more or less rectangular and with five setae besides the sensillary setae, 1 AM, 2 AL and 2 PL. Chelicerae dorsally serrated.

Only the larval stages of this genus are as yet known.

Key to the Malayan, New Guinea and Formosan Species of Schöngastia

1	Dorsal scutum roughly rectangular, posterior margin sinuous. PL much the shortest 17. AM the longest, DS 2.6.6.6.6.2. *S. oudemansi* Walch 1923	
	Dorsal scutum roughly pentagonal or hexagonal	2
2	Dorsal scutum roughly pentagonal PL the longest, AM the shortest, DS 2.10.6.6.4.2. *S. victa* Gater 1932	
	Dorsal scutum roughly hexagonal.	3
3	AL shorter than AM or PL, DS 2.12.8.4.6.4.2.2, Sens. nude. *S. jamesi* Gunther 1939	
	AL longer than AM, or PL, or both.	4
4	Sens. in line of PL.	5
	Sens. well behind line of PL.	6
5	AW 58, PW 72, DS 2.8.10.10.8.8.4 (after Kawamura). **S. katonis** n.sp.	
	AW 66, PW 91, SB 26, DS 2.10.8.10.8(10).8.8. *S. blestowei* Gunther 1940	
	AW 59, PW 80, SB 33, DS 2.10.2.10.2.10.8.6.4.2. *S. blestowei* v. **megapodius** nov.	
6	DS 2.10.2.10.2.14.2.10.12.8.4., Sens. 35, nude. *S. taylori* Gunther 1940	
	DS 2.10.10.10.10.8.2. Sens. 25 *S. vandersandei* Oudms. 1905	

Schöngastia oudemansi (Walch 1923)

Trombicula oudemansi Walch, Kitasato Archiv. Exper. Med., **5**, (3), 1923; Fletcher, Lesslar and Lewthwaite, Trans. Roy. Soc., Trop. Med. and Hyg., **22**, 161, 1928.

Schöngastia oudemansi (Walch), Gater 1932, Parasitol., **24**.

(Pl. vi, fig. 1)

This species is apparently not known to attack man. It was described from Deli, Sumatra, by Walch from rats, and in 1928 Fletcher et. al. record it as the commonest mite on rats in the Federated Malay States.

We have not seen any specimens of this species but from the data and figures given by Walch and by Fletcher we have drawn the scutum to scale, and deduced the following standard data. Otherwise, the key will separate this species from others of the genus.

Walch's data are: scutal length 50, width 72. AL 27, PL 16·6 and 12 behind sensillae. Sensillae 30 x 9. DS 22 long and arranged in his figure 2.6.6.6.4.4.2. Fletcher furnishes a figure agreeing with that of Walch.

From the above the standard data are:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.
50	68	34	26	24	40	40	27	17	39 x 9

Schöngastia vieta Gater 1932

Parasitology 1902, **24**, 143-174, fig. 5.

(Pl. vi, fig. 2)

Gater described this species from the ears of *R. rattus diardi* (Jentinck) from Kuala Lumpur, Selangor, Federated Malay States, and also recorded it from *R. r. jalorensis* from the same locality and from *R. mulleri validus* from Raub, Pahang.

We have been able to examine one of the series from Raub, and the drawing to scale of the scutum and the following standard data are from that specimen:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
55	78	20	21·5	30	30	25	50	58	35 x 13	45

Dorsal setae 2.10.6.6.4.4.2. Gater gives the scutal length as 56 and the width 76.

Schöngastia jamesi Gunther 1939

Schöngastia rotunda Gunther 1938, Med. J. Austr., **2**, (6), 202 (*nom. nud.*); *jamesi* Gunther 1939, Proc. Linn. Soc. N.S.W., **64**, (1-2), 91.

(Pl. vi, fig. 3)

Through the kindness of Prof. Harvey Sutton of the School of Public Health and Tropical Medicine, University of Sydney, we have been able to examine Gunther's type slide which is labelled "Type specimens XI *S. rotunda* (*jamesi*) Bulolo, T. N. G." There are two specimens on this slide, but only one of these, and that one much damaged by pressure, is *S. jamesi* Gunther; the other specimen is *T. hirsti* v. *deliensis* Walch (= *buloloensis* Gunther). From the type specimen we have only been able to determine SB 35, ASB 26·5, A-P 30, AM 43 +, AL 40, PL 63.

Gunther gives scutal length 50, width 85. AM broken, AL 37·5, PL 47, SB 37, Sens. 37·5 x 12·5, apparently naked. DS 2.12.8.4.6.4.2.2. The figure of the scutum given here is drawn to scale from the above data.

Schöngastia blestowei Gunther 1939

Schöngastia yeomansi Gunther 1938, Med. J. Austr., **2**, (6), 202 (*nom. nud.*); *blestowei* Gunther 1939, Proc. Linn. Soc. N.S.W., **64**, (1-2), 92.

(Pl. vi, fig. 4, 5)

Gunther described this species from a number of specimens from two men near the Sucin River, Sepik District of New Guinea. He also recorded it at the same time from the ears of bush fowl (*Megapodius duperreyi*) from the Bulolo River basin, Morobe District, and from a man at Bulolo.

We have been privileged to examine the type slide from the School of Medicine, Sydney University. This slide contained 10 specimens of the collection

from Suein River, two of which were indicated as types. Seven of these specimens have been carefully measured for our standard data as follows:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Type -	65	91	26	34	31	29	37	65	52	35 x 15	35–40
,, -	65	90	26	31·5	27	31	35	65	50	35 x 15	35–40
Parat. -	65	91	26	31	29	30	35	65	50	35 x 15	35–40
,, -	65	91	26	31	29	30	40	65	50	35 x 15	35–40
,, -	65	88	26	31	29	29	—	65	52	35 x 15	35–40
,, -	65	87	24	31	29	30	35	65	52	35 x 15	35–40
,, -	65	87	26	31	29	31	35	65	50	35 x 15	35–40
Mean -	65	89	26	31·5	29	30	36	65	51	35 x 15	35–40

Dorsal setae arranged 2.10.2.8.10.10.8.8.

Gunther gives the following: scutal length 62·5, width 94, AM 37·5, AL 75, PL 50, SB 25, Sens. 37 x 15, and DS 2.10.8.108(10).10(8).8.8. A slide of three paratypes from *Megapodius duperreyi* from Bulolo, T. N. G., is in the South Australian Museum Collection. The standard data of these specimens are as follows:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
	58	78	32	28	24	20	37	63	58	30 x 15	50
	60	82	35	28	24	20	—	—	62	30 x 16	50
	59	80	32	26	26	20	—	—	—	—	—
Mean -	49	80	33	27	25	20	37	63	60	30 x 15	50

Arrangement of dorsal setae, 2.10.2.10.2.10.8.6.4.2.

It will be seen that there are marked differences in the data of the two lots of specimens, those from *Megapodius* having a smaller scutum with the SB wider apart and placed well behind the line of PL. A-P is also shorter than in the specimens from man, while the DS are also longer. These differences, however, may not be more than varietal and for the present we can only regard them as such and name the form as *S. blestowei* v. **megapodius** nov. The drawings to scale of the dorsal scuta are from the above series of data.

In addition, the scuta in the typical *blestowei* from man is strongly pitted and there is a well-developed crest from the wall of which arises the sensillae. In the specimens from *Megapodius* we cannot see a crest nor any pitting. In the presence of a crest and pitted scutum the typical form might fit into *Paraschöngastia,* but the serrate chelicerae and the absence of circular striations on the posterior portion of the scutum exclude it.

Schongastia katonis n. sp.

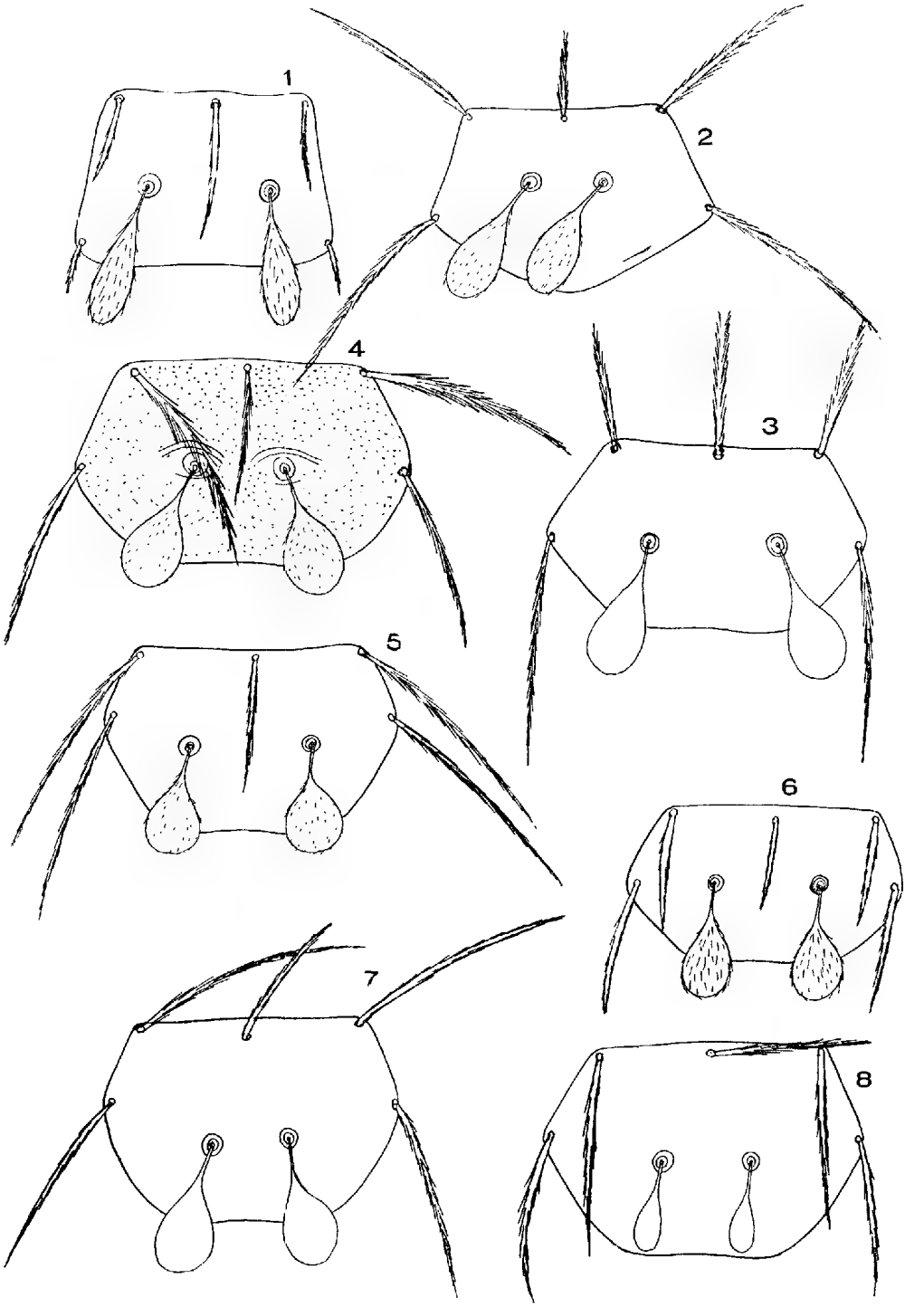
(Pl. vi, fig. 5)

In 1921 Kawamura, R., and Yaganuchi, M. (Kitasato Archives Exper. Med., IV), described a specimen received from Y. Kato in 1917, from Parao Island, in the Carolines. Although well described and figured, they did not give a name to the species, so that *katonis* is here proposed.

Kawamura and Yamaguchi give the following details, from which our standard data and drawing of the scutum are compiled.

Front edge of scutum 58, width 72·6, length 43·6. Sens. clavate, club 20·3 long, 17·4 broad. DS 30-40, arranged 2.8.10.10.8.8.4. Chelicerae serrate. Standard data:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
55	68	28	22	21·5	21	23	37	40	31 x 17	30–40



1, *Schöngastia oudemansi* (Walch); 2, *S. victa* Gater; 3, *S. jamesi* Gunther; 4, *S. blestowei* Gunther; 5, *S. blestowei* v. **megapodius** nov.; 6, **S. katonis** n. sp. 7, *S. taylori* Gunther; 8, *S. vandersandei* Oudms.

Schöngastia taylori Gunther 1940

Proc. Linn Soc. N.S.W., 1940, **65**, (3-4), 257, fig. 12-14.

(Pl. vi, fig. 6, 7)

Described from colonies on the scrotum and hind legs of a scrub wallaby (*Macropus* (*Thylogale*) *coxeni* Gray) at Bulolo, T. N. G.

Of this species we have examined the type slide containing two paratypes in addition to the type, and another slide of two paratypes. From these our standard data are as follows:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Type -	61·5	79	21	35	23·5	23·5	40	73	55	35 x 15	40–50
Parat. -	63	79	21	35	23·5	23·5	—	78	—	—	40–50
" -	61·5	79	21	35	23·5	23·5	43	78	55	—	40–50
" -	63	79	22	35	23·5	23·5	40	81	58	—	40–50
" -	63	79	21	35	23·5	23·5	41	78	60	—	40–50
Mean -	62·5	79	21	35	23·5	23·5	41	78	57	35 x 15	40–50

Arrangement of dorsal setae, 2.10.2.12.2.14.2.10.12.8.4.

Gunther gives the following details: scutal width 87, length 57, AM 42, AL 56, PL 63, Sens. 37·5-15, probably naked. N.B.—It seems possible that his measurements of AL and PL have been reversed, for they do not agree with our measurements of the type.)

Schöngastia vandersandei (Oudms. 1905)

Thrombidium van der Sandei Oudms., 1905, Ent. Berichten, **1**, (22), 216; 1906, Nova Guinea, V, Zool., 131.

Microthrombidium vandersandei Oudms. 1909, Ent. Bericht., **3**, (50), 21.

Schöngastia vandersandei Oudms. 1912, Zool. Jahrbr., Suppl. 14, 45.

(Pl. vi, fig. 8)

This species, which is the type of Oudemans genus *Schöngastia*, was described from New Guinea as attacking man. Oudemans 1906 (*loc. cit.*) gives many records from travellers in this region of being attacked by these small mites. As so many other species of Trombiculinae are now known to occur in New Guinea, it is extremely doubtful whether all these records should be listed under this one species as Oudemans has done; they probably include many species.

From the figure and brief details given by Oudemans we have constructed the scale drawing of the scutum and the following approximate data:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
60	85	25	35	27·5	27·5	45	60	50	25 x 9	40

Dorsal setae, 2.10.10.10.10.8.2.

Genus Neoschöngastia Ewing 1929

Manual of External Parasites 1929, 187. Genotype *Schöngastia americana* Hirst 1921, Ann. Mag. Nat. Hist., (9), **7**, 37.

This genus was erected for those species of *Schöngastia* in which the chelicerae are without dorsal serrations. As yet it is only known from the larvae, with the doubtful exception of *Neoschöngastia schüffneri* Walch, which Walch claims to have reared through to the nymph, of which he figures the crista. From his figure, however, it can hardly be differentiated from *Trombicula* spp., and has the same kind of long, fine, filamentous sensillae, with minute ciliations. Walch also figured the dorsal setae and the palp of the nymph, but here again no differences from *Trombicula* are evident.

In this paper 34 species and 1 variety are recognised, of which 9 species and 1 variety are new.

Key to the Malayan, Australian and Japanese Species of Neoschöngastia

1 Sensillae capitate or globose. 2
Sensillae clavate, often broadly so. 13

2 Sensillae nude. 3
Sensillae with obvious, though sometimes minute setules. 5

3 AL longer than PL, PL shorter than PW, DS 2, 6.6.6.6.4.2. **N. innisfailensis** n. sp.
PL much longer than AL and PW. 4

4 PL about twice the length of PW, DS 2.6.6.6.2(4).4(2).2 *N. womersleyi* Gunther 1940
PL only slightly longer than PW, DS 2.6.6.6.6.2(4).2. **N. melomys** n. sp

5 Coxae III multisetose. 6
Coxae III unisetose. 7

6 Coxae III with two setae. DS 2 plus ca. 10 rows of 10 each. Scutal setae with long ciliations. *N. petrogale* Wom. 1934
Coxae III with 3-5 setae. Scutal setae with short ciliations. DS 2.8.6.6.8.2.4.2.2. *N. mutabilis* Gater 1932

7 PL and most of DS foliate or lanceolate and shortly ciliated. 8
Scutal and DS normal. 9

8 PL and first four rows of DS foliate. PL much longer than PW. DS 2.6.6.6.6.4.2. *N. foliata* Gunther 1940
AM, PL and all DS except posterior two lanceolate. Sensillae? Scutum rectangular. PL much shorter than PW, DS 2.8.6.6.4.2. *N. hastata* (Gater 1932)

9 First row of DS with four setae, *i.e.*, DS 4.6.6.6.6.4.2. Sensillae in front of PL. AL longer than PL. *N. queenslandica* Wom. 1939
First row of DS with two setae only. 10

10 Scutum roughly hexagonal. DS 2.14.14.10.12.8.4. *N. edwardsi* Gunther 1939
Scutum not so. 11

11 Scutum almost rectangular; posterior margin only slightly sinuous and extending very little behind PL. DS 2.6.8.8.8.8.6.4.2. (After Hirst) or 2.4.8.10.10.8. plus about 14. *N. antipodianum* Hirst 1929
Scutum not rectangular; posterior margin extending well behind PL. 12

12 Posterior margin of scutum shallowly sinuous medially. Sensillae anterior of PL. DS 2.6.6.6.6.4.2. *N. coorongensis* Hirst 1929
Posterior margin of scutum an even curve. Sensillae behind PL. DS 2.8.6.6.6.6.4.2. (After Walch.) *N. globulare* Walch, 1927

13 Sensillae long and narrow, almost lanceolate rather than clavate. 14
Sensillae definitely clavate with more or less of a basal stem. 15

14 PL longer than AL or AM. PL off scutum. Scutum small, 34 long, 50 wide. DS 0.8.6.6.4.2. (After Gater.) *N. malayensis* Gater 1932
PL shorter than AL or AM, definitely on the scutum. Scutum larger, 55 long; 78 wide. DS 2.6.8.8.6.6.4.2. (After Gater). *N. lacunosa* Gater 1932

15 AL much longer than PL. 16
AL shorter than PL. 18

16 PL the shortest, 13 14. DS 2.6.6.4(6).6(4).4.2. *N. impar* Gunther 1939
= *bodensis* Gunther 1940
PL more than 40 and longer than AM. 17

17 Posterior margin of scutum medially concave Sensillae in line of PL and in midline of scutum DS 2.8.10.8.8.6. (After Walch.) *N. schüffneri* Walch 1923
Posterior margin of scutum a shallow even curve. Sensillae well in advance of PL. PL well behind midline of scutum. DS 2.8.6.6.4.2. *N. pseudoschüffneri* Walch 1927

18 AW less than 40. 19
AW greater than 50. 22

19 First row of DS with four setae, *i.e.*, DS 4.6.6.6.4.2. AW 35. *N. indica* Hirst 1915 = *muris* Walch 1923
First row of DS with only two setae 20

20 Scutum almost rectangular, and posterior margin rectilinear. Sensillae? DS 2.12.4.8.7.10.2.5.4 (after Gater). *N. debilis* Gater 1932
Not so. 21

21 PL about in midline of scutum. AM and PL nearly equal. Sensillae slightly in front of midline of scutum. DS 2.6(2,4).4.2.4.2.16.12. *N. lorius* Gunther 1939
PL well behind midline of scutum, longer than AM. DS 2.6.6.4.2. **N. rattus** n. sp. 22

22 DS on small platelets, 2.6.2.6.8.6.4.8.6.4.2. **N. heaslipi** n. sp.
DS not on platelets. 23

23 Sensillae posterior to, or in line of, PL. AW/A P greater than 2·7. 24
Sensillae anterior to line of PL. AW/A P less than 2·7. 31

24 PL midway between anterior and posterior corners of scutum, which is roughly trapezoidal with broadly rounded posterior corners. DS 2.12.12.12.12. p'us about 30. *N. peramelcs* Wom. 1939
Not so. PL at the posterior angles of scutum. Posterior margin evenly curved or sinuous. 25

25 A-P half SD. DS 2.8.6.6.6.4.2 26
A-P distinctly less than half SD. 27

26 AW 84, PW 101, SD 52. *N. westraliensis* Wom. 1934
AW 63, PW 84, SD 58. *N. trichosuri* Wom. 1939

27 PL shorter than PW. 28
PL equal to or longer than PW. 30

28 Posterior margin of scutum an even curve. DS 2.8.6.6.6.2.2. AM 39, AL 22, PL 46. PW 65. *N. dasycerci* Hirst 1929
Posterior margin sinuous. 29

29 AL longer than AM. AM 37·5, AL 45, PL 56, DS 2.8.6.6.6.4.2. *N. shieldsi* Gunther 1941
AL shorter than AM AM 47, AL 27·5, PL 72, DS 2.8.6.6.6.4.2. **N. hirsti** n. sp.

30 DS 2.4.4.4.2. **N. similis** n. sp.
DS 2.6.6.6.4.2. *N. derricki* Wom. 1939

31 DS 2.6.6. p'us. 33
DS not so. 32

32 DS 2.12.12.12.12.10.8.4.2. **N. guntheri** n. sp.
DS 2.8.8.8.8.6.4.2. *N. smithi* Wom. 1939

33 AW about 11 less than PW. DS 2.6.6.6.6.6.4.2. **N. phascogale** n. sp.
AW at least 20 less than PW. DS 2.6.6.6.6.4.2. 34

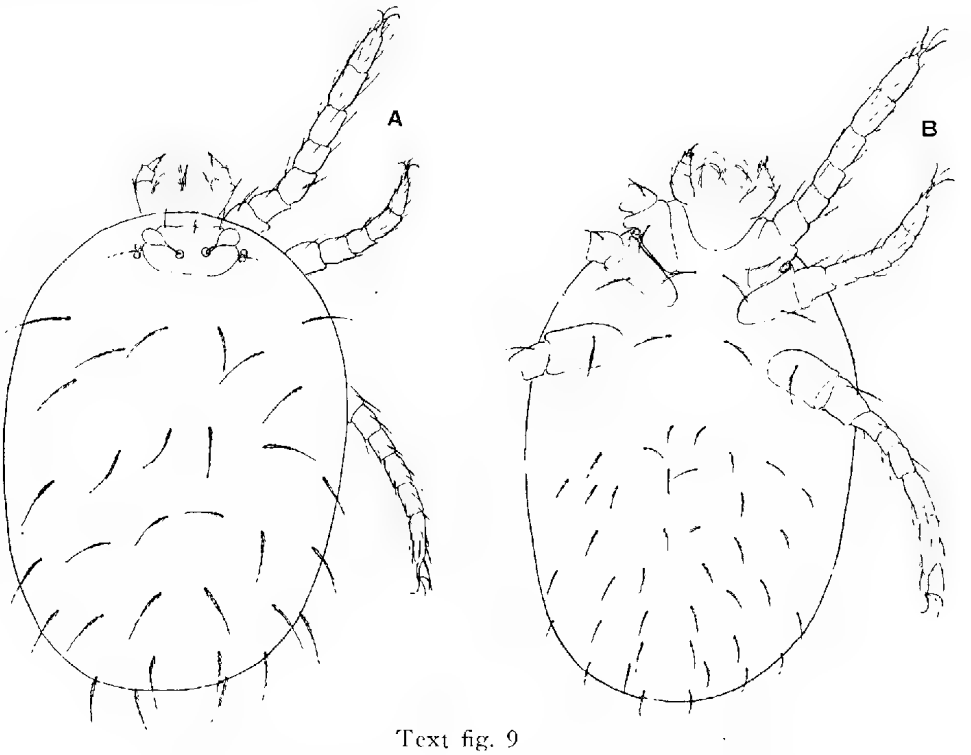
34 AW 54, PW 75. **N. cairnsensis** n. sp.
AW 70, PW 97. *N. cairnsensis* v. **gateri** nov.

Neoschongastia innisfailensis n. sp.

(Pl. vii, fig. 1; text fig. 9, A-B)

Description — Shape elliptical, with rather flattened sides. Length 365 μ, width 225 μ. Legs: I 210, II 170, III 225. Mandibles with non-serrate chelae. Palpi normal, with trifurcate tibial claw. Dorsal scutum as in pl. vii, fig. 1, with the following standard data: AW 42·5, PW 65, SB 18, ASB 23, PSB 16, A-P 26,

AM 32, AL 51, PL 44·5, Sens. 31, with globose head 16 wide and with only very indistinct ciliations under high magnification, almost nude. Eyes two on each side, closely adjacent to scutum. Dorsal setae 25 to 45 long, arranged 2.6.6.6.6.4.2, finely ciliated and tapering. Ventrally with shorter setae, arranged as in text fig. 9 B. Legs with normal chaetotaxy; tarsi with two strong claws and a longer median pulvillus somewhat claw-like.



Text fig. 9
Neoschongastia innisfailensis n. sp.: A, dorsal; B, ventral.

Loc. and Hosts—Fifteen specimens from *Melomys littoralis* Lonnberg from Innisfail, Queensland, 12 October 1938 (W. G. Heaslip).

Remarks—Of ten of the specimens measured the average standard data are as given above, and the highest and lowest values as follows:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL
Highest -	48	78	22	25	21	27	40	56	51
Lowest -	40	60	13	21	13	24	24	45	43

There are much greater variations in the standard data of individuals within this species than is usual.

NEOSCHÖNGASTIA WOMERSLEYI Gunther 1940

Proc. Linn. Soc. N.S.W., **65**, (3-4), 254, 1940.

(Pl. vii, fig. 2)

This species was described by Gunther from colonies in the ears of *Macropus* (*Thylogale*) *coxeni* Gray 1866 from Bulolo, T. N. G., November 1939.

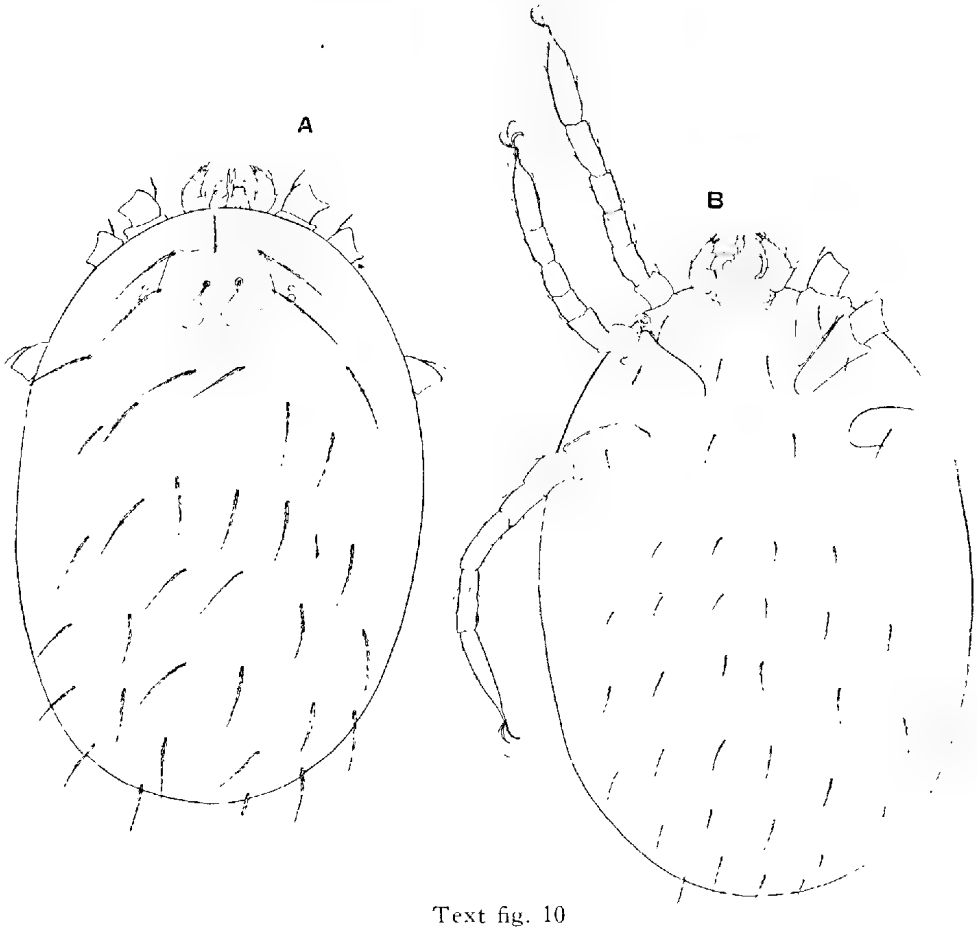
We have been able to examine the type slide containing, besides the type, seven paratypes, of which the type and three others have been measured. In addition, we have also examined a slide containing two paratypes of which one was mea-

sured, and a slide of nine paratypes of which three have been measured. Our standard data for those measured are as follows:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Slide 1, Type & 7 Parat. -	41·5	63	15	23	16·5	27	—	—	115	—	40–50
" " " -	43	63	15	22	18	25	35	69	130	—	40–50
" " " -	43	63	15	22	16·5	28	35	69	130	—	40–50
" " " -	43	65	18	25	16	28	—	66	130	—	40–50
Slide 2, 2 Parat. - - -	41·5	63	17	—	- -	—	36	66·5	130	—	40–50
Slide 3, 9 Parat. - - -	45	68	16·5	23	15	30	36	75	—	—	40–50
" " - - -	43	61·5	15	23	18	30	36·5	76·5	140	30 x 16	40–50
" " - - -	41·5	61·5	15	23	18	28	35	76·5	130	—	40–50
Mean - - - - - - - -	43	63·5	16	23	17	28	36	71	130	30 x 16	40–50

Dorsal setae arranged 2.6.6.6.2(4).4(2).2.

Gunther's data are as follows: AW 50, PW 75, SB 19, ASB 25, PSB 14, A-P 32, AM 36, AL 60-70, PL 120-140, Sens. 30 x 14, DS 54.



Text fig. 10

Neoschongastia melomys n. sp.: A, dorsal, B, ventral.

Neoschongastia melomys n. sp.

(Pl. vii, fig. 3; text fig. 10, A B)

Description—Shape elliptical with the sides rather flattened. Length 465 μ, width 260 μ. Legs: I 220, II 190, III 220. Mandibles with non-serrate chelae.

Palpi normal, with trifurcate tibial claw. Dorsal scutum as in pl. vii, fig. 3, with the following standard data: AW 51, PW 67, SB 17, ASB 21·5, PSB 16, A-P 26·5, AM 31·5 AL 63, PL 72, Sens. 30, with globose head 16 wide, and apparently nude. Eyes 2 + 2, rather small. Dorsal setae 30-55 long, pointed and shortly ciliated, arranged 2.6.6.6.6.2(4).2. Ventrally with shorter setae, one on each coxa, a pair between coxae I and between coxae III, thereafter arranged 4.6.6.6.4.4, their length gradually increasing posteriorly. Legs with normal chaetotaxy, tarsi furnished with two claws and a median longer claw-like pulvillus, tarsi I and II with a median dorsal rather short stout sensory rod, as normally.

Loc. and Hosts The type from the ears of *Melomys littoralis* Lomhbg., Innisfail, Queensland, October 1938 (W. G. H.), and 15 other specimens from rats at Cairns, Queensland, in 1939 and 1940 (W. G. H.).

Remarks—Of these 16 specimens the mean standard data are as given above, and the highest and lowest as follows:

	AW	PW	SB	ASB	PSB	A-P	AM	AL	PL
Highest -	54	70	20	22	19	27	32	67	76
Lowest -	46	62	16	19	13	24	27	57	70

NEOSCHÖNGASTIA PETROGALE Wom. 1934

Rec. S. Aust. Mus., **5**, (2), 215, 1934.

(Pl. vii, fig. 4)

This species was described from specimens taken from the scrotum of a wallaby in the Musgrave Ranges, South Australia.

The standard data for eleven specimens are as follows:

	AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	Sens.	DS
	65	85	31	24	24	32	39	48	52	31 x 17	30–48
	64	86	27	24	24	32	39	46	46	-	30–48
	63	84	30	24	24	28	38	48	48	30 x 16	30–48
	61	81	23	23	23	30	39	44	48	—	30–45
	61	80	23	—	25	30	-	—	50	—	30–46
	65	82	28	25	24	30	40	46	50	—	30–50
	65	85	24	26	23	31	39	49	46	27 x 17	30–46
	66	84	27	26	24	30	—	-	47	30 x 17	30–46
	63	88	30	27	23	32	39	47	48	32 x 17	30–47
	65	88	28	27	22	31	38	47	50	31 x 17	30–50
	66	85	31	29	23	30	40	48	50	30 x 17	30–47
Mean	64	84	27·5	25	24	31·5	39	47	49	30 x 17	30–47

NEOSCHÖNGASTIA MUTABILIS Gater 1932

Parasitology, **24**, 143-174, 1932.

(Pl. vii, fig. 5)

This species was described by Gater, but without any figure, from a cluster of mites in the ear of *Rattus sabanus vociferans* (Miller), from Sungei Buloh, Selangor, Federated Malay States.

We have been able to examine a mount of a somewhat imperfect specimen, labelled by Gater as this species, from *Tupaia glis ferruginea* Raffles from the same locality as the type material.

Standard data for this specimen, and from which the figure of the scutum given here is constructed, are as follows:

AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	Sens.	DS
43	60	8·5	23	12·5	28	—	28	53	28 x 15	35–42

DS arranged 2.8.6.6.8.2.4.2.2.

Gater gives the following: scutal width 72, length 45, SB 12, AL usually the longest, DS 42. These data differ considerably from those of the specimen examined.

NEOSCHÖNGASTIA FOLIATA Gunther 1940

Proc. Linn. Soc. N.S.W., **65**, (3-4), 255, 1940.

(Pl. vii, fig. 6)

This species was described from colonies in the ears of *Macropus* (*Thylogale*) *coxeni* Gray, for Bulolo, T. N. G.

We have been able to measure the standard data for five paratypes of Gunther's material with the following results:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
	50	71	16·5	20	18	25	20	—	91	28 x 17	50–60
	53	68	16·5	20	16·5	25	18	58	83	—	50–60
	50	68	16·5	18·5	16·5	25	21	55	90	—	50–60
	55	71	18	18	17	25	20	63	86	28 x 17	—
	58	70	18	20	18	25	24	—	83	—	50–60
Mean	53	70	17·5	19·5	17·5	25	20·5	57	86	28 x 17	50–60

Dorsal setae arranged 2.6.6.6.6.4.2.

Gunther's data are: scutal length 47, width 84, Sens. bases 19 apart, AM 19-25, AL 50-56, PL 80-100, Sens. 28 long, with club 15 x 16. DS 50-62·5. From his figure we derived the following standard data: AW 66, PW 78, SB 19, ASB 24·5, PSB 27, AM 19·5, AL 57, PL 93. These agree fairly well with our measurements, except that the AW and PW are somewhat higher in proportion. As Gunther states, the PL and first four rows of dorsal setae are foliate, but in our view not so much so as drawn by him.

NEOSCHÖNGASTIA QUEENSLANDICA Wom. 1939

Trans. Roy. Soc. S. Aust., **63**, (2), 162, 1939.

(Pl. vii, fig. 7)

This species was originally described from *Rattus assimilis* from Imbil, Queensland, from *R. youngi* from Cowan Cowan, Queensland, and from *Melomys cervenipes* and *R. lutreolus* from Imbil.

The following are the standard data from 12 of the above specimens:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
	51	75	21	27	14	32	—	—	55	27 x 16	32–45
	51	74	24	27	14	31	35	50	54		32–40
	51	73	21	27	14	32	35	48	56	30 x 16	36–40
	51	73	21	27	14	35	32	48	56	26 x 16	30–40
	51	75	26	27	14	35	35	—	54	—	35–45
	51	73	21	27	14	38	32	—	—	28 x 16	30–45
	54	80	25	27	14	35	35	50	56	—	30–45
	54	76	24	24	13	32	35	54	52	32 x 16	27–40
	49	70	24	27	13	30	32	54	52	—	29–40
	51	75	24	27	13	32	32	50	54	—	27–43
	49	70	22	24	—	30	30	54	52	32 x 16	27–40
	49	73	24	24	16	40	30	56	54	30 x 16	27–36
Mean	51	74	24	26	14	32·5	32·5	56	53	31 x 16	27–45

Arrangement of dorsal setae, 4.6.6.6.6.4.2.

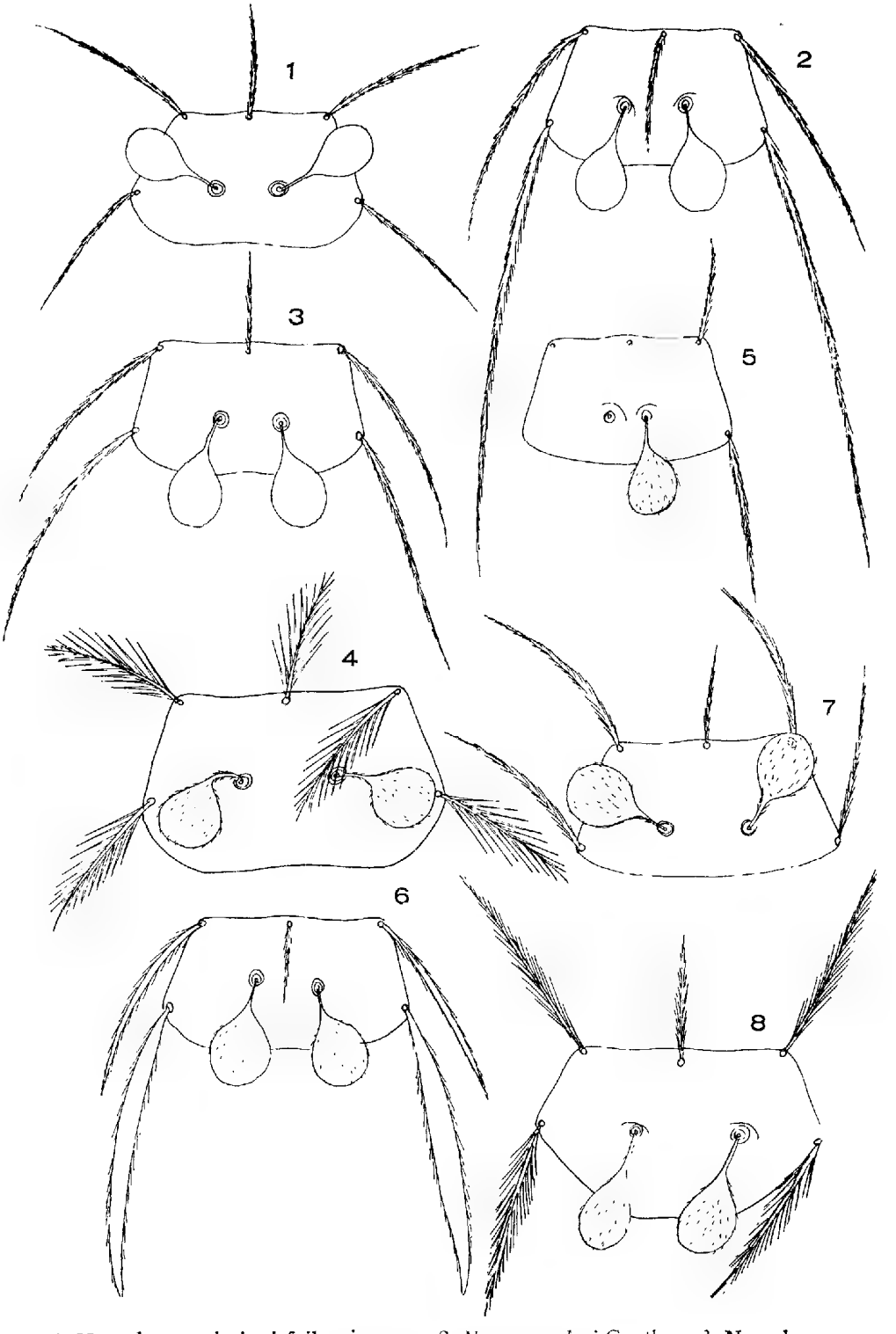
NEOSCHÖNGASTIA EDWARDSI Gunther 1939

Neoschöngastia rioi Gunther 1938 (*nom. nud.*), Med. J. Aust., **2**, (6), 202.

Neoschöngastia edwardsi Gunther 1939, Proc. Linn. Soc. N.S.W., **64**, (1-2), 86.

(Pl. vii, fig. 8)

This species was described from a number of specimens from the New Guinea bush fowl, *Megapodius duperreyi*.



1, **Neoschongastia innisfailensis** n. sp.; 2, *N. womersleyi* Gunther; 3, **N. melomys** n. sp.; 4, *N. petrogale* Wom.; 5, *N. mutabilis* Gater; 6, *N. foliata* Gunther; 7, *N. queenslandica* Wom.; 8, *N. edwardsi* Gunther.

We have been able to examine the type of this species, and have measured the data as follows:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
60	81	33	28	23	28	—	58	—	35–15	40–50

The dorsal setae are arranged, 2.14.14.10.12.8.4.

Gunther gives the scutal length 56, width 87·5, and sensillae bases 36 apart, AM 37·5, AL 75, PL 60, Sens. 29 x 15.

The figure on pl. vii, fig. 8, of the scutum is to scale from the above data.

NEOSCHÖNGASTIA ANTIPODIANUM (Hirst 1929)

Schöngastia antipodianum Hirst, Proc. Zool. Soc. London, 1921, (1), 175.

(Pl. viii, fig. 1)

This species was described by Hirst from the ears of *Rattus greyi* from D' Estree Bay, Kangaroo Island, South Australia.

From the syntype material in the South Australian Museum we have made the following measurements of standard data:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
60	70	24	29	22	42	36	65	62	29 x 19	40–55
62	67	25	32	20	42	38	69	65	—	40–60
58	66	24	29	20	42	37	69	62	25 x 17	40–60
60	67	24	27	17	40	35	70	65	28 x 17	40–58
57	67	24	29	20	40	35	70	62	28 x 18	40–58

Arrangement of dorsal setae, 2.6.8.8.8.8.6.4.2.

NEOSCHÖNGASTIA COORONGENSIS (Hirst 1929)

Schöngastia coorongense Hirst, Ann. Mag. Nat. Hist. 1929, (10), 3, 564.

(Pl. viii, fig. 2)

This species was described from the ears of a rat at Robe, South Australia.

Fifteen syntypes from the Hirst material in the South Australian Museum give the following data:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
	65	86	28	26	20	30	48	44	65	—	32–56
	60	84	28	—	19	28	45	40	62	—	32–55
	65	84	32	—	—	—	43	43	—	—	32–45
	65	86	—	—	—	34	43	40	62	38 x 19	35–55
	71	95	32	25	19	32	43	38	57	30 x 18	35–55
	70	93	32	24	19	32	46	42	64	32 x 19	35–55
	75	92	35	32	20	33	40	36	55	35 x 19	38–50
	65	86	30	25	19	30	43	33	56	30 x 18	35–55
	68	91	30	29	22	30	46	43	58	—	35–50
	73	91	30	29	19	30	—	40	55	—	32–55
	65	85	28	24	21	30	47	40	59	30 x 17	32–55
	63	83	30	29	20	32	45	40	62	—	35–55
	70	105	38	32	23	34	48	41	65	—	35–57
	66	88	32	28	20	30	48	40	57	—	32–52
	70	93	32	28	20	29	42	41	58	—	35–50
Mean	68	90	31	27	20	31	45	40	60	32 x 18	32–55

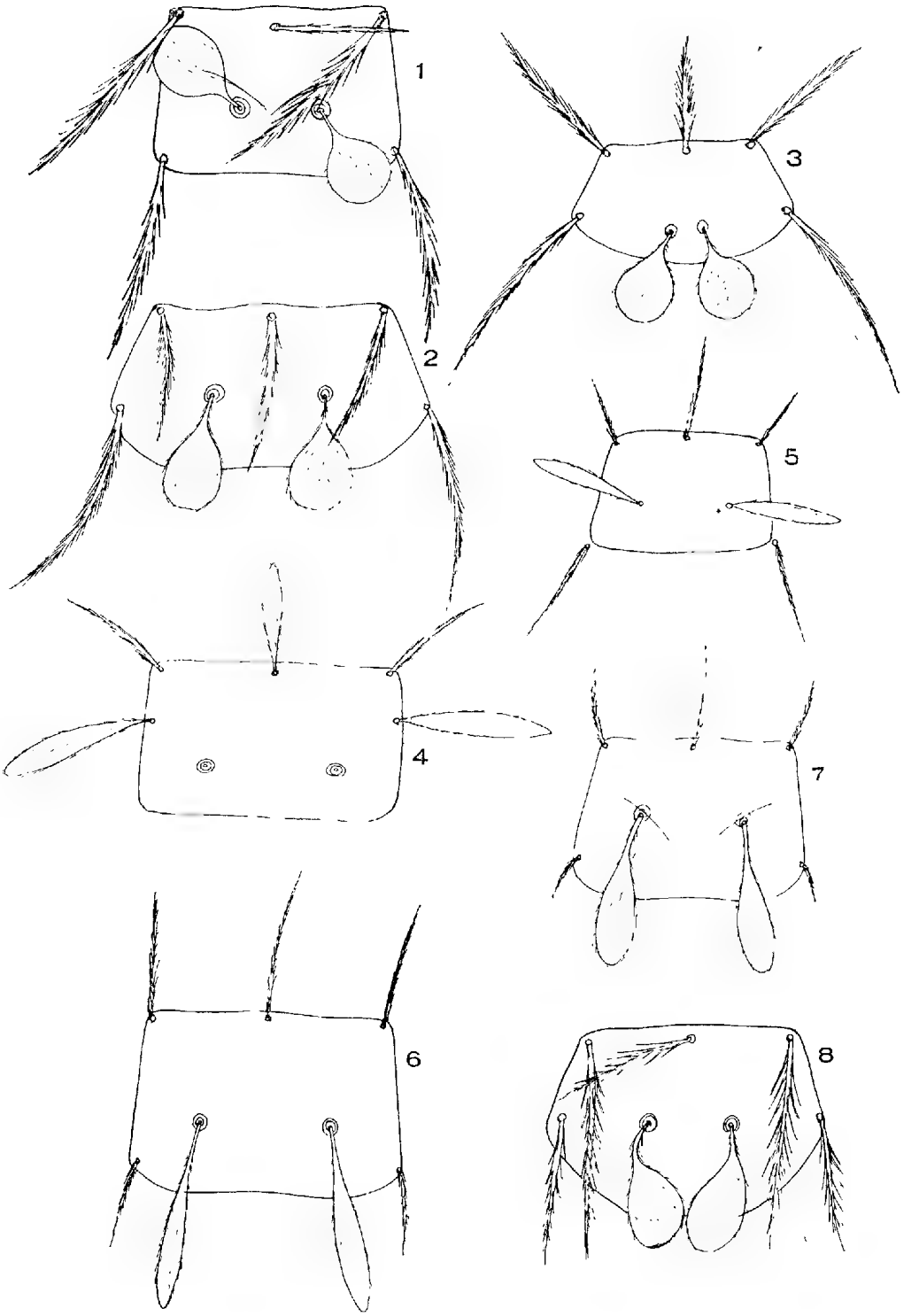
Arrangement of dorsal setae, 2.6.6.6.6.4.2.

NEOSCHÖNGASTIA GLOBULARE (Walch 1927)

Trombidium (*Trombicula ?*) *globulare* Walch 1927, Genessk. Tijd. v. Ned. Indie, 67, (6), 929.

(Pl. viii, fig. 3)

We have not been able to see any authentic specimens of this species, and our drawing to scale of the dorsal scutum and the standard data are deduced from Walch's figure and description.



1, *Neoschöngastia antipodianum* (Hirst); 2, *coorongensis* (Hirst); 3, *N. globulare* (Walch); 4, *N. hastata* Gater; 5, *N. malayensis* Gater; 6, *N. lacunosa* Gater; 7, *N. impar* Gunther; 8, *N. schüffneri* Walch.

The data are:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
43	60	8	25	9	20	34	43	61	26	33

Arrangement of dorsal setae, 2.8.6.6.6.6.4.2.

It will be seen from the above and from the key to species that *N. globulare* is well characterised from the rest.

NEOSCHÖNGASTIA HASTATA (Gater 1932)

Trombicula hastata Gater 1932, Parasitology, **24**.

(Pl. viii, fig. 4)

In the absence of sensillary setae Gater placed this species doubtfully as a *Trombicula*, but in view of the discovery by Gunther of the allied *Neoschöngastia foliata in* New Guinea, it seems more than likely that the sensillae of *hastata* will be clavate or globose as in *Neoschöngastia*.

For convenience of separation, therefore, we so place and key the species.

From Gater's description and figure, the standard data are as follows:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
69	71	37	29	15	15	30	32	42	—	45–50

Arrangement of dorsal setae, 2.8.6.6.4.2.

NEOSCHÖNGASTIA MALAYENSIS Gater 1932

Parasitology, **24**, 1932.

(Pl. viii, fig. 5)

This species was described from the ears of *Rattus malaisia* Kloss, from Sungei Buloh, Selangor, Federated Malay States. It is rather remarkable that the PL are definitely outside of the scutum; in this respect, as Gater points out, being related to Hirst's *Schöngastia aethiopica* from the Gold Coast, Africa.

Gater gives the following details: scutal length 35, width 50, SB 22. From these and Gater's figure, we give the accompanying figure of the scutum to scale from which the standard data are:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
40	54	22	20	14	28	28	20	34	34	40

Dorsal setae, 0.8.8(6).4(6).4.2.

NEOSCHÖNGASTIA LACUNOSA Gater 1932.

Parasitology, **24**, 1932

(Pl. viii, fig. 6)

Described from the ears of *Rattus sabanus vociferans* (Miller) from Sungei Buloh, Selangor, Federated Malay States.

We have been able to examine two specimens from the type host and locality, dated 23 July 1930. From these the standard data are as follows:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
66·5	74	36	31·5	23	43	46·5	35	25	53 x 6·5	42
66·5	78	38	31·5	—	43	45	35	26	53 x 6·5	42

Arrangement of dorsal setae, 2.6.8.8.6.6.4.2.

Gater gives the width of scutum as 78, length 55, and SB 37.

NEOSCHÖNGASTIA IMPAR Gunther 1939

Proc. Linn. Soc. N.S.W., **64**, (1-2), 85.
= *N. bodensis* Gunther 1940, Proc. Linn. Soc. N.S.W., **65**, (5-6), 482.

(Pl. viii, fig 7)

There appears to be no doubt that Gunther's *N. bodensis* 1940 described from the mouse deer, Bode River, British North Borneo, is the same as his *N. impar*

1939 from bandicoots and rats from New Guinea. That this is so will be seen from a comparison of the standard data derived by the examination of the type and three paratypes of *bodensis* and the type and five paratypes of *impar*.

N. impar—

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Type	- 55	—	—	20	23	33	—	21·5	13	—	—
„	- 50	63	28	21	23	33	—	21·5	13	—	28
Parat.	- 53	65	27	20	21	28	35	19	14	43 x 10	30
„	- 52	65	28	20	25	33	—	21	13	—	29
„	- 53	67	29	23	21	33	—	20	13	—	30
„	- 57	68	28	22	22	30	—	20	13	—	31
Mean	- 53	65	28	21	23	32	35	21	13	43 x 10	30

Arrangement of dorsal setae, 2.6.6.4(6).6(4).4.2.

Gunther gives scutal width 66, length 48, SB 27, AM 37·5, AL 19, PL 12·5.

N. bodensis

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Type	- 48	60	28	20	20	33	35	21·5	14	45 x 10	20–40
„	- 50	60	30	20	21	33	33	23	13	40 x 10	—
„	- 51	58	28	20	20	35	35	23	15	—	20–40
Parat.	- 50	61	32	20	20	35	35	25	15	—	—
Mean	- 50	60	30	20	20	34	35	23	14	42 x 10	20–40

Gunther gives scutal width 70, length 47, SB 34, AM 37·5, AL 25, PL 20, Sens. 33 x 11, DS 2.6.6.6.4.4.2.

Neoschöngastia schüffneri Walch 1923

Trombicula schüffneri Walch, Kitasato Arch., **5**, (3), 1923; Tr. Vth. Bien. Congr. Far East. Assoc. Trop. Med., Singapore, 1923 (publ. 1924).

(Pl. viii, fig. 8)

This species was described from man at Deli in Sumatra.

We have not been able to see any authentic material and our figures of the dorsal scutum to scale and the following standard data are from Walch's description and figures:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
57	75	22	20	26	23	42	61	44	36 x 15	30

DS arranged 2.8.10.8.8.6 or 2.8.2.8.8.8.6.

Walch, in his second paper, claims to have reared the larvae through to the nymph, which as far as can be seen is a typical *Trombicula*, without eyes and with long, slender, shortly ciliated sensillae.

Neoschöngastia pseudoschüffneri Walch 1927

Trombicula pseudoschüffneri Walch 1927, Genessk. Tijds. v. Ned. Indie, **67**, (6), 922.

(Pl. ix, fig. 1)

Described from rats from the Lampong District of Macassar.

Again we can only reconstruct the dorsal scutum to scale from Walch's details and figures, and give the following standard data derived from the same sources:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
53	72	19	21	27	37	22	67	44	36	40

DS 2.8.6.6.4.2.

From its near allies this species can be separated by the key.

NEOSCHÖNGASTIA INDICA (Hirst 1915)

Schöngastia indica Hirst 1915, Bull. Ent. Res., **6**, 183; Walch 1927, Genesslh. Tijds. v. Ned. Indie, **67**, (6), 924.

Trombicula muris Walch 1922, Kitasato Arch. Exper. Med., **5**, (3).

(Pl. ix, fig. 2)

Originally described by Hirst from Calcutta, India, on *Nesokia* (*Gunomys*) *bengalensis*, it has also been described by Walch from Deli, Sumatra, from rats, and from the Lampong district of Macassar, also from rats, and specimens are now recorded from rats at Cairns, Queensland (1940, W. G. Heaslip).

Besides the two specimens from Cairns we have been able to examine a specimen from Federated Malay States, and also a specimen, I.A.I.C.III, from Batavia, unnamed, but definitely of this species. The standard data for these specimens are:

Loc.		AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Cairns	-	35	54	19	11+	16	27	23	16	21+	—	20–30
„	-	35	54	19	19	16	27	23	16	31	—	20–35
Batavia	-	39	55	23	18	20	27	23	17	29	26 x 10	32
F.M.S.	-	37	52	21	18	16	27	23	16	31	26 x 10	20–35
Mean	-	36·5	54	20·5	18·5	17	27	23	16	30	26 x 10	20–35

Walch, in his 1927 publication, recognised the synonymy of his *muris* with that of *indica* Hirst. It is evidently a wide ranging species, extending from India to Queensland.

NEOSCHÖNGASTIA DEBILIS Gater 1932

Parasitology, **24**, 1932.

(Pl. ix, fig. 3)

Of this species which was described from *Rattus cremoriventer cremoriventer* (Miller) from Sungei Buloh, Selangor, Federated Malay States, we have not been able to examine any material.

Our scale drawing of the scutum is from Gater's data and figure, as are the following standard data:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
40	48	17	13	11	21	30	20	36	—	—

NEOSCHÖNGASTIA LORIUS Gunther 1939

Neoschöngastia jimungi Gunther 1938, Med. J. Austr., **2**, (6), 202 (*nom. nud.*); *lorius* Gunther 1939, Proc. Linn. Soc. N.S.W., **64**, (1-2), 86.

(Pl. ix, fig. 4)

This species was described from specimens from a parrot (*Lorius roratus*) from New Guinea. We have been privileged to examine the type slide, which besides the type contains three paratypes. Two of the latter and the type have been carefully measured for standard data as follows:

		AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Type	-	40	58	20	16	23	21·5	30	17	31·5	35 x 10	25
Parat	-	40	56·5	20	16	21·5	21·5	30	—	31·5	35 x 10	25
„	-	40	55	20	16	22	21·5	—	—	33	36 x 10	25

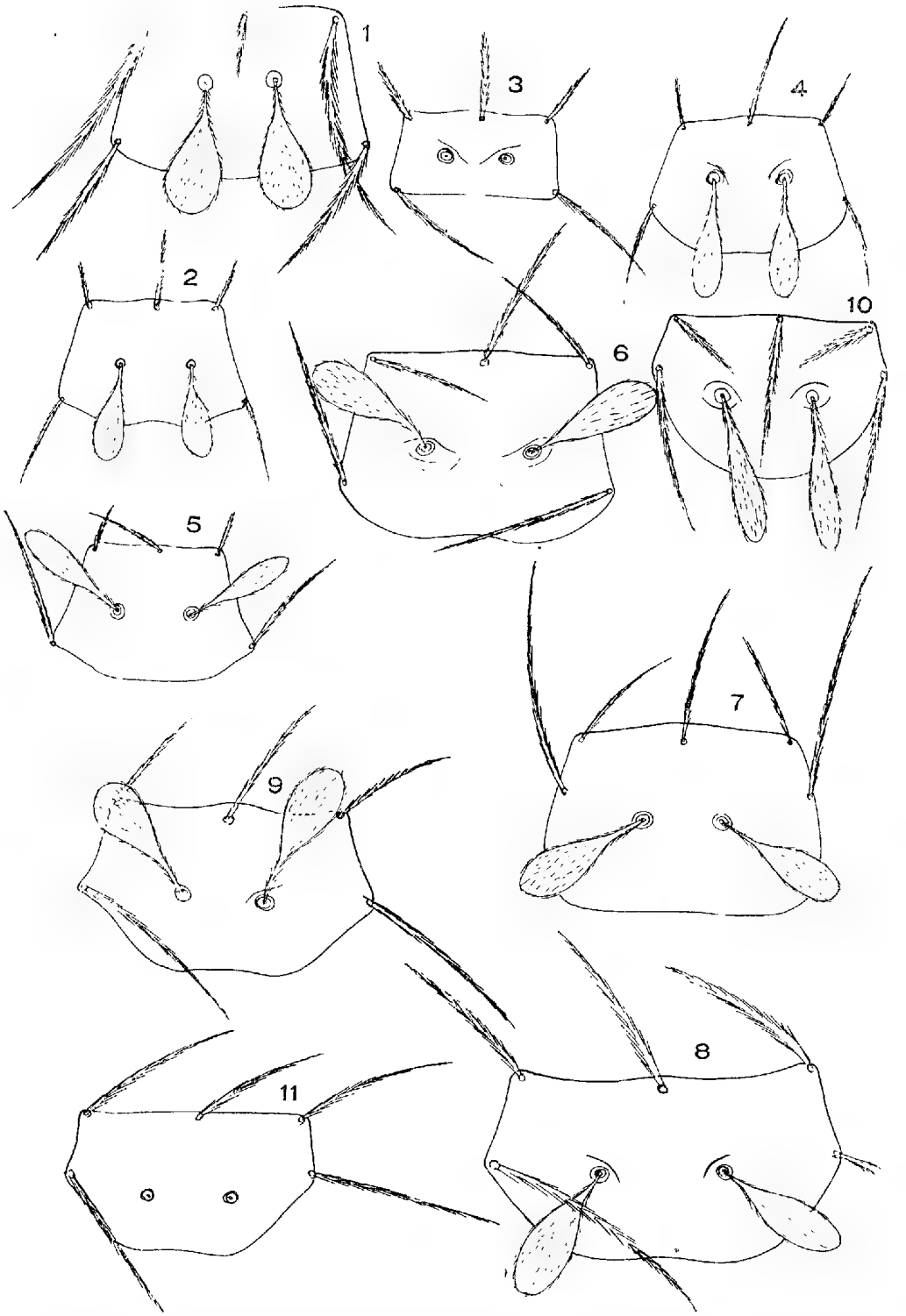
DS 2.6(2.4).4.2.4.2.16.12.

Gunther gives: scutal length 47, width 62·5, SB 20, AM 36, AL 25, PL 37·5, Sens. 30, DS 30.

Neoschongastia rattus n. sp.

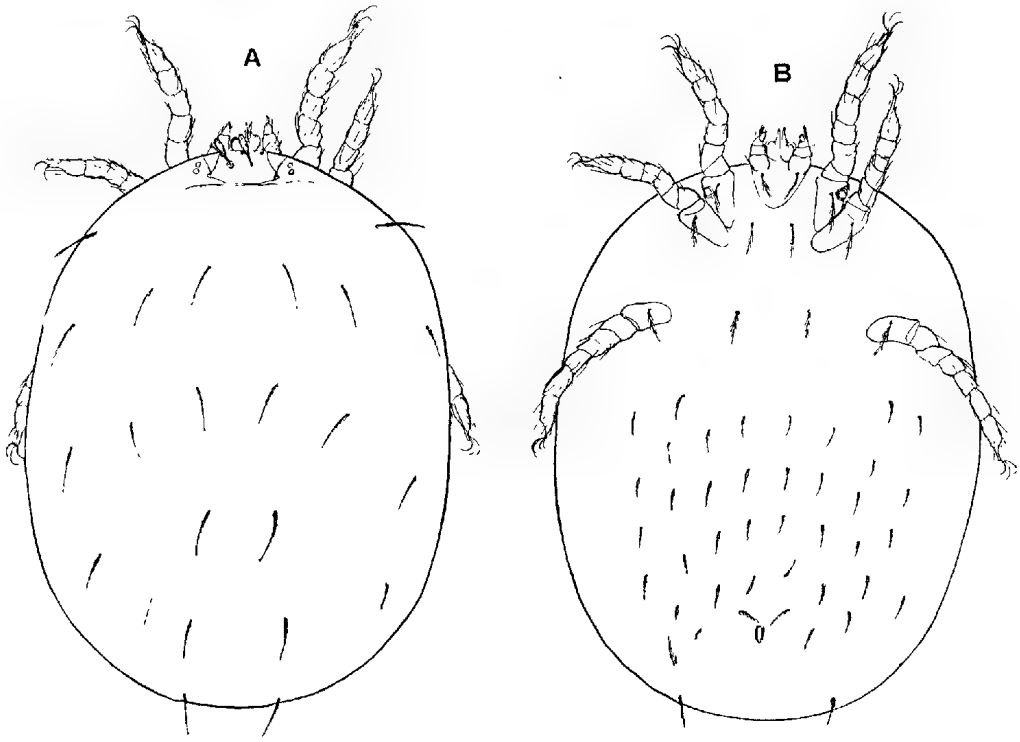
(Pl. ix, fig. 5; text fig. 11, A-B)

Description—Well-fed specimens 550 μ long, 390 μ wide, shape oval with sides flattish medially. Legs relatively small and short, I 160, II 145, III 160.



1, *Neoschöngastia pseudoschüffneri* (Walch); 2, *N. indica* (Hirst); 3, *N. debilis* Gater; 4, *N. lorius* Gunther; 5, **N. rattus** n. sp.; 6, **N. heaslipi** n. sp.; 7, *N. perameles* Wom.; 8, *N. westraliensis* Wom.; 9, *N. trichosuri* Wom.; 10, *N. dasycerci* (Hirst); 11, *N. shieldsi* Gunther.

Mandibles with non-serrate chelicerae. Palpi normal, tibial claw bifurcate. Dorsal scutum as in plate ix, fig. 5, with the following standard data, AW 36, PW 58, SB 20, ASB 19, SB 20, A-P 28, AM 24, AL 14, PL 38, Sens. 35 x 9, DS 20-40. Arrangement of DS 2.6.6.4.2.2.



Text fig. 11

Neoschongastia rattus n. sp.: A, dorsal; B, ventral.

The scutal and dorsal setae are shortly and finely ciliated. Sensillae clubbed with short stem and ciliated club. Eyes 2 + 2, small and away from scutum.

Ventrally each coxa with a single seta which has 4-5 long branches; gnathal part with a pair of similar setae, and a pair between coxae I and between coxae III, and thereafter 4.8.8.8.6.6.2. Legs with normal chaetotaxy and tarsi with paired claws, and a longer median pulvillus.

Loc. and Hosts—On rats, *Rattus assimilis*, at Imbil, 16 February 1939 (Smith), and Brisbane, Queensland, 5 July 1938 (W. G. H.).

Remarks—Of 10 specimens examined, the highest and lowest values for standard data are as follows:

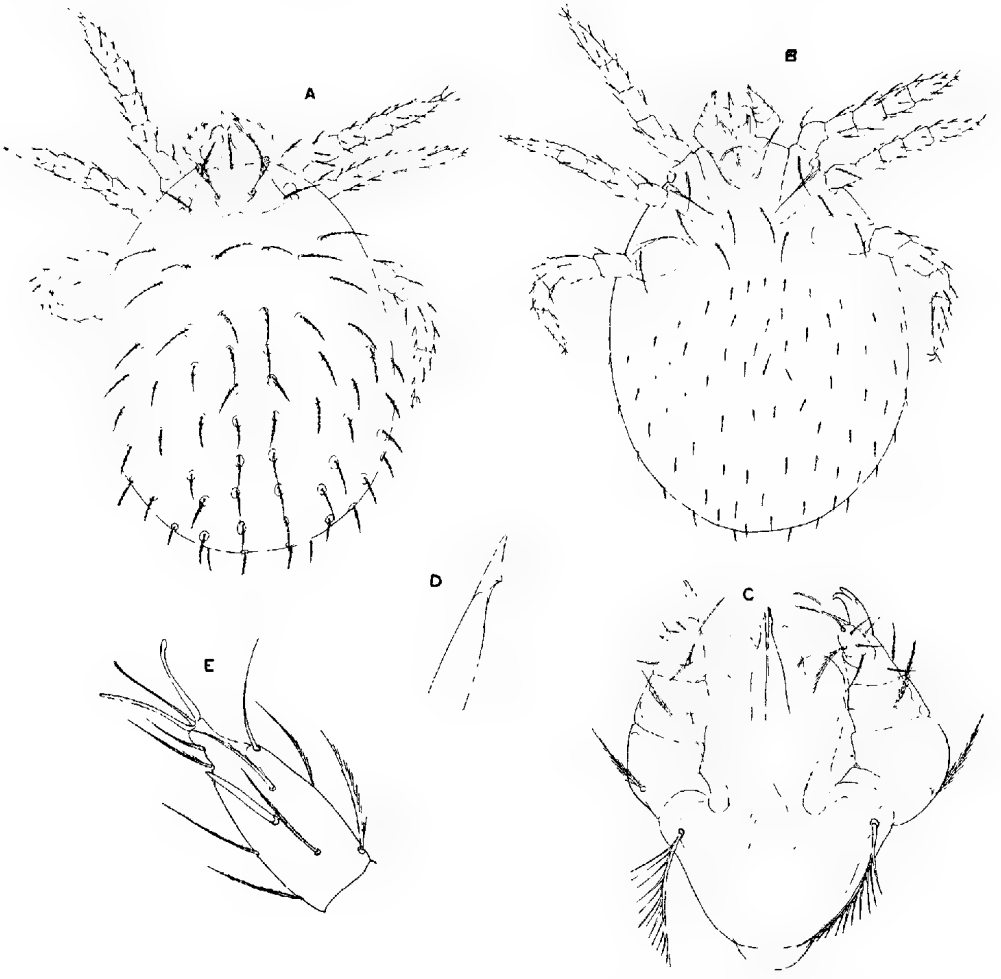
	AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	Sens.	DS
Highest	- 40	60	22	19	20	32	25	16	40	36 x 9	—
Lowest	- 32	56	19	19	18	24	22	11	34	32 x 8	—

Neoschongastia heaslipi n. sp.

(Pl. ix, fig. 6; text fig. 12)

Description—Length 375 μ, width 270 μ, shape somewhat rounded. Legs: I 240, II 225, III 240. Mandibles non-serrate with a single ventral tooth. Palpi as in text fig. 12, tibial claw trifurcate. Dorsal scutum as in pl. ix, fig. 6, with the following standard data: AW 62, PW 78, SB 29, ASB 27, PSB 24, A-P 36,

AM 46, AL 33, PL 49, Sens. 39 x 13 with strong ciliations. Dorsal setae 27-52 long, ciliated and arising from platelets, arranged 2.6.8.8.8.4.6.6.4.2, platelets 15 wide. Eyes 2 + 2, closely adjacent to scutum, anterior eye the larger. Venter; coxae each with a single long (45-50), pointed and ciliated seta; a similar pair between coxae I and between coxae III, thereafter shorter, 20-30, and arranged 12.12.12.10.8.6.4, approximately.



Text fig. 12

Neoschongastia heaslipi n. sp.: A, dorsal; B, ventral; C, mouth parts and palp from below; D, chelicera; E, tarsus I.

Loc. and Hosts—From rats at Intake, Cairns, Queensland, 1940 (W. G. H.).

Remarks—Remarkable for the small dorsal platelets. The standard data for the three specimens examined are:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
	59	75	29	28	24	38	46	32	49	40 x 13	27–52
	62	80	29	28	23	36	46	33	49	39 x 13	30–52
	65	79	29	24	24	34	46	34	49	39 x 13	30–52
Mean -	62	78	29	27	24	36	46	33	49	39 x 13	29–52

Neoschongastia perameles Wom. 1939

Trans. Roy. Soc. S. Aust., **63**, (2), 160, 1939.

(Pl. ix, fig. 7)

In addition to the original records of this species, it was collected from a bandicoot (*Isoodon torosus*) at Cairns, Queensland, in 1939, by Dr. W. G. Heaslip.

Altogether 30 specimens have been measured for standard data of which the mean, maximum and minimum are as follows:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Highest -	65	81	29	32	29	21	50	42	73	43 x 13	—
Lowest -	54	70	19	23	24	16	43	29	62	38 x 13	—
Mean -	60	73	24	27	27	19	47	36	68	39 x 13	30–50

Neoschöngastia westraliensis (Wom. 1934)

Schöngastia westraliense, Rec. S. Aust. Mus., **5**, (2).

(Pl. ix, fig. 8)

This species was described from the ears of a cat at Greenbushes, West Australia. The standard data for six specimens on the type slide are:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
84	102	37	24	24	27	54	46	75	—	45–70
86	102	38	26	26	27	50	46	75	—	45–75
86	102	35	28	24	27	51	46	75	—	45–72
81	104	38	26	24	27	-	49	78	40 x 13	45–75
84	98	35	26	24	27	-	43	75	—	43–75
84	100	35	30	26	27	—	46	73	40 x 13	45–75

Arrangements of DS, 2.8.6.6.6(4).4(6).2.

Neoschöngastia trichosuri Wom. 1939

Neoschöngastia westraliense v. *trichosuri* Wom. 1939, Trans. Roy. Soc. S. Aust., **63**, (2), 160.

(Pl. ix, fig. 9)

This form, which was originally regarded as only a variety of the Western Australian *westraliensis* Wom., must be raised to specific rank. The standard data for the only specimen from *Trichosurus vulpecula*, Nambour, Queensland, are:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
63	84	23	29	29	27	43	35	56	40 x 13	30–54

Arrangement of DS, 2.8.6.6.6.4.2.

Neoschöngastia dasycerci (Hirst 1929)

Schöngastia dasycerci Hirst Proc. Zool. Soc., London, 1929, (2).

(Pl. ix, fig. 10)

Described from the ears of *Dasycercus cristicauda* from Ooldea, South Australia. The standard data for seven specimens of the original material are as follows:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
	54	65	26	24	23	14	38	21	46	—	30–40
	54	65	26	24	23	15	40	23	46	43 x 8	30–40
	54	65	24	24	20	15	38	23	43	—	30–40
	54	62	24	23	21	15	40	23	48	43 x 8	30–40
	59	67	27	25	22	15	38	21	48	—	30–45
	54	—	—	—	—	—	41	23	—	43 x 8	30–48
	57	67	27	29	22	14	—	22	46	—	30–45
Mean -	55	65	26	24	22	15	39	22	46	43 x 8	30–48

Arrangement of DS, 2.8.6.6.6.2.2.

NEOSCHÖNGASTIA SHIELDSI Gunther 1941

Proc. Linn. Soc. N.S.W., **66**, (3-4), 157, 1941.

(Pl. ix, fig. 11)

Described from *Melomys rubex* Thomas, from Bulolo, T. N. G.

The figure of the dorsal scutum is drawn to scale from the following standard data deduced from Gunther's details and figures:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
61·5	70	24	24	16	16	37·5	45	56	—	—

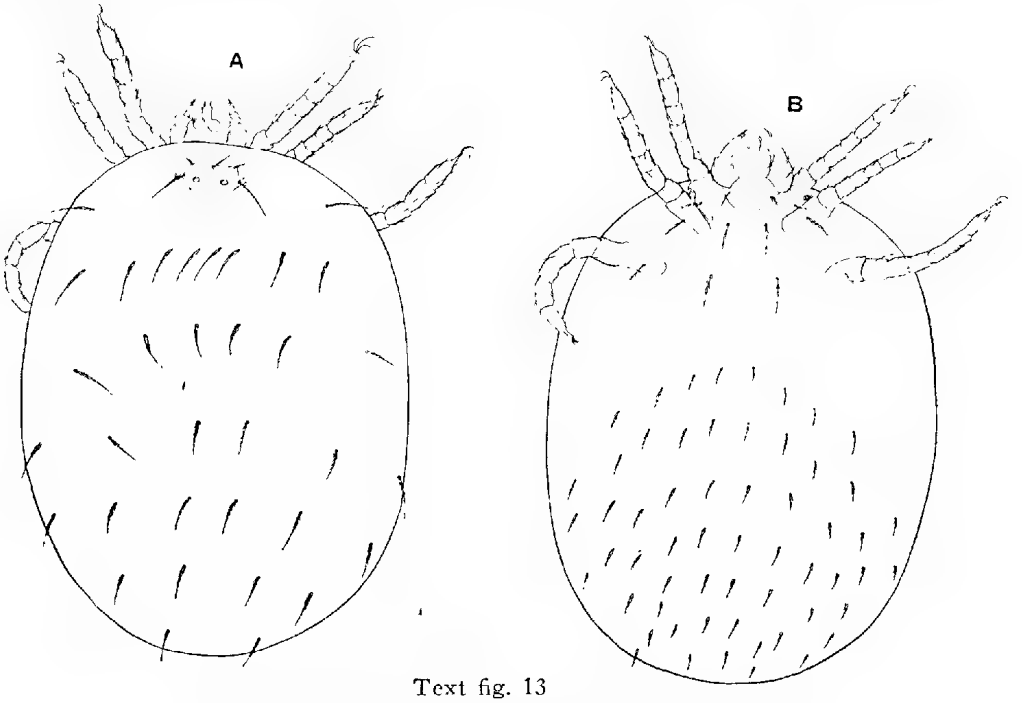
Neoschongastia hirsti n. sp.

(Pl. x, fig. 1; text fig. 13, A-B)

Description—Length to 690 μ, width 500 μ, oval, with sides medially rather straight. Legs: I 255, II 225, III 290. Mandibles with non-serrate chelicerae. Palpi normal, with bifurcate tibial claw. Dorsal scutum as in pl. x, fig. 1, with the following standard data: AW 67, PW 81, SB 32, ASB 26, PSB 22, A-P 16, AM 47, AL 27·5, PL 72. Sens. lacking in all specimens. DS 30-70 long, and arranged 2.8.6.6.6.4.2. Eyes 2 + 2. Ventrally all coxae with a single long ciliated seta; a pair of similar setae between coxae I and between coxae III, thereafter about eight rows of 8-10 short ciliated setae, arranged as in text fig. 13, B.

The standard data for the six specimens are:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Cairns	- 63	81	32	29	20	17	48	27	70	—	30–67
,,	- 62	84	32	24	24	19	46	27	70	—	30–65
Imbil.	- 67	81	32	27	20	15	46	27	70	—	30–67
,,	- 73	81	32	26	22	15	48	27	72	—	35-70
,,	- 67	81	32	26	23	15	46	30	73	—	32–70
,,	- 70	78	32	24	23	15	48	27	75	—	30–70
Mean	- 67	81	32	26	22	16	47	27·5	72	—	30–70



Text fig. 13

Neoschongastia hirsti n. sp.: A, dorsal; B, ventral.

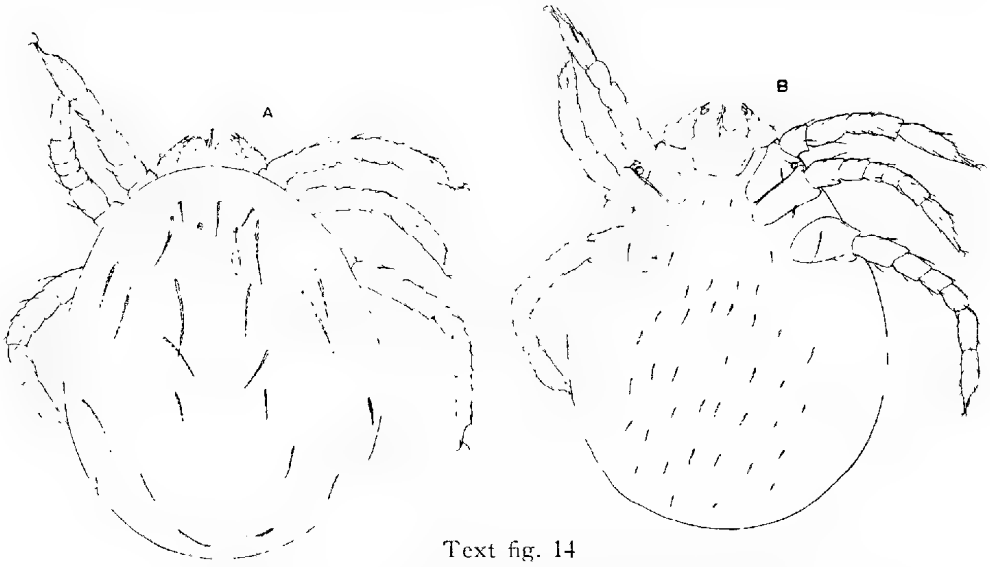
Loc. and Hosts—Two specimens from rats, Cairns, Queensland, 1938 (W. G. H.), and four specimens from *Melomys cervenipes*, Imbil, Queensland, August 1938 (Smith).

Remarks—The relationship of this species to the others can be seen from the key.

Neoschongastia similis n. sp.

(Pl. x, fig. 2; text fig. 14, A-B)

Description—Rounded species, length to 430 μ, width to 340 μ. Legs: I 260, II 227, III 290. Mandibles with non-serrate chelicerae. Palpi normal, with bifurcate tibial claw. Dorsal scutum as in pl. x, fig. 2, with the following mean standard data: AW 64·5, PW 84·5, SB 33, ASB 23, PSB 32, A-P 12, AM 53, AL 23, PL 95, Sens. 50 x 11, DS 40-90, arranged 2.4.4.4.2., occasionally 2.4.2.4.4.2. Eyes 2 + 2. Venter; all coxae with a single ciliated seta; a pair of similar setae between coxae I and between coxae III, thereafter about 36 short setae roughly in rows of eight. Tarsi normal with paired claws and single claw-like empodium.



Text fig. 14

Neoschongastia similis n. sp.: A, dorsal; B, ventral.

Loc. and Host—On rats from Cairns, Queensland, 1939 (W. G. H.).

Remarks—Can be distinguished as in the key to species. Eight specimens have been measured as follows:

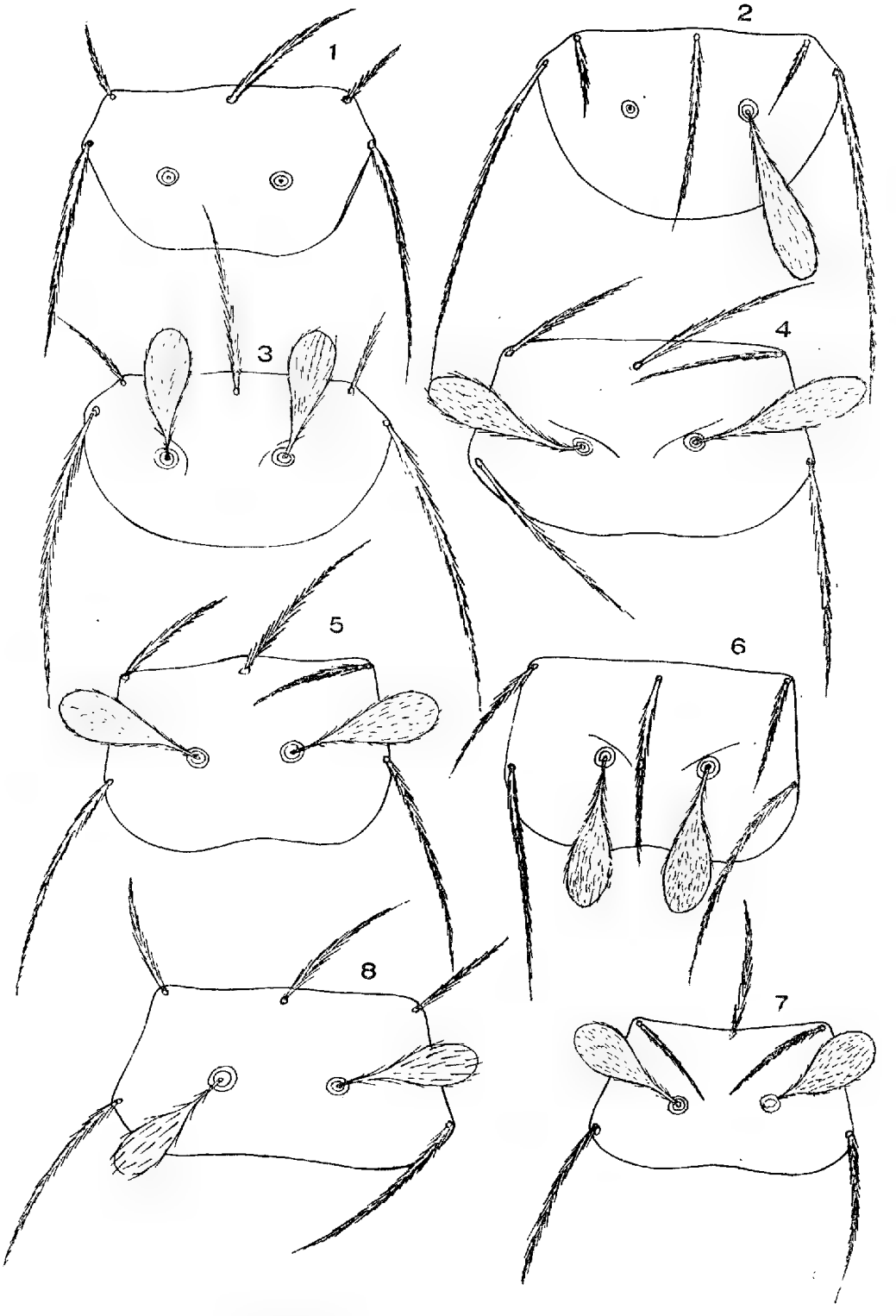
AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	Sens.	DS
62	81	32	24	32	12	—	16+	81 +	—	45–90
67	89	35	22	35	12	—	13+	86+	—	45–80
65	86	32	24	36	13	—	16+	97	—	40–95
65	86	32	25	29	13	—	—	94	—	40–97
65	84	32	22	29	11	—	19+	90	—	45–95
65	86	35	24	31	11	53	23+	89	—	45–95
60	81	32	23	32	13	—	11+	97	—	45–95
65	84	32	23	32	12	—	19+	94	—	40–90

Neoschöngastia derricki Wom. 1939

Trans. Roy. Soc. S. Aust., **63**, (2), 162.

(Pl. x, fig. 3)

The type specimen of this species was from *Rattus lutreolus* and two paratypes from *R. assimilis*, all from Imbil, Queensland, August 1938 (Smith). We have also six other specimens from rats at Cairns, Queensland, 1939 (W. G. H.).



1, **Neoschongastia hirsti** n. sp.; 2, **N. similis** n. sp.; 3, *N. derricki* Wom.; 4, **N. guntheri** n. sp.; 5, *N. smithi* Wom.; 6, **N. phascogale** n. sp.; 7, **N. cairnsensis** n. sp. 8, *N. cairnsensis* v. **gateri** nov.

The standard data for all these are as follows:

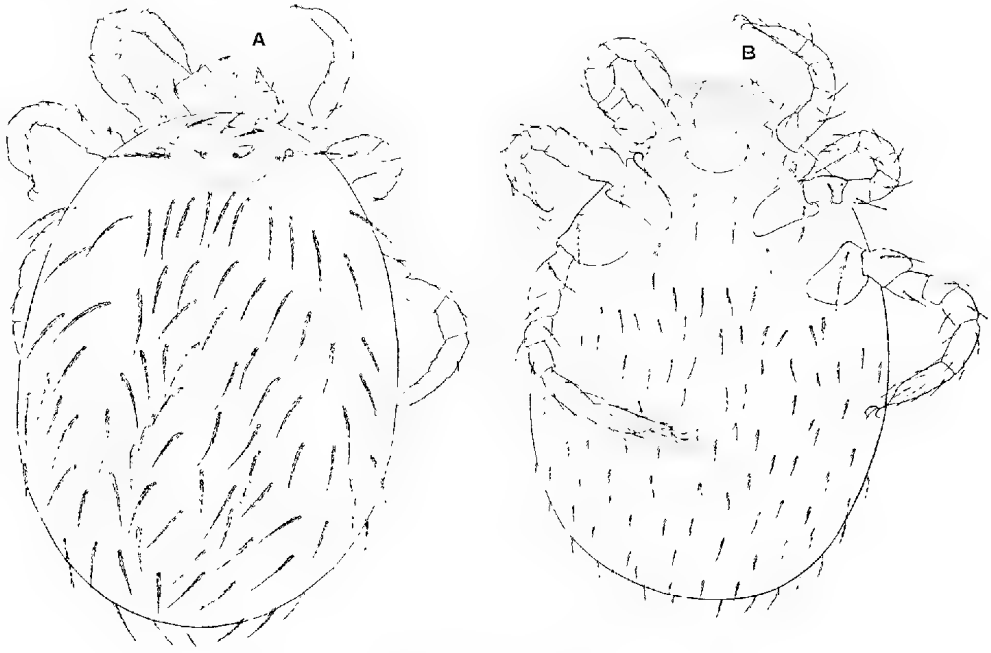
	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Type, Imbil. -	67	90	35	25	23	12	45+	18+	81+	—	50–90
Parat. ,, -	67	84	32	24	26	12	45+	—	86	—	50–86
,, ,, -	67	86	35	26	24	12	51	16+	83+	38 x 8	50–90
Cairns - -	65	84	33	26	27	11	50	27	86	—	50–90
,, - -	67	84	35	24	24	11	54	24+	89	—	50–90
,, - -	62	84	35	24	26	11·5	—	24+	90	—	50–90
,, - -	62	84	35	26	24	11	58	24+	92	38 x 11	50–92
,, - -	65	84	33	25	24	11	54	21+	86	38 x 11	50–90
,, - -	67	86	35	25	24	11	60	24+	90	—	50–90
Mean - -	65·5	85	34	25	25	11·5	57	27	89	38 x 11	50–90

Arrangement of DS, 2.6.6.6.4.2.

Neoschongastia guntheri n. sp.

(Pl. x, fig. 4; text fig. 15, A-B)

Description—Length 450 μ, width 310 μ, shape oval. Legs: I 330, II 300, III 350. Mandibles with non-serrate chelicerae. Palpi normal, tibial claw trifurcate. Dorsal scutum as in pl. x, fig. 4, with the following standard data: AW 78, PW 97, SB 31, ASB 31, PSB 27, A-P 32, AM 57, AL 40, PL 67. Sens. clubbed, 52 long by 11 wide. Dorsal setae 35-75 long, arranged 2.12.12.12.12.10.8.4.2. Eyes 2 + 2. Venter; all coxae with a single long ciliated seta, a pair between coxae I and another between coxae III, behind coxae III with numerous short ciliated setae as in text fig. 15, B.



Text fig. 15
Neoschongastia guntheri n. sp.: A, dorsal; B, ventral.

Loc. and Hosts—Numerous specimens from rats at Cairns, Queensland, 1939 (W. G. H.).

Remarks—Relationship to other species as in key. Seventeen specimens have been measured as follows:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
	78	95	30	28	26	32	60	40	65	54 x 11	40–75
	76	95	30	28	26	35	60	40	67	54 x 11	40–75
	81	97	30	28	26	32	57	41	67	52 x 11	40–75
	76	94	32	28	26	32	60	41	65	52 x 11	40–75
	78	97	32	30	27	32	56	38	67	52 x 11	40–72
	78	97	30	27	27	32	60	40	68	52 x 11	40–75
	78	97	32	30	30	32	—	38	67	—	40–75
	75	94	32	27	27	32	60	40	68	52 x 11	40–70
	78	97	32	32	27	32	54	41	65	52 x 11	35–70
	78	97	31	30	27	32	57	40	70	52 x 11	40–70
	75	97	30	31	27	32	56	40	67	52 x 11	40–70
	78	97	32	30	27	27	56	40	67	52 x 11	40–70
	81	102	32	32	25	32	—	41	70	49 x 11	40–73
	81	100	32	32	30	35	56	41	70	51 x 11	40–71
	78	103	32	35	27	36	60	38	67	51 x 11	40–70
	75	97	32	32	24	30	49	38	67	51 x 11	40–70
	75	97	32	32	32	32	54	37	65	51 x 11	40–70
Mean -	78	97	31	31	27	32	57	40	67	52 x 11	35–75

NEOSCHÖNGASTIA SMITHI Wom. 1939

Trans. Roy Soc. S. Aust., **63**, (2), 164.

(Pl. x, fig. 5)

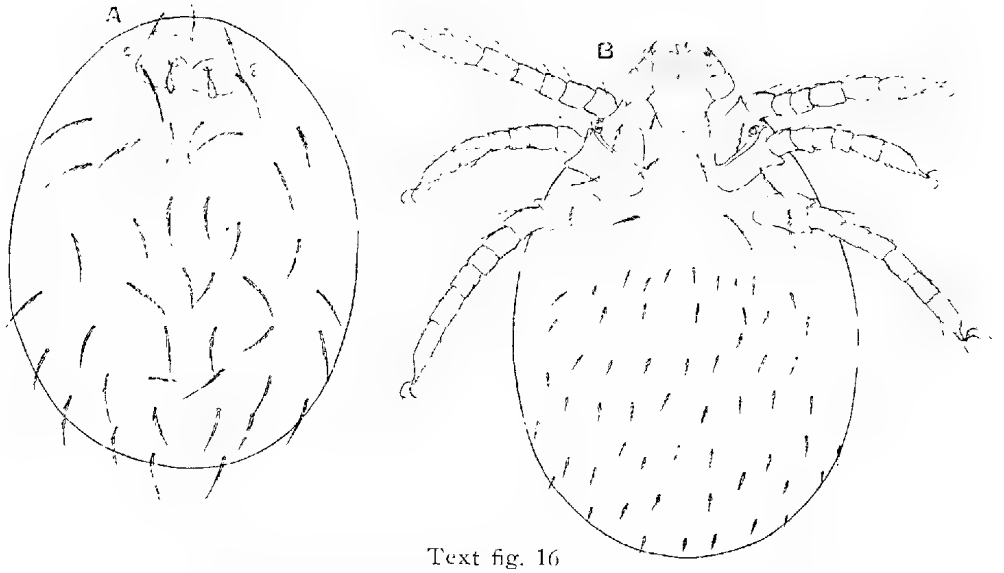
This species was described from specimens from *Rattus assimilis* from Imbil, Queensland. The type and two paratypes are on the same slide and give the following standard data:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
70	81	27	30	24	32	55	38	64	43	32–67
70	81	27	30	24	27	53	32	63	—	35–70
70	81	27	30	24	30	51	34	62	—	35–74

The arrangement of DS is 2.8.8.8.8.6.4.2.

Neoschongastia phascogale n. sp.

(Pl. x, fig. 6; text fig. 16, A-B)



Text fig. 16

Neoschongastia phascogale n. sp.: A, dorsal; B, ventral.

Description — Shape an elongate oval, length (fed) to 500 μ, width 350 μ. Legs: I 260, II 220, III 290. Mandibles with non-serrate chelicerae. Palpi normal, tibial claw bifurcate. Dorsal scutum as in pl. x, fig. 6, with the following standard data: AW 72, PW 83, SB 30, ASB 30, PSB 24, A-P 31, AM 54, AL 38, PL 64, Sens. 43 x 13, DS 32-70. Arrangement of DS, 2.6.6.6.6.6.4.2. Eyes 2 + 2. Venter: all coxae with a single ciliated seta; a pair of similar setae between coxae I and between coxae III, thereafter numerous shorter setae as in text fig. 16, B.

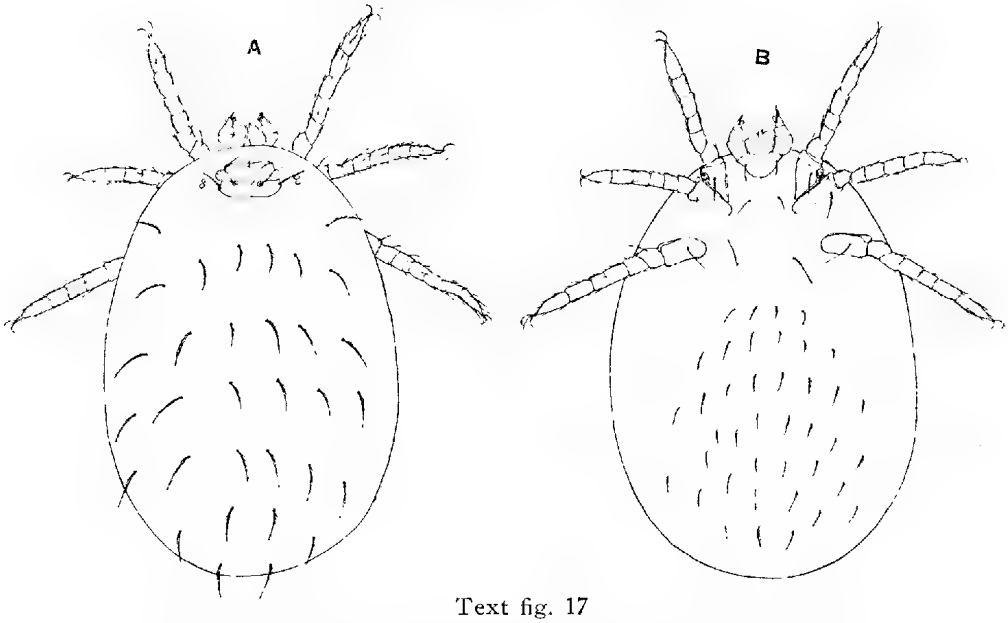
Loc. and Hosts — Type material from *Phascogale* sp. from Brisbane, 19 January 1938 (D. J. W. Smith); from *Isoodon torosus*, W. Cairns 1940 (W. G. H.); *Perameles nasuta* Palm Woods, December 1938 (D. J. W. Smith).

Remarks—Standard data for 19 specimens:

Host	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
Phascogale sp.	70	81	32	27	22	35	54	37	64	43	35–70
,,	73	83	30	32	24	32	54	40	65	43	35–70
,,	70	81	30	30	24	32	54	37	62	—	35–70
,,	70	83	32	29	24	30	54	38	67	43	35–70
Isoodon	71	84	30	29	24	29	52	38	58	41 x 13	65
,,	71	84	30	30	24	30	51	36	56	36 x 10	65
,,	71	84	30	29	23	29	50		62	39 x 13	62
,,	71	84	29	30	23	27	—	—	62	39 x 12	63
,,	72	83	28	30	23	31	55	38	63	43 x 13	65
,,	71	82	30		24	29	55	39	65	45 x 13	69
,,	68	79	28		24	30	53	38	59	—	67
,,	73	84	29	31	25	32	55	39	65	.	69
,,	75	86	30	30	23	32	55	39	62	45 x 13	65
Perameles	73	83	30	30	24	31	54	38	64	43	35–75
,,	73	86	31	30	24	32	54	40	67	43	35–70
,,	73	86	30	30	24	30	54	40	67	43	32–65
,,	70	83	30	30	22	30	—	38	62	43	32–67
,,	73	83	30	32	24	32	54	38	62	45	35–70
,,	73	86	30	30	24	30	54	40	67	48	35–67
Mean	72	83	30	30	24	31	54	38	64	43 x 13	32–75

Neoschongastia cairnsensis n. sp.

(Pl. x, fig. 7; text fig. 17, A-B)



Text fig. 17

Neoschongastia cairnsensis n. sp.: A, dorsal; B, ventral.

Description—Oval in shape. Length to 690 μ, width to 430 μ. Legs: I 260, II 210, III 260. Mandibles with non-serrate chelicerae. Palpi normal, tibial claw trifurcate. Dorsal scutum as in pl. x. fig. 7, with the following standard data (mean of 55 specimens): AW 54, PW 75, SB 27, ASB 23, PSB 20, A-P 32, AM 38, AL 29, PL 50, Sens. 35 x 14, DS 35-50 long and arranged 2.6.6.6.6.4.2. Eyes 2 + 2. Venter as in text fig. 17, B; a single seta on each coxa, a pair between coxae I and between coxae III, then many irregular rows of shorter setae.

Loc. and Hosts—Rats, Cairns, (W. G. H.); *R. lutreolus* and *R. assimilis*, Imbil, 1938 (Smith); *R. youngi*, Cowan Cowan, 1938 (Smith); *Isoodon torosus*, Cowan Cowan and Brisbane, 1939 (W. G. H.).

Remarks Apparently a very common species in Queensland.

Fifty-five specimens have been measured for standard data, of which the extremes are:

	AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	Sens.	DS
Max. -	56	85	32	27	22	35	42	36	54	40	—
Min. -	51	68	23	19	16	26·5	30	24	43	30	—

v. **gateri** nov.

(Pl. x, fig. 8)

Description—Only differs from the above in the proportionately larger scutum. The standard data for the six specimens are:

	AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	Sens.	DS
	65	100	32	30	26	38	48	35	60	38 x 14	32–58
	75	100	35	30	24	38	45	32	60	40 x 14	32–60
	65	94	33	28	21	35	32	32	57	—	30–50
	73	94	32	30	21	35	46	32	60	40 x 14	35–50
	67	90	32	27	21	35	43	32	54	—	30–50
	73	105	38	30	24	39	46	30	57	—	30–50
Mean -	70	97	34	34	23	37	46	32	58	40 x 14	30–60

Loc. and Hosts From rats, Cairns, 1938 and 1939 (W. G. H.).

Genus Paraschöngastia Wom. 1939

Trans. Roy. Soc. S. Aust., **63**, (2), 165.

Scutum with a well-defined crest, often in long curves, with the pseudostigmata in the vertical posterior walls of the crest. Anterior part of scutum pitted only, posterior with more or less circular striations surrounding pits. Body striated anteriorly, pitted posteriorly. Coxae with one, two or three setae. Genotype *Neoschöngastia yeomansi* Gunther 1939.

In this genus we now place *Trombicula gallinarum* Kaw. and Yam. from Formosa, such decision being placed on the details and figures given by Kawamura and Yamaguchi 1921. Only five species are known.

Key to the Species of Paraschöngastia

1 Coxae III with three setae. No pitted caudal area or plate. Scutal crest indefinite medially. DS 2.14.10.12.6.14.14.12.8.4. *P. dubia* (Gunther 1939)

Coxae III with one or two setae. 2

2 Coxae III with one seta. 3

Coxae III with two setae. 4

3 AM much shorter than AL or PL. AW 58, DS 2.14.14.10.8.8.6.6.2.2. Caudal area with pitting and weak striations. *P. backhousei* (Gunther 1939)

AM about equal to AL. AW 53, DS 2.12.10.8.4.2. Caudal area? *P. gallinarum* (Kaw. and Yam., 1921)

4 Pitting over posterior fourth of dorsum. DS 100 in number, arranged 2.16.8(10).12(10). 10(8).10(8).12.6.6.6.4, last five rows arising from tubercles.
P. yeomansi (Gunther 1939)

Posterior pitted area relatively small and bounded anteriorly by a circle of tubercles with long straight setae. DS 2.8(10).12(10).6.8(1).8.8(6), then circle of tubercles, then 12 arising from irregular oval tubercles or platelets.
P. retrocincta (Gunther 1939)

Paraschöngastia dubia (Gunther 1939)

Neoschöngastia incerta Gunther 1938, *nom nud.*, Med. J. Aust., **2**, (6), 202.
Neoschöngastia dubia Gunther 1939, Proc. Linn. Soc. N.S.W., **64**, (1-2), 89.
Paraschöngastia dubia Womersley 1939, Trans. Roy. Soc. S. Aust., **63**, (2), 165; (Pl. xi, fig. 2)

We have been able to examine the type specimen (unique) from the New Guinea bush fowl (*Megapodius duperreyi*) which, as stated by Gunther, is imperfect in lacking sensillae and chelicerae. The standard data are as follows:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
75	98	60	25	25	38	45	80	71	—	—

Arrangement of dorsal setae, 2.14.10.12.6.14.14.12.8.4.

The dimensions given by Gunther are: scutal length 62·5, width 100, AM 47, AL 84·5, PL 75, SB 56. Coxae III with three setae.

Paraschöngastia backhousei (Gunther 1939)

Neoschöngastia fournieri Gunther 1938, *nom. nud.*, Med. J. Aust., **2**, (6), 207.
Neoschöngastia backhousei Gunther 1939, Proc. Linn. Soc. N.S.W., **64**, (1-2), 89.
Paraschöngastia backhousei Womersley 1939, Trans. Roy. Soc. S. Aust., **63**, (2), 165; Gunther 1940, Proc. Linn. Soc. N.S.W., **65**, (3-4), 252.

(Pl. xi, fig. 3)

We have examined the type material of this species and give the following standard data:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.
58	72	48	23·5	25	42	37·5	47	42	30 x 15

DS 30-40 long and arranged as given by Gunther, 2.14.14.10.8.8.6.6.2.2.

Gunther gives the scutal length as 47 and the width 75. Coxae III with only one seta. By an error in the key to Womersley's 1939 paper the name of this species was given as *megapodius*.

Paraschöngastia gallinarum (Kaw. and Yam.) 1921

Trombicula gallinarum Kawamura and Yamaguchi 1921, Kitas. Arch. Exp. Med., **4**, 169.

(Pl. xi, fig. 4)

Kawamura and Yamaguchi attribute this name to Hatori for a "red mite" of fowls from Formosa, but as far as we have been able to ascertain Hatori did not use a specific name, and even if he did, it would be a *nomen nudum*, for he gave no description. Kawamura and Yamaguchi, however, give a very full description, so that the species is really *gallinarum* Kaw. and Yam. These authors (*loc. cit.*) claim to have reared this species through to the nymph, and state that it also has clavate sensillae but not so broadly so as in the larva.

Kawamura and Yamaguchi give the following details: length of scutum 42, width 65·1, Sens. 22·5 long, head 14·5 x 14·5 strongly ciliated. DS 33 long and arranged 2.12.10.8.4.2. Coxae all with one seta.

From the above and Kawamura and Yamaguchi's figure we compute the standard data:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.
52	60	35	16·5	26·5	31	32	35	50	22·5 x 14·5

Fletcher et al. (1938) refer to a "red mite" of fowls from the Federated Malay States as this species, but give no description, only figures of the dorsum and dorsal scutum. The arrangement of DS appears to be only slightly different, 2.12.8.6.10.4.2, from that shown by Kawamura and Yamaguchi. The dorsal scutum also only differs slightly in general form, but no dimensions are given. On the assumption that the AW is the same in both the Formosan and Federated Malay States specimens, the standard data for the latter from Fletcher's figure will be:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.
52	60	42	19	26	30	34	35	33	26

The obvious differences in these figures are that the sensillae bases (SB) are much wider apart, that the normal scutal setae are very slender and shortly ciliated and that the sensillae are only sparsely and shortly setulate. However, without fresh material the precise status of the Federated Malay States species is somewhat doubtful.

PARASCHÖNGASTIA YEOMANSI (Gunther 1939)

Neoschöngastia jamesi Gunther 1938 (*nom. nud.*), Med. J. Aust., **2**, (6), 202.

Neoschöngastia yeomansi Gunther 1939, Proc. Linn. Soc. N.S.W., **64**, (1 and 2), 81.

Paraschöngastia yeomansi Wom. 1939, Trans. Roy. Soc. S. Aust., **63**, (2), 165; Gunther 1940, Proc. Linn. Soc. N.S.W., **65**, (3-4), 252.

(Pl. xi, fig. 5)

This species was described from 50 specimens from *Megapodius duperreyi* from New Guinea. We have been able to examine the type slide containing three specimens, and also nine paratypes. From these the standard data are:

	AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
	78	103	61·5	23	25	35	—	75	50	38 x 20	40–6
	71·5	91·5	58	23	25	33	35	75	53	35 x 20	40–60
	76	96	62	21	25	33	33	74	58	35 x 20	35–65
	73	95	62	27	23	32	40	79	56	39 x 19	35–65
	76	91	64	25	—	33	41	83	—	39 x 19	—
	75	94	60	26	28	34	35	75	53	39 x 19	35–60
	72	94	65	29	25	33	40	80	55	40 x 19	40–67
	72	101	65	27	28	33	40	84	55	39 x 19	—
	73	94	62	28	23	32	39	75	52	39 x 19	35–6
	73	97	64	26	25	32	36	75	55	39 x 19	40–60
	75	104	68	29	24	32	39	78	55	—	—
	72	96	61	25	25	38	38	75	55	—	—
Mean -	74	98	63	26	25·5	33	38	77	54	39 x 19	35–6

Arrangement of DS, 2.16.8(10).12(10).10(8).10.8(10).12.6.6.6.4.

Gunther gives the following: scutal length 56, width 100, AM 37·5, AL 80, PL 60, SB 62·5.

PARASCHÖNGASTIA RETROCINCTA (Gunther 1939)

Neoschöngastia retrocoronata Gunther 1938, *nom. nud.*, Med. J. Aust., **2**, (6), 202.
Neoschöngastia retrocincta Gunther 1939, Proc. Linn. Soc. N.S.W., **64**, (1-2), 87.
Paraschöngastia retrocincta Wom. 1939, Trans. Roy. Soc. S. Aust., **63**, (2), 165; Gunther 1940, Proc. Linn. Soc. N.S.W., **65**, (3-4), 247.

(Pl. xi, fig. 6)

We have examined the type and three paratypes of this species with the following results:

	AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	Sens.	DS
Type -	70	91	55	20	23	35	36	70	50	35 x 20	35
Parat. -	70	88	55	20	25	35	—	—	—	—	—
„ -	70	80	56	22	—	35	36	70	44	38 x 20	40
„ -	70	80	56	22	24	35	36	70	50	— x 20	45
Mean -	70	85	55·5	21	24	35	36	70	48	36 x 20	40

The DS are arranged, 2.8(10).12(10).6.8(10).8(6), 17 tubercles plus 11 (13).

Gunther's details are: scutal length 52, width 87, AM 37·5, AL 56, PL 47, SB 53.

Genus **Guntherana** nom. nov.

for *Guntheria* Wom. 1939, Trans. Roy. Soc. S. Aust., **63**, (2), 157.

We are indebted to Mr. G. Whitley, of the Australian Museum, for pointing out to us that *Guntheria* Wom. is preoccupied by *Guntheria* Bleeker 1862 for a fish. We therefore propose the name of *Guntherana* in its stead.

GUNTHERANA BIPYGALIS (Gunther 1939)

Neoschöngastia callipygea Gunther 1938, *nom. nud.*, Med. J. Aust., **2**, (6), 202.

Neoschöngastia kallipygos Gunther 1939, Proc. Linn. Soc. N.S.W., **64**, (1-2), 83.

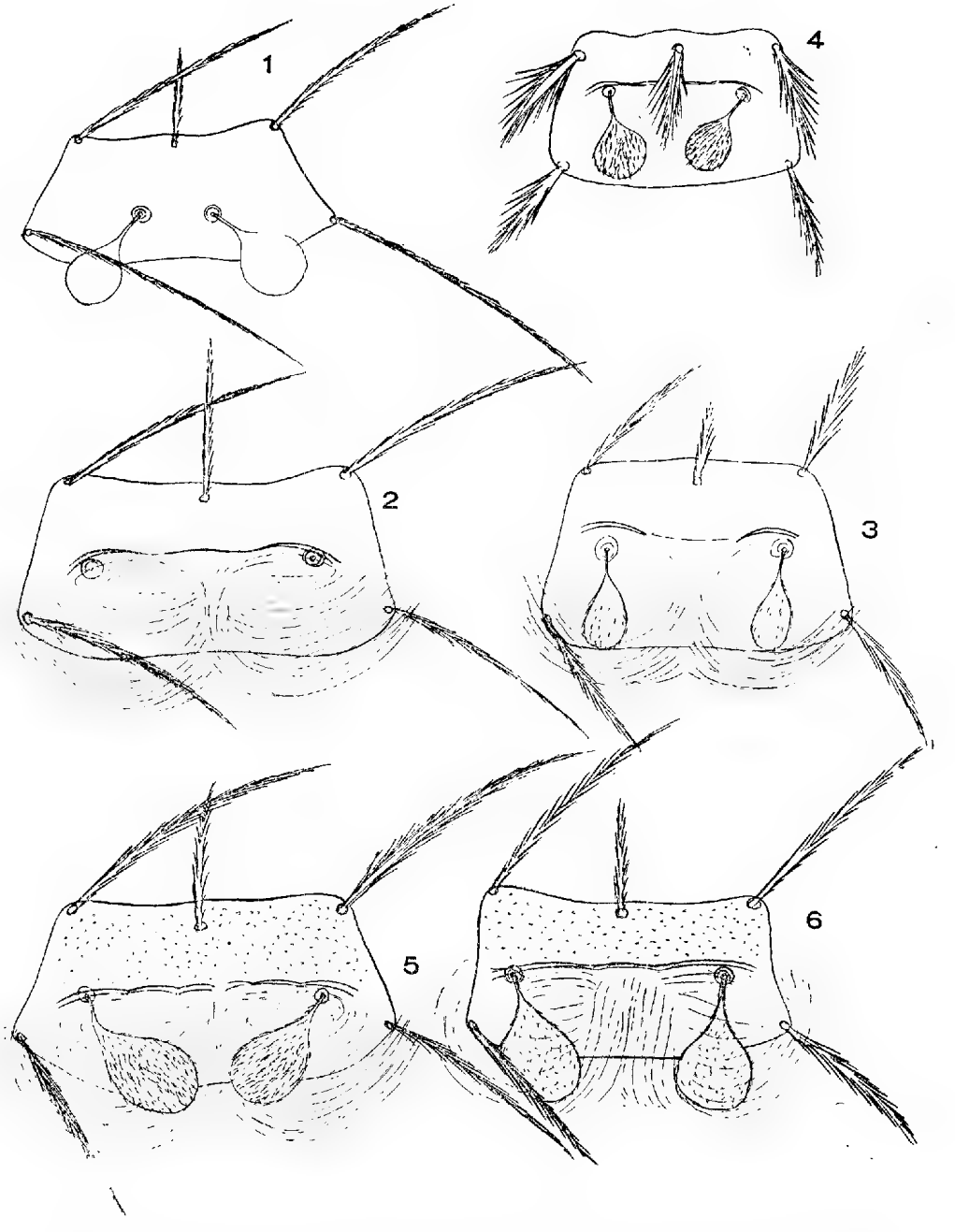
Neoschöngastia bipygalis Gunther, *ibid.*, 1939, **64**, (5-6), 471.

Guntheria kallipygos Wom. 1939, Trans. Roy. Soc. S. Aust., **63**, (2), 157.

(Pl. xi, fig. 1)

This interesting species was originally described by Gunther from New Guinea and recorded by Womersley from both rats and bandicoots from South Queensland, and subsequently (1939-1940, W. G. H.) specimens were collected from North Queensland from rats and *Isoodon torosus*. Standard data for 19 specimens, including two of type material, are as follows:

Loc. and Host	AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	Sens.	DS
Bulolo, N.G., Type -	58	68	21	21	13	26	—	65·5	80	30 x 15	—
„ „ Parat. -	58	92	23·5	—	—	—	—	—	—	—	—
M. cervinipes, Imbil., 8/1938 (Smith) - -	63	84	21	23·5	13	29	31·5	—	91·5	34 x 16	—
R. youngi, Cowan Cowan, 9/36 (Smith)	63	74	18·5	23·5	13	29	31·5	73·6	91·5	30 x 15	—
„ „	58	74	18·5	23·5	11	26·5	30	75	80	—	—
„ „	60	74	18	23·5	13	26·5	30	73·5	—	—	—
„ „	52·5	71	17	23·5	12	26·5	30	73·5	96	—	—
„ „	58	74	18·5	23·5	13	26·5	—	—	96	—	—
„ „	58	74	18·5	23·5	13	29	34	73·5	96	—	—
I. torosus, Cowan Cowan, 9/38 (Smith)	58	71	18·5	23·5	13	29	30	78	99	—	—
„ „	58	68·5	18·5	23·5	13	27	—	73·5	94	—	—
„ „	58	74	18·5	23·5	13	27	34	78	105	—	—
„ „	65	87	23·5	26	13	29	31	71	100	—	—
Rat, Brisbane, 1939 (Smith) - - - -	58	78	21	23·5	11	27	34	78	100	—	—
I. torosus, Cairns, 1939, W. G. H. - -	47	73·5	21	23·5	13	29	—	73	100	—	—
I. torosus, Little Mulgrave, 1939, W. G. H.	52·5	92	19	26	16	34	34	64	100	30 x 15	—
„ „	52·5	79	19	23·5	13	34	34	73	108	—	—
„ „	55	89·5	21	21	12	31·5	31·5	17	102	—	—
Rats, Cairns, 1939, W. G. H. - - - -	60	81·5	21	23·5	13	31·5	—	73	113	—	—
Mean - - - - - -	57·5	77·5	20	23·5	13	29	32	72·5	96	30 x 15	—



1, **Guntherana bipygalis** (Gunther) n. comb.; 2, *Paraschöngastia dubia* (Gunther); 3, *P. backhousei* (Gunther); 4, *P. gallinarum* (Kaw. and Yam.); 5, *P. yeomansi* (Gunther); 6, *P. retrocincta* (Gunther).

The DS range from 75 to 105 long, as follows: row 1 (scapula) 105, row 5 100, rest 75-80; arrangement, 2.6.4.6.2.

N.B.—The fig. 1, pl. xi, is drawn to scale from the data of the Bulolo specimens and not from the mean of all specimens measured.

Gunther gives the following: scutal width 81, length 33, SB 21, AM 28, AL 63, PL 83, and the DS are 2.6(2 or 4).4.2.4.2.6.2. We read his rows 4 and 5 as one row only and ignore the six small setae on the posterior dorsal plate, as well as his last row of two which are strictly ventral in position. In some specimens, notably those from Little Mulgrave, and some from Cairns, the posterior plate is entire and not longitudinally divided; there appear to be no other differencs and the separation into two may only be a matter of development.

Genus Walchia Ewing 1931

Proc., U.S. Nat. Mus., **80**, (8), 10. Genotype *Trombicula glabrum* Walch.

Palpi rounded laterally; palpal claw trifurcate; chelicerae each with a short chela. Dorsal plate present, as long as broad; bearing only four setae, exclusive of the pseudostigmatic organs, these setae being a pair of antero-laterals and a pair of postero-laterals. Pseudostigmatic organs clavate and setulate; eyes either lacking or represented by vestiges of a single pair. Dorsal abdominal setae moderate in size and number, less than 50 present. Legs moderate; second pair shortest; last pair longest.

Ewing laid stress generically on there being only four scutal setae besides the sensillary setae, the AM seta being wanting. Similarly in the genus *Gahrliepia* discussed by Gater (1932) and Gunther (1940) the dorsal scutum lacks the AM seta, but has a variable number of normal setae from four upwards. The minimum number of four is present in the species *G. rioi* Gunther from North Borneo, but here the scutum in posteriorly produced as a broad tongue-like process, so that the scutum is much longer than broad. In all the other species of *Gahrliepia* with produced scuta we find extra setae which are taken in from the dorsal rows by the posterior prolongation of the scutum.

Key to the Malayan and New Guinea Species of Walchia

1 Coxae III unisetose. 2
Coxae III multisetose. 4

2 Dorsal scutum indistinct. AW, PW and SB equal, 25-26. *W. morobensis* Gunther 1939
Dorsal scutum distinct. AW, PW and SB not all equal. 3

3 AW not much less than PW. ASB/SD about one-third, A-P/SD greater than half. DS 2.6.8.8.6.2.4.4.2. *W. rustica* (Gater 1932)
AW distinctly less than PW. ASB/SD about one-quarter A P/SD = half DS 2.6.6.6.6.6.6.4.2. *W. turmalis* (Gater 1932)

4 Coxae III with six setae. AW 17. Depth of posterior angle of scutum about half AW. Sensillae globose capitate. Dorsal setae 2.6.6.6.6.2.2. *W. leythwaitei* Gater 1932
Coxae III with less than six setae. AW greater than 25. 5

5 Coxae III with four setae. AW ca. 28. Depth of posterior angle of scutum about equal to AW. Sensillae globose capitate. DS 2.8.6.6.6.4.4.2. *W. enodis* Gater 1932
Coxae III with only three setae. AW 31. Depth of posterior angle of scutum about two-thirds AW. Sensillae broadly clavate with prominent setules. DS 2.6.6.6.6.4.2. *W. glabrum* Walch 1927 = *pingue* Gater 1932

Walchia glabrum (Walch 1927)

Trombicula glabrum Walch 1927, Genesk. Tijdsch. v. Ned. Indie, **67**, (6), 926.

Walchia glabrum Ewing 1931, Proc. N.S. Nat. Mus., 80, (8), 10; *pingue* Gater 1932. Parasitology, **24**.

(Pl. xii, fig. 1)

Of this species, described by Walch from rats from the Lampon District of Macassar, we have been able to identify three specimens from the Federated Malay States taken on *R. rattus argentiventer* Chasen, at Selinsing-Gunong, Semanggel, Perak, September 1932, and forwarded to us from the Institute of Medical Research, Federated Malay States. In addition, we have also examined a specimen (I.A.I.C. IV) from Batavia. All these specimens, as will be seen from the following standard data, agree well with Walch's description and figure. Gater's species was, unfortunately, described without figure but its synonymy with *glabrum* seems probable, the only differences are that Gater gives the sensillary setae as 21 long with the head "almost globular."

	AW	PW	SB	ASB	PSB	A–P	AL	PL	Sens.	DS
Perak. -	31·5	48	26	21·5	33	35	25	30	28 x 11·5	25–32
„ -	31·5	48	28	21·5	35	38	23	29	28 x 11·5	25–32
„ -	30	48	23	20	35	35	25	31	28 x 11·5	25-32
Batavia -	30	51	25	20	38	35	25	29	28 x 11·5	25–32
Mean -	31	49	25·5	21	35	36	25	30	28 x 11·5	25–32

DS 2.6.6.6.6.4.2. Coxae III with three setae. One lateral claw obsolete.

Walch gives the following details: scutal width 49, SD 50, Sens. 29, DS 2.6.6.6.6.4.2, 34 long; and Gater's details are: scutal width 47, length 57, Sens. 21 capitate, almost globose, DS 8.6.2.6.4.4.2. (= 2.6.6.6.6.4.2). Coxae with three setae.

Walchia morobensis Gunther 1939

Walchia bulolocnsis Gunther 1938, *nom. nud.*, Med. J. Aust., **2**, (6), 202.

Walchia morobensis Gunther 1939, Proc. Linn. Soc. N.S.W., **64**, (1-2), 94.

(Pl. xii, fig. 2)

We have been able to examine the type and three paratypes of this species and give the following standard data for two specimens:

	AW	PW	SB	ASB	PSB	A–P	AL	PL	Sens.	DS
Type - -	25	25	25	16·5	16·5	33	20	31	25	—
Parat. - -	25	26	27	17	—	34	18	30	25	—

Gunther gave: SB 25, AL 18, PL 30, Sens. 25.

Walchia lewthwaitei Gater 1932

Parasitology 1932 **24**,

(Pl. xii, fig. 3)

We have been able to examine a specimen from the Institute of Medical Research, Kuala Lumpur, labelled as this species. It was from *R. rattus* (sub. sp.?) from Sungei Buloh, Selangor, 15 October 1940.

The standard data are:

AW	PW	SB	ASB	PSB	A–P	AL	PL	Sens.	DS
17	31·5	17	17	21·5	28	11·5	15	-	—

DS 2.6.6.6.6.2.2. Gater's details are: scutal length 37, SB 18. Coxae III with six setae.

Walchia exodis Gater 1932

Parasitology 1932, **24**.

(Pl. xii, fig. 4)

From the Institute of Medical Research, Kuala Lumpur we have received a specimen of this species collected from *R. mulleri validus* (Miller) from Sungei Buloh, Selangor, 8 August 1930.

The data for this specimen are:

AW	PW	SB	ASB	PSB	A–P	AL	PL	Sens.	DS
28	50	23	21·5	38	35	20	26·5	—	—

DS 2.8.6.6.6.4.4.2.

Gater gives length of scutum 63, width 53, SB 24, setae on coxae III 3-5. No dimensions of sensillae are given, but they are said to be capitate with setules.

Walchia turmalis (Gater 1932)

Gahrliepia turmalis Gater 1932, Parasitology, **24**.

(Pl. xii, fig. 5)

This species should be placed in this genus rather than in *Gahrliepia*.

We have been able to examine two paratypes from the original hosts and locality.

Standard data:

AW	PW	SB	ASB	PSB	A–P	AL	PL	Sens.	DS
40	56	35	18	58	40	25	30	—	—
40	50	34	18	52	38	25	30	—	—

DS 2.6.6.6.6.6.6.4.2.

Details given by Gater are: scutal length 77, width 56, SB 34. DS 40 in number, but no arrangement or figure given.

Walchia rustica (Gater 1932)

Gahrliepia rustica Gater 1932, Parasitology, **24**.

(Pl. xii, fig. 6)

As with the preceding species, this also should be placed in *Walchia*.

We have examined a paratype specimen with the following data:

AW	PW	SB	ASB	PSB	A–P	AL	PL	Sens.	DS
40	46·5	30	17	39	33	28	25		—

Gater's data: scutal length 69, width 51, SB 30. Sen. figured but no dimensions given. DS 2.6.8.8.6.4.4.2.

Genus Gahrliepia Oudemans 1912

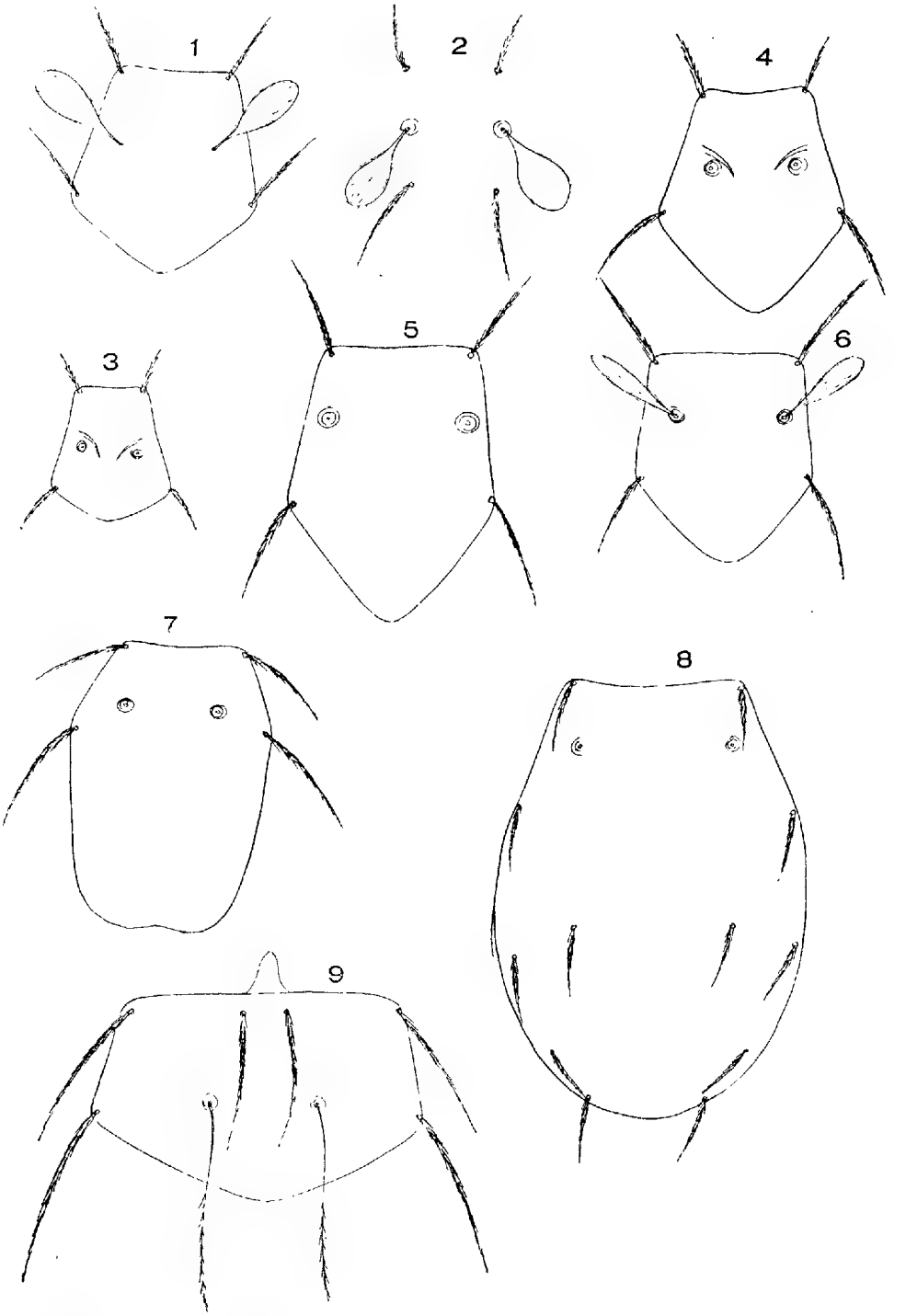
Typhlothrombium Oudemans 1910, Ent. Ber. Ned. Ent. Ver., **3**, 102.

Gahrliepia Oudemans 1912, Ent. Ber. Ned. Ent. Ver., **5**, 237.

Schöngastiella Hirst 1915, Bull. Ent. Res., **6**, 183.

Gateria Ewing 1938, J. Wash. Acad. Sci., **28**, (6), 295.

The genus *Typhlothrombium* was founded on the single species *T. nanus* Ouds. 1910, but as this generic name had been used by Berlese for an adult genus, Oudemans proposed *Gahrliepia* in its stead (1912). In *nanus*, in addition to the sensillae, the scutum carries four pairs of ordinary setae. In 1915 S. Hirst erected the genus *Schöngastiella* for *S. bengalensis*, a species very close to *nanus* but with only three pairs of scutal setae besides the sensillae. Gater 1932 described six species from the Federated Malay States as belonging to *Gahrliepia*, two, *turmalis* and *rustica* having only four normal scutal setae, the others, *rutila*, *cetrata*, *ciliata* and *fletcheri*, having 10, 8, 14 and 20 normal scutal setae respectively. It has been shown earlier in this paper that in the formation of the dorsal scutum the species *turmalis* and *rustica* are more correctly placed in the genus *Walchia*. In 1940 Gunther described *Gahrliepia rioi* from British North Borneo, also with only two pairs of normal scutal setae. In this respect it agrees with *Walchia* but must



1, *Walchia glabrum* (Walch); 2, *W. morobensis* (Gunther); 3, *W. lewthwaitei* Gater; 4, *W. cnodis* Gater; 5, *W. turmalis* (Gater); 6, *W. rustica* (Gater); 7, *Gahrliepia rioi* Gunther; 8, *G. rutila* Gater; 9, *Leeuwenhockia australiensis* Hirst.

be differentiated therefrom on the posterior tongue-like production of the scutum characteristic of *Gahrliepia*.

It follows, therefore, that in *Gahrliepia* we have species in which the normal scutal setae range from two pairs (which can be regarded as the normal or primitive number) through 3.4.5.7 to 10 pairs. In 1938 Ewing erected the genus *Gateria* (with *Gahrliepia fletcheri* Gater, as type) for those species in which some of the scutal setae were not marginal. In this genus would also be included *rutila* and *ciliata*.

However, if one carefully compares the scuta of the species of *Gahrliepia* it is seen that the posterior production of the scutum tends to take in a number of the median setae of one or more of the normal dorsal rows. At the beginning of this development we have *G. rioi* with the characteristic tongue-like extension but not yet embracing any extra setae; then through *bengalensis* with two extra, *nana* with four extra, and so on to *fletcheri* which takes in four extra median setae from the second dorsal row, eight from the third row, two from the fourth and two from the fifth row. In view of the transition the genus *Gateria* becomes unnecessary.

The setae of the dorsal rows taken in by the extension of the scutum are indicated by square brackets.

Key to the Indian, Malayan and New Guinea Species of Gahrliepia

1 With only four setae on dorsal scutum. Scutum small. SD 76. Sens. ? *G. rioi* Gunther 1940

With more than four scutal setae. 2

2 With six scutal setae. SD 80. Sens. clavate. DS 2,4[2],8.8.6.4.2.2, *i.e.*, only the two medial setae of second dorsal row on scutum. *G. bengalensis* (Hirst)

With eight scutal setae. SD 190. Sens. clavate. DS 2.6[2].6[2].6.6.4.4.2, *i.e.*, two medial setae of second and third dorsal rows are on the scutum. *G. cetrata* Gater 1932

More setae on scutum. 3

3 Scutum with twelve setae. SD 117. Sens. ? DS 2.6[2],4[2].[2].6.4.4.4.2., *i.e.*, scutum embracing two medial setae of rows 2, 3 and 4. *G. rutila* Gater 1932

Scutum with 14 setae. SD 189. Sens. ? DS 2[4].4[2].4]2[.4]2[.6.4.2.4.2, *i.e.*, scutum embracing all of second row, and medial two setae of third, fourth and fifth rows. *G. ciliata* Gater 1932

Scutum with 20 setae SD 188. Sens. clavate. DS 2[4].10[8].4[2].6[2].6.8.4.2., *i.e.*, scutum embracing all second row, eight setae of third row, and two of fourth and fifth rows. *G. fletcheri* Gater 1932

Gahrliepia rioi Gunther 1940

Proc. Linn. Soc. N.S.W., **65**, (5-6), 1940, 481.

(Pl. xii, fig. 7)

We have not seen any specimens of this species and have constructed the figure of the dorsal scutum and compiled the standard data from Gunther's details.

AW	PW	SB	ASB	PSB	A–P	AL	PL	Sens.	DS
30	50	25	18	58	24	28	40	—	—

Arrangement of DS, 2.6.6.6.4.2.

Gahrliepia rutila Gater 1932

Parasitology 1932, **24**.

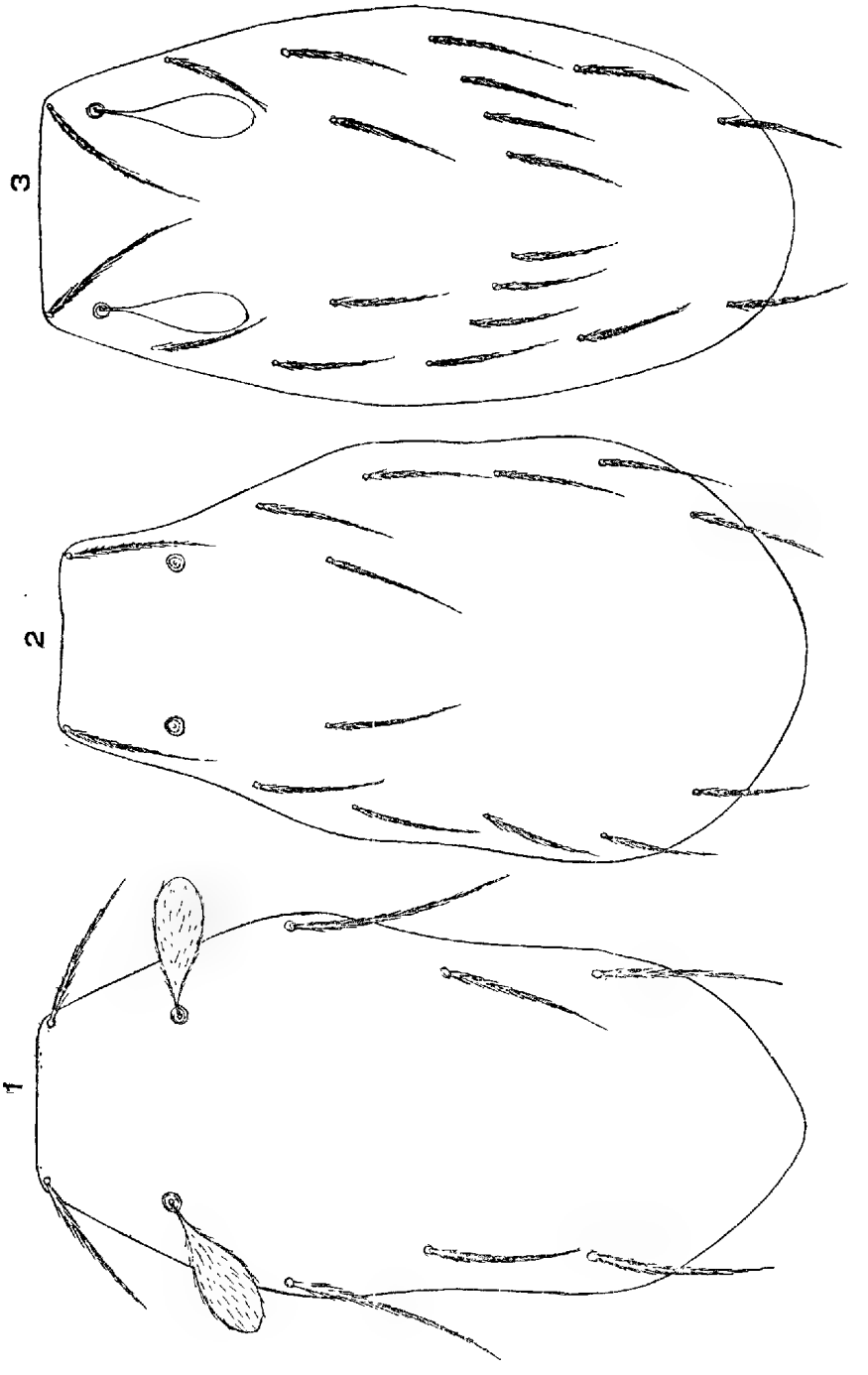
(Pl. xii, fig. 8)

We have examined a paratype, with the following data:

AW	PW	SB	ASB	PSB	A–P	AL	PL	Sens.	DS
43	73	41·5	17	99·5	35	18	18	—	—

Maximum width of scutum, 83.

Arrangement of DS, 2.6[4].4[2].[2]6.4.4.4.2.



1, *Gahrliepia cetrata* Gater; 2, *G. ciliata* Gater; 3, *G. fletcheri* Gater.

Gahrliepia cetrata Gater 1932

Parasitology 1932, **24**. (Pl. xiii, fig. 1)

As we have not seen any specimens of this species our standard data and figure of the dorsal scutum to scale are from Gater's details.

AW	PW	SB	ASB	PSB	A–P	AL	PL	Sens.	DS
42	90	49	35	155	65	40	55	37	—

Arrangement of DS, 2.6[2].6[2].6.6.4.4.2.

Gahrliepia ciliata Gater 1932

Parasitology 1932, **24**. (Pl. xiii, fig. 2)

From Gater's figure and data we get the standard data:

AW	PW	Max.W.	SB	ASB	PSB	A–P	AL	PL	Sens.	DS
40	70	109	42	30	159	53	45	38	—	—

DS 2.[4].4[2].4[2].4[2].6.4.2.4.2.

Gahrliepia fletcheri Gater 1938

Parasitology 1932, **24**.
= *Gateria fletcheri*, Ewing 1938. (Pl. xiii, fig. 3)

We have been able to examine a paratype of this species, of which the standard data are:

AW	PW	Max.W.	SB	ASB	PSB	A–P	AL	PL	Sens.
52	79	100	50	18	170	39	50	37	-

From Gater's figure and data we have:

AW	PW	Max.W.	SB	ASB	PSB	A–P	AL	PL	Sens.
54	73	99	50	15	173	31	50	35	30

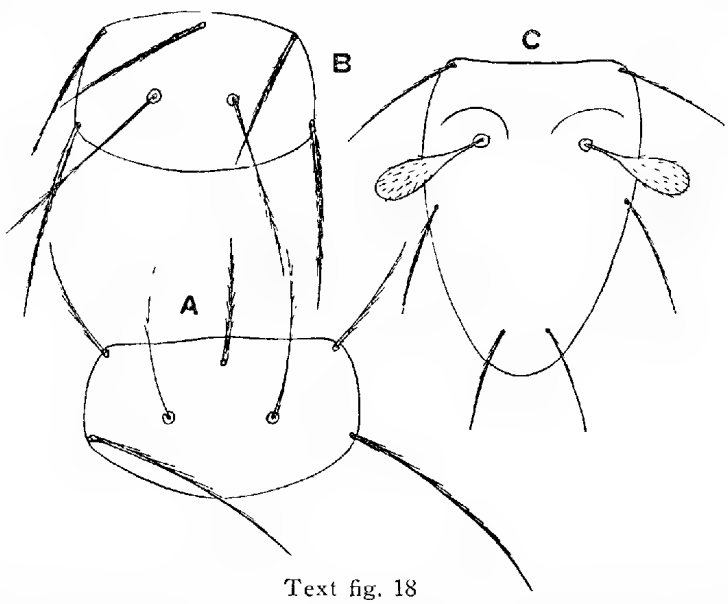
Arrangement of DS, 0.6[4].10[8].4[2].6[2].6.8.4.2.

Gahrliepia bengalensis (Hirst 1915)

Schöngastiella bengalensis Hirst 1915, Bull. Entom. Res., **6**, 1915.
Gateria bengalensis, Ewing, 1938, J. Wash. Acad. Sci., 28, (6), 295.

(Text fig. 18, C)

This species was originally described from the ears of *Mus rattus* from Calcutta, India.



Text fig. 18

Dorsal scuta. A, *Trombicula cervulicola* Ewing, x 500; B, *Trombicula isshikii* Sugimoto, x 500; C, *Gahrliepia bengalensis* (Hirst), x 500.

Unfortunately, the only dimensions given were the scutal length 80, width 56. From these and the figures given by Hirst, the following standard data have been compiled:

AW	PW	SB	ASB	PSB	A–P	AM	AL	PL	Sens.	DS
40	80	25	22	58	36	—	30	30	30	30

DS arranged, 2.4[2].8.8.6.4.2.2., *i.e.*, the median two setae of second row of dorsal setae taken in by the posterior extension of the scutum.

Genus Leeuwenhoekia Oudms. 1911

Entom. Ber., **3**, (5-8), 137. Genotype *Heterothrombium verduni* Oudms. 1910. Characterised as in the key to genera.

Leeuwenhoekia australiensis Hirst 1925

Trans. Roy. Trop. Med., **19**, 1925, 150-152.

(Pl. xii, fig. 9)

This species was originally recorded from human beings in New South Wales. I have also recorded it from Glen Osmond, South Australia, and Gunther records it from New Guinea, and W. G. Heaslip has taken it plentifully at Cairns and Brisbane, Queensland.

We give the following standard data for a number of specimens from various localities:

Loc.	AW	PW	SB	ASB	PSB	A P	AM	AL	PL	Sens.	DS
Cairns, Q.	68	80	26·5	29	25	26·5	36·5	41·5	55	50	45
,,	69	81·5	28	29	25	29	36·5	41·5	50	50	45
,,	71	91	25	29	26·5	29	41·5	46·5	55	—	50
,,	76	91	26·5	33	29	33	46	46·5	55	—	46
,,	70	92	29	29	25	33	36·5	41·5	51	50	45
,,	79	91	29	33	29	31	43	49	66	53	42
,,	64	—	—	—	—	—	41·5	—	—	—	48
,,	64	88	33	30	26·5	29	41·5	41·5	50	—	45
Glen Osmond, S.A.	70	91	30	34	26·5	33	41·5	41·5	58	55	45
,, ,, ,,	75	91	28	33	29	33	38	—	55	50	45
Cairns, Q.	73	91	29	35	29	29	46	46	53	66	48
,,	71	85	26·5	29	25	28	41·5	50	61·5	—	45
Brisbane, Q.	74	94·5	33	33	25	33	41·5	41·5	58	52	45
Bulola, N.G.	75	91·5	29	33	29	29	50	52	64	58	55
Mean	72	89	29	31	27	30	42	44	56	54	45–55

DS 2.6.6.8.10.8.6.4.2.

Acknowledgment

We are indebted to Dr. J. H. L. Cumpston, Chairman of the National Health and Medical Research Council, for permission to incorporate and publish in this paper the data collected by one of us (W. G. H.) while working in Queensland under a Research Grant of the Council.

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MORE AUSTRALIAN FRESHWATER SHELLS

By BERNARD C. COTTON

Summary

A paper by the present author, entitled "Australian Gastropods of the families *Hydrobiidac, Assimineidea* and *Acmeidae*," was read on 13 August 1942 before this Society, and the reprint bears the date 18 December 1942. However, Volume 66, (2), of these Transactions, in which the paper is published, was not issued until 24 March 1943. Two new species there introduced were later renamed by Iredale in the Australian Zoologist, 10, (2), 30 April 1943. One new genus, *Austropyrgus* Cotton, was omitted by him.

MORE AUSTRALIAN FRESHWATER SHELLS

By Bernard C. Cotton

Plates XIV-XIX

[Read 10 June 1943]

A paper by the present author, entitled "Australian Gastropoda of the families *Hydrobiidae, Assimineidae* and *Acmeidae*," was read on 13 August 1942 before this Society, and the reprint bears the date 18 December 1942. However, Volume **66**, (2), of these Transactions, in which the paper is published, was not issued until 24 March 1943. Two new species there introduced were later renamed by Iredale in the Australian Zoologist, **10**, (2), 30 April 1943. One new genus, *Austropyrgus* Cotton, was omitted by him.

Professor T. H. Johnston has published in these Transactions numerous papers on Trematode worm parasites, of which certain Australian freshwater shells are named as hosts, and the scientific names of the snails quoted are those which were to the best of our knowledge, at the time, applicable. The nomenclature of these freshwater snails is very difficult and involved, and it is only recently that attempts have been made to attain to some finality in the matter. A few of the species named as hosts are here discussed. The present author is in complete agreement with Iredale and other writers on this subject in that he believes that the classification and identification of Australian freshwater Gastropoda, especially of the families Bulinidae, Lymnaeidae and Planorbidae, are extremely difficult owing to the great variation in the species. In order to help in identification, accurate figures of certain species from known localities are here reproduced.

Burton Bradley, in the Medical Journal of Australia, 1926, p. 147-159, describes the animal and shell of four freshwater gastropods, and the names used must now be adjusted.

Family VIVIPARIDAE

Three genera are recognisable in this family, *Notopala* Cotton, *Centrapala* Cotton and *Eularina* Iredale, the latter being introduced because the genus name *Larina* Adams is preoccupied by *Larinus* Germar 1824. *Notopalena* Iredale was suggested as a subgenus of *Notopala*, with the banded northern species *essingtonensis* Frauenfeld as genotype. I am inclined to think that *barretti* Cotton should go into *Notopala* with the southern non-banded types and not with *Notopalena* as suggested by Iredale. Figured here with their opercula are the species *N. hanleyi* Frauenfeld from Tailem Bend, South Australia, *N. barretti* Cotton from Innamincka, Coopers Creek, Central Australia, *N.* (*Notopalena*) *essingtonensis* from Port Essington, North Australia, and *Centrapala lirata* Tate from Innamincka, Coopers Creek, Central Australia.

Family PALUDESTRINIDAE

Thirteen genera, as follows, are placed under this family by Iredale.

It would be almost impossible for anyone without the most intimate knowledge of Australian Fluviatile Mollusca to separate the genera listed in this genus. For that reason a brief key is here offered, in the hope that it may help students to identify these difficult genera.

a. Operculum not clawed.
  b. Aperture not free from the body whorl.
    c. Shell elongate.
      d. Operculum nucleus near the edge.

e. Aperture at the top away from body whorl .... *Austropyrgus*
ee. Aperture at top close to body whorl .... *Revisessor*
dd. Operculum nucleus distant from the edge.
f. Sutures not margined .... *Pupiphryx*
ff. Sutures margined .... *Phranntela*
cc. Shell about as high as wide.
g Body whorl dilated towards the aperture.
h. Heavy and imperforate .... *Petterdiana*
hh. Lighter and perforate.
i. Spire normal.
j. Perforation very wide .... *Beddomena*
jj. Perforation moderately wide .... *Tasmaniella*
ii. Spire very short .... *Valvatasma*
gg. Body whorl not dilated towards the aperture .... *Jardinella*
bb. Aperture free from body whorl.
k. Whorls strongly keeled .... *Posticobia*
kk. Whorls rounded .... *Fluvidona*
aa. Operculum clawed:
l. Operculum with subcentral nucleus and simple claw .... *Angrobia*
ll. Operculum with submarginal nucleus and six digitate claw *Tatea*

The four species placed by Iredale under *Potamopyrgus*, *nigra* Quoy and Gaimard, *petterdianus* Brazier, *legrandi* Tenison Woods and *buccinoides* Quoy and Gaimard, belong to the genus *Austropyrgus* Cotton 1943, of which *nigra* is the genotype. Figured here are the species *Austropyrgus nigra* Quoy and Gaimard from D'Entrecasteaux Channel, Tasmania, and *Revisessor tasmanicus* Martens from Lake Dulverton, Tasmania. The genus *Revisessor* Iredale seems to be closely allied to *Austropyrgus*.

Bradley's *Potamopyrgus* sp. is undoubtedly *Pupiphryx cooma* Iredale, from Cooma, southern New South Wales. Bradley well describes and figures both animal and shell of this peculiar species, the only one of the genus found in New South Wales.

Family BITHYNIIDAE

Gabbia Tryon and *Hydrococcus* Thiele are the two Australian genera. The Central Australian species, *Gabbia centralia* Iredale, was previously named *Gabbia iredalei* Cotton and *Gabbia affinis* Mousson *nom. nud.* was renamed and figured as *Gabbia relata* Cotton. *Hydrococcus graniformis* Thiele is a new name for *granum* Menke preoccupied.

Family THIARIDAE

Here again there is little possibility of workers in the field recognising the various genera in the family, distinct as they are, without the assistance of a key. To aid in this direction a key to the genera is here offered:

a. Shoulder of whorls with spines .... *Thiara*
aa. Shoulder of whorls without spines.
b. Whorls sculptured.
c. Spiral and axial sculpture, whorls rounded, not angled.
d. Spiral and axial ribs well developed .... *Plotiopsis*
dd. Spiral lirae on base, axial ribs above. .... *Sermylasma*
cc. Axial plications above the angle on the whorls .... *Pseudopotamis*
bb. Whorls smooth.
e. Spire elongate, acute, aperture small and oval, whorls with a tendency to angulation at the top .... *Stenomelania*
ee. Spire truncate, aperture long and oval, whorls flattened, no angulation .... *Ripalania*

Plotiopsis tatei Brazier 1881 is a new name for *Melania tetrica* Conrad 1850, preoccupied by *Melania tetrica* Gould 1847. *Melania subsimilis* Smith is a synonym. A distinct species, **Plotiopsis centralia** sp. nov., is here described.

Plotiopsis centralia sp. nov.

Holotype—Length 18 mm., breadth 7 mm. Innamincka, Coopers Creek, Central Australia. D 14133. S.A. Museum.

Shell elongate, shouldered near the tops of the whorls and having the typical shape and features of the genus; sculpture of about three prominent spiral ribs on the upper whorls, the first being situated at the angle and all crossed by spaced axial ribs becoming obsolete about the middle of the whorl, though the spiral ribs continue farther down the body whorl towards the base; apex acute. Differs from *P. tatei* in the more prominent spaced sculpture, the angled whorls and wider shell.

Also figured here are the species *Thiara amaruloidea* Iredale from Cardwell, Queensland; *Plotiopsis tatei* Brazier from Tailem Bend, River Murray, South Australia; *Plotiopsis australis* Lea from Victoria River, North Australia; *Sermylasma carbonata* Reeve from Cardwell, Queensland; *Stenomelania denisonensis* Brot from the Burdekin River; *Ripalania queenslandica* Smith from Cardwell, Queensland; and *Pseudopotamis supralirata* Smith from Torres Straits.

Family COXIELLIDAE

The South Australian species *Coxiella confusa* Smith 1898, with its rounded whorls, free mouth and umbilical chink, is apparently separable from the Victorian *C. striata* Reeve = *filosa* Mitchell. *Coxiella confusa* from the Coorong, South Australia, and *Coxiella striatula* Menke from Western Australia are here figured.

Family LYMNAEIDAE

The four genera placed in this family are *Peplimnaea* Iredale, *Austropeplea* Cotton, *Simlimnea* Iredale and *Glacilimnea* Iredale. All except the first genus are easily separable and apparently distinct from true *Lymnaea*. *Peplimnea* is more difficult to define, although in manuscripts I had already separated the Australian series subgenerically on shell characteristics. Many subgenera are placed under *Lymnaea*, of which the genotype is *Lymnaea stagnalis* Linne of Europe, North Africa and Northern Asia. The species has been introduced into Australia as an aquarium snail and thrives under such artificial conditions. There is no record of it yet having been introduced into Australian ponds, rivers and reservoirs, but it would no doubt thrive in them if given the opportunity. Both the shell with its exceptionally long spire and the radula, which shows minor differences from our common *Lymnaea lessoni*, are the chief points supporting separation. So far, no differences of any consequence have been discovered in any other anatomical details, rather has the similarity been noted. *Lymnaea lessoni* has been placed in *Amphipeplea* Nilsson 1823 = *Myxas* Leach 1822 (genotype of both is *Lymnaea glutinosa* Muller of Europe), but there is considerable anatomical difference in the Australian species. *Lymnaea lessoni* may be briefly described as follows:—Foot large, elongated; no expansion of the mantle over the outside of the shell and the limits of the parietal lamina can be distinctly traced, resembling *Lymnaea* rather than *Amphipeplea;* tentacles broad, acutely triangular and flat; the whole surface of the animal, including tentacles, base of the foot and even portion of the body within the shell is light grey and numerously spotted with minute white dots; egg-mass reniform, 18 mm. in length, containing 30 embryos. Shell large, globose, thin, pellucid, spire short, whorls few (about four), sculptured with numerous regular accremental striae, crossed by even finer regular microscopic spirals, suture slightly impressed, aperture wide, outer lip thin and simple; columella with one simple fold; inner margin of aperture widely spread with a dull nacreous deposit. The type locality of the species is River Macquarie at Bathurst, New South Wales, and the specimens described and figured are from Tailem Bend, River Murray, South Australia, where the species

is common, especially where and when conditions favour it. The following key will help in the generic location of the species:

a. Shell large, up to 25 mm. and globose .... *Lymnaea* (= *Peplimnea* Iredale)

aa. Shell small.
  b. Shell axially peculiarly wrinkled .... *Austropeplea*
  bb. Shell smooth and shining.
    c. Spire short, apex acute .... *Simlimnea*
    cc. Spire very short, apex planate .... *Glacilimnea*

Austropeplea aruntalis Cotton and Godfrey from Penola, South Australia, is figured here. The five species placed under *Simlimnea* Iredale and their distribution are:

Simlimnea brazieri Smith—Coastal rivers of New South Wales.

Simlimnea victoriae Smith—Coastal rivers of Victoria.

Simlimnea subaquatilis Tate—South Australia.

Simlimnea neglecta Petterd—Rivers of North Tasmania.

Simlimnea gunni Petterd—North and Middle Tasmania.

The genus *Simlimnea* may be described as follows:

Shell small, spire short, acute, body whorl moderate in development but not swollen; sculpture of microscopic incremental striae, but no spirals; suture distinctly impressed; aperture two-thirds or less of length of the shell; columella obliquely arcuate and spirally contorted with an excavate margin, reflexed in the umbilical region and connected with the lip above by a thin whitish callosity.

Bradley's *Limnaea brazieri* Smith 1882, type locality, Glebe Point, Sydney, New South Wales, is now known as *Simlimnea brazieri* Smith, the animal, shell and habitat of the species being very different from the large European *Lymnaea stagnalis*, the genotype of *Lymnaea*.

Simlimnea subaquatilis Tate from the River Torrens, Reed Beds, Adelaide, South Australia, is figured. *Simlimnea gunni* Petterd differs from the typical species of the genus in having a comparatively shorter spire and microscopic spirals, although in every other aspect it agrees. *Simlimnea gunni* Petterd from Launceston, Tasmania, is here figured.

Bradley's *Bullinus brazieri* Smith 1882, type locality, Ashfield, near Sydney = *brazieri* var. *pallida* Smith 1882, type locality, Chatsworth, New South Wales = *contortula* Clessin 1886, type locality, Australia, is now named *Isidorella brazieri* Smith. Differences noted in the animal from *Bullinus* and *Lenameria* are the long tentacles, situation of eye spots at the junction of the tentacles, triangular area of the proboscis on the dorsal aspect of the connecting ridge, and long foot pointed posteriorly. The differences in the shell are keyed in this paper.

His *Bullinus tenuistriatus* Sowerby 1873, type locality, River Torrens, South Australia, applies to a species found in South Australia and Victoria in the River Murray. The species figured and described by Bradley, under the above name, is probably *Lenameria gibbosa* Gould 1852, type locality, Parramatta, New South Wales. A rather variable species and the genotype of *Lenameria*.

Limnaea tasmanica Tenison Wood 1875 and *lutosa* Petterd 1888 are regarded as varieties of the European *peregra* Muller, said to have been accidentally introduced into Tasmania. The cotype of *lutosa* before me certainly resembles what may be regarded as a normal *peregra*. The facts about this amazing species are:

1 At least twenty varieties of *peregra* have been described.

2 The shape is extremely variable.

3 It is normally dextral, but a regular percentage of sinistral forms have been noted in certain localities.

4 In specimens from two different though close localities, and apparently of the same variety, those from one locality may revert to type under aquarium breeding conditions, while those from the other locality may not.

5 The species is very susceptible to environmental conditions and is also subject to periodical cycles of variation.

6 It may be smooth or sculptured with strong spiral ridges.

7 The colour varies from typical horn-yellow to banded with brown and white in the variety "*picta*."

8 It inhabits brackish water, maritime marshes, lakes, ponds, peat bogs, crawls on to dry land, or in the event of water drying up buries in mud, under stones, weeds or debris.

9 It ranges over Europe, North Africa, Asia, Cape Verde Islands, and in Iceland has been seen living in a spring at 40° C.

Family BULLINIDAE

The variability of the species in this family is extraordinary, though no doubt there is some geographical arrangement. Only names of specimens from known localities are here accepted, described or figured. I anticipated that the genus *Amerianna* Strand might be cut up into further genera with the words, "No doubt this will be split up by future workers," and, "The typically carinate shell appears so different from the ordinary *tenuistrata* type with its taller spire and rounded whorls." This has been done by Iredale. The following genera are located in the family: *Lenameria* Iredale, *Glyptamoda* Iredale, *Tasmadora* Iredale, *Amerianna* Strand, *Oppletora* Iredale and Whitley, *Isidorella* Tate. The following key will help workers to identify the genera:

a. Spire long, but usually shorter than the aperture.
  b. No prominent sculpture .... *Lenameria*
  bb. Prominent spiral sculpture .... *Glyptamoda*
aa. Spire short.
  c. Spire not truncate, body whorl wide.
    d. Columella not truncate.
      e. Columella strongly folded .... *Tasmadora*
      ee. Columella not folded .... *Isidorella*
    dd. Columella truncate .... *Oppletora*
  cc. Spire truncate, body whorl normal .... *Amerianna*

The following species are figured here: *Lenameria nitida* Sowerby, Great Lake, Tasmania; *Lenameria vandiemenensis* Sowerby, North Tasmania; *Lenameria georgiana* Quoy and Gaimard, South-West Australia; *Lenameria pyramidata* Sowerby, Lake Dulverton, Middle East Tasmania; *Lenameria pyramidata* Sowerby, dark-coloured variant from Tasmania; *Lenameria attenuata* Sowerby, Lake Dulverton, Tasmania; *Lenameria mamillata* Sowerby, Tasmania; *Lenameria queenslandica* Smith, Ipswich, Queensland; *Lenameria beddomei* Nelson and Taylor, Rockhampton, Queensland; *Glyptamoda aliciae* Reeve, River Torrens at Felixtowe, South Australia; *Tasmadora aperta* Sowerby, First Basin, Launceston, Tasmania; **Tasmadora sorellensis** sp. nov., Lake Sorrell, Tasmania; *Amerianna carinata* Adams, Boyne River, Queensland; *Amerianna bonushenricus* Adams and Angas, Arnhem Land, North Australia; *Oppletora jukesi* Adams, Yam Creek; *Isidorella newcombi* Adams and Angas, Mount Margaret, Central Australia; *Isidorella subinflata* Sowerby, River Torrens, South Australia; *Isidorella rubida* Cotton and Godfrey, Franklin Harbour, South Australia.

Amerianna bonushenricus shows a considerable difference from *carinata*. The columella fold is almost obsolete and there is no carination of the body whorl. In many respects it recalls *Isidorella* except that the spire is peculiarly depressed. It is here separated subgenerically under the name **Ameriella** sub. nov.

Tasmadora sorellensis sp. nov.

Holotype—Length 10 mm., breadth 6 mm. Lake Sorell, Middle Tasmania, D. 14132 S.A. Museum. Shell small, thin, greenish coloured, polished; columella fold well developed; spire slightly more elongate than in the typical species of the genus and the body whorl narrower. The shape and colouration readily separate this species from the genotype *Tasmadora aperta* Sowerby, which is found in Northern Tasmania.

Family PLANORBIDAE

Five genera are represented in this family: *Segnitila* Cotton and Godfrey, *Pygmanisus* Iredale, *Plananisus* Iredale, *Glyptanisus* Iredale and *Glacidorbis* Iredale. The following key will assist in their recognition:

a. Shell depressed, diameter three or more times the height, base flattened.
  b. Shell solid, compressed .... *Segnitila*
  bb. Shell thin, rounded.
    c. Whorls rounded.
      d. Small, rounded mouth .... *Pygmanisus*
      dd. Large oblique mouth .... *Plananisus*
    cc. Whorls keeled at the periphery .... *Glyptanisus*
aa. Shell comparatively high, diameter twice the height .... *Glacidorbis*

Figured here is *Segnitila victoriae* Smith, South Australia. There are apparently very weak internal lamellae in specimens of the species from Victoria, but they can only be seen when the shell aperture is broken carefully away for about one-third of the whorl. The weak development of these lamellae and the smallness of the species, distinguish this Australian genus. The species *alphena* Iredale has no internal lamellae and closely resembles *victoriae* in form. *Plananisus isingi* Cotton and Godfrey, Lake Alexandrina, is found at times in countless thousands amongst the "Carpet Weed" so common in billabongs on the Lower Murray. Although found alive at Tailem Bend Swamp some ten years ago, only dead shells have been taken during the last few years, and these are in great number. It is no doubt still plentiful in parts of the Murray. **Pygmanisus parvus** sp. nov., River Torrens; *Glyptanisus meridionalis* Brazier, South Tasmania; *Glyptanisus atkinsoni* Johnston, South Esk, Tasmania; and *Glyptanisus atkinsoni* Johnston, variant from Great Lake, Tasmania, are all figured here.

Pygmanisus parvus sp. nov.

Holotype—Diameter 5 mm. Height 1·25 mm. River Torrens, South Australia, D. 14131 S.A. Museum. Shell small, whorls rounded, aperture rounded, sculpture of growth lines only, otherwise typical of the genus and resembling the genotype, *Pygmanisus scottianus* Johnston from Launceston, Northern Tasmania.

Family ANCYLIDAE

The species figured here are *Pettancylus australicus* Tate, River Torrens, Adelaide, where the species is common on smooth stones and weeds; *Problancylus beddomei* Petterd, Queensborough, Tasmania; *Problancylus eremius* Cotton and Godfrey, Mount Lofty, South Australia, is apparently extremely rare and its generic location a problem, but whether it represents a *Pettancylus* with a marked growth stage or is generically distinct cannot as yet be determined, though it certainly has little to do with true *Gundlachia*. The specimens are probably aberrant, as Iredale suggests.

Family ASSIMINEIDAE

The estuarine species listed by me as *Assiminea tasmanica* Tenison Woods is here figured from a specimen taken at Ralph's Bay, Tasmania. The generic location of this species is doubtful. Previously placed in this family was *Paludina granum* Menke (preoccupied) = *graniformis* Thiele, which is now the genotype of *Hydrococcus* Thiele and allotted to the family *Bithyniidae*.

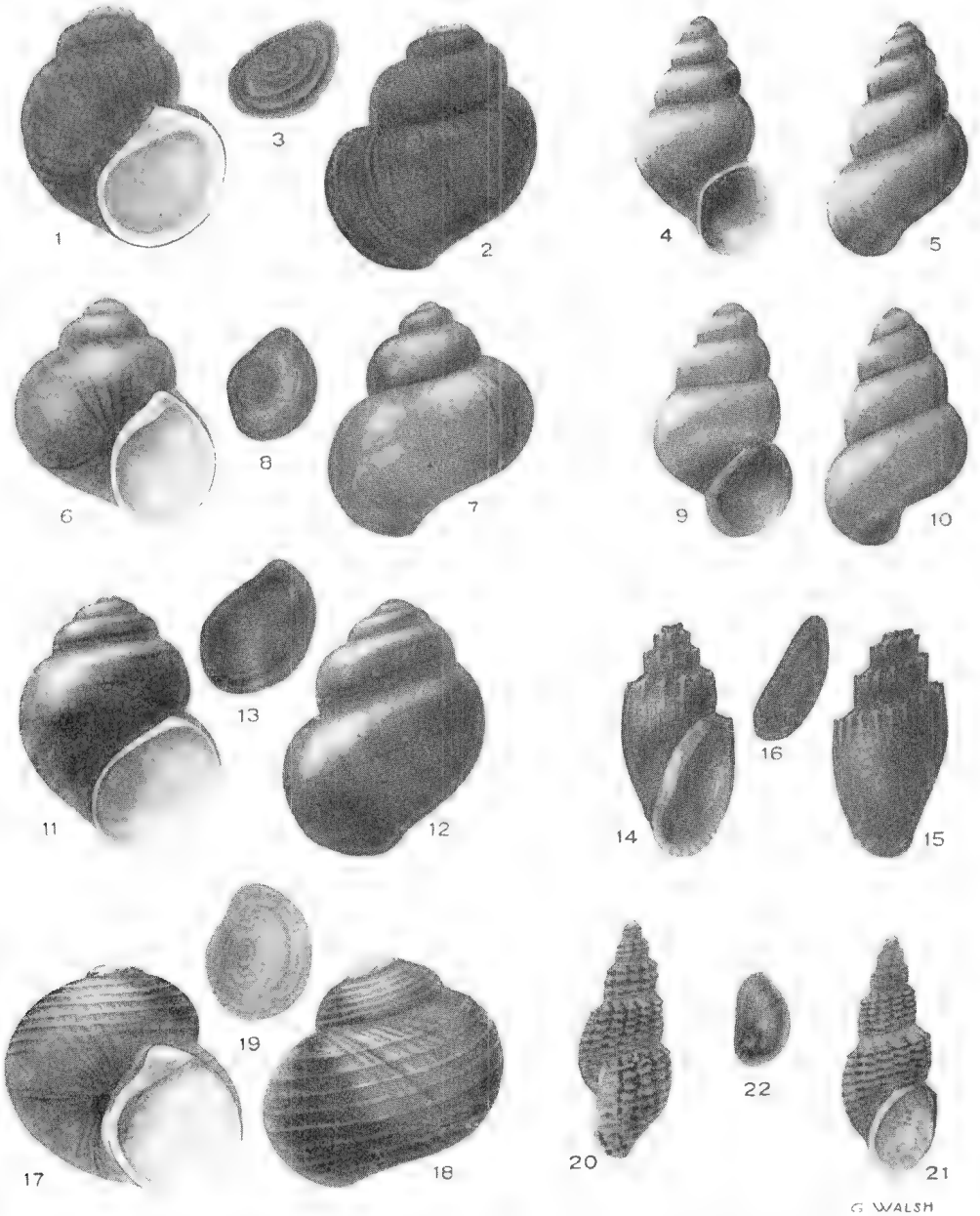

Fig. 1-2, *Notopala hanleyi* Frauenfeld, ventral and dorsal x 1·5, fig. 3, ditto operculum; fig. 4-5, *Austropyrgus nigra* Quoy & Gaimard, ventral and dorsal; fig. 6-7, *Notopala barretti* Cotton, ventral and dorsal x 2, fig. 8, ditto operculum; fig. 9-10, *Revisessor tasmanicus* Martens, ventral and dorsal x 10; fig. 11, 12, *Notopala* (*Notopalena*) *essingtonensis* Frauenfeld, ventral and dorsal x 1·5, fig. 13, ditto operculum; fig. 14-15, *Thiara amaruloidea* Iredale, ventral and dorsal x 1, fig. 16, ditto operculum; fig. 17-18, *Centrapala lirata* Tate, ventral and dorsal x 2, fig. 19, ditto operculum; fig. 20-21, *Plotiopsis latei* Brazier, ventral and dorsal x 1·5, fig. 22, ditto operculum.

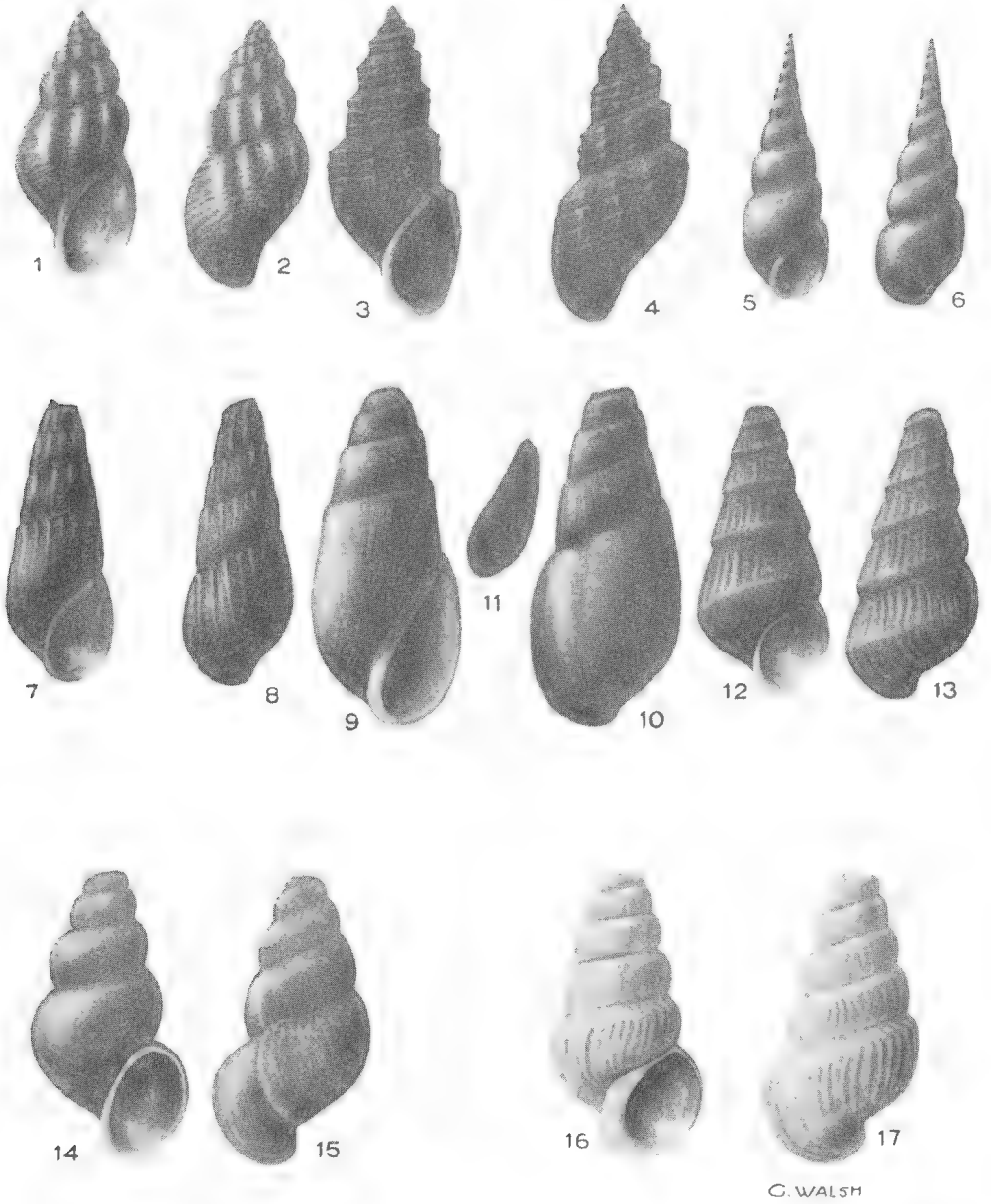

Fig. 1-2, *Plotiopsis australis* Lea, ventral and dorsal x 2·5; fig. 3-4, **Plotiopsis centralia** sp. nov., ventral and dorsal x 2·5; fig. 5-6, *Stenomelania denisonensis* Brot, ventral and dorsal x 1; fig. 7-8, *Sermylasma carbonata* Reeve, ventral and dorsal x 1; fig. 9-10, *Ripalania queenslandica* Smith, ventral and dorsal x 1·5, fig. 11 ditto operculum; fig. 12-13, *Pseudotamis supralirata* Smith, ventral and dorsal x 2·5; fig. 14-15, *Coxiella confusa* Smith, ventral and dorsal x 3·5; fig. 16-17, *Coxiella striatula* Menke, ventral and dorsal x 2·5.

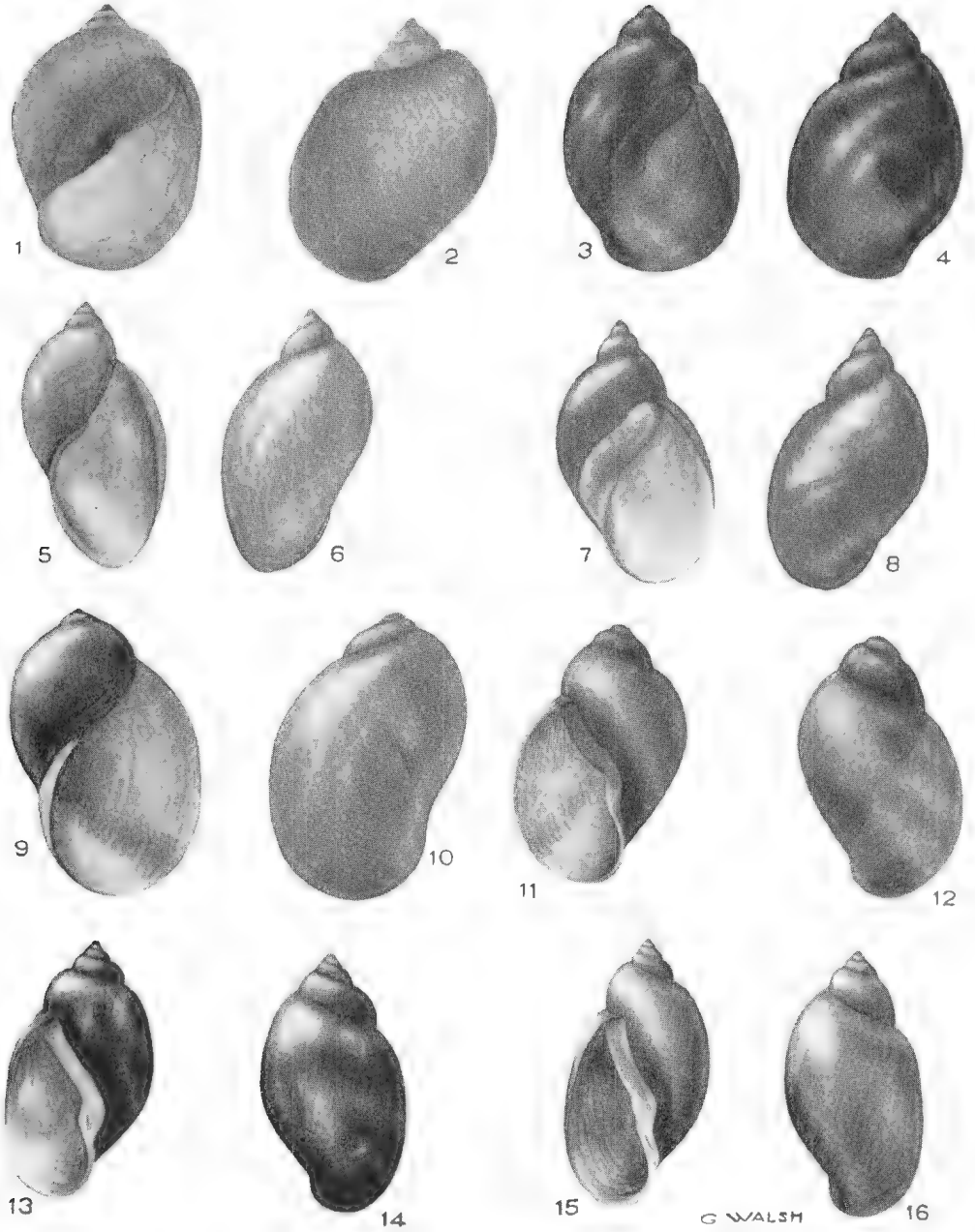

Fig. 1-2, *Lymnaea lessoni* Deshayes, ventral and dorsal x 1·5; fig. 3-4, *Lymnaea vinosa* Adams and Angas, ventral and dorsal x 1·5; fig. 5-6, *Austropeplea aruntalis* Cotton and Godfrey, ventral and dorsal 2·5; fig. 7-8, *Austropeplea subaquatilis* Tate, ventral and dorsal x 3·5; fig. 9-10, *Simlinnea gunnii* Petterd, ventral and dorsal x 7; fig. 11-12, *Lenameria nitida* Sowerby, ventral and dorsal x 4; fig. 13-14, *Lenameria vandiemenensis* Sowerby, ventral and dorsal x 1·5; fig. 15-16, *Lenameria georgiana* Quoy and Gaimard, ventral and dorsal x 2·5.

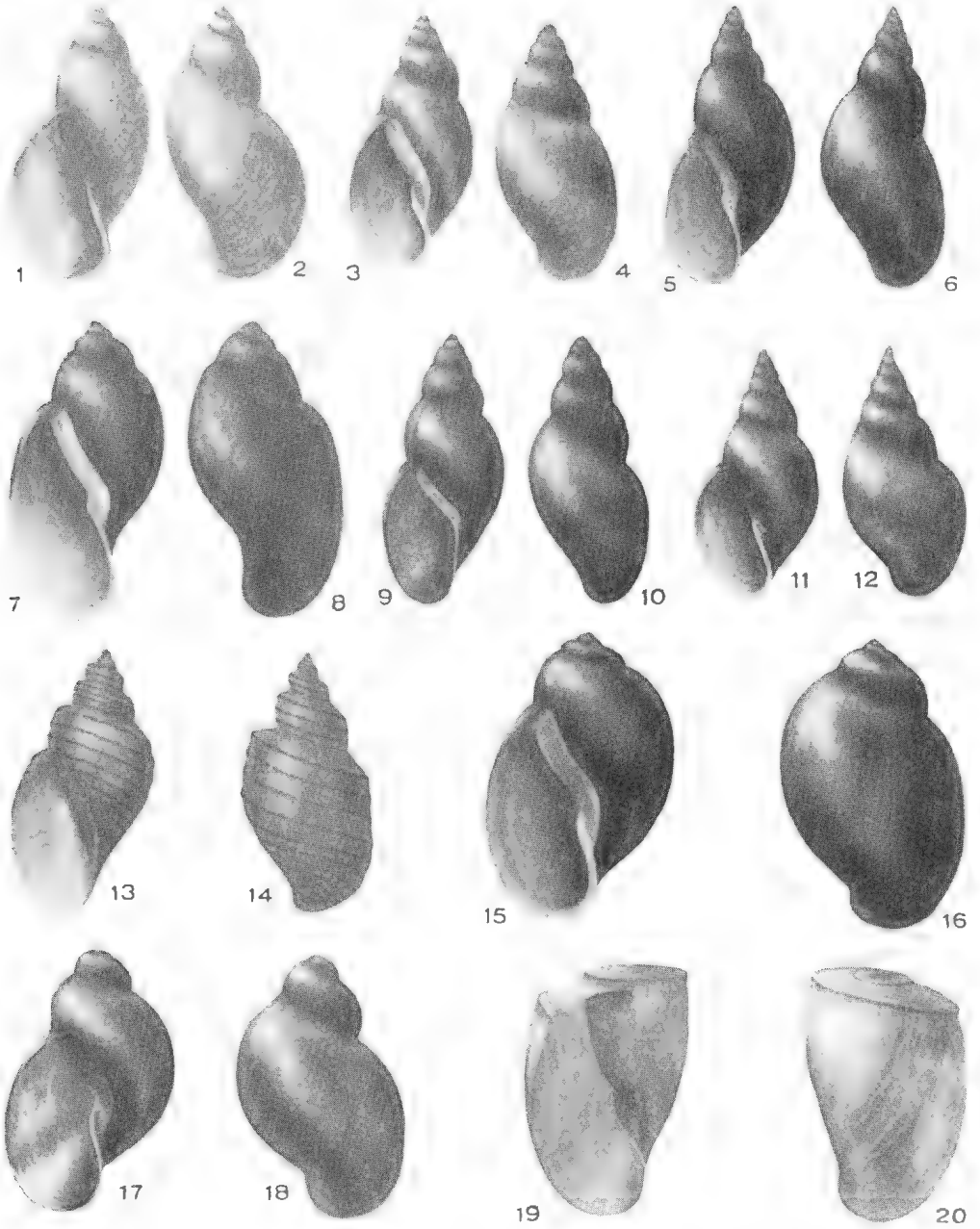

Fig. 1-2, *Lenameria pyramidata* Sowerby, ventral and dorsal x 2; fig. 3-4, *Lenameria pyramidata* Sowerby, variant, ventral and dorsal x 3; fig. 5-6, *Lenameria attenuata* Sowerby, ventral and dorsal x 1·5; fig. 7-8, *Lenameria mamillata* Sowerby, ventral and dorsal x 2; fig. 9-10, *Lenameria queenslandica* Smith, ventral and dorsal x 3; fig. 11-12, *Lenameria beddomei* Nelson and Taylor, ventral and dorsal x 2; fig. 13-14, *Glyptamoda aliciae* Reeve, ventral and dorsal x 2·5; fig. 15-16 *Tasmadora aperta* Sowerby, ventral and dorsal x 3·5; fig. 17-18, **Tasmadora sorellensis** sp. nov., ventral and dorsal x 3·5; fig. 19-20, *Amerianna carinata* Adams, ventral and dorsal x 2·5.

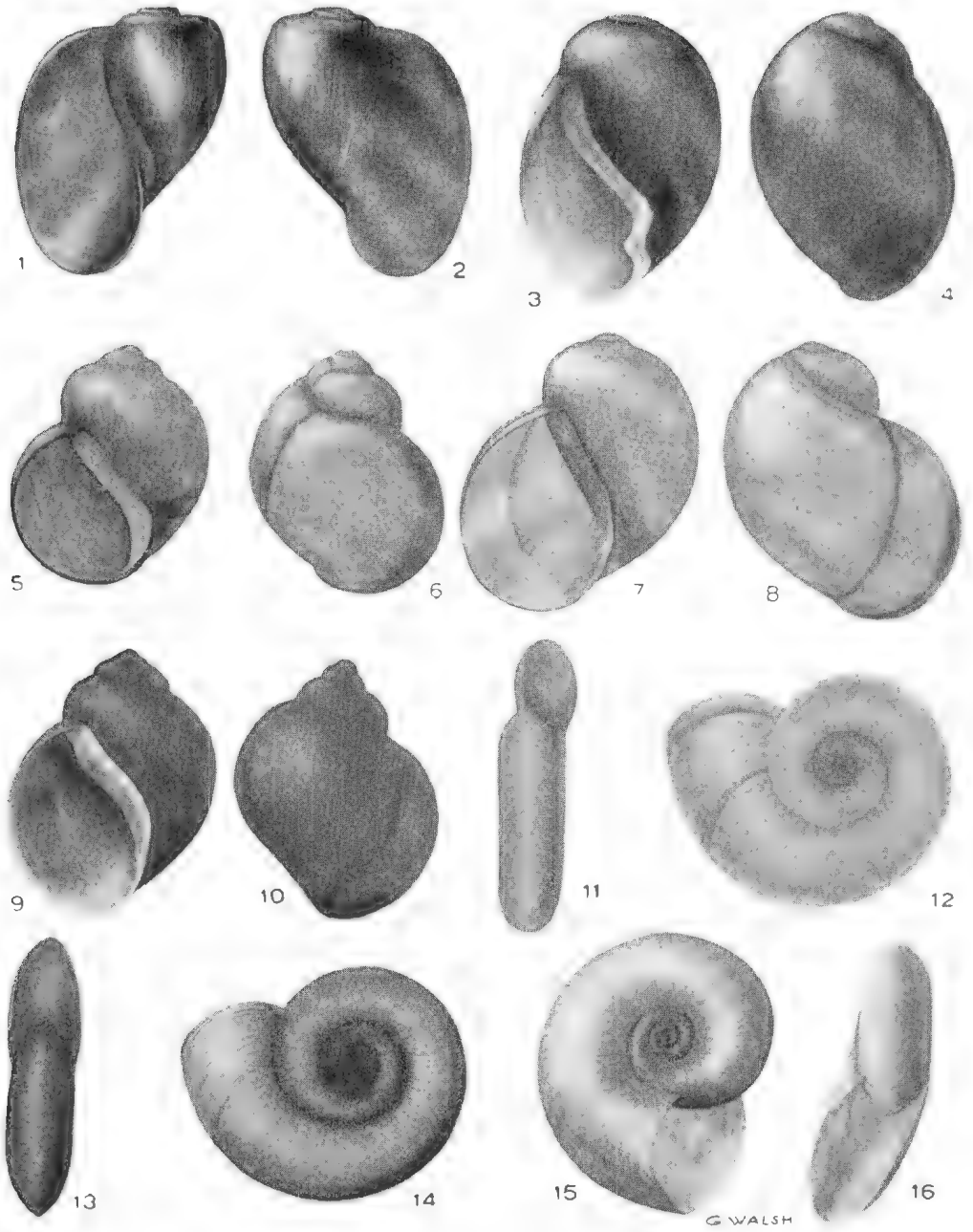

Fig. 1-2, *Amerianna* **(Ameriella)** *bonushenricus* Adams and Angas, ventral and dorsal x 4·5; fig. 3-4, *Oppletora jukesi* Adams, ventral and dorsal x 6; fig. 5-6, *Isidorella newcombi* Adams and Angas, ventral and dorsal x 2·5; fig. 7-8, *Isidorella subinflata* Sowerby, ventral and dorsal x 3·5; fig. 9-10, *Isidorella rubida* Cotton and Godfrey, ventral and dorsal x 3·5; fig. 11-12, **Pygmanisus parvus** sp. nov., lateral and dorsal x 8·5; fig. 13-14, *Plananisus isingi* Cotton and Godfrey, lateral and dorsal x 8·5; fig. 15-16, *Glyptanisus meridionalis* Brazier, dorsal and lateral x 8.

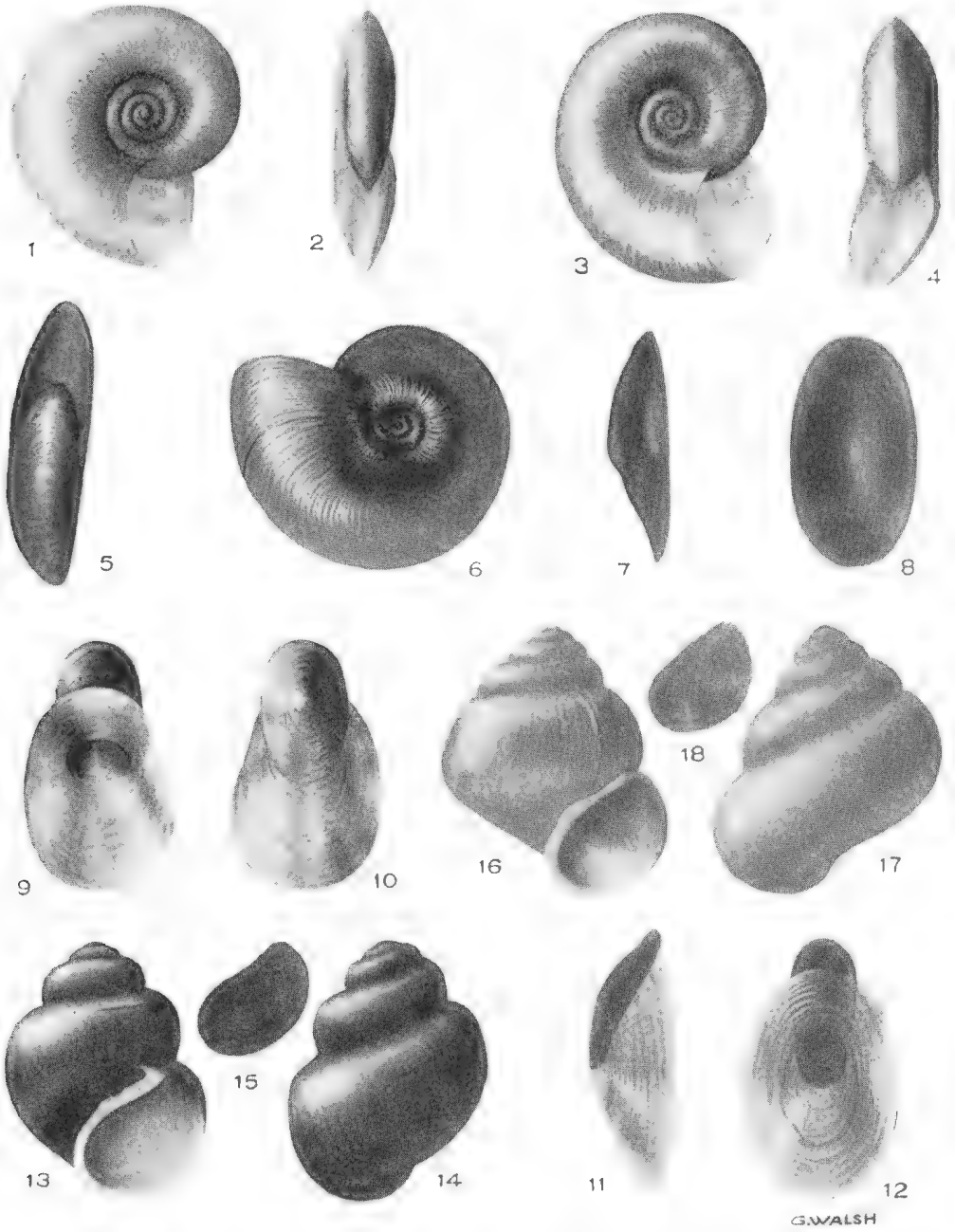

Fig. 1-2, *Glyptanisus atkinsoni* Johnston, dorsal and lateral x 10; fig. 3-4, ditto Johnston, dorsal and lateral, variant, x 6·5; fig. 5-6, *Segnitila victoriae* Smith, lateral and dorsal x 6·5; fig. 7-8, *Pettancylus australicus* Tate, lateral and dorsal x 7; fig. 9-10, *Problancylus beddomei* Petterd, ventral and dorsal x 9; fig. 11-12, *Problancylus cremius* Cotton and Godfrey, lateral and ventral; fig. 13-14, *Notopala (Notopalena) waterhousei* Adams and Angas, ventral and dorsal x 1, fig. 15, ditto operculum; fig. 16-17, *Assiminea tasmanica* Tenison Woods, ventral and dorsal x 9, fig. 18, ditto operculum.

NATIVE NAMES AND USES OF PLANTS IN THE NORTH - EASTERN CORNER OF SOUTH AUSTRALIA

By T. HARVEY JOHNSTON and J. BURTON CLELAND, University of Adelaide

Summary

In 1934 an expedition under the direction of the Board for Anthropological Research, University of Adelaide, visited the arid region lying to the north-east of Lake Eyre, our headquarters being located at Pandi Pandi on the lower Diamantina (local native name, Karitjuri), adjacent to the Queensland border near Birdsville. We also carried out investigations at Mirra Mitta, between the lower Diamantina and the lower Cooper (native name, Kunara). One of us (J. B. C.) had previously visited Cordillo Downs, Innamincka (on Cooper's Creek), and Strzelecki Creek and had published a botanical survey (Cleland, Black and Reese, 1925).

NATIVE NAMES AND USES OF PLANTS IN THE NORTH-EASTERN CORNER OF SOUTH AUSTRALIA

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[Read 10 June 1943]

In 1934 an expedition under the direction of the Board for Anthropological Research, University of Adelaide, visited the arid region lying to the north-east of Lake Eyre, our headquarters being located at Pandi Pandi on the lower Diamantina (local native name, Karitjuri), adjacent to the Queensland border near Birdsville. We also carried out investigations at Mirra Mitta, between the lower Diamantina and the lower Cooper (native name, Kunara). One of us (J. B. C.) had previously visited Cordillo Downs, Innamincka (on Cooper's Creek), and Strzelecki Creek and had published a botanical survey (Cleland, Black and Reese, 1925).

The region under review is that bounded on the west by Lake Eyre and the Arunta (Simpson) Desert, on the south by the Flinders Ranges and Lake Callabonna, on the east and north by the Queensland border. It is a particularly arid zone in which the watercourses seldom flow, the rainfall is extremely scanty and irregular, and the evaporation is high, 100 inches per year. Gregory (1906) called it "The dead heart of Australia." The Cooper, though its bed is many miles in width, had not run (we were informed) for sixteen years prior to our visit. The Diamantina had received abundant water from Queensland some months before our arrival and had overflowed its banks to fill much of its flood plain, several miles wide, but at the time of our visit it had greatly shrunk and was barely flowing, and we were able to walk dry-shod across one portion of it near our camp. The result of the overflow was that there was abundant vegetation along the banks and in small depressions in the flood plain, as well as in the so-called Goyder's Lagoon (native name, Koondarichinna), in which the river loses itself to become broken up into several small narrow watercourses [parri (Ngameni), kurrikuru (Ngameni and Wonkanguru)]. The drainage from this "lagoon," after flood, forms the Warburton and Kallakoopa, which may reach Lake Eyre (native name, Katitandra, according to Howitt). The region to the east of Lake Eyre was very poorly vegetated, plant life (apart from coolebahs marking the site of drainage channels) being restricted largely to the "gibber" or stony country lying between the moving sandhills, and to the vicinity of the artesian bores which have been sunk about thirty miles apart along the "Birdsville track." The presence of these bores permits the passage, at certain seasons, of cattle from north-eastern South Australia and western Queensland to the railway at Marree, whence they are entrained for the Adelaide market. Our observations would probably have been more extensive had conditions at the time been more favourable for plant life.

The distribution of the local aboriginal tribes is indicated in a general way in maps by Howitt (1904, 44), Horne and Aiston (1924) and Elkin (1937, 276), and in more detail, with approximate boundaries, by Fenner (1936) and Tindale (1940). The establishment of cattle stations and also some Lutheran mission stations on the lower Cooper in Dieri territory, following some good seasons, probably disturbed the distribution. Aridity caused these latter stations, as well as many others occupied by whites, to become abandoned so that they are now represented only by a few ruins, while the native population which Gason in 1874 estimated to be approximately 1,030, about 230 of them belonging to the Dieri, and about 800 included in the four tribes, Yandrawontha [Yandruwanta], Yarra-

waurka. [Yauraworka], Auminie [Ngameni], and Wonkaooroo [Wonka-nguru], has now shrunk to a few dozen full-blood aborigines. The approximate tribal boundaries at the time of our visit are indicated in Fenner's map (1936, 47). We examined for blood grouping (Cleland and Johnston, 1936) nearly all available full-bloods (47) and Fenner (a member of our expedition) carried out anthropometric work on 41. These numbers included nearly all the living aborigines of that area, the total being estimated by Fenner to be about fifty (excluding cross-breeds), but of the 41 measured, 20% of them were known to have died within eighteen months (Fenner 1936, 49), and no doubt the number now living must be very small since very few children were being born. It may be mentioned that portraits of many of the natives were painted by the late L. Wilkie who accompanied us, and are now in the South Australian Museum. Amongst those examined at our camps and included in the totals given, were several natives from other tribes bordering on our region, *viz.*, Aranda (Arunta), Arabana (Urabunna of authors), Andikeri-nga and Kuiyani, as well as one each from the Wadikali to the east and the Mittaka from Queensland. There were no full-blood representatives of the Yelyuyendi, Yauraworka and Wonkamala. Fenner mentioned that several of the individuals examined were the last remaining members of their respective tribes. Amongst tribes which appear to be now extinct are Tirari, Pilatapa, Kara-nguru, Ngurawola and Wonkamala, and to these are probably to be added Wadikali and Mittaka. Of the peoples of the region, the best known were the Dieri, since information concerning them was published by Gason (1874; 1879; 1886), Siebert, and Howitt (1904), as well as by Horne and Aiston (1924); and in the works of these authors there are scattered references to the utilisation of the vegetation by the natives. One member of our party, T. Vogelsang, was born in the Dieri country, where his people belonged to the staff of the Lutheran mission.

In addition to publishing our own observations, based mainly on our work at Pandi, we have endeavoured to bring together whatever information is available in literature and we have added [in brackets] our own comments on such information. In nearly all cases we have adopted J. M. Black's nomenclature (1922-1929).

We desire to acknowledge assistance from the Rockefeller Foundation (through the Australian National Research Council) towards our expenses; Messrs. L. Crabb of Pandi Pandi, and G. Aiston of Mulka; our colleagues of the expedition; and especially Mr. L. Reese of Minnie Downs.

Information relating to the uses by aborigines of the plant life of regions in Western Queensland due north of the area we are now considering, is contained in papers by Palmer (1884) and Roth (1897), and information of a more general character appeared in a popular book, "Our Sandhill Country," by Mrs. A. M. Duncan-Kemp (1933), whose experiences lay in the Queensland territory (occupied by the Mittaka or Murunga tribe) adjacent to that visited by us. The region to the south of the Eyre basin was dealt with by us (Cleland and Johnston 1939) in our paper on the names and uses of plants by natives of the Northern Flinders Ranges. The latter are inhabited by the Wailpi tribe who are also known as the Mardala or Anyamutna.

Palmer (1884) gave an account of 106 species of plants used by the natives of the Flinders and Mitchell Rivers, as food or medicine or as material for the making of implements, and in nearly all cases gave the names by which they were known to the natives on the Cloncurry River, which is the main tributary of the Flinders. He mentioned the names of two tribes, Myappe and Mycoolan. Roth's map (1897, pl. i) indicates that these two which he called Miubbi and Mikoolun, occupied the region around the lower Cloncurry, as well as the country between the latter and the Leichardt River.

Roth's work (1897) dealt chiefly with the Mitakoodi from the upper Cloncurry and with the tribes (Pittapitta, Kalkadoon, Woonamurra, Goa, etc.) occupying the extensive region drained by the upper portions of the Georgina and Diamantina and their tributaries. He published a great deal of information relating to the utilisation of plants as food and as raw material for implements.

Lying just to the south of the area studied by Roth is the great zone of sandhills which extends into the adjacent parts of the Northern Territory and South Australia. Mrs. Duncan-Kemp (1933) dealt with the region between the Diamantina and Georgina near the south-western corner of Queensland, between the South Australian border and the area covered by Roth's work. The tribes belonged to the group to which the terms "Pitta-pitta and messmates" have been applied by Roth. Her references to ethnobotany will be brought together in a later portion of our paper.

Amongst those who have given information relating to the area near the northern border of our region are Wells (1894) and Cleland, Black and Reese (1925).

Wells (1894) gave a short vocabulary and an account of the habits of the Andrawilla tribe inhabiting the region between the Diamantina, Eleanor and Herbert (*i.e.*, Georgina) Rivers. Pastoral map, sheet No. 15, indicates that the former police camp of Andrawilla was situated on the Eleanor near Clifton Hills Station and was on our route to Pandi which was about thirty miles further north. The tribe occupying the region when Wells was stationed there was probably the Ngameni, the Andrawilla people being one of its many small clans, the names of others being mentioned by Wells. The utilisation of cane grass [either the sandhills cane grass *Spinifex paradoxus* = *Zygochloa paradoxa* or *Glyceria ramigera* = *Eragrostis australasica*] to line the bottom of a grave and also to cover the corpse was referred to. The dome-shaped wurlies at a permanent camp were made of logs, cane grass and mud, whereas at a temporary camp a breakwind of boughs was sufficient. Fire was produced by twirling between the hands a piece of hardwood in a hole in a piece of native flax [*Crotalaria* spp.] or rotten wood, some sand being added to increase friction. Amongst the plant foods eaten were some from the bean tree, *Bauhinia* [*B. Carronii*]; yowas, somewhat like a pea, these being found in sandhills, and eaten green [? *Cyperus bulbosus*]; munyeroo "similar to an *Oxalis*," "probably *Claytonia buloncnsis*," eaten green [perhaps a confusion of nardoo (*Marsilia Drummondii*) and *Claytonia* (= *Calandrinia balonnensis*)] pigweed seeds [*Portulaca oleracea*] ground and made into a paste (damper = wai-mal-ya); "seeds" of nardoo, *Marsilia quadrifolia* [= *M. Drummondii*], ground, mixed with fish-fat, and then baked in hot ashes. Pituri or native tobacco came down from Sandringham, Queensland, the ash used in preparing it for chewing being obtained from the gidyea [*Acacia Cambagei*]. Native flax [*Psoralea patens* and *Crotalaria* spp.] was employed for making large nets for capturing fish and ducks. Amongst the native names published by him are the following relating to plants:—bark of a tree, yetanna; cane grass [*Eragrostis australasica* or *Zygochloa paradoxa*], bree-ta; *Eucalyptus*, bulka-kulla; grass, winthee; leaves, thalpoo; string, urip-a; spear, wadna-quin; stick, prit-ta [the same word, bree-ta, given for cane grass]; shield, murra-mumma; wood, thal-poo; yak-koota, bag; oo-too-manerie, hat.

Cleland, Black and Reese (1925) catalogued the flora of the north-east corner of South Australia and made some references to the use by aborigines of certain plants at Minnie Downs (near Pandi):—*Marsilia Drummondii*, nardoo, seeds pounded into an edible meal; *Panicum decompositum*, seed ground into flour; *Aristida arenaria*, stalks used for "spearing" flies for amusement; *Hakea leucoptera*, drinking water obtained from the roots; *Santalum lanceolatum*, fruit eaten; *Enchylaena tomentosa*, "currant bush" with edible berries;

Portulaca oleracea var. *grandiflora*, roots eaten after cooking; *Acacia ligulata*, ash from leaves is mixed with pituri; *A. tetragonophylla*, wood used for making boomerangs and womeras; *A. stenophylla*, bulgroo; *Crotalaria Cunninghamii* and *C. dissitiflora*, kahlo, fibre used for making string; *Eucalyptus microtheca*, coolebah, seed ground and eaten; *Cynanchum floribundum*, weela [wirla of Stirling and Waite, 1919], edible, plant used for making string; *Solanum esuriale*, berries eaten; *Cucumis trigonus* [= *C. melo* L. var. *agrestis* Naud.], ulcardo melons, eaten when quite ripe; *Eremophila Macdonnellii*, wakimba.

We obtained the following information from natives at Pandi Pandi (which is a Yaurorka name), the tribe using the particular name being indicated thus: D for Dieri; N for Ngameni; W for Wonka-nguru; and Y for Yelyuyendi (Jeljujendi). The term mickeri or mickri people is commonly applied to those coming from the sandhill (dako D, wadlu A, mudloo W, daku N) region west of the Diamantina and Warburton and including the Simpson Desert. The term is given because the tribesmen (now chiefly Ngameni and Wonkamala) obtain their water supplies from soaks (mickri W, ngapa-tjilli N), commonly deep in the sand (fig. 38 in Horne and Aiston's book). The sounds represented by p and b are interchangeable, as also are d and t.

Marsiliaceae

Marsilia Drummondii A. Br., ngardoo, N. W. D. Though nardoo is the popular name, ngardu is more correct. Gason (1874) called it ardoo, as he usually failed to detect the "ng" sound which is so common in aboriginal words. The sporocarps are pounded thoroughly between nardoo stones before the resulting coarse meal, mixed with water to make a dough, is cooked and eaten. This material, whose nutritive value is stated to be low, formed the main part of the vegetable diet on which King, the sole survivor of the ill-fated Burke and Wills expedition, subsisted until rescued. He was supplied by the Yantruwunta people of the region. The method of preparation of nardoo was described by Bancroft (1884, 104; 1893, 215-217). Horne and Aiston (1924, 54, fig. 40) have published a figure showing the method of crushing nardoo on a piddinie (lower millstone) by using a smaller handstone (koolkie).

Graminaceae

Grass. General name kalyeroo, kulgru N, wiringi W, [wirintji = fire (Arabana tribe); dried grass is used in fire-making], kuttu. *Eriochloa punctata* Benth.; *Paspalidium jubiflorum* (Trin.) Hughes and *Panicum decompositum* R. Br., pawa, bowa (seed), pau-akuttu (seed stick). Seeds ground and made into damper. Bancroft (1884, 105) gave an account of the mode of preparation of the seed of the last-named grass.

Triodia, probably *pungens* R. Br., kurumala N; its gum is poo-yu N. The method of extracting "spinifex" gum (Aranda name, nurbma) was described by Schulze (1891, 228).

Cyperus bulbosus Vahl., yaua N, yelka W, mung-aroo Y. Bailey (1912, 591) stated that mangaru of the Boulia natives of western Queensland was *C. esculentus* L. In our earlier papers we have called the species *C. rotundus*. Blake (1942) has identified it as *C. bulbosus* (syn. *C. Andrezesii*; *C. subulatus* var. *confertus*; *C. esculentus* Bailey non L.). Mr. Reese informed us it is termed kaninda at Innamincka (Yantruwunta name = Yidni minka; minka = hole, waterhole).

Liliaceae

Bulbine semibarbata (R. Br.) Haw., pund-oko, pont-uka N; mund-oka, munt-uka W. The leaves are eaten after cooking, the flowering stalks and seeds being thrown away.

PROTEACEA

Grevillea stenobotrya F. v. M., wi-alka W. Sometimes used for providing ash to be mixed with chewed pituri.

Grevillea striata R. Br., palku. Its gum is kandri palku N, kanti palku W, kandri N. Kanti W is a general name for gum. This gum is sometimes used for attaching the flint (tula) to the end of the wooden chisel.

Hakea leucoptera R. Br., kuluwa, kulua. Surface roots used as a water supply.

SANTALACEAE

Santalum lanceolatum R. Br., mundawarra, mandawarra N, munnawarra W. Fruit eaten.

LORANTHACEAE

Loranthus Mitchellianus Blakeley, koontarda; flower = tiwi N, ngamaka W. Ripe fruit eaten = kardi W, taldera N.

POLYGONACEAE

Rumex crystallinus Lange, murkera N. No name, W. Seeds converted into damper after grinding.

Polygonum glabrum Will., mankula, nunkula N, W. The stems of this tall species are pulled off and broken into pieces, then lightly cooked in the fire and the pith eaten.

Polygonum plebejum R. Br., paua-tinna N, seeds crushed on stones, then cooked and eaten as damper. Not used by Wonkanguru.

Muehlenbeckia Cunninghamii (Meisn.) F. v. M., puka miriki N, yetjelka W.

CHENOPODIACEAE

Chenopodium auriconum Lindl., pata-kurru N, W.

Bassia bicornis (Lindl.) R. Br., malto N, kaltru-kurru W.

Enchylaena tomentosa R. Br., koona-pirra N, koonapria W. Berries, eaten.

AMARANTACEAE

Trichinium obovatum Gaudich. The downy perianth is used for ceremonial decoration and is called wuntata N, W, the same name as for feathers.

Amaranthus Mitchellii Benth., koona-ngarda, kunu-ngarda N; talcu, dalcu W. Seed used for damper.

AIZOACEAE

Tetragona expansa Murr. Native name not known by informant. It is now eaten, its use being made known by the white man, according to our informant.

PORTULACACEAE

Portulaca oleracea L., biddi-curdi (Mickeri name, N). The seed, bowa, paua, paua biddi-kurdi W, is eaten. The name munyeroo D is also applied to the plant (Bancroft, 1884, 106). Horne and Aiston (1924) illustrated the method of grinding the seed.

Portulaca intraterranea Black, kauira N, pidikurdi W. The seed = pau-a (pawa) N. All of the plant above ground is eaten raw or cooked by both tribes (N, W); the root only, when cooked.

Another pig-weed from the sandhills, probably *P. oleracea* var. *grandiflora* Benth., darikya N, puralya W. Only the roots eaten after cooking.

NYCTAGINACEAE

Boerhavia diffusa L., kurri (karri) wirri (Mickeri, N, W). The root, six inches or more in length, is eaten after cooking.

CRUCIFERAE

Blennodia eremigera (F. v. M.) Benth., priddiwalkatji N, priddi- warrukatji W. Stem and flowers cooked and eaten. This and the succeeding species are eaten by emus (warrukatji).

Lepidium Muelleri-Ferdinandi Thell., priddiwalkatji N, priddi-warrukatji W. Cooked and eaten.

LEGUMINOSAE

Acacia ligulata A. Cunn., muntera, muntara N, W. The ash derived from burning twigs is used for mixing with pituri. The ash from this species ("pituri willow") is most favoured for the purpose.

Acacia salicina Lindl., tjirri. Ash from twigs of this "Broughton willow" is used for mixing with pituri.

There has been much confusion regarding this species because the name has commonly included *A. ligulata;* also, on account of this confusion, it has been stated that *A. salicina* was the chief supplier of ash for mixing with chewed pituri, and consequently the Dieri name, wirra or wirha, has become associated with it. Howitt's figure indicates that he was dealing with *A. ligulata*, not *A. salicina*. *A. ligulata* (muntera, wirra) prefers a sandy habitat, whereas *A. salicina* (tjirri) prefers alluvial flats or situations near water.

Acacia tetragonophylla F. v. M. Stems used for making spears.

Acacia Murrayana F. v. M., ngarra-ulla. Ash used for mixing with pituri. Seeds roasted and eaten.

Acacia frumentacea Tate, closely resembles *A. murrayana*. Stirling (Anthropology; Horn Exped. Report, p. 51) stated that the large seeds were ground for food—hence the specific name given by Tate. Black (1929, 688) examined material from Toorawatchy, collected by H. Basedow in 1918, and stated that a witchety grub occurred in its roots.

Acacia aneura F. v. M., mulka, malka D, N, W. Stems used for making spears.

Acacia stenophylla A. Cunn., bulgeru, bulgroo, pulkeru N, W. Ash used for mixing with pituri. Wood of a twig used for making spindles for the manufacture of string from hair (para), fur (pultje W, nalta N) or plant fibre.

Bauhinia Carronii F. v. M., talpu N, and W. The gum oidlye N, oidlu W, is eaten; the term suggests oolyie, ngulyi, of other recorders.

Legume with two pinnae (four leaflets), not in flower or fruit, boonkoodoo, punkudu. The specimen has been matched with the narrow-leaved variety of *Cassia eremophila* by Miss C. Eardley of the Tate Herbarium. Stirling and Waite mentioned punkudu as a fibre. A striped edible grub (padi, D, W), lives in the roots.

Trigonella suavissima Lindl., native clover, kalumpa, kalumba N, W. All the upper part is eaten raw.

Psoralea patens Lindl., ka-lo N, W. Same name applied to *Crotalaria* spp., from which native flax fibre is made. Used to make nets and bags. The largest plants (stems and roots) are stripped, tied into a large bundle and left to dry in the sun for three or four days; then made into a tight bundle by twisting the stems round each other, and then left in water overnight, when the bark loosens. The

plants are then rubbed in the sand and the stems are pulled through the hand so that the bark comes off in strips and is used as fibre, the stems being rejected.

Crotalaria Cunninghamii R. Br., ka-lo, used for making string. "Flax"-producing plants are discussed at the end of this paper.

Euphorbiaceae

Euphorbia Drummondii Boiss., ngama-ngama (Mickeri). Local name Currawinya clover. Widda-pooloo N, munya-munya N. It is a reputed poison plant. The leaves and branches (not the stems) are boiled in a billy for a day or more. The liquid (used also by Afghans) is drunk as a cure for gonorrhoea. As the latter is an introduced disease and no virtue can be ascribed to this decoction, its use must be attributed to the popular dictum "similia similibus curantur," the milky juice suggesting the gonorrhoeal discharge. Roth (1897, 163) mentioned that in Western Queensland the natives commonly believed that any sort of grass or shrub growing near the water's edge would relieve difficult or painful micturition, and that various species of *Euphorbia* were very frequently used for that purpose.

Euphorbia eremophila A. Cunn. Same names as for *E. Drummondii* were given by N and W.

Sapindaceae

Atalaya hemiglauca F. v. M., kuringula, kuringala N, W.

Malvaceae

Lavatera plebeja Sims., putta-ri. The name appears to be puttera (patara), which is sometimes used for wood or timber and hence for the long woody stalks of this marshmallow.

Mallow (probably *Sida virgata* Hook), wilti N, weelalya wi-alya W.

Myrtaceae

Eucalyptus microtheca F. v. M., Coolebah; pattera, puttera N, W. The following information was obtained from a Mickeri native. The branches are broken off and taken to a claypan, where the seed (paua wudlia, pau kurdi) becomes liberated from the capsules in about five days' time. The seed and debris are collected and placed in a coolamon, winnowed in a strong wind, soaked all night in water in the coolamon, and then rubbed with the hands to clean and dry the seed. The latter is then treated in the same way as that obtained from grasses. About two handsful are placed on a large lower millstone with a groove along one side, and ground with a smaller stone till very fine. The moist mass is then collected into a dish (pitchi) held below the edge of the lower stone. This paste (paua bilu) may be eaten dry, but the main portion is usually cooked in hot ashes. Ash from burnt twigs is sometimes used for mixing with pituri. Stems of the coolebah are laid lengthwise on graves. Some of the latter were seen near our camp. Photographs have been published by Waite (1917, pl. xxii, fig. 1), Horne and Aiston (1924, fig. 1), and Elkin (1937, pl. i, fig. B).

Convolvulaceae

Ipomoea heterophylla R. Br., dintani N, W. Seeds crushed and eaten when fresh (not when ripe and dry); long narrow roots cooked and eaten.

Ipomoea sp., mootcherie. Growing tops are eaten like a spinach. Duncan-Kemp (1933, 259) gave mootchery as the name for yams resembling sweet potatoes, growing in sandhills and sandy banks of watercourses in the adjacent region in Queensland.

Evolvulus alsonoides var. *sericeus*. Sometimes used as a substitute for pituri (L. Reese).

Solanaceae

No native tobacco plant is used in the Mickeri or the Pandi country, though our informant knew the ingulba of the Aranda people of the Macdonnell Ranges.

Nicotiana sp. (probably, or closely related to, *velutina* and *Goodspeedii*) occurs near the watercourses, and has been listed as *N. suaveolens*.

Pituri, pitjuri (*Duboisia Hopwoodii*) is brought from the Upper Mulligan in Queensland. We have already referred to this narcotic in an earlier paper (Johnston and Cleland 1933; 1934). Twigs and leaves of *Acacia salicina*, *A. ligulata* and other plants are burnt to obtain ash (kirri), which is mixed with pituri during preparation of the latter.

Datura Leichhardtii F. v. M., tjultrani N.

Myoporaceae

Eremophila bignoniflora (Benth.) F. v. M., thea-munni, tia-munni.

Eremophila maculata (Ker.) F. v. M., taia-munni N, W. The term is perhaps a general one for species of *Eremophila*.

Eremophila Sturtii R. Br. Mr. Reese informed us that the ash of "turpentine bush" was sometimes used for mixing with pituri. Black (1929) mentions *E. Sturtii* as the only South Australian plant bearing that popular name.

Goodeniaceae

Goodenia subintegra F. v. M. and *G. glauca* F. v. M. No name obtainable N, W. Eaten by emus.

Goodenia cyclòptera R. Br., kalla-toora-milkie N, W (= turkey-eye; kalatoora = wild turkey or bustard, *Eupodotis australis;* milki = eye), plant sometimes used as a substitute for pituri.

Leschenaultia divaricata F. v. M., mindri. The gum (mindri) is used especially for attaching stone axes to their wooden hafts, and the flint (tula) to the end of the wooden chisel. The material is obtained from the roots by heating. The plant will burn readily while green and produces a dense black smoke.

Compositae

Calotis sp. (*C. porphyroglossa* F. v. M.; *C. ancyrocarpa* J. M. Black; and *C. multicaulis* were all collected at Pandi). Te-te purra N, murumba W. Not eaten. The awns on the fruits are troublesome to the natives.

Pterigeron adscendens Benth., ngurra ngurrawa N, ngarra ngarrawa N.

Senecio Gregorii F. v. M., walko walko N, W. Eaten by lizards (kadni).

Gnaphalium luteo-album L. or *G. indicum* L. (both of which occur at Pandi). Uti uti N, koonakurtuku W. Down used for decorating natives for ceremonial purposes.

Centipeda Cunninghamii (DC) A. Br. et Aschers, koona puturku N, W. Similar name for *Gnaphalium*. Used for bad colds by putting plants around the head. Plants so used because of their aromatic odour. Kudna = filth or excrement. *Centipeda* has an objectionable odour.

Calocephalus multiflorus (Turcz.) Benth., purdi-purdi N. No name W.

Other terms are: –yakuta, bag; kattu N, yenku W, breakwind; toru, turu N, maka W, fire; puttera, timber. Huts were made of boughs covered with smaller vegetation (branches and grass) in much the same way as is illustrated by Horne and Aiston (1924, fig. 12-17) for the wilpie and poonga of the Dieri tribe, and by Elkin (1938, fig. 16).

For information regarding the use of plants and their products by natives of the Dieri region we are indebted chiefly to the work of Gason (1874), Howitt (1904) and Horne and Aiston (1924). There are also many references by Stirling and Waite (1919) in their paper on "toas" of the Dieri people.

Gason gave an account of the Dieri in 1874, his work being republished in 1879 by Woods (1879, 257-307), and in 1886 by Curr. The following references are taken from the 1879 edition. His vocabulary (pp. 296-307) contains the following names given to plants and their products:—backa, husk or outer shell; booka, vegetable food (antie = animal food) [Howitt gave the term anti or nganti for flesh]; bookaundrinie [buka-ngandri of Howitt 1904, 792], scrub, shrubbery, bushes (rather than trees); boompoo, bud; boonga, hut or wurley; dilka [djilka], thorn, burr or prickle; kaulkoo [kalku], rushes [*Cyperus laevigatus*]; kautoo, breakwind; kirra, boomerang; koonyillie, debris of leaves used by swans (kooti) in building their nests; kootcha, leaf; kuntha, grass; kunthakoola, green; kulthie, spear; kundrie, resin; kundrie mookoo, a native weapon [mookoo = bone or hard structure]; kuntha, grass; mintie, net; moonarie, bark; murrawirrie, two-handed sword [a long heavy fighting stick]; oolyie, gum [ngulyi, kino of *Eucalyptus* sp.]; oorthie, branches; pathara, boxtree [*Eucalyptus microtheca*]; patharacoorie, young tree or sapling; pilla, charcoal; pillie, bag; pitta, stick or piece of wood; pittacopara, roots of trees [copara is the same word as koppara = root, seen in Kopparamana or Kopparamara, formerly the chief native trading centre of the region]; pooldroopooldroounkuna, meal obtained by grinding seeds, the upper millstone being murdacooparoo [murda, mada = stone], and the lower, murdawola [the term "pool" refers to blowing or breathing, and thus in this case to winnowing of the material after grinding; unkana = making or doing]; powa, fine seed; thanyoo [tanyu of Howitt = *Enchylaena tomentosa*], dried fruit; thiewie [tiwi], flowers; thooroo [turu], fire or firewood; thooroomunya, firestick; wurta, butt or trunk of a tree; yegga, native orange [*Capparis Mitchelli;* higga of the Wialpi]; yuntha, a piece of wood used in the willyaroo ceremony which is described (pp. 270-271), this thin "yuntha" being attached to a long piece of string and twirled ceremonially like the "bullroarer" of Central Australian tribes; wona, a short thick stick used by women; watthiemookoo, grave [timber used as covering; wotti = wood, muku = bone or framework]. The plants and their products, stated to be eaten by the natives (pp. 287-288) are yowa [*Cyperus bulbosus*]; winkara, a very starchy root, about five inches long [probably *Boerhavia diffusa*]; munyaroo [*Portulaca oleracea*], a plant much eaten, its seed (kunaurra) being ground into meal [the latter term is similar to kuna-ngarda obtained by us for the edible seed of *Amaranthus Mitchelli*, which is prepared in the same manner]; ardoo (often called nardoo by writers [ngardu, *Marsilia Drummondii*], which is crushed or pounded and the husk winnowed, this material being the mainstay of the natives during bad seasons but it has very little nourishment and is difficult to digest); cobboboo, a gall found on the boxtree [*Eucalyptus microtheca*]; wodaroo, a long thin root, sweet and mealy and one of the best vegetables available to the natives [*Vigna lanceolata*]; coonchirrie [kuntjiri], the seed of an *Acacia*, ground and made into small loaves [tjiri = *A. salicina*]; patharapowa, seed [pana] of the boxtree [pattera = *Eucalyptus microtheca*]; caulyoo [kalyu], seed of the prickly *Acacia* [*A. Victoriae*] pounded and made into loaves; wodlaooroo, very fine seed from the silver grass [*Panicum decompositum*] which grows in creeks; wirrathandra, seed of an Acacia [*A. ligulata*]; mulkathandra, seed of the mulga [*Acacia brachystachya* and *A. aneura*], thandrana = pouring; yoongundie, a fine black seed from a plant resembling clover; mootcha, native cotton bush [*Cynanchum floribundum*], when the leaves sprout and become quite green they are gathered and cooked, while at seed time, the pods are eaten; kuloomba, indigenous clover [*Trigonella suavissima*], eaten in large quantities when cooked; willapie,

a small watery plant [probably *Thysanotus* if roots are being referred to]; yoolantie, native fig [no species of *Ficus* has been recorded from the region, but Howitt gave the name for *Mesembryanthemum;* it may be *M. aequilaterale,* which has an edible fig-like fruit]; bookabooda, native gooseberry [*Solanum ellipticum*]; mundawora, native blackberry [Koch gave mandaworra as the name for *Santalum lanceolatum,* which has a brown or black plum-like edible fruit]; thoopara, native pear [*Marsdenia australis*]. The two plant products used in manufacture are mindrie [not to be confused with mindarie = peace corroboree] and mootcha, the edible pods and leaves of the latter having been referred to above. From the outer part of the root of mindrie [*Leschenaultia divaricata*], by heating, is obtained a kind of resin [kundrie] which becomes very hard and is used for fastening a flint to a short stick (kundriemookoo) to convert the latter into an axe or tool for making weapons. The stems of mootcha, native cotton bush [*Cynanchum floribundum*], when dry, are pounded into a fine fibre, then teased and spun and made into bags and nets.

Amongst personal ornaments are (p. 289):—kultrakultra, a necklet made from reeds strung on woven hairs; mundamunda, a string (which may be 200-300 yards long) made from the native cotton bush, this string being worn around the waist; charpoo [also chanpoo, probably misprint], a white-painted band worn round the forehead of men and made from [string from] stems of the cotton bush; oonamunda (oona = arm), string about ten feet long, made from native cotton bush and worn round the arm; oorapathera, a bunch of leaves tied to the feet and worn when dancing [oora = legs, pathera or pathara = *Eucalyptus microtheca;* Horne and Aiston's fig. 35 indicates a performer wearing a bunch]; pillie, netted bag made from the stems of cotton bush and rushes, with meshes similar to our fishing nets; pirra, a trough-like water-vessel; mintie, fishing net made from rushes and usually 60 feet long by 3 feet wide; wondaroo, a closely-netted bag made from the fibre of the cotton bush.

From the tree, cooyamurra (*Acacia* sp.) [according to Howitt (1904) and Koch (1898), Kuyamara is *Eremophila longifolia*], a piece of wood, six inches long, was pointed at one end and used to pierce the nasal septum of children, the ceremony being called moodlawillpa (moodla = nose, willpa = hole); from the same kind of tree two pieces of wood, each about a foot in length, were sharpened at one end to a wedge-like shape and forced between the upper incisors which were to be evulsed from children during the chirrinchirrie ceremony (pp. 266-267). The penis of the young man about to be subincised with a sharp flint (koolpie ceremony) was laid on a piece of bark just before the operation began, and after completion of the latter, a piece of bark was placed over the wound and tied so as to prevent it from closing (p. 273). In cases of stings, leaves of bushes, heated at a fire, were applied to the affected part. Two light rods (coonya), each about three feet long, were beaten together by old men when questioning a corpse to ascertain the name of the individual responsible for his death [see also Berndt and Vogelsang, 1941, 374]. Native cotton bush was used in the making of the sugarloaf-shaped bags (ootamanurie) made by men of the camp (pp. 280-282) and placed by them on the heads of the returning members of the bookatoo, *i.e.,* the expedition to Burratchunna [Brachina] Creek, west of Blinman, to obtain supplies of red ochre.

Helms (1896, 316) gave pattara and kuntha as the "Diyeri" terms for box-tree [*Eucalyptus microtheca*] and grass respectively. He also stated (p. 280) that the gum (kundi) used for attaching the cutting stone (thula) to a piece of hardwood to form a chisel, was obtained from the grasstree (*Xanthorrhoea*) from Cooper's Creek, whence it was traded to the Wungarabunna (Urabunna, Arabana) tribe. He stated that the best gum was found in the base of old trees and in the roots; and that it was extracted by heating these portions over a slow fire, the

gum oozing out and then being mixed with sand. A substitute for this gum was obtained by the Wungarabunna [Arabana] from the gidyea, *Acacia homalophylla* [*A. Cambagei*]. It seems to us probable that the gum referred to was mindri from *Leschenaultia divaricata*, since *Xanthorrhoea* has not been recorded from the Eyrean region. *X. quadrangulata* occurs in the northern Flinders Ranges.

In the succeeding portion of this paper, the following abbreviations are used to indicate the various tribes concerned:—A, Arabana or Urabunna; D, Dieri; K, Kuiyani; Ka, Kara-nguru; N, Ngameni; Nj, Nguradjuri; P, Pilatapa; T, Tirari; W, Wonka-nguru; Wo, Wonkamala; Wp, Wailpi; Y, Yelyuyendi; Ya, Yaurorka; and Yu, Yantruwunta.

Howitt (1878) published a few remarks relating to the natives of lower Cooper's Creek. Their summer huts were merely breakwinds, made of branches of shrubs) or stalks of marshmallow [*Lavatera plebeia*]; and winter huts were made of a frame of sticks covered with grass or weeds above which earth or sand was added to make the structures waterproof. Amongst edible seeds (bowar) [bowa, paua] which were ground into meal were those of pappar grass [*Panicum decompositum;* Roth (1897, 91) stated that pap-pa was a general term for seed food in the Boulia district of Queensland, and under it were included yaraka (*Eleusine aegyptiaca, i.e., Dactyloctenium radulans*), katoora (*Sporobolus actinocladus*), and *Sporobolus Lindleyi*, all of which grasses occur in the area under our consideration and are probably utilised by the natives]. The seeds of Portulac, manyura, munyeroo [*Portulaca oleracea*] were termed manyoura bowar and were treated similarly to those of the grasses. Nardoo served as a standby in times of scarcity; those who subsisted largely on it were termed ngardu-etya. Green Portulac [*P. oleracea*], native spinach like the New Zealand spinach [*Tetragonia expansa*], native melons [*Cucumis melo* var. *agrestis*], and native oranges [*Capparis Mitchelli*] were eaten raw. Amongst edible roots were those of Portulac, others like radishes [*Boerhavia diffusa*], and small bulbs (yowar) [yaua, *Cyperus bulbosus*] which were roasted in ashes. Pitchery was also mentioned. Small axes (tomahawks, bomako) were secured to their hafts by cords made from the bark of a shrub, these cords being then covered by a hard black gum (pinta) from a medium-sized tree with oval dark-green leaves and rough bark [*?Myoporum platycarpum* or *Grevillea striata*]. Large and small fishing nets were made from fibres obtained from rushes [*Cyperus ?vaginatus*]. Logs and bushes were placed over graves, as described by Captain Sturt.

Koch (1898) published a list of plants collected on Mount Lyndhurst pastoral area, especially in the vicinity of Mount Freeling and Yeralina, which Tindale's map (1940) indicates as lying in the territory of the Kuiyani tribe and the northern-most part of the Wailpi region. Koch mentioned a large number of native names of plants and made some references to utilisation. The names are set out as given by him:—*Stenopetalum linearc*, warcoontoo, edible; *Lepidium papillosum*, nalaka, seeds eaten; *Pittosporum phillyraeoides*, madroo, seeds eaten; *Tribulus hystrix*, koola; *Zygophyllum fruticulosum*, medeewurta, eaten; *Z. glaucescens*, nilday, eaten; *Erodium cygnorum*, yarpee, windoo, wuntooka, eaten; *Oxalis corniculata*, eaten; *Heterodendron oleaefolium*, mindra, seeds eaten; *Sida virgata*, watteeworroo [watti, wood; waru, grey, dirty], burdaddee; *Abutilon Mitchelli* [from South Australia = *A. leucopetalum*], yarreedee; *Lavatera plebeia*, wirpa, korinna, wurnma, roots (apara) [kappera] of young plants eaten; *Portulaca oleracea*, monyeroo, leaves and seeds eaten; *Claytonia balonnensis* [*Calandrinia bal.*] parakilya; *Muehlenbeckia Cunninghamii*, burdinga; *Atriplex nummularium*, nilpena; *A. vesicarium*, billacurroo, dandayree; *A. holocarpum* [*A. spongiosum*] maltoo; *A. halimoides* and other annual saltbushes, maltoo; *Rhagodia spinescens*, yillaroo; *Enchylaena tomentosa*, burlahmee; *Kochia pyramidata*, ooneroo, koonambirra; *Kochia aphylla*, bulka, poondoopoondoo; *K. ciliata*,

moodlee; *Bassia quinquecuspis*, yate; *B. divaricata*, yalkirray; *Salicornia arbuscula* [*Arthrocnemum halocnemoides*], tarapoolia; *S. kali*, yilka [= prickly]; *Ptilotus nobilis*, anemaheefurta; *Boerhavia diffusa*, two forms—(a) with hairy leaves and stems, tawo, (b) with glabrous leaves and stems, padloo; *Casuarina glauca* [from South Australia = *C. lepidophloia*], alkoo; *Templetonia egena*, atara, binyee; *Clianthus dampieri*, ngarabana, minyee-minyeel parry; *Trigonella suavissima*, walpurla, kanba, kadumma, columba (last name at Innamincka) [kalumba]; *Cassia phyllodinea*, bundey [bundi], wamnalleroo; *Petalostylis labicheoides* warreedee; *Bauhinia Carronii*, moodloo; *Acacia tetragonophylla*, bararrecka; *A. papyrocarpa*, myall; *A. sentis* [*A. Victoriae*], kalyoo; *A. retinodes*, weerilda; *A. salicina* (native willow), balkoora [? confusion with *A. stenophylla*]; *Acacia* sp., ash of leaves used in preparation of pitchoree [probably *A. ligulata*], aroo, kakooroo, wurra [*wirra*]; *A. Oswaldii*, whyacka [wi-aka]; *A. aneura*, mulga, seeds eaten, timber used for clubs when suitable mallee roots were not available; *Pimelea simplex*, namala; *P. microcephala*, willparee, berries (narreemahee) [ngarrimai] edible, shrub and fruits used medicinally, bark of roots boiled and liquor drunk for throat and chest complaints, extremely tough fibrous bark of roots twisted into thin cords and tied around abdomen, or aching head, or other parts to remove pain; *Hakea Edniana*, yantana; *H. leucoptera*, kooloova [kulua] water from roots = nappa-koparee [ngapa = water, kapara = root]; *Tetragonia expansa*, paldroo, eaten as a spinach; *Trianthema crystallina*, maparee; *Melaleuca glomerata*, wooda, kooda; *Melaleuca* sp. (black teatree), woota, koota [*M. pubescens*]; *Eucalyptus oleosa*, mallee, roots used as clubs; *E. rostrata*, kalpooroo, seeds (power) [paua] eaten; *Santalum lanceolatum*, mandaworra, fruits eaten; *S. acuminatum* [*Fusanus acuminatus*] nakala, fruits eaten; *Melothria maderaspatana*, willa-lillalee, fruits eaten; *Loranthus linophyllus* [*L. Preissii*] partapee, fruits eaten; *L. pendulus* [*L. Miquelii*] weedla; *L. quandong*, yappee mulgatee, berries eaten; *Pterocaulon sphacelatus*, yunga-yunga, "horehound"; *Scaevola spinescens*, poorntoo, berries eaten; *Ipomaea heterophylla*, woonooroo, roots eaten; *Convolvulus erubescens*, noongay; *Sarcostemma australe*, meeninya, pardebardettee; *Marsdenia Leichhardtiana* [*M. australis*], toopara, roots, leaves, flowers and seeds eaten; *Solanum esuriale*, puddadee, ripe berries eaten; *S. ellipticum*, yoomeroo, berries eaten; *Lycium australe*, beeree, wadneree, fruit eaten; *Eremophila longifolia*, kooyamurra, branches used for covering corpse; *E. Freelingii*, kaltya, halya; *E. oppositifolia*, weeooka [wi-uka]; *E. Duttonii*, kaltya, halya; *E. alternifolia*, kaltya, halya; *E. maculata*, nanyoo; *Calostemma luteum*, waddywurra; *Bulbine bulbosa?* boontooka; *Thysanotus tuberosus*, tubers eaten; *Cyperus subulatus?* [from Eyrean region = *bulbosus*], kudnamurra, ala, yower [yaua], tharaka, corms eaten; grass (general term), kanta; *Panicum coenicolum* [*Digitaria coenicola*], talghee, allee, seed (power-tandra) eaten; *P. gracile* [*Paspalidium gracile*], talghee, seeds eaten; *Erianthus cruciata* [=*Dactyloctenium radulans* R. Br., of which *D. aegyptium* of Australian authors is a synonym], wallamurroo; *Poa ramigera* [*Eragrostis australasica*], dickeree; *Marsilia quadrifolia* [*M. Drummondii*], nardoo, sporocarps ground and eaten.

Howitt and Siebert (1903), in their account of two legends of the Lake Eyre tribes, mentioned some plant names:—paua, seed of plants used for food, *e.g.*, *Claytonia* Ya; wona-waru (= white mound; waru = white, wona or wompa = hill or mound), fungus [Gasteromycetes, *Podaxon* spp.] found growing near *Eucalyptus* trees; kalyu, an *Acacia* [*A. Victoriae*]; kaliwaru, *Eucalyptus rostrata* (at Innamincka); pattara, *Eucalyptus microcarpa* [error for *E. microtheca*]; wonno, woman's digging stick; malka Ya, *Acacia aneura;* kangua Ya, D, flax.

Howitt (1891) mentioned some Dieri totems (murdus) with which plant names were associated:—manyura, *Portulaca oleracea*, whose seed was kanaura; and pitcheri, *Duboisia Patersoni* [*D. Hopwoodii*]. Leaves and twigs of wira

bush were added to the latter by Dieri and Yantruwunta. The use of kunya rods at inquests and of cooya mura sticks for tooth evulsion, as reported by Gason, was mentioned (p 80, 88). Wurdigi (= mulga tree) was stated to be a totem in the Yandairunga tribe occupying the west shore of Lake Eyre [= Antakirinya tribe].

Howitt's very important work on the native tribes of South-eastern Australia (1904) contains many references to plants in relation to the social organisation and ceremonial life of the Eyrean tribes. Mention was made of the great trade route from the Northern Flinders Ranges, whence red ochre (karku D, arkaba A, harkaba W, Wo, kambara Ya, was collected, through the Cooper via Kopperamana and some other centres, to the lower Diamantina and Mulligan into Queensland, where pituri bush (*Duboisia Hopwoodii*) was obtained, ochre, pituri, grinding stones and implements being the chief objects of barter (pp. 713-716). The red-ochre expedition was called bukatu N or pocato Yu, and the ochre mine was stated to be near Beltana.

The names given in various parts of the book to plants and their products are as follows:—bili or pili, bag; bili-milki, bag on which the figure of an eye (milki) is woven; duntyi, *Crotalaria* sp. (fig. 58) [*C. dissitiflora*]; kanta D, grass, woven by the Arabana to form a kind of apron; kadla W, rush [*Cyperus vaginatus* or *C. laevigatus*]; kagnara N [? ka-ngara] seed of *Claytonia* [*Calandrinia* sp.]; kanangara D, seed of manyura [munyeroo, *Portulaca oleracea*]; kalti K, spear; kandri D [= koondi], round boomerang-shaped weapon with pointed ends (fig. 12 (7)); kandri D, A, K, name also given to the gum obtained from the roots of mindri [*Leschenaultia divaricata*], the term kandri-moku D being also used (moku = bone or other hard substance), this gum being employed for cementing chips of stone [tula] to the wooden handles [of chisels], and the axe to its haft; kakura A [kakuru = *Acacia ligulata*], bush with edible fruit; katu K, breakwind; kirha D, boomerang; kangu D, Ya, flax; kalyu, *Acacia* sp. (near Innamincka) [*A. Victoriae*]; kulua A, *Hakea leucoptera*, used for constructing huts; kuntyiri D, kutyiri N, *Acacia* sp. [tjiri = *Acacia salicina*] kunya D, pointed piece of wood or bone used in magic; kuyamara A, kuya-marra D, *Eremophila longifolia*, twigs used in funeral ceremonies to make a bed in the grave for the corpse, and also worn as a sign (D) to indicate those members of the party who had eaten ceremonially some of the fat of the deceased (p. 448-449)—two chisel-shaped pieces of kuyamara wood were used in tooth evulsion D (p. 655-656); makatira A, firestick (maka = fire A, W); malka D, Wo, *Acacia aneura* [mulga of whites is a corruption of the native name], mulga "apples" [galls] are eaten, root used as material for making digging tools; manyura N, Ka, *Claytonia balonnensis* [*Calandrinia bal.*, manyura is commonly called munyeroo by white people], edible seeds; mapara Ya, edible seed of *Claytonia* sp. [*Calandrinia*]; maru-wiri, two-handed boomerang; moku D, probably *Cucumis trigonus* [= *C. melo* L. var. *agrestis* Naud.]; muluru D, witchetty grub; munukudu D, Wo, plant with grass-like foliage and bearing tubers under each other and not in clusters, and found growing under bushes in sandhills [? *Thysanotus exiliflorus* Black non F. v. M. = *T. exfimbriatus*]; narrangama, narra Ya, shield; ngampa A, stone used for pounding ngardu (nardoo); ngarumba Ya, D, boxtree, *Eucalyptus microtheca*; ngulyi A, K, kino of a Eucalypt used for attaching the axe to its haft; ngardu, *Marsilia* sp. [*M. Drummondii*]; pirha D, A, K, wooden bowl, term also used for a tree or for a block of wood suitable for making such a bowl; pirha mara D, shield, (pirha = dish or bowl, mara = hand); piltai A, *Acacia salicina*, ash used in the preparation of pituri; pitcheri, D and other tribes, *Duboisia Hopwoodii*; pundu, "nose peg" ornament made of the wood of the kuyamara (*Eremophila longifolia*); padi D, edible witchetty grub [found in roots of various shrubs and trees]; paia-moku A, *Didiscus glaucifolius* (paia = bird, moku = bone); pita-moku A, tree

trunk (pita = wood, moku = bone or other hard material); wirha D, Yu. *Acacia salicina* [Howitt's figure is that of *A. ligulata*], ash used in the preparation of pituri; pili or bili, bag; paua Ya, edible seed ground between millstones, the larger lower, softer slab being ngurtu D or tayi Ya, and the smaller, harder upper one marda-kupara D (marda, mada D, madra Y, = stone; kupara = young or small); punga-moku D, timber forming the framework (*i.e.*, bones, moku) of a hut (punga); tanyu D, [*Enchylaena tomentosa*]; timpiwora, unknown plant; turumanya D, firestick (turu = fire); turu-kuntyi, stick made from mulga root and used for digging out small mammals from their burrows [the term turu suggests that the end of the digging stick is hardened by fire, as is done by various tribes elsewhere]; wona, woman's implement used in sport and in fighting; wapiya Wo, boomerang; wona-waru [*Podaxon* spp.], white mould which grows near *Eucalyptus* trees; yana W, *Cyperus rotundus* [= *C. bulbosus*], bulbs eaten; yelka A, grass-like plant with edible bulbs [*Cyperus bulbosus*]; yudlanti, *Mesembryanthemum* [? *M. aequilaterale*]. Yutchin is a name applied to a person who acts for another during the prolonged absence of the latter from his camp (Dieri); the intending traveller places around the neck of his representative (yutchin) a string [yootchoo, Gason, 1879, 302] made from native flax or human hair. Shields are made of soft wood [*Bauhinia Carronii*] obtained by barter from the north and north-east, *i.e.*, mainly from western Queensland, *via* Cooper's Creek, the Yantruwunta people supplying weapons and grinding stones in exchange. The Dieri made fire by drilling the edge of a shield with a sharp-pointed stick. Bukatyiri D was applied to areas where trees and shrubs were more abundant than in some other regions, such as the lower Cooper.

The Dieri and Tirari believed that the Kadimarkara were creatures which in Murra-murra [ancestral] times climbed down from the sky to earth by means of the huge Eucalyptus trees on which it rested and which grew on the western side of Lake Eyre; this was the explanation given for the presence of certain fossil remains found near Lake Eyre (p. 433). The sticks [called coonya by Gason] used at an inquest were termed kuya by the Dieri (p. 448).

Eylmann (1908) referred to Dieri murdus, mentioning the following relating to plants:—pitscheri, *Duboisia Paterson*i [*D. Hopwoodii*]; malka [*Acacia aneura*]; manyura, *Portulaca oleracea*, its seed = kanaura; kananngara, munyeru; julanti, edible seed [*Mesembryanthemum aequilaterale*]; and spores of nardu, *Marsilia quadrifolia*. Native flax, *Psoralea patens*, was used for making fibre head bands, bags and fish-nets, and illustrations of these were published.

Stirling and Waite (1919) published a paper on "toas" or aboriginal direction signs used by the Eyrean tribes, the information having been taken from the manuscript (now in the South Australian Museum) of the late J. G. Reuther, who was for eighteen years in charge of the Lutheran Mission Station at Kallapaninna. These toas were generally closely associated with the legendary wanderings of the muramuras (ancestral spirits). Many contain plant names; an example is No. 87 mentioned on p. 126, ngapamanaworani (the suffix ni = to, or in the direction of), which in Dieri means "to the place where the manawora plant stands in water (ngapa). This is a cucumber-like creeper, a piece of which is affixed to the head [of the toa]. The latter represents a water-covered flat in which the Muramura, Patjalina, found these plants growing [indicated by] (red spots)."

Mr. H. M. Hale, Director of the South Australian Museum, where these toas are now located, has kindly permitted us to examine those at present available in an endeavour to identify the plant material which is attached to the upper end of many of them. We are unable to identify or to suggest probable identifications of several of the plants whose native name (without actual plant material) is associated with the toa. The numbers quoted are those of the associated toas

as given in Stirling and Waite's paper, and, in the case of nearly all of them, they are similarly indicated in the coloured illustrations which accompany the paper.

2, 46, pingalpiri D, T, grass, also a large waterhole on Cooper's Creek, 4, katjara W, edible creeping plant like cucumber [*Marsdenia australis*]; 10, magamaga[1] tree W; 13, 16, winpara bush D [canegrass, *Eragrostis australasica*]; 26, 308, bunuru W, cotton bush [*Kochia ? pyramidata*]; 44, 195, kudnampira bush D, Ya [*Kochia pyramidata*]; 45, palkura [*Acacia* sp.]; 45, tjiri [*Acacia salicina*]; 58, palkalara grass D [*Atriplex ? nummularium*]; 59, 140, 254, kalku D, rush [*Cyperus gymnocaulus*]; 60, dikeri grass [*Eragrostis australasica*]; 61, wirla bush D (same as dantju), has edible red berries [tanyu of Howitt, 1904, 781; *Enchylaena tomentosa*]; 72, dikulu N, canegrass [*Spinifex* (= *Zygochloa*) *paradoxa*]; 84, turuku D, fire-stick; 87, manawora D, cucumber-like creeper [looks more like a mistletoe, *Loranthus* sp. than a *Cucumis*]; 88, 147, 210, karla D, rush [probably intended for kardla, kadla = rush W (Howitt, 1904, 783); specimens are *Cyperus gymnocaulus;* ka-lo is given by other writers as the name of the flax-producing plants [*Crotalaria* spp. and *Psoralea*]; 90, 318, wari-wari plants [*Sida* sp.]; 108, 202, malka T, D, mulga [*Acacia aneura*], wood used for making boomerangs (kirra); 111, kakura bush D [kakuru = *Acacia ligulata*]; 113 palkara, T (a saltbush) [*Atriplex* sp.]; 114, pulpuru bush; 70, 115, wulpu T, W, plant yielding flax-like fibre [we suggest that the plant may be *Cynanchum floribundum*]; 117, mindri D [*Leschenaultia divaricata*]; 118, 149, kuluwa bush D [*Hakea leucoptera*]; 130, yadi D, spindle with two crossbars on which string is wound; 146, 192, 221, punkutu D, W, flax prepared from punku (flax plant) [we suggest the species is *Crotalaria dissitiflora*]; 148, kalyu bush Ya [*Acacia Victoriae*]; 150, palpa bush T [*Dodonaea attenuata*]; 151, worala W, has edible roots [probably *Leschenaultia divaricata*]; 165, wonawa D, mushroom [*Podaxon* sp.]; 166, kunya D, pointed stick used as a needle or awl; 180, palpara bush D [? same as 114, pulpuru: Horne and Aiston gave palpara as the name of a small hawk, W, which is probably the same as Stirling and Waite's balpara bird, toa No. 36]; 188, kuntjikunji bush D [*Acacia* sp., very narrow leaves. Howitt gave turu-kuntyi as the name of a digging stick made from mulga root, kanta = grass]; 182, 190, yanda D, also called yuntha in Cooper's Creek district, wooden slab or "bull-roarer" used in ceremonials; 194, kandri D, curved weapon with pointed ends [a kind of boomerang, Howitt, fig. 12, (7)]; 213, yana D [*Cyperus bulbosus*]; 225, billi D, net-bag; 239, kuyamara bush D [*Eremophila longifolia*]; 240, didla bush [*Atriplex* sp.]; 241, taltranta grass [*Eulalia fulva*]; 244, billinunu D, net-bag used by women for carrying various kinds of grass containing edible seeds; 245, tjurlu bush P; 247, diladila grass N, from sandhills; 250, kuramorla, porcupine grass [*Triodia pungens*, kuramala of our list]; 253, waru (= white) bush or grass D [not a grass; twigs of ? *Atriplex*]; 262, 299, wirra bush D [*Acacia ligulata*]; 268, wonatiri D, sharpened stakes [wona] used for supporting fishing nets; 277, wodika bush W [*Acacia ligulata*]; 179, palyangani D, edible sweet gum from a tree [*Myoporum platycarpum* or *Bauhinia Carronii*]; 298, malka kanta D, mulga grass [*Aristida arenaria*]; 301, mudlamana bush [*Acacia* species]; 302, dunji bush [*Crotalaria* sp., according to Howitt, 1904, fig. 58 = *C. dissitiflora*]; 303, karamara bush [specimen consists of grass stems]; 310, wona D, digging stick; 313 pa-u grass D [general term for grasses with edible seeds]; 319, makumuru bush D [*Sida* sp.]; 322, kudukudna grass T [grass stems, species not recognisable]; 197, attached to kawolkalani toa Ya [kawolka = crow] is a plant which may be *Amaranthus* sp. or more probably *Trianthema* sp.; 112, 214, pankara W, rush [*Cyperus gymnocaulos*]; 121 (without name or details) [plant material is a grass, *Aristida*; 276, palkurunu bush D [*Heterodendron oleifolium*]; 311,

[1] Mr. Vogelsang informs us that this name is a *lapsus calami* for Reuther's name, majamaja (maya-maya). We have not been able to identify the plant, as none is indicated on the toa.

wirra bush D [the account indicates "roly-poly," *Salsola kali* and has no relation to wirha, *Acacia ligulata*]. Jelka was mentioned as an edible bulk [*Cyperus bulbosus*], and Jelkabalubaluna was the demigod (muramura) controlling its growth (p. 108). Toas 28, 54, 61, 118, 129, 152, 161, 203, 220, 227, 256, 260 and 317 are concerned with that muramura; and 17, 93, 101, 103 and 211 with another one, Ngardutjelpani, whose name suggests that he was responsible for ngarda. The origin of various plants, due to the action of muramuras was referred to (p. 110).

The observations of Horne and Aiston (1924) were centred mainly on Mungeranie which lies in the Wonkanguru territory, the latter author being the police officer there for many years, before he came to reside at Mulka which is only about 25 miles to the south. In this book there are abundant scattered references to the utilisation of plants by the natives, but only occasionally is the species indicated. We have brought together the information and have, in places, added our own comments.

From the root of the coolebah, *Eucalyptus microtheca*, water was sometimes obtained, and a long pole-like spear, called piranburra, Y, D, W, was made, the latter serving also as a digging stick to be used by men when hunting dingoes. In a woman's corroboree in which men represented spirits (moora), these men had bunches of box-tree leaves tied to each ankle. The seeds, after being ground, were eaten. From a bend of a branch, a wooden dish (pirrha) was fashioned. The throwing-stick (munkerara) was usually made from this tree.

Acacias were utilised. From the bark of one kind (yearda) an astringent fluid was obtained and used for tanning skins to convert the latter into skin water-bags (pp. 50-51, fig. 39) [the species may have been *A. salicina*, since Cleland, Black and Reese (1925) stated that its bark possessed some tanning material]. "Dead finish" [*Acacia tetragonophylla*] was used in making the koondi, a boomerang, nearly round in section; and a sharpened stick to which emu feathers were bound in order to make a head decoration (fig. 35) for one of the corroborees. The root of whitewood (*Acacia* sp.) was used for making the short handle, into the cleft end of which the axe head was inserted and then secured by binding it with hair or fur string together with mindri gum (p. 104-105, fig. 75) [the term whitewood, as far as we know, is restricted to *Atalaya hemiglauca*, which belongs to the Sapindaceae]. The wood of the mulga (*A. aneura*) was also employed for the latter purpose. Mulga seeds were ground and eaten; and a long spear or digging stick (piranburra) was made from its root. The flattened, sharpened point attached to light spears (kutchie) was usually of mulga. The hardwood of this species was used for making such implements as the kirra (boomerang), murrawirrie (two-handed fighting boomerang), wadna (woman's digging stick), and wirrie (throwing stick). The wirra, *Acacia salicina* [apparently should be *A. ligulata*], was used for obtaining the ash for mixing with pituri, and certain stones (murrallacardia W, kuncherawarroo D, were scattered to increase the supply of this acacia (p. 133-134). The method of obtaining the ash is shown on fig. 49.

The method of preparing nardoo is mentioned and an illustration (fig. 40) is given of the crushing of the sporocarps on a piddinie (lower stone) by using a hammer stone (koolkie). Yana [*Cyperus bulbosus*] was an important food supply and certain stones (yelka) were used in the corroboree to bring about the increase of the plant (p. 134). Munyeroo [*Portulaca oleracea*] was eaten raw or cooked on hot ashes; while its seeds were collected, ground on a mudda (lower millstone) with a muddathirrie held in the hand (fig. 42, 43), the resulting meal (bowa) being cooked as a damper.

Amongst other plants supplying food were wadroo [wodaroo of Gason], a legume with edible roots [*Vigna lanceolata*]; bladder saltbush [*Atriplex vesicarium*]

with edible seeds; native cucumber [*Cucumis melo* var. *agrestis*]; wild spinach [*Tetragonia expansa*]; wild cabbage; willa, a creeper whose leaves and flowers are eaten [*Marsdenia australis;* weela is the name given by Cleland, Black and Reese for a related plant, *Cynanchum floribundum*]; and mindrie [*Leschenaultia divaricata*], the outer part of whose thick root is cooked and eaten [it is possible that there has been a confusion with *Polygonum glabrum*, part of whose roots is edible; *Leschenaultia*, in its habit and appearance, closely resembles "*lignum*," *i.e.*, *Muehlenbeckia Cunninghamii*, one of the Polygonaceae]. As a potential water supply mention is made of the roots of the needlewood (trigunta, tigunta = *Hakea leucoptera*), red mallee (*Eucalyptus oleosa*) and box (*Eucalyptus microtheca*).

Fibre was obtained from rushes [*Cyperus ?vaginatus*, *C. distachyus*], and from wadnoarie (a verbena) [error for *Psoralea patens* whose flowers and habit, at first sight, suggest a verbena]. From rushes a kind of fishing net called pinegara was made, the method of preparation being described (p. 62-63); this net was not durable and was usually left in the water. The much longer fibre-string net (wooroomarroo, marroo = white) was made from wadnoarie and was handled more carefully and was put away when not in use. The preparation of the fibre and its conversion into string were described (p. 67, fig. 53-55). This fibre-string was used for making one kind of head net (munta), and formed the basis of the closely-woven forehead band, termed charpoo, which was plastered with gypsum (kopi) and was worn during ceremonials, and the somewhat similar nulta which was decorated with red ochre. Fibre was also used in making the long belt (dampera, and its attached hanging strings or wilpoo) which is wound round the waist of men. It also entered often into the formation of the longer waist-girdle (yinka) worn by men. Fibre is used for making various kinds of net-bags. One kind of bag was stuffed with grass, fur or hair and converted into a string ball, used in play. Fibre from a plant [*Cynanchum floribundum*] growing in the sandhills was mixed with human hair and animal fur and converted into a string from which a bag (p. 109) was made for holding delicate stone implements called pirries (fig. 67). For fire-making a hardwood stick of mulga was twirled in a split stick of *Crotalaria Cunninghamii* (p. 66, fig. 52, 52), shredded bark or pith being added to the spark obtained. Another method was to rub with a koondi (boomerang) the back of a softwood shield (murrawaroo) on which some triturated dung had been placed, the resulting spark being fed with leaves and grass (p. 94). From lignum [*Muehlenbeckia Cunninghamii*] and marsh-mallow [*Lavatera plebeja*] light spears (kutchie) were made, but some kind of hardwood, usually mulga, had to be used for the point. The narcotic pitcheri, made from *Duboisia Hopwoodii* which was traded from western Queensland, was used extensively.

There were at least three kinds of gum used in connection with the making of weapons. Kunti was obtained from the beefwood [*Grevillea striata*, the name kunti or kanti to be distinguished from koondi = boomerang]. Pooya W was got from *Triodia* and was bartered from the north and was used for attaching axe-heads to their handles (complete axe = kalara-piddina). Mindri gum was the most valuable and was obtained from the root of a plant (p. 102, fig. 76) [*Leschenaultia divaricata*] growing in swampy areas. It was mixed with kangaroo dung and was used for attaching the stone tool (tuhla) to the rest of the implement (koondi) and for forming the handle for ordinary stone knives (yutchawunta) and fighting knives (illyawunta, fig. 72). It was also used for covering the free extremity of the pointing bone (wirra-garoo W, mokoo-ellie duckana D, which was made of bone or of wood such as needlewood [*Hakea leucoptera*], the gum being used for the purpose of retaining the magic "poison" which was supposed to have entered the implement at the proper time (fig. 86-87). Mindrie gum was also used for attaching ornaments to the charpoo (forehead band worn by men).

Amongst the various implements made of wood by the Wonkonguru and not particularly mentioned in the foregoing information from Horne and Aiston's work, are the following: -dunpara, food platform made of four stakes; wadna, woman's digging stick; pirrha, dish (fig. 20, 22, 24, 25); kulchera, playing stick (fig. 27) [similar to wona of the Dieri and weet-weet of Victorian natives, Howitt 1904, fig. 12 (1)]; bull-roarer, inchitcha; and message sticks (fig. 18). The various kinds of boomerangs (kirra) and throwing sticks (wirrie, koondi) were illustrated (fig. 57-65). Shields (murrawarroo) were made of soft wood, *Erythrina vespertilio* [error for *Bauhinia Carronii*], and were obtained by barter from Queensland. A grave with logs lying on its surface is shown (fig. 88). The utilisation of plant material in constructing the various types of huts (poonga and wilpie) is indicated in fig. 12-17.

Basedow (1925) made some reference relating to our subject. Very brief mention was made of the use of timber and brushwood as a cover for graves (p. 206-207) by the Dieri and Yantowaunta, photographs of the two kinds being published (p. 25, fig. 1-2). The framework of heavy curved logs utilised in the construction of a hut near Cooper's Creek is figured in pl. xv, fig. 1. Fire-making by the twirling method was adopted by the Dieri tribe (p. 111), needlebush [*Hakea leucoptera*] being selected for the harder twirling stick and Hack's pea, *Crotalaria* [*C. Cunninghamii*] for the softer basal piece. Amongst the implements made from eucalypts by the Dieri, Yantowaunta, Ngameni and other Central Australian tribes were food and water carriers (coolemans), both shield-shaped and canoe-shaped (p. 92). From mulga were made straight smoothed spears (p. 190, fig. 5 b); the long slender "playing stick," kukerra (p. 82-83) [kulchera of Horne and Aiston]; a form of club (p. 169); and a kind of boomerang, marriwirri (p. 170). The use of the sporocarps of nardoo, called kalumba by the Dieri, as food and the method of grinding them is described (p. 150) [confused with the edible clover, *Trigonella suavissima*, to which the name kalumba belongs]. An account was given of the preparation and use of pitjuri (from *Duboisia Hopwoodii*), the necessary ash being obtained by burning twigs of *Acacia salicina* and eucalypts (p. 155-157).

In 1937 Elkin (p. 285) referred to the use by the Dieri of the kuyamara plant (*Eremophila longifolia*) and published photographs of a Yauraworka grave and one at Innamineka [Yantruwunta]. In the same year Aiston published a paper relating to pituri, stating that its preparation (1937, 372) was a close monopoly and that any child born to the horde or tribe who belonged to the "pitcheri moora" [one of the subdivisions of several of the Eyrean tribes] automatically succeeded to all rights and privileges in the distribution. The trade route from the pituri country in far-western Queensland to Koparra murra (Kopperamanna of whites) in Dieri territory, and thence to other regions, was referred to. Other references to utilisation of plants in the Eastern Eyrean region are: wirra, *Acacia salicina* [*A. ligulata*], as the plant from whose tops ash for pituri was obtained; mindry bush [*Leschenaultia divaricata*] or other herbage was added to wooden bowls in which water was being carried, to prevent slopping; herbage was used for trapping shrimps and fish (p. 375); fibre string made from a verbena [*Psoralea patens*, Leguminosae] from the swamps and from the broom bush [? *Cynanchum floribundum*] from the sandhills, was utilised for making the bags used for holding pituri (375-376).

Berndt and Vogelsang (1939, 170) referred to the use of grass or bushes to line Dieri graves, on top of which wood, bushes or twigs were placed. In a later paper (1941) they stated that kujamara was used as a native tobacco, and as a poison for adding to waterholes to catch emus, and also in mortuary ceremonials; while the pointing bone (dukana) was wrapped in emu feathers and kujamara plant and then left in the earth for several months. There were a few additional

references:—buka-buka, trees or shrubs; patara, tree [*Eucalyptus microtheca*]; para-warana, a native tobacco; pilti [pilli], dilly bag; and turu-upita, firestick [turu-pita; turu = fire, pita = stick]. These two authors also published a comparative vocabulary of the Dieri and Ngadjuri tribes (1941 a), including some Wailpi words (from the northern Flinders Ranges). The Ngadjuri occupied the southern portion of the Flinders Ranges. We will use D, Nj and Wp to indicate the tribe using each term of interest to us:—bullroarer, wetana, mura-ngali Nj, junta, D; bush with green berry [? *Solanum* sp.], ungina Nj; billy button [? *Calocephalus multiflorus*], wilu Nj; green bush [*Cassia* spp.], bundi Nj, pita-kulja-kulja D; small grey bush having medicinal qualities, judali Nj [yudli (Wailpi tribe), Cleland and Johnston 1939, 178 = *Scaevola spinescens*]; wild carrot [? *Boerhavia diffusa*], kuku Nj; clover [*Trigonella suavissima*], walbula Nj, kalumba D; club, wiri Nj, Wp; creeper (*Clematis*), winda-murlku Nj [probably *Tecoma doraloxylon* from which spears (winda) are made, murlku = flower]; fire-stick, gadla-widni Nj, manja D (gudla Nj, manja D, = fire); fire drill—upright twirling stick, aru-watung Nj; basal stick, watate-widni Nj; flower, murlku Nj, tiwi D; grubs from sandalwood, bulkara-bati Nj, padi D [bati, padi = grub]; mallee, gula Nj; water-bearing mallee root, gu-nga Nj, ngapa D [ngapa = water]; mulga [*Acacia aneura*], mulka Nj, malka D; native tobacco, pitjuri Nj, pitjiri D [*Duboisia Hopwoodii*]; fishing net, minda, mindi Nj, jama D; nutgrass [*Cyperus bulbosus*] jalka Nj, jaua D; wild pear [*Cynanchum floribundum* or *Marsdenia australis*], ngawala Nj, its roots, ngandi Nj; knobbed playstick, jakura Nj; playstick [kulchera of Horne and Aiston] kukuru Nj, aya Wp, kuku-ru-pirkina D; plain playstick, waba Nj; porcupine grass (*Triodia*), nala Nj; wild potatoes [? *Ipomaea*], balku Nj; wild peach [*Eucarya acuminata*], wuti Nj, wulti Wp; quandong [*Santalum lanceolatum*], guti Nj; reeds [*Cyperus vaginatus*] from waterholes, jaki-walala Nj, wirka D, wilti D; [so-called] sandalwood tree [*Myoporum platycarpum*[2]], bulkara Nj, baru Nj, kalju-mara D, emburu Wp; *Acacia* seeds, minga Nj, kuntjiri-paua D (pau = seed) [tjiri = *A. salicina*]; ground seeds, bulpa Nj, punpu D; she-oak [*Casuarina lepidophloia*], gudli Nj; silver wattle [*Acacia rivalis*], vaka Nj, its seeds = vaka mai Nj; spear, winda Nj, kalti D, wadlala Wp; spear-thrower, midla Nj; stick, widni Nj, pita D; stone for grinding seeds, murku (stone), gunja-buri Nj, marda-kuparu D, mara wadla Wp; stone axe, kalara D; string or fibre, ita Nj, nguri Nj, jinka D; tree, kakati Nj, patara D [term used further north mainly for *Eucalyptus microtheca*]; ti-tree [= tea tree, *Melaleuca pubescens*, ocda, wuta Wp], guda Nj; water from mallee root, gu-ngu-galwi Nj; yacca [*Xanthorrhoea quadrangulata*], wuara Nj; yam, ngumpa Nj; yam stick, kata Nj, mungu-wiri Wp.

Additional information concerning the names of plants amongst the Wailpi tribe is contained in papers by Hale and Tindale (1925) and by Cleland and Johnston (1939).

Curr (1886) circulated amongst people who were in contact with aborigines a request for the native names of a number of objects, amongst them being: (1) grass, (2) war spear, (3) reed spear, (4) womerah, (5) shield, (6) toma-

[2] It will be noted that Berndt and Vogelsang mentioned bulkara and emburu for the sandalwood tree. The latter is not the true sandalwood (*Eucarya spicata*) but is *Myoporum platycarpum*, for which we (1939) received the name imburu from the Wailpi. We listed bulara and bulgar for the true sandalwood from Ooldea, and Helms (1896) published the latter name for *M. platycarpum* in the south-western part of the Great Victoria Desert. Berndt and Vogelsang (1941 a) also gave kalyumara as a name for their sandalwood. Howitt (1904, 805) stated that kalyumara was applied to a wide expanse of country where kalyu, an *Acacia* [*A. Victoriae*], occurred, and also to a large sheet of water in Cooper's Creek near the Queensland border. Kalyumara may be a misprint for Kuyamara which was mentioned by Berndt and Vogelsang in another paper (1941), but we have already noted that Koch (1898) and Howitt (1904) identified the plant as *Eremophila longifolia*, which, like *Myoporum platycarpum*, belongs to the *Myoporaceae*.

hawk (presumably axe), (7) boomerang, (8) wood, (9) bark. Amongst the replies received were some from the area now under our consideration. To avoid repetition of the English names, they will be indicated by the appropriate numbers.

Jacobs (in Curr 1886, 14-15) gave the following terms as used by tribes on the north shore of Lake Eyre: (1) kuttu, (2) kuju, (5) stharrananma [?ngarrananma], (8) pinta. Paull (pp. 18-21) gave a short vocabulary of the Ominie [Ngameni] tribe from the Warburton River region and included: (1) kanta, (2) kaltee, (5) pirramurra, (7) keera, (8) moolya, (9) pitchee; also chisel, tula; throwing stick, preeta; and mentioned the use of nardoo, pitcheree, and mindree gum, as well as the utilisation of rushes for making mats. Cornish (pp. 22-23) gave a different set of terms, also from the Warburton River, but presumably from the territory occupied by another tribe: (1) chilpa; (2) wonna, (3) kutchie, (4) munkoorara, (5) mooloowarroo, (8) mucka, (9) pitchamooroo. Salmon (pp. 24-27) from Koongi Lake, Cooper's Creek [Yauraworka tribe]: (1) poka, (2) windra, (4) yarra, (5) narratitta, (6) mudramoodipa, (7) yarrakoodakoodari, (8) wottee, (9) dallamurroo; canoe, ukobichi; pitcheree, ash (toorpa) obtained from leaves of gum tree; gum tree, yallawarroo [?*Eucalyptus rostrata*]; boxtree, kulparoo [*E. microtheca*]; fishing net, peerly [pi-li, bi-li]. Cornish (pp. 28-29) gave the following names from the Yowerawoolka tribe [Yauraworka]: (1) kuntha, (2) winara, (4) munkoorara, (5) narateta, (8) mukka, (9) delamooroo. Howitt (pp. 30-31) mentioned: (6) bomaiko [kommiyakoo in Wells, 1894], and (8) pattara from near Innamincka. Jacobs (pp. 108-109) reported from Kopperamana [Dieri and Wonkanguru]: (1) kanta, (2) kalti, (4) kuckuru, (6) karlara, (8) pita, (9) pitji. Warren (p. 112) mentioned peuda as the fruit of the pigface [*Mesembryanthemum aequilaterale*] at Strangway Springs [Arabana tribe]. Kingsmill (120-121) gave: (1) thuthara, (2) wardlata, (3) kidchie, (5) muala, waroo, (6) bome, yackoo [obviously misprint for bomee yackoo, Howitt's bomiako, Wells' kommiyakoo], (8), curdla, (9) coorkieleinga, from the Kooyiannie [Kuiyani] tribe at Beltana. Phillipson (112-113) mentioned that at Umbertana [Umberatana; probably Wailpi tribe] the natives ground into flour the seeds of silver wattle [*Acacia rivalis*] and of bower grass [paua, bow-a, applied to any grass with edible seeds]; (1) yuta, (2) winda, (5) teepara, (7) waldna, (8) nutchoo, (9) beetetee; throwing stick, weeanderloo. For the Unyamootha tribe [Anyamutna = Wailpi] Gason (122-123) gave: (1) yoothera, (2) winda, (5) thippira, (6) adgna [= stone], (7) wanna, (8) urla, (9) pithadie. Wills (116-117) reported for the Tura or Eura tribe, Mount Serle [probably a clan of the Wailpi, which tribe Gason (in Curr, p. 119) called Wipie]: (1) uta, (2) wurlata, (4) woonrara, (8) wittie, (9) bidthati.

In a short paper Browne (1897), in writing of the natives of "the lower north" of South Australia gave an account of their method of cooking cress, *Lepidium ruderale*, by means of steaming; and of the treatment of rushes, *Juncus* sp., to obtain from them fibre to be rolled into string; and also of the utilisation of leaves and stems of *Xerotes effusa* [*Lomandra effusa*] for suffocating kangaroo rats (bokra) in their burrows in such a way that these marsupials could be easily reached by the natives. It seems probable that the region referred to was near, or south of, the southern Flinders Range, and that the tribe was the Ngadjuri. The species of rush may have been either *Cyperus vaginatus* or *Juncus* sp.

Mrs. Duncan-Kemp's observations (1933) were centred on Mooraberrie, between Farrar Creek and the Diamantina, about 120 miles north-east of Birdsville. Her book contains, scattered through it, many references to the use made by local natives of the vegetation of the area. Since they are likely to escape scientific notice and since they relate to the region adjacent to that which we

investigated, such references are now incorporated in our paper. The local tribes were messmates of the Pitta Pitta and included amongst others, the Murranudda, Karanya, Kooridala, Ooloopooloo and Mittaka. The last-named bordered on the Yelyuyendi (Yalliandra in Duncan-Kemp, p. 190), whose territory included Pandi. Some of the information is similar to that given by Roth (1897).

The method of preparation of nardoo was mentioned (p. 261). Nardoo flour was stored in small dilly bags until needed and was stated to be an article bartered along the trade routes (p. 208).

References to Gramineae are as follows: munta, edible seeds obtained from ants' nests [probably seeds of the grasses *Dactyloctenium radulans* and *Panicum decompositum*] (p. 117); pindi, Mitchell grass [*Astrebla pectinata*] (p. 61); wunjee, apparently a general term for grass (p. 147); patti, hard-baked slab or cake made from grass seeds and stored under stones for future emergency (p. 56); method of winnowing, cleaning and grinding seed food (p. 84) [method similar to that described by Roth (1897, 91) for "star grass," *Dactyloctenium aegyptium* — *D. radulans*, native name yaraka]; spinifex [*Triodia*, probably *pungens*] pulverised on a flat hearth-stone to extract gum (kunta) (p. 79); katoora, seed of barley grass traded from the north and north-east [Bailey, 1912, 624, and Roth, 1897, 91, stated that katoora was *Sporobolus actinocladus*]. Katoora was used for ceremonial purposes, being ground along with a crude flour made from pulverised dried fish obtained from permanent waterholes (p. 147); necklets made from grass (p. 146) and worn by women at corroborees; heeb, rope made from grass (p. 130); mungkora, dilly bag used for storing meal and made of woven grass or reeds (p. 258, 261); dried grass or leaves used for making signal fires, the kind of smoke differing according to the plants used (p. 198); fibre made from a "brown river grass" [? *Themeda triandra*] in the same way as from native flax [*Crotalaria* spp. Palmer (1884, 109) mentioned that the grasses, *Panicum leucophenum* and *P. trachyrachis* produced fibre which was used by the natives of the Cloncurry and Mitchell Rivers, Queensland]; a native when spying could travel or remain for hours under water by using as an air-pipe a hollow reed inserted into the mouth, the nostrils having been plugged (p. 206). Nutgrass [*Cyperus bulbosus;* Bailey (1912, 591) gave *C. esculentus*, now considered a synonym of *C. bulbosus*, as the mungarn of Western Queensland] edible, was called mungaroo (p. 29); talculli, sweet onion bulbs [*Bulbine* sp.] from sandhills, edible (p. 69).

Among the Proteaceae, mention was made of the water-storing capacity of the roots of needle bush, pinta-murri (p. 73) [*Hakea leucoptera*]; shields and coolamons were obtained from corkwood [*Hakea Ivoryi*] (p. 218, 291). Many uses were found for the coolebah [*Eucalyptus microtheca*], native name karabadi (p. 261); timber was used for firewood and firesticks (p. 229), for making message sticks (p. 196) and large coolamons (koordoo); the seed, termed karapari (p. 261), was crushed and converted into damper (patti); and the bitter kino was also utilised. Eucalyptus leaves were used medicinally (p. 224):—a narrow hole about six feet deep was excavated and lined with these leaves; layers of very hot stones were placed in the hole, and when the desired temperature was reached these stones were removed; the patient, wrapped in an emu-skin blanket (multara), was taken to the hole, stripped naked, placed in the bed and covered to the neck with warm sand and eucalyptus leaves, remaining there for 10-15 minutes; he was then covered in the emu-skin and taken back to camp, the whole procedure being carried out under instructions from a "medicine man" (mulunjera).

Acacias were utilised extensively. One kind (poo-ka-ti-ka) supplied the ash used in preparing pituri (p. 221). [Roth (1897, 100) gave the same term, but later (1901, 31) called it pukartika, identifying it as *Acacia hakeoides*.] The wood of mulga, gidgee and minnareechie was used for making clubs and nulla-nullas

(p. 213). The last-named tree is the red-barked or ringed gidgee (p. 131, 262) [*A. cyperophylla*], whose timber was used for making long churingas, boomerangs and spears. Gidgee [*A. Cambagei*] supplied a bitter gum (p. 75); its wood was used for message sticks, short hunting spears, boomerangs and nulla-nullas (p. 197, 211, 212), for forming the framework of huts (p. 244), and for firewood and firesticks. Edible grubs were obtained from the roots of species of *Acacia* and senna [*Cassia* spp.] (p. 256), as well as from the wild broom [*Cassia* spp.], grubs from the last-named being termed parootra boonti [boondi is applied elsewhere to *Cassia* spp.]. From *Bauhinia* [*B. Carronii*] were made large shields (worra); from the stems, scored by women as the rainy season approached, a sweet edible sap (minni) or gum was collected after rain (p. 75); and its blossoms were pounded in a coolamon and the liquid drained into another receptacle, mixed with "honey" from the "sugarbag" or honey ant (cerumba teeta; teeta = ant), the mixture being allowed to ferment for 8-10 days when a semi-intoxicating liquor was obtained (p. 76). Whitewood gum [*Atalaya hemiglauca*] was considered to be a poor substitute for that from *Bauhinia*. The succulent parakeelya [*Calandrinia*] was chewed by natives when short of water (p. 74). Seeds of pigweed [*Portulaca oleracea*], kooni, and of an allied species, curda, were eaten (p. 69). Amongst edible fruits were the quandong [*Santalum lanceolatum*], which was pounded and made into a damper and baked but which was sometimes eaten raw (p. 156); jilleroo, a red fruit from the sandhills [? *Enchylaena tomentosa;* this name is applied at Mount Lyndhurst to *Rhagodia spinescens,* a related saltbush]; and "wild orange," wombunye [Roth (1897, 93) identified the plant as *Atalantia glauca—i.e.,* the native cumquat of Bailey 1912]. Edible roots were yams, mootchery (p. 259) from the sandhills [*Ipomoea heterophylla*]; witooka [*Boerhavia diffusa,* Roth, 1897, 92]; and yalka, a thick parsnip-like root [possibly *Vigna lanceolata*] which was roasted in the ashes (p. 69). Plants eaten raw included parakeelya; wild spinach [*Tetragonia expansa*], bogil-a-ri (p. 29); woolitcha (p. 69), mustard plant [? *Stenopetalum* or *Lepidium*] eaten with meat; stalks of wild geranium or crowsfoot (p. 69) [*Erodium cygnorum*]; and truffle, wiididha (p. 260) [Hymenogastraceae, *Hydnangium glabrellum* (Z. & D), apparently the same kind as that referred to by Roth, 1897, 93]. Pituri is frequently mentioned. Several plants were used for their reputed medicinal qualities[3]: the leaves and pods of the "shooting grass" or "scurvy grass" [*Commelina ensifolia,* according to Bailey, 1912, 561] are boiled and eaten like cabbages (p. 14); pennyroyal [*Mentha australis*], pookankudye (p. 129) [drunk as a decoction for coughs and colds, according to Roth who also stated that strongly scented plants were used for "sniffing at" in cases of headaches (1897, 163)]; eucalyptus leaves for making a "sweating bath" (p. 224), referred to previously; warmed mashed leaves of eucalypts and kudges [? gidgee, *Acacia Cambagei*] placed on a pad of soft bark and then applied over a wound and tied in place with strips of soft bark (p. 248); astringent herbs and mud applied to stop bleeding wounds, or the latter were painted with the "white milk of the caustic bush" [*Sarcostemma australe*]; pituri was chewed by young male initiates in order to deaden pain inflicted during certain ceremonies (p. 240); a plaster of mud and leaves was used to support a fractured arm (p. 270); the syrup from "wild strawberry vine" [? *Melothria maderaspatana*] was drunk in case of dysentery; the red sap of the wild pear tree was used for gastric disorders; and a warmed poultice of mashed vine leaves was applied to swollen parts (p. 270) [Roth (1879, 162) mentioned having seen pounded boxtree bark (*Eucalyptus*

[3] Palmer (1884, 106-108) mentioned many species of plants used for medicinal purposes by Queensland aborigines. Schulze (1891, 229) stated that Aranda natives drank concoctions of leaves or bark or whole plants as medicine, those utilised including *Callitris verrucosa, Acacia sentis* [*A. Victoriae*], *A. strophiolata, Stemodia, Cynanchum floribundum,* and others.

microtheca) soaked in hot water and then held against the affected part for a bad headache]; wounds were packed with leaves and thick black mud, poolka (p. 199, 222).

From the fruit of the "emu apple" [*Owenia acidula*], as well as from the roots and berries of various plants, colours used for corroborees were obtained (p. 75). Wild hop [*Dodonaea attenuata*] was used for decoration and for making a frothy drink (p. 76). A musical instrument, dejeridu, was made from wood (p. 149). Game was sometimes wrapped in leaves before cooking (p. 252). A kind of grid or wooden cradle, poo-tee-poo-tee-ya, was used for drying meat in the sun (p. 280). The "old man" saltbush [*Atriplex nummularium*] was avoided at seed-time by women, for fear of impregnation (p. 77). Flax (kalo) was used for making dilly bags, fish nets and emu nets (p. 112) [the description indicates *Psoralea patens*]. The leaves of an evil-smelling creeping plant [? *Chenopodium* sp. or one of the Compositae, *e.g.*, *Centipeda Cunninghamii*] from the sandhills were placed around camping places to repel ants (p. 202). There are many references to the making of wurlies or breakwinds of boughs, and of rain huts (koo rou-i), winter huts (unna-kud-ye), and humpies, by using timber, grass, bark, grass twine, leaves and sand (p. 79, 131, 228, 244). Vegetation was used in making game traps, *e.g.*, bough alleyways (yelka-yelka) for emus and kangaroos, and mokwari or pigeon traps [both kinds described by Roth, 1897, p. 97-98]. The dead were either placed on a platform of sticks or were wrapped in sheets of bark, placed on the ground, and then covered with boughs and logs, the grave covering being termed mocroo kumbo, *i.e.*, death sticks (p. 233). The mourning caps (mungawarra or pata-marro) made of gypsum [burnt and then ground into a powder termed kopi, if for general use, or pata when used for mourning; warru = white, mung = forehead] and worn by women were sometimes adorned with leaves of gidgee or *Bauhinia* (p. 232). Boughs and stakes were utilised to make palisades (erulli) and lighter screens (kelpi) which were used during various stages in initiation ceremonies (p. 239).

Our present paper contains several native names given for "flax" and the plants from which it is obtained. Apart from grasses, the list includes Cyperaceae (and perhaps Juncaceae), Leguminosae and Asclepiadaceae. The Malvaceae may also be concerned since *Lavatera plebeja*, common along the banks of the Diamantina and other watercourses, was reported by us (1939) to be used as a source of fibre in the Northern Flinders Ranges; and *Sida virgata* belongs to a genus containing fibre plants. The Cyperaceae are represented by *C. vaginatus* and perhaps *C. distachyus* (= *C. laevigatus*).

We received the name ka-lo (*i.e.*, flax) for *Psoralea patens* as well as for *Crotalaria* spp. Stirling and Waite referred to karla as a rush, but we have suggested that the word should be karla or kadla, which means a rush. From rushes (*Cyperus* spp.) a coarse fibre was obtained but a more valuable material (ka-lo) was made from *Crotalaria* and *Psoralea patens*. Since we obtained the name boonkoodoo for *Cassia eremophila*, Stirling and Waite's punku and punkudu may have referred to it, unless the *Cassia* had been mistaken for *Crotalaria dissitiflora*. Roth (1897, 94) mentioned that large and small fishing nets were made from some sort of native flax (ka-lo of the Pitta Pitta tribes) which he thought might be *Linum marginale* A. Cunn. He also stated (p. 103) that ka-lo was used for making dilly bags and was obtained from a "beautiful, though common, blue-flowered native flax," and that another kind of fibre was obtained from a plant called munji growing to a height of about two feet, with yellow flowers, and found in the sandhills west of Boulia. He gave an account of the method of making kalo flax. Roth (1901, 31) subsequently mentioned that native flax was a *Psoralea*. Palmer (1884, 110) had already recorded that *P. Archerii*,

termed wonuno, was a fibre-producer in the Cloncurry River region. Roth's munji was almost certainly a *Crotalaria*. Bailey (1912, 132) stated that all kinds of *Crotalaria* yielded good fibre, and amongst many species occurring in Queensland he mentioned *C. Cunninghamii* and *C. dissitiflora*, to both of which we know the term ka-lo is applied in the Diamantina area. Bailey (p. 136) did not refer to any Queensland species of *Psoralea* as being used as a fibre plant, though *P. patens* occurs there.

Gason gave mootcha as the name of the native cotton bush from whose dry stems fibre was obtained. Howitt (1904) mentioned kangua as flax, and gave duntyi as the name of *Crotalaria* [*C. dissitiflora*]. Stirling and Waite (1919) referred to wulpu as flax and as the plant, and to punkutu as flax from the punku plant; duntji was mentioned without comment. Horne and Aiston (1924), and Aiston (1937) referred to fibre from wadnoarie, a verbena, but we have already indicated that they were dealing with *Psoralea patens* whose minute coloured flowers are, at first sight, apt to suggest a verbena. These authors (1924, 67, fig. 53-55) gave an account of the method of preparation of the fibre from the dry stalks. They also stated that fibre was obtained from a plant in the sandhills. Cleland, Black, and Reese (1925) referred to *Crotalaria Cunninghamii* and *C. dissitiflora* (kalo), as well as *Cynanchum floribundum* (weela) as plants from which natives manufactured string. Gason's mootcha is *Cynanchum floribundum*. We suggest that Stirling and Waite's wulpu may refer to the same species, and that their punku and punkudu may belong to *Crotalaria dissitiflora*.

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AUSTRALIAN SHELLS OF THE FAMILY HALIOTIDAE

By BERNARD C. COTTON, South Australian Museum

Summary

Australia and New Zealand have the bulk of the world's species of the interesting family Haliotidae, commonly known in various parts of the world as Mutton Fish, Sea Ears, Ormers, Abalones, Awabi, Pauas, and Venus Ears. Before attempting to classify the family generically it is necessary to determine the genotype of the type genus *Haliotis*, which is a problem presenting considerable difficulties. The original description of *Haliotis* Linne 1758 is followed by the specific description of the species *H. midae* Linne 1758, without locality, though it is the well-known and peculiar shell found commonly in South Africa. This is the species accepted by Thiele, Handbuck der Systematischen Weichtierkunde, p. 29, 1929, as genotype. The next species listed by Linne is the well known European *H. tuberculata* Linne 1758, which has also been regarded by certain writers as the genotype. Montfort, Conchyliologie Systematique, 2, 119, 1810, gives *H. asinina* Linne 1758 as the typical species, a course which is followed by Winckworth, Journal Conchology, 19, (7), 218. It seems that *H. midac* has first claim to be quoted as genotype of the genus *Haliotis*.

AUSTRALIAN SHELLS OF THE FAMILY HALIOTIDAE

By Bernard C. Cotton, South Australian Museum

[Read 12 August 1943]

Plates XX to XXV

Australia and New Zealand have the bulk of the world's species of the interesting family Haliotidae, commonly known in various parts of the world as Mutton Fish, Sea Ears, Ormers, Abalones, Awabi, Pauas, and Venus Ears. Before attempting to classify the family generically it is necessary to determine the genotype of the type genus *Haliotis*, which is a problem presenting considerable difficulties. The original description of *Haliotis* Linne 1758 is followed by the specific description of the species *H. midae* Linne 1758, without locality, though it is the well-known and peculiar shell found commonly in South Africa. This is the species accepted by Thiele, Handbuch der Systematischen Weichtierkunde, p. 29, 1929, as genotype. The next species listed by Linne is the well-known European *H. tuberculata* Linne 1758, which has also been regarded by certain writers as the genotype. Montfort, Conchyliologie Systematique, 2, 119, 1810, gives *H. asinina* Linne 1758 as the typical species, a course which is followed by Winckworth, Journal Conchology, 19, (7), 218. It seems that *H. midae* has first claim to be quoted as genotype of the genus *Haliotis*.

Haliotis australis Gmelin 1791 was recorded by Menke from Western Australia in error, as it is the well-known species widely distributed in New Zealand and bears no resemblance to any Australian species. *Haliotis pulcherrima* Martyn 1784 was reported from King George Sound also in error. Two young shells mounted on a tablet from the May Collection bear the locality "Australia." They are typical, but in all probability there has been a mistake in the locality, as the species is only known from the Polynesian Region.

Key to Australian Genera

a. Shell rounded.
  b. Orifices small and not conical.
    c. Shell smooth and large and medium height .. ... *Schismotis*
    cc. Shell spirally lirate, small, high and circular .. .... *Exohaliotis*
  bb. Orifices large and conical.
    d. Dorsal surface with corded spirals.
      e. Raised and prominent dorsal rib ... ... *Marinauris*
      ee. No raised and prominent dorsal rib ... . *Notohaliotis*
    dd. Dorsal surface tuberculate ... . *Ozinotis*
aa. Shell very elongate ear-shaped .. .. *Teinotis*

Schismotis Gray 1856

(Pl. xx)

Genotype, *Haliotis excisa* Gray 1856. A species based on a specimen which is a monstrosity with the perforations connected by a slit. Locality, ?.

This species was previously named *albicans* Quoy and Gaimard 1834, King George Sound, Western Australia. *Haliotis laevigata* Donovan 1808 is a still earlier name which may apply to this species but it is based on a figure without description or locality. The figure appeared in Rees' Encyclopaedia, November 1 1808, pl. vi of the Conchological series, and this was referred to by Iredale in Proc. Linn. Soc. N.S.W., 1924, p. 222. The Encyclopaedia is not obtainable in South Australia but the Public Library of Melbourne has it and a photostat of

the plate is here reproduced to provide students with the record of this species. In South Australia the species grows bigger and heavier than any other and indeed is the largest species in Australia, if not in the world. A specimen from Anxious Bay, South Australia, measures 200 mm. x 155 mm. x 60 mm. Another from Robe measures 150 mm. x 150 mm. x 75 mm., and is a particularly high specimen. The species is found in deeper water and on open ocean beaches in the South-East and Southern Yorke Peninsula where, at the latter place, one farmer uses it as a scoop for removing the sandy soil from post-holes. It is also a common object on the native camp sites which abound in that district. It is rarer in the Gulf St. Vincent, where it is usually of a smaller size and uniformly white, even in the juvenile. From Yorke Peninsula westwards the young, and sometimes specimens approaching adult size, are decorated with irregular, alternate red and white radial flames, and the common "Bonnet Limpet," *Sabia conica* Schumacher 1817, is frequently attached to the dorsal surface of the body whorl. The orifices are very small and are connected by a weak groove and in beach rolled specimens or even well worn living specimens this may be eroded through to form a slit, a condition seen in the monstrosity *S. excisa* Gray. It is recorded from throughout the Flindersian Region.

Teinotis Adams 1854

Genotype, *Haliotis asinina* Linne 1758, "Indian Ocean."

The genus was introduced for the species *Haliotis asinina* Linne, which has an elongate shell with large aperture and the animal has a large foot. It is widely distributed in the Pacific and on the Northern Australian coasts. We have it from North West Islet (Kimber) and Murray Island, North Australia (A. M. Lea). As explained previously, Montfort 1810 cited this species as type of *Haliotis*, but Adams pointed out in introducing his genus that *asinina* is the genotype of the *Haliotis* of Montfort 1810 and not of the true *Haliotis* Linne 1758.

Exohaliotis Cotton and Godfrey 1933

(Pl. xxiv, fig. 3)

Genotype, *Haliotis cyclobates* Peron 1816, Kangaroo Island—*excavata* Lamarck 1822, "Australia" (= South Australia).

This peculiar round, elevated species is confined to the eastern end of the Flindersian Region and no specimen or fragment can be found in the Verco Western Australian material. It is quite common in South Australia and is found from Streaky Bay to the South-East. A large specimen from Venus Bay (Weeding) measures 90 mm. x 75 mm. x 50 mm. The colour may be quite bright of a pale greenish background crossed by radial red and white stripes, or the shell may be unicoloured creamish-white. One specimen has the former colouration at first and then, after a repaired break in the body whorl, the pattern becomes abruptly unicoloured. The radula from a South Australian specimen shows some differences from that of *Marinauris roei*, the most notable being the narrower central tooth. A specimen from Corny Point, South Australia, is figured here.

Notohaliotis Cotton and Godfrey 1938

Genotype, *Haliotis ruber* Leach 1814, New South Wales.

Shells of this genus are usually large and have not the raised spiral rib of *Marinauris*. The species here placed under this genus are somewhat varied and may be arranged in two groups. There is the genotype with its associates *improbula* and *coccoradiatum* which tend to be elongate and raised dorsally. Then there is the *conicopora-vixlirata* type which is rounder, has a depressed dorsum and somewhat exert spire.

Notohaliotis coccoradiatum Reeve 1846

Type locality, "St. Vincent and Spencer Gulfs" = Port Jackson, New South Wales.

This is the well-known species which is found at Port Jackson, New South Wales, and has been also recorded from Tellaburga Island, Victoria. It is not found in South Australia or the Flindersian Region and is certainly confined to the Peronian. It is a much smaller species than *ruber*.

Notohaliotis conicopora Peron 1816

(Pl. xxi)

Type locality, Pelican Lagoon, Kangaroo Island, South Australia.

Shell large, round, dorsal surface of body whorl depressed, spire prominent; spirally scabrously corded and irregularly axially undulate; orifices prominent and conical.

There is little doubt but that *granti* Pritchard and Gatliff, *gigantea* Menke and *cunninghami* Gray are synonyms, the species being well figured by Reeve under the last name from what appears to be almost certainly a South Australian specimen. A specimen from Guichen Bay, South-East South Australia, is here figured, and the size and locality records of some other Southern Australian specimens given, in millimetres.

	Max. Diam.	Min. Diam.	Height	
Beachport	175	135	43	Adult
Kangaroo Island	156	125	35	Adult
Middleton	105	90	25	
Guichen Bay	100	75	23	
Guichen Bay	140	110	37	Specimen Figured
Kangaroo Island	95	75	23	
St. Francis Island	72	55	17	
Victoria	140	110	35	
Victoria	140	115	39	

From *N. improbula* and *ruber* the present species is distinguished by the depressed dorsal surface, prominent spire and rounder shell.

Notohaliotis vixlirata sp. nov.

(Pl. xxii)

Ellenbrook, Western Australia. Holotype, D. 7962.

Shell large, dorsal surface depressed, spire elevated, orifices prominent and conical; spiral lirae very fine in the early stages of growth and obsolete in the later and adult stages when the accremental striae become more and more valid with age until they are strongly marked; no irregular axial ribs as in *conicopora*, though in general shape and size recalling that species. Major diameter 178 mm., minor 140 mm., height 51 mm. This species is readily separated from *conicopora* by the lack of both the strong scabrous spiral cords in the adult and the axial irregular undulations. The holotype specimen bearing the above name has been on exhibition in the South Australian Museum shell gallery since 1930. We have specimens in various stages of growth, from Albany and Esperance.

Notohaliotis improbula Iredale 1924

(Pl. xxiii)

Type locality, Port Fairy, western Victoria.

This species is undoubtedly closely allied to *N. ruber*. It differs in being more elongate, less tightly coiled showing the whorling inside, and having coarser sculpture as pointed out in the original description. In addition the Flindersian specimens attain to a larger size, a fully grown specimen from Beachport, South Australia, figured here, having the following measurements: maximum diameter 180 mm.,

minimum diameter 140 mm., height 50 mm. The species is widely distributed and common in the Flindersian Region, living specimens being always obtainable at such places as Marino Rocks, South Australia, between tide marks. The animal varies somewhat in the colouration of the foot, which on the under-surface may be sometimes predominately cream-coloured in the median area, and at other times predominately dark greyish-brown. It is active and will move about comparatively quickly on the inner glass surface of a marine aquarium jar.

NOTOHALIOTIS RUBER Leach 1814

Type locality, New Holland (= Port Jackson, New South Wales).

Haliotis naevosa Martyn 1784 is a synonym, but invalid as Martyn's work was not binomial. A Tasmanian shell from the May Collection bears the label: "*Haliotis naevosa* Martyn = *tubifera* Lamarck" and is undoubtedly *N. ruber*. This specimen agrees in size with *tubifera* Lamarck, but the meagre description of the species could apply equally well to *conicopora* as that species is recognised in this paper, but not as Iredale interprets it as of the group now called *Marinauris*. In any case *tubifera* will not be used in Australian lists, as it is apparently a synonym of *ruber* or *conicopora*. Furthermore, there is no suggestion in the original description that the species has anything to do with the genus *Marinauris*. It can only apply to a species of *Notohaliotis*. The type locality given by Lamarck for *tubifera* is "New Holland," but Iredale thinks Southern Tasmania may be the locality.

SANHALIOTIS Iredale 1929

Genotype, *Haliotis varia* Linne 1758. Locality, ? (= Philippine Islands).

Species are *Sanhaliotis aliena* Iredale 1929, Queensland, which we have from Groote Eylandt, Gulf of Carpentaria (Tindale) and North-West Islet, Capricorn Group (Kimber); *howensis* Iredale 1929, Lord Howe Island; *hanleyi* Ancey 1881, New Caledonia; *crebresculpta* Sowerby 1914, New Caledonia; *dissona* Iredale 1929, Michaelmas Quay, Queensland. In addition the following four species may also belong to this genus.

SANHALIOTIS SQUAMATA Reeve 1846

Type locality, North-west Coast of Australia.

This Dampierian species is closely allied to the next, *funebris* Reeve, though the author states that: "This is a larger and flatter species than the *H. squamata* and the ridges (spiral) are more widely separated and less squamate." We have a specimen from Shark Bay, Western Australia, which is probably its southern limit.

SANHALIOTIS FUNEBRIS Reeve 1846

Type locality, New Holland.

This species may be found only in South Western Australia, and is definitely recorded from Swan River, Western Australia, which according to Hedley is the locality placed on the specimen in the South Kensington Museum. There is little doubt but that *diversicolor* Reeve 1846, New Holland, and *tayloriana* Reeve 1846 Hab.? are synonyms over which *funebris* has page priority. Incidentally, if *squamata* should prove synonymous it has priority over *funebris*.

SANHALIOTIS ASTRICTA Reeve 1846

Type locality, "Hab. ?"

This species appears in Hedley's "List of Marine Mollusca of Queensland," and the specimens in the South Australian Museum are from Port Darwin. It is probably a Dampierian species extending into the Banksian, but we have neither Queensland nor Western Australian specimens.

Sanihaliotis elegans Philippi 1899

Type locality, Western Australia.

Reeve quotes Port Adelaide, New Holland, but it has never been taken in South Australia. Our Western Australian specimens are typical and come from Rottnest Island. Verco, in his notes, states "Shark Bay (Henn.)" but I have not seen specimens from there. This is probably a Dampierian species ranging up to Northern Australia. It is placed in this genus although the elongate shape and terminal spire suggest that it should be separated under a distinct genus.

Marinauris Iredale 1927

(Pl. xxiv, fig. 1-2; pl. xxv, fig. 1-3)

Genotype *Marinauris melculus* Iredale 1927, Caloundra, Queensland = *Neohaliotis* Cotton and Godfrey 1938, genotype *Haliotis scalaris* Leach 1814, South Western Australia.

The genus may be described as follows:—Shell of medium size, flattened, circular, spire subcentral, slightly elevated; sculpture of more or less developed spiral cords and sometimes axial folds and a tendency to the development of a spiral median dorsal rib; orifice close and somewhat tubular; columellar plate wide and flat; internal colouration silvery, all whorls exposed. Distribution: all around the Australian and Tasmanian coastline. The radula of *Marinauris roei* Gray is here figured and shows the remarkably wide central tooth which may be typical of this genus. A specimen of the shell from Arno Bay, South Australia, where it is common, is also figured.

The genus *Padollus* Montfort 1810 has for its genotype *Haliotis rubicundus* Bolten 1798, which is probably the same species as *parva* Linne 1758 from South Africa. *Sulculus* Adams 1854 has *Haliotis incisa* Reeve, "Habitat?" for genotype, since this is the first species listed after the description of the genus. Also in the list is *parva*. The generic description furthermore leaves little doubt but that this genus is a direct synonym of *Padollus*. *Padollus* is therefore available for the African species which are small, depressed, and have a prominent spiral rounded rib on the dorsum, a fact which was mentioned by Iredale when he introduced *Marinauris*. Species belonging to this genus are: *Marinauris melculus* Iredale 1927, Caloundra, Queensland; *ethologus* Iredale 1927, Caloundra, Queensland; *hargravesi* Cox 1869, New South Wales, rare; *brazieri* Angas 1869, New South Wales; *roei* Gray 1826, South Western Australia = *scabricostata* Menke 1843, Mistaken Island, a species we have from Shark Bay (Ashby); *scalaris* Leach 1814, South Western Australia = *rubicundus* Gray 1826 (preocc. *rubicundus* Bolten 1798) = *tricostalis* Menke 1843, South Western Australia, figured here is a young example from Leven's Reach, South Australia, and an adult from Corny Point; *emmae* Reeve 1846, "New Holland" (= South Australia), a closely allied species confined to the eastern end of the Flindersian Region, figured here from the Gulf St. Vincent.

Ovinotis gen. nov.

Genotype *Haliotis ovina* Gmelin 1791, habitat?

Reeve records this species from New Holland and the Philippine Islands. We have specimens from Torres Strait, North Australia, Murray Island and Lady Elliot Island (Lea).

Shell orbicularly oval, spire depressed, whorls plicately rayed with swollen wrinkles or knobs, orifices conical. Reeve remarks of this species: "An extremely characteristic species . . . . neither Lamarck or Deshayes seem to have been acquainted with it." *H. concinna* Reeve 1846, from the Philippine Islands, also belongs here.

OVINOTIS DRINGI (Reeve 1846)

Type locality, North Coast of Australia.

This species does not appear to be represented in the South Australian Museum collection. According to Reeve's description it has the tuberculate sculpture of *ovina* and may be that species, though Reeve's figure probably depicts a juvenile which therefore looks different from *ovina*, the radial plications being undeveloped. *H. gemma* Reeve 1846, Habitat ? and *H. papulata* Reeve 1846, North Coast of Australia, are apparently synonyms.

Summing up, one may list the distribution of the Australian Haliotidae according to the various States as follows:

QUEENSLAND—*Marinauris melculus* Iredale, *ethologus* Iredale; *Teinotis asinina* Linne; *Sanhaliotis aliena* Iredale, *dissona* Iredale, *squamata* Reeve, *astricta* Reeve? *Ovinotis ovina* Gmelin.

NEW SOUTH WALES—*Marinauris hargravesi* Cox, rare, *brazieri* Angas, more common than the previous species; *Notohaliotis ruber* Leach, *coccoradiatum* Reeve.

VICTORIA—*Marinauris emmae* Reeve; *Notohaliotis improbula* Iredale, *coccoradiatum* Reeve; *conicopora* Peron; *Schismotis laevigata* Donovan; *Exohaliotis cyclobates* Peron.

TASMANIA—*Notohaliotis ruber* Leach = *tubifera* Lamarck; *Marinauris emmae* Reeve; *Schismotis laevigata* Donovan.

SOUTH AUSTRALIA—*Marinauris emmae* Reeve, general, *scalaris* Leach, and *roei* Gray, both taken from Yorke Peninsula, westwards; *Notohaliotis improbula* Iredale; *conicopora* Peron; *Schismotis laevigata* Donovan; *Exohaliotis cyclobates* Peron.

SOUTH WESTERN AUSTRALIA—*Marinauris scalaris* Leach, *roei* Gray, *semiplicata* Menke; *Schismotis laevigata* Donovan; *Notohaliotis improbula* Iredale; *Sanhaliotis squamata* Reeve, *elegans* Philippi, *funebris* Reeve.

NORTH WESTERN AND NORTH AUSTRALIA—*Sanhaliotis aliena* Iredale, *squamata* Reeve, *astricta* Reeve, *elegans* Philippi; *Marinauris roei* Gray.

The Paper Nautilus *Argonauta nodosa* (Solander 1786) taken on the eastern Gulf St. Vincent Beaches.

The first record of a specimen of *Argonauta nodosa* from the Adelaide side of Gulf St. Vincent was that of a specimen taken by the late Duncan Donaldson in 1935 at Henley Beach, and now in the South Australian Museum Collection.

After the heavy gales of middle July of this year a number of specimens were found on this side of the Gulf, and two were presented to the Museum. The data are:—

(1) Brighton, an empty shell, taken by A. R. Tilbrook.

(2) Brighton, taken by a Mr. O'Neill; the dead animal was used as bait.

(3) Port Noarlunga, taken by Mrs. Angas Johnson, with eggs, resembling tapioca in appearance and size, were estimated at about 20,000, but a portion may have been lost. Presented to the Museum.

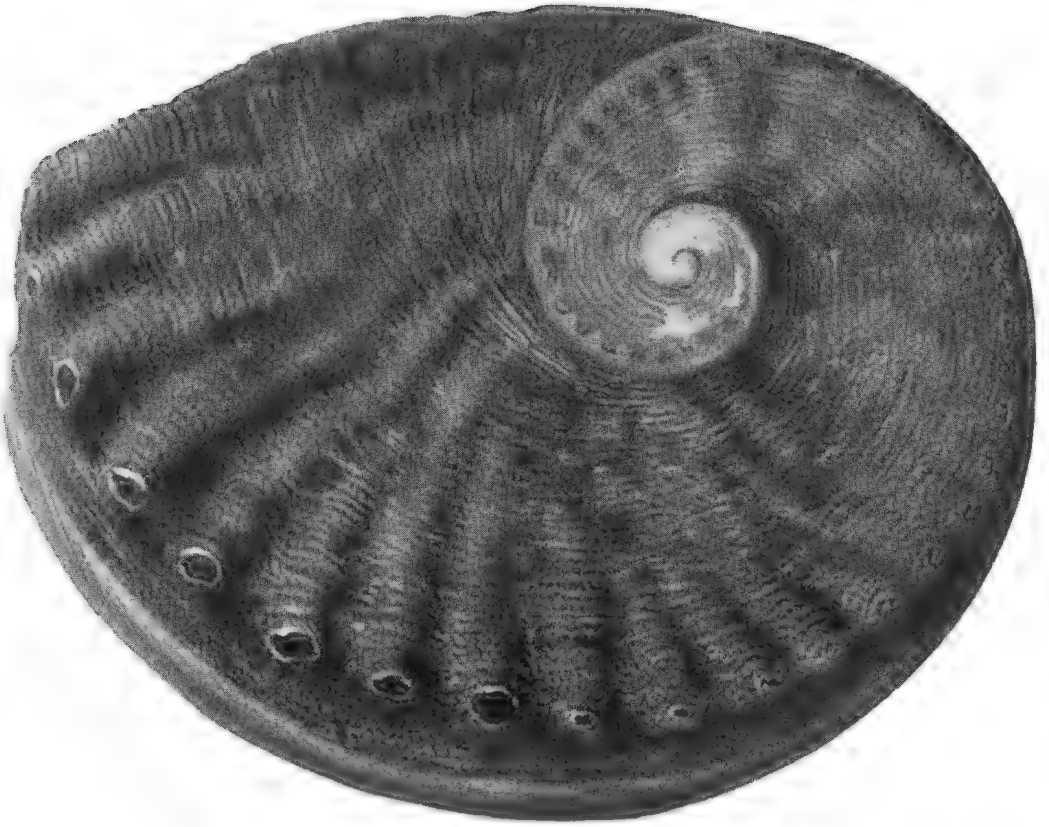
(4) Christie's Beach, taken by S. V. Gray. The alive animal was removed and thrown back into the sea, as it was incorrectly taken to be a common squid occupying the shell.

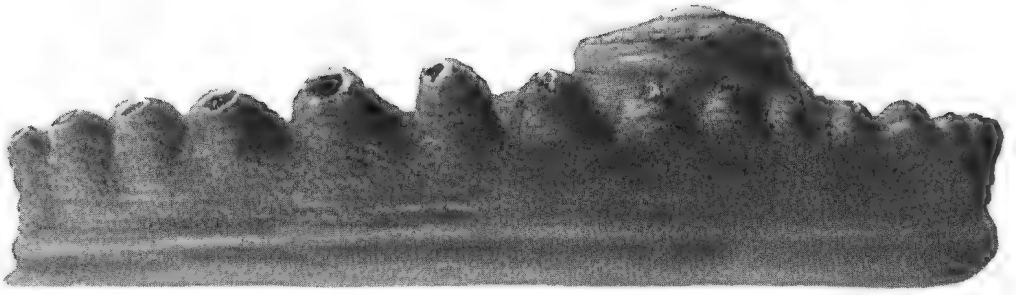
(5) West Beach, taken by D. Horsburg. The shell had been damaged and repaired in life.

Other specimens were found at Grange, Semaphore and Glenelg.

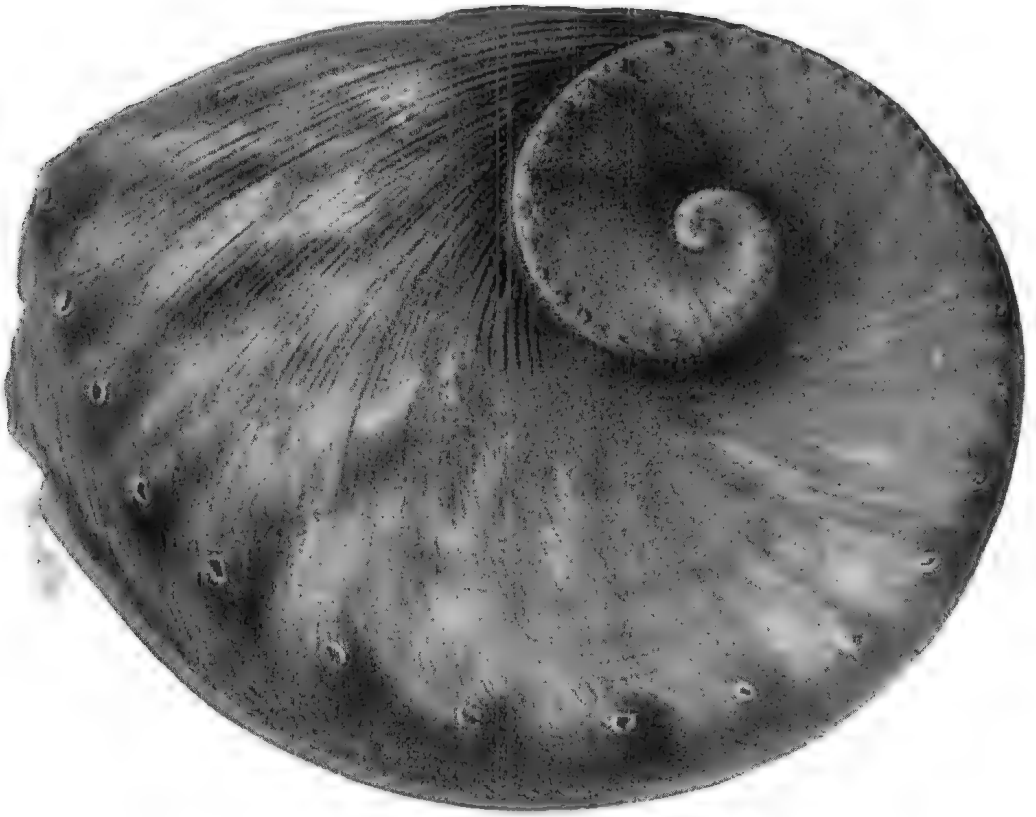
B. C. COTTON
9 Sept. 1943

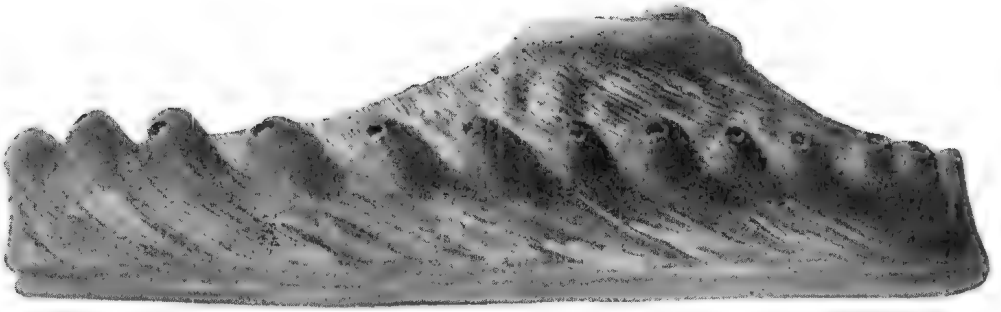
Photostat showing "*H. laevigata*" from Rees' Encyclopaedia, 1808, pl. vi, Conchological Series, by Donovan. Reduced to x 0·6.





Notohaliotis conicopora Peron, x 0·9, from Guichen Bay, South Australia.





Notohaliotis vixlirata sp. nov., x 0·7, from Ellenbrook, Western Australia.

Notohaliotis improbula Iredale, x 0·7

Photo by Walsh

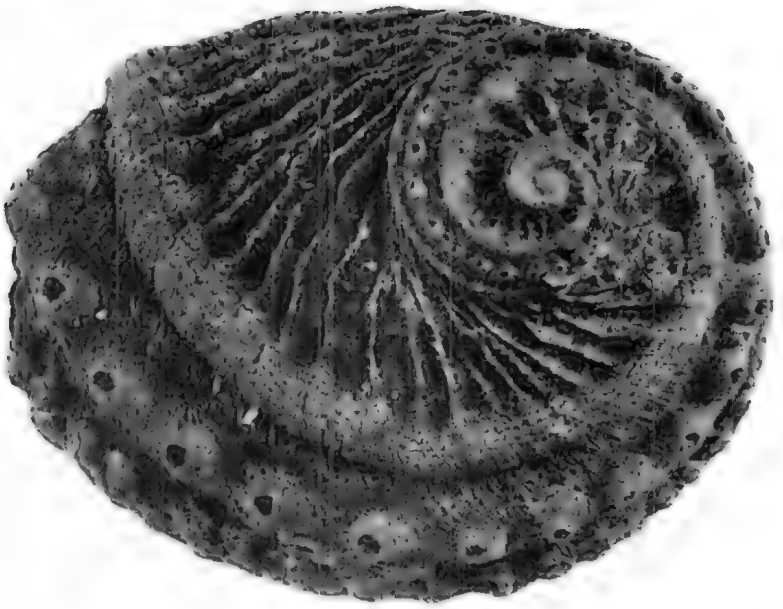


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Fig. 1 *Marinauris scalaris* Leach 1814, natural size, from Corny Point, S.A.
Fig. 2 *Marinauris scalaris* Leach 1814, natural size, from Levens, S.A.
Fig. 3 *Exohaliotis cyclobates* Peron 1816, slightly enlarged.

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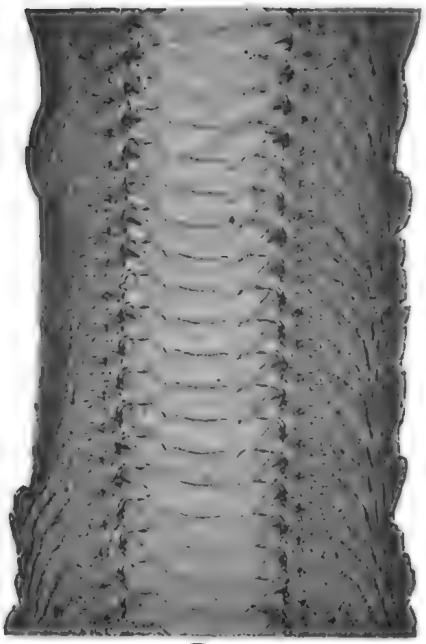

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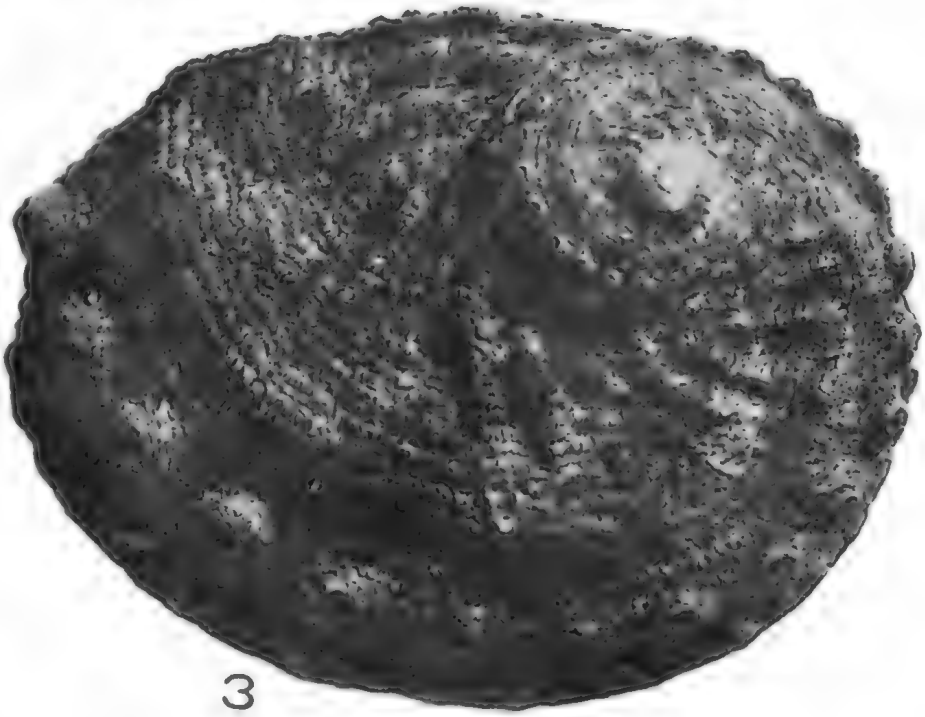

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Fig. 1 *Marinauris roei* Gray 1826, natural size, from Arno Bay, S.A.
Fig. 2 *Marinauris roei* Gray, radula, x 15
Fig. 3 *Marinauris emmae* Reeve 1846, natural size, from Gulf St. Vincent.

A MODIFICATION OF BERLESE'S MEDIUM FOR THE MICROSCOPIC MOUNTING OF ACARINA AND OTHER SMALL ARTHROPODS

By H. WOMERSLEY, A.L.S., F.R.E.S., South Australian Museum

Summary

The use of media based upon a mixture of gum arabic and chloral hydrate for the mounting of acarina and other small atrthropods has been in almost universal practice among entomologists and acarologists for a long time.

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By H. Womersley, A.L.S., F.R.E.S.,

South Australian Museum

[Read 12 August 1943]

The use of media based upon a mixture of gum arabic and chloral hydrate for the mounting of acarina and other small arthropods has been in almost universal practice among entomologists and acarologists for a long time.

Of these Berlese's medium apparently based on the original De Faure is perhaps the most widely used in the study of mites. Although in use by Berlese and his colleagues for many years, the formula was apparently not published until 1921 when it appeared in Bolles Lee on information supplied by A. D. Imms.

The formula as there given was:

Distilled Water - - -	20 mils.
Chloral Hydrate - - -	160 grms.
Gum Arabic - - -	15 grms.
Glucose Syrup - - -	10 grms.
Glacial Acetic Acid - -	5 mils.

It has, however, been the experience of most workers with this medium, that preparations soon show signs of crystallization, and that ultimately the slides become entirely opaque and useless.

D. C. Swan 1936, Bull. Ent. Res., 27, (3), 389, in an endeavour to obviate this disability, published a formula in which the chloral hydrate was reduced to 60 grms., and stated that he had found this satisfactory over a number of years. On information supplied by myself, he also suggested that the crystallization was possibly due to loss of acetic acid, as the preparation could be cleared by running a drop of glacial acetic acid around the edge of the cover slip and gently warming.

In my experience I find that even 60 grms. is too high, as there is still a tendency to sporadic crystallization. To overcome these troubles I have now for several years been using a formula based on a smaller proportion of chloral-hydrate and the replacement of the volatile acetic acid by the more viscous lactic acid. Further, as a mixture of equal parts of lactic acid and phenol has long been used for temporary mounting, I have incorporated some phenol. The use of phenol may also have the tendency of preventing the crystallization of the chloral hydrate, as a mixture of equal parts of these two crystalline substances pounded together forms a liquid.

The formula as now used is as follows:

Distilled Water - - -	100 ccs.
Gum Arabic (pulv.) - -	40 grms.
Chloral Hydrate - - -	50 grms.
Phenol - - - -	50 grms.
Glucose Syrup - - -	10 grms.
Glacial Lactic Acid - -	20 ccs.

Over several years this medium has not shown any sign of crystallization. Owing to the presence of the phenol, however, the stock solution tends to become darker on exposure to light, but this does not affect the small quantity used in a mount.

Preparation of the Medium

The best quality of powdered gum arabic is used, and mixed to a paste with 50 ccs. 96% alcohol. The 100 ccs of distilled water are then added in the cold when the gum readily dissolves; if a little remains insoluble, it may be heated on a water bath. Without the use of the alcohol it is a long and difficult business getting the gum into solution.

The solution is then heated on a water bath and filtered while hot through three or four layers of the finest bolting silk. It is then returned to the bath and evaporated down to 100 ccs. or until the alcohol is driven off.

The phenol and chloral hydrate are rubbed down in a mortar until liquefied and then added to the solution, followed by the lactic acid and glucose. The solution is again heated on a water bath and filtered hot through a Buchner or cintered funnel.

The resultant solution has a clear amber colour and a refractive index of 1·448[1].

Method of Mounting Acarina

For temporary mounts for identification, or drawing and measuring, specimens stored in 96% alcohol are pipetted on to a slide and covered with a drop of 50% or glacial lactic acid, and gently heated over a spirit lamp. This results in perfect clearing and extension of the specimen, so that the finest details of both dorsal and ventral surfaces can be seen. With the more delicately chitinised forms it is an advantage to stain by using 50% lactic acid that has been let down with saturated aqueous picric acid.

For permanent mounts the specimens are transferred to a drop of the above medium on another slide, covered and heated gently until ebullition occurs. The slide can then be put aside to set. The preparation hardens in a few hours, after which it can be handled safely and labelled. If the specimens have been stained with picric, it is advisable to add a little of this also to the medium to retard loss of colour over a period of time.

Specimens can also be mounted straight from life, but even if it is not necessary to make a temporary mount, specimens that have been preserved in alcohol must first be passed through water or any strength of lactic acid to remove the alcohol. The advantages of this class of media are the low refractive index, the quickness of clearing and mounting, and the fact that, if necessary, the specimens can be soaked off in water and remounted in the medium at any time.

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[1] This figure has been kindly determined for me by Prof. Kerr Grant.

REMARKS ON SOME NEMATODES FROM AUSTRALIAN REPTILES

By T. HARVEY JOHNSTON and PATRICIA M. MAWSON, University of Adelaide

Summary

For assistance in connection with the material studied in the preparation of this short paper we are indebted to the late Dr. T. L. Bancroft of Eidsvold, Queensland, and his daughter, Dr. J. M. Mackerras; as well as to Professor J. B. Cleland. The work has been carried out in connection with the Commonwealth research grant to the University of Adelaide.

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By T. Harvey Johnston and Patricia M. Mawson University of Adelaide

[Read 12 August 1943]

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Host List

Amphibolurus barbatus Cuvier. *Strongyluris paronai* (Stoss.), Eidsvold, Brisbane; New England, New South Wales. *Oswaldofilaria chlamydosauri* (Breinl), Eidsvold.

Amphibolurus muricatus Shaw. *Oswaldofilaria chlamydosauri* (Breinl), Burnett River, Queensland. *Strongyluris paronai* (Stoss.) and *Physaloptera gallardi* Johnston and Mawson, Sydney. *Physaloptera antarctica* Linst., Sydney.

Chlamydosaurus kingii Gray. *Oswaldofilaria chlamydosauri* (Breinl), Eidsvold. *Strongyluris paronai* (Stoss.), Burnett River.

Physignathus lesueuri Gray. *Thamugadia physignathi* (Johnston 1912), Eidsvold.

Gehyra variegata D. and B. *Pharyngodon kartana* Johnston and Mawson 1941, Eidsvold. *Pharyngodon* sp. (perhaps *P. tiliquae* Baylis), Eidsvold.

Phyllodactylus guntheri. *Pharyngodon kartana* Johnston and Mawson, Lord Howe Island.

Intermediate host, Culex fatigans. *Oswaldofilaria chlamydosauri* (Breinl), Burnett River.

Oswaldofilaria chlamydosauri (Breinl)

(Fig. 1-2)

Syn. *Filaria chlamydosauri* Breinl 1913; *Foleyella chlamydosauri* (Breinl) Yorke and Maplestone 1926.

From *Amphibolurus barbatus, A. muricatus* and *Chlamydosaurus kingii,* all from the Burnett River, Queensland. The males are about 2-3 cm. long, the females 6-7 cm.

Distinct papillae were not observed on the head. The simple mouth opens directly into the oesophagus which is divided into a narrow anterior and a slightly wider posterior part, these being respectively ·35 mm. and 1·3 mm. long in the male, and 16 mm. and 1·9 mm. in the female. The nerve ring surrounds the base of the anterior portion.

The male tail is 2·5 mm. long and on its extremity bears a small rugosity, more pronounced in some specimens than in others (fig. 4). The caudal papillae are arranged exactly as described by Breinl. The spicules are ·11 mm. and ·21 mm. long, that is, slightly smaller than for the type specimen; both are greatly enlarged proximally, the longer ending in a spoon-shaped portion, the shorter in a round knob. In the female, not previously described, the reproductive tubes extend nearly to both extremities; the vagina is long and opens to the vulva just in front of the midbody. The uteri and vagina contain larvae.

Filaria chlamydosauri Breinl was transferred to *Foleyella* by Yorke and Maplestone 1926. Since that genus is characterised by the possession of wide

caudal alae in the male, and by the oesophageal position of the vulva, the species cannot remain there. The genera of Filarioidea so far recorded from reptiles are *Foleyella, Saurositus, Hastospiculum, Oswaldofilaria, Conispiculum, Macdonaldius, Thamugadia,* and *Setarospiculum.* We have been unable to procure a description of the last-named, but a key to the others has been compiled and may be found useful by other workers. *Filaria chlamydosauri* agrees generally with the genus *Oswaldofilaria,* species of which are recorded from the caiman and an iguana from South America. Breinl's species differs from *Oswaldofilaria* in the absence of a vestibule; but since a description of *Setarospiculum* is not available, we consider it inadvisable to erect a new genus.

KEY TO THE GENERA OF FILARIIDAE FROM REPTILES
(excluding *Setarospiculum*)

1	Oesophagus divided into two parts.	2
	Oesophagus not divided into two parts.	5
2	Spicules subequal.	*Saurositus*
	Spicules unequal.	3
3	Cuticle on each side of mouth thickened	*Hastospiculum*
	Cuticle on each side of mouth not thickened.	4
4	Vulva at about mid-body; no caudal alae in male	*Oswaldofilaria*
	Vulva just post-oesophageal; wide caudal alae in male	*Foleyella*
5	Vulva at mid-body; no caudal alae in male	*Conispiculum*
	Vulva just post-oesophageal; no caudal alae in male.	6
6	Chitinous ring around small vestibule; spicules unequal	*Macdonaldius*
	Mouth leading direct to oesophagus; spicules equal	*Thamugadia*

LIFE HISTORY—*Microfilaria chlamydosauri* was described by Breinl (1913, 42) from the host from North Queensland. The presence of microfilariae in a specimen of *Amphibolurus barbatus* in the London Zoological Gardens, but originally from Australia, was recorded by Plimmer (1912, 139). Johnston and Bancroft (1920, 16) mentioned their presence in the latter host species in the Upper Burnett region, Queensland, and stated that the intermediate host was *Culex fatigans.* The parasite was the species now under review, though it was not then identified. Mackerras (1938, 108) stated that *A. barbatus* was almost invariably infected with a species of *Filaria* in Queensland, but that the parasite had not been observed in that lizard in Canberra.

In 1919 experimental infection of *Culex fatigans* with microfilariae from *A. barbatus* was carried out in Queensland by Dr. J. M. Bancroft, working in collaboration with the senior author. Larvae were collected from the mosquitoes at varying periods after infection, but further studies were not undertaken at the time. The material has now been investigated as far as its condition has permitted.

Eight days after infection the larvae were short (90 μ) and relatively thick (10 μ), and the intestine was not formed. Fifteen days after infection the length varied between 305 and 530 μ, and the width 20-30 μ. The oesophagus and intestine were distinct, the former being 90-120 μ long and surrounded at 22-50 μ from the head end by the nerve ring. The intestine ended in a large clear chamber, the rectum, but the anal aperture was not recognised. At about the position of the future anus was a large, apparently unpaired, papilla visible in all specimens. No other caudal papillae were present, though a suggestive thickening of the hypodermis was seen near the end of the tail in some specimens. Distant from the tail, about one-quarter of the body length was a more deeply staining mass of cells along the body cavity.

Seven days later (after 22 days) a considerable elongation had taken place, the length being ·55-·82 mm. At 28 days greater differentiation was observable and the mouth and anal apertures were present; anal papillae were now absent;

and hypodermal cells had increased so greatly in number that the body cavity was almost obliterated. At 30 days larvae were found in the proboscis and some were escaping from between the labella and their length had reached ·9 mm. Larvae had not increased in size even after 49 days from infection.

These facts indicate that infected mosquitoes in the Upper Burnett district become infective in about thirty days and may remain so for about twenty (or more) days.

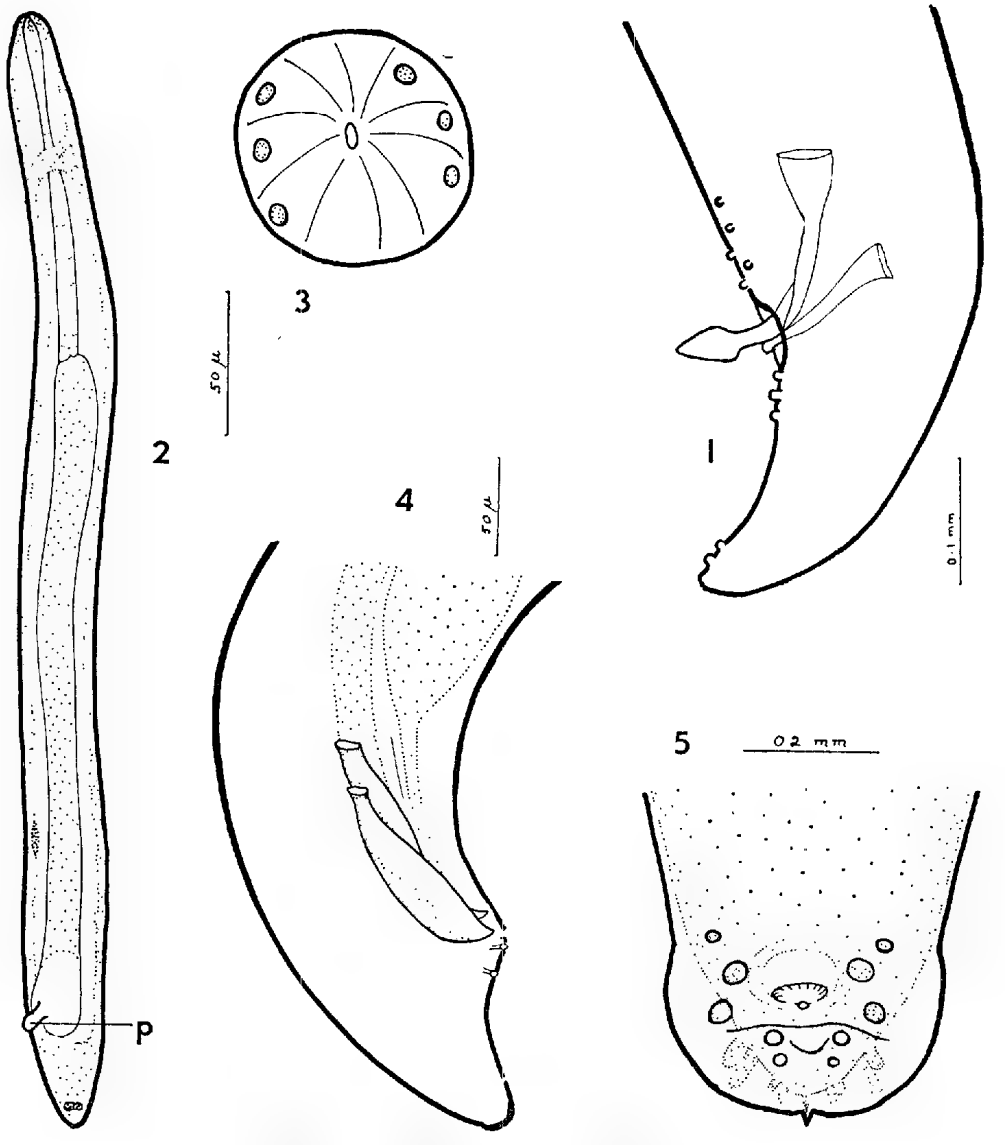

Fig. 1 and 2, *Oswaldofilaria chlamydosauri:* 1, posterior end of male; 2, 15-day larva from *Culex fatigans.* Fig. 3 and 4, *Thamugadia physignathi:* 3, en face view of head; 4, male tail. Fig. 5, *Strongyluris paronai*, male tail, p., anal papilla, Fig. 2 and 3 to same scale.

THAMUGADIA PHYSIGNATHI (Johnston 1912)
(Fig. 3-4)

From veins of liver and mesentery of the type host, *Physignathus lesueuri*, from Eidsvold, Queensland.

The specimens agree closely with the original description, except in regard to the male tail. The anal papillae, of which one preanal and two postanal pairs were mentioned, are extremely inconspicuous, the preanal pair not being seen in any specimen. The alae are so slight that they may be regarded for purposes of classification as absent. The spicules are subequal, about ·11 mm. long, as shown in fig. 4.

The original description mentioned the presence of "three small papillae" on head; this should read "three pairs of small papillae." The absence of a vestibule, the mono-partite oesophagus, the equal spicules and the absence of alae in the male, and the position of the vulva in the female, indicate that this species belongs to *Thamugadia*. The microfilariae were first described by Johnston and Cleland (1911, 489), and were also mentioned by Johnston (1911, 240) and by Cleland (1916, 256).

Pharyngodon kartana Johnston and Mawson 1941

P. kartana was originally recorded from a gecko from Kangaroo Island, and is now identified from another gecko, *Phyllodactylus guntheri*, from Lord Howe Island. The males in this collection show minor variations from the type. They differ in the greater length of the cloacal prolongation, the lesser degree of bifurcation of the second caudal papilla, and the lesser chitinisation of the spicules.

Pharyngodon sp.

Some males falling into the genus *Pharyngodon* were taken from a gecko, *Gehyra variegata*, from Eidsvold. They agree very closely with *P. tiliquae* Baylis 1930, but in the absence of females their definite identification as such is uncertain.

Strongyluris paronai (Stossich)

(Fig. 5)

From *Amphibolurus barbatus* from Eidsvold (Queensland), and New England; *A. muricatus*, Sydney; and *Chlamydosaurus kingii*, Burnett River. This species was re-described by us (1942) and stated to have seven pairs of caudal papillae in the male; in some particularly clear specimens amongst the present material three more pairs were observed (fig. 5).

Physaloptera gallardi Johnston and Mawson 1942

This species, originally described from *Amphibolurus barbatus* from Narara, New South Wales, is now recorded from *A. muricatus* from Sydney.

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SOME NEMATODES FROM AUSTRALIAN ELASMOBRANCHS

By T. HARVEY JOHNSTON and PATRICIA M. MAWSON, University of Adelaide

Summary

The material on which the following report is based was, except in one instance, taken from elasmobranchs dissected by Zoology classes at the University. The work has been undertaken in connection with the Commonwealth Research Grant to the University. Types of new species have been deposited in the South Australian Museum. Professor Tiegs, University, Melbourne, kindly forwarded material from *Mustelus*.

SOME NEMATODES FROM AUSTRALIAN ELASMOBRANCHS

By T. Harvey Johnston and Patricia M. Mawson
University of Adelaide

[Read 12 August 1943]

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The following is a list of the parasites examined, arranged under their hosts.

Heterodontus philippi (Bloch and Schneider), Port Willunga: *Echinocephalus spinosissimus* (Linst.), **Paraleptus australis** n. sp., **Cucullanus heterodonti** n. sp., *Phlyctainophora* sp.

Mustelus antarcticus Gnthr., Victoria: **Paraleptus australis** n. sp.

Urolophus testaceus (Mull. and Henle), Sydney: **Paranisakis australis** n. sp., *Echinocephalus spinosissimus* (Linst.).

Trygonorrhina fasciata (Mull. and Henle), Port Willunga: **Proleptus trygonorrhinae** n. sp.

Cucullanus heterodonti n. sp.,
(Fig. 1-2)

The males are 18 mm. long, the females 20-30 mm. The mouth opening is dorso-ventrally elongate, its edge slightly serrated. There are three pairs of cephalic papillae. The buccal mass is ·3 mm. long by ·33 mm. wide in the male, ·4 mm. by ·4 mm. in the female, with walls about 80 μ thick at the widest part. The oesophagus is 1·6-1·76 mm. long, widening towards its base. The nerve ring is about ·52 mm. from the head; the excretory pore shortly behind this.

In the male the preanal sucker is 1·6 mm. in front of the anus, and the tail ·4 mm. long terminating in a small spike. There are nine pairs of papillae, and one median preanal papilla, arranged as in fig. 2. The spicules are massive and equal, 3·2 mm. long; the gubernaculum is about ·12 mm. long.

The female tail is ·44 mm. in length. The vulva is situated 8 mm. from the posterior end in specimen 23 mm. long; the eggs are 54 μ by 80 μ.

Proleptus trygonorrhinae n. sp
(Fig. 3-4)

From the fiddler, *Trygonorrhina fasciata*, from Port Willunga. The males are up to 32 mm., the females to 35 mm., in length. The lips are small and surrounded by an inflated collar. Each bears externally two small papillae, and internally one median tooth. The oesophagus is divided into an anterior muscular and a wider posterior glandular part, ·56 mm. and ·4 mm. long, respectively, in the male. The nerve ring lies at the base of the anterior part, the small spine-like cervical papillae at the level of the anterior border of the nerve ring, and the excretory pore at the posterior border.

The male tail is ·8 mm. long and is frequently rolled in a spiral. The caudal alae are unequal, but the four pairs of preanal and six pairs of postanal papillae are more or less symmetrically arranged. The longer spicule is needle-like, 1·2 mm. long; the shorter spatulate ·24 mm. long.

In the female the rounded tail is ·6 mm. long. The vulva is ·1 mm. in front of the anus, the uteri uniting a short distance in front of this point. The eggs are 45 μ by 32 μ.

The species differs from *Proleptus robustus* Baylis 1933, and *P. obtusus* Linst., in the relative positions of the nerve ring, cervical papillae, excretory pore, and termination of the muscular part of oesophagus, as well as in the asymmetrical nature of the caudal alae.

Paraleptus australis n. sp.,

(Fig. 6-8)

From *Heterodontus philippi* from Port Willunga, South Australia, and *Mustellus antarcticus* from Victoria.

The males are 25-30 mm. long, the females up to 45 mm. long, each carrying two large papillae externally, and internally one stout median tooth anteriorly and six pointed teeth, three on each side of the median tooth; dorsally and ventrally at the junction of the interlabia is another tooth.

The postlabial cuticle is voluminous, in most cases campanulate, in some collar-like.

The oesophagus is 4 mm. long in a young female, its anterior ·8 mm. slightly narrower than the succeeding part. The nerve ring is ·5 mm.; the excretory pore ·7 mm. from the head.

The spicules are very unequal, the longer 4·2 mm. in length, needle-like, the shorter ·4 mm., and spatulate. The caudal alae are but slightly developed, and all the caudal papillae are sessile; of these there are four pairs of preanal, three pairs immediately postanal, one pair half-way down the tail, and one pair, with double nerve endings, near the tip.

The posterior end of the female narrows suddenly after the anus, ending in a rounded tip. The vulva is 19 mm. from the posterior end in a 43 mm. long specimen, in the same specimen the vagina is 6 mm. long; there are two ovaries. The eggs are 50 μ by 32 μ.

The species differs from the only other of the genus, *P. scyllii* Wu, in the absence of caudal alae, in the number of teeth on the lips, and in the inequality of the spicules.

There seems to be some doubt as to the position of the genus *Paraleptus* Wu 1927, since it has been placed by Chitwood and Wehr (1933) as a synonym of *Abbreviata* Travassos 1920. We certainly consider that our species is distinct from *Abbreviata* on account of the position of the vulva.

Echinocephalus spinosissimus (Linst.)

(Fig. 9)

A number of specimens of this species were collected from *Heterodontus philippi* at Port Willunga, and a few from *Urolophus testaceus* from New South Wales.

The species was present in every host specimen examined, and reached a much larger size than any previously recorded, namely, the males up to 66 mm., the females to 70 mm. The external surface of each lip bears two large papillae and a small median one, the internal surface is trilobed, the middle lobe slightly smaller, and each lobe carries two longitudinal ridges of thickened cuticle. No teeth are present. The head bulb carries about forty rows of small spines. The nerve ring is just posterior to the head bulb; the cervical papillae ·2 mm., and the excretory pore ·23 mm. behind the anterior end of the body (in a young female). The oesophagus is 4·4 mm. long in a young male, 7 mm. in a large female, and the cervical sacs are about half this length.

The spicules are equal, 1·2 mm. long in a 34 mm. long male, 2 mm. in a 66 mm. male. The tail, ·7 mm. long in a young male, tapers to a rounded tip, bearing slight caudal alae about ·25 mm. long on each side at the level of the anus. There

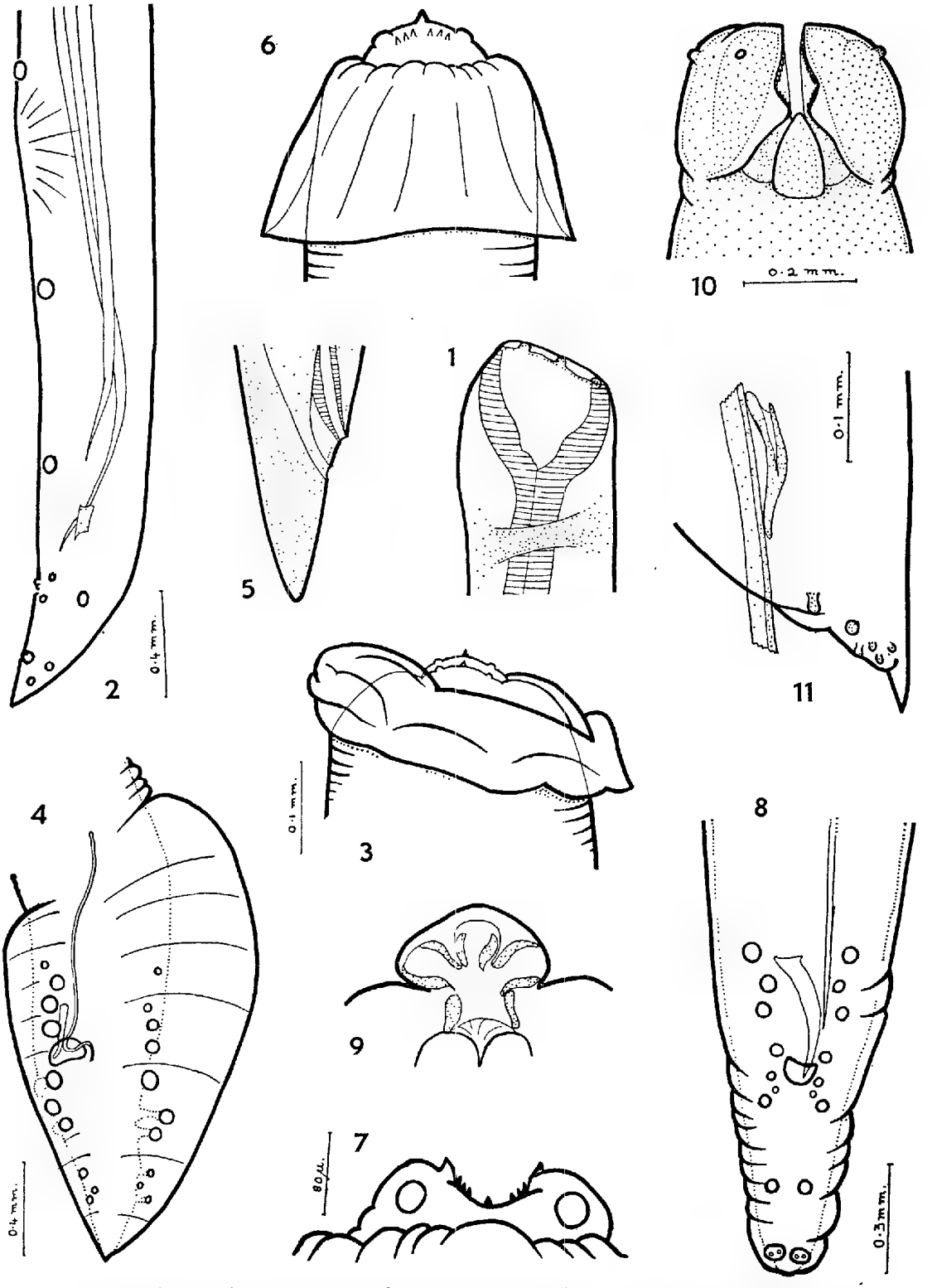

Fig. 1-2, *Cucullanus heterodonti:* 1, head; 2, male tail. Fig. 3-5, *Proleptus trygonorrhinae:* 3, head; 4, male tail; 5, female tail. Fig. 6-8, *Paraleptus australis:* 6, head, lateral view; 7, head, dorsal view; 8, male tail. Fig. 9, *Echinocephalus spinosissimus:* inside of lip. Fig. 10, 11, *Paranisakis australis:* 10, head; 11, male tail. Fig. 1, 2, 7 and 8 to same scale; fig. 3 and 5 to same scale.

are one pair of pre-alar papillae, four pairs in the alae, and two pairs posterior to the alae. In the gravid female the body scarcely tapers until reaching the level of the vulva, when it tapers suddenly to the anus (which is situated almost immediately behind the vulva), and ends in a rounded-tipped cylindrical tail ·8 mm. long. The eggs are thin-shelled, 45 μ by 27 μ.

In the presence of interlocking ridges on the median lobe of the lip, the greater size, the equal spicules and smaller number of caudal papillae in the male, our specimens differ from those described by Baylis and Lane 1920 (and re-described by Baylis 1939). The general characters of the head and oesophagus, however, indicate their identity with Linstow's species.

Philyctainophora sp.

From *Heterodontus philippi*, Port Willunga. In the course of dissection three cysts were taken from different specimens of *Heterodontus;* in each case they occurred in tissue in the pharyngeal region, either posteriorly near the Cuvierian duct or anteriorly near the hyoid arch. They were about 1·5 cm. long, and about 1 cm. or less in diameter. On careful opening no form could be followed; they appeared to be merely irregular thick-walled cysts containing a fluid, full of larval nematodes. The latter were on the average ·35 mm. long, 15 μ in diameter, the posterior end tapering to a fine point and the anterior truncated and apparently bearing a small tooth-like structure. No internal structures were observed. Apart from the fact that no structure suggestive of a female worm was observable in the cyst, the occurrence and the appearance of the larvae closely resemble those described as *P. lamnae* from a shark, *Lamna cornubica,* by Steiner (1921), and are placed in the same genus. We consider it likely that the latter should be assigned to the Philometridae.

Paranisakis australis n. sp

(Fig. 10, 11)

From the stingray, *Urolophus testaceus*, from Sydney. The intestines of about twenty-five specimens dissected were singularly free from parasites, in marked contrast with the condition in *Heterodontus*. Only about ten nematodes were obtained, and of these four were specimens of an apparently new species of *Paranisakis*, of which the description is as follows.

Male 4·5-5 cm., female 5-6 cm. long. Head wider than long. Lips each bearing a row of fine denticles on inside of anterior border and along lateral flanges. Labial papillae very small. Interlabia about half length of lips. In female length of oesophagus 3 mm.; excluding the spherical ventriculus, ·3 mm. in diameter. Nerve ring in female ·8 mm. from head; excretory pore ·88 mm.

Posterior end of male twisted in spiral; tail pointed; spicules 3·5 mm. and 2·9 mm.; gubernaculum ·25 mm. long. About six pairs of large preanal papillae and six pairs postanal, as in fig. 11.

In female 5·5 mm. long, vulva with prominent lips, 2·2 mm. from head. Eggs 36 μ by 72 μ. Tail pointed.

The species agrees very closely with *P. pastinacae* (Rud. 1819) as described by Baylis 1936, but differs from it in the greater length of the spicules.

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THE PEDOLOGY OF A SOUTH AUSTRALIAN FEN

By C. G. STEPHENS, M.Sc., A.A.C.I. [1]

Summary

In January and February 1942 a soil survey was made for the Land Board of South Australia of an area known as Eight Mile Creek Swamp, which lies adjacent to the coastline in the lower South-East of South Australia. It comprises Sections 468, 469, 470, 471 and 472 in the Hundred of MacDonnell, and Sections 589, 590 and 591 in the Hundred of Caroline. The swamp is approximately 3,500 acres in area and is the largest of a series of swamps extending to beyond Cape Northumberland about eight miles to the west, and to the Nelson River a similar distance to the east. In the vicinity of Port MacDonnell some of the smaller swamps have been reclaimed, and the soil survey of Eight Mile Creek Swamp was undertaken during the initial stages of the clearing and draining of that formation. The purpose of the present paper is to discuss the pedology of the swamp soils and to point out that the physical and chemical characteristics of the peats are very similar to those of the English fens.

THE PEDOLOGY OF A SOUTH AUSTRALIAN FEN

By C. G. Stephens, M.Sc., A.A.C.I.[1]

[Read 9 September 1943]

Plate XXVI

In January and February 1942 a soil survey was made for the Land Board of South Australia of an area known as Eight Mile Creek Swamp, which lies adjacent to the coastline in the lower South-East of South Australia. It comprises Sections 468, 469, 470, 471 and 472 in the Hundred of MacDonnell, and Sections 589, 590 and 591 in the Hundred of Caroline. The swamp is approximately 3,500 acres in area and is the largest of a series of swamps extending to beyond Cape Northumberland about eight miles to the west, and to the Nelson River a similar distance to the east. In the vicinity of Port MacDonnell some of the smaller swamps have been reclaimed, and the soil survey of Eight Mile Creek Swamp was undertaken during the initial stages of the clearing and draining of that formation. The purpose of the present paper is to discuss the pedology of the swamp soils and to point out that the physical and chemical characteristics of the peats are very similar to those of the English fens.

The swamp, like the greater part of the lower South-East of South Australia, overlies Miocene polyzoal limestone, which in the locality of the swamps appears to have been extensively faulted; for Eight Mile Creek Swamp and the other coastal swamps are characterised by lines of spring ponds which discharge several hundred million gallons of water per day. The alignment of the spring ponds along a series of eight almost parallel north-west to south-east lines suggests the presence of a series of stepped fault lines which have been planed off by erosion to their present almost common level.

In Eight Mile Creek Swamp the water from the ponds is carried by several permanent streams, of which Eight Mile Creek and Deep Creek actually discharge water naturally into the sea. The water in these streams comes from Ewen's Ponds and Deep Creek Pond respectively. Apart from two small ponds emptying by way of a small creek into Ewen's Ponds, the water from the other spring ponds is either directly absorbed by the swamp or flows a short distance as in the case of Bone and Badenoch Creeks before being absorbed. Water is also discharged into the sea by seepage and "bubblers" on the beaches.

The very wet conditions necessary for swamp formation have been caused by the partial restriction of the movement to the sea of the waters of these springs by a coastal barrier of flints and highly calcareous sand. This barrier is composed of wave terraces of flints shed from the Miocene limestone and aeolian sand partially covering these terraces and generally assuming a low ridge and swale dune topography. Dune formation is accentuated at the eastern end of the barrier. According to the level plan of the area prepared by H. L. Fisk of the Lands Department of South Australia, the swamp lies at an elevation of between four and ten feet above extreme high water mark. In general, the western two-thirds of the coastal barrier is up to ten feet above that datum, with a few higher ridges, and the eastern third of the barrier rises to heights of at least thirty feet above sea-level.

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[1] An officer of the Division of Soils of the Council for Scientific and Industrial Research stationed at the Waite Agricultural Research Institute.

The dry land on the north side of the swamp rises gently from its edge and is underlain by the Miocene limestone. In much of this area the flints shed from the limestone have accumulated in large amounts in the soil profile, and also characterise the soils of the many islands of dry land in the swamp.

Prior to the drainage of the swamp, the water table is reported to have been generally at or near the surface with much of the area under extensive sheets of water. The nature of the swamp water is revealed by analyses of samples from the creeks, drains and ponds. An analysis of water from near the outlet of the Eight Mile Creek is reported in Bulletin No. 19 of the Department of Mines of South Australia (7) and shows a total soluble salt content of 28·72 grains per gallon, 7·26 grains representing Cl and 10·15 CO_3. No reaction value is given but this is probably the best water available on the swamp. Water taken from a subsidiary eastern drain contained 83 grains of soluble salts per gallon and had a reaction of pH 7·63. Water from Deep Creek contained 74 grains per gallon and had a reaction of pH 8·09; water from the surface of a pond east of Bone Creek contained 60 grains per gallon and had a reaction of pH 7·23, and water from one of the western drains contained 82 grains per gallon and had a reaction of pH 7·74. In each case approximately half the soluble salt content was in the form of chloride.

Although much the greater part of the water of the swamp is telluric in origin and comes from the spring ponds in the swamp itself, there is, during the winter months, an influx of water from the north and north-west, where some surface drainage water enters and where there is also an inflow of water due to the rising of springs just off the edge of the swamp.

Apart from some transitional soils around the edge of the swamp and an area of highly saline brown fine fibrous peat at the eastern end of the swamp, four soil types have been named and mapped. They are as follows:

(1) Badenoch friable peat.
(2) Orwell coarse and fine fibrous peat.
(3) Milstead coarse fibrous peat.
(4) Hitchcox limey peat.

The aggregate area occupied by the swamp soils proper and the transitional soils is 3,514 acres. The areas of the individual types are shown in Table I.

TABLE I

AREAS OF SOIL TYPE; BY PLANIMETER

Soil	Area in acres
Badenoch friable peat	1,798
Orwell coarse and fine fibrous peat	644
Milstead coarse fibrous peat	683
Hitchcox limey peat	86
Brown fine fibrous peat	12
Transitional peats and peaty loams	291
Total	3,514

The distribution of these soil types and some details of the transitional and dry land soils and of the coastal barrier are shown on the accompanying map (fig. 1). The soil types are typified by distinct vegetation associations which, along with the general ecology of the swamp, are described in detail by Miss C. M. Eardley (1) in a contemporaneous paper in this journal.

The Badenoch friable peat is the most extensive soil of the swamp. It is a black humified peat. The profile of this soil type, as illustrated in fig. 2, consists of a surface soil of jet black friable and granular peat, usually with very little

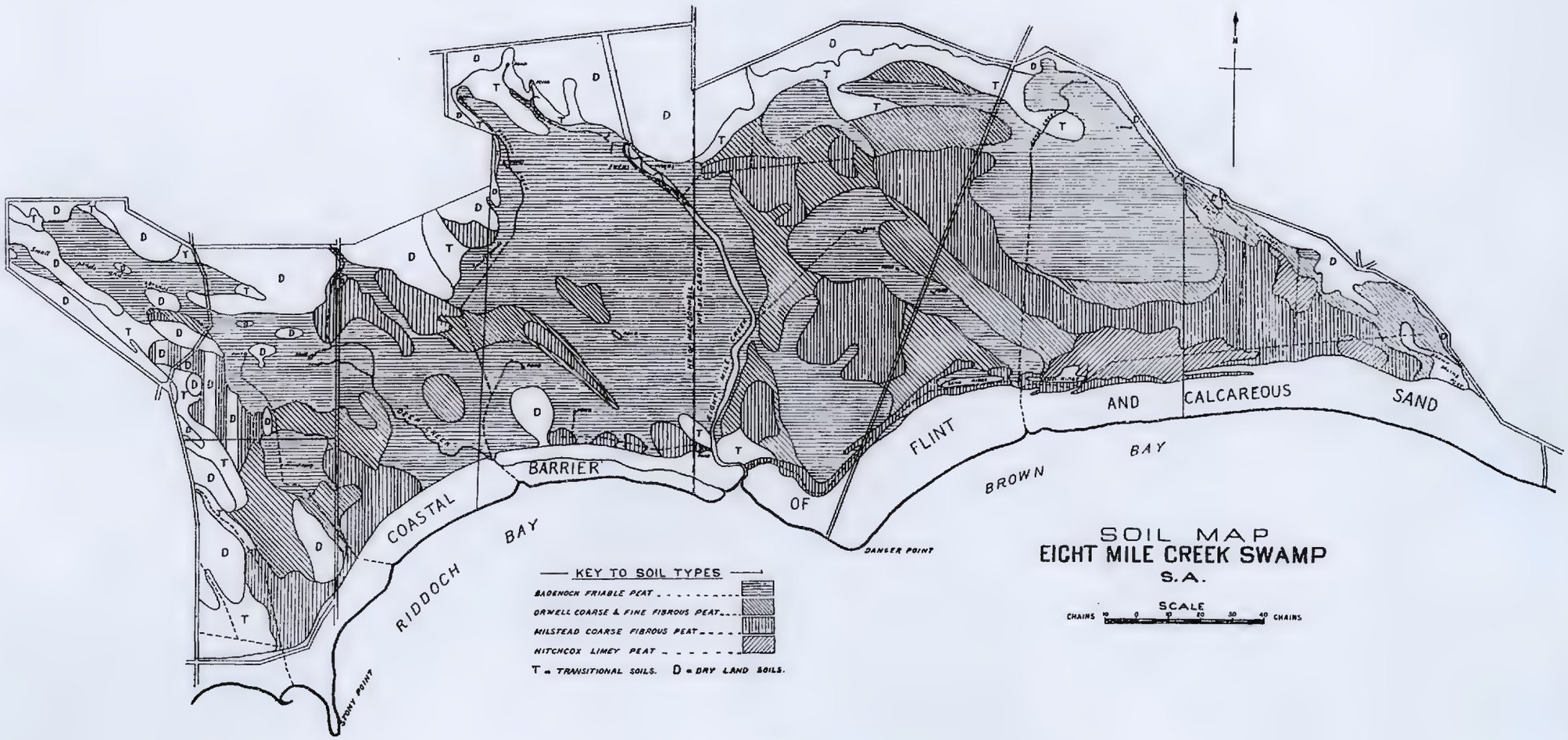

SOIL MAP
EIGHT MILE CREEK SWAMP
S.A.
SCALE
CHAINS 10 0 10 20 30 40 CHAINS
KEY TO SOIL TYPES
BADENOCH FRIABLE PEAT
ORWELL COARSE & FINE FIBROUS PEAT
MILSTEAD COARSE FIBROUS PEAT
HITCHCOX LIMEY PEAT
T = TRANSITIONAL SOILS. D = DRY LAND SOILS.
RIDDOCH BAY COASTAL BARRIER OF FLINT AND CALCAREOUS SAND
BROWN BAY
STONY POINT
DANGER POINT
DEAD CREEK
EIGHT MILE CREEK
MT. GAMBIER
MT. BURR
CAROLINE

Fig. 1

unhumified material and about 15 inches deep; beneath the surface horizon lies black fine peat to an average depth of 42 inches. These first two horizons are discernible in plate xxvi A. Deeper lies a more variable black and brown mixed coarse and fine peat to an average depth of about 66 inches. This overlies limestone or grey calcareous sand. Sometimes between this last horizon and the lime-

Fig. 2
The Badenoch peat

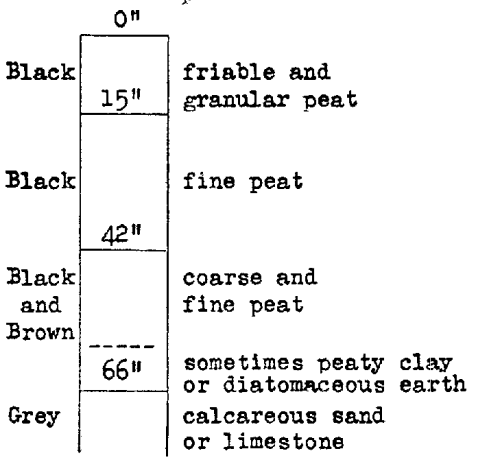


Fig. 3
The Orwell peat

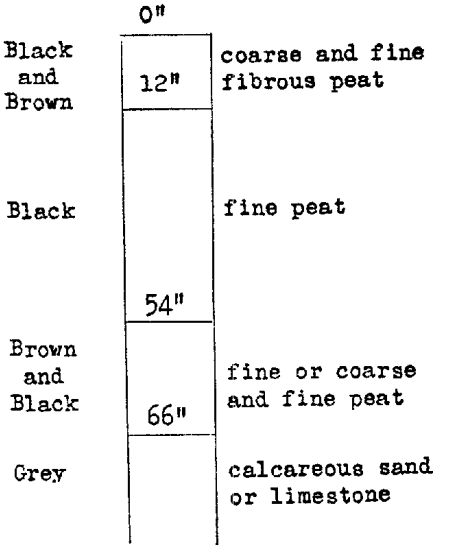


Fig. 4
The Milstead peat

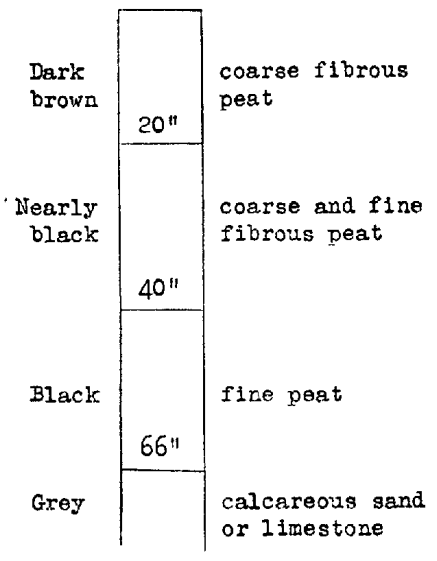
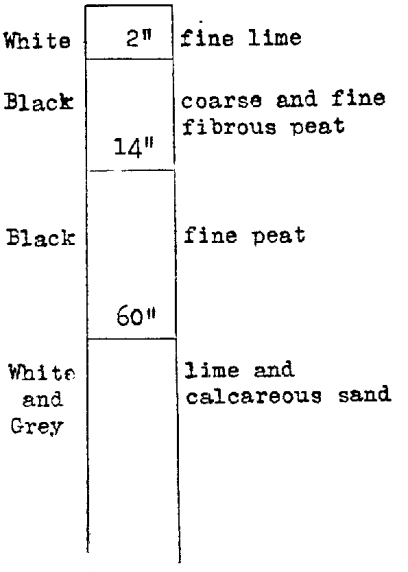


Fig. 5
The Hitchcox peat



stone there may be clayey horizons, and occasionally there is present a yellow pulpy material which bleaches on drying. This, on microscopic examination, proved to be diatomaceous earth. Genera recognised by the Zoology Department of the University of Adelaide in this material included *Navicula, Cymbella* and *Synedra.*

The soil type, which has been named the Orwell coarse and fine fibrous peat, consists of a surface soil of partly humified material about twelve inches deep. The colour is mixed black and dark brown and has a generally fibrous appearance. This overlies a black, fine peat with some roots to about 54 inches, and this in turn overlies black and brown, fine or coarse and fine peat. Beneath, at an average depth of 66 inches, lies either grey calcareous sand or limestone. The profile of this type is illustrated in fig. 3, and the two upper horizons are visible in pl. xxvi B.

The remaining extensive soil type consists of an unhumified peat. It has been named the Milstead coarse fibrous peat. The surface material, which is up to 20 inches in depth, consists of a coarse fibrous peat, dark brown in colour. This overlies about the same depth of nearly black, coarse and fine fibrous peat somewhat similar to the surface horizon of the Orwell peat. Beneath, and to an average depth of 66 inches, lies black, fine peat, and beneath this lies either grey calcareous sand or limestone. As with the Badenoch and Orwell peats, there are some subsoil variants which have peaty clay horizons on top of the limestone and occasionally flint is present, more particularly in the subsoils of the shallow phases along the northern side of the swamp. The Milstead peat is illustrated diagrammatically in fig. 4, and the upper horizons are visible in pl. xxvi C.

In the eastern portion of the swamp there occur limited areas of an unusual peat. This has been named the Hitchcox limey peat, and it is illustrated in fig. 5. The surface consists of up to six inches (average two inches) of white, fine lime, which is pulpy when wet. It appears to be largely derived from the calcareous skeletal remains of *Chara*. Under the lime lies about a foot of black coarse and fine fibrous peat, which in turn overlies black, fine peat to a depth of 60 inches. Below this again lies an horizon of fine lime and calcareous sand, and lower still grey calcareous sand. A deep example of the lime surface horizon is clearly shown in pl. xxvi D.

At the eastern end of the swamp there is an area of brown, fine fibrous peat which is both highly calcareous and saline. The surface is covered with a film of calcareous material derived from *Chara*, and the subsoil is composed of black, fine peats and peaty clays with flint gravel and resting on limestone.

All around the landward edge of the swamp there are many areas of transitional soils which are variously related to each of the Badenoch, Orwell and Milstead peats. These transitional soils are generally shallower and less organic and sometimes more calcareous than the principal soils of the swamp.

In general, interspersed in the peat soils are shells about three-quarters of an inch long of the snail, *Lenameria pectorosa* (Conrad 1850), and these undoubtedly contribute to the alkaline reaction of the peat and have possibly contributed something to the lime surface of the Hitchcox peat, for occasional shells may be found in the surface lime horizon of that soil type. However, the original organic acidity of the peat has undoubtedly been largely neutralised by the alkaline reaction of the waters issuing from the various spring ponds. Frequently, in the subsoils of the peats, there are found shells about one-tenth of an inch long of *Austropyrgus buccinoides* (Quoy and Gaimard 1834).

In Table 2 is shown the calculated composition of typical profiles of the peats, the components being expressed as organic matter, calcium carbonate, mineral matter (other than calcium carbonate and soluble salts), soluble salts and water (105° C.) in the air-dry material. In addition the composition is shown in terms of organic matter, calcium carbonate, and mineral matter as above, re-calculated to a 100% basis. These latter data have been plotted on a triangular diagram (fig. 6) which shows the composition of complete profiles from each of the principal soil types, the Badenoch, Orwell, Milstead, and Hitchcox peats. The highly organic character of these is apparent, and the minor differences such as lime and mineral

matter content are also readily seen or estimated. Mineral matter increases steadily with depth in all four peats. Table IV records all the physical and chemical data for the peat and other soil samples taken from the swamp and its vicinity.

Excluding calcium carbonate, the ratio of organic matter to mineral matter in the peats varies up to above 10 and thus closely resembles the peats of the English fens as described by Pearsall (3) and Tansley (5), who record values up to 4 for surface soils and 11·5 for subsoils. The apparent density ranges from 0·3 upwards, and generally increases with depth. The Badenoch peat is significantly denser than the Orwell, Milstead and Hitchcox peats, as is to be expected from its generally humified character. Water-holding capacity is over 600% in the Milstead peat and approximately 400% in the others. Although no determinations of swelling and shrinkage were made, it was apparent from the Keen-Raczkowski boxes used in the above determinations that these properties were of the order of 100%.

TABLE II

COMPOSITION OF PEATS FROM EIGHT MILE CREEK SWAMP, SOUTH AUSTRALIA

Soil type	Badenoch friable peat			Orwell coarse and fine fibrous peat				Milstead coarse fibrous peat				Hitchcox limey peat			
Soil number	7377	7378	7379	7380	7381	7382	7383	7373	7374	7375	7376	7350	7351	7352	7353
Depth in inches	0-14	14-58	58-90	0-12	12-50	50-66	66-84	0-14	14-28	26-63	63-84	0-6	6-15	15-60	60-80
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Organic matter	71.4	69.9	67.0	75.4	63.7	60.2	0.6	79.7	73.4	56.7	0.6	6.9	62.1	51.1	3.7
Calcium carbonate	0.0	0.0	0.0	0.0	0.0	0.0	79.0	0.0	5.2	1.4	82.2	86.9	8.6	1.0	89.4
Mineral matter	10.0	11.4	16.0	9.3	15.1	23.5	19.6	5.7	6.0	25.9	16.8	4.1	13.7	33.8	6.0
Soluble salts	1.5	0.4	0.7	0.3	0.3	0.6	0.1	0.3	0.5	0.3	0.0	0.3	0.5	0.3	0.1
Water (105° C.)	17.1	18.3	16.3	15.0	20.9	15.7	0.7	14.3	14.9	15.7	0.4	1.8	15.1	13.6	0.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Organic matter	88	86	81	89	81	72	1	93	87	67	1	7	74	59	4
Calcium carbonate	0	0	0	0	0	0	79	0	6	2	82	89	10	1	90
Mineral matter	12	14	19	11	19	28	20	7	7	31	17	4	16	40	6
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

The peats are generally neutral to alkaline in reaction with some horizons, particularly in the Badenoch peat, faintly acid in character. In this property the peats of Eight Mile Creek Swamp and the alkaline waters of the ponds and creeks closely resemble the peats and natural waters of the English fens and broads as described by Tansley (5) for the East Anglian fens, and by Godwin and Turner (2) for the waters of Calthorpe Broad. That such an unhumified, coarse, fibrous material as the Milstead peat should not be acid in reaction can only be due to its periodical inundation by the alkaline water from the spring ponds. As stated by Tansley (5) for the peats of the English fens, "The organic soil is formed by the decay of plant debris under relatively anaerobic conditions and is therefore *peat*. It is irrigated by water relatively rich in basic ions and often alkaline in reaction." In addition, the alkaline nature of the waters of Eight Mile Creek Swamp is undoubtedly primarily responsible for the abundance of the fresh-water shells and the *Chara* mentioned previously. Fresh-water shell marl occurs under much of the Cambridgeshire fen land as beds 5-10 cm. thick and lying 30-40 cm. below the surface. Wilson and Staker (8) have described peat soils of New York which contain horizons of material derived from *Chara* calcareous remains, but none of these are on the surface. Teakle (6) has described soils from Herdsman's Lake in Western Australia which contain horizons of calcareous material derived from land shell and other sources.

The total nitrogen content of the peats is very high. Phosphoric acid and potash were estimated by extraction with hot hydrochloric acid. The former is

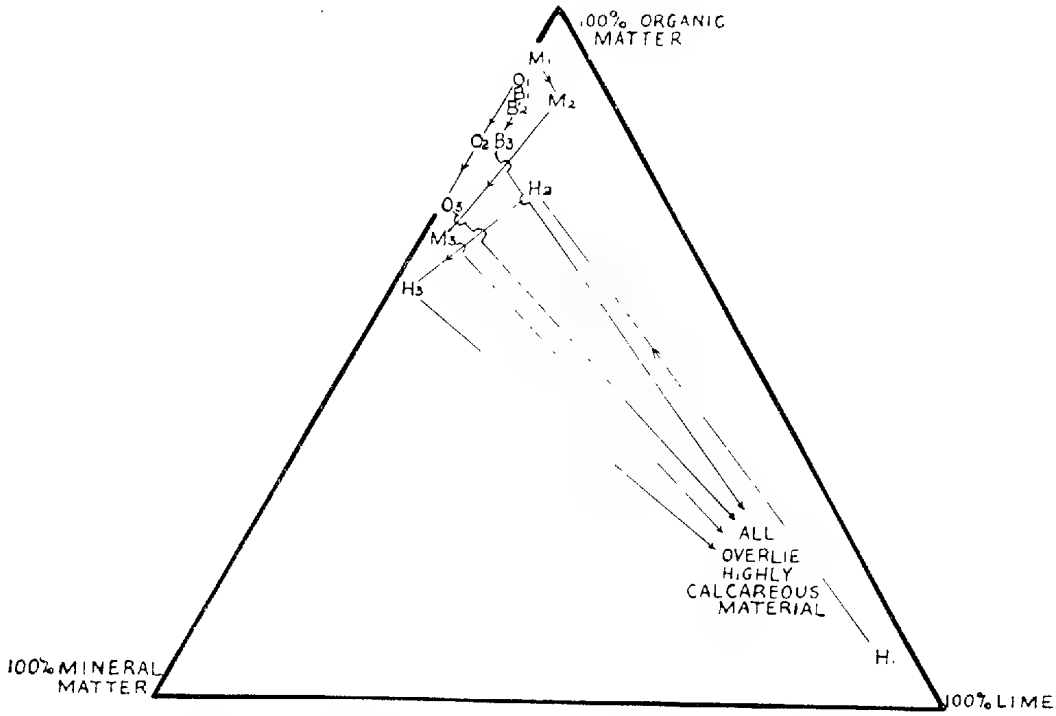


Fig. 6

Triangular diagram showing the composition of the various horizons of the Badenoch ($B_1B_2B_3$), Orwell ($O_1O_2O_3$), Milstead ($M_1M_2M_3$) and Hitchcox ($H_1H_2H_3$) peats.

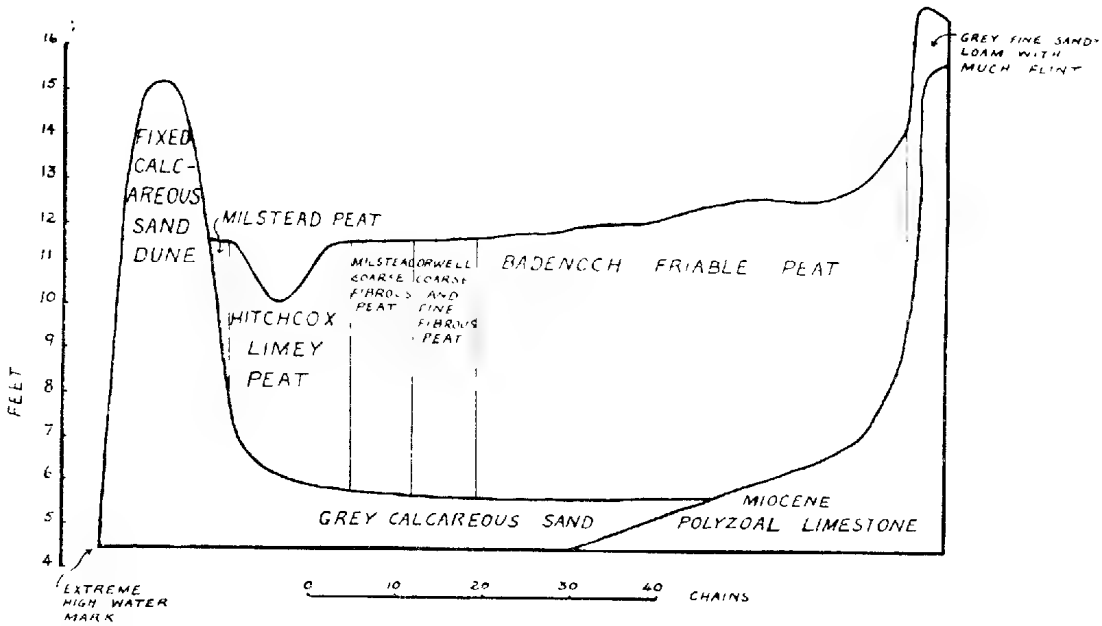


Fig. 7

Section across the eastern end of Eight Mile Creek Swamp about 20 chains east of Bone Creek. (Partly based on levels by H. L. Fisk.)

present in moderately large amounts, and the latter in what would appear to be small quantities. In this connection they resemble the highly productive peat soils of Egg Lagoon on King Island, Tasmania, as described by Stephens and Hosking (4), which soils are also high in nitrogen and phosphate.

Organic carbon, which was determined by dry combustion, accounts for over 40% of some of the peats. It seems on the average to be a little lower in the Badenoch peat than in the other named types. Carbon: nitrogen ratios are set out in Table III, and from them it is seen that the more humified character of the Badenoch peat is reflected in lower values than in the Milstead and Orwell peats.

TABLE III

CARBON : NITROGEN RATIOS

Soil	Values for surface soils		
Badenoch peat - -	17·5	17·5	15·0
Orwell peat - -	26·2	22·7	
Milstead peat - -	28·2	26·2	
Hitchcox peat - -	13·3 (lime horizon)	18·7 (upper peat horizon)	

Included in Table IV are estimations of total soluble salts and chloride radicle. At first sight some of these figures may appear somewhat high, but these estimations are on air dry soils with moisture contents up to about 20%. In the field these values will be diluted many times by the high proportion of water held in the peat. However, the salt content of the Orwell and Milstead peats may be marginal for some agricultural plants until decreased by the drainage system. The brown, fine fibrous peat is definitely highly saline.

Pot experiments on the Badenoch, Orwell and Milstead peats indicate that they may be deficient in copper, manganese, zinc and boron for optimum plant growth. Responses to phosphate and potash were also obtained.

The peat soils described above are all due to the accumulation of organic matter under the past and prevailing ecological conditions on the swamp. That there has been some variation in these conditions is indicated by the occasional presence of the horizon bearing diatomaceous material. Recent variation is reflected in the vegetation, and thus particularly in the nature of the surface horizon in the different soil types. The simplest illustration of the structure of the swamp, and of the relationship of the different peats to topographical detail, is given by a north-south section (fig. 7) through the eastern end of the swamp, some 20 chains east of Bone Creek. From this diagram can be seen the reason for the variation in the nature of the basal material on which the peats lie —either highly calcareous sand or polyzoal limestone. Also, it is apparent that the Badenoch peat has developed on the best-drained sites, with the Orwell peat intermediate between it and the lower situated Milstead peat. The Hitchcox peat, with its *Chara* lime surface is confined to definite depressions in the floor of the swamp. Other sections reveal that the Badenoch peat is not necessarily confined to the highest sites but also occurs on slopes. As would be expected from its humified character, favourable drainage rather than elevation is the determining factor.

According to Tansley (5): ". . . . the term *marsh* is applied to the 'soil-vegetation' type in which the soil is water-logged, the summer water-level being close to or conforming with the surface but not normally much above the ground level, and in which the soil has an inorganic (mineral) basis: *fen* to a corresponding type (whose vegetation is closely similar) in which the soil is organic (peat) but is somewhat or decidedly alkaline, nearly neutral or somewhat but not extremely acid. *Bog* . . . . forms peat which is extremely acid. *Swamp* is used for the type in which the normal summer level is above the soil surface." Also,

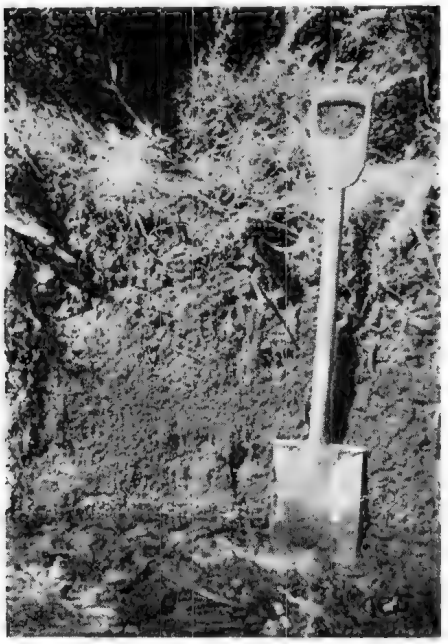
Table IV

Analytical Data on the Peats and Soils of Eight Mile Creek Swamp

Soil type	Badenoch friable peat				Badenoch friable peat			Badenoch friable peat			Badenoch friable peat				Orwell coarse and fine fibrous peat			
Soil number	7367	7368	7369	7370	7377	7378	7379	7384	7385	7386	7387	7388	7389	7390	7363	7364	7365	7366
Depth in inches	0-16	16-40	40-54	54-62	0-14	14-58	58-80	0-15	15-52	52-63	0-12	12-38	38-63	63-84	0-10	10-20	20-60	60-82
Organic carbon	-	-	-	-	40.3	41.1	40.4	34.1	-	-	32.9	41.9	42.1	16.4	39.6	-	-	-
Calcium carbonate	-	-	-	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	2.9	-	-	-
Moisture	-	-	-	-	27.1	18.3	16.3	24.3	-	-	23.3	18.6	16.1	9.3	15.0	-	-	-
Loss on ignition	-	-	-	-	73.5	69.9	67.0	60.7	-	-	58.0	70.3	70.4	28.8	73.3	-	-	-
Water holding capacity	-	-	-	-	417	267	216	-	-	-	332	265	221	522	-	-	-	-
Volume weight	0.6	0.7	0.7	1.2	0.5	0.6	0.6	0.6	0.7	0.7	0.6	0.7	0.6	0.2	0.3	0.5	0.4	0.7
Nitrogen %	1.35	-	-	-	2.30	2.30	1.59	1.95	-	-	2.19	2.18	1.72	0.99	1.51	-	-	-
% K_2O) HCl extract	-	-	-	-	-	-	-	-	-	-	0.17	-	0.12	-	-	-	-	-
% P_2O_5)	-	-	-	-	-	-	-	-	-	-	0.22	-	0.09	-	-	-	-	-
Total soluble salts	0.42	0.32	0.88	0.09	1.53	0.41	0.72	0.23	0.22	0.53	0.19	0.44	0.65	0.67	0.90	0.63	0.59	0.48
Chloride Cl'	0.10	0.10	0.13	0.01	0.31	0.09	0.09	0.07	0.07	0.09	0.04	0.17	0.22	0.11	0.35	0.23	0.23	0.11
Reaction pH	7.8	6.9	5.8	7.1	6.3	6.3	6.2	7.6	7.3	6.4	7.8	6.6	6.3	6.7	7.6	7.9	7.6	6.6

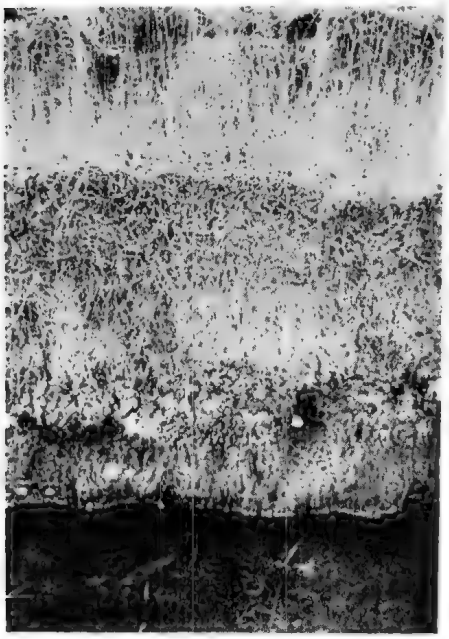
Soil type	Orwell coarse and fine fibrous peat				Milstead coarse fibrous peat					Milstead coarse fibrous peat				Hitchcox limey peat			
Soil number	7380	7381	7382	7383	7358	7359	7360	7361	7362	7373	7374	7375	7376	7350	7351	7352	7353
Depth in inches	0-12	12-50	50-66	66-84	0-10	10-18	18-42	42-58	58-80	0-14	14-26	26-63	63-84	0-6	6-15	15-60	60-80
Organic carbon	40.9	37.4	24.9	-	33.8	-	-	-	-	43.2	41.3	32.0	-	4.0	36.0	29.6	-
Calcium carbonate	0.0	0.0	0.0	77.0	2.7	-	-	-	-	0.0	8.2	1.4	62.2	86.9	8.6	1.0	89.4
Moisture	15.0	21.9	15.7	0.9	12.3	-	-	-	-	14.9	14.0	15.7	0.4	1.8	15.1	13.6	0.8
Loss on ignition	75.4	63.9	57.3	0.6	73.2	-	-	-	-	73.7	[illegible]	6.7	0.2	3.0	69.2	50.8	3.8
Water holding capacity	456	261	215	54	-	-	-	-	-	649	537	236	45	154	420	212	77
Volume weight	0.3	0.6	0.7	1.1	0.3	0.4	0.7	0.8	0.8	0.3	0.4	0.8	1.2	0.6	0.4	0.7	0.9
Nitrogen %	1.80	1.80	1.70	-	1.41	-	-	-	-	1.65	1.64	1.64	-	0.30	1.92	1.69	-
% K_2O) HCl extract	0.20	-	0.18	-	-	-	-	-	-	0.12	-	0.13	-	-	-	-	-
% P_2O_5)	0.11	-	0.15	-	-	-	-	-	-	0.06	-	0.15	-	-	-	-	-
Total soluble salts	0.27	0.28	0.60	0.10	0.69	0.61	0.26	0.11	0.06	0.25	0.46	0.32	0.05	0.26	0.52	0.45	0.10
Chloride Cl'	0.05	0.09	0.13	0.02	0.22	0.21	0.07	0.03	0.15	0.05	0.13	0.09	0.01	0.07	0.12	0.10	0.02
Reaction pH	6.9	6.8	6.5	8.5	7.6	8.0	8.2	8.6	7.7	8.4	7.6	7.5	8.8	7.9	7.6	7.1	8.4

Soil type	Shallow calcareous phase Milstead peat			Transitional peaty soil			Brown, fine, fibrous peat			Grey calcareous flinty loam				Fixed calcareous sand			
Soil number	7394	7395	7396	7391	7392	7393	7347	7348	7349	7397	7398	7399	7400	7354	7355	7356	7357
Depth in inches	0-5	5-27	27-40	0-6	6-14	14-30	0-7	7-30	30-42	0-7	7-16	16-24	24-33	0-8	8-30	30-52	52-84
Organic carbon	22.6	-	-	11.0		-	17.0	12.4	7.6	7.4	-	-	-	4.0	-	-	-
Calcium carbonate	31.0	-	-	25.5	51.1	31.1	45.5	33.2	23.3	40.2	31.4	25.0	66.1	74.4	85.7	84.8	86.5
Moisture	19.7	-	-	8.6	4.9	4.1	8.0	7.5	5.4	4.8	2.3	-	-	1.8	0.4	0.2	0.3
Loss on ignition	39.4	-	-	22.3	16.0	6.5	33.2	24.4	14.2	21.8	2.6	3.3	2.0	8.2	1.2	1.8	1.0
Water holding capacity	-	-	-	-	-	-	-	-	-	-	-	-	-	70	58	34	39
Volume weight	0.5	0.7	1.3	0.8	0.8	1.1	0.4	0.7	0.9	0.8	1.0	1.3	1.2	1.0	1.1	1.4	1.3
Nitrogen %	1.17	-	-	0.74	-	-	1.29	0.80	0.32	0.47	-	-	-	0.37	-	-	-
% K_2O) HCl extract	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% P_2O_5)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total soluble salts	1.26	0.53	0.20	0.33	0.43	0.15	4.64	0.72	0.28	0.10	0.08	0.08	0.08	0.07	0.11	0.03	0.03
Chloride Cl'	0.44	0.17	0.04	0.11	0.16	0.04	2.40	0.35	0.11	0.02	0.02	0.02	0.02	0.02	0.03	0.00	0.01
Reaction pH	7.7	7.7	7.9	8.5	8.3	8.4	7.7	8.0	8.2	8.3	8.7	8.7	8.8	8.2	9.2	9.5	9.3



A
The upper horizons of the Badenoch friable peat.

B
The upper horizons of the Orwell coarse and fine fibrous peat.



C
The upper horizons of the Milstead coarse fibrous peat.

D
The upper horizons of the Hitchcox limey peat.

"In marsh, fen and swamp the water is telluric in origin, in bog it may or may not be."

In view of the above definitions and the similarity between the waters and soils of Eight Mile Creek Swamp and the English fens, there is no doubt that it is a characteristic fen formation.

The author is indebted to Mr. H. Black, Resident Engineer of the South-Eastern Drainage Board, for maps and other facilities; to Mr. B. C. Cotton, of the South Australian Museum, for the identification of the fresh-water shells; and to the Zoology Department of the University of Adelaide, for the examination of a sample of the diatomaceous material.

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AN ECOLOGICAL STUDY OF THE VEGETATION OF EIGHT MILE CREEK SWAMP A NATURAL SOUTH AUSTRALIAN COASTAL FEN FORMATION

By CONSTANCE M. EARDLEY, B.Sc.,
Systematic Botanist, Waite Agricultural Research Institute

Summary

The vegetational study of this swamp was undertaken in February, 1942,in conjunction with a soil survey of the same area by Stephens (1943). The swamp is now being drained and cleared for settlement, and reports on the soil and vegetation were drawn up for the South Australian Lands Board. Stephens' paper (1943) on the soils appears in the current volume of this journal and is indispensably linked with the present one. The writer is indebted to Stephens for the data quoted on the physical properties of the soils and waters, also for the preliminary field work and mapping and the free use of these maps and soil profiles. Readers are referred to his paper for further necessary information on the soils and peats and for a map of the area.

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[Read 9 September 1943]

Plates XXVII to XXIX

Contents

I INTRODUCTION

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Plant determinations were made by the writer, using the resources of the Adelaide University Herbarium and Mr. J. M. Black's private herbarium; the nomenclature of the South Australian plants is that of Black's "Flora of South Australia," pt. i (2nd Ed., 1943), pts. ii-iv (1924-1929) and annual "Additions."

The synonymy of the English and American plants given is less well-known to the writer, and many standard works of reference have had to be employed, with sometimes conflicting results; the significance of this will appear in the section on "The Aquatic Zone."

The specimens collected at Eight Mile Creek are deposited in the Herbarium of the Waite Agricultural Research Institute. No systematic determinations of algae were made, and the mosses present were not of much ecological importance.

II THE SWAMP AND ITS ENVIRONMENT

Eight Mile Creek Swamp is situated in the south-eastern corner of the State, within a few miles of the Victorian border, immediately behind the littoral dunes and sands. This part of South Australia is, for the most part, fairly flat country, and contains many swampy areas over a widespread region; it is the largest well-watered area in the State, and this is only partly due to precipitation.

The rainfall is a winter one and ranges from 25-33″ in the area bounded by Millicent, Mount Gambier, Cape Northumberland and Eight Mile Creek. Figures are available for Cape Northumberland, only ten miles away, which give a sufficiently accurate picture of the climate of Eight Mile Creek. They are as set out below in Table A, and were supplied by Stephens.

TABLE A Meteorological data, Cape Northumberland

Month	Rainfall (P) in inches	Evaporation (E) calculated from relative humidity and mean temperatures	P/E
January	0·87	4·4	0·20
February	0·99	4·8	0·21
March	1·12	3·9	0·29
April	2·05	3·0	0·68
May	3·16	2·1	1·50
June	3·93	1·6	2·46
July	3·90	1·4	2·79
August	3·50	1·8	1·94
September	2·51	2·3	1·09
October	1·92	3·2	0·60
November	1·40	3·7	0·38
December	1·28	4·4	0·29
Aver. Annual Totals	26·63	36·6	0·73

Great quantities of drainage water also reach this corner of the South-East, underground, from Victorian sources. Such water is sure to have an enhanced mineral content; indeed, it largely passes through limestone country and hence is alkaline and highly calcareous. Under these conditions it is not to be expected that the oligotrophic vegetation characteristic of an ombrogenous bog of low mineral content would develop.

The raised bogs or "Hochmoor" common in Europe are examples of ombrogenous bogs. They consist usually of a dense mass of *Sphagnum* and have a convex surface; they can be formed only in areas with a high P/E ratio, being watered by rainwater alone, which is low in soluble salts. The acid peat, normally formed from decaying plants under damp conditions, is not neutralised or made alkaline by ground-water draining into the bog. Drainage water is the cause of the alkaline reaction of peats of the topogenous or fen type.

Different plants characterise these alkaline or nearly alkaline fen peats. They are eutrophic species with high mineral requirements, and *Sphagnum* is notably absent. As soon as the peat is built up above the level of the alkaline ground water,

unmodified acid peats are produced, and colonisation by oligotrophic plants, like *Sphagnum*, may take place, as Godwin and Turner (1933) have shown at Calthorpe Broad in Norfolk.

None of the peats of Eight Mile Creek Swamp is more than slightly acid—most are neutral to alkaline (pH 5·8-8·8)—and they bear a fen vegetation, including many well-known cosmopolitan, eutrophic, swamp species. No *Sphagnum* was found; it is also absent from the acid bogs of the Mount Lofty Ranges. The only record of its occurrence in South Australia is in the lower South-East area now under consideration, in a locality within 40 miles of Eight Mile Creek Swamp (Crocker and Eardley, 1939). It is interesting to note that though this *Sphagnum* occurred mainly on open swampy depressions with some rushes and sedges, on soil having a pH value of 4·3 in the surface horizon, these flats were surrounded by a dense thicket of one or both of the identical tea-tree species forming the climax association on Eight Mile Creek Swamp, and the *Sphagnum* was found even among the dense stems of this thicket. Godwin and Turner (1933) also record *Sphagnum* in a fen scrub or "carr" formation in Norfolk.

Many of the swamps in the South-East have been greatly altered by drainage, clearing and cultivation. The swamp described here, and also one or two smaller ones of the same type (but not yet examined) further along the coast to the east, are among the last to remain in a virgin state.

Eight Mile Swamp extends about five miles along the coast and no more than two miles inland. Its waters come from precipitation, surface drainage and a series of spring ponds scattered about the swamp, which run over into creeks, of which Eight Mile in the centre is the largest emptying naturally into the sea. Another creek, Deep Creek, reached the sea at the same place *via* a long meander in the coastal barrier, but has now a shorter, artificial exit. None of the other creeks reaches the sea directly, and many, like Bone Creek at the east and Badenoch Creek at the west end, simply flooded out over the swamp, probably giving an abnormally high water level in their immediate neighbourhood.

Since 1937, many drains have been made leading these blind creeks to the sea or into the two largest, and ponds have had their overflows drained in the same way. The swamp is now becoming drier, as may be seen by comparing present conditions with those recorded by H. L. Fisk's traverses of 1938-40 (South Australian Lands Department). The period between his first survey and the present one—three and a half years—is too short to show successional changes in the vegetation, except by deliberate experiments, of which there were none, and few indications of such changes were obtained. According to Fisk, the elevation of the swamp is from four to ten feet above extreme high water mark and the coastal barrier up to ten feet above it, except in the eastern third where there are sand ridges at least thirty feet above sea level.

The peat has an average depth of five or six feet (1·5-1·8 m.), and it is formed in a trough running parallel to the coastline (see Stephens, 1943, fig. 7). The landward wall and floor of the trough consist of Miocene polyzoal limestone, and the seaward wall consists of fixed calcareous dune sand, changing to grey calcareous sand under the peat, where it overlies the limestone layer.

As yet, we have little clue to the possible age of this peat deposit, and there is no detailed knowledge of post-Pleistocene climatic changes here as there is for western Europe, but see Crocker (1941). Sometimes clayey peats or diatomaceous earths occur between the lowest peat and the Miocene limestone, which suggest a period of uneven, shallow inundation. The species found in the diatomaceous earth were identified by the Zoology Department of the University of Adelaide as belonging to the genera *Navicula*, *Cymbella* and *Synedra* (v. Mahony, 1912).

Nothing was seen in the peat profiles to suggest that its formation has been discontinuous, and the depth of between five and six feet (1·5-1·8 m.) is quite comparable with peat depths in the English fens and around the Norfolk Broads. Godwin's numerous *"Studies of the post-glacial history of British vegetation"* show that the depth of the fen peats is commonly of the order of two or three metres; Wicken Fen is one of the deeper peats and has 385 cm. ($12\frac{1}{2}$ ft.) of nearly pure peat (Godwin and Clifford, pt. iii, 1940). There are rare cases of much deeper peats in the fens, but they are due to special conditions (*e.g.*, "Old Decoy," a former river bed, has peat 625 cms. deep, Godwin and Clifford, l.c.). There is an intrusive layer of clay here in the seaward part of the fens, dividing the peat into upper and lower layers (Godwin and Clifford, pt. ii, 1939). Godwin here describes a cross-country section, 17 miles long, showing that the upper peat and the fen clay beneath are continuous for that distance; the depth of the upper peat was from two to five feet. Wicken Fen is outside the range of the fen clay and has a single layer of peat approximately twice as deep (Godwin and Clifford, pt. iii, 1940).

Godwin, who has correlated climatic history, forest zones and archaeological periods from work on English peats, considers that peat formation became general in the fens in the Atlantic climatic period, during Neolithic times -say 3,500 years B.C. (Godwin and Clifford, pt. i and ii, 1939). And though it would be rash to postulate similar rates of formation for the closely similar peats of Eight Mile Creek Swamp, it is reasonable to suppose that these latter peats were formed under climatic conditions at least as warm as those of the fens, and that therefore the growth rate of the constituent plants would not have been any slower on account of the temperature factor. Water is unlikely to be a factor limiting plant growth on a swamp—it controls the type of community, but all are dense. The conclusion is that our peats have probably formed at least as quickly as the English ones, and that, therefore, the Eight Mile Creek peat is probably younger than the slightly deeper ones of the fens, *i.e.*, does not date back as far as 3,500 B.C.

The reed-swamp vegetation of Eight Mile Creek is so like that of the Norfolk Broads, even to the extent of sharing important dominant species, as will presently be shown, that one does not hesitate to compare formation rates of this type of peat in the two places, with due regard only to the varying masses of material likely to have been formed under the two kinds of climate. Both places also have similar types of fen scrub ("carr" in England, "tea-tree thicket" in South Australia), but here one must also consider the possibility of differential rates of peat formation, on the one hand by *Rhamnus* spp. or an alder-willow-birch carr, and on the other hand by the evergreen Myrtaceous genera, *Melaleuca* and *Leptospermum*, of the South Australian tea-tree thicket. This is an important point, because tea tree peat is the most plentiful type at Eight Mile Creek, and its rate of formation would be the critical one in assessing the age of the swamp. No literature has been seen dealing with relative formation rates of peats from different vegetation types, but the necessary information for such an analysis is accumulating.

Raised *Sphagnum* bogs of the ombrogenous type have usually a much deeper layer of peat than topogenous fens. They are not so well known in England, but Godwin et al. have studied a few profiles, *viz.*: (1) on the Somerset Levels by the Severn Estuary (Godwin and Clifford, pt. vi, 1941), and (2) at Tregaron in Wales (Godwin and Mitchell, 1938), which show about two metres of fen peat at the base, with three to six metres of *Sphagnum* peat above, giving a total depth of as much as 8·5 metres (about 28 ft.) at Tregaron. Godwin considers the latter peat older than that of the fens, but the deep Somerset peat roughly the same age.

Tansley (1939) reproduces two records of borings made by Osvald in raised bogs of the central limestone plain, at Athlone and Edenderry, in Ireland. In both, the upper layer of acid moss peat (*Sphagnum*) is about 4·5 metres thick, and below is a further 3·25-4·25 metres of alkaline fen and reed-swamp peat, *i.e.*, 8·75 metres (about 29 ft.) in all, even deeper than the Tregaron peat. Probably the depth of a fen peat is limited by the necessary condition of being within reach of ground water. With raised bogs there is not this limitation, and they grow higher and higher. Depths for peats of both types in Tasmania and the adjacent King Island were supplied by Stephens. They were just over 40 inches, except for a reed-swamp peat intermixed with clay, up to 65 inches deep. In South Australia, the Mount Compass acid peats probably attain a depth of eight feet in parts.

Eight Mile Creek Swamp was probably far too wet and impenetrable in the past for much human interference. Now that clearing has started, the almost solid tea-tree thicket is being rolled (pl. xxix, fig. 9), and the fallen débris is to be burnt *in situ*.

The vegetation was found to be an excellent guide in mapping the boundaries of the four important swamp-soil types. This is only logical, for they are all peats, and peats are essentially plant remains, depending for much of their individual character on the species of plant from which they are derived.

The swamp is probably a mature one, in equilibrium with the environmental conditions recently destroyed, and occurs in a region whose climatic climax is a sclerophyll forest dominated by *Eucalyptus* spp., though the surrounding country is now cleared and settled. On the seaward side, the swamp abuts normal coastal plant formations, and some mutual modifications may be detected.

III GENERAL OUTLINE OF THE VEGETATION

The vegetation of the swamp consists mainly of various tea-trees of the family Myrtaceae, with occasional Eucalypts, and a large selection of reeds, rushes and sedges. On the landward margin there are transition Eucalypt woodlands on transitional soils, also a certain amount of grassland probably subject to occasional inundation. The littoral vegetation on the seaward side has already been mentioned.

It will be shown that the Eight Mile Creek Swamp formation bears many resemblances to the alkaline fens of East Anglia in England. The most important environmental factors in swamp formations are: (1) the height of the water-table and its variations, (2) the mineral content and pH of the ground water, (3) climate, including rainfall.

The general trend of succession in fens is well established. First, the waters are gradually blocked up by the accumulation of aquatic plants which detain silt, making a suitable medium for the growth of reeds; these, in turn, build up the soil a little higher and are replaced by other plants, until finally a dry-land woodland is established. This process of "Verlandung" is usually arrested at some equilibrium point, but examples have been studied by Godwin and Turner (1933) at Calthorpe Broad; also by Pearsall (quoted by Tansley, 1939) at Esthwaite Water in the English Lake District, where progress along such lines was demonstrated by observations made at an interval of 15 years.

No such comparisons are available for Eight Mile Creek; it is expected that the gradual drainage of the area would speed up the process. The drying of the peat will naturally cause shrinkage or wastage and a sinking surface level. The drains which are always wet do not sink in this way, and, in the English fens, pumps often have to be installed to continue drainage. The course of natural succession in a fen may be seen either in time or space. It may also be seen by identifying the plant remains in the successive layers of peat.

If the terms "marsh," "fen," "bog," and "swamp" are accurately used (according to Tansley's definitions, 1939), Eight Mile Creek must be described as *swamp* and *fen* country. The points of importance for these designations are: (1) water régime, (2) amount of organic matter present, and (3) pH value of the soils.

There is strong correlation between the behaviour of the watertable at Eight Mile Creek Swamp and the different vegetation types. Godwin and Bharucha, pl. ii (1932), have demonstrated such a relationship very precisely in Wicken Fen, and conclude that the *maximum winter water level* is the controlling factor in the formation of fen scrub or "carr," which is only found on soil above winter water level. There is less information available about the water level changes in Eight Mile Creek Swamp, and they would be complicated by the recent drainage policy (but see Ward, 1941, for the seasonal fluctuation of the ground-water table in the South-East).

The swamp soils will be discussed in detail in connection with the associated vegetation, of which there are the following four main types:

(1) Dense *Tea-tree thicket*, about 14 feet high, the dominant and most widespread community on the swamp.

(2) A more open and lower *shrub* community with *low sedges* between the bushes.

(3) A *sedge meadow* (Weaver and Clements, 1929) of these same low sedges alone.

(4) Aquatic communities of *water plants*, together with *reed-swamps* marginal to the streams and ponds.

Besides these, the communities of the adjacent areas must not be neglected, they are:

(5) *Eucalypt woodland.*

(6) *Grassland.*

(7) *Littoral plants* of the more or less stabilised sands.

The first four communities form a series, and, in a normal hydrarch succession, would replace each other on decreasingly wet soils in the following order:—*aquatic communities* (4), *sedge meadow* (3), *shrub-and-sedge* (2), culminating in the *tea tree thicket* (1) of the soils mainly above flood level. Here and there a stage is skipped, and, *e.g.*, *reed-swamp* (4) and *tea-tree thicket* (1) grow in juxtaposition beside a pond. The shrub-and-sedge zone (2) is definitely intermediate in character and position between the *sedge meadow* (3) and the *tea-tree thicket* (1), growing on an intermediate type of peat and usually fringing the tea-tree thicket.

These four swamp communities and the three adjacent formations will now be described in detail. In a later section, on the probable history of the swamp, evidence is brought forward to show that succession has proceeded in the reverse direction, in comparison with the classic type of hydrosere in which "Verlandung" is taking place.

Human interference with the swamp has been small until recently. The official drainage scheme began only in 1937; rolling and burning in 1941 and 1942 respectively—the burning not until after this vegetation survey. There was certainly some burning of the margins and probably clearing of the two main creek channels before this. One such recently burnt patch had been monopolised by three very similar native bushes of the family Compositae (*Senecio lautus*, *S. orarius* and *Erechthites prenanthoides*); *Cirsium lanceolatum* (Scotch Thistle) was an alien weed also invading here and elsewhere.

IV THE IMPORTANT SWAMP COMMUNITIES DESCRIBED

(Pl. xxvii; fig. 1, 2, 3, and 4)

(a) The Aquatic Zone.[1]

(i) *Nasturtium officinale—Potamogeton pectinatus* Association.

The hydrophytes (submerged and partly submerged aquatics) of the flowing streams and still ponds are mainly freshwater plants, though some have quite a tolerance for brackish water (*e.g., Ruppia, Phragmites communis, Triglochin procera, Potamogeton pectinatus*). *Ruppia*, indeed, has been found in an evaporating salt-lake (Wood and Baas Becking, 1937).

The waters are generally calcareous and rarely saline. Representative samples of free water from various ponds, drains and creeks on the swamp gave pH values of 7·23, 7·63, 7·74 and 8·09, and the soluble salts ranged from 28·72 grains per gallon in Eight Mile Creek itself (a good domestic-purposes water) to values of 60, 74, 82 and 83 (still potable waters) in ponds and smaller creeks and drains; about half these salts were in the form of chloride (Stephens, 1943). No saline water was actually obtained for analysis, but an almost dry swamp at the east end had a decidedly saline soil; its vegetation will be considered in the next section on the sedge meadow. The soils of the reed-swamp themselves were so close to open water that their profiles were not examined, no doubt they consisted mainly of reed-peat (including *Triglochin* peat).

The dominant species was Water Cress (*Nasturtium officinale*), which occurred in great masses, as large as a rowing boat, from deep down in the water to the surface, often filling the stream. Local dominance was assumed by *Potamogeton pectinatus*, called "Water Mat." This is one of a group of closely related species of water plants which share a grass-like habit; they are practically indistinguishable when not in flower. *Ruppia maritima* and *Althenia Preissii* should undoubtedly be added to the group of "Water Mats," though rarely seen in flower in February, 1942.

The submerged aquatics were:

Nasturtium officinale.[3] Water Cress—introduced. **D**.[2]
Potamogeton pectinatus.[3] A Water Mat—very common. Local **D**.
Ruppia maritima.[3]
Althenia Preissii (now *Lepilaena Preissii*). Slender Water Mat.
Myriophyllum elatinoides. "Sheoak Weed," Water Milfoil.
Hydrocotyle vulgaris.[3] Marsh Pennywort (and half submerged).
Lilaeopsis? Not seen flowering. Large specimens in deep water—probably needs shallow water for flowering.
Characeae. "Set-net," stonewort (*Chara* or *Nitella*).
Eleocharis acuta (and half submerged).
Ranunculus rivularis? Not seen flowering.
Lemna minor.[3] Duckweed. A small surface plant in still waters.
Epilobium sp. Occasionally found quite submerged, but not flowering.
Various freshwater Algae.

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(1) J. M. Black, 1943, makes the following relevant names changes:—*Phragmites communis* Trin. becomes *Ph. vulgaris* (Lamk.) Crép.; *Althenia Preissii* (Lehm.) Graebn. becomes *Lepilaena Preissii* (Lehm.) F. v. M.; *Scirpus lacustris* L. becomes *S. validus* Vahl.; the form *Eleocharis* is adopted in place of *Heleocharis*; *Cladium rubiginosum* (Soland.) Domin, of the "Additions" reverts to *C. glomeratum* R. Br. of the First Edition; *Carex pseudo-cyperus* R. Br. not of L., becomes *C. fascicularis* Soland. ex Hook. f.

(2) **D** = "dominant," when placed beside a plant name.

(3) = spp. found in England.

TABLE B* COMPARATIVE LISTS OF AQUATIC SPECIES IN SOUTH AUSTRALIA, IN EAST ANGLIA, AND IN NORTH AMERICA

EIGHT MILE CREEK SWAMP, SOUTH AUSTRALIA	DISTRIBUTION	EAST ANGLIAN FENS AND BROADS (ENGLAND) (v. Tansley, 1939)	NORTH AMERICAN SWAMPS (v. Weaver and Clements, 1929)
REEDSWAMP		REEDSWAMP	
Phragmites communis, Common Reed D	Cosmopolitan; persists in soil above water level	*Phragmites communis* D	*Phragmites communis*, Reed Bulrush D
Typha angustifolia, Cumbungi, Bulrush D	Cosmopolitan (v. discussion)	*Typha angustifolia*, Lesser Reedmace	*Typha angustifolia*, Cat-tail
		Typha latifolia, Greater Reedmace D	*Typha latifolia*, Cat-tail D
Triglochin procera, local D	An Australian endemic sp.	Small, unimportant spp.	*T. striata* R. & P. A small, unimportant sp.; also at Eight Mile Creek
Olearia (*ramulosa* ?), local D	Australia		
Cladium Mariscus, large sedge, but not tussock habit, local D	Cosmopolitan (v. discussion)	*Cladium Mariscus*, Saw Sedge D	*Cladium jamaicense* Crantz, closely related
Scirpus lacustris (*S. lacuster* in Black's Flora —now *S. validus*)	Cosmopolitan (v. discussion)	*Scirpus lacustris* forms., Bulrush D	*Scirpus validus* Vahl., Great Bulrush D
S. americanus Pers. (= *S. pungens* Vahl. ?)	America, Australia, Europe	*S. pungens* in Jersey	*Scirpus americanus* Pers.
Sium latifolium var. *univittatum*, Water Parsnip	An Australian var. of a European type	*Sium latifolium* and *S. erectum*	*Sium* spp.
Gahnia psittacorum	Australia	Cf., similar habit of great tussock-forming sedges, *Carex paniculata* and *C. acutiformis*	
Eleocharis acuta. Also sedge meadow	Southern hemisphere	*Eleocharis palustris* R. Br. Similar habit and range	*E. palustris*, Spike Rush D } Sedge meadow
Cladium articulatum	Australia		Cf. *Cladium junceum*, in Aust. & N.Z. D
Carex pseudocyperus (now *C. fascicularis*)	Cosmopolitan (v. discussion)	*Carex pseudocyperus* and many other *C.* spp.	*Carex*, many spp. In sedge meadow
Juncus caespiticius	Australia }	Many other *Juncus* spp.	*Juncus* spp.
J. pallidus; also drier habitats	Australia }		
Urtica incisa, also in thickets, Stinging Nettle	Australian form of cosmopolitan *U. dioica*	*Urtica dioica*, also in fen carr; almost same sp. as Australian plant	*Urtica dioica*, Stinging Nettle
Polygonum serrulatum	Australia and Old World	*P. lapathifolium*, Cornwall; also Australia	*Polygonum*, sp., floating, Smartweed
Epilobium glabellum and *pallidiflorum*, some quite submerged	Australia and New Zealand	*Epilobium*, other spp., some submerged forms. Willow-herbs	*Epilobium* spp.
SUBMERGED AQUATICS		SUBMERGED AQUATICS	
Nasturtium officinale, naturalized D	Northern Europe and Asia. Widely naturalized. Native *Nasturtium* spp. occur in Australia and America also	*N. officinale*, Common Water-cress	*N. officinale*, naturalized
Potamogeton pectinatus, sub- D } Same grass-like habit	Cosmopolitan	*Potamogeton pectinatus* forma D	*Potamogeton pectinatus*
Ruppia maritima } Same grass-like habit	Cosmopolitan. Various forms exist	*Ruppia maritima*	*Ruppia maritima*
Althenia Preissii } Same grass-like habit	Australian sp. Others in W. Mediterranean		
Myriophyllum elatinoides	Australia, New Zealand, South America	*Myriophyllum*, other spp. Water Milfoil	*Myriophyllum*, other spp.
Hydrocotyle vulgaris	Australia, Europe, Africa	*H. vulgaris*. Great habitat range in fen. Sometimes D	*Hydrocotyle*, other spp.
Lemna minor, Duckweed	A cosmopolitan family	*Lemna minor* and other cosmopolitan *Lemnaceae*	*Lemna minor*
Ranunculus rivularis ? (4)	Australia, New Zealand	*Ranunculus fluitans* and *R. circinatus*	*Ranunculus* spp., (e.g., *R. aquatilis*), v. closely related to English and other S. Aust. forms
Lilacopsis (*Crantzia*) ? (4)	Australia, New Zealand, South America		
Characeae. Not studied	*Chara* and *Nitella* are cosmopolitan	*Chara*	*Chara*
Algae. Not studied	Many types are cosmopolitan	Algae	Algae

(4) Not in flower.

* Identical or closely related spp., in the two or three countries are indicated by underlining.

(ii) *Phragmites communis—Typha angustifolia* Association.

Surrounding the open water of ponds or banking that of the creeks and rapidly invading the clear channels, is the well-known *reed-swamp* formation; some of its members can grow submerged, but normally they stand well above the water surface. The dominants of the *reed-swamp* are the cosmopolitan *Phragmites communis* and *Typha angustifolia.* Important plants of the formation are:

Phragmites communis[3] (now *Ph. vulgaris*). Common Reed, Bamboo Reed. **D.**
Typha angustifolia.[3] Bulrush or Cumbungi (Australia), Reedmace (England), Cat's-tail (America). **D.**
Triglochin procera. Local **D.**
Olearia ramulosa. Water Cypress. Local **D.**
Sium latifolium var. *univittatum.*[3] Water Parsnip. Common here, but rare in South Australia.
Gahnia psittacorum. May be dominant around ponds. Parrot Sedge, Giant Sword Rush.
Eleocharis acuta.
Cladium Mariscus.[3] May be dominant around ponds. Pom-Pom Rush (Saw Sedge in England).
C. articulatum.
Scirpus americanus. Bayonet Rush.
S. lacustris[3] (*S. lacuster* in Black—now *S. validus*). Tooley Rush.
Carex pseudocyperus[3] (now *C. fascicularis*).
Juncus caespiticius.
J. pallidus. Pale Rush.
Urtica incisa. Stinging Nettle.
Polygonum serrulatum.
Epilobium glabellum } Willow Herb.
E. pallidiflorum }
Cassytha glabella (occasional).
Mentha gracilis and *Mimulus* sp. or *Mazus* sp. Small ground plants, occasional on the bank.

Many of these plants are quite at home in a drier environment than a reed-swamp, often with an altered habit of growth. The list probably does not account for all the Cyperaceae and Juncaceae to be found in this habitat, which would repay more intensive study. The striking thing about reed-swamps is the cosmopolitan nature, not only of their general appearance, but of the constituent species, many of which are identical in widely separated parts of the globe, and others merely closely-related variants. This applies also to other types of aquatic communities (Wood and Baas Becking, 1937).

Eight Mile Creek consists of swamp and fen country, obviously comparable to the English fens of East Anglia, and it will be of interest to set out the parallelism in the vegetation. Such close correspondence does not exist between land-plant formations, or even acid bogs of Australia and Europe (v. Wood and Baas Becking, 1937). Now refer to Table B, where some information on North American swamps is also included.

There are good examples of rapid spread of water plants, when introduced to new countries, which may help to explain the almost universal occurrence of the dominants in a given climatic zone, *viz.: Nasturtium officinale* (Water Cress), a European and Western Asiatic plant naturalised in America and the British Colonies; the North American *Elodea canadensis,* which spread with such spectacular rapidity in Britain in the second half of last century and is now found in most countries, often as a pest, though not yet recorded as spontaneous in South Australia; and *Eichhornia speciosa* (Water Hyacinth),

a native of Florida and South America, now a nuisance in Australia, India, etc. We believe *Phragmites* and *Typha*, etc., to be genuine natives, but something similar may have happened in the distant past; the possibility of seed transport by water-fowl may have some connection with this extensive distribution.

With species so widespread as this, one cannot avoid having doubts about their taxonomic identity, and a world-wide field and cabinet study of the species is needed, though the cosmopolitan nature of water plants is familiar from text books (Warming, 1909).

Some studies of this kind have been made on *Cladium Mariscus*, in Britain by Conway (1936-42), where it is common in certain localities only, *e.g.*, East Anglia, especially Wicken Fen; also by Blake (1943), with particular reference to forms from the Pacific region. *Cladium Mariscus* sens. lat. has a global distribution, many of the forms are now ordinarily known by other specific names and fairly well defined geographically. Blake, an Australian specialist on the Cyperaceae, is of the opinion that the Australian plant should also be considered a distinct species, as it is a further geographical form, and has published it as *C. procerum* S. T. Blake (1943). There is no doubt that these forms should be distinguished in some suitable way, but the method of giving them distinct specific names causes the ordinary worker to lose sight of the fact that this group of species exists and is much more closely interrelated than most others of the genus. In this particular case, a system of sub-specific geographical names would probably be workable. Hitherto the Australian form has been accepted as identical with the European one.

Scirpus lacustris L. is another example; the Western American form has been known as *S. validus* Vahl. for some time. Blake quotes the work of Beetle (1941 and 1942), who finds that the Australian form agrees with *S. validus* which has a circum-Pacific distribution, *S. lacustris* being restricted to Europe with a variety in Asia (Blake, 1943). Bentham and Hooker (1908) mention varieties of this species, but accept it as cosmopolitan.

Carex pseudocyperus is not now considered to include the Southern Hemisphere forms, and the Australian plant is to be known as *C. fascicularis* Boott.

Black (1943) accepts the last two changes, but not that of *Cladium Mariscus*. These problems of identity should be kept in mind when studying the comparative table of species (Table B). In the past, many of these names have been quoted as synonyms, which is not quite accurate.

Typha is also a taxonomically difficult genus, and Melvaine (1940) has published a revision of the New South Wales material, and comes to the conclusion that the Australian specimens are "not definitely identical" with the European, stressing the necessity for a good field knowledge of the habit. The present writer was not equipped with "a good field knowledge" of *Typha*, so followed Black (1st and 2nd Ed.) in naming the specimens. Black considers our *Sium* a variety of *S. latifolium*; and no critical work on *Phragmites* has been seen. *Potamogeton pectinatus* and *Ruppia maritima* are both known to have variants; these have not been studied in South Australia where water plants are relatively unimportant. There also appears to be close relationship between some of the aquatic species of *Ranunculus*.

In the other cases, the corresponding species are not quite so closely related, and for *Gahnia psittacorum* it is legitimate to make a comparison with the great tussock-forming sedges, *Carex paniculata* and *C. acutiformis*, composing the reed-swamp in some of the Norfolk Broads. Many of the

Cyperaceae run very much to type in different geographical areas. A further examination of the reed-swamp at Eight Mile Creek would probably group *G. trifida*, and perhaps *Cladium filum* (which are also large tussock sedges practically indistinguishable even when in flower) with *G. psittacorum*, both in this habitat and in drier ones.

The presence of *Olearia* (*ramulosa?*) in the reed-swamp is interesting; it is a bushy plant which often completely lines the sides of creeks and grows out into the centre, soon blocking the channel with a mass of roots in the water and leafy branches above it. This *Olearia* sp. is a small-leaved Composite and most unlike all the other members of the reed-swamp. Two *Olearia* spp. were found at Eight Mile Creek. Most species of this genus are very difficult to determine or distinguish, even when in flower.

Triglochin procera is endemic in Australia and occurs widespread in fresh and brackish waters of all the States. Small specimens have also been seen in an acid *Sphagnum* bog in South Australia. It has not a widely accepted common name, but belongs to the "Arrowgrass" genus, and is probably the largest and tallest of the genus, as the specific name indicates. The specimens found growing in the deep waters of Eight Mile Creek and its ponds are giants, with leaves long, narrow and ribbon-like, in a group growing straight up from the mud, in this case often 150-180 cm. below the surface of the water. There is a cylindrical flower-stalk in the centre bearing a dense spike of small flowers above water-level; the leaves stand out of the water and usually have their distal portions drooping over and floating on the surface. The average width of the leaves, as described in various floras, is about 1·2 cm., with a maximum of 3·2 cm. The specimens found had leaves fleshy below and up to 7·7 cm. broad, and flowering spikes 4 cm. in diameter. Intermediate sizes of *T. procera* were found, between the giants and the barely recognisable, moribund plants on the areas with a limey surface soil and saline peat. These apparently started to grow in a shallow, drying swamp and literally became stranded.

Triglochin has large, tough, fibrous rhizomes which present a great obstacle to cutting the waterways clear of vegetation. They may also form a very thick layer of plant remains, decaying, at first, as hollow tubes 2-3 cm. in diameter. Sods of such material had been cut out of Hitchcox Drain when enlarging it, and were locally called "hassocks." These rhizomes contain much starchy tissue and bear a great mass of fleshy roots below, some with tubers attached, and a coating of fibres from old leaf-bases on the upper side. The genus is cosmopolitan and not very large. Of the two British species, *T. maritima* grows in salt-marshes and has a rhizome and root system very like those of *T. procera* (Tansley, 1939). *Triglochin* spp. do not seem to be important in Britain or the United States, except for *T. maritima*, which has been recorded as an HCN-containing poison plant of damp meadows in the United States (Marsh et al., 1929). *T. maritima* is apparently a strictly coastal salt-marsh plant in Britain, and Godwin and Clifford, pl. iv (1940), found some "*Triglochin* clay" deposits among the peats of the East Anglian Fens, containing recognisable *Triglochin* remains. This was taken as evidence of the marine or tidal deposition of the clay. The Australian *T. procera* is certainly not an indicator of saline conditions.

The English "reed-grass" swamps, in which aquatic grasses like *Glyceria*, *Phalaris arundinacea* and *Molinia* are dominant, in place of the sedges and rushes, might be mentioned. Associations of this type are of doubtful occurrence in South Australia. Apart from the important dominants discussed earlier, the reed-swamps have a certain degree of geographical individuality in species and genera.

Pidgeon (1940) describes communities fairly similar to those at Eight Mile Creek Swamp for the early stages of brackish-water and freshwater-river successions in the coastal area of New South Wales.

(b) THE SEDGE MEADOW AND ITS VARIATIONS.

(Pl. xxviii; fig. 5, 6, 7 and 8)

Cladium junceum—C. glomeratum Association.

This area is generally evenly covered with a dense growth of one particular sedge, *Cladium junceum* (Blue Wire-rush), about 30-70 cm. high; sometimes with a small admixture of the almost indistinguishable *C. glomeratum* (*C. rubiginosum*) and, in places, the latter is the dominant constituent, but the meadow can properly be called a Cladietum. Weaver and Clements (1929) quote such a *sedge meadow* for North American swamps, dominated by an *Eleocharis-Carex-Juncus* complex; the Spike-rush here (*Eleocharis palustris* R. Br.) is similar in habit to our *Cladium junceum*. Pidgeon (1940) cites *C. junceum* as a dominant in one stage of brackish-water succession in the central coastal area of New South Wales, though she does not describe a pure meadow society of it; and Wood and Baas Becking (1937) record it as a peat-former in an acid bog (pH 4·0-4·5) at Mount Compass in South Australia. Tansley treats these marsh meadows under grassland, and also under reed-swamp, giving *Juncus effusus* L. as the dominant plant, with other *Juncus* spp. and sometimes *Eleocharis palustris* R. Br., as in North America.

The *sedge meadow* is the characteristic vegetation of Stephens' Milstead coarse fibrous peat soil type, the surface horizon obviously consisting mainly of the dark-brown, undecomposed mass of sedge rhizomes and roots, giving a springy surface. Lower down, the material is more decomposed, and the peat reaches a depth of 66 inches. The significance of the vertical sequence of the peat types will be discussed for all of them in the section on "The Probable History of the Swamp." The present vegetation differences are associated with the distinctive surface horizons, which alone will be given for each vegetation type (see fig. 2).

For the most part there are no other plants of importance in this very uniform *sedge meadow* (pl. xxviii; fig. 5 and 8), but there are three modifications of the main soil type to be described in due course.

The unmodified *sedge meadow* probably has the soil water-logged for a large portion of the year. The varying requirements of the alternative dominants have not been studied, though the indications are that *C. glomeratum* favours the low-lying areas with the lime surface, but it was also found in the *Gahnia*-tussock sedge meadow. One or other of them is so overwhelmingly important that further plants present are only incidental. The list (including modified areas) is as follows:

Cladium junceum } either one of these is **D**.
C. glomeratum (formerly *C. rubiginosum*) }
Agrostis Billardieri, a Blown Grass.
Agrostis sp.
Chara (or *Nitella*). Local **D**.
Chenopodium ambiguum.
Epilobium sp.
Funaria, moss.
Gahnia trifida, Cutting "Grass"; with similar large tussock sedges not in flower. Local **D**.
Eleocharis acuta.
Juncus maritimus var. *australiensis*.

Lobelia anceps.
Luzula campestris.
Muehlenbeckia adpressa, a coastal species.
Olearia ramulosa.
Samolus repens.
Scirpus nodosus.
Selliera radicans, a very widespread ground plant in swamp communities.
Senecio sp. or *Erechthites,* closely resembling each other.
S. lautus.
Spiranthes australis Lindl. Swamp Orchid. (*S. sinensis* (Pers.) Ames in Black, 2nd Ed.).
Triglochin procera. Local **D.**
T. striata, a small plant.
Urtica incisa, Stinging Nettle.

At the east end of the swamp, where the *sedge meadow* meets the sand-hills, is a small *Cladium Mariscus* society, whose habitat requirements are not understood, forming a thicket about 130 cm. high, with *Urtica incisa* all through it. Some *Agrostis* spp. and *Poa* spp. permeated most of the communities like a light web.

The first of the modifications is associated with the Hitchcox limey peat soil type (fig. 2), which is characterised by a surface layer of lime from two to six inches thick, overlying a coarse and fine fibrous peat. It seems very likely that some of this surface layer has been formed from the green algal freshwater plant, *Chara,* whose structure could still be detected in the snow-white incrustation covering some bare patches in the *sedge meadow* (pl. xxviii, fig. 6), or even on the ground between the sedges (pl. xxviii, fig. 5). *Chara* must grow submerged in water, and it is common in the South-East, to see it dried white and brittle in belts, like a layer of salt, around a receding pond or shallow swamp where the growth has been dense.

Green water-plants of many kinds can cause calcium or other cations to be deposited, usually on their surfaces, from a solution rich in bicarbonate, as they extract CO_2 from the water during photosynthesis, causing precipitation of the carbonate. Still waters are more suitable for this deposition than those of turbid streams. There are also bacteria which behave in the same way. *Chara* limestones are well known (for a South Australian occurrence v. Howchin, 1909), but their rate of formation must be slow; it has been calculated as one foot in about 2,500 years in Green Lake, Wisconsin (quoted by Twenhofel, 1932). *Chara,* as a rule, is found only in hard waters. Some of these calcareous surfaces of the Hitchcox limey peat contained the shells of small water-animals, which must also play a part in their formation. It would only be necessary to have frequent or constant flooding, in this region of alkaline waters, to get the right conditions for the deposit of calcareous matter such as this in an open area; consequently it is concluded that this soil type was formed under wetter conditions than those of the normal *sedge meadow.* These patches were dry in February 1942—a new state of affairs, probably due to the draining.

The second modification also occurs in this zone of wet soils with a limey surface; it is characterised by a spongy, brown, fine fibrous peat of a saline type. The limey surface was in the form of still-recognisable *Chara* remains, and there were a great many dwarfed dead plants of *Triglochin procera* here; the fibre-coated rhizomes of *Triglochin* have already been mentioned, and it is believed that this area has been under deep water, with what Fisk, in his survey of August, 1939, described as "a kind of water-lily or hyacinth" growing in "soupy" mud. This plant was *T. procera,* and it is suggested that the

decay of the thick growth of rhizomes and fibrous leaf-bases has produced this fine fibrous peat. In February, 1942, at the time of the vegetation survey, it had become just dry enough to walk on. The death of the *Triglochin* plants may simply have been due to drying or also to the effect of the accompanying rise in salt concentration. It is essentially a water plant.

The third modification is the type of *sedge meadow* dotted with numerous big tussock sedges of a Cutting Grass (*Gahnia trifida*) 1·3-1·5 m. high (pl. xxviii, fig. 7), and it is found on the *shallower* peats of the Milstead coarse fibrous variety and other types. In appearance it resembles the *shrub-and-sedge* community to be described later. Some of the non-flowering tussocks were suspected of being the closely similar *Cladium filum*, but its presence at Eight Mile Creek was never confirmed by fruiting specimens.

The *Chara* phase and the *Triglochin* phase occur (usually in the Cladietum glomerati) at the eastern end of the swamp, which received the floodwaters from Bone Creek before it was connected by a drain to the sea. The *Gahnia*-tussock *sedge meadow* is on obviously drier areas, mainly on the landward side of the swamp, and at times the low sedge gives way to grass sward between the *Gahnia trifida* clumps. This community is probably not one of the stages in the normal swamp succession. Moreover, it is within reach of the fires known to have been put in from the edge, for many years past, by leaseholders desiring to penetrate the swamp property and make use of what pasture was available. Sometimes small, open, dried-up winter swamps were seen here with the remains of either *Chara* or *Ruppia maritima*.

(c) The Tea-tree Thicket and included "Islands."

(Pl. xxix, fig. 9)

Leptospermum pubescens—Melaleuca squarrosa Association.

The *Tea-tree thicket* is the climax vegetation (under the swamp conditions) and covers a greater area than the other types (v. Stephens, fig. 1). It consists almost solely of two shrubs of practically identical habit and very even in height (about 4·5 m. or 15 ft.). They form a closed community so dense that one can hardly force a way between the thin, unbranched, vertical, woody stems; and there is little room or sufficient light for the growth of smaller plants in the thicket, or even for leaves on the two dominants, except at the top of the plants which have a continuous, nearly level canopy of foliage, broken occasionally by twigs of the larger-leaved Swamp Gum (*Eucalyptus ovata*).

The raw material of the *Tea-tree thicket* peat is the woody stems and small leaves of the two dominants. Apparently they are not very fibrous and decompose fairly quickly into a good, humified, fine black friable peat—the Badenoch friable peat—with which the *Tea-tree thicket* is constantly associated. This soil type is the best on the swamp and gives quite definite acid reactions in some of the horizons, the range being pH 5·8-7·8; the pH value falls regularly with increasing depth of peat. There is the suggestion of such a tendency in the related Orwell coarse and fine fibrous peat, but in the other types (uncomplicated by the presence of lime) there is only one pH value on the acid side of neutrality, and that occurs in the surface horizon of the Milstead coarse fibrous peat (sedge meadow). Any of these peats which have an acid reaction are probably not much exposed to the calcareous ground-water and, for other reasons also, it is assumed that the *Tea-tree thicket* grows on thoroughly well-drained soils only (v. fig. 1). The cause of the increase in acidity with depth of the peat may be connected with increasing humification (*i.e.*, an acid-producing process).

It is uncertain whether the stemmy habit of the *Tea-tree thicket* is due to the presence of a very thick crop of plants or whether each plant stools freely from the base. The latter is the case in the similar Rhamnetum at Wicken Fen near Cambridge (Godwin and Bharucha, pt. iii, 1936). In England a fen scrub of this type is called "carr"; at Wicken this carr is almost a pure community of two species of *Rhamnus*, the more important one being the Alder Buckthorn, *Rhamnus Frangula* L. (= *Frangula alnus* Miller). A more usual type of carr is that dominated by deciduous trees of the *Alnus* (Alder), *Salix* (Willow) and *Betula* (Birch) type, eventually changing over to woodland with *Quercus* (Oak), etc. (as at Calthorpe Broad, Godwin and Turner, 1933).

An analogous formation is described for hydroseres in North America by Weaver and Clements (1929) dominated by *Alnus*, *Salix* and *Populus* (Poplar). In our opinion, the *Tea-tree thicket* at Eight Mile Creek corresponds more closely with the Rhamnetum at Wicken than with the *Alnus-Salix-Betula* type of fen carr. The earlier comparison between the reed-swamp formations in South Australia and in the Fens and Broads of East Anglia revealed that the facies and the dominant species were practically the same. In this case there is no identity of dominant species, but still a similarity of facies; the two dominant species at Eight Mile Creek are evergreens of the family Myrtaceae, with particularly Australian affinities.

The occasional presence of *Eucalyptus ovata*, one of the dominants of the surrounding sclerophyll woodland, is clearly parallel to the occurrence of ordinary English woodland trees in carr, and illustrates the divergence of species between the two geographical regions the further one goes from the aquatic vegetation.

In the Tea-tree zone there are occasional small rises, the larger ones bear definite Eucalypt woodland (*e.g.*, "Timber Island"), and the smaller ones have *E. ovata* (White Swamp Gum) as the dominant. The two *Tea-tree thicket* species are relatively unimportant, the vegetation is more open, and the list of accompanying species obviously belongs to the Eucalypt woodland formation. These small patches, moreover, are associated with the fine, grey, sandy loam and flinty loam soil types common on the margins of the swamp, which will be dealt with later, and are no doubt relict areas as yet uninfluenced by the normally increasing swampiness of Eight Mile Creek. The present drainage policy (apart from clearing) would have ensured the survival of these islands. It would also, on theoretical grounds, have favoured the invasion by *Tea-tree thicket* of the shrub-and-sedge community, and finally the sedge meadow.

At present the swamp is being cleared for cultivation; the ordinary tractor-drawn scrub-roller is being used to smash down the *Tea-tree thicket* and leaves behind it an almost solid layer of prostrate, woody stems about two feet (60 cm.) deep. It is fairly easy to walk on this, and where re-growth has started, the normally repressed associated plants become frequent; the dominant Tea-trees sprout again also. This formidable layer of débris is eventually burnt. The list of associated plants is given below, together with that for the "islands" of Eucalypt woodland. The big sedges, *Gahnia* (two species) and *Cladium Mariscus*, are fairly common in the thicket, but cannot often attain their tussock or clump habit in such crowded conditions.

Tea-tree thicket:

Leptospermum pubescens. Silky Tea-tree (known earlier as *L. lanigerum*). **D.**
Melaleuca squarrosa. Bottle-brush Tea-tree. **D.**
Acacia myrtifolia.

Billardiera cymosa.
Cassytha pubescens.
Cladium Mariscus (base of stems long and scaly with leaf remains).
Correa sp.

Cyperaceae—various:
Eucalyptus ovata. Not dominant here.
Gahnia psittacorum. Not in the usual tussock form, constantly associated.
G. trifida. Not as a tussock.
Imperata cylindrica. Blady Grass (*I. cylindrica* var. *major* in Black, 1943.)
Leucopogon australis.
Muehlenbeckia adpressa.
Olearia glandulosa and *O. ramulosa.*
Phragmites communis. Ubiquitous in the swamp.
Pimelea macrostegia or *P. ligustrina* (not in flower).
Poa caespitosa. Hair-like grass permeating ground layer of 30 cm.
Pultenaea stricta.
Rubus parvifolius.
Senecio (*lautus* ?).
Sprengelia incarnata.
Swainsona lessertiifolia, scrambling on other plants.
Typha angustifolia. Marginal, next to Cladietum.

Eucalypt "Island (c.f. Eucalypt Woodland list):
Eucalyptus ovata, White Swamp Gum. **D.**
Leptospermum scoparium. A Tea-tree; sub-**D.**
L. pubescens
Melaleuca squarrosa } Not dominant here.
Exocarpus cupressiformis.
Imperata cylindrica. Blady Grass (= *I. cylindrica* var. *major,* in Black, 1943).
Helichrysum ferrugineum.
Pimelea glauca.
Olearia glandulosa.
Pteridium aquilinum. Bracken.
Correa sp., not in flower.

(d) The Shrub-and-Sedge Community.

(Pl. xxviii, fig. 8)

Leptospermum pubescens—Cladium junceum Ecotone.

This is a reasonably open shrub community 90-120 cm. (3-4 ft.) high, with the low sedge dominants of the sedge meadow in the spaces. Its intermediate nature between sedge meadow and Tea-tree thicket has been mentioned before, and the soil is the partly humified, intermediate type, Orwell coarse and fine fibrous peat, which has less of the coarse material produced by the sedges on the surface of the sedge meadow and a proportion of the fine black Tea-tree peat.

The dominant shrubs are dwarf *Leptospermum pubescens,* Silky Tea-tree (formerly known as *L. lanigerum* in South Australia) and *Melaleuca squarrosa,* Bottle-brush Tea-tree, the same two which form the Tea-tree thicket. These two do not crowd out other shrubs here, as in the Tea-tree thicket, and those most commonly present are further types of Tea-trees and large tussock sedges, together with quite a variety of plants not suited to very swampy conditions. Among these may be seen young White Swamp Gum trees (*Eucalyptus ovata*), which is probably unable to establish itself on the wetter phases. Some patches of unusually tall and dense *shrub-and-sedge*

vegetation were seen, which gave the impression of Tea-tree thicket in the course of development. The list of other plants present is given below.

Shrubs:

Leptospermum pubescens. **D.**
Melaleuca squarrosa. **D.**
M. gibbosa.
Leucopogon australis (probably not the almost indistinguishable coastal sp., *L. parviflorus*).
Gahnia trifida } Large tussock sedges.
G. psittacorum }
Leptospermum scoparium. A tea-tree.
Olearia ramulosa.

Undergrowth:

Cladium junceum } Continuous ground cover.
Poa caespitosa }
Leptocarpus Brownii } In the *Cladium* stratum.
Juncus maritimus var. *australiensis* }
Agrostis Billardieri. Common.
Samolus repens.
Villarsia sp.

Other Plants which may be present are:

Acacia myrtifolia. A shrub.
Cassytha pubescens.
C. glabella.
Eucalyptus ovata. Young plants, White Swamp Gum.
Hakea nodosa. A shrub.
Logania ovata. A shrub.
Muehlenbeckia adpressa.
Phragmites communis. Found in many communities.
Sprengelia incarnata. A swamp plant, rare at Eight Mile Creek.
Typha angustifolia.

The actual swamp communities have all now been described, and a plant notably absent is the broom-like shrub, *Viminaria denudata,* so constant a member of the swamps of the large Fleurieu Peninsula region, south of Adelaide, and other parts of the State, including the South-East. There is clearly something unsuitable to *Viminaria* in this environment, perhaps the high soil pH value.

V ADJACENT AREAS

(e) Eucalypt Woodland

(Pl. xxix, fig. 10 and 11)

Eucalyptus vitrea—E. ovata Association.

This woodland or scrub is found around the landward borders of the swamp on grey loam or grey fine sandy loam soils containing more or less flint, and also on transitional shallow peats, peaty loams and the few brown loam soils. In the case of the peaty soils, the Eucalypt woodland is liable to include clumps of typical Tea-tree thicket on peat.

The islands of grey, sandy loam, bearing *Eucalyptus ovata* and scrub, which occur in the Tea-tree thicket, have already been described, and are, like the clumps of Tea-tree in the woodland just mentioned, a good demonstration of the relationship of *Eucalypt woodland* and Tea-tree thicket. *Eucalypt woodland* occurs on drier soil with much less organic matter than that of the Tea-tree thicket, which, of course, is a swamp peat.

There are only two important Eucalypts, *E. ovata,* the Swamp Gum, a pale-barked, smooth-branched tree, and *E. vitrea,* with a dark-brown, fibrous bark on trunk and limbs. *E. ovata* is also found on the swamp, but not *E. vitrea,* which is uncommon in South Australia and restricted to the South-East.

The trees are 6-12 m. (20-40 ft.) high, with shrubs and smaller plants forming an undergrowth of varying density. The plants in the Eucalypt woodland are given below—some clearly belong to the swamp communities.

Eucalyptus vitrea. **D.**
E. ovata. **D.**
Acacia melanoxylon. Blackwood, tree as tall as the Eucalypts. T.
A. pycnantha (a society probably due to burning). S.
Acaena Sanguisorbae. Bidgee-widgee.
Agrostis Billardieri.
Astroloma humifusum and other Epacrids.
Banksia ornata. S.
Bursaria spinosa. S.
Cassytha pubescens or *C. glabella* on tea-tree.
Casuarina stricta. 9 m. (30 ft.) high. Drooping Sheoak. T.
Cladium or *Gahnia.* Not in flower. S.
Dipodium punctatum. Hyacinth Orchid.
Epilobium pallidiflorum.
Exocarpus cupressiformis. Native Cherry. S or T.
Gahnia trifida. A Cutting Grass. S.
Hakea nodosa. S.
Helichrysum ferrugineum. S.
Hydrocotyle sp.
Imperata cylindrica. Blady Grass.
Leptospermum scoparium. Tea-tree. S.
L. pubescens. Silky Tea-tree. S.
Leucopogon australis, and perhaps *L. parviflorus,* the coastal species. S.
Loranthus pendulus. Mistletoe on Eucalypts and Acacia.
Muehlenbeckia adpressa.
Pelargonium australe.
Poa caespitosa. A hair-like, all-pervading grass.
Pteridium aquilinum. Bracken, common.
Scirpus nodosus.
Selliera radicans.

S = shrub, except small prostrate ones. T = tree.

(f) GRASSLAND (Pl. xxix; fig. 10, 11)

The *grasslands* occur on grey sandy loams with flint similar to those carrying Eucalypt woodland; the small amount of black clay soil in the swamp also carries grass. There is undoubtedly some natural grassland—for example, an area of grass beset with *Gahnia trifida* tussocks, 1-1·5 m. (up to 5 ft.) high; also the open, half-bare, grassy flats in the Eucalypt woodland; but some of the grassland is probably due to the clearing of the scrub. The grassland is marginal, occuring alternatively to the woodland; the reason for the presence of grassland rather than woodland is often clearly due to the shallowness of the soil or to occasional inundation.

The turf was composed mainly of *Themeda* sp. (Kangaroo Grass), *Danthonia* sp. (Wallaby Grass), *Agrostis* sp. and *Selliera radicans* (not a grass, but a common, small, creeping swamp plant), with perhaps very low sedges of the sedge meadow, some *Acaena Sanguisorbae* (Bidgee-widgee Burr) and the invading weed, *Cirsium lanceolatum* (Scotch Thistle), which

establishes itself wherever possible in the swamp. There would be more annual species of grasses in spring and early summer.

(g) LITTORAL (Pl. xxix, fig. 12)

Leucopogon parviflorus Association.

The coastal sands are calcareous, and, in places, flinty. At the east end of the swamp there are high dunes of unstabilised sand, but elsewhere the sands are fairly level, fixed, and slightly elevated above the beach. The vegetation is of the type common to such coastal situations in South Australia (Wood, 1937).

The most important plant is the shrub *Leucopogon parviflorus* (a plant with small, white, edible berries), found on both fixed sands and dunes. We believe it is generally replaced on the swamp by *L. australis*, but the two species are far too alike to be very sure.

The dunes have a less varied selection of the plants found on the fixed sands, together with a few characteristic ones, like the grey cushion-bush (*Calocephalus Brownii*) and the pioneer sand-binding grass *Spinifex hirsutus*. On the fixed sands, the sedge, *Scirpus nodosus*, is an important sand-binder, like the Sword Rush (*Lepidosperma gladiatum*). The associated sward-forming grasses, *Distichlis spicata* and *Sporobolus virginicus*, are also important surface stabilisers, and there are other small shrubs and tussock grasses.

Prior to 1937, Deep Creek had a meandering exit, passing through these coastal sands for some distance. A short, new channel to the sea has now been cut, but the old course remains, and in it grows much vegetation related to creeks rather than sands. Similarly there is an area with swampy swales of tall Tea-tree alternating with sandy rises. Probably the sands tend to invade the swamp in such places.

The lists of plants are as follows:

Dunes:

Leucopogon parviflorus. **D.**
Calocephalus Brownii. **D.**
Carpobrotus aequilaterus (Haw.) N.E. Br. (= *Mesembrianthemum aequilaterale* Haw.), Pigface.
Lotus australis.
Olearia sp. (not in flower — *O. axillaris* ??).
Pelargonium australe.
Pimelea serpyllifolia.
Poa caespitosa var. *Billardieri*. A maritime tussock grass with almost pungent leaves.
Polypogon monspeliensis.
Rhagodia baccata. Coastal saltbush.
Scirpus nodosus. An important dune sedge.
Sonchus megalocarpus. Native coastal Sow-thistle.
Spinifex hirsutus. Important sand stabiliser.
Swainsona lessertiifolia. Scrambling plant.
Tetragonia implexicoma. Coastal climbing spinach.

Fixed Sands:

Leucopogon parviflorus. **D.**
Scirpus nodosus. Sub-**D.**
Acaena Sanguisorbae.
Agrostis sp.
Anagallis arvensis.

Apium australe. Sea Celery.
Cakile maritima var. *edentula.* A strand plant.
Carpobrotus aequilaterus (= *Mesembrianthemum*).
Cladium junceum (sedge meadow plant).
Dichondra repens.
Distichlis spicata } Associated sward-forming grasses.
Sporobolus virginicus }
Hydrocotyle hirta. Probably a swamp plant.
Lagurus ovatus. Common coastal grass.
Lepidosperma gladiatum. Sword Rush, common.
Muehlenbeckia adpressa.
Pelargonium australe.
Pimelea serpyllifolia. A coastal shrub.
P. sp., annual.
Poa caespitosa var. *Billardieri.*
Polypogon maritimus.
Salicornia (not in flower).
Samolus repens.
Scaevola microcarpa or *pallida* (not in flower).
Senecio lautus. Sometimes also a strand plant.
Solanum aviculare (rare).
Sonchus megalocarpus.
Sporobolus virginicus.
Stipa teretifolia. A coastal grass.
Swainsona lessertiifolia.
Sward-forming grass (not in flower).

VI THE WATER TABLE AND THE PLANT ASSOCIATIONS

The Lands Department surveys in connection with drainage plans of this area were made by Fisk in 1938-1940; there had been an earlier, not very detailed survey. Most of Fisk's water-levels were recorded in the months of June, July and October, and the ground-water levels in the South-East are known to be generally highest in August-September and lowest in April (Ward, 1941), so that Fisk's levels must be near the maximum for the season. The fall in water-level due to drainage could hardly have been very great at the time of his surveys.

Eight S.-N. contour sections were drawn across the swamp at intervals, from end to end, using Fisk's levels and water-level data, and indicating the vegetation types (two are reproduced in fig. 1). In none of these sections is the water level anywhere more than 22 cm. ($8\frac{1}{2}$ in) above natural surface level in the Tea-tree thicket (October 1938), and, for the most part, so far below this that the Tea-tree thicket soils can seldom have free water above them. All the other swamp communities show water at inundation levels in these sections, though the shrub-and-sedge community on the Orwell coarse and fine fibrous peat is seen to occur both in submerged and in fairly dry places. The water-level in the swamp has been a rising one, historically speaking, and these small parts of the Tea-tree thicket now subject to inundation may have grown up under drier conditions and might eventually succumb to this encroaching winter flood if at all prolonged.

The Cladietum on the Hitchcox limey peat, with its *Chara* and *Triglochin* patches, is submerged longer than any of the other vegetation types, except the reed-swamp—probably all the year round in most seasons. That it was seen dry in February, 1942, can only be due to the successful drainage. The Hitchcox limey peat and the brown, fine fibrous peat are soil types certainly formed under these conditions of flooding, and can be expected to change to some degree if the flooding stops.

TWO S.-N. SECTIONS OF THE SWAMP SHOWING TOPOGRAPHY, VEGETATION AND WATER LEVELS.

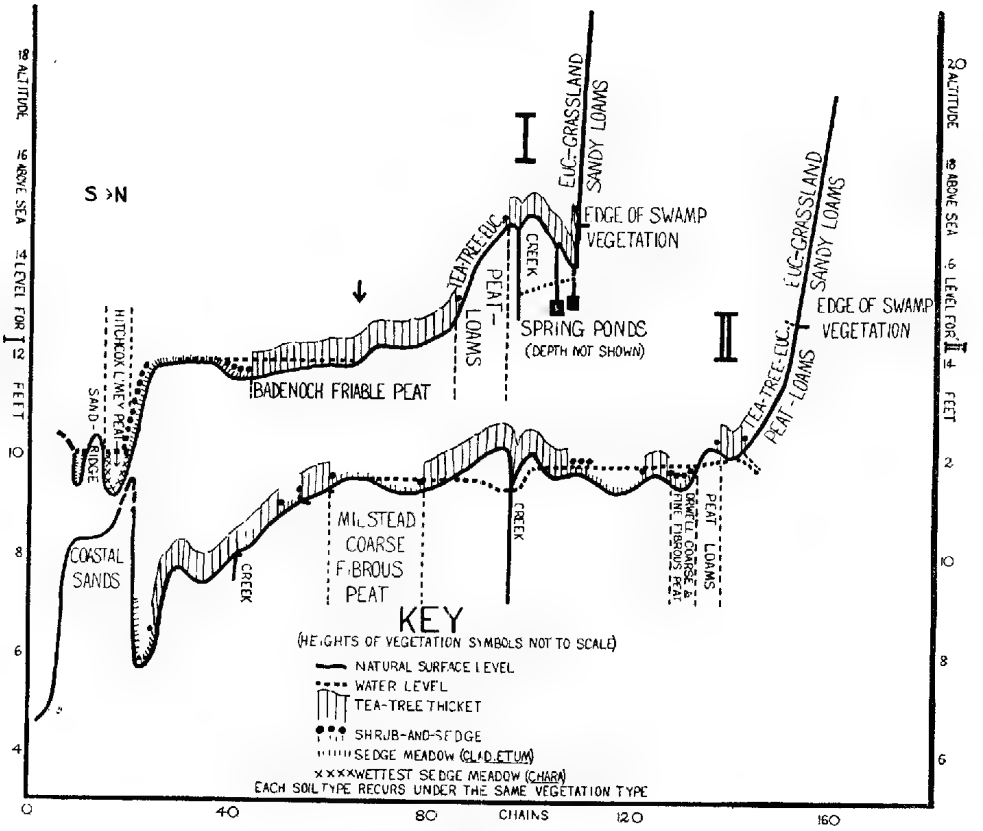

Fig. 1

No. I is 110 chains east of the mouth of Eight Mile Creek (v. map in Stephens', fig. 1) and almost parallel to the new drain from Bone Creek, which is 10-15 chains to the west. At the north end, the section passes through ponds at the source of Bone Creek; and at the south, through a little of the most swampy part of the whole area, showing the Hitchcox limey peat soil type carrying *Chara*.

The water levels were recorded by Fisk in June, 1939, and were the same in February, 1940. The arrow indicates the southern edge of a burnt patch, evidently limited by surface water. Only the swamp vegetation types are given in detail; the reed-swamp is always a narrow fringe and does not show on a plan of this scale.

No. II lies 30 chains east of the mouth of Eight Mile Creek and passes practically through Danger Point. In general level it is lower than No. I (exaggerated by two feet on the plan), but the trough shown behind the coastal sands is far less swampy than similar ones further east, and carries the normal Cladietum without *Chara*. Note the general occurrence of the Cladietum in submerged depressions and of the Tea-tree thicket on the slopes and higher ground. Water levels recorded July, 1940.

(Based on levels by H. L. Fisk, and soil map by C. G. Stephens.)

VII PROBABLE HISTORY OF THE SWAMP

An upper age limit of something less than 5,500 years has already been suggested for the swamp, after a consideration of the known age of the English Fen peats. Future local studies of peat pollens and climatic history will modify this figure. In the meantime, a tentative history of the area will be given.

During Pleistocene or Recent geological times, the sea has gradually retreated from the south-eastern portion of the State, leaving a succession of consolidated

calcareous or unconsolidated sandy ridges at various distances inland, parallel to the present coastline. These ridges represent old coastal dunes (Crocker, 1941). At some time before or after emergence of the land, the Eight Mile Creek springs were formed by faulting, and, as their waters accumulated on account of incomplete drainage, the area became first slightly swampy and then increasingly so.

From our present experience, it seems likely that the first swamp vegetation to colonise the region and leave peat remains would have been the driest of the swamp communities, viz., the Tea-tree, which may have replaced Eucalypt woodland or some other type of vegetation as the soil became wetter.

On this hypothesis, the whole of the swamp has been through an initial Tea-tree thicket stage, and one would expect to find Tea-tree peat at the bottom of all the peat profiles. On studying the section across the swamp in Stephens' fig. 7 (1943), one obtains a picture of the underlying beds of calcareous sand or Miocene limestone and an idea of the relationship between his four peat types and surface level. It is clear that the Hitchcox limey peat and the Milstead coarse fibrous peat occupy the lower levels of that section, and it is known that these areas were regularly under water in winter.

PROFILES OF THE FOUR SWAMP PEAT TYPES (after Stephens), showing the probable sequence of vegetation.

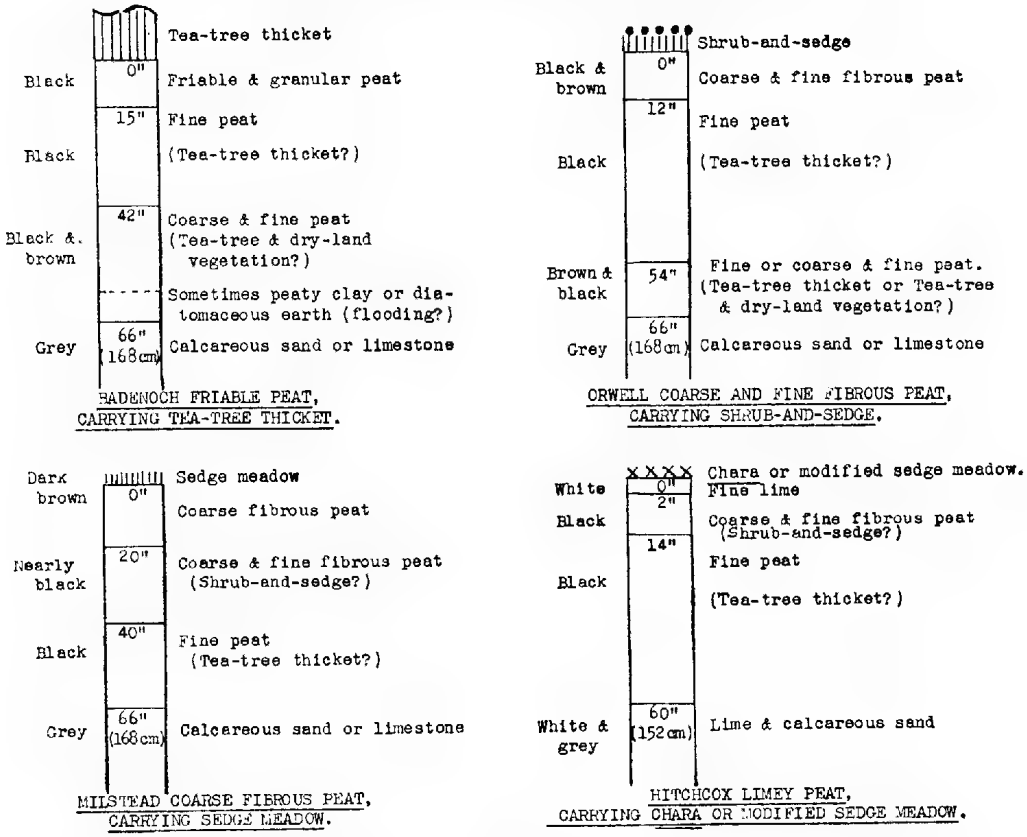

Fig. 2

The vegetation is not to scale; that probably responsible for forming the peat layers is given with a query; symbols as in Fig. 1.

Now, on examining Stephens' four soil profiles (fig. 2 herewith), which were named according to the nature of the surface horizon in each case, it is seen that at the bottom of the Milstead and Hitchcox peats there is black, fine peat. Our peats and vegetation types have not yet been correlated by the careful microscopic examination of detritus of the various peats, which is really necessary to identify them accurately; but this black, fine peat is almost certainly humified Tea-tree thicket remains. In the less swampy Badenoch and Orwell soils there is a more mixed peat at the bottom, and it is probably to be interpreted as the remains of a former vegetation changing over to Tea-tree thicket rather more slowly than in the case of the Milstead and Hitchcox peats, because the area was not so wet. A microscopic analysis of this mixed peat might give a clue to the nature of the former vegetation.

Returning to the Milstead and Hitchcox peats, above the basal black fine peat is coarse and fine fibrous peat. This is most likely the remains of a shrub-and-sedge community, representing the opening out of the Tea-tree thicket and more vigorous growth of sedges with increased flooding. Above this, the coarse fibrous peat of the Milstead soil type represents the establishment of the pure Cladietum on account of more frequent inundation; and the layer of lime typical of the Hitchcox limey peat must be due to almost permanent flooding, as already discussed, and is probably connected with the first arrival of the flood-waters of a blind creek at a low-lying spot, *e.g.*, the waters of Bone Creek.

In the same way, shrub-and-sedge has succeeded the Tea-tree thicket on the Orwell peat, while the Badenoch peat is still dry enough to carry the Tea-tree thicket and has a less humified surface horizon.

If this theory of the sequence of events is correct, one could probably destroy the intractable Tea-tree thicket by impeding the natural drainage and letting the spring waters accumulate—but it might take a long time, and, sooner or later, would establish a new Tea-tree area on the dry land of the adjacent parts, which have been described. Succession can take place in both directions in the plant sequence, and here we have an example of the reverse of the more usual type of succession in the hydrosere. If the above experiment of impeding the drainage were performed, there would be two opposing tendencies at work—one, the gradual rise of the water table, and the other, the natural rise of the soil level due to peat accumulation. As we have seen, the water has had some victories in the past, when the Hitchcox limey peat was formed; though, in general, the rise of soil level has prevailed.

VIII SUMMARY

A vegetation survey of a coastal swamp in the south-east corner of the State was made, in connection with the soil survey of the same area, prior to draining, clearing and settling it. Previous human interference has been slight, on account of the wetness of the soil and density of the vegetation.

The environment of Eight Mile Creek Swamp is described, and compared with that of acid, ombrogenous *Sphagnum* bogs and topogenous fens, with their distinct vegetation types, in other parts of the world. Some of the largest fenlands are found in East Anglia in England, and it is believed that Eight Mile Creek Swamp bears a very close relationship to these, on account of the similar alkaline ground water, peat types (Stephens, 1943), and especially the eutrophic vegetation types, which, in the wetter communities, involves identity of dominant species. On this basis, some comparison is attempted between the fen peats of a given depth and known age and the Eight Mile peats nearly as deep, 150-168 cm. (5-5½ ft.), and of unknown age. It is tentatively suggested that the South Australian peats are less than 5,500 years old.

There is very close correspondence between the four main peat soil types and their associated vegetation, which was safely used to map the soil boundaries.

The main factor limiting the extent of each type of swamp vegetation is the level of the water table; and the climax vegetation of the swamp is a closed Tea-tree thicket growing on the Badenoch friable peat, the best-drained of the peat soils, most of it being higher than winter water-level. It is also the commonest type, covering over half the total area. The vegetation and soils of three adjacent communities are also discussed. These are quite Australian in their floristic affinities and not cosmopolitan like the aquatic plants of the swamp.

The above seven vegetational units are described ecologically and floristically, and a detailed comparison is appended between the aquatic species at Eight Mile Creek and in East Anglia, together with some indication of further parallels in North America. The taxonomic implications of this are also touched upon.

As the swamp is poorly drained and supplied with water from several springs as well as the drainage from the surrounding country, it is believed that the history of the area is one of increasing swampiness, and the course of plant succession is discussed from this point of view, with additional evidence supplied from the sequence of distinctive peat types in the soil profiles. These peat types have been correlated with certain vegetation types on the experience gained with the surface horizons only; no attempt has yet been made to identify plant detritus in the peat. It would seem that succession has proceeded in the reverse direction to the well-known "Verlandung" cycle, beginning with climax Tea-tree thicket and ending with flooded sedge meadow and aquatic communities.

Profile sections of the swamp are discussed in relation to vegetation type and winter water-level.

IX ACKNOWLEDGMENTS

This account of the vegetation is due to Mr. Stephens' suggestion and is based on his cognate study of the soils (q.v. 1943). Assistance on many desired points of information has been received from: the University Zoology Department concerning diatoms, and the Geology Department in connection with *Chara* limestone; Mr. H. L. Fisk of the Lands Department, Mr. Rowland Hill of the Lands Board, and Mr. H. Willkie of the South-Eastern Drainage Board, the last three of whom have great personal knowledge of Eight Mile Creek Swamp. Professor J. G. Wood, of the Adelaide University Botany Department, has read the paper during preparation and suggested many important improvements. Finally, the work was carried out under the aegis of the Waite Agricultural Research Institute.

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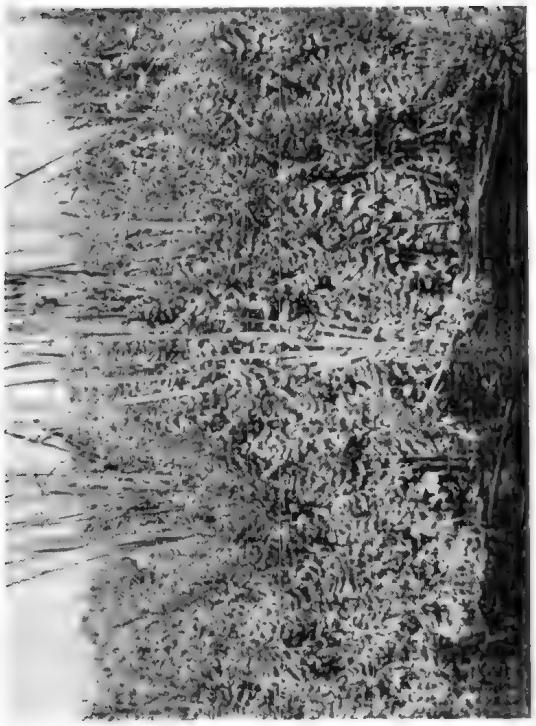

Fig. 2

Fig. 4

Fig. 1

Fig. 3

Fig. 5

Fig. 6

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Fig. 8

Fig. 10

Fig. 12

Fig. 9

Fig. 11

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EXPLANATION OF PLATES

PLATE XXVII

Fig. 1 *Reedswamp* bordering Eight Mile Creek. The boat-oar points to a large plant of *Triglochin procera; Typha angustifolia* (Cumbungi or Bulrush) grows densely behind it.

Fig. 2 *Reedswamp* standing in water bordering Eight Mile Creek Channel; mostly *Sium latifolium* var. (Water Parsnip) flowering and growing 3 ft. above the water-surface, with some *Olearia ramulosa* (Water Cypress) and the taller *Typha angustifolia.*

Fig. 3 *Reedswamp* fringing Deep Creek Pond, with some Tea-tree.

Fig. 4 *Reedswamp* around small spring at head of Eight Mile Creek. The white plumes are inflorescences of *Phragmites communis* (= *P. vulgaris;* Common Reed), and the clumped heads those of *Cladium Mariscus* (Pom-pom Rush); *Gahnia psittacorum* is also flowering. Tea-tree thicket surrounds the stream-side community.

PLATE XXVIII

Fig. 5 *Sedge meadow* (*Cladietum juncei*) on *Hitchcox limey peat soil type,* also characteristic of the closely related *Milstead coarse fibrous peat soil type.* The more shrubby communities are visible in the background.

Fig. 6 A recently flooded flat covered with dry, brittle, snow-white *Chara.* The surrounding *sedge meadow* looks identical with fig. 5, but is actually a *Cladietum glomerati;* at east end of swamp on *brown, fine, fibrous peat soil type.* Just visible in the background is a tussock-sedge society of *Gahnia trifida* in grassland; the soil is a shallow phase of the *Orwell coarse and fine fibrous peat type.*

Fig. 7 *Gahnia trifida* (Cutting Grass) in the *sedge meadow* (*Cladietum glomerati*) on shallow *Milstead coarse fibrous peat soil type.* The *Gahnia* tussock shrubland is common on the shallower peat soils of various types at Eight Mile Creek.

Fig. 8 *Shrub-and-sedge* on *Orwell coarse and fine fibrous soil type,* with sedge meadow (*Cladietum glomerati*) in foreground on shallow *Milstead coarse fibrous peat soil.*

PLATE XXIX

Fig. 9 *Tea-tree thicket* (*Melaleuca squarrosa* and *Leptospermum pubescens*). In the foreground is a layer of fallen débris 2 ft. thick, due to rolling. This is the dominant and widespread vegetation type on the swamp and the associated soil is the *Badenoch friable peat.*

Fig. 10 *Eucalypt woodland* with the rough-barked *Eucalyptus vitrea* (left) and the smooth, pale-barked branches of *E. ovata* (right). There is a winter swamp of sedge or grass turf in the foreground. At landward margin of swamp on *grey, fine, sandy loam soil with flint.*

Fig. 11 *Eucalypt woodland, Eucalyptus vitrea* only, on *grey, flinty loam soil,* at landward margin of swamp. The sward-covered winter swamp in the foreground is on *transitional swamp soil.*

Fig. 12 *Calcareous coastal sands,* the dominant shrub *Leucopogon parviflorus* forming a dense line near the sea.

AN EXCEPTIONAL AUSTRALIAN AXE HEAD

By H. M. COOPER, Assistant in Ethnology, South Australian Museum

Summary

It has been frequently obvious that due appreciation of the natural ability of the Australian aboriginal has either been entirely unrecognised or grudgingly conceded. Intensive study of his material culture, however, reveals many instances of a considerable degree of skill and originality.

AN EXCEPTIONAL AUSTRALIAN AXE HEAD

By H. M. Cooper, Assistant in Ethnology, South Australian Museum

[Read 9 September 1943]

Plate XXX

It has been frequently obvious that due appreciation of the natural ability of the Australian aboriginal has either been entirely unrecognised or grudgingly conceded. Intensive study of his material culture, however, reveals many instances of a considerable degree of skill and originality.

An example of a highly developed handicraft in stone-working is shown in the implement described in the following notes, and illustrates not only a proficiency in various techniques of stone-shaping but also a high appreciation of symmetry and balance.

The writer feels that the result achieved justifies its description and illustration.

The specimen is one of the collection of axe heads in the South Australian Museum; it is believed, according to available records, to have been collected during one of McKinlay's expeditions (1861-1865), but, unfortunately, there are no data recording the locality from which it was derived.

The axe head belongs to the grooved type and is made from a hard piece of stone, greyish in colour, possibly a sedimentary rock, although this cannot be verified in the absence of a slide derived from the axe head itself.

The main body of the piece has been shaped and dressed by "pecking," a process probably carried out with a hard-pointed chisel-like stone tool, worked by hard blows or with the aid of another hammer stone. This pecking technique is clearly shown in the groove formation; but elsewhere the peck-marks have, partly, been obliterated by subsequent smoothing of the surfaces by a rubbing or polishing process.

The fine strongly-backed edge formed by the meeting of the two faces has been attained by grinding, a process which has also been applied to other parts of the axe head, with the exception of the flat butt and two small patches, one on each side of the basal corners. Here the natural surface of the stone has been left untouched, obviously for economy of work. It has often been noted that the aboriginal, being a practical worker, wasted neither time nor labour in needless effort. The flattened base shows some evidence of its use as a hammer or anvil.

For efficiency in use, it was customary for an axe head to be mounted in a strip of green wood made long enough to form a convenient handle, the ends being bound together and the axe head further held in place by means of gum. The practice of sometimes grooving the stone obviously assisted in its fixation.

The dimensions of the specimen are as follows:

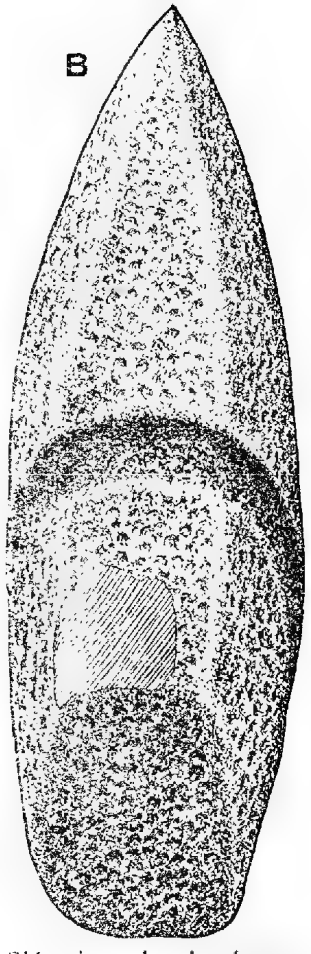
Greatest length - - - -	15·5 cm.
Greatest breadth - - - -	11·75 cm.
Greatest thickness - - -	5·75 cm.
Depth of groove - - - -	·35 cm.
Centre line of groove from base - -	4·75 cm.
Weight - - - - -	2·07 kg.

The exceptional symmetry given to the piece, with its carefully formed edges and proportions, is well brought out in the drawings and photograph.

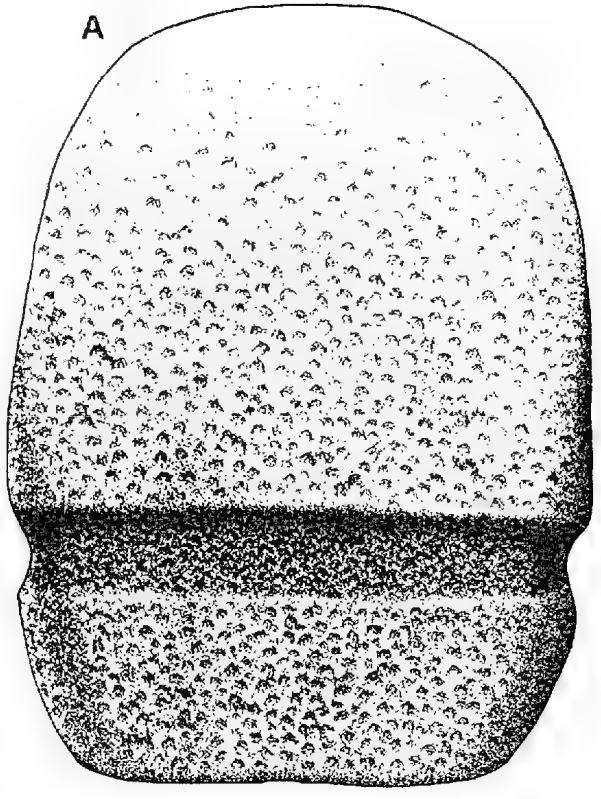
An examination of this specimen and others of the series of grooved axe heads in the South Australian Museum, has suggested to Mr. H. V. V. Noone and the writer that they really serve the dual purpose of axe and hammer.

Aboriginal axe head

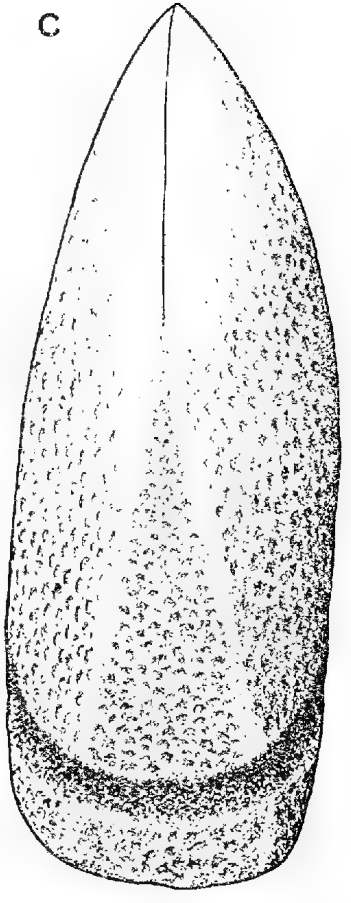
Photo G. Walsh



Side view, showing base



Face view



Side view, showing working edge

del. G. Walsh

AUSTRALIAN ACANTHOCEPHALA NO. 4

By T. HARVEY JOHSTON and E. W. BEST, University, Adelaide

Summary

PROSTHORHYNCHUS MENURAE (Johnston 1912)

The material available consisted of one female and two complete and one fragmentary male, from the lyre bird, *Menura novaehollandiae*, syn. *M. superba*, Gosford district, New South Wales (Gallard collection, Australian Museum). We also re-examined the type specimen, a female, from the Queensland Museum.

AUSTRALIAN ACANTHOCEPHALA
No. 4

By T. Harvey Johston and E. W. Best, University, Adelaide

[Presented 9 September 1943]

Prosthorhynchus menurae (Johnston 1912)
(Fig. 1-8)

The material available consisted of one female and two complete and one fragmentary male, from the lyre bird, *Menura novaehollandiae*, syn. *M. superba*, Gosford district, New South Wales (Gallard collection, Australian Museum). We also re-examined the type specimen, a female, from the Queensland Museum.

The type specimen measures 19 mm. in length and 1·1 mm. in breadth, and the other female 11 mm. x 1·3 mm. Both contain mature eggs (fig. 4, 5) which measure up to 0·12 mm. in length and 0·035 mm. in breadth. In smaller eggs polar prolongations are very obvious, but in the largest eggs these are less distinct and the inner shell has a pair of lateral bulges not quite in the mid-line; such an egg is shown in fig. 5.

In the type specimen only a few of the basal hooks of the proboscis are everted but two male specimens had the proboscis everted for about two-thirds of its length, this portion measuring 1·4 mm. The fully everted proboscis would therefore be about 2 mm. long, bearing 26 longitudinal rows each of 35-40 hooks. The form of the latter varies gradually from the thin, almost rootless, basal hooks to the heavier, strongly rooted hooks of the mid-region. As far as can be judged from the inverted portion of the proboscis the anterior hooks are longer and more slender than the median ones. Hooks from the basal rows and the mid-region are figured (fig. 2, 3).

The double-walled proboscis sheath is inserted at the base of the proboscis, and measures 2·0-2·5 mm. in length and 0·3-0·37 in breadth. The ganglion lies at its posterior end (fig. 6). The very long, slender lemnisci are coiled in the anterior half of the worm. The lacunar system of the sub-cuticula is reticular at the anterior end (fig. 7) and changes gradually to the condition shown in fig. 8, where there is a pair of very distinct longitudinal vessels with regular lateral branches. The small nuclei are arranged in circular lacunae (fig. 8). The circular muscles of the body wall are very obvious and regularly arranged.

The male specimens were so much wrinkled as to be unsuitable for measurement and it proved to be impossible to make out details of their anatomy, but the testes appeared to be relatively large and situated at about mid-length.

The species was assigned by Meyer (1933) to *Prosthorhynchus*, and the re-examination of the material confirms that assignment.

Gordiorhynchus bancrofti n. sp.
(Fig. 9-16)

Host—Ninox strenua. *Locality*—Eidsvold, Burnett River, Queensland.

The description is based on four female specimens. The general body form is long and cylindrical, the length reaching to 65 mm. and the width about 11 mm. The proboscis is borne at an angle to the rest of the body and would be about 1·3 mm. long when completely everted. The proboscis sheath is inserted about 0·8 mm. behind the tip of the proboscis and measures 1·7 mm. by 0·3 mm.; the

inner wall is inserted 0·2 mm. in advance of the outer. The anterior part of the proboscis (the proboscis proper in the view of some authors, *e.g.*, Yamaguti 1935) is 0·3 mm. in width and the posterior part (neck) is slightly wider. The proboscis hooks are deeply embedded in a transparent cuticle and are arranged in 28 longi-

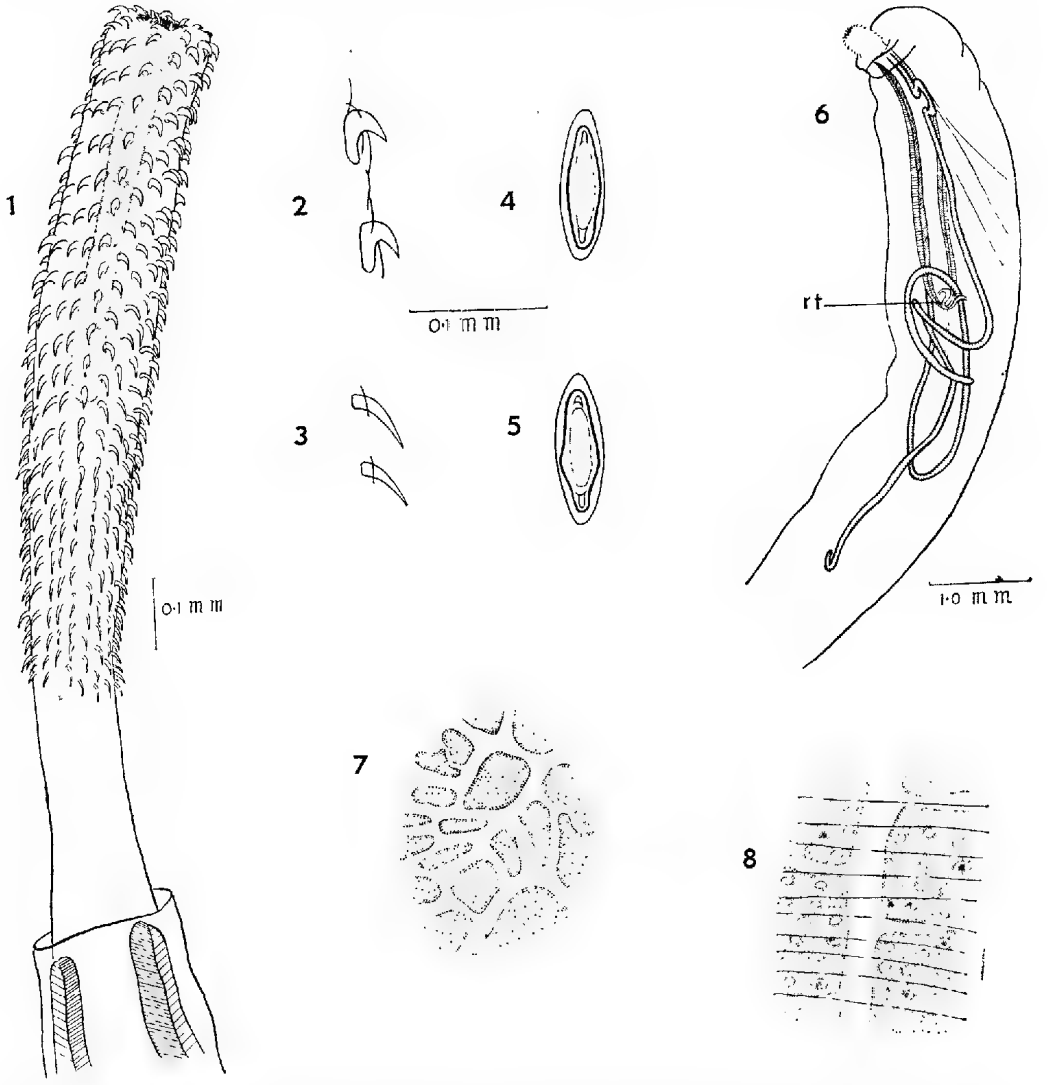
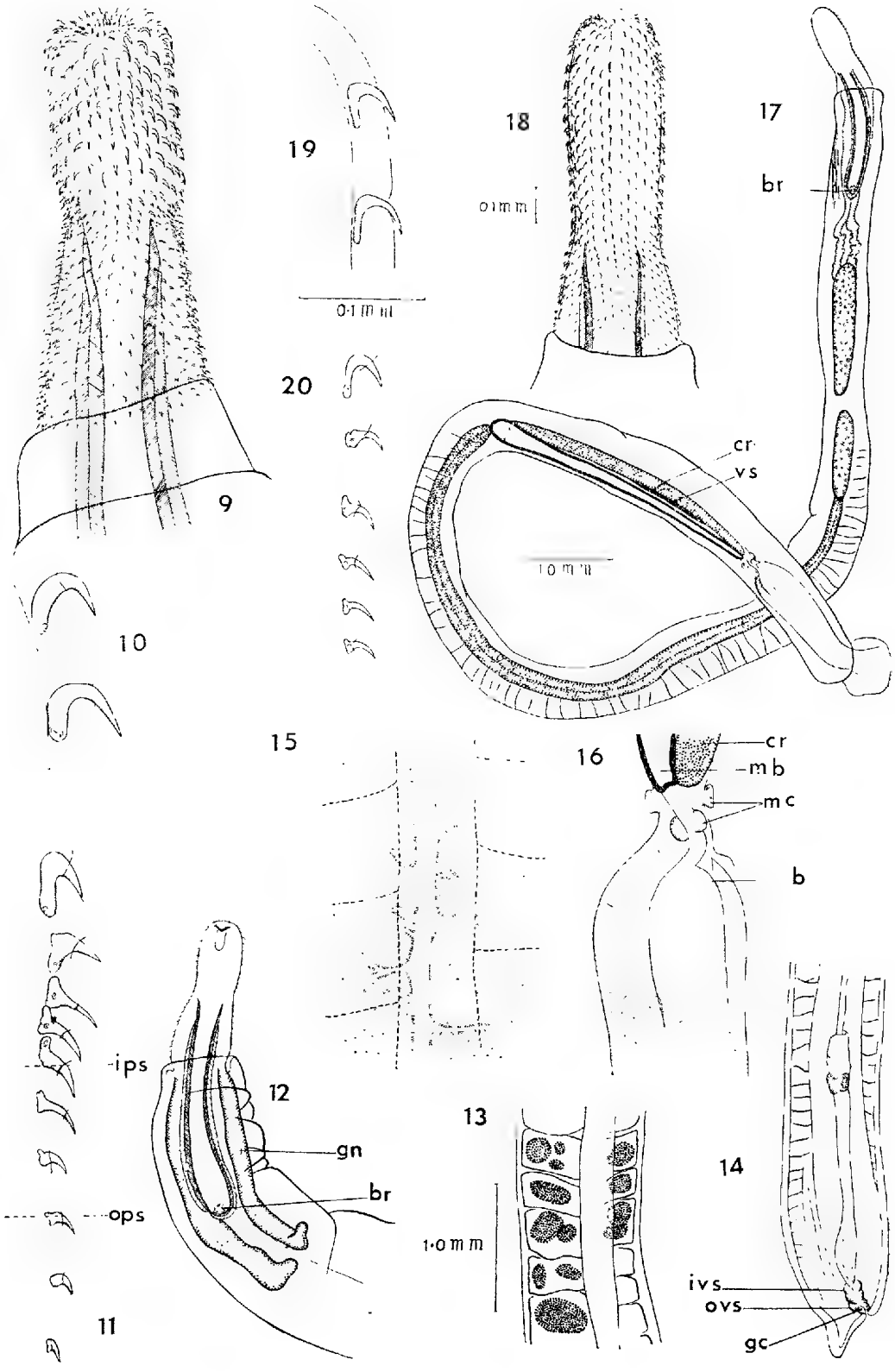


Fig. 1-8 *Prosthorhynchus memurae:* 1, proboscis; 2, hooks from mid-region; 3, basal hooks; 4 5 eggs; 6, anterior end of female; 7, lacunar system of anterior end; 8, lacunar system of mid region of body. Fig. 2-5, to same scale; 7 and 8, to same scale. b, bursa; br, ganglion; cr, cement reservoir; gc, gland cell; gn, giant nucleus; ips, level of inner proboscis sheath; ivs, inner vaginal sphincter; mb, markbeutel; mc, muscle cell; ops, level of outer proboscis sheath; ovs, outer vaginal sphincter; rt, retinaculum; vs, vesicula seminalis.

tudinal rows each of 27-30 hooks, of which the last 11 or 12 are posterior to the insertion of the proboscis sheath. The anterior hooks are strongly recurved and have massive, backwardly-directed roots with a marked depression at the extremity. Just anterior to the insertion of the proboscis sheath these hooks give place to slighter forms whose roots are anterior. A marked depression is present in these roots also. The remaining hooks or spines have very small roots. The dimensions of representative hooks are shown in fig. 10, 11.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The paired lemnisci are solid, finger-like structures of about the same length as the proboscis sheath. They arise behind the insertion of the proboscis sheath at the base of the whole proboscis and extend 0·8 mm. behind it. The ganglion is situated at the base of the proboscis sheath. Two giant muscle cells are present in the body wall just in advance of the ganglion. The genital ligament is unusually heavy and muscular.

Except for a small portion at both ends, the body cavity is divided into a very large number of segments by partitions which extend from the body wall to the genital ligament. A cavity in the genital ligament is continuous throughout the length of the body. The ovarian balls develop in variable number within the segments of the body cavity. The lacunar system of the sub-cuticula consists of two main longitudinal vessels, between which lateral vessels form a network. The origin of these lateral vessels does not appear to be related to the underlying "pseudosegmentation" of the body cavity.

In none of the specimens were fully mature eggs found in the cavity of the uterus, the uterine bell, or the body cavity. Eggs are oval and have no polar prolongations. The uterine complex occupies a clear space where some of the muscles associated with the genital ligament pass to the body wall and the longitudinal cavity of the ligament becomes much widened (fig. 14). The uterine bell measures 0·45 by 0·2 mm., and its two posterior cells surrounding the posterior apertures are conspicuously granular. The uterus is short, 1·5 mm. in length, and the first pair of vaginal gland cells extends about 0·5 mm. into its base. The vaginal sphincter is double and the gland-cell surrounding the aperture is conspicuous, giving the appearance of a third sphincter muscle. The female opening lies to one side of a small terminal projection about 0·3 mm. in length.

The species described is obviously very closely related to the type species of the genus, *G. clitorideus* Meyer 1931, even to the presence of the terminal papilla mentioned above, but it differs from that species in the shape and armature of the proboscis, the Australian species having more numerous anterior hooks and a less abrupt change in form between the anterior and subsequent hooks, and also in the presence of the very thick cuticular layer on the proboscis. The species is dedicated to the late Dr. T. L. Bancroft, who collected it.

Gordiorhynchus falconis n. sp.

(Fig. 17-20)

A single male specimen of a species which obviously resembled the preceding in generic characters was obtained by one of us (T. H. J.) from *Falco berigora* from Hermannsburg, Central Australia. The pseudosegmentation which characterises the females of the genus was present in this case in the male.

The body form is cylindrical, length 18 mm., width 0·6 mm. The proboscis is 0·9 mm. long and 0·23 mm. wide for the greater part of its length. It narrows slightly at the level of the insertion of the proboscis sheath and the posterior portion reaches 0·3 mm. in diameter. There are 38 rows, each of 28-29 hooks, which are all of a more slender form than, though of the same general shape as, those of *G. bancrofti*. The inner wall of the proboscis sheath is inserted at the level of the seventeenth hook, 0·6 mm. behind the tip of the proboscis, and the

Fig. 9-16—*Gordiorhynchus bancrofti:* 9, proboscis; 10, anterior hooks; 11, hooks at level of insertion of proboscis sheath; 12, anterior end; 13, mid-region, to show pseudosegmentation; 14, posterior end; 15, lacunar system, indicating independence of underlying pseudosegmentation; 16, region between bursa and markbeutel showing peculiar muscle cells.

Fig. 17-20—*Gordiorhynchus falconis:* 17, male; 18, proboscis; 19, anterior hooks, 20, hooks at level of insertion of proboscis sheath. Fig. 9, 16 and 18, to same scale; 12-14 and 17, to same scale.

outer wall less than 0·1 mm. behind it. The hooks are embedded in a transparent cuticle which appears as a marked, clear area at the tip of the fully everted proboscis. The form of the proboscis and its hooks is shown in fig. 18-20, which are drawn to the same scale as the corresponding figures for *G. bancrofti* for purposes of comparison.

The lemnisci are rather slender, finger-like structures extending backwards to the level of the anterior testis. The proboscis sheath is 1·4 mm. in length and 0·2 mm. in width, and the anterior testis lies 0·7 mm. behind it. The ganglion lies at the posterior end of the proboscis sheath. The testes measure 1·4 by 0·3 mm. and 1·0 by 0·3 mm. respectively. The two long tubular cement glands pass back from the level of the posterior testis. The markbeutel is unusually long and slender, measuring 3·0 mm. by 0·3 mm., and there are a correspondingly long, narrow vesicula seminalis and cement reservoir (3·0 by 0·15 mm.). The ejaculatory duct is surrounded by six peculiar cells shown in fig. 16, 17. The bursa is partly everted in the type specimen but the pronounced appendages and bursal rays, about 14 in number, are still within the body wall.

The differences between *G. falconis* and the European species are even more marked than those between *G. bancrofti* and the type species, *G. clitoridcus*. In particular the very slender form of the hooks in this species results in a very gradual change in form from the anterior hooks to those at the base which are little more than spines.

Host List

Menura novaehollandiae Lath., *Prosthorhynchus menurae* (Johnston) Meyer.

Ninox strenua Gould, **Gordiorhynchus bancrofti** n. sp.

Falco berigora Vig. and Horsf., **Gordiorhynchus falconis** n. sp.

We acknowledge indebtedness to H. A. Longman, Director of the Queensland Museum, Brisbane, for permitting re-examination of the type of *P. menurae*; to Dr. A. B. Walkom, Director of the Australian Museum, Sydney; and the late Dr. T. L. Bancroft, Eidsvold, Queensland, for forwarding material. The work was carried out in connection with the Commonwealth Research grant to the University of Adelaide. Types have been deposited in the South Australian Museum.

CONODONTS FROM WATERHOUSE RANGE, CENTRAL AUSTRALIA

By IRENE CRESPIN, Commonwealth Palaeontologist

Summary

Conodonts are teeth-like structures, almost microscopic in size. The origin of these forms is still in doubt. There are two schools of thought, one which assumes that conodonts are related to primitive fishes, and the other that they are related to the Annelida. Extensive investigations into assemblages of conodonts in various palaeozoic deposits in America tend to support the view that the zoological relationship is with the Annelida. The teeth are transparent, very polished and amber-coloured. It seems that they have been attached to some kind of skeletal material, as some such substance is occasionally adhering to the specimens.

CONODONTS FROM WATERHOUSE RANGE, CENTRAL AUSTRALIA

By Irene Crespin, Commonwealth Palaeontologist

[Presented 9 September 1943]

Plate XXXI

Conodonts are teeth-like structures, almost microscopic in size. The origin of these forms is still in doubt. There are two schools of thought, one which assumes that conodonts are related to primitive fishes, and the other that they are related to the Annelida. Extensive investigations into assemblages of conodonts in various palaeozoic deposits in America tend to support the view that the zoological relationship is with the Annelida. The teeth are transparent, very polished and amber-coloured. It seems that they have been attached to some kind of skeletal material, as some such substance is occasionally adhering to the specimens.

In America, conodonts are apparently restricted to certain horizons, and Stauffer (1935) states that "Conodonts in palaeozoic sediments assume much of the importance of the foraminifera in later sediments. They may be used to identify horizons where megascopic fossils are poor or wanting."

The small series of conodonts herein described was found in the crushings of a hard brownish to yellowish calcareous shale from the South Gorge, Waterhouse Range, Central Australia, 40 miles south-west of Alice Springs. The collection of fossiliferous rocks was made by Dr. C. T. Madigan on behalf of the Commonwealth Oil Refineries Ltd., and many of the specimens were sent to the writer for micro-palaeontological examination. The rocks are Ordovician in age and belong to the Larapintine Series, which is represented by fossiliferous shales and limestones containing abundant macro-fossils, including brachiopoda, pelecypoda, cephalopoda and trilobita.

Conodonts do not seem to have been previously recorded from the Ordovician rocks in Australia, but Harris and Thomas (1937) noted "what may be an annelid jaw" in the Silurian beds at Heathcote, Victoria.

Twenty-three incomplete specimens were secured from the Waterhouse Range material. Two genera are present, *Oistodus* and *Paltodus*, both described by Pander in 1856. Both genera are common in conodont assemblages in Ordovician rocks in America. Two new species are herein described—*Oistodus larapintinensis* and *Paltodus madigani*. The plate has been prepared by Mr. F. Canavan, of the Mineral Resources Survey, Department of Supply and Shipping, Canberra.

All specimens are in the Commonwealth Palaeontological Collection at Canberra.

DESCRIPTION OF SPECIES

Genus Oistodus Pander 1856

Oistodus larapintinensis sp. nov.

(Pl. xxxi, fig. 1 13)

Holotype (Comm. Pal. Coll. No. 234) — Single cusp or blade, transparent, polished, horny and amber-coloured. Cusp—long, straight, tapering to a fine point, rather sharp-edged, laterally flattened, with a sharply convex keel running along the centre. Cusp curves broadly to base, which is triangular, broad, flat and flaring laterally. Upper surface slightly convex, under surface somewhat flattened.

Paratypes (Comm. Pal. Coll. Nos. 235-246)—The twelve figured specimens are smaller than the type but are similar in essential characters. The curve where the cusp joins the base is narrower and inclined to be angulate. A cavity can be seen extending along the length of the cusp in fig. 3.

Observations—The specimens described as *Oistodus larapintinensis* vary in shape and size, but there is little doubt that they belong to the same species. This Australian species strongly resembles *O. curvatus* Branson and Mehl, common in the Decorah shales (Ordovician) of America, but the straightness of the cusp and the presence of the sharply-convex keel distinguish it from that form.

Occurrence—South Gorge, Waterhouse Range, Central Australia.

Age—Ordovician (Larapintine Series).

Genus PALTODUS Pander 1856

Paltodus madigani sp. nov.

(Pl. xxxi, fig. 14, 15, 16)

Holotype (Comm. Pal. Coll. No. 247)—Single cusp or blade, transparent, horny, polished, amber-coloured. Cusp sharply curved throughout length. Base broad, expanded. Upper side of cusp evenly convex with central keel. Under surface keeled with a longitudinal groove along anterior margin near keel.

Paratype (Comm. Pal. Coll. No. 248)—Whitish to amber-coloured, horny cusp, which curves sharply just above base and tapers to a fine point. Base broad, keel present but other features poorly preserved.

Observations—Only two specimens in the collection are referable to the genus *Paltodus*. This genus is also well represented in the Ordovician rocks of America, and is usually found associated with *Oistodus*. *P. madigani* can be compared with *P. cornutus* Stauffer and *P. arcuatus* Stauffer, but can be distinguished from them by the position of the keel and rather broader base.

Occurrence—South Gorge, Waterhouse Range, Central Australia.

Age—Ordovician (Larapintine Series).

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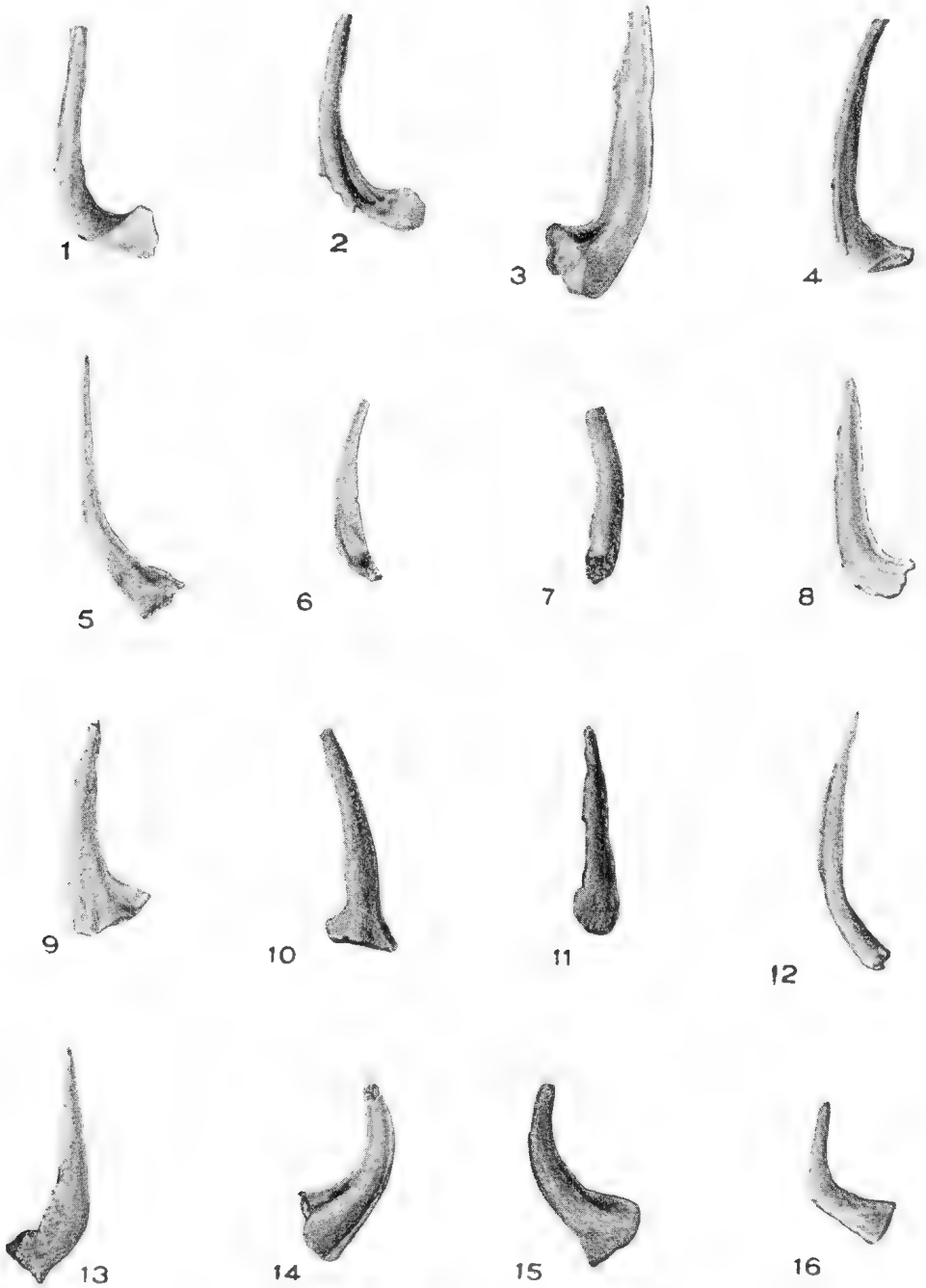


Oistodus larapintinensis sp. nov.

Fig. 1 Holotype—South Gorge, Waterhouse Range, Central Australia. Comm. Pal. Coll., No. 234.

Fig. 2-13. Paratypes—South Gorge, Waterhouse Range, Central Australia. Comm. Pal. Coll., Nos. 235-246.

Paltodus madigani sp. nov.

Fig. 14. Holotype—South Gorge, Waterhouse Range, Central Australia. Lower Surface. Comm. Pal. Coll., No. 247.

Fig. 15. Holotype—Upper Surface.

Fig. 16 Paratype—South Gorge, Waterhouse Range, Central Australia. Comm. Pal. Coll., No. 248.

All specimens x 30.

SOME GRANITIC ROCKS OF SOUTH - EASTERN SOUTH AUSTRALIA

By D. MAWSON and L. W. PARKIN

Summary

Outcrops of granitic rocks are very numerous in the South-Eastern District of South Australia within the region hounded by a line joining Murray bridge, Meningie, Kingston, Bordertown and back to Murray Bridge. These granites appear to be all either older Paleozoic or pre-Cambrian in age. Dr. Ward's map of South Australia, issued by the Mines Department in 1928, shows that region to be peppered with a number of small outcrops of older rocks, though in the past, much of it has been popularly regarded as semi-desert country occupied only by Tertiary to Recent limestones and sand drifts.

SOME GRANITIC ROCKS OF SOUTH-EASTERN SOUTH AUSTRALIA

By D. Mawson and L. W. Parkin

[Presented 9 September 1943]

Plate XXXII

Outcrops of granitic rocks are very numerous in the South-Eastern District of South Australia within the region bounded by a line joining Murray Bridge, Meningie, Kingston, Bordertown and back to Murray Bridge. These granites appear to be all either older Palæozoic or pre-Cambrian in age. Dr. Ward's map of South Australia, issued by the Mines Department in 1928, shows that region to be peppered with a number of small outcrops of older rocks, though in the past, much of it has been popularly regarded as semi-desert country occupied only by Tertiary to Recent limestones and sand drifts.

This present contribution to the knowledge of the older rocks of that area is the first of several investigations of the kind now being undertaken from the Geological Department of the University of Adelaide.

Here we deal with outcrops of granitic rocks situated between Coonalpyn and Meningie, and a notable occurrence at Taratap adjacent to the Coorong highway to the north-west of Kingston.

REDDISH-COLOURED FLUOR-BEARING GRANITES

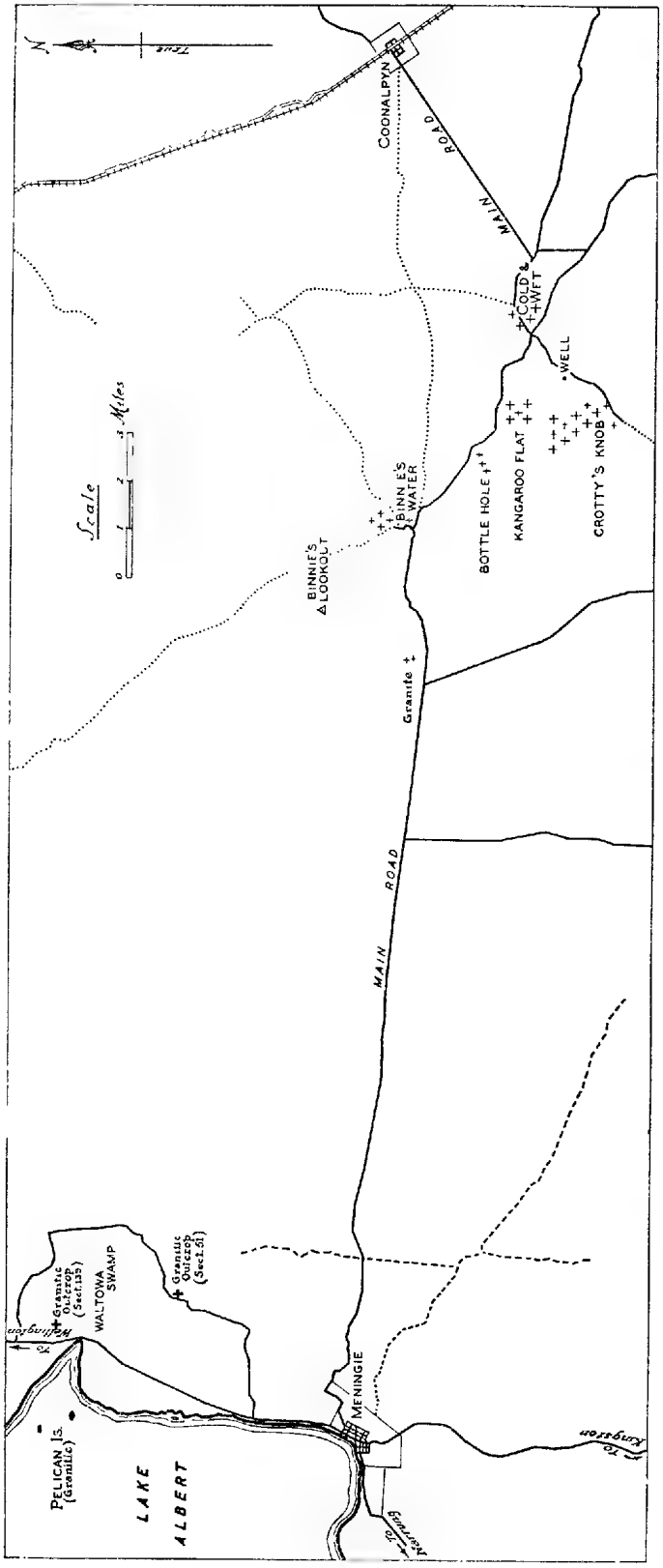
The plain, traversed by the railway line at Coonalpyn, elevated 72 feet above sea-level, is underlain by the same Tertiary formations which are so well exposed in the face of the deep trench excavated by the Murray River in its lower course. At about six miles to the south-west of Coonalpyn, the main road to Meningie rises over low hills where surface erosion has exposed Miocene marine limestone capped by a thick cover of kunkar travertine.

Granite Outcrops at Cold and Wet

Some six and a half miles from Coonalpyn, at Cold and Wet sheep station, 125 feet above sea-level, granite outcrops from beneath the Miocene formation.

The contact of the marine limestone and the granite is well shown in a large excavation made many years ago in an effort to provide a water supply for railway requirements, but subsequently abandoned. The limestone is there seen to rest on an eroded and greatly weathered surface of the granite. It is obvious that these granite outcrops were of the nature of islands and shoals in the Miocene sea. That the surface of the granite bed-rock at the time of deposition of the Miocene limestone was very uneven is illustrated by the fact that the windmill bore at Cold and Wet homestead, distant only one or two hundred yards from outcropping granite, met the granite underlying the limestone at 92 feet below the surface. In that bore the underground water, which is of good potable nature, rises to 30 feet above the granite bottom.

Granite outcrops, though not conspicuously so, for about half a mile to the west and south-west from Cold and Wet homestead. To the north, the overlying Miocene formation constitutes the surface rock. The granite [5802] adjacent to the homestead is a biotite-hornblende variety closely similar to that of Crotty's Knob to be described later. Intersecting it are veins [5800] of aplitic, micro-granite porphyry.



Crotty's Knob Locality

At somewhat over three miles to the south-west from Cold and Wet homestead is a bold outcrop of granite forming a low line of hills about a mile in length. Several outstanding granite rocks have been brought into relief along this outcrop; the most striking of these is known as Crotty's Knob, the summit of which is about 380 feet above sea-level.

Following the margin of the granite to the north and west, at a distance of about half-a-mile from Crotty's Knob, the upper limit of the Miocene in that locality is observed to lap over the granite at an elevation of about 325 feet above sea-level. There the limestone is a compact granular rock containing abundant foraminifera. It is of the nature of consolidated shallow water, marine, calcareous sand in which are quartz grains derived from the bed-rock granite. This and other examples of the Miocene limestone from this locality have been described by Mr. Frederick Chapman in this volume (see p. 39).

The rock of Crotty's Knob is fairly typical of the large area of granite of the Cold and Wet region. The knob itself is the most notable of several outstanding protuberances of this granite. It is a monolith (pl. xxxii, fig. 2) developed by erosion rising about 35 feet above the otherwise almost flat surface of the granite rise which protrudes above the surrounding Miocene terraine. At

about 200 yards to the east of this major feature are some large tors, one of which is characteristically hollowed out below and left resting on four points standing on the granite pavement. The petrological characters of this granite are as follows:

The Hornblende-Biotite Granite from Crotty's Knob

This [3799] is a medium-grained rock in which the quartzes, being of a dark colour, stand out strongly. The feldspars are, as a whole, of a lighter colour than in the case of the granite from Binnie's Water, described later in this record. The orthoclase is a brownish-flesh colour, and the plagioclase is a dirty white. Both plagioclase and ferromagnesians are more abundant than in the Binnie's Water rock. Hornblende, as well as biotite, can be distinguished in the hand-specimen.

The texture is hypidiomorphic granular, and the grain-size comparable with the granite from Binnie's Water. The quartz appears quite dark-coloured when viewed in the hand-specimen, and is obviously a smoky variety.

The feldspar as seen in thin-section is principally dusty orthoclase and clear plagioclase; there is also some mottled dusty microperthite.

The hornblende, which has an extinction angle $Z \wedge c - 12°$, is clearly distinguished by its decided green tints, whereas the biotite is pleochroic in light yellow to dark yellow-brown practically opaque owing to extreme absorption. There is evidence that some of the hornblende has taken the place of original biotite by secondary magmatic changes.

There is some titaniferous magnetite and occasional minute grains of sphene, some lozenge-shaped. Associated with the biotite are tiny prisms of zircon. Very minute rods of apatite are observable in some areas. Grains of fluorite, occasionally showing a purple tint, have been observed embedded in the biotite; fluorite is, however, less in evidence in this rock than the granite from Binnie's Water.

Another specimen [5097], similar in character to the above and of specific gravity 2·784, has been chemically analysed by E. R. Segnit with the result detailed. From this the norm has been calculated as stated herewith. Thus the C.I.P.W. classification of this rock is 1. 4. 2. 3. A Rosiwal modal determination is also stated below.

CHEMICAL ANALYSIS
(By E. R. Segnit)

SiO_2	74·08
TiO_2	0·24
Al_2O_3	13·50
Fe_2O_3	0·60
FeO	1·64
MnO	0·03
MgO	0·16
CaO	1·09
Na_2O	3·86
K_2O	4·19
H_2O+	0·23
H_2O-	0·06
P_2O_5	0·04
BaO	0·03
ZrO_2	0·02
S	0·04
F	0·16
	99·97
Less O for F	0·06
Total	99·91

NORM

Quartz			32·71
Feldspar	Orthoclase	24·96	61·50
	Albite	32·43	
	Anorthite	4·11	
Corundum			1·08
Zircon			0·03
Hypersthene	en	0·40	2·37
	hy	1·97	
Magnetite			0·93
Ilmenite			0·51
Pyrite			0·07
Apatite			0·11
Fluorite			0·30
	Water		0·29
		Total	99·90

MODE

Quartz		37·0
Feldspar	Microperthite	48·4
	Plagioclase	11·5
Biotite		2·0
Hornblende		0·5
Accessories		0·6
	Total	100·0

A granite-porphyry [5480] of the Crotty's Knob suite and a variant of the granite just described was collected from a point less than a quarter of a mile west of McGaskel's homestead, which is scarcely a half-mile north east of Crotty's Knob. There, a prospector's shaft has been sunk to some depth through the granitic rock, unweathered blocks of which are available in the dump heap. As seen in the hand-specimen this is a faintly-pinkish, medium-grained, granitic rock in which larger pinkish-flesh-coloured orthoclase and greyish-white plagioclase are embedded in a finer-grained aggregate of feldspar, quartz, and black ferromagnesian minerals.

Examined in microscopic slide, it is found to be composed predominantly of orthoclase and perthitic orthoclase amounting to about 50% by volume of the rock. Greyish-white plagioclase of the composition of acid oligoclase is present to the extent of 15%. Some 32% of the rock is quartz, occurring as well distributed macroscopic crystals. Hornblende, pleochroic in green to brown colours, is the next most abundant mineral, amounting to almost 2% by volume. Rarely, flakes of biotite and grains of magnetite appear.

A large platform of granite located about a half-mile or more north of Crotty's Knob is a sphene-bearing, hornblende-biotite variety closely related to [5480].

Aplitic veins, sometimes distinctly granophyric, traverse the granite of Crotty's Knob. They are mainly composed of quartz and orthoclase, the latter often riddled with albite veining. Plagioclase is plentiful, but very little biotite is present and there is no hornblende.

Kangaroo Flat Outcrops

To the north and north-east from the granite rise of the neighbourhood of Crotty's Knob, is lower country occupied mainly by outcrops of Tertiary limestone. To the south-west and south the surface falls away toward the Coorong, the intervening region being occupied by Tertiary to Recent marine limestones and dune rocks. To the south-east, the elevated region around Cold and Wet and Crotty's Knob extends towards Mount Boothby and is apparently underlain by granite at no great distance below the surface, though the region is almost devoid of granite outcrops; the surface rock is mainly calcareous and siliceous blown-sand rock and travertinized marine Tertiary limestone.

On the way from Cold and Wet to Meningie, at not more than two miles north of Crotty's Knob, is a low scrubby area, 150 feet above sea-level, with occasional outcrops of granite, known as Kangaroo Flat. In this locality, at about three-quarters of a mile to the north-north-east from a house built onto an overhanging wall of granite, is a small occurrence which has been mined, where pyrolusite replaces the Miocene limestone. There the underlying granite outcrops in close proximity to the manganese workings. The granite of this outcrop approximates in character to that of the Cold and Wet locality.

Bottle Hole Outcrop

Another notable appearance of the granite is located about two and a half miles north-north-west of Crotty's Knob. This is on a tree covered rise elevated (230 feet above sea-level) slightly above the neighbouring region of Tertiary limestones. There is there a considerable development of tors; also a gnama hole, with a small opening, full of water; this has earned for the locality the name of Bottle Hole.

The granite [3798 A] of this place is closely similar to that of Binnie's Water, described in detail below. The grain-size of the specimen collected is perhaps

slightly less coarse and the dark-coloured quartzes are perhaps more conspicuous. Perthitic orthoclase is still the predominant feldspar. The plagioclase is apparently very slightly less calcic. Fluorite is still to be observed associated with the biotite, which is singularly rare and usually chloritized. Hornblende is absent.

Granites near Binnie's Lookout

Still further to the west the underlying granite makes a notable appearance at Binnie's Water, which is 90 feet above sea-level. A number of outcrops were examined within a mile to the north and north north-east of this spot. It appears likely, also, that a line of granite several miles in length underlies the high sandy ridge rising to 325 feet above sea-level known as Binnie's Lookout Ridge.

At the foot of this ridge on the west side, and about a quarter mile north of the main road to Meningie, is a reddish, leucocratic, granophyre [5801], obviously closely related to the more normal granite of Binnie's Water. The only ferromagnesian mineral is biotite, of which there is very little. The outcrop, which is only a few yards across, is inconspicuous, being exposed in a washout. Its surface is elevated only about 30 or 40 feet above sea-level.

A sample of the normal granite of the Binnie's Water locality was collected adjacent to the water hole north of and within 100 yards of the main road between Coonalpyn and Meningie. This fluor-bearing granite is described herewith.

The Biotite Granite of Binnie's Water

This is a pink granite of medium grain-size. The prevailing colour of the rock is due to the presence of a large proportion of coarse pink to reddish orthoclase. There is also some nearly white feldspar which is a plagioclase. The quartz, which appears as compact grains, is of an unusually dark colour as seen in the hand-specimen; it is to some extent a smoky variety of quartz. Biotite is the only ferromagnesian mineral and is notably scarce, so that this granite may be referred to as a leuco-variety. The accessory minerals are revealed only in the microscopic slide. A determination of specific gravity carefully executed gave the figure as 2·63.

Examined microscopically, [3796] is seen to be hypidiomorphic, holocrystalline and of true granitic texture. The grain-size is fairly uniform, the average dimension of the individuals of quartz and feldspar as seen in the slide ranging from 2 mm. to 3 mm. In the hand specimen a not inconsiderable proportion of the feldspar individuals are seen to reach about 1 cm. in length.

The quartz occurs in large anhedral crystals in clear relief against the feldspar. Gas and liquid inclusions are plentiful. Tiny whisps of muscovite and grains of zircon are also to be identified.

Feldspar is present in three varieties. Firstly, the orthoclase which is usually extremely turbid, evidently owing to incipient kaolinization. Carlsbad twinning is a feature. Secondly, there is a notable development of perthite. In this, linear growths of albitic feldspar traverse the orthoclase. The plagioclase is distinguished by its higher R.I. and the occasional appearance of albite twin lamellae. On account of advanced turbidity of the feldspar the perthitic character is considerably masked. Thirdly, plagioclase appears in well-defined crystals often of considerable size; it is relatively free from secondary alteration. The composition as determined by extinction angles $Z \wedge c$ on the zone normal to the 'a' axis and on the zone normal to the 010 face, lies between $Ab_{67}An_{33}$ and $Ab_{70}An_{30}$; that is to say a calcic oligoclase.

The biotite is in small amount; occasionally it exhibits a chloritic alteration of pneumatolitic origin, not due to weathering. The fresh biotite is strongly pleochroic: $X =$ light-brownish-yellow, $Y = Z =$ dark brown to almost opaque.

It appears to be of an iron-rich type. Pleochroic haloes and inclusions are abundant.

Fluorite is present in notable amount, usually as tiny grains associated with aggregations of biotite occasionally interleaved with it, but sometimes appearing freely in the feldspar-quartz aggregate. Individuals up to 2 mm. diameter have been observed. It is usually colourless but occasionally it carries patches tinted purple. The mineral is easily identified on account of its high negative relief, well-developed cleavages and isotropic nature.

Iron ore, as very infrequent grains of what appears to be titaniferous magnetite, are present, usually associated with the biotite.

Sphene, in tiny grains, is occasionally seen in association with the magnetite and with the biotite that has suffered alteration. Tiny rods of zircon and of apatite are also present.

The chemical analysis, the norm and the mode are as stated below. In terms of the C.I.P.W. classification the rock is I. 4. 2. 3. (Toscanose).

CHEMICAL ANALYSIS
(By L. R. Parkin)

SiO_2	75·18
TiO_2	0·14
Al_2O_3	12·89
Fe_2O_3	0·60
FeO	1·07
MnO	0·02
MgO	0·04
CaO	1·04
Na_2O	3·59
K_2O	5·06
H_2O+	0·37
H_2O-	tr.
P_2O_5	tr.
F	0·15
	100·15
Less O for F	0·07
Total	100·08

NORM

Quartz			32·28
Feldspar	Orthoclase	30·02	64·30
	Albite	30·39	
	Anorthite	3·89	
Diopside	wo	0·35	0·71
	en	0·10	
	hy	0·26	
Hypersthene			0·92
Magnetite			0·93
Ilmenite			0·30
Fluorite			0·31
	Water		0·37
		Total	100·12

MODE

Quartz	30·0
Orthoclase	33·0
Plagioclase	8·3
Perthite	23·0
Biotite	5·0
Fluorite	0·4
Magnetite, apatite, zircon, sphene	0·3
Total	100·0

A fine-grained aplite vein [3797 A] traversing the granite at Binnie's Water is composed almost entirely of quartz and orthoclase. Micro-graphic intergrowths of these minerals are distributed through the slide. Fluorite appears to be absent.

ADAMELLITE AND GRANODIORITE

It will have been observed that the granites of the region embracing Binnie's Lookout to Cold and Wet are evidently closely related. No further outcrop of the reddish, fluorite-bearing granite suite, beyond the one occurrence already noted at its base on the west side, is met with west or south of Binnie's Lookout ridge. In that direction there is a low region elevated very little above sea-level extending to the Coorong and Lake Albert. This area is occupied by marine, lacustrine and aeolian formations of Pleistocene to Recent Age. The only outcrops of igneous rocks in this broad belt are four extremely limited exposures of adamellite which appear as inliers from beneath the recent deposits. All of them are in the neighbourhood of Meningie and are related in character and unlike the granites already described.

The Pelican Islets

The first two are very small whale-back islets, the Pelican Islets, rising several feet above the waters of Lake Albert near its eastern shore, as indicated in the map herewith. The more easterly islet (pl. xxxii, fig. 1) upon which a landing was made, is composed of two parts; the more southerly being oval in shape and rising 6 feet above the lake waters; the other section is only 18 yards long but rises 9 feet above the lake water.

These outcrops offered no opportunity for securing really fresh material for examination. Such as has been obtained is from platy exfoliations of about 12 inches in thickness. The feldspars are therefore duller and somewhat modified in colour from what may be expected to prevail a few feet further below the surface. In the hand-specimen large, porphyritic, white feldspars are embedded in a coarse granitic aggregate of colourless quartz, feldspar, and abundant bright black biotite.

Microscopically examined the mineral suite and general nature of the rock [3800 A] suggests affinity with the rock from Taratap to be described in detail later. Orthoclase occurs in very large, slightly turbid, phenocrystic sections containing microperthitic albite. There are occasional inclusions of twinned plagioclase. Plagioclase is present in amount in excess of the potash feldspar, but though larger individuals do occur, it appears in the main in rather smaller crystals with more even distribution. Its composition $Ab_{60}An_{40}$ agrees with normal andesine. Quartz occurs in large optically continuous aggregations. The biotite is quite like that of the Taratap rock. Inclusions of zircon as tiny rods and apatite in more symmetrical sections are a feature of the biotite. Occasionally grains of magnetite are associated with the biotite. More rarely minute grains of sphene, zircon and larger prisms of apatite are met with not in immediate association with the biotite.

Waltowa Swamp Outcrops

The third and fourth occurrences of granitic rock in the Meningie area are tiny whale-backs rising not more than 6 feet above the ground, located respectively on Section 139, Hundred of Malcolm, and Section 51, Hundred of Bonney (see sketch map herewith). They are in an area of recent lacustrine sediments of a former extension of Lake Albert and at lake level. In both cases the rock in the hand-specimen bears a close resemblance to that of the Pelican Islets, but the material for study is considerably weathered. In microscope slide the rock [3801] from Section 51 is seen to contain a somewhat smaller percentage of orthoclase and there is greater uniformity of size among the mineral constituents. While it conforms in other features with the Pelican Islet rock, it is distinctly richer in apatite which occurs in prisms up to 0·3 mm. across. Sphene, zircon and titaniferous magnetite are also present.

Outcrops North-east of Kingston

The only other area in south-eastern South Australia to the east of the Murray River system where there are known to occur granitic rocks of the same general appearance is in the vicinity of the Coorong road, between 10 and 25 miles north-north-east of Kingston. There several small outcrops are located. Of these the most important is a low rise about 150 yards in diameter situated within a half-mile of the Coorong highway on its north side at a point 11 miles from Kingston. At this spot the road engineers have recently opened up, for road metal, a large excavation known as Taratap quarry. Consequently quite fresh rock is now available for study. A feature of this outcrop is the abundance of

xenoliths embedded in it. Examination has shown it to be a biotite-granodiorite as described below.

In the near neighbourhood of this quarry are two other small occurrences within half-a-mile to the east and south-east and two others exposed on the sea beach, nearly due west of it.

Biotite-Adamellite from Taratap Quarry

This is a coarse-grained, granitic rock, the greater part of which is equigranular but studded through it are large feldspar phenocrysts as much as 5 cms. in diameter [4415]. In some of the quarry face the phenocrysts are less in evidence than elsewhere. The chemical analysis quoted below was made on an average sample [3802] and [3803] in which the phenocrysts are not extreme in their development. The prevailing colour of the fresh rock is grey, owing to the predominance of feldspar of a faintly bluish-grey colour. There is much colourless transparent quartz, and biotite is abundant in brilliant, shiny, black flakes and aggregates. The specific gravity of a medium-porphyritic specimen of this rock was found to be 2·78.

In the highly weathered rock the feldspar is stained a rusty-brown and the porphyritic feldspars stand out in relief above the general surface.

Microscopically examined it is seen to have a holocrystalline, hypidiomorphic granular texture with, in the case of the non-porphyritic base aggregate, an average grain-size of 4 mm. The essential minerals are quartz, very abundant feldspar and plentiful biotite.

Quartz is present both as large clear individuals and as small interstitial grains. Inclusions are not abundant.

Orthoclase is less abundant than the plagioclase. It is present mainly as scattered phenocrysts. The larger crystals are slightly turbid and display irregular boundaries against which the plagioclase is usually idiomorphic. The typical grating structure of microcline is to be observed on a minute and irregular scale, mainly along cracks and boundaries. This suggests that the effect in due to strain. The R.I. is lower than Canada balsam and the optic sign is negative. The phenocrysts are studded with inclusions of quartz, plagioclase, biotite and pyrite.

The plagioclase is idiomorphic and generally clear. Twinning is characteristic and zoning well marked. Some sections cut normal to 010 give extinction angles corresponding to the composition $Ab_{66}An_{34}$, but the majority are more sodic than this, while the zoned sections demonstrate the transition. The feldspar is optically positive, and may be generally referred to as an acid andesine.

Biotite occurs in abundant aggregates and some large plates are bent. The colour and pleochroism are striking: $X =$ pale straw yellow, $Y < Z =$ dark mahogany. Large inclusions of zircon with well-marked pleochroic haloes are very common, the haloes ranging up to 0·1 mm. in diameter. Prisms and sections of apatite and grains of pyrite are also quite usual inclusions.

Although the biotite is absolutely fresh, there are isolated cases where secondary deuteric changes have resulted in chloritization with the development of some granular sphene.

Apatite is notably abundant and is often grouped with the biotite. The prisms are as much as 0·5 mm. across. Sphene in small granules is met with, especially in biotite which has suffered secondary changes. Zircon is present in tiny prisms, often associated with the biotite. Magnetite, probably titaniferous, appears only in very small amount. Pyrite, in isolated granules, is rather rare. What may be tiny octahedrons of fluorite occur in one of the micro-slides.

From the chemical anaysis by L. W. Parkin, with some determinations of minor elements by E. R. Segnit, appearing below. The magmatic character according to the C.I.P.W. classification is II (I) 4. 3. 3.

CHEMICAL ANALYSIS
(Mainly by L. W. Parkin)

SiO_2	66·08
TiO_2	1·14
Al_2O_3	13·41
Fe_2O_3	0·73
FeO	5·08
MnO	0·03
MgO	1·22
CaO	3·86
Na_2O	2·46
K_2O	4·16
H_2O+	0·38
H_2O-	0·19
P_2O_5	0·56
BaO	0·04
CO_2	0·10
Cr_2O_3	nil
ZrO_2	0·04
S	0·12
F	0·14
	99·74
Less O for S & F	0·10
Total	99·64

NORM

Quartz			25·04
Feldspar	Orthoclase	24·63	58·50
	Albite	20·80	
	Anorthite	13·07	
Diopside	wo	0·56	1·10
	en	0·17	
	hy	0·37	
Hypersthene	en	2·88	9·15
	hy	6·27	
Magnetite			1·07
Ilmenite			2·16
Apatite			1·31
Pyrite			0·23
Zircon			0·05
Fluorite			0·19
Calcite			0·20
	Water		0·57
	Total		99·57

MODE

Quartz	23
Orthoclase	20
Plagioclase	38
Biotite	16
Accessories	3
Total	100

NORTHERLY OUTCROP ON REEDY CREEK WATERCOURSE

About 14 miles north-north-east of the Taratap quarry and 3 miles east of the Coorong Highway on the northern border of the Hundred of Duffield in the area of the Reedy Creek watercourse, are some further small outcrops of a richly biotitic, granitic rock, related to that of Taratap. The specimens obtained are too far weathered to warrant detailed examination but they come within the range of adamellite or granodiorite. There are about four outcrops in linear arrangement striking in a direction N. 35° W. (true), extending for a length of over half a mile. The highest point on these outcrops is about 20 feet above the swampy flat, which is but little raised above sea-level.

RELATIONS AND AGES OF THESE GRANITES

It has been observed that the granites dealt with, located to the east of the Murray River, fall into two distinct types. The first of these, and apparently more extensively developed, is that best illustrated by the outcrops at Crotty's Knob in the Cold and Wet area. Those of the Binnie's Water area are very closely related but more leucocratic in character, containing less ferromagnesian constituent and more orthoclastic content. These rocks, in general appearance, closely resemble the granites of the neighbourhood of Murray Bridge, 53 miles to the north-west, and of Palmer, 20 miles further to the north-north-west. Their chemical similarity is illustrated in the table (p. 242), where the composition of both the Crotty's Knob rock and that of Swanport (Murray Bridge) are stated. A definite link is that the granites from both these areas are notably fluorite bearing. Consequently, as there is no known evidence to the contrary, it is safe to assume that the granites outcropping to the south-east of Coonalpyn and those of the Murray Bridge area are part of the same bathylithic intrusion.

TABLE OF ANALYSES

	I	II	III	IV
SiO_2	74·08	74·20	66·08	69·31
TiO_2	0·24	0·29	1·14	0·74
Al_2O_3	13·50	14·53	13·41	14·13
Fe_2O_3	0·60	1·14	0·73	0·66
FeO	1·64	0·90	5·08	3·49
MnO	0·03	0·03	0·03	0·05
MgO	0·16	0·20	1·22	1·61
CaO	1·09	1·00	3·86	2·01
Na_2O	3·86	3·06	2·46	2·67
K_2O	4·19	3·55	4·16	4·43
H_2O+	0·23	0·15	0·38	0·54
H_2O-	0·06	0·15	0·19	0·10
P_2O_5	0·04	0·08	0·56	0·10
BaO	0·03	nil	0·04	0·10
ZrO_2	0·02	n.d.	0·04	0·13
CO_2	n.d.	0·11	0·10	—
F	0·16	0·19	0·14	—
Cl	n.d.	0·03	n.d.	—
S	0·04	0·10	0·12	0·14
	99·97	99·71	99·74	100·21
Less O for F & S	0·08	0·10	0·09	0·04
Total	99·89	99·61	99·65	100·17

I. Hornblende-Biotite-Granite of Crotty's Knob; analyst, E. R. Segnit, Department of Geology, University, Adelaide.

II. Biotite-Granite from Swanport (near Murray Bridge); analyst, W. S. Chapman, with determination of fluorine, by A. W. Kleeman (2).

III. Biotite-Granodiorite, Taratap; analyst, L. R. Parkin, with determination of minor elements by E. R. Segnit.

IV. Adamellite Porphyry, Victor Harbour (mean of analyses of two varieties); analyst, A. W. Kleeman, Department of Geology, University, Adelaide (3).

The second group dealt with in this paper are grey porphyritic rocks. In the hand-specimen they are in marked contrast with the reddish even-grained character of the first group. They vary in nature from adamellite to granodiorite. The outcrops of these lie to the south of the belt of red fluorite-bearing granites. In general appearance they are very like the porphyritic adamellite of Granite Island, Victor Harbour, which is located about 40 miles to the west of the nearest (Pelican Islands) of these new records. The rock from Taratap, described earlier in this paper, appears to be the most basic of all the outcrops examined and is distinctly more plagioclastic than that of Granite Island, a fact well illustrated by comparison of the analyses set out in the table above. A microscopic study of rocks from the various outcrops indicates that members of this group occurring in the Meningie area bear a much closer chemical correspondence with the Granite Island porphyritic adamellite than does the rock from Taratap. The mineralogical and structural character of the rocks from both areas bear such similarity that it may be assumed that the outcrops herein recorded are an eastward extension of the Encounter Bay to Cape Willoughby (Kangaroo Island) intrusions.

As the rocks of both groups referred to in this discussion are unstressed, they have been recognised as apparently of the youngest of our South Australian granites.

However, until quite recently there has been such great uncertainty as to the age of the metamorphosed rocks intruded by these granites where they impinge on the eastern flank of the Mount Lofty Ranges that it has, in the past, seemed unsafe to give final consideration to the question of age of these intrusions. Now,

Fig. 1 The two portions of the more easterly of the Pelican Islets.

Fig. 2 Crotty's Knob, viewed from its north-west end.

with the extension of the mapping of the Cambrian and Pre-Cambrian rocks of the State, we are able to approach the problem with greater assurance.

In discussing the age of the Encounter Bay and Cape Willoughby intrusions, Tilley and Browne long ago indicated their Palaeozoic age, assuming that the rocks intruded were of Cambrian age. Recent mapping does tend to confirm the view held at that time that the Encounter Bay granites do intrude members of the Adelaide Series of sediments, but the age of the latter has been stepped back into the pre-Cambrian. However, although evidence is wanting of the actual intrusion of these granites into the undoubted (fossiliferous) Cambrian, yet there is every indication that they were introduced into their present position amongst Proterozoic rocks not earlier than the orogenic period which ended the period of Cambrian sedimentation in South Australia. Though not intruded by the granites, fossiliferous formations of Lower-Cambrian age are definitely part of the folded system forming the rocks of the Mount Lofty Ranges. Consequently, the contention of Tilley and Browne is probably correct, namely, that the introduction of those granites very likely took place concomitantly with the post-Cambrian disturbances which converted the South Australian Cambrian geosyncline into a magnificent anticlinorium.

As to the date of the period of orogeny which put an end to the long succession of sediments that had accumulated in the South Australian geosyncline during late Proterozoic and early Cambrian time, we have as evidence the following facts:

Firstly, whereas there is in South Australia a great development of Early to Middle-Cambrian sediments, nowhere has there been met with any formation of Upper-Cambrian age.

Secondly, in the western MacDonnell Ranges, Central Australia, where the stratigraphy of the Late-Proterozoic and Cambrian sediments bears some relationship to that of the corresponding period in South Australia, the Upper-Cambrian is also missing and the Middle-Cambrian is overlain unconformably by an Ordovician formation with evidence of an erosion interval between the two groups.

Thirdly, igneous activity on a considerable scale is recorded in the Upper-Cambrian of Tasmania and Victoria.

The above facts indicate that the latter part of Cambrian time was an outstanding period of orogeny in South Australia, and in part of Central Australia. It has been indicated that it was in the process of this upheaval that the Encounter Bay granites were intruded, and now it appears logical to couple with these the adamellites of Meningie and granodiorite of Taratap.

Whether the red fluorite-bearing granites of the Murray Bridge and Coonalpyn areas are of the same age as those just referred to is yet uncertain. But as they are unstressed and apparently located in the heart of the anticlinorium of late Cambrian age they would appear, in the present state of our knowledge, to belong to the same period of orogeny as those more southerly and distinctly different types encountered between Kangaroo Island and Kingston. Outcrops of the latter group are usually remarkable for the abundance of xenoliths, indicating that they are to some extent, at least, contaminated rocks.

In conclusion, we wish to express our indebtedness to Mr. L. H. Mincham, who brought under our notice most of the granite outcrops described and whose generous assistance in the field greatly facilitated our investigation.

References

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2 Kleeman, A. W. 1934 Trans Roy. Soc. S. Aust., **58**, 237-241
3 Kleeman, A. W. 1937 Trans. Roy. Soc. S. Aust., **61**, 207-220
4 Tilley, C. E. 1918 Trans. Roy. Soc. S. Aust., **43**, 316-341

ABORIGINAL NAMES AND UTILIZATION OF THE FAUNA IN THE EYREAN REGION

By T. HARVEY JOHNSTON, University of Adelaide

Summary

Under the auspices of the Board for Anthropological Research, University of Adelaide, expeditions visited Pandi on the lower Diamantina, adjacent to the Queensland border, in 1934, and the northern Flinders Ranges in 1937. Investigations regarding blood-grouping of the full-blood aborigines were published by Cleland and Johnston in 1936 and 1938 respectively. Opportunity was taken in each case to ascertain the uses made of the local flora by the natives, the results being recorded by the same authors in 1943 and 1939 respectively. In company with Professor J. B. Cleland, some native names of species of animal life were obtained on each occasion. Further investigation has revealed that much published information is available but is widely scattered in literature. The present paper is an attempt to bring it together under a zoological classification.

ABORIGINAL NAMES AND UTILIZATION OF THE FAUNA IN THE EYREAN REGION

By T. Harvey Johnston, University of Adelaide

[Presented 9 September 1943]

Under the auspices of the Board for Anthropological Research, University of Adelaide, expeditions visited Pandi on the lower Diamantina, adjacent to the Queensland border, in 1934, and the northern Flinders Ranges in 1937. Investigations regarding blood-grouping of the full-blood aborigines were published by Cleland and Johnston in 1936 and 1938 respectively. Opportunity was taken in each case to ascertain the uses made of the local flora by the natives, the results being recorded by the same authors in 1943 and 1939 respectively. In company with Professor J. B. Cleland, some native names of species of animal life were obtained on each occasion. Further investigation has revealed that much published information is available but is widely scattered in literature. The present paper is an attempt to bring it together under a zoological classification.

The Eyrean drainage system occupies a very much greater expanse of territory than that at present under consideration. Very little of the water reaches Lake Eyre now, because of the very high evaporation rate (about 100 inches per year), the low annual rainfall (about five inches, received very irregularly), the slight fall of the land, and the increasing aridity. The region bordering on Lake Eyre (Katitandra of the natives) has been described by Gregory (1906) as "the Dead Heart of Australia." The drainage system includes the huge area drained by the Barcoo (Cooper's Creek), Diamantina (Kuyuna of the Wonkanguru), Georgina, Finke, and Alberga, as well as those streams in Central Australia which trend easterly and south-easterly to become lost in the deserts and sandhills before they can reach their original outlet. This immense region has a length of about 650 miles (from the Barclay Tableland to the northern end of the Flinders Ranges), and a breadth of about 1,000 miles (from the Musgrave and Macdonnell Ranges to the Great Dividing Range in Queensland). It is proposed to restrict the paper to a consideration of the region lying between 137° and 143° E, and between 24° and 33° S. This will exclude the region lying north of Bedourie on the Georgina, but will include the Flinders Ranges and adjacent areas as far south as the head of Spencer Gulf. It will include the far north-western portion of New South Wales (west of the Darling) and the adjacent part of Queensland. Just beyond the eastern limit of the restricted area is the eastern limit of those tribes which practise circumcision, while the eastern boundary of the tribes which practise subincision almost bisects it in a north-south direction, such distribution being indicated by Tindale (1940) in his map of Australian tribal boundaries. A partial survey of the ecology of portion of the region has been published by Andrewartha (Trans. Roy. Soc. S. Aust., **64**, 1940).

The north-eastern corner of South Australia has been traversed by several expeditions:—Captain Sturt, Sir Thomas Mitchell, Burke and Wills, the various expeditions sent out to relieve the last-named two, as well as parties concerned with surveying and with pastoral possibilities. The South Australian Museum, in 1916, sent out a small party under E. R. Waite to collect plant and animal material in the Strzelecki region, the various reports by Waite, White, Rainbow, Zietz, Black, MacCulloch and Lea being published in 1917. Gregory (1906) was more particularly interested in the geography and geology of the vicinity of Lake Eyre. A succession of good seasons following the flooding of lower Cooper's Creek led

to the establishment of Lutheran missions (abandoned some years later, and now represented by ruins) in the Dieri country, and a few police stations were organised there as well as to the north. It is to the missionaries and some of these police officers that much of our knowledge of the natives of the region is due, and much is still awaiting publication, being contained in the Reuther manuscripts which are in the possession of the South Australian Museum. The police officers concerned were Gason, Wells and Aiston. Strehlow, who published a monumental work on the Aranda people, began his anthropological work at one of the Dieri mission stations, and Siebert who collaborated with Howitt, was on its staff, as also was Reuther. Part of the manuscript of the last-named (that relating to the toas or direction-indicators associated with local myths concerning the wanderings of ancestral or mura-mura beings) was worked up by Stirling and Waite and published in 1919.

The most important anthropological work relating to the region near Lake Eyre was that published by Gason (1874; republished in 1879 and 1886), and by Howitt (1885; 1891; 1904). The latter was interested especially in the tribal organisation, and some of his papers (1903) were written in collaboration with Siebert. Horne and Aiston (1924) dealt in a more popular way with the Wonganguru people whose territory adjoined that of the Dieri. Elkin (1937; 1938) published papers relating to these regions but did not concern himself with our present subject, whereas there are many references to native names and utilization of animals in their tribal economic and social organisation contained in the other works mentioned. M. Howitt (1902) and Fry (1937) published several local legends. Gatti's Dieri-Italian vocabulary (1930) is based largely on Gason's work in regard to the names of animals. The mammals of the Lower Diamantina were studied in the field by Finlayson, who published his results in a series of excellent papers dealing with the morphology and habits of the various marsupials and rodents. He also mentioned their native names.

Hale and Tindale spent some time in the northern Flinders Ranges (Wailpi tribe) and published information relating to our subject (1925). Berndt and Vogelsang (1941) gave a comparative vocabulary of many Dieri, Ngadjuri and Wailpi terms.

The northern part of the Pangkala territory lies in the region we are considering, and Schürmann (1844; 1846) published much information concerning that tribe and relating to our subject.

Roth (1897; 1901) published a considerable amount of information regarding the relation of the natives to the fauna of the area in western Queensland lying to the north of the region which we are considering. Reference will be made to his work only insofar as it relates to matters or to species of animals with which we are dealing. Strehlow, as well as Spencer and Gillen (1896; 1899) studied the Aranda (Arunta) people inhabiting the territory to the north-east of our Eyrean region; while Taplin (1873; 1879), Wyatt (1879), Meyer (1840; 1846; 1879), Teichelmann and Schürmann (1840), and Moorhouse (1846) have dealt with that lying to the south of our selected area. The Elder Expedition obtained information concerning the region to the west (Helms 1896).

Mrs. Duncan-Kemp published a popular book, "Our Sandhill Country" (1933), concerning an area west of Farrar Creek in the vicinity of Bedourie in far-western Queensland, her home at one time being at Mooraberrie, which is in the territory of the Karuwali tribe. Her remarks were not always localized tribally, but mention was made of the Pitta-pitta, Ooloopooloo, Karanya, Mittaka and others. Her work contains many references of interest which are now incorporated to bring them under scientific notice. Her region lies between that visited by us and that studied by Roth.

Tindale (1940) published a very important paper and a map indicating the boundaries of Australian tribes. Pressure by other tribes, due to economic stress, new railways or settlements, or diminution of population associated with drought or disease, has led to movements towards Lake Eyre and towards the sea coast, so that tribal boundaries may be differently indicated on maps according to their respective dates. Howitt (1904, 45) referred to the process in connection with the Wonkamala, Wonkanguru and Dieri peoples. Finlayson (1932, 150) mentioned the invasion of the Yelyendi territory by the Wonkanguru; and Horne and Aiston (1924, 35) referred to the displacement of the latter tribe southwards by the Ngameni, the Dieri becoming pushed further south by the invading Wonkanguru. The rapid diminution of the full-blood aboriginal population in the lower Diamantina and Cooper regions has been referred to by Fenner (1936), Tindale (1941, 73, 78), and Johnston and Cleland (1943, 150).

Curr (1886) distributed widely throughout those parts of Australia where local information concerning aborigines could be obtained, a list of terms and objects for which native names were desired. The names of a number of different animals (a few mammals, several birds, and a few others) were thus brought together. The names of the contributors (in the order in which they appear in the book), the particular localities concerned, and the local tribe, if mentioned, will be indicated now to avoid repetition later. Where the native tribe is not stated or where the name given is not regarded as being tribal but merely that of a horde or of a district, the tribal designation is that quoted by Tindale in his list of Australian tribes (1940), or is that which I believe to be correct, after consulting Tindale's tribal map (1940), my comments being enclosed in brackets:—Le Souef and Holden, Port Lincoln and the western shore of Spencer's Gulf, Pangkala; Jacobs, north-west of Lake Eyre [Arabana]; Jacobs, northern shore of Lake Eyre [probably Wonkanguru]; Todd, Peake Telegraph Station [Arabana]; Warren and Hogarth, west of Lake Eyre [Arabana]; Paull, Warburton River, Ominee tribe [Ngameni], the territory of that tribe meeting those of the Wongonooroo [Wonka-nguru], Kuranyooroo [Kara-nguru] and Yarleeyandee [Yelyendi] at Cowarie on the Warburton; Cornish, Warburton River [probably Ngameni]; Salmon, Cooper's Creek at Koongi Lake [Yauraworka]; Cornish, Cooper's Creek to the eastward of its northern branch, Yowerawolka tribe [Yauraworka]; Howitt, Cooper's Creek at Innamincka [Yantruwunta]; Sullivan and Eglinton, Cooper's Creek, near the Bulloo River [three tribes are indicated in Tindale's map, but the lack of a more definite locality prevents a definite assignment; the vocabulary is essentially the same as that given for the Tereila tribe by the next author]; Foott, Nockatunga, Wilson River [the locality is stated by Myles to belong to the Thiralla (*i.e.*, Tereila) tribe]; Miles, Thargominda, Bulloo River, Wonkomarra tribe [Wonkumara of Tindale, p. 175]; Sullivan, Lower Bulloo River [Myles called the tribe Bitharra; Bitjara in Tindale's map]; Gason, from Mount Freeling to Perigundi Lake, Dieyerie [Dieri]; Jacobs, Kopperamana [Dieri]; Warren, Strangway Springs [Arabana]; Phillipson, Umbertana [Umberatana, Wailpi tribe]; Wills, Mount Serle, Tura or Eura tribe [Wailpi]; Kingsmill, Beltana, Kooyiannie [Kujani]; Gason, Unyamootha tribe [Unyamatna = Wailpi]; Green, Wonoka, Arkaba-tura tribe [Jadliaura, Tindale, p. 185]; Green, eastern shore of Lake Torrens, Kortabina tribe [Pangkala, Tindale, p. 182]; Sawers, Gawler Range [Pangkala]; Beddome, Marachowie [Pangkala]; Valentine, Mount Remarkable, Doora tribe [Nukunu, Tindale, p. 182]; Le Brun, forty miles east of Port Pirie [Ngadjuri, Tindale, p. 180]; Crozier, Evelyn Creek, Pono tribe [Wanjiwalku, Tindale, p. 194]; Dewhurst, Evelyn Creek, Pono tribe [Wajiwalku]; Morton, near the north-west corner of New South Wales, Mulyanapa tribe [Malja-ngapa, Tindale, p. 192]; Reid, Torrowotto, Milya-uppa tribe [Maljangapa, Tindale, p. 192]; Anonymous, Lower Diamantina, 141° E, 25° S.

Karawalla tribe [Karuwali, Tindale, p. 160; Mrs. Duncan-Kemp's observations were made mainly at Mooraberrie in the territory of this tribe]; Heagney, Kungarditchi tribe [Kungadu-tji, Tindale, p. 164]; Fraser, Whitula Creek, Birria tribe; Curr, Birria tribe [Bidia, Biria, Tindale, p. 156]; Heagney, Koongerri tribe [Ku-ngkari, Tindale, p. 164]; Dix, Boolcoomatta [Wiljakali of Tindale, p. 195; Wilya of Howitt 1904]; Machattie and Little, Moorloobullo tribe, at junction of King's Creek and the Georgina River [Karanya tribe, Tindale, p. 160]; Eglinton Bitta Bitta tribe, Hamilton River, near Boulia [Pitta Pitta of Roth 1897; Pitapita of Tindale, p. 170].

Wells (1894) published a short vocabulary of the Andrawilla tribe from the Lower Diamantina. He stated that fourteen smaller clans or tribes were included in that tribe, one of these being the Koringurra. This latter is obviously Kuringura, i.e., Kara-nguru. Andrawilla is the locality where Wells, as police officer, was stationed, at the junction of the Eleanor and the Diamantina, about thirty miles south of Pandi, where we were camped. The Kara-nguru tribe is now extinct. Johnston and Cleland (1943, 141) considered that the Andrawilla people probably belonged to the Ngameni, a neighbouring tribe.

Howitt (1891) published a rough map indicating the regions occupied by various tribes in the vicinity of Lake Eyre, but the distribution, as shown, differs markedly from that of later maps, particularly in regard to the Wongkurapuna [Arabana], Kuyani and Murdula [Mardala = Wailpi] tribes, but his later map (1904, 44) is much more in agreement with that published by Tindale (1940). Howitt (1891) indicated a tribe termed Yandairunga occupying the western shores of Lake Eyre, where the Arabana dwelt. In 1904 he termed it Yendakarangu. Tindale (1940, 178) reported that the former name applied to the Antakirinya tribe [Andigerri of some authors] which lived west of the Arabana. We are referring in the present paper to the faunal names attributed to this tribe by Howitt, but are not including information relating to it derived from other sources. This tribe migrated to the Arabana territory in recent times, no doubt attracted by the construction of the northern railway to Oodnadatta. The tribe termed Kurnandaburi by Howitt (1940), from the vicinity of Mount Howitt, Cooper's Creek, Queensland, is considered by Tindale (1940, 160) to be probably the Karendala, but may be the Kungadutji whose territory was adjoining; we have listed the references as belonging to the Karendala.

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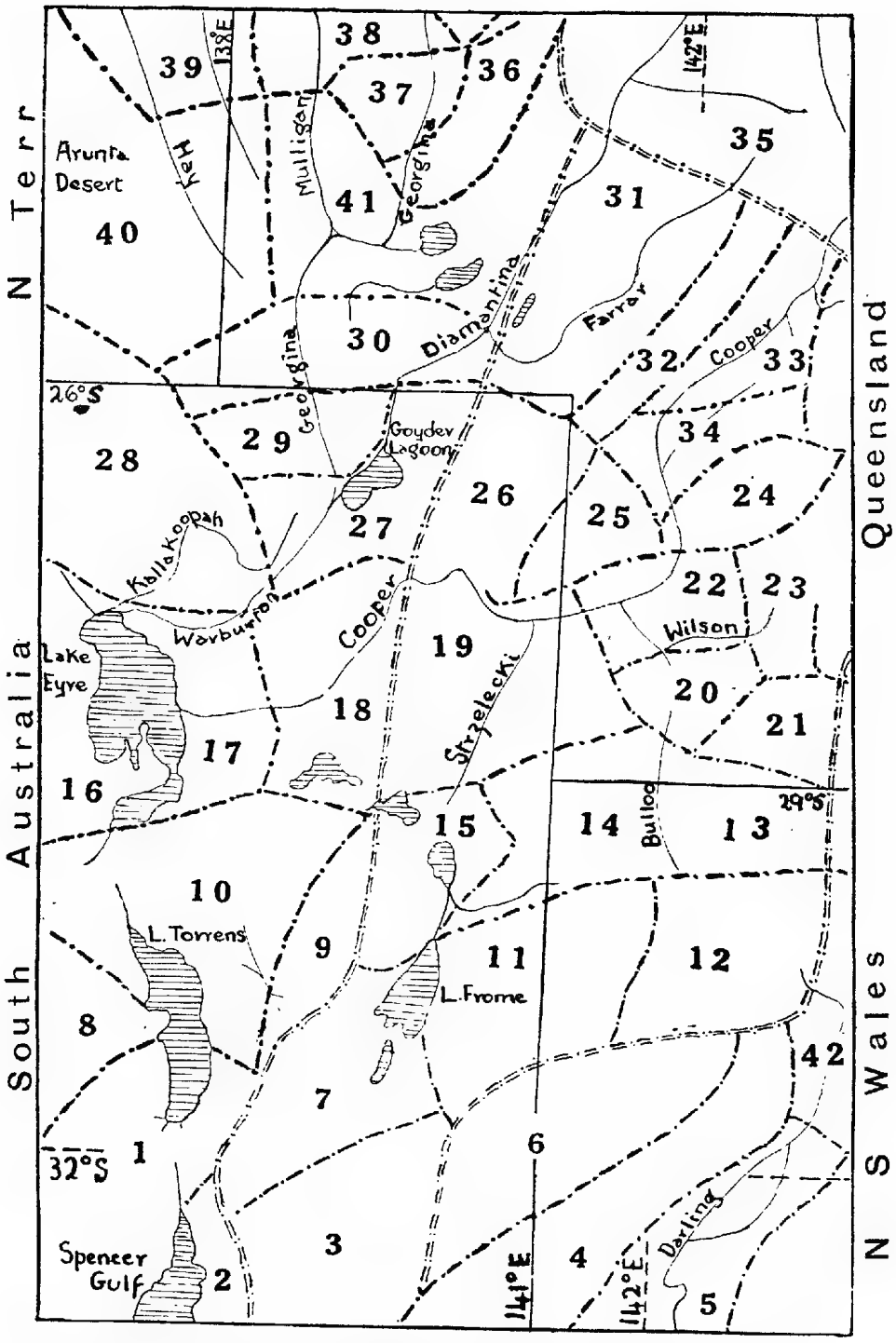
The following abbreviations for tribal names have been used by us:—A, Arabana (Urabunna); An, Antikirinya (Andigerri, Yendakarangu, Yandairunga); B, Bitjara; Ba, Barkindji; Bi, Birria; D, Dieri; Ja, Jadliaura; K, Kuyani; Ka, Kara-nguru; Kd, Karendala (Kurnandaburi); Kg, Kungadutji; Ku, Ku-ngkari; Kw, Karuwali; Ky, Karanya; Ma, Malja-ngapa; Mi, Milpulko (? part of Naualko tribe, Tindale, 1940, 1942); N, Ngameni; Nj, Ngadjuri; Nu, Nukunu; P, Pilatapa; Pa, Pangkala; Pp, Pittapitta; T, Tirari; Te, Tereila; W, Wonkanguru; Wa, Wanjiwalku; Wi, Wilyakali (Wilya); Wk, Wonkumara; Wo, Wonkamala; Wp, Wailpi; Y, Yelyendi; Ya, Yaurorka; Yu, Yantruwunta. DK has been used to indicate information from Mrs. Duncan-Kemp's work unless definitely localised.

The tribes included in our restricted area have a two-class social system with descent in the female line. These two moieties are exogamous and intermarrying. The distribution of such a system is indicated by Howitt (1904;



TRIBAL BOUNDARIES IN THE EYREAN REGION (after Tindale, 1940)
1, Pangkala; 2, Nukunu; 3, Ngadjuri; 4, Dangali; 5, Barkindji; 6, Wilyakali; 7, Jadliaura; 8, Kokata; 9, Wailpi; 10, Kuyani; 11, Malyanapa; 12, Wanjiwalku; 13, Karenggapa; 14, Wadikali; 15, Pilatapa; 16, Arabana; 17, Tirari; 18, Dieri; 19, Yantruwunta; 20, Tereila; 21, Bitjara; 22, Wonkumara; 23, Ngandangara; 24, Karendala; 25, Ngurawola; 26, Yauraworka; 27, Ngameni; 28, Wonkanguru; 29, Karanguru; 30, Yelyendi; 31, Karuwali; 32, Marulta; 33, Biria; 34, Kungadutji; 35, Majuli; 36, Karanya; 37, Kungkalenya; 38, Pitapita; 39, Andekerebina; 40, Wonkamala. 41, Mitaka; 42, Naualko. The dotted line almost bisecting the map indicates the eastern limit of the tribes practising subincision; that on the right of the map marks the eastern limit of tribes practising circumcision.

map, p.90). The two classes correspond to those of Eaglehawk and Crow of Victoria (Mathew 1899). Amongst the Dieri and some neighbouring tribes the terms Kararu and Matteri are employed. Each class was composed of individuals belonging to a number of groups or murdus (also called mada, muddu), and Howitt (1904, 91-98) has given lists of those which he found represented in the various tribes. These murdus, according to the Dieri legend, were originally animals or plants ordered by the great spirit (Mura) to assume human form when he instituted the class divisions (Howitt 1885,; 1904, 96). These murdus, after having become human, scattered in various directions, retaining their original names, and thus these totem (or murdu) names have become irregularly distributed in the different tribes occupying the Eyrean region (Howitt 1904, 782-783). The present inhabitants regard themselves as descendants of the particular murdu to which each belongs. The legendary actions and wanderings of the ancestral muramuras play a very important part in the beliefs and ceremonial life of the aborigines.

A perusal of the names given by Curr's correspondents (1886), and incorporated in this paper, will indicate a wide variety of spellings (and, to some degree, of pronunciations also) for the same native term. There are, of course, some minor changes in the name of a particular animal as one passes from one district to another, while in other cases the change is so marked that entirely different terms are applied to such animals. An attempt has been made to group similar terms.

Primates

We have considered the aborigines as part of the fauna and have accordingly collected the various terms applied: (a) to them as a group, (b) to the individual male, *i.e.*, an aboriginal man, and (c) a native woman. We have also included the terms applied to the invading white man by the aborigines.

Human hair is converted into string and used for waist girdles and head bands (Schürmann 1879, 211, 233). The waist girdle of human hair or of opossum fur was termed kakkallee Pa if made only from hair from the human head, kakka = head, Schürmann 1844, 9; kundindi Pa, purlupu Pa, Schürmann 1844, 20, 61; murdie W, dampera W, yinka W, Horne and Aiston 1924, 38, 45, 46, 68, 175; oolpooroo D, Sanger 1883; yinka D, Gason 1879 — D, Howitt 1904, 662. Head net or band, charpoo W, Horne and Aiston; chanpoo D (charpoo, p. 297), Gason 1879, 289; tjarpu D, Fry 1937, 201; munga Nj, jarpu D (charpoo of other authors), Berndt and Vogelsang 1941, 6. Hair, human or from other sources, was utilized in making charms (Horne and Aiston 1924) to be worn as a protection:—tharta W, against snakes and enemies, referred to later in this report; nalta W, now generally made from rabbit fur, to obtain through dreams information or to awaken remembrance of things forgotten (p. 137); tutta, composed chiefly of tails of marsupials tied together with sinews but containing some human hair (p. 136).

Human hair string was attached to the pointing bone:—wirragaroo W, Horne and Aiston 149, 152, 176, fig. 86-87; badnu Nj, naria-moku D, Berndt and Vogelsang 1941, 8; mookoo D, Gason 1879; muku, Howitt 1891, 90 (the small bone of the human leg is used). The bone-pointing ceremony is termed mookooellie duckana D, Gason 1879, 275; mukueli dukana D, Howitt 1891, 90, muku = bone, dukana = to strike; mukujali dukana D, Fry 1937, 201. The phallocrypt worn by men was wilpoo W, Horne and Aiston, 38, 47, 176, made of fibre and of fur of rabbit and "white rat" (*i.e.*, *Thalacomys*); wunari Nj, ngampu D, Berndt and Vogelsang 1941, 8; malberinye, ngulta, Pa, Schürmann 1844, 25, 48 (tassels of opossum fur); thippa, unpa D, Gason 1879 (from fur of rats or wallaby); tippa D, Howitt 1904, 646, 805) (from fur of "native rabbit"); purapura, wirupa D, Fry 1937, 190, 201. The string attached to the bull-roarer (yuntha D;

wetana Nj, junta D, Berndt and Vogelsang 1941) is made from human hair or from native flax (Howitt 1904, 660).

Hair or fur:—putti, butti Pa, Schürmann 1844, 23; multa (fur) moodoo (hair) Ka, Wells 1894; multje W, natta N, at Pandi. The method of converting hair, fur or fibre into string was described and illustrated by Spencer and Gillen (1899, 613-614, fig. 123), and by Horne and Aiston (1924, 67-68, fig. 53-55).

The Blacks (general term for aborigines as given by Curr's correspondents):—Tura Pa, Ja, Green; thura K, Kingsmill; tua A, Jacobs; ura Pa, Sawers; eura Wp, Phillipson — Wp, Wills; doura Nu, Valentine; ura Wk, Myles; yoora, toora Pa, Le Souef and Holden. Kurnawara D, Gason; kurna Yu, Howitt — Te, Sullivan and Eglinton; kerna Kw, Anon — Ya, Cornish — Pp, Eglinton; karna D, W?, Jacobs. Yarlee Wa, Crozier; yalli Wa, Dewhurst; yarlye Ma, Morton [this term appears in the tribal name Yelyendi, Yellyandi of the local whites]. Yooroonguna Wp, Gason. Yoo-oo-oodla N, Cornish. Warno Wk, Myles. Weembabitcha Wi, Dix; wimbiga Ma, Reid. Capo Kg, Heagney. Marroopoo N, Paull. Nooga Te, Foott; ngoorra B, Sullivan. Nulla A, Todd — A, Warren and Hogarth. Kooroo Ya, Salmon. Kurrana murtoo Ky, Machattie; mirti Bi, Curr. Carcoora Kg, Heagney; karkoora Ku, Heagney.

Blackfellow — Nulla A, Todd — A, Warren and Hogarth — A, Warren. Ura Wk, Myles — Pa, Sawers — Pa, Beddome; yoora Wp, Gason; yoo-oo N, Cornish; eura Wp, Phillipson — Wp, Wills; orroroo Kw, Anon. Tura Pa, Ja, Green; thura K, Kingsmill. Yarlye-oora Ma, Morton. Kurna Wp, Phillipson — D, Gason — Yu, Howitt — Te, Sullivan and Eglinton — Wa, Crozier; kurrana Ky, Machattie; koornoo Ya, Salmon — Ya, Cornish ;kerna Pp, Eglinton — N, Ya, Cornish; koonga Wk, Myles; kanna N, Paull; karna D, Jacobs. Karmachunara W ?, Jacobs. Tuachuju A, Jacobs. Tharinga B, Sullivan. Nanga Pa, Beddome. Mirti Bi, Curr. Wimbiga Ma, Reid. Karkoora Ku, Heagney.

Other references are—Meru, epa, juri [eura] Nj, wulka Wp, Berndt and Vogelsang 1941, 7; Kurna D, Gason 1879, 293; kalka-aroo Ka, Wells 1894, 521; wulka Wp, Hale and Tindale 1925; yura Pa, Schürmann 1844, 87; karana Ky, Tindale 1940, 160—term occurs in the name of the Karanya tribe; meyu Nj, Tindale 1940, 180 [same term, meyu, mayoo, applied in the Adelaide tribe, Wyatt, Taplin]; kana D, Howitt 1904, 299, 780; Gatti 1930, 121; Fry 1937, 197.

Blackwoman—Munkera A, Todd; moncurra N, Cornish; monkurra Ya, Cornish. Boku A, Jacobs; bookoo A, Warren and Hogarth. Ikalla A, Warren. Widla D, Gason — W ?, Jacobs; willa N, Paull; walka Te, Sullivan and Eglinton; wullga Te, Foott. Artoo Wp, Phillipson — Ja, Green; artunia Wp, Wills; yooratoo Wp, Gason. Yewa Ya, Salmon. Noa Yu, Howitt; this term is used for wife amongst some Eyrean tribes. Wilthetha B, Sullivan; wethetha Wk, Myles. Kumbuka Wa, Dewhurst; kambukka Ma, Morton; koombutcha Wi, Dix; kumbuga Wa, Crozier. Wondthowery Kg, Heagney. Kurdrie K, Kingsmill. Carroo Pa, Green. Nongo Ma, Reid. Punga Kw, Anon. Munchmali Bi, Curr. Moitu Pp, Eglinton. Purraja Ky, Machattie. Balara Pa, Sawers; pallara Pa, Le Souef and Holden.

Other references are—Atuni Nj, widla D, adni Wp, Berndt and Vogelsang 1941, 7; adni Wp, Hale and Tindale 1925; mankara D, young woman, Gatti 1930, 122.

White man—Oodnya Wp, Phillipson; oogtna Wp, Wills; oonyoo Wp, Gason; coodnoo K, Kingsmill; goodenue Pa, Green; koonyoo Nj, Le Brun; all of these terms are obviously akin. Koopa Pa, Le Souef and Holden; coopa Pa, Beddome; koopia woonka A, Todd. Pirri-wirri Yu, Howitt; birrie Te, Sullivan and Eglinton; birri-birri B, Sullivan; birre-birre Wa, Crozier; peri-peri Kw, Anon; boree Ma, Reid (same word for ghost). Bingera Nu, Valentine. Purloo Ya, Salmon.

Doona Wk, Myles (same word for ghost). Thundukoa Wi, Dix. Too-too Ma, Morton (same term for dead). Tita Pp, Eglinton. Wite pella D, Gason — Ky, Machattie (obvious corruption of "white fellow").

Schürmann (1844) recorded mundultu yura Pa (p. 33, 34) for a European as distinct from mirrinye yura, a native (yura = man; mirrinye = like or similar to; mundultu = European, as an adjective, p. 34) (the term is quoted in his MS additions as mandullu = kunyu = dead); and palkarra yura Pa (p. 50), as a white man (pankarra = white). Perkannia meyu (Teichelmann and Schürmann 1840; 1933, 136) and pinde meyu (Williams 1839; 1933, 69) were applied by the Kaurna of the Adelaide plains to a white man. Wiltfella Yu, Howitt 1901, 292.

It will be noted that many of the terms relate to "ghost" or "dead." Schürmann (1844) recorded that muntyo or kunyo was the term for dead (p. 36), and that nara, wilya or wilya kunyo, amongst the Pangkala, meant ghost or departed soul (p. 38, 72). Wyatt (1879) stated that koonyoo, amongst the Kaurna, was an imaginary being (p. 171), and an object of terror (p. 168) which was said to fly at night and make a noise in the trees, but was never seen; it could alight on a sleeping man and press on his liver, causing excessive pain and sometimes death. Wyatt suggested that the real cause of the pain was the excessive gorging to which natives were prone. Woods (1879, p. xxix) said that kuingo was a fabulous personification of death (Kaurna tribe). Sawers reported that goodnee Pa (? error for goodnu, *i.e.*, koonyu) was a ghost. Teichelmann and Schürmann (1840; 1933, 107) reported that kuinyo was applied to a dead person and also to a monstrous creature like that referred to by Wyatt. The Murray natives, according to Moorhouse (1846; 1935, 29), called it nokunno. The Pangkala name of the fiend was Marralye (Schürmann 1844, 28; 1879, 235; Wilhelmi 1861, 190), who could assume the form of a bird which flew at night and pounced on his victims, injuring or even killing them without leaving any marks. Marralye was distinct from the nocturnal purkabidni who, though of gigantic human form, could be conquered (Schürmann 1879, 236).

Pindi was stated by Teichelmann and Schürmann (1840; 1933, 123, 137) to be a pit or grave or habitation of souls before or after death; whites, when first seen by the aborigines, were regarded as the souls of their own ancestors revisiting their native country; these souls were considered to be retained in a large den (pindi) until liberated. Hence the term pindi meyu for a white man, and pindi mai for European food. Pindi came to be used by the Kaurna as meaning European.

Howitt (1904, 442-446) discussed the belief that white men were ghosts of members of the tribe, returned in the flesh from death, and gave an instance concerning himself and the Dieri who called him pirri-wirri-kutchi (= wandering ghost). Pirri-wirri is obviously the same term as birri-birri and peri-peri recorded by some of Curr's correspondents. Howitt also reported that kutchi (= ghost, or spirit of the dead, p. 647) was applied by the Dieri to any of the strange equipment of the whites, *e.g.*, a dray and a team of bullocks. Wells (1894, 519) reported that koochoo was a demon who endeavoured to steal young women (Karanguru tribe); Gason (1879, 283) translated kootchie D, as devil.

The term munkera (young woman or girl), or a variant of it, was used by natives of the Eyrean basin to indicate some constellations. Orion's Belt was munkawa (= the woman) according to Howitt (1891, 91). The Pleiades were believed to be seven young women who in ancestral times escaped from a pursuing muramura by leaping into the sky (pari wilpa D), taking their fires with them. The constellation is pallari Pa (= women), Schürmann 1844, 51; munkara walkawura (= the young women), Howitt 1891, 91; mankara wora of the Dieri, and bulali of the Ngadjuri (Berndt and Vogelsang 1841, 8). The latter authors gave mankarawara as the Dieri name for the Southern Triangle, as well as for the

Pleiades. Stirling and Waite (1919, 124), when referring to toa 77, stated that the Mankara-worana were the girls whose souls were believed to be the Pleiades. Horne and Aiston (1924, 141) mentioned the flight of seven girls into the sky (pari-wilpanina = vast hole) each carrying a fire, to escape a moora woman, the girls becoming stars, now known as Monkira. The latter is also the name of a township on the lower Diamantina in Queensland. The legend concerning the Pleiades is widespread and occurs in Victoria also (Howitt 1904, 439-440). Teichelmann and Schürmann (1840; 1933, 114-115) reported that the Kaurna called the Pleiades mankamankarranna (mankarra = young girl), and Orion's Belt tinni-inyaranna, a group of youths who hunted kangaroos, emus and other game on the great celestial plain (wonnna) while the mankamankarranna dug roots which were around them.

Howitt (1904, 787) described an Arabana legend referring to the ancestral wanderings of a number of girls, mankara-waka-ya-pirna (= girls-little-and-big), who according to another legend were transferred to the sky as stars, the former being the Pleiades and the latter the stars in the belt of Orion. One of the male muramuras (Madaputa-tupuru or Marukadlana) became Antares, the principal star in Scorpio. Schürmann 1844, 33, reported that amongst the Pangkala, Orion's Belt was minye and mirrarri (= boys or men). Gason (1879, 300) stated that moongaro (in Dieri) meant spirit or soul, while Mathew (1899, 213) called it ghost. Worana D, was a fabled creature, half man, half beast, believed to live on an island in Lake Eyre (Katitandra), according to Siebert (in M. Howitt 1902, 412).

Carnivora

Canis dingo, Dingo. The same term is sometimes used for "wild dog" as well as for "tame dog" (*i.e.*, a camp dog or partly domesticated dingo); in other cases the terms are quite distinct; and the same term may be given for a wild dog in one of Curr's lists and for a tame dog in another. In view of the foregoing, the terms will be listed together.

We received the following names at Pandi, the latter being the Yaurorka name for dingo; territa, N; mudla, W. Curr's correspondents (1886) have supplied a long list of names, as follows:—murdla A, Todd; madla A, Jacobs; mudla A, Warren; mudlu A, Warren and Hogarth; mulla N, Cornish; munga Pp, Eglinton; mullok Ky, Machattie. Pande Kw, Anon; pandi Ya, Salmon, Cornish. Kintala Wp, Phillipson; kintalla Yu, Howitt; kentella D, Jacobs; kintalo D, Gason; kinthalla N, Paull. Tirrita W ?, Jacobs; thirita Wa, Crozier. Wilka Ma, Morton; wilka Wp, Gason — Ja, Pa, Green — Pa, Sawers — Wp, Phillipson, Wills; wilki A, Warren and Hogarth; wilker K, Kingsmill; wilga Pa, Beddome, Le Souef and Holden. Koonoo Ma, Morton; koonai Wa, Crozier; kunnuya Wa, Dewhurst; coonatha Kg, Heagney. Kaltha Ma, Reid; kalley Wi, Dix; kalli in some Darling tribes. Mari Wk, Myles; mirre B, Sullivan. Dethee Kg, Heagney; deethee Ku, Heagney; thit-the Te, Sullivan and Eglinton; thithe Te, Foott. Coortnini Pa, Sawers; kurdninni Pa, Le Souef and Holden. Quana Nu, Valentine. Coppa Pa, Beddome. Becurli Ky, Machattie. Poolkaga Ma, Reid. Puruina D, Jacobs. Punamya Pp, Eglinton. Tuti Bi, Curr. Gardley Nu, Valentine [this term resembles kadli, the name given to the dingo by the Adelaide tribe, Taplin 1879, 131. Kali, given above, is keli of the Narrinyerri, and kellu of the Moorundee people of the lower Murray (Taplin 1879, 131)].

Gason (1874; 1879, 298) mentioned kintalo as the Dieri name; Wells (1894, 520) gave teerita for the Andrawilla tribe (*i.e.*, Karanguru), and stated that the pups were eaten (p. 517).

Howitt (1885, 6) mentioned kintala as a Dieri totem (murdu); and in 1891 gave several tribal names for the dingo murdu:—kintala D (p. 38), mudla An (p. 39), titi Kd (p. 39). In 1904 he repeated (p. 91-98) kintala D; madla W;

tirta Yu, N; dirangatha Yu; madla An, A; pandi Ya; jitti Kd; and kurli Wi; and mentioned Dulderana as the name of a mura-mura dog in an Arabana legend. Other references were made by Eylmann (1908, 167), kintala D; Hale and Tindale (1925, 57), wilka Wp; Finlayson (1939, 115), mudla W, kinturra D; Spencer and Gillen (1899, 60), matla A; Berndt and Vogelsang (1941, 5), wilka Nj, wurdingi Nj, kintala-jampa D [jampa = wild], wilka Wp; Schürmann (1844, 22), kurdninni Pa, wilga Pa (p. 72), the domesticated animal; kintala, pandi D, Gatti 1930; kintala D, Fry 1937, 193; mudlayapa A, kintalla D, yappulu D, Helms 1896, 316. Fry (1937) recorded Kantupanturana as a big dog-like legendary animal (p. 195), and pandi-pandi (p. 273) as an animal like a wolf. Siebert (in M. Howitt 1902, 413) reported pandi as the name of a legendary beast of which the natives were much afraid.

Schürmann (1846, 1879, 211, 218) mentioned that, amongst the Pangkala, dingoes were eaten, that the tip of the tail was tied to the beard as an ornament, and that the whole tail was sometimes tied round the head for a similar purpose (and then termed wilgarti, 1844, MS). The same information was published by Wilhelmi (1861; 1862). Horne and Aiston (1924) referred to the hunting of these animals by the Wonkanguru (p. 57-58, 79), who ate the pups; and stated that the tribe did not use dingo skins as water-bags (nilpa).

Stirling and Waite (1919, in their account of the toas or direction signs indicating localities and events associated with ancestral spirits (mura-mura), mentioned names of dogs who accompanied some of these mura-muras in their wanderings. These animals and the toas associated with them were:—67, spotted dog, Wartjiyampana; 126, Ngurluwarila; 132, a bitch, Pantupayana; 170, Tjakula; 274, Pirrila; all of these being Dieri terms. Toa 284 (Ngameni) refers to making water-bags from dingo skins.

Horne and Aiston (1924, 128) gave an account of the Kuyani legend associating the wild dog with the famous red-ochre deposits near Parachilna in the Northern Flinders Ranges. In ancestral (mura-mura) times, a big dog, Marindi, fought a gecko, Adnoartina. The gecko tied hair-string round his tail to make him fight better by preventing his courage from entering into his tail, and then fought at night because his nocturnal vision was much better than that of the dingo. He bit the dog's throat, and the escaping blood dyed the rocks on the banks of the creek. The most valuable kind of pigment was "dog's blood ochre." A brief account of the Dieri legend relating to this deposit was given by Fry 1937, 196-198, 273-274. The constriction now seen around the base of the tail of geckoes (now small individuals when compared with their ancestors) was due to the string used by the ancestral adno-artina.

Canis familiaris domestica—White-man's dog as distinct from the aboriginal's dingo and its various hybrids with the former. Dogga. Gason (1874) gave dog-doga as its name amongst the Dieri. Puppa Pa, Schürmann 1844, 53, puppy. Papa is the Loritja name for dingo (Strehlow 1908, 62). Marra Pa, Schürmann 1844, 28, puppy or other young animal.

Vulpes vulpes Linn. Fox—Finlayson (1939, 115) noted that in the Pandi area no native name was associated with the fox, feral cat, or rabbit. The introduction of the fox has been referred to by Wood Jones (1925, 356). The Dieri, when they first saw it, termed it kintala yampa, *i.e.*, wild dog (T. Vogelsang).

Felis domestica. Cat (feral)—The introduced cat became feral soon after white settlement of the various colonies. The Elder Expedition found feral cats in Central Australia, far remote from any settled area. Putji, putji-putji, putji-kata, kata, are all applied in Central Australia, as well as in the Eyrean region. Marraitye idnya, which was sometimes abbreviated to idnya (marraitye = similar to; idnya, native cat [*Dasyurus viverrinus*]), Pa, Schürmann 1844, 5, 29. Wilga,

meaning strictly a tame dingo, was also applied to a domestic cat by the Pangkala, Schürmann, l.c., p. 72. The term "wild cat" should not be confused with "native cat" (*Dasyurus* spp.; polyprotodont marsupials), as has been done by Miss Young (Helminth parasites of Australia. Imp. Bur. Agric. Parasitol., 1939, 57, 101), who attributed to *Dasyurus* sp. the record by Cobbold (Parasites, a treatise, etc., 1879, 308) of *Bothriocephalus decipiens* (= *Diphyllobothrium decipiens*) from an Australian cat (i.e., feral *Felis domestica*), its actual locality being south-eastern Queensland, though not indicated by Cobbold.

Arctocephalus cinereus and *A. doriferus*. Seals—Nangki Pa, Schürmann 1844, 32.

Chiroptera

Bat (general name)—Miltyinye Pa, Schürmann 1844, 32; pinchiepinchiedara D, Dason 1879, 285, eaten; pinchipinchinarra W, Finlayson 1939, 115. The latter author reported that bats were uncommon at Pandi, the only species taken by him being *Nyctophilus geoffroyi pallescens*. An account of the latter was given by Wood-Jones (1925, 435), who stated that this small long-eared bat appeared to be the commonest and most widely distributed species in Australia, occurring in scrub and mallee country as well as in the arid interior, the subspecies *pallescens* being the dominant form in the northern part of South Australia. Waite (1917, 430) obtained few *Chalinolobus gouldii* Gray and abundant *Scotophilus greyi* during the South Australian Museum's expedition to the lower Cooper.

Howitt (1904) mentioned as names of a bat (and its totem)—tapaiuru D (p. 91); tapayuru D (800); tapairu W (92); N (94); tabaira, east and north-east from Dieri territory, along the Cooper, Yu, (96); waparu (96); karabana (782); but the last-named is also given (91, 783) for a small marsupial and its associated totem (D), so that it is probable that term may have been used by Howitt for a bat in error for tapaiuru which is not given in his list on p. 782-783, but is listed elsewhere as a totem animal amongst various Eyrean tribes (p. 91-96). Eylmann 1908, 167, mentioned tabajura D, totem, as the flood-bird, *Scythrops novae-hollandiae*. Berndt and Vogelsang (1941, 4) gave milka and pintji-pintjindara as Ngadjuri and Dieri names respectively for bats. Spencer and Gillen (1899, 447, 655) mentioned that the small bat *Nyctophilus timoriensis*, and the large white bat, *Megaderma gigas*, termed by the Aranda, unchipera (p. 447, 655) and elkintera or erlkintera (p. 447, 648), respectively, were totem animals. Strehlow (1908, 62) reported these two species to be ntjipera and irkentera, respectively, while the common bat, not identified, was ulbulbana (Aranda). Australian bats, formerly identified as *N. timoriensis*, are now assigned to *N. geoffroyi* Leach, var. *pallescens* being the Central Australian form. Mr. T. Vogelsang informed me that pintji-pintji-dara was a common small bat which during the day clung to trees; *Nyctophilus geoffroyi* is probably the species.

Ungulata

Aboriginals modify the European names of the introduced Ungulates, usually (in the Eyrean region) by adding a terminal a; thus goat becomes go-ta or nanningota; sheep, tjipi; camel, kamela; donkey, donki; ox, bullocka.

Horse—The horse is the only introduced animal which in the Eyrean region is called by a native name. Nanto D, Howitt 1904, 199; A, Warren 1886, 112. Mr. T. Vogelsang informed me that the term is still used by the natives of lower Cooper's Creek. Curr (1886, 150) mentioned nanto as a kangaroo, Adelaide tribe (Kaurna), his information having been derived from Wyatt. The latter (1879, 173) reported that the term was applied to a kangaroo, horse, bullock or other large animal, an old hoary male kangaroo being termed nanto boorka (booroko = white-haired, hoary; boorka = frost), while wouwe was applied to the female kangaroo and also to sheep (p. 178). Williams (1839; 1933, 63) recorded nanta as a horse

and nantuterka as a male kangaroo, Kaurna tribe (turka = kangaroo, p. 66). Teichelmann and Schürmann (1840; 1933, 123) mentioned nanto as a male kangaroo and pindi nanto as a horse or pony (p. 137). The term pindi and its relation to the white settlers has already been discussed in this paper (pindi meyu = white man). Kühn (1886) mentioned nantoo as the name for horse (p. 145) and kangaroo (p. 146) on Yorke's Peninsula (Narrang-ga tribe). Since explorers from Adelaide and the settled districts of the State would take local natives along with them when first visiting the Eyrean region, the term nanto (or pindi nanto) would become introduced into the region as the name for the new animals (horses) accompanying the expedition, the Eyrean aborigines having their own names for the kangaroo (tjukuru) which belonged to a species (*Macropus rufus*) different from that of the grey animal of the Adelaide plains (*M. major*).

Pony became ponynge Pa, Schürmann 1844, 88; and we received boonee (*i.e.* pony) as the name for horse amongst the natives at Ooldea. Moorhouse (1846; 1935, 25) recorded meinchun as the name for horse amongst the Lower Murray natives (Morgan to Mannum); Wyatt (1879, 172) stated that michan = to smell, so that the native name may have some relation to the odours of horses. Howitt (1901, 292) mentioned that, during his expedition in 1861, the term yarraman was used by the Yantruwunta for a horse and that the name must have been transmitted from tribe to tribe until it reached those wild blacks. Morris (Austral English, 1898) referred to the earlier usage by natives of the term as yerraman, according to Sir Thomas Mitchell (1848).

Donkey—Donki D, Gatti 1930, 99.

Ox, bullock—Bulakoo D, Gason 1879, 290; bullocky Pa, Schürmann 1844, 48; 1879, 250. The application of the same term (nanto) to kangaroo and bullock (Wyatt 1879) by the Kaurna has been mentioned above. Is it a coincidence that that term buloker was applied to the kangaroo by the Kemandok (Kureinja tribe, Euston to Wentworth, Tindale 1940, 191) according to Macfarlan (in Curr 1886, 282), and by the Yit-tha tribe (Jita-jita, Tindale 1940, 196) inhabiting an area near the lower Lachlan in New South Wales according to Macdonald (in Curr 1886, 288) or is it a transference of terms?

Wells (1894, 520) reported wirri-pa Ka as a calf, and amma-milki Ka as a cow. The latter word means milk-giver, a combination of the Karanguru amma = milk or breast [or udder], and milki, a corruption of the English word. Ngama — milk or breast, Nj, D, Berndt and Vogelsang 1941, 7; amma D, Gason 1879, 294, breast. Moorhouse (1846; 1935, 29) recorded noulla [onomatopeia] as the term for a cow or bullock.

Taplin (in Woods 1879, 3) told of the reaction of the Narrinyerri natives when some stray bullocks from New South Wales first entered the district. The aborigines concluded they were demons (brupar) and decamped in terror. They called them wunda witjeri, which means creatures with spears (wunda) on their heads, and Taplin reported that that name was still retained for horned cattle.

Pig—Yupara Pa, Schürmann 1844, 87; piki D, Gatti 1930, 99. The Kaurna used the term piko, Teichelmann and Schürmann 1933, 173.

Camel (dromedary)—Kameel, kamuli D, Gatti, 1930, 99. Howitt (1901, 293) reported that the Yantruwunta at first applied the term warugati (the name for the emu) to the camel, probably because of its grey skin (waru = grey, gati = skin). Kamela is applied in the Musgrave Ranges by the Pitjandjara and Yankundjajara tribes.

Goat—Go-ta or nannygota D; same terms used in the Musgrave Ranges by the two tribes just mentioned.

Sheep—Tjipi D, Tseepa or tjipa, Musgrave Ranges. Tjipi kuparu D, lamb, Gatti 1930, 100 (kuparu = young, small). The Kaurna tribe applied wouwe to

sheep as well as to the female kangaroo (Wyatt 1879, 178), but Williams (1933, 70) stated that the term tipa was used for the former.

Cetacea

Porpoise—Kattappi Pa, Schürmann 1844, 17. *Delphinus delphis* is the commonest species in the South Australian gulfs.

Whale—Kangkarru, wata Pa, Schürmann 1844, 70. Berndt and Vogelsang (1941, 10) mentioned ngakula Nj as a whale, but this is probably an error for shark, since Moorhouse (1846; 1935, 28) reported nakudlo as the term used for shark by the adjacent tribe along the Murray. The Ngadjuri was an inland tribe, but its neighbours, the Nukunu, Kaurna and the Murray tribes had sea frontages. The large *Balaena australis* used to be common in the South Australian gulfs and in sheltered coves until the arrival of whalers exterminated it. Various small Ziphiid whales (*e.g., Mesoplodon* spp.) and large Delphinidae (*Globiocephala*) are from time to time found stranded on these coasts and were, no doubt, used by the natives as food, as was *Balaena*. Ribs of the last-named whale were used, when available, instead of small tree trunks and branches, to form the framework of wurleys or huts. Amongst the Kaurna and Ramindgeri the animal was called kondole (Meyer 1879, 203; Taplin 1879, 59); kondolle (Wyatt 1879, 170 — whale, also its blubber); kondolli (Teichelmann and Schürmann 1840; 1933, 106); or kondarli (Taplin 1874, 2); and gave its name to the horde, Kondolinyeri, living on the peninsula on the north-west side of the sea-mouth of the Murray (Taplin 1879, 2). Meyer (1846; 1879, 203) gave an account of a Narrinyerri (Ramindjeri) legend associated with kondolli (repeated by Taplin 1879, 59-60). Though it relates to a region outside the limits set for this paper, I have ventured to include it.

In ancestral times a corroboree was being held, but as the performers had no fire, it was carried out during daytime. A large, powerful man, Kondole, was invited through two messengers, Kuratje and Kanmari, to attend the feast because he possessed fire. Kondole hid his fire and then came, but the tribesmen determined to obtain his fire by force and eventually wounded him in the neck with a spear. This action caused great excitement, most of the performers becoming transformed into various animals. Kondale ran into the sea and became a whale, and, ever after, blew water out of the wound which he had received in his neck. Kuratje and Kanmari became small fish, and since the former had only a mat of seaweed to cover him, he became a dry fish without fat, while Kanmari, who was dressed in a good kangaroo skin, became a fish with a great deal of oil under the skin. Some of the performers became opossums; the young men whose heads were ornamented with tufts of feathers became cockatoos, hence the crests of the latter. Kondole's fire was taken and placed in a grass tree (*Xanthorrhoea* or yacca), where it still remains and may be brought out by rubbing, this plant being used for producing fire by the rotary method. Kanmari is the lake mullet, *Agonostomus forsteri*, and is indicated as conmuri by Waite in his Handbook of South Australian fishes (1923, 108). Wyatt (1879, 171) mentioned kooraiche as the name of the mullet. There are four species of mullet to be found in the vicinity of Encounter Bay and the mouth of the Murray; *A. forsteri* (= konmuri), *Mugil argenteus* (= wankari), *M. cephalus* (sea mullet) and *Myxus elongatus*. Kuraitji probably applies to one of the two last named, *Myxus* (sand mullet) being much smaller than the other and more likely to be the species referred to.

Rodentia

Oryctolagus cuniculus Linn. Rabbit— Rabbita. Rabiti D, Fry 1937, 287. Now widely distributed in the region and forming an important article of diet for the aborigines. The effect of the introduction of the rabbit on the local fauna has been referred to by Wood Jones (1925, 286).

Rabbit skins, because of the ease with which they can be obtained in the Lower Cooper region, are tanned by using a particular acacia, yearda (considered by Johnston and Cleland 1943 to be *A. salicina*), and then used for making water-bags (nilpa), the method being described by Horne and Aiston (1924, 51, fig. 39).

Rats and mice—Gason (1879, 285) mentioned the following Dieri names:—miaroo, rat; poontha, mouse; cowirrie, a species of rat (this name is also that of an important Dieri trading centre, Cowarie, on the Warburton); pulyara, long-snouted rat; koolchie, a species of rat; koonappoo, a species of mouse; kulunda, black and white rat, similar to the house rat; all of these kinds were eaten. Wells (1894, 517) stated that rats (miarroo) were eaten by the Kara-nguru.

Howitt (1891, 39) mentioned as Dieri murdus, punta (mouse), maiaru (rat), karapana (a mouse), and kokula (a rat); but the last-named identification may have been incorrect, since he stated later (p. 39) that kokola was a wallaby (An) and a bandicoot (Kd). In 1904 Howitt gave a list of Eyrean murdus, including maiaru D, W, rat; punta D, Yu, shrew mouse; karabana D, small mouse; kunamari Yu, rat (p. 91, 92); parina Kd, rat; korinya Kd, small burrowing rat (p. 97). It may be mentioned regarding kunamari that Howitt and Siebert (1903, 528) stated that mari D was a kind of wallaby.

Stirling and Waite (1919, 149) mentioned a toa, No. 275, concerning a kokula, a species of rat which carried its young on its back. As indicated above, kokula is a small marsupial, Howitt (1903, 97) calling it a small bandicoot. Berndt and Vogelsang (1941, 7-8) mentioned punta as the name of the mouse and rat (Dieri); mungu as that of the former and wada that of the latter amongst the Ngadjuri tribe.

Gason (1874, 272) stated that, during the mindarie (or peace corroboree), young men who were about to be initiated were decorated by each having, attached to the head, a thippa made of tails of rats. He also stated (p. 289) that this bunch of tassels was made from the tails of native rabbits (*i.e.*, the rabbit bandicoot, *Thalacomys* spp.).

It is to the excellent accounts of the native fauna by Finlayson, who undertook field work in the far north-eastern region of South Australia, that we now know the Wonka-nguru names of the local rodents. Some species have now become either rare or extinct in that region. Two species at times are represented by migratory hordes (Finlayson 1939, 348, 354).

Rattus villosissimus Waite. Finlayson (1939, 88-94) stated that its name was miaroo W, but that the term had an earlier usage and was applied (presumably by whites) to many, if not all, kinds of rats. He, as well as Le Souef and Burrell (1926, 107), reported that it was the migratory horde rat of Western Queensland and the Northern Territory. It was first described by Gould in 1854 as *Mus longipilis*, nom. praeocc.

We received the name mai-aru N, W, for this edible rat which was dug out from cracks in the mud of the flood plain of the Diamantina. This species, and the succeeding one, were mentioned by Finlayson in his book, "The Red Centre" (1936, 99).

Pseudomys minnie Troughton.—Finlayson gave an account of this "river rat," which is also a migratory species (1939, 94-101; 1939, 348-354). It is the pallyoora of the Wonga-nguru and ranges from Longreach, Queensland, to Lake Eyre and Ooldea, being abundant at Goyder's Lagoon. We received the same name, W, N, at Pandi. The species has a conspicuous white tail. Gason's pulyara is the Dieri name. Howitt 1904 mentioned balyara (N) and baliyara (Ya) as a small pouched mouse and as a totemic animal (p. 94, 95); and also referred to palyara (Ka, N) as the long-snouted marsupial rat (p. 646). These references should probably be to the rodent now under consideration.

Notomys aistoni Brazenor—Finlayson (1939, 103) reported that this edible jerboa mouse, called oorarrie by the Wonga-nguru, was easily captured in clay-pans by children. The related *N. fuscus* was reported to us at Ooldea to be known as darraka warra (darraka = bone, warra = long, *i.e.*, long legs).

Notomys cervinus Waite (? Gould)—Finlayson (1939, 108) stated that this species may be the wilkintie of the Wonka-nguru. He mentioned that if the animal seen by Capt. Sturt were an oorarrie, then *N. aistoni* would be a synonym of *N. cervinus* Gould, and the species described by Waite would be without a valid name. Wood Jones (1925, 343) referred to the species as *Ascopharynx cervinus*, following Waite (1900).

Cowirrie—Gason (1879, 285) called it a rat (Dieri). Howitt (1904, 796) reported that kauri was a small marsupial (Yu, Ya), a burrower, and at times migratory. His remarks suggest that it was predatory. It was called a rat by the local whites. Cowarie, a former trading centre on the Warburton, has the same name. Mr. Vogelsang recognised cowarie of the Dieri as the pale sandy jerboa mouse, identified by Wood Jones as *A. cervinus* Gould. Brazenor's *N. aistoni* is a synonym. Finlayson's term oorarrie is probably an error for cowarie. The latter author referred to *N. aistoni* (1939, 358; 1940, 135) from Ooldea and from the Eyrean region, probably from Cowarie. He also reported that dargawarra was the native name for *N. alexis everardensis* in the Everard Ranges (1940, 125).

Leporillus conditor Gould, a house-building rat, now extinct, but known to the Wonka-nguru as wopilkara (Finlayson 1939, 111-114). It has been re-described also by Wood Jones (1925) and Troughton (1923). Perhaps Gason's kulunda, "a black and white rat, similar to a house rat" (Dieri tribe) may be this species or, more probably, *L. apicalis* Gould.

Mus musculus Linn.—Finlayson (1939, 115) stated that the common mouse lived in the Eyrean region like indigenous murids, and that its Wonka-nguru name was puntapunta, and that the species (because of its having a native name) was probably present in the area for a much longer period than other introduced mammals such as the fox, cat and rabbit, which had no native names. It seems to me more likely that the name belonged originally to small native mice resembling *Pseudomys forresti* var., recorded from Mulka by Finlayson (1939, 101), or *hermannsburgensis* Waite (menkie of the Aranda tribe). The term punta (poontha of Gason) is applied to mice by the Dieri, while the Ngadjuri called them mung-u (Berndt and Vogelsang 1941). Kühn (1886, 145) recorded mantoo as a mouse, Yorke's Peninsula.

Hydromys chrysogaster Geoff.—Finlayson (1939, 114) reported the presence of this large water rat in the Cooper and Diamantina regions, its name in the latter being tinna appa (Wonka-nguru). Tinna or tidna means track or foot, and appa or ngapa is water. Howitt (1904, 95) stated that a water rat, tundubulyeru, was a totem animal in the Yaurorka tribe; bulyeru suggests palyura (= *Pseudomys minnie*), but baliyara is mentioned as a different totem of the same tribe; it is probable that Howitt's term applies to *Hydromys*.

Unidentified ? rodents—Schürmann (1844) mentioned a large number of Pangkala names of kinds of mammals which he called rats, mice or burrowing animals. Some of them may be small polyprotodonts, but he gave no indication of their identity. They are accordingly grouped together under the present heading:—bunta, mouse sp. (p. 4); inyalla, burrower (7); italla, burrowing rat (8); karnanyuru, "an animal building a nest of sticks to a great height" MS [*Leporillus*, probably *conditor*]; karpili, burrower (16), rat (p. 86); kauanna, burrowing rat (17); madla paru, yailba mirrinye, species of animal (24)—paru = animal, game or meat, mirrinye = similar to, yailba is a burrowing species, hence

an animal resembling the yailba; mai erri, mouse sp. (24), mai = vegetable food, *e.g.*, roots; melokunyo, mouse sp. (30); paltyarra, rat sp. (52) [the name suggests palyara, applied to *Pseudomys* further north]; pulku, mouse (59); wallumba, common rat (67) [presumably the native *Rattus greyi* which Wood Jones (1923, 301) recorded from Eyre's Peninsula]; walyari, rat or mouse sp. (67); yailba, burrowing sp. (77); yartini (paltyarra mirinya, *i.e.*, similar to paltyarra, a species of rat), spotted bandicoot (82) [this species is referred to later in this paper when dealing with bandicoots].

MARSUPIALIA

Each species probably had its particular name in each tribe. All kinds, from kangaroos to marsupial mice, were eaten. Gason (1879, 278) stated that kangaroos did not occur in the Dieri country, but that they were known to that tribe because they were seen in the country to the south [Kuyani] when men were visiting the red ochre deposits [of the northern Flinders Ranges]. Howitt (1891, 89) mentioned that the Dieri obtained skins of wallabies [*Petrogale xanthopus*] and kangaroos [probably *Macropus robustus erubescens*] from the Murdulla or hill tribes [Wailpi] and used them as coverings for corpses; but such skins were not seen amongst the Yantruwunta and Yaurorka people.

The dress of the southern Pangkala consisted of one or two kangaroo skins, or of those of several wallabies or opossums sewn together with sinews from a kangaroo or wallaby tail, an awl of kangaroo bone being used as a needle (Schürmann 1846; 1879, 210; Wilhelmi 1861, 166). The cloak was called palta, and if many skins were used, it was then termed karpalla palta (karpalla = sewn or stitched). The awl was ini Pa (Schürmann, 1844, 167) or wonabunyie D, whether obtained from the leg of a kangaroo or emu (Gason 1879, 303). The kangaroo of the Pangkala must have been *Macropus major*, the opossum chiefly *Trichosurus vulpecula*, and the wallaby may have been *Petrogale lateralis* or, more probably, *Thylogale eugenii* (now extinct on the mainland). These people skinned kangaroos before cooking, whereas the more northerly tribes did not. Skins were not tanned.

Gason (1886, 119) stated that wallaby skin rugs were used by the Wailpi. Morton (1886, 158) reported that the Malyanapa used rugs made of a single kangaroo skin or of several opossum skins sewn together. A skin rug was termed dala kati by the Dieri (kati = skin), and if made from kangaroo it was called dalara (Fry 1937, 197, 271). A kangaroo skin was used for covering a corpse (Schürmann 1879, 248).

The tip of a wallaby's tail was tied to a native's beard as an ornament (Schürmann 1846; 1879, 211; Wilhelmi 1861, 167; Pangkala tribe.)

Kangaroo sinews were also used for attaching the peg to the end of the spear-thrower (midla), and the barb to the end of a hunting spear (Schürmann 1879, 213; Wilhelmi 1861, 169-170). A kangaroo tooth was utilised as a boring tool to make a depression in the end of the spear, to receive the peg of the midla. Knapsacks or bags were made from kangaroo skins by the Pangkala, that carried by men being termed nurti, while the larger one used by women was nudla (Wilhelmi 1861, 171). Bags made from skins of kangaroos and opossums, and used by the Arabana and Wonkanguru for carrying food, were referred to by M. Howitt 1902, 43. Skin bags filled with feathers were termed mana-junga D (— hand water-bag), and were beaten as percussion instruments during a dancing ceremony (Fry 1937, 270).

Certain marsupials were forbidden as food for Pangkala boys and girls; the penalties for eating the wallaby, yurridni, or either of the two kinds of bandicoots, yartiri and kurkulla, were the development of a brown (instead of black) beard and the premature arrival of the menses in the two sexes respectively (Schürmann 1879, 220; Wilhelmi 1861, 176).

Roth (1897, 102, fig. 237-238) described the method of making water-bags (nilpa) from the skins of kangaroos, pademelons and opossums. Duncan-Kemp (1933, 56), as well as Horne and Aiston (1924, 51, fig. 39), referred to them, the same term (nilpa) being used by the Wonkanguru and the tribes northward as far as the territory of the Pittapitta. Berndt and Vogelsang (1941, 7) reported wudli-jakuda and tjukuru-jakuda as the Ngadjuri and Dieri names respectively for these water-bags (wudli, tjukuru = kangaroo; jakuta, yakuta = bag). Morton (1886, 158) stated that opossum skins were utilised as water-bags by the Malyanapa tribe. The use of sinews and hair string in addition to resins (from *Triodia* or from *Leschenaultia*) for the fixing of an axe head (kalara) in its handle was described by Horne and Aiston (1924, 104-105, fig. 75).

Cleland and Johnston (1939, 175) referred to the use amongst the Wailpi of broombush, *Templetonia egena*, to cover traps or pits dug along wallaby pads to catch rock wallabies, *Petrogale xanthopus*, and euros (*Macropus robustus*). Berndt and Vogelsang (1941, 7) mentioned as general terms for kangaroo, gudla Nj, and tjukuru D, but both of these are applied to the red kangaroo. Duncan-Kemp 1933, 285, referred to the use of bolas, pit traps and game traps made of rough palisades for capturing kangaroos.

The aborigines believed in the existence of huge animals and trees in ancestral times (mura of the Dieri and allied tribes; jelkura of tribes further north; and altjira of the Aranda tribes to the north-west). A muramura killed an enormous kangaroo and pegged out its skin, the place where this happened becoming Lake Eyre (Stirling and Waite 1919, 109). Taplin (1879, 55) reported that the natives of the lower Murray believed that their chief ancestral beings hunted mighty kangaroos and the places where the skins were pegged out became denuded of grass and changed into salt lagoons.

The native names for kangaroo, given later, fall into a few groups, one of which represented by thaldara or thaldra of the Cooper's Creek tribes becomes thuldra amongst the tribes of the Wilson River (a tributary of Cooper's Creek in south-western Queensland, near the New South Wales border), thurlda or tulta amongst the Darling River tribes, and tulatyi amongst the Narrinyerri of the lower Murray (Curr 1888, 168-169). The last name is of interest as it is the only native name for a kangaroo or large wallaby (except Cook's wallaby) which was taken over and received wide usage amongst the whites. The original kanguru, *i.e.*, the species seen by Captain Cook at Endeavour River in North Queensland, is now known to be a wallaby, *Macropus* (*Wallabia*) *canguru*. Tulatyi is obviously the toolach (or more correctly toolachi or toolache) of the south-eastern part of South Australia, a species (*Wallabia greyi*) whose last known surviving member died in captivity a few years ago and is now preserved in the South Australian Museum.

Macropus rufus The many names received from Curr's correspondents (1886) as applied to the kangaroo in our region must refer to this species, since it is the red kangaroo which occurs there:—koongoora A, Todd; kungara A, Jacobs; koongaroo A, Warren and Hogarth, Warren. Chookaroo D, Gason, Jacobs; chookeroo N, Paull; chookooroo N, Cornish — Ya, Salmon, Cornish; chukeroo Wa, Crozier; tchukuro Yu, Howitt; yschuckuru W ?, Jacobs. Kurdloo Pa, Sawers; kudla Nu, Valentine; koodla Pa, Green; oodloo Wp, Wills; coordloo Pa, Beddome; oordloo Wp, Phillipson; kurloo Wi, Dix; koola B, Sullivan; ooloo Wp, Gason; koodla Ja, Pa, Green; kulla Wk, Myles; coola Kg, Heagney; koora Kw, Anon. Turlda Wa, Dewhurst; talda Ma, Morton; tharlta Ma, Reid; thuldra Te, Foott; thaldara Te, Sullivan and Eglinton. Balcun Ku, Heagney; palgan Bi, Curr. Koonabulla Ky, Machattie. Cutchira Kg, Heagney. Matumba Pp, Eglinton. Yarnda K, Kingsmill.

Other references are as follows:—chookaroo D, Gason 1879, 285; tchukuru D, Howitt 1885, 6; chookooroo Ka, Wells 1894, 521; kungarra A, Helms

1896, 316; koongarra W, Finlayson 1936, 157; tjukuru D ?, Stirling and Waite 1919, 135, toa 156; wudlu (male) Nj, Wp, waulwi (female) Nj, Berndt and Vogelsang 1941, 7; wudlu Wp, Hale and Tindale 1925; 57; koordloo Pa, Sawers 1886, 132 (Gawler Ranges); koolabila Dk, Duncan-Kemp 1933, 242; kupirri Pa, Schürmann 1844, 21, white kangaroo, corrected in MS to red kangaroo. It is known as okira amongst the Aranda; and mal-lu at Ooldea. Schürmann (1844, 22) mentioned kurdlu as "an animal of the Marsupian species," but the same term was reported by Sawers (kurdloo) and Beddome (coordloo) for the kangaroo in the northernmost part of the Pangkala territory, where the species would be *M. rufus*.

Howitt (1891) mentioned chukuru D, totem (p. 38); taldra Kd, totem (p. 39). In his later book (1904) he gave many references to the kangaroo as a totem animal amongst the tribes of our region:—chukuro N (p. 657), chukuru N (p. 94), taldra Kd (p. 97), tirlta Wi (p. 98); turlta and thurlta of the Darling and Paroo tribes (p. 98-99). Berndt and Vogelsang (1941, 7) mentioned as general terms for kangaroo, gudla Nj, and tjukuru D, but both of these are applied to the red kangaroo.

The red kangaroo does not occur in the southern part of the Pangkala region, where the dominant vegetation is the mallee which constitutes the home of *M. major*. The reason for its absence is supplied in a local legend published by Schürmann (1846; 1879, 239-240) and re-published by Wilhelmi (1861, 193; 1862). Cawthorne (1858) also wrote an account of it, and in his second edition gave a metrical version. Schürmann suggested that a specimen of *M. rufus* must have found its way south. The animal in the legend was called Kupirri (Kuperree in Cawthorne, edit 2) and was stated to be of huge size and to have devoured all who had attempted to spear it. The natives were stricken with terror when they saw it and threw away the spear-thrower (midla) along with the spear, hence their aiming was ineffective. Two hunters, Pilla and Indya (Idnya of Schürmann 1844, 5; Wilhelmi 1861, 193; Inda in Cawthorne, edit. 2), tracked the animal to the north, and finding it asleep at once attacked it, but their spears became blunt before they could kill it. This disappointment led to their quarrelling, Pilla stabbing Indya several times with a blunt spear, but while doing so he received a severe blow on the nose with a spear-thrower. After reconciliation they again attacked Kupirri, killing it. On opening it they found the bodies of their devoured tribesmen, who became restored to life and assisted in cooking and eating the monster. The two heroes were metamorphosed into animals, still known by their names; Pilla became the opossum and the scar on the injured nose is still indicated by the longitudinal furrow which it bears, while Indya became the native cat whose former spear wounds (caused by Pilla) are indicated by the white dots distributed over the skin. The latter part of the legend relates, of course, to *Trichosurus vulpecula* and *Dasyurus viverrinus*.

Macropus major syn. *M. giganteus*—The grey kangaroo from the southern portion of the Pangkala territory was this species. Warru, Taplin (1879, 131—nante, Adelaide tribe), Schürmann 1844; warroo Pa, Sawers (1886, 132), Gawler Ranges; bulka, warru Pa, Le Souef and Holden 1886, 8.

Schürmann (1844) mentioned the following Pangkala terms:—warru (p. 53); warruparu, kangaroo meat (p. 54), paru = meat, game, animal; warru puppa, joey—puppa (? European term, puppy) = young one, pup (p. 53); ngudli, pouch of kangaroo or other marsupial (p. 47); pulka or bulka (= old), "old man" kangaroo (p. 59); wakkari, female kangaroo (p. 65); warrukatta, kangaroo hunt (p. 70); wantyukko, young kangaroo; kadlukko, fully-grown kangaroo (p. 9); kulyara, young male (p. 20); munta, net-bag made of kangaroo sinews (MS).

Macropus robustus (*erubescens*)—Manja Wp, Hale and Tindale (1925, 57); juru Nj, manja Wp, Berndt and Vogelsang (1941, 6). It will be noted that the white man's name (euro) for this sturdy mountain kangaroo in South and Central Australia is that given (juru) by the Wailpi of the northern Flinders Ranges. Wallaroo, also a native term, is its eastern Australian name and was mentioned by Cunningham when writing in 1827 of New South Wales. Kunnulla is applied to it at Ooldea.

Petrogale xanthopus, rock wallaby—Andu Wp, Hale and Tindale 1925, 57; gandu Nj, andu Wp, Berndt and Vogelsang 1941, 10. Finlayson (1936, 158) gave karndoo as the Dieri name for a wallaby-like animal and suggested that it might belong to *Macropus robustus* or *Petrogale xanthopus;* it is obviously the same as gandu. It seems to me likely that gunda (Nj) of Berndt and Vogelsang (1941, 10), a small wallaby, is the same; also karndo Pa, Green 1886, 126 (east of Lake Torrens); and karndoo Pa, Beddome 1886, 133 (between Quorn and Lake Torrens). The species occurs in the Flinders Ranges.

Petrogale lateralis—Wood Jones (1924, 228) believed that the rock wallaby from the hilly country west of Lake Torrens probably belonged to this species, whose range extends to Central Australia. Kunoo Pa, Sawers 1886, 126, Gawler Ranges. Kunna Pa, Schürmann 1844, 21, kangaroo sp., is almost certainly the same species.

Wallaby—Yurridni Pa, Schürmann 1846, 87; 1879, 220; Wilhelmi 1861, 176; 1862; yuridni Pa, Schürmann 1844, 87; yumballa Pa, Schürmann 1844, 86. Reference to the use of skins as clothing has already been made.

Schürmann's names and remarks suggest that there were at least two species of wallabies in that part of Eyre's Peninsula. *Thylogale eugenii*, now extinct on the mainland, was probably one kind, while the other may have been *Lagorchestes* or *Onychogale*.

Howitt and Siebert (1903, 528) gave an account of a Dieri legend in which reference was made of a kind of wallaby, mari, which was killed by a muramura who converted its skin into a large water-bag. This same legend was repeated by Howitt (1904, 804-806). The latter (1891, 39) mentioned as names of wallabies and totems, kokola (Yandairunga, i.e., Antikirinya) and korinya, a small species (Kurnandaburi, *i.e.*, Karendala), but the former has been termed by him (1904) a bandicoot (p. 97) and a pouched mouse (p. 95); while korinya (p. 91) was referred to as a small burrowing rat. Roth 1897, 34, recorded kokola Pp. as a bandicoot.

Howitt (1904, 98) recorded bauanyal Wi, and bauanya Mi, as names for the pademelon [? *Thylogale*]; and wongaru Wi, and muringa Mi, as the respective tribal names for the local small wallaby from the north western corner of New South Wales. Roth (1897) reported ka-la-wari as the Pittapitta term.

Wallaby—Gason (1879, 285) gave kulkuna as the Dieri name for a "very swift" wallaby. I suspect that it was the hare wallaby, *Lagorchestes* sp. (? *leporoides* Gould), concerning whose speed Gould stated that for a short distance it was more fleet than that of any others known to him. Wood Jones (1924) considered that it was now extinct in South Australia. Le Souef and Burrell (1926, 214) mentioned as *Lagorchestes* a small, very fast, hare wallaby from Lake Frome; the species was not noted, but appears to have been *L. hirsutus*. Finlayson (1936, 158) stated that *L. conspicillatus* occurred in the region further north, its range extending from the east coast almost to the Simpson Desert but was absent from the Eyrean basin. He went on to state that Sturt may have seen *Lagostrophus fasciatus* in the plains of the interior. In 1927 he gave an account of the "native hare," *Lagorchestes leporoides* (1927, 370). Mrs. Duncan-Kemp (1933, 286) stated that the hare wallaby was called a "grass rat."

Scrub wallaby—Wadla Nj, Berndt and Vogelsang (1941, 6). This is the same term (wudlu) as those authors mentioned for the male red kangaroo, *Macropus rufus*, which is certainly not a scrub wallaby. Perhaps the term is to be regarded as a general one in the region for kangaroos and wallabies. The scrub kangaroos of South Australia are *M. major* and its subspecies, *melanops*.

Bush wallaby—Gason mentioned the presence of a bush wallaby known to the Dieri as kaunoonka (1879, 285). Finlayson (1936, 158, 160) referred to kanunka as the Wonkanguru term for a marsupial (Potoroinae, resembling *Caloprymnus*) from the very arid regions from which that tribe migrated to the Diamantina, and suggested that it was perhaps *Bettongia lesueurii*. It is of interest to note that Strehlow (1908, 62) reported that tnunke was the Aranda term for the latter. Howitt (1891, 38) recorded kanunka as a bush wallaby and totem (Dieri). In his book (1904) he mentioned kanunga as a kangaroo rat and as a murdu (totem) amongst Eyrean tribes, D (p. 91), Yu (92), Ya (95); but he must have been in error when he reported (783) that it was a rabbit bandicoot, *Perogale lagotis* (sic). Fry (1937, 287) recorded kanunka D, as a kangaroo rat.

Since Gason distinguished the local kangaroo rat as wurtarrie, it is possible that kanunka may have been another of the hare wallabies, *Lagorchestes* or *Lagostrophus*. Howitt called watari (1904, 783) and kanta-wateri N (p. 94) each a kangaroo rat (totem). Kararjili D, Fry 1937, 190, rat wallaby.

Caloprymnus campestris Gould, plain rat-kangaroo—This animal, described in 1843, from the stony tablelands and open plains of northern South Australia, was not heard of again until rediscovered by Finlayson (1931, 162; 1932, 150), who gave an excellent account of its habits and capture in the Diamantina region and published a series of photographs of this interesting little animal in his book, "The Red Centre" (1936, 96-104). He reported (1932) that it was known to the Yelyendi and to the Wonkanguru (who adopted the Yelyendi name) as oolacunta, to the Yaurorka as coorgee, and to the Dieri as wirtiree. Tate's record of it from the Head of the Great Australian Bight, where the name weelba was applied, was considered to be an error, based probably on another rat-kangaroo, *Bettongia* sp. Brief mention was again made by him (1936, 159). Gason (1879, 285) referred to wurtarrie as the Dieri term for a kangaroo rat, Howitt (1904, 94, 783) calling it wateri and watari. Coorgee suggests kurka D, W, reported by M. Howitt (1902, 408) as a kind of kangaroo rat; and kulka Pa, Schürmann.

Bettongia ogilbyi Gould, closely allied to the eastern form, *B. penicillata* Gould—This rat-kangaroo was formerly widely distributed and common in South Australia, but Wood Jones (1924, 214) stated that it had become extremely rare in this State in a very short time. Le Brun (1886, 142) gave bookurra as the name of the kangaroo rat in Ngadjuri territory; and Browne (1897, 72-73) indicated the native method of using the leaves and stems of *Xerotes* (= *Lomandra*) *effusa* to smoke out these animals (bokra) in the "lower North," presumably by the Ngadjuri tribe. Green (1886, 126) gave the term oolka and boorachie as Pangkala names, the former being obviously kulka Pa (Schürmann 1844, 19), while boorachie suggests poorakie, an Adelaide term (presumably aboriginal) for a rat-kangaroo. Poorakie may be the same term as purroilko, a species of kangaroo, recorded by Moorhouse 1935, 37, for the adjacent Murray River tribe.

Cawthorne, in his notes to his version (2nd edit.) of the Kupirri legend, mentioned yerke as a rat-kangaroo. Howitt reported pirrapirra (1904, 97) and wirijura (1891, 39) as names of rat kangaroos amongst the Kurnandaburi people [Karendala tribe], and madura (1904, 789) amongst the Arabana. Schürmann (1844) recorded ngandalla (p. 44) and purrai (p. 61, a large species) as rat-kangaroos, Pa.

Phascolomys sp., wombat—Yalpu Wp (also totem), Hale and Tindale 1925, 57. Berndt and Vogelsang (1941, 10) recorded yalpu Wp, and watu Nj. Warto Pa, Schürmann 1844, 70; wartundu yappa Pa, wombat hole, Schürmann 1844, MS. The kaurna also applied warto to the animal (Teichelmann and Schürmann 1933, 152), which is known as wardu to the Wirrung tribes along the Great Australian Bight. It seems to me that all these references relate to a *Lasiorhinus latifrons* Owen, judging from the known range of the two South Australian species as given by Wood Jones (1924, 268).

Trichosurus vulpecula, common opossum—Pildra, rare in Dieri country (Gason 1879, 285). Reference has already been made to a Pangkala legend regarding the red kangaroo (kupirri) and the opossum (pilla), as recorded by Schürmann and others.

The following names were supplied by Curr's contributors (1886):—pildra D, Gason — D, Jacobs; pilta Wi, Dix — Ma, Morton — Wa, Dewhurst; pilla Pa, Sawers — Le Souef and Holden; pilda A, Jacobs; peelda Ja, Green; peedla Pa, Green; pilka W?, Jacobs; pillpa Pa Sawers; bilda K, Kingsmill — Wp, Gason — Nu, Valentine — Wp, Phillipson; bilta Wp, Wills. Wombla A, Warren and Hogarth; womboola A, Todd; wampala N, Cornish. Marloo N, Paull; murloo Ya, Salmon; mullo Ya, Cornish; murlu Wa, Crozier; burloo Kw, Anon — Ky, Machattie. Warnunga Kg, Heagney; warnonga Ku, Heagney; woornanga Bi, Curr; yoranga Ma, Reid. Murrathurra Te, Sullivan and Eglinton — Te, Foott. Koorakunnia B, Sullivan. Cothera Kg, Heagney. Tinaballi Pp, Eglinton. Gurrigen Wk, Myles. Curr (1886, 168-169) pointed out that bilta was the common term on the Darling River and pilta on Cooper's Creek.

Howitt (1904) recorded mirraltiera Kd (p. 97), yaranga Wi (98), and yerilpari Mi (98), and muruthera Kd (1891, 39) as a totem animal. Wumbula A, Helms 1896, 316; pilla Pa, Schürmann 1844, 56. Finlayson (1936, 160) mentioned unta as its name along the Diamantina and Cooper, but the term does not resemble any of those reported above, but it suggests antana, the Aranda name for the species (Strehlow 1908, 62), and wainta which is applied by the Everard tribes (Helms 1896, 317). Stirling and Waite (1919, 146), toa 248 W, referred to the mortal combat between the muramuras, Pildra and Yikaura; the latter is the native cat, *Dasyurus geoffroyi*. Berndt and Vogelsang (1941, 7) recorded the opossum as bilda Nj, and pildra D. It was known to the Adelaide tribes as pilta.

Opossums were eaten. Amongst some tribes their skins were sewn together with kangaroo sinews to form rugs. The latter were called bilda-palda [palda = cloak or rug] amongst the Ngadjuri, while a pad made from the skin was called walka by the same people (Berndt and Vogelsang 1941, 7). Myles (1886, 36) stated that opossum rugs were rare amongst the Wonkamarra; they were worn by the Malyangapa (Reid 1886, 178). Schürmann (1846; 1879, 210) mentioned that opossum skins were rarely used as clothing by the Pangkala, and described the mode of preparing them; he also stated that string made from the fur of this animal was worn round the head and neck of men and was woven into nets for the head and for pubic tassels (p. 211, 230, 233).

Schürmann (1844) reported the following Pangkala terms relating to pilla (p. 56), the opossum:—pilla butti, pilla putti, opossum hair (p. 4, 5, 6) butti or putti = hair or fur; kundindi, belt or girdle made from (spun) fur of this animal (p. 20); malberinye, phallocrypt (ngulta, p. 48) consisting of tassels made from opossum fur (p. 25); manga, thread or yarn spun from the fur and woven around men's heads (p. 26), this head band being termed ngarkiri (p. 46); womballa, female opossum (p. 75); and yarndi kuibo, the peculiar odour of opossums (p. 81).

Pseudochirus laniginosus, Ring-tail opossum. Pipara Pa, Schürmann 1844, 57.

Thalacomys lagotis (*Peragale lagotis*; *Macrotis lagotis*). Bilby, pinto, pinkie, native rabbit; the largest species of the genus which includes all the rabbit bandi-

coots. Capietha [Kapi-ta] D, Gason 1879, 285, native rabbit. Roth (1897, 33) used the term bilbi, but expressed doubt whether it was the local Pittapitta name. Howitt (1904) gave many references to rabbit bandicoots as totem animals in the Eyrean region, and associated the name *Peragale lagotis* with them, though it is quite possible that allied species (not then recognised scientifically) were included: —pira-moku, kapita, D (p. 91), N (94); talka, W (92), A (94), nara-moku, Yu (92) [moku = bone or hard structure], Ya (95); kapita, D (646); he also referred (p. 794-797) to kapita in his account of the Anti-etya and Ngardu-etya legends (anti or nganti = flesh; ngardu = nardoo, sporocarps of *Marsilea Drummondii*; etya = eaters—thus flesh and nardoo eaters) (p. 794-797). Eylmann (1908, 167) recorded piramukku (*Perameles lagotis*) as a Dieri murdu (maddu).

Hale and Tindale (1925, 46, 57) mentioned the pinto (presumably following Waite 1917, 433, in using this term) or rabbit bandicoot (which they did not identify) as a totem animal called wara by the Wailpi of the northern Flinders Ranges. I am not able to state which variety of *T. lagotis* occurred in that region; probably it was *T. sagitta*. It might be mentioned that the Kaurna tribe used pingko for a small burrowing animal with a white tail (Teichelmann and Schürmann 1933, 137), obviously *Thalacomys lagotis*—hence the corrupted term pinto.

Wood Jones (1924) gave an account of the South Australian species and stated that the typical *T. lagotis* was now probably extinct in this State, its last known habitat being near Lake Alexandrina. Troughton (1932) considered the animal from the lower Murray as a distinct subspecies, *T. lagotis* var. *grandis* Troughton. The Barcoo bilby was reported by Wood Jones as *T. sagitta* which lived in the great drainage system of Lake Eyre and whose Dieri name was kapita, urgata being applied to it [by the Aranda] at Charlotte Waters. He published a key (p. 154) to the various species. Krefft in 1866 stated that the name for the rabbit bandicoot amongst the natives of the lower Murray was wurrapur. This term closely resembles wirrappo, reported by Moorhouse (1846) as that applied to a "small mammiferous animal" by the aborigines of the Murray, between Mannum and Morgan.

Finlayson (1930, 178) stated that Thomas' *T. sagitta* from Killalpaninna was near *T. lagotis*, and in a later paper (1935, 233) recorded it as a variety of the latter, mentioning that it was the kapita of the Dieri and thulka of the Wonkanguru. Wood Jones (1924, 164) had reported that thulka was its name amongst the Kukata people and was commonly changed into talkie by the local whites. Two of the Dieri toas (75, 169) described by Stirling and Waite (1919) relate to kapita (*T. lagotis*).

Thalacomys leucurus—The Eyrean form was described by Finlayson (1932, 168) as *T. minor* var. *miselia* and was stated (1935, 227) to be known to the Wonkanguru as yallara. It was more common than the kapita. He believed that *T. leucurus* Thomas was a synonym of *T. minor* Spencer. Troughton (1932, 231) discussed *T. minor* and considered that the specimen from Mungeranie, identified by Le Souef as *T. leucurus* Thomas, belonged to Spencer's species (*minor*), whose native [Aranda] name at Charlotte Waters was urpila. Iredale and Troughton (1943, 20) regarded *T. minor* (vars. *minor* and *miselia*) as distinct from *T. leucura*, but in his recent work, Troughton (1941, 74) considered *minor* as a dark phase of *T. leucurus*, and *miselia* as representing the typical adult stage of Thomas' species.

The tails of the various species are striking because of their whiteness and of the black tip varying in length according to the species or variety. They are used extensively for ornamental purposes by Central Australian natives, the term tippa or thippa being used in the Eyrean region, but some authors have applied it also to "rat tails." Apart from the water rat, *Hydromys*, *Pseudomys minnie* and *Leporillus apicalis* (from the lower Darling and Murray), I do not know of any

native rodent in that area possessing a white tip to the tail. These tails, singly or in bunches, are tied to the end of the beard or elsewhere. Gason (1879, 289) stated that the Dieri gave the name thippa to a bunch of tassels made from tails of native rabbits, about fifty being needed to make an ordinary tippa to be used as a phallocrypt. When the latter was made from fur of rats or wallaby it was called unpa. Presumably "rat" in this latter case referred to a true rodent such as *Rattus villosissimus* or *Pseudomys minnie*, Paull (1886, 18) mentioning that the Ngameni wore a pubic fringe spun from the fur of rats, while Sanger (1883) stated that ampah [unpa of Gason 1879] was a phallocrypt of twine made from the fur of animals. Howitt and Siebert (1903, 530) used the term tipa for the pendant made from tails of the rabbit bandicoot. Gason stated (p. 272) that thippa were fastened to the prepared hair of the head of initiates at the mindarie (or peace) ceremony in such a way that the ends of the tails (of rats) hung down over the shoulders. Howitt (1891, 84; 1904, 662) gave similar information (based on Gason). Fry (1937, 201) reported the term as tipi D.

Howitt (1904, 646-650) referred to a Karauguru and Ngameni legend concerning the muramura, Malku-malku-ulu, a Ngameni name whose Dieri equivalent was Tippa-tippa-ulu, meaning "the two with the tippa," a pubic tassel made from the tails of kapita, *Peragale lagotis*. This tippa was worn as a phallocrypt only by circumcised men (p. 647), but men of a pinya (revenge expedition) wore it fastened to the beard. There is also a reference (p. 805) to another muramura wearing a tippa. The ornament is called alpita by the Aranda (Spencer and Gillen, 1899, 646). Stirling and Waite (1919, 114) referred to kararitji (toa 5) as the string spun from the fur of the tails of the "white kapita, probably the rabbit bandicoot, *Thylacomys lagotis*," by a muramura (Tirari tribe).

Horne and Aiston (1924) mentioned telca W, as a white rat and stated (p. 9) that there was a native legend that, before the arrival of the white man there had been a very luxuriant season on the Diamantina and Warburton, but there followed an immense fire which swept down almost to Lake Eyre, many of the blacks being burnt to death. Willoo, the plover (stone plover or curlew), being a cunning bird, turned himself into a stone and watched the blaze, but Telca (the ancestral telca) saved himself by burrowing deep in the earth until the flames had gone by. Two mooras who were stated to have been the cause of this conflagration, decreed that, ever afterwards when fire was being made, special precautions must be taken. Telca is the rabbit bandicoot, *T. lagotis sagitta*.

Bandicoots—Wood Jones (1924, 140) stated that *Isoodon obesulus* was formerly common all over South Australia but was now on the verge of extinction. Finlayson (1931, 161) also referred to this fact. Waite (1917, 433) reported finding remains of the species in the pellets of an owl near Lake Perigundi.

Finlayson (1935, 235) obtained from old natives in the Wonkanguru area an account of two species of Peramelids, one of which was possibly a small *Perameles* and the other probably *Chaeropus castanotis*. The latter was recorded from Cooper's Creek by Wood Jones (1924, 171), who stated that its Kukata name was wilyalya. Burkuna was the bandicoot totem amongst the Wilya tribe (Howitt 1904, 98). Le Brun (1886, 142) mentioned mully as the Ngadjuri name for a bandicoot; kurkullu Pa, Schürmann 1844, 23; kurkulla Pa, Schürmann 1879, 220; *Isoodon obesulus* is a probable identification.

Schürmann (1844, 82) mentioned yartini Pa, as a spotted bandicoot, an animal similar to paltyarra, a species of rat. It was recorded later by him (1879, 220; Wilhelmi 1861, 176) as yartiri Pa, bandicoot. If for spotted we read particoloured it may refer to *Perameles eremiana*, described by Spencer from Central Australia; but if we interpret spotted as indicating obvious variations in pelage colour as well as the presence of marked dark or light barring, then *P. myosura*,

a species known from the region of the Gulfs and extending west to Western Australia is a probable identification. What is the status of Gason's kooraltha, a "spotted ferret"? It is suggested later in this paper that it may be *Dasyurus viverrinus*, but it may perhaps be one of the bandicoots just mentioned. According to Troughton (1941, 67), *P. myosura* occurs from Ooldea to the Swan River, but formerly ranged easterly to the head of St. Vincent Gulf and the Murray.

Dasyurus geoffroyi Gould, northern native cat, *Dasyurinus geoffroyi*, according to Iredale and Troughton 1934. Tickawara [tjikawa-ra] D, Gason (1879, 285), eaten; tikanara [?error for tikauara] D, Howitt (1891, 38), murdu. Several toas (No. 70 T, 90, 107 W, 248 W) mentioned by Stirling and Waite (1919), have relation to the muramura, Yikaura. Berndt and Vogelsang (1941, 5) gave aku-indji and jikaura as the Ngadjuri and Dieri names respectively. Roth (1897, 33) recorded it as ik-no-urra Ep.

Howitt (1904) mentioned the native cat as a totem animal in many tribes, *e.g.*, yikaura D (p. 91), N (94), Ya (95), yirauka (96, error for yikaura); piramoku, tribes to the south-east of Lake Pando (782); yikaura, tribes to the south of Lake Pando (783); but he also termed piramoku D, N, a rabbit bandicoot (91, 94). It is a very important totemic animal, achilpa, tjilpa, of the Aranda. Sawers (1886, 132) recorded gedna Pa, from the Gawler Ranges, Pangkala. Finlayson (1933, 202) stated that the Dieri referred to the presence on the Barcoo of a spotted animal, yikaura, which had not been seen for many years, and that it was probably *Dasyurus* sp. The disappearance of native cats from South Australia and eastern Australian localities was referred to by Wood Jones (1923, 92, 94), who mentioned that the allied species, *D. viverrinus*, used to occur along the Murray River in South Australia.

Horne and Aiston (1924, 57) mentioned a legend from Beltana (Kuyani) relating to the native cat, which when first seen had a smooth black coat. The natives speared the unknown animal, piercing it in many places, the injuries being now represented by the white spots. This legend differs considerably from that previously mentioned when dealing with the red kangaroo, opossum and native cat.

Gason (1879, 285) mentioned kooraltha as the Dieri name of the spotted ferret. As far as I know, the only spotted marsupials in Australia (apart from the cuscus, *Spilocuscus maculcaudatus*, from Cape York Peninsula) are species of *Dasyurus*. Since Gason recorded tickawara as the Dieri name for the native cat, it is probable that, unless these two terms referred to the same species (Gason being unaware of it), two species of *Dasyurus* may have been known in the region.

Dasyurus viverrinus (= *D. quoll* Zimm. according to Iredale and Troughton's check-list, 1934, 12). Native cat—Schürmann 1844, reported the following Pangkala terms: idnya (p. 5); idnya yappapaityapaityа (p. 79), yappa = hole, hence perforated, spotted; paitya = angry, quarrelsome, thus the term means the very quarrelsome spotted "cat." The term was reported as indya in the Kupirri legend as reported by Schürmann (1879, 239) and referred to earlier in the present paper. The animal was called ngrui moch (= many spots) by the Murray natives, according to Wood Jones (1923, 92). Moorhouse (1846; 1935, 24) reported that it was termed mabong by the Moorundie natives who lived along the Murray River between Morgan and Mannum (according to Tindale's preface to Moorhouse's reprinted work, 1935), and belonged to the Ngaiawang tribe (Tindale 1940, 180). Teichelmann and Schürmann (1840; 1923, 111) stated that it was known as mabo amongst the Kaurna tribe of the Adelaide plains. It is quite possible that Berndt and Vogelsang's Ngadjuri term, aku-indji (1941, 5), may refer to *D. viverrinus* (indya, idnya), rather than to *D. geoffroyi*, the terms being similar.

Sminthopsis crassicaudata centralis Thomas—Finlayson (1933, 197) recorded this variety of fat-tailed pouched mouse from the Wonkanguru region, where it

was called nilee. Thomas, in 1902, had already reported it from Killalpaninna in the Dieri area of Cooper's Creek. Its resemblance to the shrews of the Northern Hemisphere was noted by Wood Jones (1923, 112). Waite (1917, 454) reported finding it in the Cooper's Creek region where it is preyed on by white owls, *Tyto alba delicatula.*

Sminthopsis larapinta Spencer was reported by Finlayson (1933, 199) from the Wonkanguru region, where its name was melatjhanie.

Dasycercus cristicauda Krefft—Finlayson (1933, 200) gave an account of this small Dasyurid as *Chaetocercus cristicauda hillieri* Thomas from the lower Diamantina, where its Wonkanguru name is mudagoora. Wood Jones (1923, 103) wrote of it as *Chaetocercus cristicauda* whose name at Ooldea was mulgara, and at Charlotte Waters was amperta (Aranda), but later (1924, 132) pointed out that the correct generic name was *Dasycercus* which took priority over *Amperta* Cabrera (based on its Aranda name), *Chaetocercus* being already preoccupied. Iredale and Troughton (1934, 8) placed *Phascogale hillieri,* described by Thomas in 1905 from Eyrean material, in the synonymy of Krefft's species, as also did Troughton (1941, 34).

Howitt (1904, 791) stated that madagura was a small marsupial (Arabana), and he referred (p. 789) in the same legend to "madura, the kangaroo rat, whose burrow (like that of any animal which threw the earth out behind it) was called pul-yundu." Whether madura and madagura are the same animal I cannot say, but it may be mentioned that Howitt often applied the same name to different animals, as will be shown below. Finlayson's observations identified madagura as *Dasycercus.*

Notoryctes typhlops Stirling, marsupial mole—Duncan-Kemp (1933, 66) mentioned that this animal, kakoma of the tribes living amongst the sandhills west of the territory occupied by the Pittapitta and related tribes, was eaten by the natives and the skins were used for ceremonial purposes and for making loin cloths. Roth (1897, 33) stated that kokoma Pp, was a rat. Finlayson (1935, 235) mentioned that there was no scientific confirmation of the presence of the mole in Queensland and that it was not recorded in Longman's list (1930) of the mammals of that State. The region, however, lies in the great arid sandhill region whose zoology has not yet been satisfactorily investigated, and the presence of the animal there is likely. Spencer (1896), in the Horn Expedition Reports, recorded its occurrence as far south as Charlotte Waters. I have obtained it from Ooldea, from which locality Wood Jones (1923, 128) has already reported it; its name there is aru-dharra-da.

Mammalian Names Not Identified

Maiaru—Finlayson (1936, 99) stated that all mammals smaller than a kangaroo were called rats by the local whites in the lower Diamantina area, though the native name applied to *Rattus villosissimus* by the Wonkanguru was miaroo. Gason's Dieri term miaroo probably belongs to the same species, since he mentioned other kinds of rats. Howitt (1904) used the term maiaru as the name of a totem animal (a rat), amongst the Dieri (p. 91) and Wonkanguru (92), but he termed it a marsupial rat (782) in the northern part of the Eyrean basin— probably an error. In an earlier paper (1891) he used the term for a rat.

Punta—Gason said that poontha D was a mouse. Finlayson stated that puntapunta W was *Mus musculus.* Mr. T. Vogelsang informed me that the duplication of a term in the name of a plant or animal might mean a young or small form of the same kind, so that puntapunta might mean a small kind of mouse. Howitt (1891, 38) called punta D a mouse; but later (1904) called it a shrew mouse (p. 91), Dieri (91), Yantruwunta (92) and Yaurorka (95); but reported it to be a small marsupial (783) amongst the south-eastern totems of the Eyrean

area; he also stated that it was a small marsupial which was called a rat by the local whites. Schürmann 1844, 61, reported that punta Pa was similar to marnta and that the latter was a marsupial.

Palyura—Gason called pulyara D a long-snouted rat. Finlayson recorded pallyoora W as *Pseudomys minnie*. Howitt (1904) mentioned amongst totem animals a small pouched mouse, balyara N (p. 94), baliyara Wo (95); palyara, a long-snouted marsupial rat eaten by the Karanguru and Ngameni (646); and palyara, a small marsupial (a totem animal in the northern part of the Eyrean basin. Schürmann 1844, 52, recorded paltyarra Pa as a rat. *Pseudomys* spp. can scarcely be called long-snouted rats; hence the possibility of the term being applied in the northern portions to a native mouse, *Pseudomys* spp. as indicated by Finlayson, and elsewhere in the area to some marsupial mouse like a *Sminthopsis*. Eylmann (1908, 167) reported paljara as a rat (Dieri totem). The name tundubulyeru was reported to be used for the water rat; bulyeru seems to be the same term as palyaru, p and b being interchangeable in most native words.

Kokula—Howitt (1891, 39) called kokola Kd, a bandicoot. Later (1904) he reported as a small marsupial kokula D (p. 91), W (92), A (94), N (94); a pouched mouse, kokula Wo (95); a small bandicoot, kokula Kd (97); marsupial rat, kokula (totemic in the south-eastern part of the Eyrean basin). Stirling and Waite (1919, 149), in referring to toa 275, mentioned kokula as a species of rat which carried its young on its back. Roth (1897, 34) recorded kokola Pp as a bandicoot. Troughton (1941, 35) mentioned that the young of *Sminthopsis* and (p. 307) of some rats, including *Conilurus albipes*, could cling to the fur of the mother and thus be carried by the latter. The available evidence suggests that kokula is probably a small Phascogaline marsupial, *e.g.*, *Sminthopsis* sp.

Other "rats" and "mice"—Koolchie D, a rat; koonappoo D, a species of mouse; kulunda D, a black and white rat; all reported by Gason (1879, 285). Karapana D, a mouse (Howitt 1891, 38); karabana D, a small mouse (Howitt 1904, 91, 783); korinya Kd, a small burrowing rat (Howitt 1904, 97), termed a small wallaby in a previous paper (1891, 39); kunamari Yu, rat (Howitt, 1904, 92), mari was stated by Howitt and Siebert (1903, 528) to be a kind of wallaby; parina Kd, rat (Howitt 1904, 97); myara A [maiaru], rat, Warren 1886, 112. Duncan-Kemp (1933, 14) mentioned "blue poorakies" and paely ooras (desert rats and mice) as being collected in the sandhill country near Farrar Creek [Karuwali tribe].

Other marsupials, probably Dasyuridae—Gason (1879, 285) mentioned three Dieri names for "native ferrets":—thillamillarie; arutchie; and a "spotted ferret," kooraltha. It has already been suggested that the last may be a species of *Dasyurus* other than *D. geoffroyi* (*e.g.*, *D. viverrinus*); the other two were perhaps *Phascogale* and *Dasyuroides*. Padi-padi Yu, a pouched mouse (Howitt 1904, 92). Nidla D, Ya, Yu (Howitt 1904, 796), a small marsupial called a rat by the whites; is this Finlayson's nilee, *Sminthopsis crassicaudata*? Schürmann (1844) referred to two Pangkala marsupials:—marnta (p. 28) and punta (p. 61), an animal similar to marnta; these two terms probably belong to members of the Phascogalinae. Punta has been applied to mice.

Monotremata

Tachyglossus aculeatus Shaw—Echidna or native porcupine. Finlayson (1936, 161) reported it as very rare in the lower Diamantina region, where its Wonkanguru names were inappa and innuwallinga. Gillen (1896, 180) gave its Aranda name as inaarlinga, while the ancestral echidna (p. 184) was Inapwerla; Spencer and Gillen (1896, 650) using the terms inarlinga and inapwertwa respectively. Roth (1897, 36) stated that the Pittapitta applied the terms nunguni-pari and narapari to the animal.

Ornithorhynchus anatinus—Hale and Tindale (1925, 56) referred to Basedow's opinion (1925, 304, pl. 41) that a design scratched on a rock by natives of the Flinders Ranges was strongly suggestive of a platypus, that author in 1914 considering that there was reason for supposing that the animal had been observed in Dalhousie Springs. Though on very rare occasions the species has been seen in the lower Murray, it has not been reported further north in this State and the absence of suitable streams there would seem to render its occurrence quite unlikely. The native rock engraving is suggestive of an echidna or possibly a tortoise.

Aves

General terms Bird: pai-a is the common term throughout the region; piya D, Gason 1879, 302; pi-a Pp, Roth 1897, 31, 37, pi = that which travels or lives in air; paia, Howitt 1904, 788; paija D, Fry 1937, 203; irta Pa, Schürmann 1844, 8; yuta Wp, Hale and Tindale 1925, 57; talli Pa, Schürmann 1844, 62, young bird. Feathers: yarri Pa, Schürmann 1844, 81 (wing or feather); poornoo, kouaru Pp, Roth 1897, 31, 35; kurl-ya Ka, Wells 1894, 520.

Egg, names supplied by Curr's correspondents (1886): papoo A, Todd; pappu A, Jacobs; parpoo N, Cornish; bapoo A, Warren and Hogarth; pampu W?, Jacobs; pompo Kw, Anon; pumpo Ky, Machattie; pampo Ya, Salmon; pompoo Ya, Cornish; bembo Pp, Eglinton. Pepe Wp, Wills; peipe K, Kingsmill; pie-pie Wp, Gason; peepee Pa, Beddome — Ja, Green; peppi Pa, Sawers. Kaapee N, Paull; capee Yu, Howitt; kuppy Te, Foott; kuppe Wk, Myles; kuppie D, Gason; kuppee Wp, Phillipson; kupinya Te, Sullivan and Eglinton; kuppo B, Sullivan; kabbi D, Jacobs; kupi Wa, Crozier; karpi Ma, Morton; kappi Wa, Dewhurst, Kookurry Ku, Heagney; coocurry Kg, Heagney; kokarri Bi, Curr. Mooka Nu, Valentine. Pirty Ma, Reid; berty Wi, Dix.

Other terms Nest: wola (piyawola) D, Gason 1879, 301; pudni Pa, Schürmann 1844, 59. Thaubulyoo D, Gason 1879, 303, rotten egg. Wardnu Pa, egg-shell, Schürmann 1844, 69; murka Pa, yolk (p. 36); peli Pa, egg-white (p. 55). Paia-moku D, Howitt 1904, 788, applied to the Umbelliferous plant, *Didiscus glaucifolius;* payamoku D, Stirling and Waite 1919, toa 68, bird bone used for piercing nasal septum. Wima paija D, Fry 1937, 203, dream bird, *i.e.*, one associated with sacred ceremonies (wima). Malberinye Pa, Schürmann 1844, 25, phallocrypt made of feathers (or of tassels of opossum fur). Aunie D, Gason 1879, 296, flock of birds (or mob of cattle). Kullari Pa, a fabulous bird said to peck people's heads (Schürmann 1844, 20); it was apparently different from the fiend, Marralye, which took the form of a bird and attacked, and at times killed, natives (p. 28). Gason (1879, 278) referred to a Dieri ceremony to make wild fowl lay eggs; such birds occur in great abundance after the floods come down from Queensland highlands and fill the river-beds, lakes and watercourses. Reid (1886, 179) reported that the Mulya-ngapa natives believed that after death they became birds. The use of feathers by the Dieri for stuffing skin bags to convert them into percussion instruments for use during dancing (Fry 1937, 270) has already been noted. Many of the native names for birds are onomatopoeic.

Casuariiformes

Dromaeus novae-hollandiae Lath. Emu—Woroocathie D, Gason (1879, 286). Curr's contributors (1886) reported the following terms: warreewatte A, Warren; warrewotti A, Warren and Hogarth; warrawatty Yu, Howitt; warrachie Pa, Ja, Green; warraitya Pa, Le Souef and Holden; warretchie Wp, Gason; warrachie Wp, Wills; worrachie K, Kingsmill; warrache Wp, Phillipson; warradi Pa, Sawers; warrawudgi Kw, Anon; warrawidgee Ya, Salmon. Warrukotti A, Jacobs; woroocathie D, Gason; worrukatti D, Jacobs; warroogatty N, Paull;

workatji W?, Jacobs; waraguita N, Cornish; waroogatee Wp, Phillipson; wargutchi Ky, Machattie. Koolpurri Te, Foott; koolberri Wk, Myles; koolbarce, Te, Sullivan and Eglinton; koolbarree B, Sullivan [= kool-par-i Roth 1897]; goolburra Pp, Eglinton; coolperry Kg, Heagney; koolperry Ku, Heagney. Kathie Ma, Reid; kaltee Wi, Dix; kolcti Ma, Morton; karde Nj, Le Brun; karrie Nu, Valentine; karlye Pa, Beddome; kurlithe Wa, Crozier; kurlitchi Wa, Dewhurst. Quarra Ya, Cornish. Erlea A, Todd. Kubana Bi, Curr.

Names reported by Howitt as totemic were: warugati D (1891, 38); waranati An (39), and kulbara Kd (39); warugatti (1901, 293). In his later work (1904) he reported the following as totemic: warogati D (p. 91), W (92), A (94); warukati A (783); warkitji N (94); kewora Ya (95); pulkara Wo (95); kulbara Kd (97), and kulthi Wi, Mi (98). Many of these terms will be recognised as being essentially the same as others quoted above. Kewora is quorra; kulthi is kaltee or kathie (*i.e.*, skin); kulbara is the same as koolpurri and its variants, as well as koolpari of the Pittapitta referred to below. Erlea, mentioned by Todd (1886) for the Arabana, is the same as erlia and ilia reported for the Aranda by Spencer and Gillen (1899, 648) and Strehlow (1908, 64) respectively. It is of interest to note that Howitt (1904, 97) recorded that warogatchi was applied to the crow by the Kurnandaburi (= Karendala); this is probably an error for wakaratchi (wakaretji) the term applied to the crow by other tribes in that locality. Karlye suggests kalaia, the Loritja term for the emu, the latter term being used also at Ooldea by the Andigerri; while Helms recorded kaleya from the Everard Ranges (1896, 317).

Other records are warugati D, Howitt 1885, 6 — Gatti 1930, 107; warraitya Pa, Schürmann 1844, 69; worrugatti A, Helms 1896, 316; warugatti Yu, Howitt 1901, 293; warra-katchie Ka, Wells 1894, 520; waridji Nj, warukati D, warichi Wp, Berndt and Vogelsang 1941, 6; warichi Wp, totem, Hale and Tindale 1925, 46, 57; warukatti D, M, Howitt 1902, 407; warukati D, Eylmann 1908, 167 — Fry 1937, 188, 197; warroo getti W, Horne and Aiston 1924, 135; warraguti A, Spencer and Gillen 1899, 60; waragutie A, Spencer and Gillen 1899, 114; wakaje, Duncan-Kemp 1933, 235; warukatji, Stirling and Waite, toas 1, 3, 8, 82, 123, 143, 157, 236, 238, 242, 246, 296; warrukatji N, W, Johnston and Cleland 1943, 154. Waru-kati = grey skin (Howitt 1904, 783) and hence the emu is known as the grey bird. Roth (1897) reported several names used by the Pittapitta: wakaje, kool-par-i (= nodding head, *i.e.*, the bird with the nodding head), multara maro (*i.e.*, the possessor of the multara, an emu-feather ornament), and pooroo-ro (= the feathered one; its feathers, poorono, are used extensively for decoration). Pappiti Pa, male emu; pitti Pa, emu eggs, Schürmann 1844 MS.; kalbanna, emu feathers (p. 10). The eating of emu eggs by young men was prohibited by the Kungerri and Kungadutji tribes (Heagney 1886, 375) and by the Karanguru, those disobeying were liable to become grey-headed (Wells 1894, 517). Wonapanyi D, is the polished sharpened "radius" of an emu and was used for piercing the nasal septum (Sanger 1883); Gason 1879, 303, called it wonabunyie. Sharpened emu bones were pushed through the skin of the arm, thigh, and scrotum during ceremonies for increasing wild fowl (Gason 1879, 278); and for rain-making (Horne and Aiston 1924, 44, 115, fig. 80). It was also forced down the urethra of a youth immediately prior to being subincised with a small stone knife (Horne and Aiston, p. 161). Emu sinews were used for attaching the barb to the light spear, kutchie (Horne and Aiston, p. 79), and for tying feathers of hawks, crows and eagles into bunches (kootcha) for decorative purposes (Gason 1879, 289). Emu feathers were used extensively in connection with ceremonial decorations and dancing. Those bound into a bundle and stuck into the headband were called kukamandra D, Fry 1937, 201; multara W, Horne and Aiston 1924, 118; multarra Ka, Wells 1894, 520; maltara Stirling and Waite 1919, toa 8;

maltarra Pa, Schürmann 1844, 26, attached to the waist belt, the ornament worn in the hair being termed woppa (p. 75); multara Pp, Roth 1897, 36, a roll of such feathers being worn over portion of the body wherever there is pain, also called min-ta-ra and min-ma (p. 163); tilyari Pp, bunch worn over the buttocks, Roth 1897, 38; wurtawurta or wurdawurda D, worn in the headband or in the waist-band (yinka or dampera), Gason 1879, 289 — Horne and Aiston 1924, 47; aroo D, Gason 1879, 289, large feathers from the tail, used as a fan. Horne and Aiston published illustrations showing feather ornaments (fig. 34, 35, 82). Howitt (1904, 330, 662, 663, fig. 15) recorded the following names for emu feather decorations: kabuluru, kakabilla, maltara and ngaru. Gason (1879, 272) and Howitt (1891, 85) mentioned the use of emu feathers in the Dieri mindari ceremony; and the latter author (p. 679) referred to the carrying of a very striking token (fig. 41) of emu feathers by messengers calling people together for the wilyaru, as well as the mindari, ceremonies. Emu feathers were sometimes woven into the hair-string forming the waistbelt (Schürmann 1846; 1879, 211-212, 233; Wilhelmi 1861, 167-168). Emu feathers were stuffed into a net (munta W) worn on the head; and they were also utilised to make kurdaitja shoes and the sheath in which the stone knife (yutchawunta) was carried (Horne and Aiston 1924, 138).

Basedow (1925) mentioned that the emu (dangorra) figured amongst the aboriginal constellations (p. 315, 332-333, 349), but did not indicate the name or locality of the tribe concerned.

Australites were termed "emu eyes": oooga, Duncan-Kemp 1933, 72, carried as charms by old men of the Diamantina tribes, and credited with powers of night vision; warukati milki-tandra D, emu eyeball, regarded as representing a mura (mindiri), Fry 1937, 201; warroo getti milki W, Horne and Aiston 1924, 60, 135. According to the last-named authors these small, characteristically shaped, glassy meteorites were supposed to be eyes lost by emus while walking about looking for food. These articles were stored in a netbag containing abundance of emu feathers (fig. 44). When an emu hunt was about to be undertaken, these "eyes" were taken out by the "Kurdaitcha" men, while the remaining hunters were armed with boomerangs (kirra). The former threw "eyes" at the emus, and this was believed to cause the birds to become blind and thus easily driven into water, when the hunters would close in and kill them.

Sphenisciformes

Eudyptula minor Forst. Penguin—To-lai Pa, Schürmann 1844, 63.

Galliformes

Leipoa ocellata G. Pheasant, malle fowl—Kalbanya Pa, Schürmann 1844, 10, pheasant; budni Nj, Berndt and Vogelsang 1941, 7.

Quail—Mulliepirrpaoonga D, Gason 1879, 286; purrullu Pa, Schürmann 1844, 61. The species was probably *Coturnix pectoralis* G.

Turniciformes

Button Bird—Moko irta Pa, Schürmann 1844, 33; moko = knot or button or any rounded hard substance, irta = bird. A small species. Perhaps the button quail or little quail, *Turnix velox* G, was referred to, but the bald coot, *Porphyrio melanotus*, seems more likely.

Columbiformes

Geopelia placida G. Dove—Kurukuku Wp, Hale and Tindale 1925, 57. We obtained the term kurukuku N, W, for this and the succeeding species at Pandi —obviously an onomatopoeic name.

Geopelia cuneata Lath. Diamond Dove—White 1917 recorded *G. cuneata* to be the widely distributed species in the Eyrean region. Koorookookoo D, Gason

1879, 286; kurukuku D, Fry 1937, 189. Teulon 1886, 212, recorded it as korwoothoo of the Barkindji tribe. Waparu D, Gatti 1930, recorded as a dove, is the flock pigeon.

Histriophaps histrionica G. Flock pigeon—Woparoo D, Gason 1879, 286; wapparoo Ka (pigeon), Wells 1894, 521. Duncan-Kemp (1933, 154) referred to mok-wa-ri, pigeon traps in the form of straight narrow drives, 20 to 30 feet long, through vegetation along lagoons and waterways. Roth (1897, 98; 1901) gave additional information regarding the mokwari, the pigeon concerned being recorded as *Histriophagus* (error for *Histriophaps*) *histrionica* whose name amongst the Pittapitta and Karanya tribes was pa-rou-li (p. 50).

Ocyphaps lophotes Temm. Top-knot, crested pigeon—Murambara Wp, Hale and Tindale 1925, 57. Mulapara D, T. Vogelsang.

Phaps chalcoptera Lath. Bronzewing—Murnpie D, Gason 1879, 286; murnpe D, Gatti 1930; marnpi Pa, pigeon, Schürmann 1844, 28; murnbi Pa, pigeon, Sawers 1886, 132. Wyatt (1879, 172) reported mernpe as a bronzewing pigeon, Adelaide tribe.

Pigeon—Moodlubra D, Gason 1879, 286 [error for murlapara]; murlapara A, Stirling and Waite 1919, 147, toa 259; mulapara D, Fry 1937, 182. These terms all apply to *Ocyphaps lophotes*.

Strehlow (1908, 64) mentioned kokoku and manpi as names of two species of doves amongst the Loritja peoples; these terms are obviously similar to those for the two species of dove and for the bronzewing respectively amongst the Eyrean tribes. The name of the township Murnpeowie suggests murnpi-owie, *i.e.*, bronzewing pigeon-water. The name of Stirling and Waite's mampi bird (1919, 127, toa 99, D) suggests mernpie or manpi, but the figure on the toa represents a crested bird such as a top-knot pigeon.

Howitt (1904, 483) published a photograph of Pigeon Rocks, which are supposed by the Arabana tribe to be full of pigeon spirit individuals (mai-aurli) left behind by the ancestor of the pigeon totem group. The pigeon concerned is probably the rock pigeon, *Lophophaps plumifera* G. (syn. *leucogaster* G.), whose Aranda name is inturrita (Spencer and Gillen 1899, 650).

Ralliformes

Waterhen—Gason (1879, 287) published Dieri names for three species which we have identified. Spencer and Gillen 1899, 60, 114, recorded kutnichilli as an Arabana totem. Wunadjildi Nj, Berndt and Vogelsang 1941, 10, waterhen. Both terms perhaps belong to *Tribonyx ventralis*.

Gallinula tenebrosa G.—Wattawirrie D, Gason 1879, 287, a species of waterhen.

Tribonyx ventralis G.—Kilkie D, Gason 1879, 287, waterhen.

Fulica atra L.—Muroomuroo D, Gason 1879, 287, black waterhen (muru — black). T. Vogelsang informed me that the species was commonly termed the black diver because of its appearance and habit. Howitt (1904, 97) mentioned muro-muro Kd as the large black cormorant [*Phalacrocorax carbo*]. Gason (1879, 287) reported doolpadoolparoo D, as a black diver, but this term belongs to a grebe.

Porphyrio melanotus Temm.—Moko irta Pa, Schürmann 1844, 33, "button bird," may be the bald coot whose head is provided with a prominent-coloured horny plate (moko = button or hard substance, irta = bird).

Porzana fluminea G. Spotted crake—Tampatampana D, T. Vogelsang (tampana refers to the jerky progressive movement commonly adopted by rails). Thanpathanpa D, Gason 1879- 287, slate-coloured snipe.

PODICIPIFORMES

In addition to references to divers, mentioned above, there are others which may belong to grebes. Weoopa Pa, Green 1886, 126; ninmilye Pa, Schürmann 1844, 39, waterbird (diver, MS). Woochoo-bukanni Ka, Wells 1894, 520, diver, is a cormorant.

Podiceps poliocephalus Jard. Selby—Thookabie D, Gason 1879, 287, diver. T. Vogelsang informed me that the correct name is tooka-tookabi.

Podiceps ruficollis novae-hollandiae Steph.—Doolpadoolparoo D, Gason 1879, 287, black diver. Identified by T. Vogelsang.

PROCELLARIIFORMES

Mutton bird, presumably *Puffinus tenuirostris* Temm.—Mannallara Pa, Schürmann 1844, 26.

PELECANIFORMES

Pelecanus conspicillatus Temm. Pelican—From Curr's work (1886) the following names have been collected: Tampanpara A, Jacobs; tumpunara N, Cornish; toompingaroo N, Paull; thampara K, Kingsmill; tampangra Yu, Howitt; thaumpara D, Gason; tampangara D, Jacobs; thampano Ma, Reid; kaubungarra Wk, Myles. Worandoo A, Warren and Hogarth; warrunto A, Todd; worrantjuna W?, Jacobs. Turta Kw, Anon; thirta Kg, Ku, Heagney; tarta Bi, Curr. Widli Pa, Le Souef and Holden; weedley Pa, Green. Mamunou Nu, Valentine. Dukkamirri Ya, Cornish; dookamerri Ya, Salmon. Karbonera Ma, Morton. Malimurro Pp, Eglinton; murlimarroo Ky, Machattie. Kowberruggera B, Sullivan.

Other references are: widli Pa, Schürmann 1844, 71; thaumpara D, Gason 1879, 287; tum-pungarra Ka, Wells 1894, 521, its pouch = waroora; uranta A, totem, Spencer and Gillen 1899, 60; urantha A, Spencer and Gillen 1899, 114; tampangara T, D, Stirling and Waite 1919, 120, 125, toas 49, 80; milli-murro DK, Duncan-Kemp 1933, 233. A pelican bone was worn through the nasal septum as an ornament, Horne and Aiston 1924, 41, fig. 32; Sanger 1883 (= padlamookoo, D).

Cormorants—White (1919) recorded seeing *Phalacrocorax carbo* (*novae-hollandie*) and *P. melanoleucus* on Cooper's Creek. We observed the former at Pandi. Boorkoopiya D, Gason 1879, 287, long-beaked cormorant (boorka = wade, piya, *i.e.*, pai-a = bird); cormorants and darters are not wading birds; the species is probably the blue heron, *Notophoyx novae-hollandiae*, though the stilt, *Himantopus leucocephalus*, is a remote possibility. Ita Pa, Schürmann 1844, 8, shag; since he recorded the black shag under a different term, it is possible that ita belongs to the coastal pied cormorant *P. fuscescens* (*leucogaster*).

Phalacrocorax carbo L.—Malura D (T. Vogelsang). Howitt (1904) reported two names for the cormorant totem: malura D (p. 91, 782, 788), Ya (95); and tantani W (92, 788), A (93), An (93), N (94), and Wo (95). Other references are: malura D, Eylmann 1908, 167; muloora D, Gason 1879, 287. Yaldu Pa, Schürmann 1844, 78, black shag, belongs to *P. carbo*, which is the common black cormorant of the South Australian coasts. The same term, yal-tow, was reported by Fraser (1839, 114; 1840, 62) as applied by the Adelaide tribe to *P. carboides* (= *P. carbo*). Howitt (1904, 97) recorded taragoro and muromuro as terms for the small and large species of black cormorants amongst the Kurnandaburi [= Karendala]; if correctly named, they must have been *P. sulcirostris* Brandt and *P. carbo*, but it should be pointed out that the black diver, muru muru, of the Dieri is not a cormorant but a waterhen, *Fulica atra*. Horne and Aiston (1924, 123) mentioned tantani as a black cormorant. Howitt (1891) recorded malura D (p. 38) and tantani An (39) as totems. Strehlow (1908, 64) reported tantana of

the Aranda to be a black heron—probably an error for cormorant, there being no Australian black heron. Green (1886) recorded tanthunnie Pa, as a black duck, no doubt the result of having confused the latter with the cormorant.

Phalacrocorax melanoleucus Vieill—Wutju bakanni D, T. Vogelsang; woo-choo-bukanni Ka, Wells 1894, 517, 520, diver, is the same species.

LARIFORMES

Larus novae-hollandiae Steph. Silver gull—Kalliworra Pa, yao Pa, Schürmann, 1844, 11, 79; latter name (onomatopoeic) also given by the Adelaide tribe. Kirrpiyirrka D, Gason 1879, 287. The latter name is almost the same as tirry-girryka reported by Teulon 1886, 213, as the Barkindji name for a wagtail like *Rhipidura motacilla*. The species would be *R. motacilloides* — *R. leucophrys*.

Skua—Schürmann (l.c.) mentioned two Pangkala names for the "bozen bird," kangai (p. 3) and parndabirru (p. 53). The true boatswain birds (*Phaeton*) do not occur in South Australia, but the term is sometimes applied to the skuas, of which two species, Richardson's or Arctic skua (*Stercorarius parasiticus*) and the southern skua (*Catharacta antarctica*) occur in our waters. Probably Schürmann's names apply to these two species.

Geochelidon nilotica Gmel. Gull-billed tern—Muti-muti D, Fry 1937, 195 (tern). This is the chief inland species of tern.

CHARADRIIFORMES

Snipe—Gason (1879, 287) mentioned Dieri names for four species, all listed as waders: chooiechooie, "snipe" [probably the greenshank, *Tringa nebularia*] dickadickulyerra and mootoomootoo, "species of snipe"; and thanpathanpa, "slate-coloured snipe." The last-named is a Ralliform bird, *Porzana fluminea*.

Dotterel—Horne and Aiston (1924) have confused two Wonkanguru names, one for a dotterel and one for a swallow. Wee-er wee-erlerra is called swallow (p. 119) and dotterel (p. 175); digidigellera (which almost certainly belongs to the swallow) is given as the name of the former on page 175, and of the latter on page 119. The relation of these birds to the rain-making ceremony is described. The only dotterel observed during our visit to the Diamantina was *Charadrius melanops*.

Peltohyas australis Gould. Dotterel—Palpara D, T. Vogelsang; balpara Stirling and Waite 1919, toa 36, unidentified. Palpara W, Horne and Aiston 1924, 141, said to be a hawk, is the same name, but we received patara at Pandi as the name of a kite. *P. australis* is the dotterel of the gibber plains and is called locally the gibber bird, according to Morgan 1930, 267.

Burhinus magnirostris Lath. Curlew, stone plover—Willaroo D, Gason 1879, 286; wee-lo and willaroo in Leach's "An Australian Bird Book," 1911, 51; willoo W, Horne and Aiston 1924, 9, 159; weeloo Pa, Green 1886, 126; wiloo Pa, Sawers 1886, 132; welu Pa, Schürmann 1844, 71; 1846; 1879, 241 — Wilhelmi 1862, 34; wudlaru Nj, and willuru D, Berndt and Vogelsang, 1941, 5. Howitt (1904) mentioned as names of the curlew totem: willangu Yu (p. 92), wilyuru N (p. 94), wilangu Ya (p. 95), and wilyaru (p. 783). Stirling and Waite's wuluru D, toa 292, suggests willuru, but the figure on the toa is more like the head of a bustard.

A legend with which was associated the willoo (Horne and Aiston 1924, 159) has been referred to under *Thalacomys* (telca). Schürmann (1946; 1879, 241) published a Pangkala legend: In ancestral times Welu was a fierce warrior and an immoderate lover whose amours were foiled by the neighbouring Nauo tribe whom he determined to exterminate. He speared all the men except two, Karatantya and Yangkunu, who fled for shelter into the top of a tree. Welu climbed after them to kill them, but the young men broke the branch which was supporting

their enemy. Welu fell to the ground, where a native dog killed him. Welu became a bird, the curlew, while the names of the two young men were perpetuated in those of two species of hawks. This legend was re-published by Wilhelmi (1861 184; 1862, 34), but he omitted mention of the hawks and stated that the two young men became changed into two lizards, Ibirri and Waka, which are mentioned later in the present report.

Eupodotis australis Gray. Bustard, wild turkey—Curr's correspondents (1886) supplied many names: kallatoora N, Paull; kulatheora D, Gason; kurlatora Ma, Morton; kurlathura Wa, Crozier; kaldura Wa, Dewhurst; kurreturo Ky, Machattie. Wala Wp, Gason; walla Pa, Beddome — Pa, Le Souef and Holden-Nu, Valentine; wirdla Pa, Green. Worka Ku, Heagney; wurkum Kw, Anon. Thurlchega Ma, Reid. Goonging Kg, Heagney.

Other references are: walla Pa, Schürmann 1844, 67; kulathoora D, Gason 1879, 286; kalathurra A, totem, Spencer and Gillen 1899, 60; kalathura A, totem, Spencer and Gillen 1899, 114; kalatoora, kallatoora W, N, Johnston and Cleland, 1943, 156; wal-la Wp, Hale and Tindale 1925, 57; wala Nj, kala-tura D, wal-la Wp, Berndt and Vogelsang 1941, 5.

Johnston and Cleland (1943, 156) mentioned that in the lower Diamantina region the plant, *Goodenia cycloptera*, was termed kalla-toora-milkie (= turkey eye) by the Ngameni and Wonkanguru tribes, because of the appearance of the flower.

Lobibyx novae-hollandiae Steph., syn. *Lobivanellus lobatus* Lath., spurwing plover—Darudaru D (T. Vogelsang); Fry 1937, 195, plover; Stirling and Waite 1919, toa 269, unidentified.

Plover—Pildari kintye Pa, pilderilderi Pa, Schürmann 1844, 56. These terms probably refer to two related species, one being *Lobibyx novae-hollandiae* and the other perhaps *Zonifer tricolor*. Kantya = porcupine grass (*Triodia*) or spear; if this term is the same as kintye, the latter may refer to the prominent spur present on the wing of the spurwing and so permit identification of Schürmann's name.

Haematopus spp. Redbill—This term is often applied to the oyster catchers, *H. unicolor* Forst. and *H. ostralegus* L., both of which occur on Eyre's Peninsula. Bithu Pa, [onomatopoeic for the oyster catchers], kudnannaga Pa, Schürmann 1844, 3, 19. Bithu was said to accompany the souls of the departed Pangkala on their flight to the island (p. 3), mungaltanna, in Spencer's Gulf (p. 35), where such souls (wilya) would become changed into white men (p. 73). Further reference was also made by Schürmann (1846; 1879, 235-236; Wilhelmi 1861, 189) to this bird, which was said to shriek at night.

Himantopus leucocephalus G.—Muta-muta D, T. Vogelsang. Mootoomootoo D, Gason 1879, 287, a species of snipe, refers to the stilt.

Megalornithiformes

Megalornis rubicundus Perry (syn. *Antigone australasiana* G.). Brolga, native companion—Curr's correspondents (1886) supplied the following names: Puralka A, Jacobs; puralku D, W?, Jacobs; pooralkoo N, Cornish; pooralko Ma, Morton — Ya, Cornish; pooralco N, Paull; booralkoo D, Gason; puralko Wa, Dewhurst; bouralko Yu, Howitt; brolgar Ky, Machattie. Wooroo A, Warren and Hogarth. Koodri Ya, Salmon. Mulumpari Wa, Crozier. Mulvani Bi, Crozier. Koorltho Ma, Reid. Koonthurra B, Sullivan — Te, Sullivan and Eglinton; goonthurra Te, Foott; goontherra Ku, Heagney; goontheri Kg, Heagney; golathurra Pp, Eglinton; kuntharata Kw, Anon. Wooroo is a heron and the term was probably attributed wrongly by Warren and Hogarth to the brolga.

Other references: booralkoo D, Gason 1879, 287; buralko D, Howitt 1891, 38; poo-ral-koo (crane) Ka, Wells 1894, 520; kuntara Kd, totem, Howitt 1891,

39. Amongst the tribes of the Georgina and Diamantina watersheds Curr's lists indicate as names: booralgoo, borolga, boralga, bralgo, baralgar, booralga and brolgar—hence the term brolga given by the white population. Mulumpiri Ya, Stirling and Waite 1919, toa 140; the term is the same as that recorded above by Crozier as the name for the brolga.

ARDEIFORMES

Nycticorax caledonicus Gmel. Nankeen heron, night heron—Ooroo D, Gason 1879, 287. Stirling and Waite's (1919) wuru bird D, toa 179, belongs to this species. Mr. T. Vogelsang informed me that wuru was a night bird. Helms 1896, 316, recorded wurru A, as the blue heron.

Egretta alba L. White heron—Moolpa D, Gason 1879, 287. Stirling and Waite's (1919) mulpu bird D, toa 160, belongs probably to the same species.

Notophoyx novae-hollandiae Lath. Blue heron—Kogunya Ka, Howitt 1891, 39, blue crane; wurru A, Helms 1896, 316. Wadna Pa, Schürmann 1844, 64, crane, may belong to this species; wadna means a throwing stick or boomerang, and the native name is probably related to the dark form and to the attitude of the bird whilst watching for its prey.

Notophoyx pacifica Lath. White-necked heron Culiennulyandurie D, black and white crane, Gason 1879, 287.

"Crane, black with white on wings." Howitt mentioned as a totem bird malparu Yu (p. 92), N (94), Ya (95); malburu K, (96); malbaru (783). The information does not permit of definite identification but the bird is almost certainly *Notophoyx pacifica*, though the jabiru or even the stilt, *Himantopus leucocephalus* G., is a possibility.

"Crane"—Murra-mil-le DK. Also a constellation which, together with kibulyo (= duck) guards "the entrance to the ghostly wild-fowl swamps" where the spirit-people dwell. Duncan-Kemp 1933, 123.

ANSERIFORMES

Duck General term, Pi-ya Ka, Wells 1894, 520; tharalkoo D, Gason 1879, 303 (same name given for the teal); mari Nj, tau-urla D, Berndt and Vogelsang 1941, 5. Pai-a is the general term used for a bird in the region. Taurla is the pink-eared spoonbill duck.

Anas superciliosa Gmel. Black duck—Curr's correspondents (1886) reported the following terms: pia N, Paull; peya Bi, Curr. Murrara Wp, Wills; murrarra Pa, Le Souef and Holden; maru-maru D, Jacobs; marara Wp, Gason; maurra Pa, Sawers; nurry Nj, Le Brun; nowirra Te, Foott. Willunga Te, Sullivan and Eglinton — B, Sullivan. Mungowrie Ma, Morton; mingenarra Kw, Anon; mingalla K, Kingsmill. Yella-moora Kg, Ku, Heagney. Durmmi A, W?, Jacobs. Oodla-oodla A, Todd. Mulchawarroo A, Warren and Hogarth. Dickeri Ya, Salmon. Tarralko Yu, Howitt. Chippala D, Gason. Urle Wk, Myles. Barndoo Wp, Phillipson. Manou Nu, Valentine. Ngalta Ma, Reid. Kultappi Wa, Dewhurst. Tanthunnie Pa, Green. Peptilu Pp, Eglinton. Kurligoolpar Ky, Machattie. Ngoorrir Ja, Green. Pundrewunga Wa, Crozier. Tanthunnie of Green is probably attributed to the black duck in error for the black cormorant, tantani. Marrara Pa, wild duck, Schürmann 1844, 29, is probably *Anas superciliosa*, the commonest Australian species.

Chenonetta jubata Lath. Wood duck—Curr's correspondents (1886) mentioned the following names: barndo Wp, Wills; burndoo Ja, Green. Goonary Kg, Heagney; goonery Ku, Heagney; koonallee Wi, Dix; kunarli Ma, Morton; koormaly Ma, Reid; koonare B, Sullivan; goornabrinna Ya, Salmon; koodnapina D, Gason; kooraburra Te, Foott. Bitta-bitta Wk, Myles. Ngowera Te, Sullivan and

Eglinton; neirey Nu, Valentine; kowwar Ky, Machattie; moondon-ngarie Pa, Green. Chiberli Kw, Anon. Yarkalto A, Todd. Yangacaroota-poone K, Kingsmill. Bompeparoo Pp, Eglinton.

Some of these terms (or obvious variants of them) are similar to those recorded for the black duck—tarralko (yarkalto), chippala, nurry, ngowera. Kala Pa, Schürmann 1844 (MS). White (1917, 448) reported the occurrence of *C. jubata* on the Cooper.

Dendrocygna eytoni Eyton. Whistling duck—Tjipala D. Chipala D, Gason 1879, 287; this author gave the same term (1886, 106) as the Dieri name for the black duck. The Pittapitta called it kibulyo (Roth 1897, 34). Duncan-Kemp 1933 123, mentioned kibulyo, duck, as a constellation. Morgan 1930, 268, identified the species on the lower Diamantina as *D. eytoni*.

Casarca tadornoides Jard. and Selb. Mountain duck—Kockadooroo D, Gason 1897, 287.

Querquedula gibberifrons Müll. Teal—Tharalkoo D, Gason 1879, 287; taralku D, Fry 1937, 276, duck; marrar Pa, Green 1886, 126; willungari Kd, Howitt 1904, 97. White (1917, 448) reported that the species bred along the Cooper.

Malacorhynchus membranaceus Lath. Pink-eared spoon-bill duck—Tau-urla D, Berndt and Vogelsang 1941, 5, belongs to this species. Manataulawuluni D, Stirling and Waite 1919, 151, toa 291 (ni = to or to the place of; wulu = two; mana = mouth; taula = taurla = pink-eared duck; hence the word means to the place of (*i.e.*, resembling) two duck bills). Thowla D, Gason 1879, 287.

Nyroca australis Eyton. Brown duck with red beak—Koodnapina D, Gason 1879, 287 (koodna = excrement, pina = large, great). The same term was given by Gason (1886, 106) for the wood duck (Dieri).

Unidentified ducks—Inyarrie A, totem, Spencer and Gillen 1899, 60, 114; wungara A, totem, Spencer and Gillen 1899, 657 [wonkara of the Aranda and Loritja, Strehlow 1907, 64]; kultapa Wi, totem, uleburri Mi, totem Howitt 1904, 98. In a neighbouring tribe (Barkinji)on the Darling, the last named two terms appear to be replaced in the list of totem animals by kultuppa, the whistling duck (Howitt 1904, 99), hence it is possible that the three names all refer to the same species; but it should be noted that Dewhurst reported kultappi as the black duck, and Teulon 1886, 213, mentioned kooltapa as the teal, Barkindji tribe.

Chenopis atrata Lath. Black swan—The following names are listed from Curr's correspondents (1886): kooti A, Warren and Hogarth — Pa, Sawers — Pa, Le Souef and Holden; kute A, Todd; kootee N, Paull; koodie N, Cornish; kootie D, Gason; kurti D, A, Jacobs; koodri Ya, Cornish; cootee Pa, Ja, Green; cootie K, Kingsmill; oortee Wp, Phillipson; cotee Yu, Howitt; kurti Ky, Machattie; kuteru Ma, Morton; kutteroo Wa, Dewhurst; kootero Ku, Heagney; kootooroo Te, Sullivan and Eglinton — B, Sullivan; kuteruk Wa, Crozier; gootheroo Kg, Heagney. Thurragoora Te, Foott. Youngooli Ma, Reid, Kurrawatti Ya, Salmon.

Other references are: kootie D, Gason 1879, 287; guti A, totem, Spencer and Gillen 1899, 60, 114; korti Pa, Schürmann 1844, 18; kuti A, Helms 1896, 316 — D, Fry 1937, 275. Down of the swan and wild ducks was used for ceremonial decoration in the Dieri mindarie corroboree (Gason 1879, 272; Howitt 1891, 85; 1904, 662).

In a Dieri legend associated with the Pleiades women, a mura woman named Kuti who in her endeavours to obtain a fire-stick fought and killed a Nardu woman, was then turned into a swan and flew away, carrying the fire-stick in her

mouth—hence the name Kuti for the swan, and hence also the red edging to the inside of the beak indicating where the Mura burnt her mouth (Horne and Aiston 1924, 141-142). Another version of this legend was published by Fry 1937, 275.

Biziura lobata Shaw. Musk duck—Ngannalli Pa, Schürmann 1844, 45; a similar term, ngannelli, was mentioned as the name of a waterbird; ku ra-ru An, Howitt 1891, 39.

Cereopsis novae-hollandiae Lath. Cape Barren goose—Yarrendi Pa, Schürmann 1844, 81, goose.

ACCIPITRIFORMES

Uroaetus audax Lath. Eagle—Curr's contributors (1866) reported the following terms: Karrawurra N, Paull; curawura D, Gason; kurrawerra Ma, Morton; kurrera Wa, Crozier; corrowira Kg, Heagney; corowera Ku, Heagney, Wildoo Wp, Gason — Pa, Green; wildou Nu, Valentine, Cooriadthilla Kg, Heagney, Billara Ma, Reid, Kunthullo Kw, Anon, Wolye Pa, Beddome, Purti Wa, Dewhurst, Perrowalli Pp, Eglinton, Yarnu Pa, Le Souef and Holden.

Other references are: Yarnu Pa, Schürmann 1844, 81; curawura D, Gason 1879, 286; wildu Wp, Hale and Tindale 1825, 58 [wilda is applied in the Everard Ranges, Helms 1896, 317]; wildu Nj, Wp, kara-wara D, Berndt and Vogelsang 1941, 5; karawara D, totem, Eylmann 1908, 167 — Gatti 1930, 101; karawora D, Stirling and Waite 1919, 145, toa 234; karawora, Horne and Aiston 1924, 123; karaura D totem, Howitt 1885, 6; 1891, 38; kurara An, totem, Howitt 1891, 39; kooridala DK, Duncan-Kemp 1933, 114; Pp, Roth 1897, 35. Howitt referred (1904) to the following totemic names: karawora D (p. 91), W (92), A (94), N (94); kariwora Ya (95); kuraru An (93); bilyara Wi, Mi (98), and Paruinji (99), becoming billiara amongst the Barkindji of the Darling River.

Young people were forbidden to eat the flesh of the eagle, Kg, Ku (Heagney 1886, 375). Gillen (1896, 180) reported that if girls or young women before their breasts had fully developed, ate flesh of the eagle (iritcha, irritcha, Aranda) and certain other animals, it was believed that the result would be permanent checking of mammary development as well as great leanness; but boys could eat only the legs of the bird and so impart strength and improve the growth of the limbs. (See also Spencer and Gillen 1899, 472).

The eagle figured in aboriginal stellar lore. Kurawurathidna (*i.e.*, eagle track or foot) was applied by the Dieri to a cluster of stars representing the claw of the eagle and seen in the western hemisphere during the winter months (Gason 1879, 295). Basedow (1924, 349) reported that the Southern Cross was called warridajinna (= eagle's claws), but did not mention the name of the tribe. Duncan-Kemp (1933, 122) stated that Mars was Kooridala and that Sirius was a hawk, while another star was Wakerdi, the crow, according to the tribes bordering on the Karanya. Green (1886, 126) reported that the morning star was wildoo kyleela Wp., *i.e.*, the two eagles. Berndt and Vogelsang (1941, 9) stated that the Southern Cross was wildu Nj, and paia-tidna (bird's foot) D. Green (1886, 126) reported that the Cross, according to the neighbouring Pangkala tribe, was Mamburdi, whereas Schürmann (1844, 10) recorded it as Kadnakadna purdli. Amongst the Kaurna, wilto was a star as well as an eagle (Teichelmann and Schürmann 1933, 155).

Eagle feathers are used extensively in the region by men for decorative and ceremonial purposes. They are neatly tied into a bunch, originally with sinews of emu or wallaby or hair string and worn in the front of the head band or at the sides of the waist band. This ornament was termed kootcha by the Dieri (Gason 1879, 289), ilpilla by the Aranda (Spencer and Gillen 1899, 649), and pingkara by the Pittapitta (Roth 1897, 113; Duncan-Kemp 1933, 241). Salmon (1886,

24) used kootya Ya as meaning feathers. The uses of eagle feathers during the rain-making ceremony were mentioned by Horne and Aiston (1924, 111-113) for the Wonkanguru, and by Roth (1897, 168) for Diamantina tribes in Queensland.

Eagle down (as well as that from other birds such as swan and duck) was used for making the distinctive bands and patterns associated with particular ceremonials (Horne and Aiston, p. 42, fig. 32, 33, 34). In connection with the Dieri tooth evulsion ceremony (chirrinchirrie), the teeth after removal were smeared with fat, then wrapped in a bunch of emu feathers and kept for a period of one year before being thrown away, under the belief that, if thrown away earlier, the eagle would cause to grow in their place larger teeth which would turn up on the upper lip and cause death.

Spencer and Gillen (1899, 641) mentioned that in the Arabana wilyaru ceremony the novice was painted to represent an eagle-hawk and the leader carried a long spear, the end of which was decorated with eagle feathers. The numerous diagonal cuts made on the back during the ceremony were indicated by Howitt (1904, 659, fig. 39). Gason (1879, 270) described the wilyaru ceremony, the purpose of which was to increase the supply of snakes and lizards.

Hambly (1936, 16-17) gave an account of an Arabana legend associated with the wilyaru cuts. Long ago there were two hawks, Wantu and Irritja, each with its brood occupying a tree. Since the former was the stronger he compelled the latter to bring him food, which included blackfellows. Irritja was content to catch and eat wallabies for himself. In sympathy with Irritja was a little hawk, Kutta, who fought Wantu unsuccessfully and then fled to obtain the aid of the bell bird who lit a fire at the base of Wantu's tree, killed Wantu and burned his brood. Out of gratitude for this deliverance from Wantu, the Arabana gave themselves tribal marks in imitation of the feathers on the back of the bell-bird. I cannot find any other reference to this legend. Two of the names, Irritcha and Kutta-kutta (eritja and kutakuta in Strehlow 1908, 62-63, respectively) are Aranda terms for the eagle (*U. audax*) and "little night hawk" respectively (Spencer and Gillen 1899, 657). Strehlow called the latter a "night bird." The night hawk or nightjar is *Eurostopodus mystacalis* Temm. (Caprimulgidae), but the former term is often applied also to the owlet-nightjar, *Aegotheles cristata* (Podargidae). Strehlow (1908) recorded Aranda and Loritja names for *Aegotheles* and *Podargus*, hence Kuttakutta probably belongs to *E. mystacalis*. The only name found by us resembling wantu is wontu, the Loritja name for the mallee fowl, *Leipoa ocellata* (Strehlow 1908, 64). The bell-bird of the region is *Oreoica gutturalis*, whose Aranda name is kunbalumbala (Strehlow, l.c., 63).

Eagles (unidentified)—Schürmann 1844 mentioned three Pangkala names (in addition to yarnu, eaglehawk) as those of species of eagles: willu (p. 72), wallulu (72, corrected to willulu in MS) and walburru (66) [= strong]. The first is suggestive of wildu (eaglehawk), and the first and second may refer to *Hieraetus morphnoides* and *Haliastur sphenurus*, while the third may be a sea eagle (*Pandion leucocephalus*) or *Gypoictinia melanosterna*.

Hieraetus morphnoides G. Little eagle—Kuniennundruna D, Gason 1879, 286, largest hawk except eagle. Mura Nj, Berndt and Vogelsang 1941, 5, red eaglehawk, is probably this species.

Haliastur sphenurus Vieill. Whistling eagle—Kookoonga D, Gason 1879, 286, kite; the latter name is due to an error in identification according to T. Vogelsang. Kukunga A, Helms 1896, 316, hawk. The term resembles closely kogunya Kd, Howitt 1891, 39, stated to be the blue crane.

Falco cenchroides—Thirrie-thirrie D, Gason 1879, 286, small speckled hawk.

Astur novae-hollandiae (*albus*). White hawk—Thoaroopathandrunie D, Gason 1879, 286.

Astur novae-hollandiae (cinereus). Grey hawk—Milkieworie D, Gason 1879, 286, large grey hawk. In his book (1904) Howitt mentioned miltipalu Ya, a large grey hawk and a totem (p. 95), but referred later (96) to milkiwaru (omitting miltipalu) amongst the totems represented east and north-east of Lake Pando. He also mentioned milketyelparu D, totem (91), milketyelpara (96) and milkiyerpara N, totem (94), but without any indication of identification; but these belong to the Kararu moiety, whereas milkiwaru (miltipalu) belongs to the Matteri. Mr. Vogelsang believes milkiwari to be the fish hawk, *Pandion leucocephalus*.

Falco berigora. Brown hawk—Pittiekilkadie D, Gason 1879, 286, speckled hawk. Identified by T. Vogelsang.

Astur fasciatus Vig. Horsf. Sparrow hawk—Kirrkie D, Gason 1879, 286, whistling hawk, very swift. Ngalulka Nj; kirki D, Berndt and Vogelsang 1941, 6, sparrow hawk. Howitt (1891, 39) reported kirki Au, as a totem, calling the bird a night hawk, but this identification must have been an error.

Milvus migrans Bodd. Black kite—Patara-patara N, W. This name was obtained at Pandi, where it was termed the morning bird because it called at daylight. Perhaps palpara, Horne and Aiston 1924, 141, refers to the same species.

Hawks—Schürmann (1844) mentioned the Pangkala names of three species of hawks: karkantya (p. 15), perudu (56), and purrelli (MS), the last term being also used for a fish and hence may refer to the fish-hawk, *Pandion leucocephalus*.

In the curlew (wil-lu) legend of the Pangkala, karatantya and yangkunu were reported by Schürmann (1846; 1879, 241) to be the names of two hawks. In his vocabulary of that tribe (1844) he recorded karkantya as a species of hawk (p. 15) and kattaintya as a goatsucker (p. 17), *i.e.*, a nightjar (? *Eurostopodus mystacalis*); and yangkunu as a white cockatoo (p. 79). Teichelmann and Schürmann (1933, 103) recorded karkanya (Kaurna tribe) as a species of hawk whose name was derived from the ominous sound of its voice which, when heard at night, indicated that the souls of one or more aborigines would be taken away, after which those natives would become ill. Fraser (1839, 113; 1840, 61) reported that carcownya was the name applied by the natives of the Adelaide district to *Falco berigora*.

Horne and Aiston (1924, 141) referred to a kind of hawk, Palpara D, associated with the stealing of fire in muramura times. Mrs. Duncan-Kemp (p. 59) mentioned pijerdo as a small brown scavenging hawk; and Roth (1897, 49, 74) referred to it as an ordinary small brown hawk (Pittapitta; Karanya); the species may have been *Falco cenchroides*.

STRIGIFORMES

Tyto alba Scop—Wurchiewurchie D, Gason 1879, 286. White (1917) reported it to be fairly common in the region. Wyatt (1879; 1933, 43), as well as Teichelmann and Schürmann (1840; 1933, 156), recorded that the Adelaide tribe called the white owl winta. Winta Pa, Schürmann 1844, 73, may have been applied to this and/or the next species.

Tyto novae-hollandiae Steph. Grey owl—Windtha D, Gason 1879, 286; winda Nj, winta D, Berndt and Vogelsang 1941, 7, large owl; wooroona DK, Duncan-Kemp 1933, 195, grey owl. The species is *T. novae-hollandiae* according to T. Vogelsang.

Ninox connivens Lath., and perhaps also *N. strenua* G. and *N. boobook* Lath. —Killawoloowolloorka D, Gason 1879, 286, dark brown owl.

Ninox boobook Lath.—Kurko Pa, owl, Schürmann 1844, 73; kurkurruku A, owl, Helms 1896, 316. I believe these terms refer to the boobook whose Loritja name is kurkurr (Strehlow 1908, 63).

Owls—Berndt and Vogelsang 1941, 8, reported ngangi Nj and munju D, as names of a small owl, but these terms belong to the owlet nightjar, *Aegotheles cristata*. Howitt (1904, 96) mentioned manpi, an owl, as a totem in the Eyrean region. Stirling and Waite (1919, 127, toa 99) referred to the manpi bird, but the figure on the toa does not represent an owl; I consider that the term is really murnpi (manpi), a pigeon. Howitt's manpi is probably an error for munyi, the owlet nightjar.

White (1917) recorded observing *Ninox boobook*, *N. connivens* and *Tyto alba* in the Dieri region. Feathers of the white owl are used in head decorations in various corroborees (Roth 1897, 118, fig. 283); and in the mindarie or peace ceremony of the Dieri (Gason 1879, 272; Howitt 1904, 662). Horne and Aiston (1924, 45) stated that the head plume of the Wonkanguru mindarie corroboree, when composed only of feathers of the white owl, was called wumpigena.

PSITTACIFORMES

White cockatoo—Curr's correspondents (1886) reported the following terms: kadaroonga A, Warren and Hogarth; kudaroonka N, Cornish; kudrungoo D, Gason; koodrunkoo Ya, Cornish; keirdrangu D, Jacobs; karrong N, Paull, Nerrapinta Ya, Salmon; nardnanpu A, Jacobs. Thirindhella Te, Sullivan and Eglinton; derringerri Wk, Myles; thirindthela B, Sullivan. Warrandoo Wp, Phillipson; weurando Wp, Wills; warranthoo K, Kingsmill; korkanda Ma, Reid. Younganna Pa, Green; yomgona Pa, Sawyers. Quodockee Nu, Valentine. Woolaki Ja, Green. Kuta Ma, Morton. Kilumburra Wa, Dewhurst. Kugalurinya Wa, Crozier. Murramute Kw, Anon; mooranerry Kg, Ku, Heagney; murmari Bi, Curr.

Cacatua sanguinea G.—The term white cockatoo is commonly applied to *Cacatua galerita*, the sulphur-crested cockatoo, but in the Eyrean region the common white bird is the corella, *C. sanguinea* (syn. *C. gymnopis*). Curr's terms probably include the aboriginal names for both, though most of them no doubt refer to the corella. The latter occurs in great flocks along the Diamantina and the following terms belong to it: warandu Wp, Hale and Tindale 1941, 57; we received the same name in the Northern Flinders Ranges; kadrangu D, gudaki Nj, Berndt and Vogelsang 1941, 5; kudrungoo D, Gason 1879, 286; kundru ungoo Ka, Wells 1894, 521, termed "parrot." Roth (1897, 51) mentioned many names distributed amongst the many tribes further north along the Diamantina and its tributaries; amongst the Pittapitta, Karanya and some others it was kolloora or kollora, but the Goa people called it koo rella, whence the common European name, corella, was derived. Its feathers were used largely for decoration either as a large bunch fastened to the head or as single feathers worked into the headband (Howitt 1904, 330; Horne and Aiston, p. 45).

Black cockatoos—Iralla and yaralta Pa, Schürmann 1844, 780, without indication as to which term belongs to the red-tailed species, *Calyptorhynchus banksi* Lath., and which to the yellow tailed *C. funereus* Shaw. These cockatoos do not appear to be eaten by natives (Wells 1894, 517; Duncan-Kemp 1933, 46), but their tail feathers are used for decorative purposes, especially in connection with rain making ceremonies (Horne and Aiston 1924, 45, 158).

Cacatua leadbeateri Vig. Schürmann (1844, 79) gave yangkunnu as the Pangkala name for the "white cockatoo with a red crest." It has already been mentioned in connection with the wi-lu legend, Schürmann (1840; 1879, 241) reporting it as a hawk. Younganna Pa, Green 1886, and yomgona Pa, Sawers (1886), are similar terms and, no doubt, are intended to apply to the same bird as yangkunnu. Kugalurinya Wa, white cockatoo, Crozier (1886), is obviously the same term as kahgoolarinya Ba, which Teulon (1886, 212) reported to be the name of Leadbeater's cockatoo.

Cacatua galerita Lath. White cockatoo, sulphur-crested cockatoo—Some of the terms mentioned under "white cockatoo" may refer to this species, as also may kakki Pa, Schürmann 1844, MS. Teulon 1886, 212, recorded it as kollybooka Ba, and mentioned that the name was also applied to the pointers to the Southern Cross, the latter being called Mirrabooka.

Cacatua roseicapilla Vieill. Galah—Very common in the vicinity of water supplies. Killunkilla D, Gason 1879, 286; killan-killi Ka, Wells 1894, 520. We received the name gillan-gilla, killan killa Wp, in the Northern Flinders Ranges. It was known as killumba by the Barkindji (Teulon 1886, 212). Perhaps killumburra Wa, Dewhurst 1886 should refer to this species instead of the white cockatoo.

Roth (1897, 50) mentioned many names for the galah amongst north-west-central Queensland tribes, some of them being ga-la- ga-la (Walookera tribe), ge-la-ro (Woonamurra), boombabaro (Karanya), kelun-ji (Pitapitta). Our name galah is obviously derived from ga-la just mentioned.

Leptolophus hollandicus Kerr (syn. *Calopsittacus novae-hollandiae*). Cockatoo parrot, cockatiel—Kooranyawillawilla D, Gason 1879, 286. Kuranya is the term for the rainbow amongst some tribes, and the bird's name is probably related to the colouration of its head. Wurebu Nj, grey parrot, Berndt and Vogelsang 1941, 8, probably belongs to this species.

Melopsittacus undulatus Shaw. Budgerigar- Cathathara D, Gason 1879, 286; wuluri Nj, katatara D, Berndt and Vogelsang 1941, 8 — Fry 1937, 272. We obtained the latter name, N, W, at Pandi. Howitt (1904) mentioned it as a totemic bird; pinyangu Yu (p. 92); katatara N (p. 94), D (782), Yu (796); since tillngaru, unidentified, Ya (p. 95) occupies the same position amongst the Matteri murdus, it probably refers to this bird. Feathers of the shell parrot were sometimes woven into the long girdle (dampera W) made of fur or hair-string and worn by initiated men (Horne and Aiston (p. 47). Kulyeritye Pa, Schürmann 1844, 20, "a small speckled species of parrokeet," is probably this species.

Trichoglossus moluccanus Gmel. (*T. novae-hollandiae*). Blue Mountain lorikeet—Tyirrera Pa, Schürmann 1844, 64; walaja Nj, Berndt and Vogelsang 1841, 8.

Psephotus varius Clark (syn. *P. multicolor*). Mulga parrot—Wardlaru Wp, name obtained by us in the Northern Flinders Ranges. Gupilja Nj, Berndt and Vogelsang 1941, 8.

Psephotus haematonotus G. — Bard-laru Wp, Hale and Tindale 1925, 57; Berndt and Vogelsang 1941, 8; same name as for the preceding species.

Barnardius zonarius Shaw. Port Lincoln parrot—Wartadi Wp, name obtained by us in the Northern Flinders Ranges. Pudlaye Pa, Schürmann 1844, 59, parrot with black head.

Neophema elegans G., or *N. chrysostoma* Kuhl. Grass parrot, green parrakeet Koltye Pa, Schürmann 1844, 18; mandelja Nj, Berndt and Vogelsang 1941, 8.

"Scrub parrot," a little larger than the grass parrot and of a paler green, but in other respects similar to that bird." Wayuridna Pa, Schürmann 1844, MS. (? *Neophema chrysogaster* Lath.)

Psephotus haematogaster G., syn *xanthorrhous*. Bluebonnet — Pulanku D, Berndt and Vogelsang 1941, 8. This is the same name as Gason's poolunka D, (1879, 286). Wimpatinpalunga D, Fry 1937, 270, little bird, coloured red, green and yellow.

Green tree parrot—Guli Nj, Berndt and Vogelsang 1941, 8. Probably juvenile *Platycercus adelaidae* G.

Parrot—Dgeeda Pa, Beddome 1886, 133; the term suggests tjita, a general term for small birds amongst more westerly tribes. Perhaps the same as tyirrera Pa = *Trichoglossus moluccanus*.

Coraciiformes

Podagus strigoides Lath.—Munyi D. (T. Vogelsang). Moonyie D, Gason 1879, 286, mopawk; munka-noo Ka, Wells 1894, 521, mopoke.

Aegotheles cristata Shaw. Owlet nightjar, night hawk—Munyi, monyi D (T. Vogelsang); ngangi Nj, munju D, Berndt and Vogelsang 1941, 8, small owl. Same name applied to *Podargus*. The possibility of kutta-kutta, associated with an eagle legend, being the name for this species, has been referred to earlier in this paper. Both *Podargus* and *Aegotheles* were recorded from the Lower Cooper by White (1917). Spencer and Gillen (1899), 651) referred to kuttakutta as a little night hawk.

Dacelo gigas Bodd. Kookooburra—Occurs only in the southern portions of the region with which we are now concerned. Picky Nu, Valentine 1886, 138; kookark Pa, Le Souef and Holden 1886, 8; ngungana of the Adelaide tribe; takkooka, korrookahkahka Ba, Teulon 1886, 208, 213.

Halcyon pyrrhopygius G. Kingfisher—Julu Nj, Berndt and Vogelsang 1941, 7.

Eurostopodus mysticalis Temm. Nightjar—It has been stated in this paper that kutta-kutta of the wilyaru legend of the Arabana people probably belongs to this species to which the term night-hawk is sometimes applied. White (1917) recorded its presence in the Eyrean region.

"Goatsucker" (probably the preceding species)—Kattaintya Pa, Schürmann 1844, 17.

Cuculiformes

Cuckoo—Wirrukku Pa, Schürmann 1844, 74. ? *Cuculus inornatus* or *Cacomantis flabelliformis*.

Scythrops novae-hollandiae Lath. Giant cuckoo, flood bird, channelbill, Diamantina bird—Tabajura D, totem, Eylmann 1908, 167; Howitt (1904, 91-96) reported tapaiuru, tapairu and tabaira, as a bat, a totemic animal for several Eyrean tribes. Duncan-Kemp (1933, 267) recorded mukkundrie as the name of this bird amongst Diamantina tribes and gave an account of the legend relating to it, explaining why the bird was doomed to be a nestless harsh-voiced follower of storms and flood-waters. In ancestral times Mukkundrie incited other birds to mutiny, and in punishment its species was banished to become a wanderer till it became extinct. The demon spirit, Marmoo, to spite Nungeena, goddess of birds, suggested to Mukkundrie that it should overcome the difficulty of propagating by laying its eggs in the nest of some other bird to be hatched. Marmoo was then punished by being sent to earth as a crow, and it is the crow's nest which the flood bird now commonly chooses for its own egg laying after ejecting the crow's eggs. The chick is stated to reach the flying stage before the imposture is detected. The crows then attack the chick and chase it from tree to tree until it reaches a hollow tree or is killed.

Passeriformes

Cheramoeca leucosterna G. White-breasted swallow—Horne and Aiston 1924, 119, referred to a white-breasted swallow as well as a dotterel associated with a Wonkanguru rain-making ceremony, but reversed the two native names on page 175. The terms are digidigellera and wee-er wee-erlerra; the former probably belongs to the swallow.

Porzana fluminea G. Spotted crake—Tampatampana D, T. Vogelsang Wp, Hale and Tindale 1925, 58; wirra-yuldu-ulidja, Wp, obtained by us in the Northern Flinders Range.

Hylochelidon ariel G. Fairy martin—Tjuli-tjuli N, purda-muppa W; names obtained at Pandi. Tjuli-tjuli D (T. Vogelsang).

Hirundo neoxena G. Welcome swallow—Mulyamulyayapunie D, Gason 1879, 286, swallow; mulya = mud, mourning cap; the name of the bird has reference to the characteristically-shaped mud nest.

Rhipidura leucophrys Lath. Wagtail—Inderinderi Wp, obtained by us in the Northern Flinders Ranges; thindriethindrie D, wagtail, Gason 1879, 286; pintie-pintie W, Horne and Aiston 1924, 124. *Rhipidura tricolor*, woman's bird; tindi-tindi A, Howitt 1904, 789, probably a fly-catcher or wagtail; tindri tindri D, wiltjililki Nj, Berndt and Vogelsang 1941, 10; nginda-nginda at Ooldea.

Petroica goodenovii Vig. Horsf. Red robin—Malitelita Wp, *P. goodenovii*, Hale and Tindale 1925, 57. Choonda D, red-breasted robin, Gason 1879, 286; jupi Nj, Berndt and Vogelsang 1941, 8 (robin redbreast); ngarkundinye Pa, Schürmann 1844, 46, redbreast.

Robin—Jimbalumba, Howitt 1904, 96, Australian robin. Perhaps *Pyrrholaemus brunneus* G.

Colluricincla harmonica Lath. Shrike-thrush—Anda-anda Wp, Hale and Tindale 1925, 57.

Oreoica gutturalis Vig. Horsf. (syn. *O. cristata* Lewin). Bellbird. This bird has already been referred to when mentioning the wilyaru ceremony (see under "eagle"). Bakkubakku Pa, Schürmann 1844, 1. It is kunbalunbala of the Aranda and banbanballala of the Loritja (Strehlow 1908, 63).

Sphenostoma cristatum G. Crested wedge-bill—Koongkgarra (= nose possessor) DK, Duncan-Kemp 1933, 117.

Coracina novae-hollandiae Gmel.—Tenatjeri N, pirri tjunka waliri W, names obtained at Pandi.

Shrike—Palkerrintye Pa, Schürmann 1844, 51.

Pomatostomus superciliosus Vig. Horsf. Babbler—Inyula Wp, Hale and Tindale 1925, 58; unulunula Wp, (onomatopoeic) obtained by us in the Northern Flinders Ranges.

Pomatostomus ruficeps Hartl. Babbler—Inyula Wp, Hale and Tindale 1925, 57.

Epthianura tricolor G. Crimson chat—Milyala kuppera W, obtained at Pandi. The Aranda call it ninchi-lappa-lappa and consider that men who in ancestral times were continually painting themselves red were changed into this scarlet-fronted chat (Spencer and Gillen 1899, 652). Strehlow's Aranda totem No. 81 (1908, 63), ninjalapallapalla is, no doubt, the same.

Ashbyia lovensis Ashby. Desert chat—Wee-icka DK, Duncan-Kemp 1933, 57 (yellow and brown gibber bird or paper-bag bird resembling the orange desert chat). Onomatopoeic name. Mrs. Duncan-Kemp told the local legend of the Kalidgaworra and Dubbo Downs tribesmen [Mitlaka]. In ancestral times the huge dragon-lizards, Printhee [perenti of Central Australia, *Varanus giganteus*], Kwoolcudee and Boolah-dee fought for possession of a woman, Wee-icka (white flower), and fought so hard and dug the ground so much that the mountains fell and covered the plain with stones (gibbers). White Flower died, so Printhee (presumably the victor) was without a wife. He lived in a cavern, from which he emerged regularly to raid the tribes and capture the most desirable women for wives and tore to pieces those refusing to wed. Wee-icka became transformed into the little gibber bird or desert chat which has to make its nest in a hole scraped out in the stony soil, and its penetrating call, "wee-icka wee-icka," tells the tribesmen that White Flower still lives amongst the gibbers. White (1917, 458) gave

a brief account of the bird's habits. In the lower Eyrean region the term gibber bird is applied to the dotterel, *Peltohyas australis* (Morgan 1930, 267). Mr. Vogelsang informed me that poothoopoothooka D, Gason 1879, 286, sparrow [putuputuka] was the desert chat, and was termed locally a sparrow.

Lark (? *Cinclorhamphus cruralis* and *C. mathewsi*, both reported by Morgan 1930, 272, to be common in flooded areas; ? *Mirafra horsfieldi*), dere-lja Nj, Berndt and Vogelsang 1941, 7; thiewillagie D, Gason 1879, 286. T. Vogelsang informed me that the latter (tiwilitja D) was the diamond sparrow; it was so recorded by Berndt and Vogelsang. Kutjikutjijiri D, Fry 1937, 206, a lark; kutji-kutji D, Stirling and Waite 1919, toa 217, unidentified. Kulyunnu Pa, Schürmann 1844, 20 (native lark).

Malurus assimilis North. Wren—Yuruyuruya Wp, Hale and Tindale 1925, 57. Kutji-kutji, kutjikutjijiri D (T. Vogelsang); recorded by Fry 1937, 206, as a lark.

Artamus personatus G. Woodswallow—Ralpula Wp, Hale and Tindale 1925, 57. Warraka Pa, Schürmann 1844, 69, swallow; warra (waru) = grey, hence the name suggests a greyish swallow, *e.g.*, *Artamus personatus*.

Myzantha flavigula G. Honey-eater—Madlaci-tana Wp, Hale and Tindale 1925, 58. Schürmann 1844, 64, reported tyityapi Pa as the name of a "honey-sucker" (tyi suggests tiwi = flower).

Wattle birds—Ngarkarko, ngarkabukko Pa, Schürmann 1844, 45; apparently the two species, *Anthochaera carunculata* Shaw and *A. chrysoptera* Lath. Ngark-ngarko is obviously onomatopoeic and resembles closely the call of the large wattle bird, *A. carunculata;* presumably the other term applies to the smaller wattlebird.

Anthus australis Vieill. Pipit—Yaliworuna Wp, Hale and Tindale 1925, 57.

Taeniopygia castanotis G. Zebra finch—Ithi Wp, Hale and Tindale 1825, 57.

Zonaeginthus [*Staganopleura*] *guttatus* Shaw. Diamond sparrow—Iti Nj, tiwilitja D, Berndt and Vogelsang 1941. Tiwiltya, unidentified totem in southern Eyrean region, Howitt 1904, 96, is obviously the same.

Passer domesticus. Mr. Vogelsang stated that the sparrow was called by the Dieri, tiwilitja pirna (tiwi = flower; pirna = large; tiwilitja = diamond sparrow), *i.e.*, a large kind of finch.

Corvus cecilae Math. and *C. bennetti* North, and in the southern part of the region, *C. coronoides* Vig. Horsf. Curr's correspondents (1886) supplied the following terms for crows: wokkoola A, Todd; wokkala A, Jacobs; wakilla A, Warren and Hogarth; wackala N, Cornish; waucurla K, Kingsmill; wawkala Wp, Gason; woocalla Pa, Green; wawgala Bi, Curr; wakala Pp, Eglinton; worcala Ja, Green; walkala Wp, Wills; wawkerlo Kg, Heagney; waukerlo Ku, Heagney; walkulla Nu, Valentine; wolko, koro wolko Wp, Phillipson. Wongara Pa, Sawers; wornkarra Pa, Le Souef and Holden; wongala Pa, Beddome. Kowulka Wa, Crozier; kaulka Wa, Dewhurst; kowilka N, Paull; kowulka Ya, Cornish — D, Gason; kaoolika Ya, Salmon; kawolka D, Jacobs. Wathakur Wk, Myles. Worgaritchee Te, Sullivan and Eglinton; wakaretche Te, Foott; worga B, Sullivan; wagoo Wi, Dix; wakoo Ma, Reid; wako and warko of various Darling River tribes; wokeri Kw, Anon; wakeri Ky, Machattie.

Other references are: kowulka D, Gason 1879, 286; kookunta Ka, Wells 1894, 520 (not eaten, p. 517); wukkalla A, Helms 1896, 316; wakla Wp, Hale and Tindale 1925, 57; wakala Nj, wakla Wp, Berndt and Vogelsang 1941, 5; wornkarra Pa, Schürmann; wakerdi DK, Duncan-Kemp 1933, 114; kaualka D, totem, Howitt 1885, 6; wakala A, Spencer and Gillen 1899, 60, 114; workerdi Ka,

Roth 1897, 50; wakerdi Pp, wakala Pp, Roth 1897, 39, 50; kawalka, kowulka D, Fry 1937, 188, 278. We obtained the names kaua-ka N, and wakala W, at Pandi. Howitt (1891) reported crow totems as follows: kaualka D (p. 38), wakalo An (39), and wogarachi Ka (39); and in his book (1904) he recorded the following totemic names: kaualka D (p. 91, 780, 783), N (94), Wo (95), wokula W (92), wokalo An (93) wokala A (94), and warogatchi Kd (97). Several of the toas (258, 395, 297 D, 197 Ya) have reference to Kawolka (Stirling and Waite 1919).

Mention has been made earlier of Wakerdi as a constellation (Duncan-Kemp 1933, 123); and of the legend relating to the crow and the flood bird, *Scythrops*.

Other crows—Karruwogona Kd, small crow, Howitt 1904, 97 [*Corvus bennetti*]; mena nalkara Nj, white-eyed crow, Berndt and Vogelsang 1941, 5 [*Corvus cecilae*]; kawalka D, *Corvus coronoides*, Eylmann 1908, 167.

Strepera fuliginosa G. Black bell-magpie—Piralla Pa, Schürmann 1844, 57 (black magpie).

Cracticus torquatus Lath. Grey butcher-bird—Audipi Wp, Hale and Tindale 1925, 57.

Gymnorhina tibicen Lath. Black-backed magpie—Wurukuli Wp, Hale and Tindale 1925, 57; koorabaukoola D, magpie, Gason 1879, 286.

Gymnorhina hypoleuca G. (syn. *G. leuconota*). White-backed magpie—Kurra Pa, Schürmann 1844, 23 (magpie). Berndt and Vogelsang 1941, 7, mentioned bindi-garu Nj as the small black-backed magpie; the use of the term "small" suggests that the bird was not *Gymnorhina tibicen*, but may have been the "Murray magpie," *Grallina cyanoleuca* Lath. (syn. *G. picata* Lath.), or perhaps *Cracticus torquatus* Lath.

Grallina cyanoleuca Lath. Peewit—Mati-mati D (very short a), T. Vogelsang.

Unidentified birds—Yellow-breasted bird, arku-eta Nj, Berndt and Vogelsang 1941, 4 [? *Ptilotis penicillata*]. Stirling and Waite (1919) mentioned wonpatjara W, toa 320.

Unidentified birds whose Pangkala names were recorded by Schürmann 1844: irerinye, a species of sea bird (p. 8); kulka ita (19); kurdli ita (MS); murrerinye (36) [this term resembles murrara, *i.e.*, the black duck]; ngangkalla, any male bird (44); ngannelli, water bird [term is almost the same as that for the musk duck]; purperinye Pa (61), MS addition by Schürmann is "? nightingale" [perhaps the species may be *Cinclorhamphus rufescens* (*mathewsi*) or *C. cruralis*]; puttiperinye, putti = hair (62); tartatarta (63); tutturru, a sea bird (tuttu = song) (63) [? sea curlew, *Numenius cyanops*]; yunyalla (87); yandutyuru, sea bird (79); yupunnu, kangaroo bird (87) [*Rhipidura leucophrys* (*R. tricolor*) is suggested because of its common association with horses and cattle, probably it was similarly associated with larger herbivorous marsupials before the arrival of white men in Australia].

Reptiles

Snakes and lizards are eaten and are not skinned before being roasted. Pythons are especially appreciated, while venomous snakes may or may not be eaten. The wilyaru ceremony of the Dieri had for its object the procuring of a good supply of snakes and other reptiles (Gason 1879, 270; Howitt 1904, 798, minkani ceremony, Minkani being apparently one of the Kadimarkara—a wonna—whose fossil remains are to be found in the Eyrean deltas). Young people of the Ngameni were not permitted to eat a fat snake (such being reserved for their elders); the penalty for disobedience was the turning of the hair grey (Stirling and Waite 1919, toa 55). Amongst the Pangkala, lizards were the proper food for girls when puberty was to be accelerated, and snakes for women to promote

fecundity (Schürmann 1846; 1879, 220; Wilhelmi 1861, 176). Thootchoo [tjutju] D, Gason, 1879, 304, reptile or insect; tjuntju D, Fry 1937, 272, reptile.

Horne and Aiston (1924, 137) reported that a charm (tharta, W) for protection against attack by a snake was worn at night around the forehead or waist. It was made of hair smeared with ochre and grease mixed to form a stiff paste, so that there were projecting knobs of ochre. This charm was supposed to give warning by pricking the skin of the sleeper and thus awaken him if a snake or an enemy should invade his camp. These authors also reported (p. 161) that amongst the Wonkanguru, after subincision, the fat of a venomous snake was rubbed on the wound.

Kadimarkara is a term frequently used in the region, especially in connection with local legends. These were supposed to be monsters resembling crocodiles and the large fossil bones found in the area, as well as peculiarly formed rocks, are regarded as being their remains. References to these are: Howitt and Siebert 1903, 525, 532; Howitt 1904, 433, 800, 801; Stirling and Waite 1919, toas 3, 6, 64, 89.

Gason probably over estimated considerably the lengths of various snakes when recording their Dieri name, but Waite (1929, 183) pointed out the difficulty in estimating the lengths of living reptiles, mentioning his own experience when he carefully estimated the length of a snake moving across his own room and found that his estimate of 4 feet 6 inches was based on a reptile 3 feet 10 inches long, or in other words, an authority in herpetology had over estimated by at least 25%. Gason might be expected to make a greater error, perhaps 33% to 100%.

In attempting to identify Gason's species use has been made of the descriptions by Lucas and Frost (1896), Kinghorn (1929) and Waite (1929); and also of identifications of specimens in the South Australian Museum by T. Vogelsang, who was able to associate Dieri names with some of them.

Ophidia

Snake—Curr's correspondents (1886) recorded the following: wobma A, Todd — Ja, Green — K, Kingsmill; wobna Wp, Wills; wabma A, Warren — Pa, Le Souef and Holden — Pa, Beddome; wabna Wp, Phillipson; wabina A, Warren and Hogarth; wapma Pa, Sawers; woma Wp, D, Gason; wooma Ya, Cornish; worma Nu, Valentine. Wincherta K, Kingsmill. Juno Pa, Beddome. Kirtoba Ky, Machattie. Thoolperoo, thiagara Kg, Heagney. Koorianurra Ku, Heagney. Titta A, Jacobs. Tippamakatu W? Jacobs. Wonungunnie (carpet snake) N, Cornish [apparently the same as warraguni A, W, referred to later]. Parday Ya, Salmon. Kadi Bi, Curr. Turu Ma, Morton; turroo Wa, Dewhurst; thuru Wa, Crozier; thora Ma, Reid; tooroo, Darling tribes, Anon; thoro, Darling tribes, Haines. Toothoo N, Paull; tutjo D, Jacobs; tuchu Yu, Howitt [tjutju]. Minga Kw, Anon. Goondarra Pp, Eglinton [koondara Pp, of Roth 1897]. Ngoothe Te, Sullivan and Eglinton. Yethe Wk, Myles; yelchi B, Sullivan. Moona Wk, Myles — Te, Foott. Teulon (1886, 213) reported the names of several kinds of unidentified snakes from the vicinity of Bourke, Darling River, mentioning that amongst the Barkindji mulkerry was another name for tooroo (snake).

Most of these terms must apply to the large python or carpet snake of the dry interior, where it is commonly called woma or womma. Waite (1917, 436; 1929, 203) was able to identify it definitely as *Aspidites ramsayi* Macleay. Stirling and Waite (1919) referred to many toas relating to the woma or tjutju D, K — toas 9, 11, 34, 85, 159, 207. Wabma Wp, Hale and Tindale 1925, 58 (woma, *Aspidites ramsayi*); wumma Ka, Wells 1894, 519; woma, Horne and Aiston 1924, 29, 116, fig. 81, highly prized as food by the Wonkanguru; wabma

Pa, Schürmann 1844, 64 (diamond snake); woma D, Gason 1879, 285; woma, Duncan-Kemp (1933, 111); wonma Pp, koondara Pp (koo = curved, bent), general term for snake, Roth 1897, 31, 34, 39); wama, woma D, Fry 1937, 284, 196; wumma A, D, Helms 1896, 316; woma D, M. Howitt 1902, 405, 408 (Wonkanguru legend of its origin); bulu-bulu D, W (young woma), M. Howitt 1902, 408; tjutju D, Gatti 1930, 118.

The gigantic (totemic) carpet snake of ancestral times was Cummurra whose activities were commemorated in a snake corroboree (Duncan-Kemp 1933, 215-216). Roth (1897, 3, 153, 160) recorded it as Kammare (Pittapitta), a huge supernatural water-snake which was responsible for causing death by drowning. This serpent migrated from one waterhole to another along a rainbow. It is referred to briefly by Haubly 1936, 17. Reference has just been made to Minkani, the ancestral woma (Kadimarkara) of the Arabana tribe. Howitt (1904), 801) gave an account of the killing of the muramura, Woma, and its relation to certain landmarks, including the mound springs of the region. Berndt and Vogelsang (1941, 9) reported that amongst the Ngadjuri the mythological snake was akuru, and a small red snake associated with it was babu-laru. Duncan-Kemp (1933, 279) reported Wim yel-la as a mythical black snake.

Howitt (1891) mentioned as totemic, woma D (p. 38) and waraguni Kd (p. 39). In his later work (1904) he reported many names for the carpet snake (totemic) amongst Eyrean tribes and, since they occupy the same position in the list of murdus of the Kararu (or corresponding) moiety, they relate to the same species: woma D (p. 91, 873), N (94), Ya (95); manga Yu (92); chirka Wo (95); wadnangani W (92); wadnangari A (94); warangum (? error for waraguni) Kd (97); turu Wi (98); turru Mi (98). Spencer and Gillen (1899, 60, 114, 657) reported wabma as an Arabana totem (obma of the Aranda, l.c., p. 653); and Eylmann (1908, 167) recorded wonma as a Dieri murdu.

Python spilotes variegatus. Carpet snake — Binaru Wp, totem, Hale and Tindale 1925, 46, 58. Mudlannu Pa, Schürmann 1844, 34; warambini Pa, Sawers 1886, 132. Koorimara Pp, Roth 1897, 35 [may belong to some other species of python, *e.g., Liasis*; the term suggests koodiamurra Ku, Heagney].

Berndt and Vogelsang 1941, 9, reported mudlu Nj, woma D, and binaru Wp, as the carpet snake. It has already been mentioned that woma was applied to *Aspidies*. *Python variegatus* is largely arboreal and has not been recorded from the arid region to the north of the Flinders Ranges. Mudlu and binaru are applied to the latter species.

Acanthophis antarcticus Shaw. Death adder — Yalliri Pa, Schürmann 1844, 78.

Pseudechis porphyriacus Shaw. Black snake—Nurru Pa, Schürmann 1844, 41; womgo Pa, Sawers 1886, 132 (the name suggests wanku or wonkoo of other authors). This identification is uncertain, at least for womgo.

Notechis scutatus Peters. Tiger snake —Arkubi Nj, Berndt and Vogelsang 1941, 9.

Wip-aru —Gason 1879, 286, reported that wipparoo D, was applied to a long thin black snake, shaded with other dark colours, about seven feet long, its bite being followed by instant death. Helms (1896, 316) stated that wiparu A, D, possessed a light grey-yellow belly. Sawers (1886, 132) recorded wiparoo Pa as a yellow snake. Berndt and Vogelsang (1941, 9) mentioned wiperu Nj, wiparu D, as the whip snake, but they also (p. 4) reported wiparu D, and apara Nj, as names for the large adder. The latter name, if correctly applied, would refer to *Acanthophis antarcticus*, a short thick broad-headed snake, about 30 inches long, the other species, *A. pyrrhus*, being only 20 inches in maximum length. Hale and Tindale (1925, 58) reported appara as a lizard (*Hinulia*). Gatti (1930, 99)

considered that wiparu was a Dieri attempt to say vipera. The term viper is not applied in Australia, as far as I know, to any Australian snake.

There are three species which may be indicated: *Demansia textilis* (brown snake, mallee snake, mulga snake); *D. psammophis* (whip snake, saltbush snake); and *Pseudechis australis* (mulga snake). Gason's remarks regarding its highly venomous character, if correct, would seem to exclude the second which is also shorter than the other two, but he probably confused some of the characters belonging to the three species. Mr. Vogelsang has recognised the species amongst museum material; it is *Demansia psammophis* Schlegel.

Wirrawirrala D, Gason 1879, 286, a large, very venomous snake, 6 to 10 feet long, with yellow belly. The brown snake, *Demansia textilis*, is the species, though *D. psammophis* and *P. australis* may also have a yellowish ventral surface.

Mr. Vogelsang informed me that the Dieri called the Birdsville region Wirrawirra, la = from, the name of the snake implying that it came down from the Diamantina.

Marrakilla D, Gason 1879, 286, a large brown snake, about seven feet long, with a large head, very venomous and vicious. The snake is *Pseudechis australis*, which Kinghorn (1929, 159) reported as venomous, vicious, and dangerous, flattening its neck when angry. It closely resembles the brown snake in its colouration, but is relatively thicker and is rather more greenish above and greyish-yellow below.

Wonkoo D, Gason 1879, 286, a light brown and grey snake, four to seven feet long, venomous and very vicious. Berndt and Vogelsang 1941, 9, stated that wanku D was a small snake. Sawers' (1886, 132) wongo Pa, black snake, has a similar name, as has also Schürmann's warnko = wabma pulyo Pa (= small snake), 1844, 69. Mr. Vogelsang informed me that wonku D, was a general name for a small venomous snake, including the younger stages of those referred to earlier.

Stirling and Waite (1919) mentioned two toas 94 N and 185 D, wonkuturuni [wonkutukuni]; ni = to, or in the direction of; tuku = back (turu = fire); and the translation given (p. 126, 138) is "to the snake's back," the snake thus being wonku, a name referred to earlier in this section.

Unidentified snakes—Several reptiles regarded by Gason as snakes are almost certainly legless lizards (Pygopodidae), though blind snakes, Typhlopidae, are a possibility. I have listed most of them under Pygopodidae.

Thandandiewindiewindie D, Gason 1879, 286, a small black venomous snake, 5 feet 6 inches long, with a small mouth. Thoona D, Gason 1879, 286 grey snake, 5 feet long, venomous; toona means greyish-white, the colour of crudely burnt lime (T. Vogelsang); perhaps the name applies to a young *Demansia psammophis*. Korimora Kd, totem, brown snake, Howitt 1891, 39; 1904, 97; if it is the brown snake it is *Demansia textilis*; if a brown Pygopodid, it probably would be *Lialis burtonii* or *Delma fraseri*. Eylmann (1908, 167) reported tuku pirra pirra D, totem, as a species of snake (tuku = back, pirra = flat and broad, T. Vogelsang); if a snake, then it may be *Pseudechis australis*. Muni Pa, small black snake, and nilteni Pa, a small species, Schürmann 1844, 35, 39. Mulkunkoora D, Gason 1879, 286, black and green spotted venomous snake, 5 feet long, perhaps an erroneous description of the harmless *Pseudodelma impar* or *Lialis burtonii*.

Wells (1894, 521) reported tippa Ka, coola Ka, as snakes, and tundri prilla Ka, as a venomous species; he mentioned that wooti-inna and yarra-gun-inna were names of women, named after snakes (p. 519). The latter were presumably wooti and yarraguni. The latter name is obviously the same as warraguni, carpet snake. Tippa is probably the same as Jacobs' titta A, and tippamakatu W? (pythons). Coola (kula) is probably Gason's koolielawirrawirra which seems to be a legless lizard, *Pseudodelma impar* Fischer.

Lacertilia

Gason (1879, 260) gave an account of the Dieri story of the creation of human beings. The Muramura first made a number of small black lizards, the same kind still to be seen under dry bark, and promised them power over all other creeping things. He then altered their feet into fingers and toes and by means of his forefinger made the face into human form and then placed one of the lizards in a standing position which it could not retain until the tail was cut off—thus the human erect posture was attained. The sexes were then differentiated. Gason's remark indicates that it was a gecko, perhaps *Peropus variegatus*, moonkamoonkarilla of Gason (p. 285). Teichelmann and Schürmann (1933, 148) reported that amongst the Kaurna tribe tarro-tarro was the name of a species of lizard and also of a fabulous person said to have made the male and female sexes. Schürmann, when dealing with the Pangkala tribe, reported (1879, 241) that a small kind of lizard, the male of which was called ibirri and the female waka, was believed to have divided the sexes in the human species and that male natives tried to destroy the waka, while women vented their hatred on the ibirri. Schürmann, in his earlier work (1844, 5, 65), gave similar information.

Geckonidae, frequently termed wood adders locally. *Gymnodactylus miliusii* (*milii*) Bory St. Vinc., aljen-nara Wp, Hale and Tindale 1925, 58.

Peropus variegatus D and B, mun-ka Wp, Hale and Tindale 1925, 58; Waite 1929, 85 (also reported as dtella); munka Nj, small wood adder, Berndt and Vogelsang 1941, 4, must refer to the same species; moonkamoonkarilla D, small black short-tailed lizard, generally found under bark, Gason 1879, 285, also belongs probably to the same species. The species is also called pitji-la D (T. Vogelsang); pitchi = bark, la = from. Pilta W, Howitt 1904, 784, a small lizard living under bark may be either *Peropus variegatus* or *Gymnodactylus milii*.

Heteronota binoei Gray—Tjupa-tjupa D (T. Vogelsang), Choopa D, Gason 1879, 285; tiuba-tiuba Ka, N, Howitt 1904, 648; and tiubba-tiubba, Howitt 1904, 717, belong to the same species, and probably kupa Ya, Salmon 1886, 24, also.

The Kuyanni legend of the gecko, adno-artina and the dingo in ancestral times (Horne and Aiston 1924, 128-129) has already been referred to earlier in this paper, *Gymnodactylus milii* is a probable identification.

Mrs. Duncan-Kemp (1933, 274) referred to coora-bin DK, the frog (or barking) lizard, a gecko, which was regarded "as a harbinger of evil, incarnating the tarkee (disembodied spirits) who are jealous of human beings in the flesh and wander the earth on evil intent"; the tarkee having a place in stellar mythology and occupying the black pit visible just below the Southern Cross. *Gymnodactylus milii* or perhaps *Nephrurus laevis* De Vis (illchiljera of the Aranda) are possible identifications.

Pygopodidae—Some of Gason's spotted "snakes" are undoubtedly legless lizards, all of which are harmless.

Pygopus lepidopus Lacep—Wandaru D, T. Vogelsang. Wandaroo D, Gason 1879, 286, green and yellow snake, about 5 feet long, with very thick body, quite harmless, with sleepy appearance. Its actual length is only 2 feet. Howitt (1904, 96) recorded wonduru as a large snake, totemic amongst the tribes of the lower Diamantina and Warburton; he has previously (1891, 39) reported wanbura An, as a snake totem, Kopula Kd, totem, a speckled brown snake, Howitt 1891, 39; 1904, 97; is probably *P. lepidopus*.

Koolielawirrawirra D, Gason 1879, 286, a small harmless yellow and black spotted snake, 3 feet long; probably a Pygopodid, *Pseudodela impar* Fischer or perhaps *Lialis burtonii*.

Kurawulieyackayackuna D, Gason 1879, 286, a flat-headed venomous snake.

4 feet long, with green back and with yellow spots of its body. *Lialis burtonii* is a probable identification because of its colouration and its narrow, pointed, flattened head. Mulkunkoora may be *Pseudodelma impar* or *Lialis burtonii*.

Lialis burtonii—The species was recorded from the Eyrean region by Zietz in 1917, and by Lucas and Frost (1896, 125) from the Macdonnell Ranges. The following references may belong to the species. Kadapa N, slow worm, totem, Howitt 1904. Mithindie D, Gason 1879, 286, white and yellow spotted snake, about 3 feet long, harmless; mithindi Ya, totem, Howitt 1904, 95, slow worm, occupying the same position as kadapa in the list of Kararu totems, also spelt mitindi (p. 96); mittindi D, snake, Eylmann 1908, 167; Teulon 1886, 213, reported meetindy Ba, as a kind of snake.

Agamidae, jew lizards and allies; abundant in the region under consideration.

Amphibolurus barbatus Cuv. Frilled lizard—Kadni Wp, Hale and Tindale 1925, 58; kudnu Nj, ardnu, Wp, frilled lizard, Berndt and Vogelsang 1941, 7 (ardnu is *Trachysaurus* according to Hale and Tindale); kunnie D, Gason 1879, 285, jew lizard; kadni Ka, Wells 1894, 521, lizard, — D, Fry 1937, 190, 194 — A, Helms 1896, 316, *A. barbatus;* kadni T, D, Stirling and Waite 1919, toas 232, 307, lizard; kanni D, totem, Eylmann 1908, 167; kani D, Fry 1937, 284.

Howitt (1891, 39) recorded kadni An and kani Kd, frilled lizard, as totemic. In his book (1904) he published many references to kani (which he identified as a jew lizard, *Amphibolurus barbatus*, p. 783), a totemic lizard in the Matteri moiety: kani Ya, iguana (p. 95), Yu, iguana (92), west and north-west from Lake Eyre (96, 716); kanni Kd, frilled lizard (97); karni Wi, Mi, frilled lizard (98); kadni N, iguana (94). A ceremony associated with bartering was termed kani-nura (nura = tail) because the tail of the lizard was used as a token in connection with taking of a very young boy (also termed a kani-nura) from his mother's people to those of his father and with his subsequent return (Howitt 1904, 716-717). Kadno Pa, a yellow striped lizard, Schürmann 1844, 9, may be *Amphibolurus barbatus* or *A. muricatus*, probably the former; the name is so similar to those just given, and the species has two definite longitudinal bands of lighter colour than the rest of the back; but they are not yellow.

Berndt and Vogelsang (1941, 7) reported kudnu Nj, and kadni D, Wp, as the jew lizard, recording other names for the frilled lizard; these authors seem to have confused three species, since Hale and Tindale stated that ardnu was the Wailpi name of *Trachysaurus*.

Amphibolurus pictus Peters — Kadiwaru D, T, Vogelsang, waru — grey; kudieworoo Gason D, 1879, 285, red-backed lizard; kadiwaru D, Howitt 1904, 717, — D, Fry 1937, 284 Ya, M, Howitt 1902, 411; iti-iti Nj, kadiwaru D, Berndt and Vogelsang 1941, 7, small lizard.

Tympanocryptis cephalus Günther—Titjuri D, T, Vogelsang; thitthurie D, Gason 1879, 285, small rough-skinned lizard, (thitti — ticklish, referring to the prominent spines on the back of the species). Madakata kata D, T, Vogelsang; manakata kata Ka, N, Howitt 1904, 648; Mr. Vogelsang informed me that Howitt's name was incorrect; mada = stone, mana — mouth, kata = harsh noise, its name referring to the sound it makes when moving under stones in the gibber country.

Moloch horridus Gray —Naiari DK, Duncan-Kemp 1933, 63; same name applied by the Murranudda clan to the little black ant on which it feeds (p. 64); habits described , p, 64-66. Mrs. Duncan-Kemp (p. 271-272) referred to the place of these "sandhill devils" in aboriginal stellar mythology. In ancestral times these lizards were virgin women who kept to their own territory and, when gathering food, protected themselves with dogs against possible molestation by men.

Wherever the naiaris rested they left babies behind them in the form of white spirit stones, certain localities still being termed Naiari Waters. These offspring were warned against speaking to men, since the latter would take them away if they did. The leader of the ancestral men and a great hunter was Balleroo who wanted these naiari women as his wives and endeavoured to hunt and trap them, but the women fled to the sky, taking their own dogs with them. Balleroo followed them there and can be seen at night with his white girdle (the Milky Way) chasing the women (now the seven sisters of the Pleiades) but never catching them as the latter reside in Karani, *i.e.*, the women's country. Later the naiaris were changed into the little lizards, which are still voiceless because their mothers in ancestral times had not permitted them to speak. Naiari ceremonies are performed only by women.

Scincidae

Hinulia fasciolata Günther, appara Wp, Hale and Tindale 1925, 58.

Ablepharus boutonii Desjard., ngarupuruna Wp, Hale and Tindale 1925, 58.

Trachysaurus rugosus Gray, mudlu, arnu Wp, Hale and Tindale 1925, 58; alda Wp, sleepy lizard, Berndt and Vogelsang 1941, 7; kalla Pa, sleeping lizard, Schürmann 1844, 11; ngura wordu-pumuna D, Howitt 1904, 803 (nura = tail, wordu = short); nurawordubumuna D, Stirling and Waite 1919, 109, 145, toas 75, 130, 132, 134, 148, 183, 235, 263. The last two terms are the names of a Muramura who figured in a certain legend (toa 235) described by Howitt 1904, 803-806, part of his wanderings being perpetuated in the serpentine course of a portion of Cooper's Creek. He was one of the Kadimarkaras. The legend was also given by Howitt and Siebert (1903, 528-531), the name being reported as nurawordubumuna. The latter is the correct name since nura means a tail, while ngura is a leg. Stirling and Waite, toa 235, tjutjunurawordunl, translated the term as "to the stumpy crocodile's tail," but tjutju means snake (or reptile) and no crocodile possesses a stumpy tail (nura wordu). The regenerated tail of *Pygopus lepidopus* is sometimes short and broad (Waite 1929, 91, fig. 64).

Tiliqua scincoides Shaw. Blue tongue—Karrenye Pa, Schürmann 1844, 16, "ratling lizard." It is presumed that "ratling" means ratlin, the transverse bars forming steps of a rope ladder and, if so, then the species would be a markedly barred lizard such as *Tiliqua* spp., or perhaps *Egernia cunninghami* or *Hinulia fasciolata*. The bands are few and wide in *Tiliqua* and least obvious in *Egernia*. Karrenyerenye means blue or purple (Schürmann 1844, 161) and the name of the lizard no doubt refers to the blue tongue which *Tiliqua* displays when on the defensive.

Omolepidota branchiale Günth.—Wonnaloora D (= shining, and has reference to the appearance of the skin), T. Vogelsang; Gason 1879, 285.

Hemiergis peroni Fitz.—Oolaunni D, T. Vogelsang; Gason 1879, 285, lizard with transparent skin, spotted yellow and black.

Rhodona bipes Fischer—Kultjandarra D, T. Vogelsang; kulchandarra D, Gason 1879, 285, "lives under the ground and only appears above after heavy rains. The natives describe it as venemous and affirm (that) its bite is certain death, wherefore they are very frightened of it, and even avoid killing it from fear of its poisoning their weapons." It is, of course, a harmless sand-burrower. Waite (1929, 165) recorded it from Cooper's Creek.

Varanidae, "iguana" of authors, goanna.

Varanus giganteus Gray, popular name in Central Australia is perentie or sjonba, Waite 1929, 125; printhee Duncan-Kemp 1933, 57. The latter author mentioned the legend of the desert chat and the perenti, termed karapara in her district, parapara by the Pittapitta and paripara by the Karanya (Roth 18997, 37,

50). This has already been referred to in the present paper. Berndt and Vogelsang 1941, 6, were in error when stating that the large goanna, *Varanus gouldi*, was pirinti D. Mr. Vogelsang informed me that the term, when used by the Dieri, belonged to *V. giganteus*. The Aranda names for the latter are echunpa and irrunpa (Spencer and Gillen 1899, 648, 651), though Lucas and Frost (1896, 134) called it parenthie.

M. Howitt (1902, 412-413) published an Arabana legend which explained the colour pattern and the habitat of the pirinti A, and of kapiri (*V. gouldi*), the former now being restricted to the rocky or hilly region north of Oodnadatta, and the latter to the more sandy country where kulva (= kulva, native name for the needle-bush, *Hakea leucoptera*) occurs.

Varanus varius Shaw—Patara-muru D, T, Vogelsang, Patharamooroo D, Gason 1879, 285, black iguana, reported as very rare in the Dieri region. Patara = boxtree, *Eucalyptus microtheca*, or timber; muru = black; the attitude of this very dark large species suggesting a small blackened branch of a tree.

Varanus gouldi Gray—This is the common "goanna" of the drier regions of this State and is widely distributed in Australia, especially in the more sandy, treeless portions. Kopirri D, Gason 1879, 285, kaupirrie (p. 299). Howitt (1891) reported as totems, kopiri D (p. 38), kopri An (39), tura-guru Kd (39); and in his later work (1904) recorded kapiri (96, 798), kaperi (783), birnal Mi (98), and turra-gurra Kd (97). Capirie A, totem, Spencer and Gillen 1899, 60; radna Wp, Hale and Tindale 1925, 58. Kapiri D, A, W, M. Howitt 1902, 405, 406 (lace lizard), 408 (legend relating to its origin), 412-413 (Arabana legend explaining distribution and colouration); kapiri, kaperi D, Fry 1937, 196, 284; karpirri A, Helms 1896, 316 (*V. gouldii*).

Berndt and Vogelsang 1941, 6, reported budna Nj, kapiri D, for "goanna"; and pirinti D, radna Wp for *Varanus gouldii*. Pirinti does not belong to *V. gouldii* but probably all the remaining four terms do, though in the Flinders Ranges *V. varius* may occur in addition to *V. gouldi*; the term budna may possibly belong to it, since the colouration of *V. varius* resembles that of the parenti.

The special ceremonies (kaupirrie wima [winma = song] of Gason 1879, 279; minkani of Howitt 1904, 798) associated with the increase in numbers of woma and kapiri were referred to by these authors. Gason also reported that this animal was regarded as a conductor of lightning and that during a thunderstorm it buried itself in the sand. If eaten by children, the latter, when they grew up, would become grey or develop much hair on the breast. Berndt and Vogelsang (Trans. Roy. Soc. S. Aust., **63**, 1939, 171; Rec. S. Aust. Mus., **6**, (4), 1941, 378) referred to a Dieri rain-making ceremony involving the rubbing of goanna fat into the body of a boy in the belief that the grease would cause vapour to rise from the body and form into a cloud from which rain would fall.

Roth (1897, 50) reported that the smaller species of "iguana" was termed karingara by the Pittapitta and Karanya tribes. Probably *V. gouldi* was the lizard so indicated. Howitt (1904, 95) mentioned karingara as a Yauorka totem, but gave no indication regarding its identity. It occupied a position amongst Matteri murdus corresponding to nungalli Yu (p. 92, 446) and wompirka N (p. 94), both termed lizards. Wells (1814, 521) recorded wump-pikka Ka as an "iguana." We can accordingly add all these terms to the list of names for *V. gouldi*.

Unidentified lizards — Schürmann (1844) recorded the following Pangkala names of lizards: katyeti (p. 17); pardna (53); yarrapalla, a small species (81) (yarra = quick —perhaps *Hinulia* sp.); ibirri, "a small species of lizard said to have separated the sexes; women call it waka; whenever one of these little animals makes its appearance it is usually the cause of merriment and jokes" (p. 5, 65): it has been suggested earlier in this paper that the species was one of the geckoes.

perhaps *Peropus variegatus*. In the wi-lu (curlew) legend, Schürmann (1879) made no mention of lizards, though he referred to them (ibirri and waka) in the next legend as indicated above. Wilhelmi (1861, 194; 1862, 34) altered that legend by stating that the two youths became small lizards whose male was ibirri and whose female was waka.

Gason (1879, 285) reported the Dieri name of a lizard which we have not been able to identify: wakurrie, about three inches long, flat-headed [probably a small gecko such as *Diplodactylus vittatus*; Teichelmann and Schürmann (1933, 150) recorded wakurri, Kaurna tribe, as a lizard].

Amphibia

Frog—Gason (1879, 286) mentioned kulathirrie D and thidnamura D (thidna = foot; mura = hand) as an edible frog and toad respectively. Howitt stated that amongst totem animals were tidnamara D (1885, 6; 1891, 38), orikomatu Kd (1891, 39) and kurdmuri An, bullfrog, (1891, 39). In his later work (1904) he referred to the following; tidnama D [? error for tidnamara] a small frog (p. 91); tidnamara W (92), A (94), N (94), and tribes south-east from Pando, *i.e.*, Lake Hope; kaladiri D (91, 783); taralyu N (94); kutyarku Yu (92); kuyarku Ya (95), apparently the same as kutyarku, since kuyaku Yu was mentioned as a bream (92); kelka A (94); orekomatu Kd (97). Kalatiri D, Gatti 1939, 116. Tinamara D, Fry 1937, 272. Green (1886, 126) reported ngerna Wp [ngarna of other recorders]. Since kaladiri, kutyarku, yelka and kuyarku all occupy similar positions in the lists of murdus of Eyrean tribes, as published by Howitt (1904), they all probably refer to the same species of frog; while tidnamara, a small species, occupies a different position, though both groups of totems belong to the Kararu moiety. Howitt was thus apparently referring to two different species, a larger represented by kaladiri (kulathirrie of Gason), and a smaller represented by tidnamara (thidnamura of Gason). Orekomatu, a totem of a tribe along the Cooper much further to the east, occupied almost the same position as kaladiri and probably refers to the same species. Eylmann (1908, 167) mentioned tidnamara as a Dieri maddu. Berndt and Vogelsang (1941, 6) reported waka Nj, kalatiri D, and ngar-na Wp. The last-named had already been recorded by Hale and Tindale (1925, 58) as the Wailpi name for the waterhole frog, while the large species from the sandhill country was stated to be yalja; the latter stored up water and thus permitted its aestivation, but it was dug up by natives and its stored water utilized in an emergency (p. 48). Spencer (1896a, 160-165) gave an account of the habits and published figures of the adult and tadpoles of *Chiroleptes platycephalus* in Central Australia. This water-holding frog, whose habits Waite (1929, 246) described under *Phractops platycephalus*, forms its burrows in the harder claypans rather than in the beds of sandy creeks. The latter situation is not firm enough for *Chiroleptes* but is the favoured habitat of the rather large *Limnodynastes ornatus* Gray which burrows down into moist sand, about a foot below the surface of the creek bed (Spencer 1896, 18-19, 42-43), and though becoming swollen with absorbed water, it does not become so distended as the former. *Chiroleptes* is especially adapted for survival in a dry environment by its ability to store abundance of water in its body cavity and elsewhere, and to burrow some distance down into the clayey soil where it can survive for months. *Limnodynastes* was stated to be not so abundant as *Chiroleptes* or *Hyla rubella*. Spencer pointed out that the fully-distended frog became nearly spherical and just filled the cavity at the end of its burrow, the walls of the cavity being moist but not wet. These frogs apparently breed very soon after rain or flood and pass through the tadpole stage very rapidly.

The third species of frog which occurs commonly in waterholes is the small, variously coloured, *Hyla rubella* Günther, a description of the adult and larvae

from Central Australia being given by Spencer (1896, 170-172) who stated that, after rain, it was as common as, or commoner than, *Chiroleptes*. It measures little more than an inch in length whereas *Chiroleptes* reaches 2·6 and *L. ornatus* about 2 inches long. *Heleioporus pictus* Peters also occurs in Central Australia but is much less common than the three mentioned. Its size is similar to that of *L. ornatus*. Waite referred to these species in his handbook on South Australian reptiles and amphibians (1929). Kaladiri (and the other names which we have associated with it) and yalja are *Chiroleptes platycephalus*, and tidnamara and ngarna belong to *Hyla rubella*. Schürmann (1844, 16) mentioned karranna as a Pangkala term for a frog, and in his MS. additions he reported itine as a species of frog, and kulbi as a tadpole. Karrana is really the same as ngar na (onomat.) and applies without doubt to local species of *Hyla*.

Duncan-Kemp (1933, 45) referred to the presence in the Diamantina region of two kinds of edible frogs, a large grey green lethargic species found aestivating deep in the mud of dry creeks, and a very small red-capped frog. The former were stated to possess storage tanks in their abdomens and may be either *L. ornatus* or (more probably) *C. platycephalus*. Tadpoles were caught by hand by children and eaten alive (p. 288).

Roth (1897, 50) mentioned that koo-yer-ko was the name of a frog amongst the Karanya tribe; this is obviously the same as Howitt's kuyarku or kutyarku (onomat.) of the Yaurorka and Yantruwunta. He reported (p. 38, 94) that there were three edible frogs in the Diamantina region inhabited by the Pittapitta: taralko, a large "bullfrog," 4½ to 5 inches long; koompa, 3½ inches; and nemaka 2½ inches; a general term for any small frog was neng-o. In addition there were large greenish frogs, ka-ti-loa (p. 94), which were apparently not eaten, but were dug up from their burrows in hard ground with yam sticks or from sandy soil. Katiloa was probably either *Chiroleptes* or *Limnodynastes*, or both. Nemaka may have been *Hyla rubella* and taralko may have been *L. ornatus*.

Limnodynastes dorsalis Gray (presumably the same species as that identified by Spencer 1896 as *L. ornatus*) was stated to be mchichera (totem) of the Aranda. Strehlow (1908, 66) identified injitjera (Aranda), ngangi (Loritja), as *Heleioporus pictus*.

Duncan-Kemp (1933, 147) referred to "Wompoo, half bird, half frog, a fantastic creature of swamp and brake," to whom offerings of pituri wrapped in a coolibah leaf, were placed in the fork of a tree overhanging the water.

Pisces

There are few definite identifications recorded. The chief general terms for fish are kuya and paru. Curr (1886, 3) stated that Bulloo and Paroo, names of two long rivers which flow south towards the Darling, both mean fish, but apart from a reference by Todd (1886, 10) relating to Arabana territory, I cannot find any other indication of bulloo as a name for fish. In the Bulloo region, Curr's lists give kuya and paru as the terms.

Teleostei

Curr's correspondents (1886) reported the following terms for fish: bulloo A, Todd. Paroo A, Warren and Hogarth, Todd, Warren — N, Paull — Ya, Cornish — Yu Howitt — Wp, Phillipson. Paroo, etc. (each sort has its particular name), D. Gason. Koopi Pp, Eglinton; koppi Ky, Machattie. Kammoo Bi, Curr. Wongo Kw, Anon. Kooya Ya, Salmon — B, Sullivan — Pa, Sawers; kooa Te, Sullivan and Eglinton — Ma Morton; kooia Wa, Crozier; kooyea Ja, Green; kuya Pa, Le Souef and Eglinton — Wa, Dewhurst; queea Nu, Valentine; gooya Kg, Heagney; gooia Te, Foott; guia Wk, Myles. Goombilla Ku, Kg Heagney. Worri A, Jacobs; warrie N, Cornish; morri [? error for worri] D,

Jacobs. Roth (1897, 31) listed ko pe as a general term for fish amongst the Pitapitta; and koopa amongst the neighbouring tribes [hence koopi and koppi in Curr's list]; koo (as a root stem) = water. Paru D, Fry 1937, 279.

Wells (1894) gave the following names for different fish, multa-multa, mudlacoopa, paroo and warrie Ka, Eleanor and lower Diamantina. He mentioned that fish fat was mixed with crushed seeds of nardoo [ngardu = sporocarps of *Marsilea Drummondii*] and then baked in hot ashes (p. 517). The method of using a large net made of native flax was mentioned (p. 518).

Gason (1879, 287, 301) stated that fish were few and unimportant (as articles of diet) in the Dieri country, being caught in the waterholes which could be termed creeks or rivers only after floods had arrived in that region. He gave names of four kinds, paroo (a small flat bony fish), multhoomulthoo (a fish weighing 3-3½ lbs.); moodlakoopa (a fish averaging 4 lbs.); and murkara (a large fish). A net (mintie), usually 60 feet long by 3 feet wide, and made from rushes, was used for fishing (p. 289). He mentioned kurdiemurkara (p. 299): "a suppositious large fish at the bottom of lakes and deep waters." This fabulous creature, kadi-markara, regarded by others as some kind of reptile, figured frequently in the legends of the region (Howitt 1904, 433, 789; Stirling and Waite 1919, toa 3) and is commemorated in Curdimurka, a railway station west of Lake Eyre.

Howitt (1891, 38) mentioned as Dieri murdus, kirapara (a bone-fish) and markara (mullet). In his book (1904) he listed the following totem fish: markara D (p. 91), N (94); makara (783) — apparently the same as markara; kuyaku Yu, bream (92) [kuyarku is termed a frog Ya on page 95, where it is probably a misprint for kutyarku, a frog]; kirrhapara, kirhapara N (94, 96), not identified but the term kirapara was used by him in 1891 for a "bone-fish"; mudlakupa, no details (96); ngampuru Ya (95) [name applied to a caterpillar Yu (92)]; namba, bone-fish, Wi, Mi (98). He mentioned (448) as terms for fish, paru D; kuya Ya, Yu; and stated (450) that kuyi-paua (paua = seed; fish seed) was associated with the mortuary practices of some tribes, *e.g.*, Tangara (*i.e.*, Antakirinya).

Eylmann (1908, 167) stated that the Dieri fish murdus (maddu) were markara (a large species) and kirapara, a kind called "red fish" by the natives. He published an illustration of the mesh of a Dieri fish net.

Some of the toas mentioned by Stirling and Waite (1919) referred to fish (paru D) — toa 145, 281. Glassy stones (gypsum) served as fish charms (parumarda, marda = stone). Dried fish were pounded into a meal by the Dieri and kept in that form for future use (p. 133). Markara A, D, a large species; mudlakupa A, D, a small fish (? bream). Helms 1896, 316.

Horne and Aiston (1924) mentioned that paroo W was the black bream (*Therapon* spp.), and murakara was the perch or "yellow belly." They stated that the fibre string net was called wooroomarroo and the rush made net, pinegara W (p. 62). The method of net-fishing was described (p. 63-64).

Berndt and Vogelsang (1941, 6) gave the terms guja Nj, paru D, for fish; and witi-wala Nj for any kind of fish trap. At Pandi we obtained the terms warri N, W, for perch (*Therapon percoides* and a smaller, paler species of the same genus, ? *T. unicolor*) and makara N, W, for the "yellow belly," *Plectroplites ambiguus* (callop or tarki of the lower Murray River).

We can now attempt to identify the various fish. The largest species is *Plectroplites ambiguus* = makara. Mudlakupa (mudla = nose; kupa = young, small, same term for child) is its young stage, according to T. Vogelsang, its name being given on account of the shape of the anterior part of the head.

Several species of *Therapon* (*Terapon*) occur in the Diamantina and Cooper, and these "bream" can be expected to be carried into the Eyrean region as a result

of floods. *T. percoides* and *T. unicolor* are between 6 and 7 inches in length and weigh about half a pound. *T. welchi* and *T. barcoo*, from Cooper's Creek, are 8 and 5½ inches respectively (McCulloch and Waite 1917, 472, 475). The latter is allied to *T. hilli* from Queensland streams, and the former to *T. bidyana* (teheri, bidyan) of the Murray basin. The Pandi natives did not distinguish between the two kinds of *Therapon*, warri being applied to both. Multa multa is applied by the Dieri to *Therapon* spp. because these fish soon become soft (multa) after death; they are the least favoured of all local fish (T. Vogelsang).

The 'bone fish" of Howitt (kirapara, ngamparu, namba) is the bony bream which occurs sometimes very abundantly in streams and waterholes in Central Australia. The species in the Finke and Eyrean regions is *Chatoessus* (= *Nematalosa*) *horni* (interpitna of the Aranda, Spencer and Gillen 1899, 650). Mr. Vogelsang informs me that this species is the commonest in the Dieri region where it is called paru, this term being also a general one for fish. *Nematalosa erebi* (tukari) is common in the Murray basin.

Roth (1897, 96) stated that in the Georgina and some other creeks, aborigines groped carefully in the mud and caught a kind of catfish. This was probably *Neosilurus hyrtlii*, which has a wide distribution in Central Australia, but according to T. Vogelsang is very rarely seen in the lower Cooper, even after floods.

Schürmann (1844) recorded the Pangkala terms for a large number of fish (kuya) probably marine from Spencer's Gulf and in most cases not at present identifiable. Those mentioned in his MS additions are indicated by (MS) Pityurnu, fish scale; winni, wiudi, fish hook, same word for an angle. Kuya bidni was the name for Sleaford Mere because of the prevalence of fish there (p. 24). Unidentified fish are: kadlayini (kadla = tail); kadlayini murra, a small species; kakkaninye [kakka = head, hence presumably a large-headed fish, perhaps a flathead, *Platycephalus* spp.]; kallalla; kanalla kuya, a freshwater fish (MS) [there are very few creeks in the region; *Galaxias attenuata* is a possible identification]; kandalguru; karpatye or murtunya, a small blue fish; kurai [? mullet, *e.g.*, *Myxus*]; kuralbo, a small fish; minggatta; munyarra a small species; murtunyu; nemi or yalluyu; welunnu; wirrinni; wornka; yalleki, yerilyeli; yunnuyu.

The following names were also mentioned by Schürmann (1844), and an attempt is now made to identify the fish: kalunu, whiting [*Sillago bassensis* or perhaps *Sillaginodes punctatus*]; kumbarra, vabmarra, groper [*Achaerodus gouldi*]; marrenye, snapper [*Pagrosomus auratus*]; murti, salmon [*Arripis trutta*]; ngaltai, barracouta [*Thysites atun*]; pullamba, "a small crustaceous species of fish," also "porcupine grass" [the fish is probably *Allomycterus jaculiferus*, but may be *Diodon holocanthus*; the latter was reported by Waite to be rare in South Australian waters, though its characteristic swim-bladder was often found on beaches after rough weather]; purrelli, "hedgehog fish," "any crustaceous species of fish" [*Atopomycterus nichthemerus*, globe fish]; wallilli, cod fish [the term cod is applied to several species in South Australia; the Murray cod may be ruled out as it is restricted to the Murray waters; a rock cod, *Physiculus barbatus* (belonging to the Gadidae) occurs in our gulfs; the term rock cod is also used commonly for some of the gurnards, more especially *Scorpaena cruenta*].

Fishing net—Jama D, Gatti 1903, 117; minda Nj, mindi Nj, jama D, Berndt and Vogelsang (1941, 7); peerly Ya, Salmon 1886, 24. Methods for catching fish: Bi, Fraser 1886, 378; Schürmann 1846; 1879, 218; Wilhelmi 1861, 175; 1862, 15; Duncan-Kemp 1933, 121-122, 148, 150. The last-named author (p. 147) referred to the drying and pulverising of fish obtained from permanent waterholes, this crude "fish flour" being ground up along with seed from a barley grass, katoora, the latter being indicated by Roth (1879, 91) as *Sporobolus actinocladus*.

This fish-flour was used for ceremonial purposes. Roth also illustrated various methods of using nets to catch fish (fig. 220-225).

Elasmobranchii

Sharks—Schürmann (1844) reported the following Pangkala names of sharks from Spencer Gulf: kadalyili (p. 9); konye (18); piri manka, dogfish (57) (piri = enough, manka = dots or scars); wolgarra (75). In a manuscript addition to his vocabulary Schürmann mentioned kattalyilli (apparently the same as kadalyili) as a dogfish. *Heterodontus philippi* (*portus-jacksoni*) is commonly called dogfish in the two South Australian gulfs, and is marked with several obvious coloured lines or blotches. There are at least two other local sharks called dogfish, and these are allied to the dogfish of European waters—*Squalus fernandinus* and (less commonly) *Scymnorhinus licha*, but these are not spotted or striped. The term piri-manka suggests a shark with numerous spots, *e.g.*, one of the carpet sharks (*Orectolobus* spp.) or one of the small cat-sharks, *Parascyllium* spp. or *Halaelurus* spp. The last genus is regarded as a synonym of *Scyliorhinus*. Piri-manka is more likely to be *Scyl. vincenti*, while kadalyili may be *Squalus fernandinus*.

Reference was made earlier in this paper to the probable error regarding Berndt and Vogelsang's record of ngakula Nj as a whale, instead of a shark, nakudlo being the term applied to the latter by the neighbouring tribe along the Murray River.

Rays Minna Pa, a kind of stingray, Schürmann 1844, 32. In his MS additions he recorded karna as a stingray which attacked men with the spike on its back [the species was *Dasyatis brevicaudatus*, a large form, armed with a long caudal spine, and one which commonly enters shallow water. The latter is the only true stingray likely to be met with by the aborigines whose fishing was done by standing in shallow water, the other known South Australian stingrays being inhabitants of deep water]. Amongst the other rays likely to be encountered by them were *Rhinodon philippi* (shovel-nose ray), and the skate *Raja australis*. Since the latter has spines along its middorsal line, it may be Schürmann's minna, though it is not a stingray. The eagle ray, *Myliobatis tenuicaudatus*, is probably not sufficiently common in shallow water for a native name to have been attached to it by the Pangkala. Schürmann, in his MS additions, mentioned pidnu Pa as the "fiddler fish" [*i.e.*, *Trygonorrhina fasciata*].

ARTHROPODA

Crustacea

Freshwater crayfish or yabbie—The small smooth bodied crayfish of Australian rivers and waterholes were generally regarded as belonging to one widely distributed species, *Parachaeraps bicarinatus* Gray, while the larger spiny forms from mainland streams were popularly called lobsters and identified as *Astacopsis serratus* (Hale, Crustaceans of South Australia, Adelaide, 1927, 72-77). Miss E. Clark studied these crustaceans from numerous Australian localities and showed that there were many species included under those terms (Mem. Nat. Mus., Melbourne, 10, 1936, 5-58; 12, 1941, 31-40). The yabbie from the arid regions was determined as *Cherax destructor* Clark. These crustaceans are sought for as food by the aborigines.

Curr's correspondents (1886) supplied the following names for lobster or crayfish, but the two latter terms apply to only one kind (the yabbie) in the region under review. Koonkideri A, Warren and Hogarth; koonkoodirri N, Paull; koonkooderie N, Cornish; kurnkuderri D, Jacobs; kurukudirri (? error for kunkudirri) A, Jacobs; kuniekundri D, Gason; kidneykooderi Ya, Cornish. Buggila

Wk, Myles; boogali B, Sullivan; boagalli Wa, Crozier. Unde Kw, Anon. Muracuru Wa, Crozier. Umpurra Wa, Dewhurst; thoombur Ku, Heagney; thornabun (?misspelt) Kg, Heagney. Thandoola Te, Sullivan and Eglinton. Wolkoo Nu, Valentine. Narraminyah Ya, Salmon. Thinta Te, Foott. Kutera Ma, Morton. Trunagi Ky, Machattie.

Other references are koonickoondie D, Gason 1879, 287 (same term used for scorpion); koonta Ka, Wells 1894, 520. We received the term kunku-derri N, W, at Pandi and were informed that yabbies were always cooked before being eaten. After cooking they were termed kunkuderri waina.

Spencer 1896, 60; 1896a, 229, 244, referred to the presence of *Astacopsis bicarinatus* (illya-anna of the Aranda tribe = *Cherax destructor*) in waterholes along the Finke, Macumba, etc., which drain into Lake Eyre. It was much appreciated as an article of food by the natives. Stirling (1896, 53) referred to the relative edibility of the crayfish and the local freshwater crab. The freshwater crayfish (or crawfish) was termed by the Adelaide tribe konguia (Williams 1839; 1933, 60; Wyatt 1879; 1933, 30) or kunggurla (Teichelmann and Schürmann 1840; 1933, 108). Schürmann (1844, 21) gave the same term, kunggullu, as the Pangkala name for a crayfish and a marine crab.

Parathelphusa transversa Martens. Freshwater crab—A small burrowing species occurring in streams and waterholes in the arid parts of Australia, and capable of surviving through periods of drought by living like the crayfish in a burrow a few feet below the surface. It was figured by Hale (Crustaceans of S. Aust., **1**, 1927, 154). Its use by the natives on the Finke was reported by Schulze. Spencer (1896, 60; 1896a, 229, 245) mentioned its presence in the rivers and creeks west and north-west of Lake Eyre. It occurs in the lower Diamantina, where it is eaten raw; we received the term koranti N, W, for it. Berndt and Vogelsang 1941, 5, reported jilaki Nj and kung-kutiri D as being a crab, but the latter term is the same as that listed above as belonging to the crayfish. Horne and Aiston's reference (1924, 50) to freshwater crabs, six inches across and occupying burrows containing each a couple of gallons of water, must relate to the crayfish, since the carapace of the crab is only an inch and a half in length. The term "land crab" has been used in south-eastern Australia, according to Morris (Austral English, 1898, 105), for the smallest kind of burrowing crayfish, *Engaeus fossor*, which has habits similar to *Parathelphusa* and retains a small quantity of water in the bottom of its burrow. The work of Smith and Schuster (P.Z.S. 1912, 144-127) and Miss Ellen Clark (Mem. Nat. Mus., Melbourne, **10**, 1936, 37-54; **12**, 1941, 37-40) has indicated that many species of this and related genera occur in Australia. Mrs. Duncan-Kemp (1933, 92) referred to holes formed by edible crabs and containing up to six quarts of clear water.

Arachnida

Scorpion—Kunickoondie D, Gason 1879, 287 (same term used for crayfish); kanimunti D, Gatti 1930, 118. The habit of the local scorpion along Strzelecki Creek was referred to by Waite (in Lea 1917, 490). Mr. H. Womersley informed me that the species collected by Waite was *Urodacus* sp. Kattarna Pa, Schürmann 1844, 17.

"Tarantula" spider—Murunkura D, Gason 1879, 287; — D, Gatti 1903, 120. Mr. Womersley informed me that the so-called tarantulas of the Far North of this State were Sparassidae, almost certainly species of *Isopeda*. Rainbow (1917, 485) recorded three, *I. dolorosa*, *harni* and *gloriosa*, collected by Waite during the Museum Expedition to the Cooper's Creek. Hogg (Horn Exp., Rep. 2, Zool., 340-342) recorded several species of the genus as having been taken between Oodnadatta and the Macdonnell Ranges, chiefly near the former locality. Mr. Vogelsang informed me the Dieri term meant crawling, a crawling creature; mara

= hand, nkura = leg, referring to the use of both by a child when crawling. Berndt and Vogelsang (1941, 9) reported that a trapdoor spider from the Ngadjuri territory was arambura, and marankara D, was stated to be the black spider, but T. Vogelsang informed me recently that the latter Dieri name was sometimes used as a general term for spider but was more usually applied to the trapdoor spider, *i.e.*, Gason's "tarantula." Schürmann (1844, 14) reported kara Pa as a "tarantula" and kara yalga Pa, as a cobweb.

Latrodectus hasselti. Black spider ("red backed")—Gason 1879, 287, reported that the "black spider" was kooniekoonierilla, D. Rainbow (1917, 485) recorded it from Cooper's Creek, and Hogg (Horn Report, 2, 1896, 322, as *L. scelio*) from the Macdonnell Ranges. Berndt and Vogelsang (1941, 9) reported that spider web was waku ngungura and that the black spider was waku Nj, and marankara D; but the latter was applied by Gason to a trap-door spider. We received the name murra ngura N, W, for *Latrodectus* at Pandi, where its bite was stated to cause pain lasting all day. Perhaps mutta-na Ka, Wells (1894, 521), a spider, may refer to the same species. Mrs. Duncan-Kemp (p. 270) reported that the aborigines in her district applied a warmed poultice of mashed vine leaves in cases of bites by this spider. T. Vogelsang informed me that the red-backed spider, kapara of the Dieri, also called kana-jeri, *i.e.*, man-like, was connected with some evil spirit. Children, especially the younger ones, were warned not to touch it or tease it, otherwise the associated evil spirit might cause various forms of itch and skin diseases or even death, and might poison edible plants and grubs, or even the water, and thus bring about starvation of the natives as well as bird life.

Other spiders—Pitchula D, Gason 1879, 287; pitjila D, T. Vogelsang, so named because it lives under bark; pitji = bark, la = from; the same term was applied to a gecko. Mutta-na Ka, Wells 1894, 521. Koto DK, a rather large, grey-brown trapdoor spider with a pinkish tinge, a burrower in the sand-hills, where it was preyed on by goannas (karapara), Duncan-Kemp 1933, 62. This spider is probably the same as that recorded by Roth (1897, 35, 5) as ko-po of the Pittapitta, and kurra of the Karanya tribe.

Itch - Witcha D, Gason 1879, 282-283. A papular eruption which was extremely irritating and very contagious, and made its appearance each year, was attributed by Gason to the general want of cleanliness and the presence of so many mangy dogs. There is no evidence to indicate whether it was an impetigo or was due to scabies. The former is much more probable and may be accentuated by some seasonal dietary deficiency.

Myriapoda

Centipede—Thinga-thinga Ya, Salmon 1886, 24. Thiltharie D, Gason 1879, 287, a species reaching seven inches in length. Mr. Womersley suggests that this may be *Scolopendra subspinipes* Leach, which is common in the drier parts of this State. Hale and Tindale (1925, 58) reported that all centipedes were termed wange jeri by the Wailpi.

Insecta

Orthoptera

Grasshoppers—General term: pindrie D, Gason 1879, 287; wichirika Wp, Hale and Tindale 1925, 58; pitji ilki Nj, pindri D, wichirika Wp, Berndt and Vogelsang 1941, 6; nindabarrie Pa, Schürmann 1844 (MS). Waite (1917, 418) referred to two unusual locusts (*Brachytettix*, figured by Lea 1917, pl. xxxiii, fig. 1-3; and *Eremobia*) obtained in the Cooper's Creek region.

Thorodia melanoptera. Mantis—Wulungara Wp, Hale and Tindale 1925, 58. Mantis (pindie, mootna DK) are roasted on hot stones and eaten. Duncan-Kemp 1933, 61. Howitt 1891, 39, reported wadnamara An, insect, as a totem; wadna = digging stick, mara = hand, so perhaps the insect may have been a mantis

(because of its stick-like raptorial limbs) or a cricket because of its digging feet. In 1904, 92, he recorded wonamara W, as a caterpillar.

Cockroach—Irebilye Pa, Schürmann 1844, 8.

Odonata

Dragonfly—General term, witu witu Wp, Hale and Tindale 1925, 58; kuyurkuru Pa, same term for stick and hornet. Schürmann 1844, 24.

Anoplura and Mallophaga

Pediculus humanus. Louse—Pir-di Ka, Wells 1894, 521; this seems to be the same term as that (purdie) given by Gason for a grub. Kudlu Pa, Schürmann 1844, 18; kooloo Pa, Beddome 1886, 133; gudlu Nj, kata D, Berndt and Vogelsang 1941, 7. Kata N, W (head and body lice); this term was obtained by us at Pandi. Strehlow 1908, 67, recorded kulu (Loritja) and ita, itja (Aranda) as terms for louse. We obtained the names kulu (Yankundjajara) and chita (Pitjandjara) in the Musgrave Ranges. Kata D, Fry 1937, 198. Kutta D, lice or vermin, Gason 1879, 299. Kuttanylpa D, lice or nits (presumably *P. humanus*), Gason 1879, 299; nulkunya Pa, nits or lice, Schürmann 1844, 40.

Phthirius pubis. Pubic louse—The terms witja N, and i-da (eeda) W, were obtained by us at Pandi.

Mallophaga on birds—Paia witja N, W (paia = bird), was the name given at Pandi. Kurra D, Gason 1879, 299, vermin on animals. Warukati kata D, emu louse, Fry 1937, 198.

Itch, due to insects Witja N, W, at Pandi; same word as Gason's witteha D.

Hemiptera

Cicada—Waldamburri Wp, Hale and Tindale 1925, 58; wutnimmera A, Spencer and Gillen 1899, 60, 114 (totem).

Lerp (Psyllid) from *Eucalyptus oleosa*, edible, owaree (au-ari) Wp, Cleland and Johnston 1939, 176; the species was probably *Spondyliaspis eucalypti* Dobson.

Schürmann (1844, 76) reported that worta pala was a "small obnoxious insect" (worta = stump or stem); in view of the scanty information, it is not possible to suggest any identification, unless it be some kind of plant bug.

Coleoptera

Pan beetle—Howitt (1904, 91) called the species *Helaeus perforatus*. This Tenebrionid was reported by Howitt (1904) as a totem animal, dokubirabira D (p. 91), Yu (92), N (94), Ya (95), and amongst tribes north-easterly, and easterly from Lake Perigundi along the Cooper (96). *Helaeus perforatus* Latr. is the type of the genus and was described from King George's Sound, Western Australia, according to Masters (P.L.S., N.S.W., **11**, 1886, 324). Macleay did not mention it but stated that most known species occurred in Western, South and Central Australia and were generally inhabitants of the dry, barren plains of the far interior (P.L.S., N.S.W., **12**, 1887, 514). Blackburn (Trans. Roy. Soc. S. Aust., **23**, (1), 1899, 35-41) referred to the various species, including *H. perforatus* and *H. interioris* Macleay, the latter from Central Australia and from the Darling River. Carter (P.L.S., N.S.W., **35**, 1910, 90), whose material was collected at Perth, mentioned the distinguishing characters of *H. perforatus*. Lea (1917) referred to many species of the genus but mentioned only one, *H. interioris* (p. 579, pl. xxxvi, fig. 79), as having been collected in the area by the South Australian Museum Expedition, but the locality was not stated. Blackburn (Horn. Exp. Rep., **2**, 1896, 275) mentioned two species from the Finke

region, but neither of the two referred to above is included. It is almost certain that Howitt's dokubirabira was *Helacus interioris*. Pullipullilbi Pa, beetle, pulli = fat, Schürmann 1844, 60.

Coleopterous larvae—Many of these, more especially those of longicorns and the larger buprestids, are eaten. The various references usually do not distinguish between larvae of beetles and of Lepidoptera; they have been collected into a later part of this paper.

LEPIDOPTERA

White butterfly, *Delias aganippe*; arlevilivili Wp, Hale and Tindale 1925, 58.

Butterfly, kala-pinka-pinka N, W, term obtained at Pandi; pilyilye Pa, Schürmann 1844, 56.

Hawkmoth, *Deilephila livornica*, wulga Wp, Hale and Tindale 1925, 58.

Moth, mi-atta Ka, Wells 1894, 521.

Teara contraria. Bag moth—Caterpillar web, pang-a yakuta N, W, term obtained at Pandi; yakuta N, W = bag. Yet-an-na Ka, Wells 1894, 519, = bag. The common presence of the conspicuous webs or "bags" of this moth on the twigs of *Eucalyptus microtheca*, *Acacia* spp, *Cassia* spp, but rarely on *Eucalyptus rostrata*, was referred to by Spencer (Horn Exp. 1896, 44-46), who published an illustration. We obtained the term wang-ga at Ooldea.

HYMENOPTERA

Native bee, stingless (? *Trigona* spp.), mitji-mitji Nj, muntju-runtju D, both terms also applied to blowfly, muntju = fly, Berndt and Vogelsang 1941, 4.

Teulon (in Curr 1886, 206) mentioned a method used by the Barkinkji (Darling River tribe) for tracking native bees (tintee-noora). Having caught a bee which had settled, a tiny piece of down was attached to its back by using the milky juice of a plant (Euphorbiaceae), and thus the insect would have its flight retarded and would also be more easily seen by the pursuing native in search of honey.

"Hornet," kuyurkuru Pa, Schürmann 1844, 24; same word for dragonfly or stick, kuyuruku — slender.

Iridomyrmex spp. Pissant, urine ant.—Wipa, ngari Wp, Hale and Tindale 1925, 58; kumburunye Pa, kumbu = urine, Schürmann 1844, 20; moonnee, Teulon 1886, 193.

Myrmecia forficata, Bulldog ant—Aldu Wp, Hale and Tindale 1925, 58; ardu Nj, aldu Wp, Berndt and Vogelsang 1941, 4.

Black ant (? *Camponotus* spp.) -Wipa Nj, mirka D, wipa Wp, Berndt and Vogelsang 1941, 4; wipa Pa, ant, Beddome 1886, 133; wipa Pa, Schürmann 1844, 73; mirrka D, Gason 1879, 300; kadlo Pa, a large black species, lion ant, Schürmann 1844, 9 [probably intended for "ant lion" (Neuroptera)].

Other ants—Schürmann (1844, 16) reported the following terms: Karrulyuru Pa; mita Pa, a species whose grubs are eaten (33); manya, mito pulyo Pa, ant grub (27); bokalla, bokalla wipa Pa (3); kuyanna, "male grub" of the mita ant, which is not edible and is separated from the female, bidlyo, by winnowing (pp. 2, 24)—this is probably the species of ant referred to in later paragraphs. Berndt and Vogelsang (1941) mentioned the following: green ant [? *Chalcoponera* sp.], muni Nj; winged ant, wipa Nj, katjiriri D; winged ant-hole, wipa-junta Nj, wipa-wadlju Nj, karjiriri-minka D (minka D, wadlju Nj = hole). Stirling and Waite 1919, 117, toa 22, W, indicated pijara as an ant-hill. Ant, paridan Wo; ant path, paridi kadi Wo (kadi = path or way), Howitt 1904, 792. Merri-ka Ka, Wells 1894, 519 [same term as mirka]. Teeta, Duncan-Kemp 1933, 202; leaves

of a creeping plant (which Johnston and Cleland 1943, 171, suggested might be *Centipeda Cunnghamii* or a *Chenopodium*, 1941, 4) were placed around camps to drive off these little black ants; the term naiari was applied to these ants, as well as to *Moloch horridus* which feeds on them (p. 64).

Mrs. Duncan-Kemp (p. 117) also mentioned that native women collected seed-food (nunta) from ant nests. We observed a similar method at Macdonald Downs, Central Australia. Wheeler described a harvesting ant, *Monomorium* (*Holcomyrmex*) *whitei* from the Musgrave Ranges, and illustrated its "nests" (Trans. Roy. Soc. S. Aust., **39**, 115, 807, pl. lxv). Schürmann (1846; 1879, 214) reported that large white grubs found sparingly in ant hills about September along with the very numerous small red insects were eaten by the Pangkala after having been sorted out by placing the mass (containing earth and insects) on a large piece of bark (yuta) about 4 feet long and 8 to 10 inches wide. The material was thrown up repeatedly and caught in the yuta, which was held in such a way that the heaviest portion became sorted out towards one end, the lightest towards the other, and the grubs in the middle part. These living grubs were then wrapped in a clean dry grass and chewed and sucked until all nutriment was abstracted.

Cudmore (1894, 525) referred to a small horde which lived in the mallee near Popiltah Lake, close to the border between South Australia and New South Wales and just north of the Murray. This horde ate cats, presumably feral, and black scrub kangaroos (*Macropus melanops*) but not rabbits. They also were very fond of "white ants (or ants' eggs)," using a koolamon or sheet of bark about 2 feet long and 6 to 8 inches wide as a kind of sieve for shaking the ants out from the earth; the insects were then slightly roasted by placing the koolamon on the hot ashes. Tindale (1941, 81) mentioned this small group of natives as the Nanja horde (Cudmore had stated that its leader was Nonnia) of the Maraura tribe, which he stated had become extinct.

The two accounts do not quite agree and there could be some doubt whether the insects were termites or true ants. Mr. Womersley suggests that they are more likely to be true ants, the white organisms being the puparia. Taken in conjunction with Schürmann's remarks (1844, 2, 24) earlier in this section, it is practically certain that they all relate to the same kind of ant.

Melophorus inflatus. Honey ant—Honey used by natives in mulga country and commonly called "sugar bag" and "wild honey" (not to be confused with that from native bees, *Trigona* spp., though the same term, according to Mrs. Duncan-Kemp 1933, 96, is applied to both). Kerumba teeta DK, Duncan-Kemp 1933, 259, teeta = ant; nest described; habits p. 260; this name resembles the Aranda term, yarumpa, mentioned by Spencer and Gillen 1899, 186, 657. Judging from a remark by Mrs. Duncan-Kemp (*l.c.*, p. 116) nooroo, the "blubber-like parasitic ant" from the sandhills is probably the same species. The same author (p. 76) mentioned that natives mixed ant-honey with diluted nectar from bauhinias and permitted the mixture to ferment for eight or ten days to produce a semi-intoxicant. Froggatt (Horn Exp. Report, **2**, 1896, 385-392) published an account of the Central Australian species (under the old name, *Camponotus*), and Spencer (1896, 87-88) referred to them. Roth (1897, 93) mentioned other methods of finding honey by the Pittapitta, and stated that green ants were eaten by the Mittakoodi.

Diptera

Mosquito—Curr's correspondents (1886) supplied the following terms: Kunnutyullu Pa. Le Souef and Holden; ooinya A, Todd; ueni A, Warren and Hogarth; kooinyee N, Paull; yoowinya N, Cornish. Koontee Ma, Morton; koonti Wa, Crozier; kunthi Kw, Anon; kondie Ma, Reid; koontie N, Paull — D, Gason; kunti D, Jacobs — Ya, Cornish — Wa, Dewhurst; koonti Ya, Salmon; gunte Ky, Machattie; coontee Wp, Phillipson; oontee Wp, Wills; oondee Wp, Phillipson.

Yoorie Wk, Myles; euric Te, Sullivan and Eglinton. Coolie-coolie K, Kingsmill; gooley-gooley Pa, Green; gooleyrr Ja, Green; oolilie Wp, Gason. Oonawilli B, Sullivan; noonarully Te, Foott. Koioloro Pa, Beddome. Teepa A, Warren. Tudinna A, Jacobs. Pirtipupu W?, Jacobs. Mooroonga Pp, Eglinton. Noka Kg, Ku, Heagney; naka Bi, Curr. Nowwine Nu, Valentine; yuwunu Pa, Le Souef and Holden.

Other references are koontie D, Gason 1879, 287; koonti Ka, Wells 1894, 521; kumu-tyullu Pa, Schürmann 1844, 21. We received the names, kunti N, and winje W, at Pandi.

Horne and Aiston (1924, 9-10) referred to the abundance of mosquitoes in the vicinity of the lagoon at Mungeranie where, according to tradition, a moora, wandering over the earth, came and camped there. The insects were so vicious that he scratched his forehead (mung) until it was sore and to avoid further attacks, sank into the ground—hence the name Mungeranie.

Teulon (1886, 190) mentioned that the Barkindji tribe protected themselves by smoking fires and by daubing their bodies with fish grease.

Sand fly. ? *Culicoides* sp.—Pittaboobaritchana D, Gason 1879, 287; kalalballa Pa, Schürmann 1844, 10. We were informed that it was called pitta-puparitji N, W, at Pandi. Gason (p. 303) referred to punga D, a small fly, hardly discernible, but capable of inflicting a sting as painful as that of a wasp.

Blow fly, probably *Neopollenia stygia* and *Calliphora augur*. Yappo Wp, Green 1886, 126; mitji-mitji Nj, muntju-runtju D, Berndt and Vogelsang 1941, 4 (same term as for a native bee, muntju = fly). We obtained the names koonka-murra N, and murra-multa W, at Pandi. It was termed duboora on Yorke's Peninsula (Kühn 1886, 145).

Fly—The following terms must relate especially to the very common troublesome small black bush-fly, *Musca vetustissima*, though some closely allied, but less common, species would be included. These flies invade the eyes, nose, ears and mouth and readily attack human sores, faeces and food, and are almost certainly responsible for transmission of various disease-producing organisms.

Curr's correspondents (1886) recorded the following names: Ooringoorie N, Cornish; oringore A, Todd; gooingerri Ky, Machattie; wingeroo Wi, Dix; wingorlo Ma, Reid; ngurrinhurri A, Jacobs. Moonchoo Ya, Cornish, D, Gason; muncho Wp, Phillipson D, Jacobs; moonchow N, Paull; moondyoo Ya, Salmon; moonthooan Kg, Heagney; moonan Ku, Heagney — Bi, Curr. Mokinga Te, Foott; mooginger Te, Sullivan and Eglinton; mogundhoo Wk, Myles. Yoorgoori A, Warren and Hogarth. Yapoo Wp, Gason; yappoo Wp, Phillipson [same term recorded above for blow fly]; papou Nu, Valentine; buppa Pa, Green. Dritji W?, Jacobs. Girmun D, Jacobs. Thumpara K, Kingsmill; yoombara Pa, Sawers; yumbera Pa, Beddome; yumbarra Pa, Le Souef and Holden. Ulberu Wa, Crozier — Ma, Morton; ilburroo Wa, Dewhurst. Mooki Pp, Eglinton. Mongi Kw, Anon. Teulon (1886,213) mentioned wing-oroo and mokay as names for the "eye-fly," Barkindji tribe; the insect is *Musca vetustissima*.

Other terms recorded for a fly are yapu Wp, Hale and Tindale 1925, 58; moonchoo Ka, Wells 1894, 520 — D, Gason 1879, 300; muntju D, Berndt and Vogelsang 1941, 4. We received the names muntju N, murri-murri W, for *Musca vetustissima* at Pandi, and munku for it at Ooldea. Yumbarra Pa, "common fly" Schürman 1844, 86, must refer to the latter also.

It is of interest to note that Spencer and Gillen (1899, 648) referred to churinga amunga as a stone churinga (sacred engraved stone or piece of wood) of the fly (amunga; manga of Strehlow 1908, 67, Aranda) totem, used for curing sore eyes. When we were in the Macdonnell Ranges in 1929 we received the term amunga for *Musca vetustissima*, which infests the eyes of those suffering from conjunctivitis.

"Horsefly" (probably Tabanidae)—Kunti Pa; pindapinda, a large species, Schürmann 1844, 21, 57, pinda = slow. Dumboola Kühn 1886, 145. Yorke's Peninsula.

Flesh fly (? *Sarcophaga* spp.)—Kadlarti Pa, flesh-fly, maggot, Schürmann, 1844, 9, kadla = tail. Perhaps the term applies to various blow flies possessing a long ovipositor.

Flies, ? Hippoboscidae *Ornithomyia* sp. seen on a cockatoo were termed paia pulka N, W (paia = bird).

Siphonaptera

Flea (human, presumably *Pulex irritans*)—Yelbi Pa, Schürmann 1844, 83, "natives declared that the fleas were an importation by the whites." Koonkamurra N, W, the same term as that given for a blow fly, was received by us at Pandi as the name applied to a flea whether from man or some other mammal. Teichelmann and Schürmann (1933, 106) reported that the Kaurna called the [human] flea pindi kudlo (*i.e.*, European louse), the Adelaide natives maintaining that the flea was introduced by the whites.

The Pitjandjara and Yankundajara natives in the Musgrave Ranges gave us tildi as the term for flea; we observed *Ctenocephalus canis* and *Echidnophaga myrmecobii* (a native species) on dogs and rabbits there, and the latter on an aborigine.

Insect Larvae

Many grubs or caterpillars are eaten, especially those from the larger moths and beetles. Certain galls are also edible, e.g., mulga "apples" (Howitt 1904, 791, Wo); the gall (cobboboo D) found on the boxtree, *Eucalyptus microtheca,* (Gason 1879, 288).

The term witjeti or witchetty (Spencer and Gillen 1899, 423) is used widely amongst whites for edible grubs. The native seems to have a special name for each kind, as was indicated by Strehlow (1908). Hale and Tindale (1925, 48) stated that the Wailpi recognised three kinds of edible larvae—caterpillars of a large moth, *Xyleutes,* were obtained from the roots of the red gum (wera), *Eucalyptus rostrata;* while larvae of different kinds of longicorn beetles were found in the sapwood of the main trunk and upper branches. They mentioned the name verti Wp, and stated the Wailpi called Mount Padawurta Verti warta and that Padawurta was obviously a corruption of the term (p. 57). There is another explanation, pa-di is a common term in the Eyrean region for grub and is the same as ba-ti (given by Berndt and Vogelsang 1941, 6, as the Ngadjuri word) or bardee (ba-di) of the natives of the Adelaide plains (Teichelmann and Schürmann 1933, 95); wurta means root or base of a trunk, or the thick end (Gason 1879, 306), *e.g.*, tidna wurta = thick end of a foot, *i.e.*, the heel. Verti warta and Padiwurta are thus two terms having the same meaning and apparently referring to the grub-like shape of the peak. This edible grub, wai-api Wp, from the roots of the red gum, was mentioned by Cleland and Johnston 1939, 176, but the same term (wyappi, yai-appi) was also obtained for seeds of trees (yappi = fruit).

Other references are padi D, bulkara bati Ng, grubs from sandalwood. Berndt and Vogelsang 1941, 6; mool-yi Ka, Wells 1894, 520; wakaree Ka, an edible grub from trees, Wells 1894, 517; purdie [pa-di] G, Gason 1879, 287, 303; paddi D. Eylmann 1908, 167;; padi D, totem, Howitt 1891, 138; jadna Nj, kali-bili-bili, panga D, Berndt and Vogelsang 1941, 5; kuyakinka D, grubs from gum trees. M. Howitt 1902, 407; witchetty grubs, Duncan-Kemp 1933, 261. Johnston and Cleland (1943, 154) mentioned that a striped edible grub (padi D, W) occurred in the roots of *Cassia.* Mrs. Duncan-Kemp stated that parootra boonti was a small white edible grub from the wild broombush [probably also a *Cassia* = boonti].

Howitt (1904) mentioned several names, all totemic: muluru (witchetty of Spencer and Gillen) D (p. 91, 799), Ya (95); padi T (800), Wo (95); padinguru Yu (92); paringoro Kd, small grubs from trees (97); wonamara W (92), A (94); maruwali N (94); miri-miri, a maggot, T (800); ngampuru Yu (92). The last-named was called a fish, Ya totem (p. 95); one of these must be an error. Probably the latter is correct, since namba was called a bone-fish, Wilya tribe (p. 98), and paru = fish. Padi D, Fry 1937, 204, grub from grass, is dried and crushed or ground to a powder, this "grub flour" being termed paditurara. Schürmann (1844) reported the following Pangkala names: batta, a kind of grub (p. 2); kullilli, edible grub, of which four kinds were named, kullilli nunma, kullilli patta, kullilli yako and kullilli yulko (p. 20); manna, a ground grub (36); parti, grub, caterpillar (54) [same term, barti, bati, padi, used by tribes to the east and north-east].

MOLLUSCA

Cephalopoda

Nautilus (so called)—Pirra Pa, Schürmann 1844, 57; same term for moon and shell, probably because of the colour. The shell of the local paper nautilus, *Argonauta nodosa*, is sometimes washed ashore on South Australian beaches, and has been illustrated by Cotton, Handbook Mollusca S. Austr., 2, 1940, 464, fig. 450.

Cuttle fish—Yayardlu Pa, Schürmann 1844, 83. Cotton (*loc. cit.*) has illustrated the gladius of the various species of *Sepia* recorded as occurring in South Australian waters.

Gastropoda

"Periwinkle" (from the Georgina, South of Bedourie), accishan Ky, Duncan-Kemp 1933, 45. Probably species of operculate gastropods, *Bythinella* (*Notopala*) or perhaps *Plotiopsis*, since the animals were stated to be snail-like, but with a hard reddish flap over the front. *Bithynia australis* and *Melania balonnensis* (= *Plotiopsis bal.*), widely distributed Australian species, were collected by the Horn Expedition (Tate 1896).

Pelecypoda

Centralhyria stuarti. Freshwater mussel -Usually termed *Unio stuarti*; widely distributed in Central Australia; much appreciated as food by the aborigines. Koorie D, Gason 1879, 287, 289; kuri D, Howitt 1904; koori Ka, Wells 1894, 521; kuri D, T, Stirling and Waite 1919, toa 38, 175, 201. Stones used for cracking shell food were called yerndoo DK (Duncan-Kemp 1933 48). Kuri D, Fry 1937, 201, a flat piece of pearl shell [probably *Melo* or *Meleagrina*].

The shell may be pierced and polished and attached by means of a string (spun from human hair) to the end of the beard, or suspended from the neck (Gason 1879, 289) as an ornament. It is also used to inaugurate the Dieri circumcision ceremony (Gason, *l.c.*, 286; Howitt 1891, 72; 1904, 656), when the shell is suspended around the neck of the one to be operated on. Such a shell was termed coorietoorooka or kuri-turuka by the Wonkanguru (Horne and Aiston 1924, 47, 159). Instead of the local mussel, prepared pieces of marine shell, *e.g.*, from the pearl shell, *Meleagrina* spp., or the large gastropod baler shell, *Melo* spp. (*Cymbium* spp.), are sometimes used. Horne and Aiston's fig. 36 indicates part of a baler shell. Spencer and Gillen (1899, 652) stated that such marine shells were converted into magic articles, lonka-lonka of the Aranda. Howitt (1904, 714) mentioned seeing amongst the Yantruwunta, suspended from the neck, a portion of a large univalve shell [?*Melo*] said to have come from the north. It is of interest to note that the great aboriginal trade route from north-western and west-central Queensland to the Flinders Ranges passed through the Eyrean region, Kopperamanna and Cowarie being very important trading centres before the white occupation of the area. Along this route passed weapons, shields, stone axes, red ochre, pitjuri and such shells as those of *Melo* and *Meleagrina*. Berndt and Vogel-

sang (1941, 8) stated that pearl shell [ornament] was termed makil-a Nj and kaldrati D.

Roth mentioned that *Unio* [*C. stuarti*] was a very common article of diet and recorded several names applied to it by the Western Queensland tribes, the Pitta-pitta and Wonkajera calling it tooroolka and toorooka respectively. Sanger (1883) mentioned the use of these mussels (*Anodon*) as articles of diet by the Dieri.

Fraser (in Curr, 1886, 378) stated that mussel shells, as well as flints, were used (by the Biria tribe) as cutting implements. Machattie (1886, 367) reported that these shells were utilised by the Karanya for scarring the arms and shoulders. They were used by Eyrean tribes for scraping rushes [*Cyperus* spp.] to obtain fibre for making rush string and nets (Horne and Aiston 1924, 62).

Gason (1879, 296) reported that the Dieri called the rainbow koorickirra; kurikirra D, Gatti 1930, 101; no doubt because of the similarity to the iridescence of the inner surface of the mussel shell (kirra = boomerang or curved object). Berndt and Vogelsang (1941, 8) used the same Dieri term, kuri-kir-a, the Ngaduri equivalent being guring-i and the Wailpi, wuranyi.

Ostrea angasi. Oyster—Yallarta Pa, Schürmann 1844, 78. The name is obviously the same as Yalata, the township at Fowler's Bay. It was stated by me that that name was the native term for a mollusc resembling an oyster and occurring abundantly as a fossil near the original homestead of Yalata, and that the term probably applied to the cockle, *Arca trapezia*, which Tate recorded as a common Tertiary fossil there (Johnston, Proc. Roy. Georgr. Soc. S. Aust., **42**, 1941, 41). Since *Ostrea* occurs also in the South Australian Tertiary, my earlier statement must be corrected to apply to *Ostrea*.

Unidentified molluscs.—Schürmann (1844) mentioned the following Pangkala names: markalla, a shell (p. 28); metullu, "a species of shell fish"; metullu pirra, a kind of shell [probably a white shell, pirra = moon or shell] (p. 31); ngarnkidi, a kind of shell used for peeling roots (p. 46); yultunna, shell (p. 86); kundo birra, large shells, spoon (p. 20) [apparently a shell which was used by whites as a ladle or spoon, *e.g.*, a scallop or cockle]. Wilhelmi (1861, 171) reported that the Pangkala carried in their kangaroo-skin bags (nurti) a small shell which served as a drinking vessel.

ANNULATA

Leech (Hirudinea)—Mulu Pa, Schürmann 1844, 34. The species is probably *Limnobdella australis*, which readily attacks human beings.

NEMATODA

Nematodes which were being collected from the stomachs of wallabies in the Flinders Ranges were termed bodlilkalli by the Wailpi. The term probably applies to worms generally.

PORIFERA

Sponges—Schürmann (1844, 59, 82) recorded pulballa and yarruru as Pangkala names for sponges (probably marine). He also stated that munu (p. 36) was a venomous marine animal often found dead on the sea beach; perhaps the Scyphozoon Coelenterate, *Charybdea* sp., may have been the organism, as it is capable of inflicting severe stings if its tentacles should come in contact with people bathing or swimming. It occurs at times in numbers in the two gulfs and has been known to injure people there. *Physalia* is a possibility, but *Charybdea* is more likely to be the culprit.

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THE AUSTRALIAN HOMOCLIME OF THE ZONE OF NATURAL OCCURRENCE OF PARTHENIUM ARGENTATUM

By J. A. PRESCOTT, Waite Agricultural Research Institute

Summary

The desert plant guayule, *Parthenium argentatum* is a native of Mexico and of the "Big Bend" country of Texas. From time to time it has become important as a source of rubber, and for some years efforts have been made in the United States to grow the plant under cultivation, and plantations have been established, particularly in California.

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[Presented 9 September 1943]

The desert plant guayule, *Parthenium argentatum*, is a native of Mexico and of the "Big Bend" country of Texas. From time to time it has become important as a source of rubber, and for some years efforts have been made in the United States to grow the plant under cultivation, and plantations have been established, particularly in California.

The plant is a perennial shrub, native of a semi-arid region with a rainfall of the order of 15 inches. Its edaphic requirements are relatively restricted to well-drained localities. In view of the fact that Australia probably possesses climatic zones parallel to both the natural habitat and the localities of cultivation, it has been thought of interest to attempt an assessment of the Australian regions where climatic conditions similar to those of the natural habitat were likely to be encountered. The main sources of information about the geographical distribution of guayule are to be found in Lloyd's account for the Carnegie Institution of Washington (1911) and in the accounts of the Russian workers Bukasov (1930) and Pissarev (1930). According to the Russian botanical expedition of 1925-1926, the plant is found in the northern part of the State of San Luis Potosi, together with the adjacent districts of the States of Coahuila and Nuevo Leon and the eastern part of Durango. Lloyd gives in some detail the periphery of the area concerned, and Pissarev gives a map which agrees broadly with the information supplied by Lloyd. Lloyd suggests that 10 per cent. only of the area outlined may actually carry guayule. The plant occurs over an altitude range of from 3,000 to 6,000 feet and rarely up to 7,000 feet. The lower altitudes occur at the northern extremity of the zone in Texas and the higher altitudes on the Tropic of Cancer. This association of increasing altitude with approach to the equator results in a relatively narrow temperature range. With respect to detailed climatic information, only for the Texan stations at the northern limit of the habitat are details available (U.S. Yearbook of Agriculture, 1941). For the Mexican habitat the Harvard climatic maps of North America (1936) are the most suitable. Information regarding the soils of Mexico by Rodriguez and Brambila (1937), affords some guide to the environment in so far as the major soil groups mapped are related to climatic conditions.

Additional information of some considerable value is that given by Lloyd on the plant communities to which guayule belongs. Lloyd describes the associations which are dominated by guayule, and certain species of prickly pear are mentioned. In view of the climatic studies on the spread of prickly pear in Australia by Johnston (1924), the association of *Opuntia megalarthra, O. stenopetala, O. microdasys* and *O. imbricata* with *Parthenium argentatum* may afford a useful guide to the probable Australian homocline of its natural habitat. Of these, *Opuntia microdasys* is stated by Johnston to be rather common in parts of the Pilliga district of New South Wales. Dodd (1940) reports that a small patch at Cuttabri was destroyed some years ago. *O. imbricata*, which also occurs in Australia, has a wider geographical range than *O. microdasys*, and is therefore rather less useful as an indicator plant.

In discussing the climatic requirements of a given species of plant it is necessary to take into account temperature as well as rainfall factors, and in the following analysis use has been made of the periodic constants of the temperature:

annual mean, phase and amplitude as recently outlined (Prescott, 1943). For the main zone, values for two only of these—mean temperature and amplitude—were available, but for at least one locality in Texas, Fort Stockton, a full analysis was possible. The rainfall regime is one of summer maximum with a very dry winter. It can be expected that guayule will grow in summer and be dormant in winter in its native habitat.

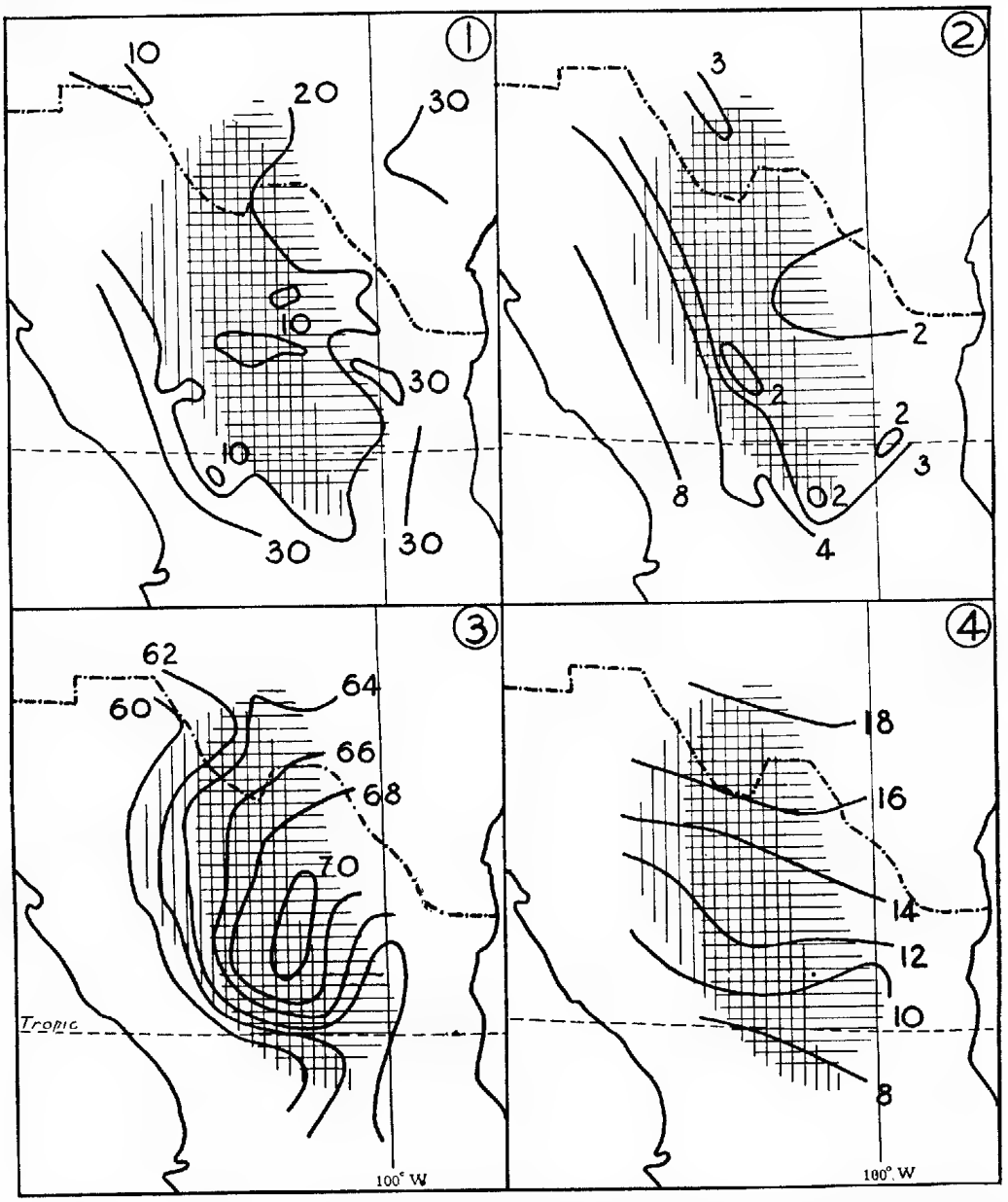

Fig. 1 Maps of the climatic conditions in the zone of natural occurrence of *Parthenium argentatum* in the United States and Mexico. The vertical shading indicates the area according to Lloyd, the horizontal shading according to Pissarev.

1 Annual rainfall, in inches.
2 July rainfall, in inches.
3 Mean annual temperature (°F).
4 Amplitude of temperature, calculated as half the range.

The data are taken from the Harvard Climatic Maps of North America.

The essential data on which the present analysis is based are given in a group of six maps presented in fig. 1 and 2.

A more detailed examination of the rainfall data, given by the Harvard maps for alternate months, indicates that along the eastern margin rather more than 70 per cent. of the rain falls in the summer and autumn months of June to November, with probably as much as 90 per cent. falling in this period along the western margin. The total annual rainfall has a range of from 10 to 20 inches.

The ratios of rainfall to saturation deficit calculated for the mid-summer month July indicate conditions of a semi-arid nature. In Australia a ratio of 5 marks the approximate limit of arid conditions for any given month (Prescott, 1936). The mean annual temperature of the zone varies from 61° F. to 70° F., and the amplitude varies from 18° F. in the north to 8° F. in the south.

The next step in the analysis was to superpose the two sets of lines representing mean temperature and amplitude on the map of the natural guayule zone as given in fig. 1 (3) and (4). Each point of intersection gives a combination of mean and amplitude which could in nearly all cases be matched in Australia, and the corresponding point was plotted on a map of Australia. The temperature zone of the natural habitat can thus be paralleled with respect to at least two characteristics, and this is illustrated in fig. 4. There remains the search for parallel rainfall conditions. The limits sought were those of Australian seasonal rainfall of between 10 inches and 15 inches falling in the months November to April. The appropriate combinations of rainfall and temperature are to be found to the north-

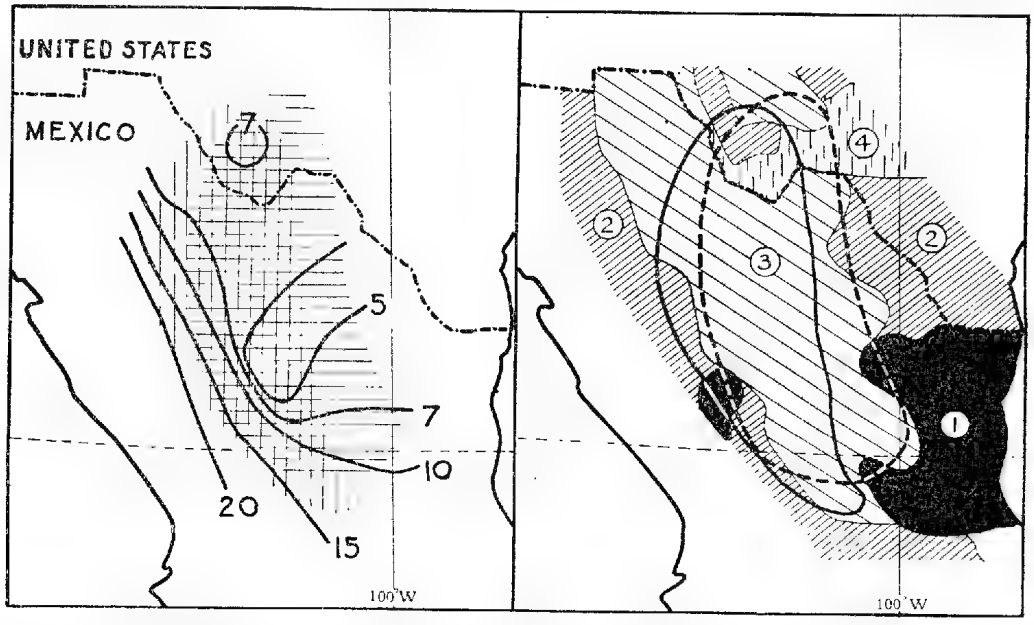

Fig. 2 Maps of the July climate and soil zones in the area of occurrence of *Parthenium argentatum* in the United States and Mexico. The shading in the left hand diagram is as in Fig. 1. In this diagram are given the lines of equal value for the ratio of rainfall to saturation deficit for the month of July. The right-hand map is compiled from Mexican and United States sources and indicates the major soil zones of the area. The continuous line represents the boundary according to Lloyd and the broken line according to Pissarev.

The soil zones are: (1) Black earths and rendzinas.
(2) Reddish-brown and chestnut soils.
(3) Grey, brown and red soils of arid regions.
(4) Shallow and stony soils.

The shallow and stony soils no doubt extend into zone (3) in Mexico.

west of the western slopes of New South Wales, extending into Queensland in the general direction of Charleville and Blackall. In Table I are recorded the climatic data for stations in this Australian region. The winter rainfall is higher than for corresponding localities in Mexico and Texas and favourable conditions may extend somewhat into the more arid regions.

TABLE I

CLIMATIC DATA FOR STATIONS IN THE SUGGESTED AUSTRALIAN HOMOCLIME OF THE ZONE OF NATURAL OCCURRENCE OF PARTHENIUM ARGENTATUM

	Rainfall November to April ins.	Rainfall Annual ins.	Temperature Mean °F.	Temperature Amplitude °F.	Ratio of rainfall to saturation deficit for January
Goondiwindi	14·9	24·8	67·5	13·8	6·5
Roma	14·7	23·4	68·4	14·1	6·5
St. George	12·3	20·1	68·8	15·3	4·8
Bollon	11·1	18·1	68·8	15·1	4·1
Collarenebri	10·9	18·5	68·5	15·3	3·4
Coonamble	10·8	19·2	66·8	15·3	3·8
Gilgandra	12·2	22·7	63·2	15·1	4·7
Mungindi	12·1	19·9	67·9	14·4	—
Walgett	10·2	18·0	67·7	15·9	3·8
Moree	13·4	22·9	67·5	14·8	5·0
Narrabri	14·6	25·7	66·6	15·8	4·8
Gunnedah	13·1	23·4	64·7	15·4	4·4
Tamworth	14·9	26·6	63·2	14·2	6·0
Jerry's Plain	14·8	25·2	64·4	12·9	6·5
Dalkeith	13·2	23·7	60·1	13·3	7·3
Mudgee	12·8	25·3	59·8	14·0	10·4
Canowindra	10·6	22·0	62·2	15·6	4·4
Dubbo	11·5	22·0	63·7	15·4	6·1
Parkes	10·4	21·1	63·7	14·3	4·5
Wellington	11·5	22·7	62·4	14·9	4·3
Marsden	10·0	20·1	62·0	16·0	4·3

Confirmatory evidence may be obtained by examining the climatic records for Texas. The data for Fort Stockton, Texas, may be regarded as of some importance, as this station marks the northern limit of the zone. These are given below:

TABLE II

CLIMATIC DATA FOR FORT STOCKTON, TEXAS

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Temp. °F	46·5	50·5	57·9	64·7	73·5	79·9	81·2	79·8	73·9	64·9	54·1	46·4
Rainfall (ins.)	00·47	0·64	0·47	1·04	1·69	1·54	1·87	1·77	2·37	1·36	0·76	0·69

Annual rainfall	14·66 inches
Seasonal rainfall—May to October	10·60 inches
Mean annual temperature	64·4° F.
Temperature phase (lag behind solar radiation)	23·8 days
Temperature amplitude	17·5° F.

We may now proceed to determine as nearly as possible an Australian homoclime for Fort Stockton. The highest temperature amplitude in Australia is just over 16° F., so that an exact parallel is hardly to be found, but combinations of a mean of 64·4° F. with amplitudes of 15° F. and over are available. In view of the fact that Fort Stockton has a summer rainfall, it is only on the eastern side of Australia that an appropriate combination of rainfall and temperature is likely to be found.

On the map of New South Wales, illustrated in fig. 3, are projected the isopleths for appropriate climatic constants. An intersection of the lines for the appropriate mean temperature and phase with an amplitude of 15° F. occurs near

Hillston, while there is a further series of approaches near Narrabri and Gunnedah. The intersection with the appropriate summer rainfall of 10·6 inches indicates that the homoclime of Fort Stockton can be reasonably represented by an area in the vicinity of Coonamble. The three last-named stations in New South Wales occur within the zone of parallel temperature and moisture conditions as given in fig. 4.

Finally, the evidence with respect to the recorded behaviour of prickly pear in Australia was examined. A number of species of *Opuntia* appeared to be of possible significance. These are *Opuntia lindheimeri, O. streptacantha, O. pachona,*

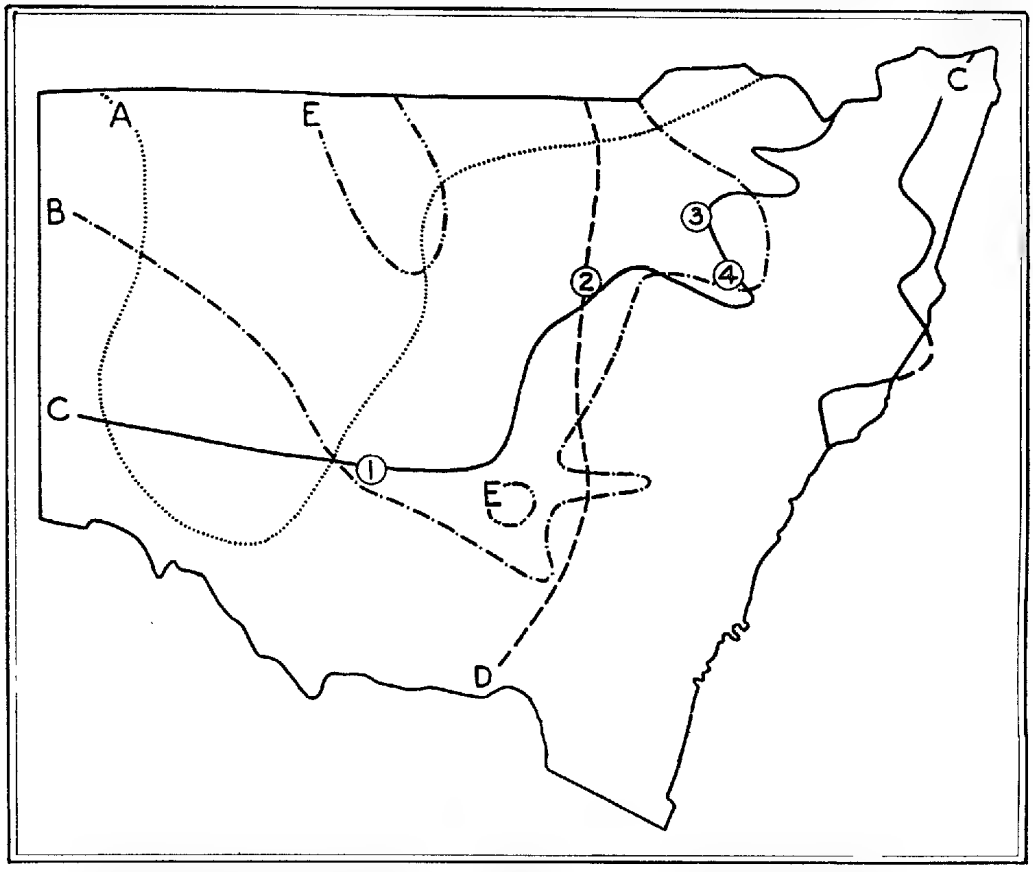

Fig. 3 Map of New South Wales on which are projected isopleths for the following climatic characteristics approximating to those of Fort Stockton, Texas.

A Temperature phase: 23·8 days lag behind solar radiation.
B Temperature amplitude: 15° F.
C Mean annual temperature: 64·4° F.
D Warm season rainfall: 10·6 inches.
E Temperature amplitude: 16° F.

Australian localities sharing some of these characteristics are:

(1) Hillston, (2) Coonamble, (3) Narrabri, (4) Gunnedah.

The characteristics for the five stations concerned are:

	Temperature			Rainfall	
	Mean annual °F.	Amplitude °F.	Phase days	Total annual ins.	Summer season ins.
Fort Stockton, Texas ...	64·4	17·5	23·8	14·7	10·6
Coonamble, N.S.W. ...	66·8	15·3	24·7	19·2	10·8
Narrabri, N.S.W.	66·6	15·8	24·4	25·7	14·6
Gunnedah, N.S.W. .	64·7	15·4	26·6	23·4	13·1
Hillston, N.S.W.	64·0	15·4	24·6	14·1	6·2

O. tomentosa, O. rufida, O. imbricata and *O. microdasys.* It has already been indicated that *O. microdasys* is a member of some of the plant communities dominated by *Parthenium argentatum* and that this species of prickly pear has established itself in the Pilliga country of New South Wales. This country lies in the triangle between Coonamble, Gunnedah and Narrabri, localities which have already been noted as having climatic affinities with those of the Texan habitat of

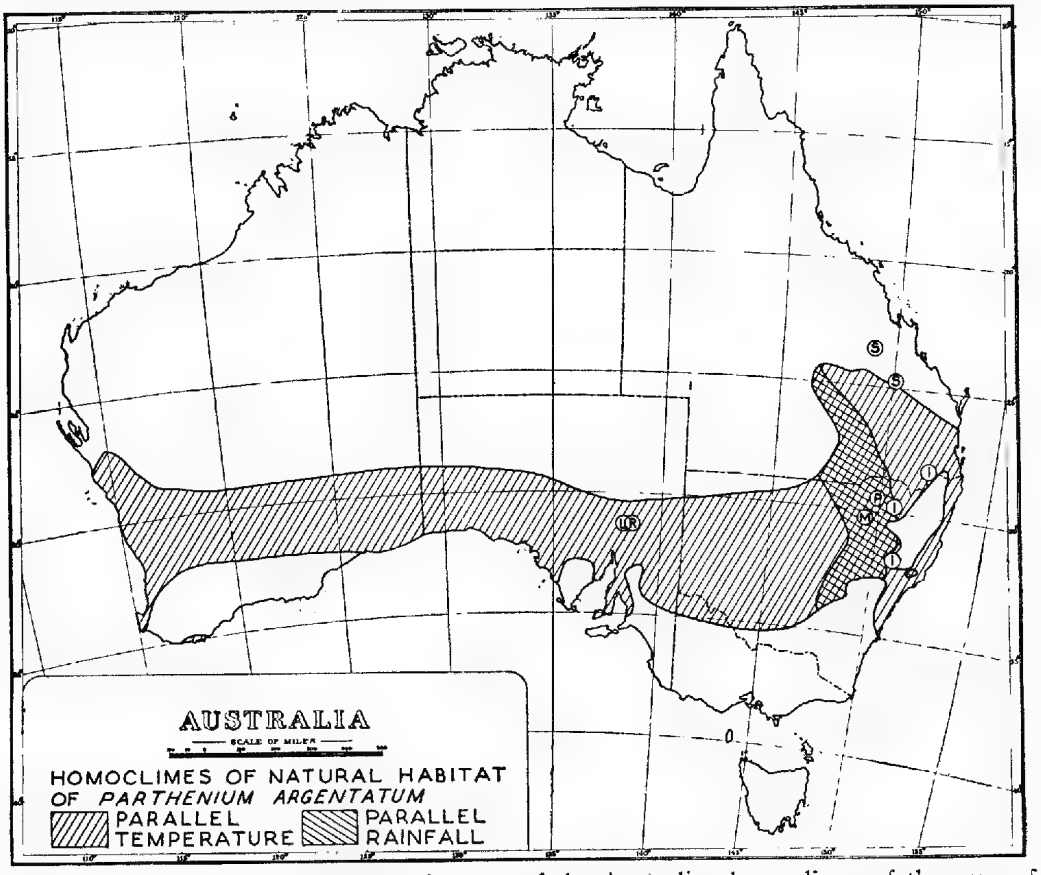

Fig 4 Illustrating the general features of the Australian homoclimes of the zone of natural occurrence of *Parthenium argentatum.* The letters L, R, M, P, I and S indicate the localities of recorded occurrences of species of *Opuntia* of the same or adjacent American zones. L: *O. lindheimeri;* R: *O. rufida;* S: *O. streptacantha;* P: *O. pachona;* I: *O. imbricata;* and M: *O. microdasys.*

guayule. Johnston (1924) suggests that *O. microdasys* would probably continue to thrive northwards from the Pilliga, invading the western portion of the Darling Downs and adjacent plains. He further suggests that this species and *O. imbricata* mentioned below are the two which would be most likely to spread in the region having a rainfall between 10 and 20 inches, received very largely, but not entirely, during summer. His conclusions are thus in keeping with the present conclusions regarding guayule. The publication of Britton and Rose (1919) has been consulted with respect to the other prickly pears of interest in this connection.

Of those which have become acclimatised in Australia, *O. lindheimeri* occurs naturally in south-western Louisiana, south-eastern Texas and Tamaulipas, Mexico, on the more humid lowlands to the east of the zone of guayule. Several clumps of this species are reported to be growing near Parachilna, South Australia.

O. streptacantha is very common on the Mexican tablelands, especially on the deserts of San Luis Potosi. These deserts also form the southern-most range of

the habitat of *Parthenium argentatum*. *O. pachona* is closely related to *O. streptacantha* and may be a race of that species. In Australia *O. streptacantha* is restricted to Central Queensland, from Rockhampton west to Emerald and south towards Camboon. It occurs in dense patches in the Dingo Blackwater section and in the Banana district. *O. pachona* has been reported in the Moree district of New South Wales, where a large plant was destroyed some years ago.

O. tomentosa is also a native of Central Mexico, but as it is a very widely spread cultivated form, its original home is not recorded within narrow limits. In Australia this species has become thoroughly acclimatised in an area 240 miles wide between Rockhampton and Emerald.

O. rufida occurs in Texas and northern Mexico. The type locality, Presidio del Norte, is within the zone of *Parthenium argentatum*. Presidio has, however, the low annual rainfall of 7·8 inches. *O. rufida* is said to occur in patches near Blinman, South Australia.

Opuntia imbricata occurs from Central Colorado to Texas, New Mexico and central Mexico. The plant is hardy in south-western Kansas. It obviously has a wider range than many of the other species of *Opuntia* introduced into Australia. It is one of the species associated with guayule in its native habitat. In Australia it occurs at Warwick, Queensland, in several districts (Sofala, Murrurundi, Warialda, Scone) of New South Wales and in South Australia. These stations are on the wetter side of the homoclime for guayule as given in fig. 4. The information concerning the distribution of these species in Australia has been entered on the map of fig. 4. The only reported occurrence which is difficult to explain is that of *O. lindheimeri* at Blinman in South Australia.

Summary

From an examination of the climatic data available for the Texan and Mexican zones of occurrence of *Parthenium argentatum* (guayule), it is suggested that the Australian homoclime, including temperature and seasonal rainfall conditions, is to be found in an area extending from the western slopes of New South Wales in the general direction of Charleville and Blackall in Queensland. The suggestion is supported by the recorded behaviour of certain species of *Opuntia* which have become established in Australia.

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A NEW SPECIES OF LAGORCHESTES (MARSUPIALIA)

By H. H. FINLAYSON

Summary

Lagorchestes asomatus n. sp.

External characters unknown; size, judged by the skull of the aged type, considerably smaller than in *L. hirsulus*, therefore the smallest of the genus.

A NEW SPECIES OF LAGORCHESTES (MARSUPIALIA)

By H. H. Finlayson

Plates XXXIII and XXXIV

[Presented 9 September 1943]

Lagorchestes asomatus n. sp.

External characters unknown; size, judged by the skull of the aged type, considerably smaller than in *L. hirsutus*, and therefore the smallest of the genus.

The species, which is founded upon the cranial characters of a single aged example of unknown sex, is sharply distinguished from other members of the genus by its enormous auditory bullae, and the great reduction of the premaxilliary region and the incisor dentition. It is nearest to the Central Australian forms of *L. hirsutus* Gould, with which species comparison is chiefly made in the ensuing description.

Cranial form typically lagorchestine in its shortness and great breadth, and in the extreme height of the skull posteriorly, leading to a characteristic rapidly tapering, wedge-shaped outline. The upper profile descends more abruptly from the vertex to the nares and lambda, than in *hirsutus*.

Muzzle region shorter than in *hirsutus* and differing further in the exaggerted lateral expansion of the proximal maxilliary portion, and the reduction both in width and depth of the distal premaxilliary segment. The nasals are similar to those of *hirsutus* but are narrower anteriorly and more expanded posteriorly, though the latter is by no means commensurate with the expansion of the underlying muzzle. They terminate in a short, blunt point which overreaches the naso premaxillary junction by only 2 mm. and coincides in dorsal view with the gnathion below. The surface of the nasals is almost flat throughout and their junction with the walls of the muzzle sharp and angular. In lateral view also the muzzle is very different from *conspicillatus* or *hirsutus* in its rapidly tapering form, the depth at I^3 being scarcely half that at the anteorbital foramen. The infranasal spur is almost absent from the premaxillae.

The interorbital region with its edges thin and sharp at the constriction and tapering posteriorly more rapidly than in *hirsutus*, almost as in *conspicillatus*. The constriction narrower than in the central race of *hirsutus* but equalled by the insular *dorreae*. The area is decidedly concave, but the hollow does not extend to the posterior nasal region, as in the other species.

The zygomatic outline as seen from above is very broad, the ratio, greatest breadth/basal length = ·73 as in the widest skulls of *conspicillatus*. The anterior and posterior angles about as in *hirsutus*, but the maximum width still more posterior and the terminal posterior width markedly greater than the anterior, and the shape correspondingly different and nearer the average condition of *Thylogale*. The individual zygomata are stouter than in *hirsutus*, especially the squamosal element; the infrazygomatic process is equally large and is contributed chiefly by the maxilla. On the wall of the orbit, the lacrymal is narrower.

The braincase much as in *hirsutus* but its surface more rugose and pitted, and the vault decidedly lower.

The occipital area is broad and low to a greater degree than in any of the other species and resembles the *Petrogale* condition at its maximum. The paraoccipital process upright, not recurved terminally as in *hirsutus*, and almost com-

pletely merging with the bulla anteriorly. Tympanic annulus very large and the free margin of the mastoid curved forward parallel to its lower border.

In the palatal aspect the anterior foramina are longer than in *hirsutus*. The palate is reduced anteriorly and is widest in its midlength. There are two large reniform vacuities, each 11 x 5 mm. ca., extending to within 3 mm. of the posterior margin and the space behind them is almost complete, not multi-perforate as in *hirsutus*. Posterior and anterior nares both narrower and shallower.

The parapterygoid fossa very deep and well defined but reduced to a mere crescentic slit by the encroachment of the bullae; the ectopterygoid ridge unusually well developed and thrust outwards almost at a right angle to the basicranial axis. The alisphenoid bullae enormously inflated, more so than in any other member of the subfamily, and in absolute size exceeded in the Macropodidae only by *B. lesueuri* in the *Potoroinae*. The cubic capacities of the bulla in *B. lesueuri*, the present species, and *L. hirsutus*, are in the approximate ratio 334 : 236 : 81, and if allowance is made for the small size of the skull of the new species, the disparity between the first two volumes is considerably decreased.

The mandible presents an extreme phase of the lagorchestine trends towards shortened horizontal body of the ramus and lengthened ascending portion, the vertical height of the coronoid margin considerably exceeding the length of the body from the base of the coronoid to the incisor alveolus. Symphysis short and inferior dental foramen very small as in *hirsutus;* masseteric foramen smaller; condyle round and larger.

Dentition

Upper incisors remarkable for their very small size, the antero-posterior length of the series 5·3 mm. as against 7-7·5 mm. in *hirsutus* of similar wear; the teeth much worn but apparently similarly proportioned and disposed in the premaxillae. Canine about 2 mm. long, rooted just posterior to the suture and lying nearly prone upon the diastemal margin and probably functionless. P^4 an extremely large tooth, 6·3 mm. long as against 4·8-5·1 mm. in similarly worn *hirsutus;* too worn for the finer details of structure to be made out, but clearly of the same general type as in *conspicillatus* and *hirsutus*, *e.g.*, parallel-sided, scarcely wider posteriorly than distally, a well-marked talon and internal ledge running the whole length of the tooth, a fossette on its posterior margin, a blade showing vestiges of four shallow vertical grooves externally and a continuous trenchant edge lying buccal to the midline of the tooth. The forward drift of the cheek teeth with advancing age (unusually marked in *Lagorchestes*) reaches a maximum in this species, P^4 occupying a position nearly 4 mm. anterior to its point of eruption; the P^4-I^3 diastema is thereby reduced to 7 mm., little more than the length of the former tooth.

The molar rows are nearly as long as in the decidedly larger *hirsutus* skull, and the individual teeth are somewhat heavier. The crown pattern, so far as it can be made out, is similar, but the tooth rows are more arched and the anterior members project laterally beyond the alveolar margin to a much greater extent and their outer cusps are plainly visible, in dorsal view projecting beyond the walls of the muzzle. Both the latter features are probably accentuated by the age of the skull and the forward drift of the cheek teeth, above mentioned.

The lower incisors are much reduced (though relatively less so than the upper); narrow, delicate and nearly parallel-sided in their mid-course. Lower P_4 4·9 mm.; without talon or ledge but with four shallow grooves on both surfaces. Lower molars much narrower than upper; relatively more so than in *hirsutus*.

Dimensions

Greatest length, 65·8; basal length, 58·7; zygomatic breadth, 42·9; nasals: length, 27·6; nasals: greatest breadth, 9·9; nasals: least breadth, 4·3; nasals:

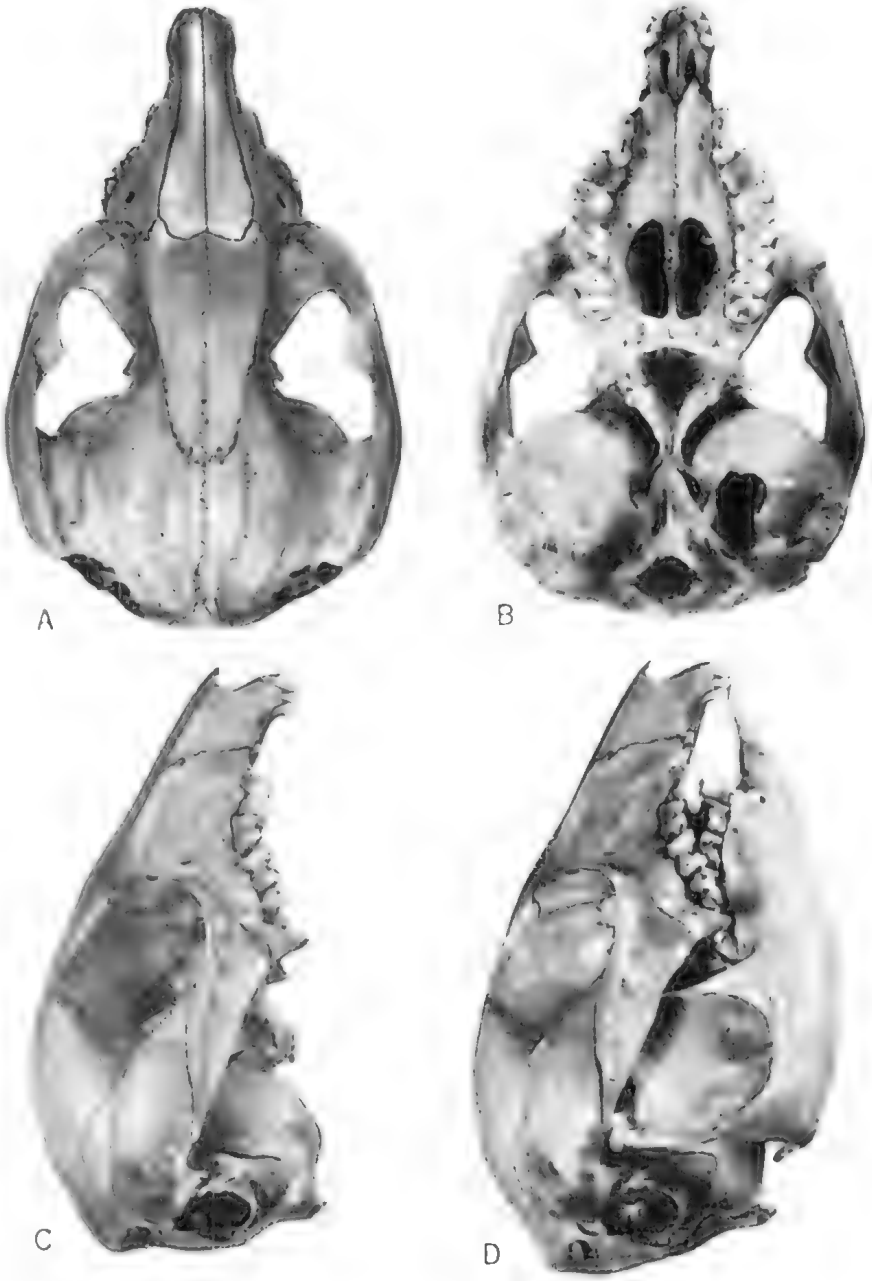
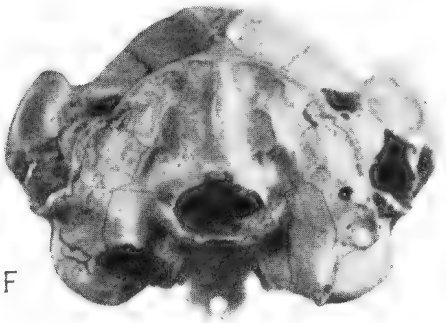


Photo by H. H. Finlayson

Fig. A, B, C—Dorsal, palatal, lateral aspects of skull of **Lagorchestes asomatus** sp. nov. (x 1·1 ca.).

Fig. D—Lateral aspect of same with mandible *in situ* (x 1·1 ca.).



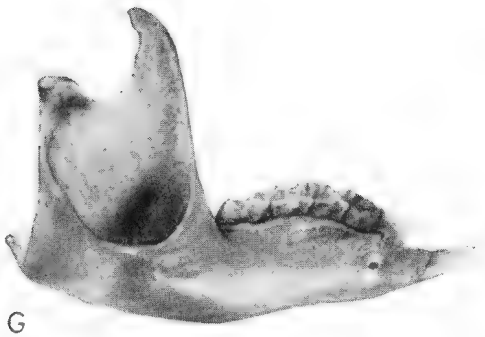


Photo by H. H. Finlayson

Fig. E, F—Anterior and posterior aspects of skull of **Lagorchestes asomatus** sp. nov. (x 1·2 ca.).

Fig. G, H—Lateral and posterior aspects of mandible of same (x 1·2 ca.).

overhang, 2·2; depth of muzzle,[1] 9·7; constriction, 9·6; palate: length, 36·7; palate: breadth inside M^2, 11·2; anterior palatal foramen, 4·0; diastema, 7·1; bulla, 14·4 x 14·0; basicranial axis, 21·5; basifacial axis, 39·5; facial index, 183; mandible: greatest length, 45·0; mandible: greatest breadth, 41·9; mandible: greatest perpendicular height, 30·5; antero posterior length of upper incisors (worn), 5·3; P^4, 6·3 x 2·3; M^{s1-3}, 13·2; M^{s1-4}, 19·0; M^1, 5·7 x 5·2; lower I_1, 9·2 x 2·6.

Type.—Aged skull of unknown sex. South Australian Museum Registered Number, M3710. Collected by Michael Terry between Mount Farewell and Lake Mackay in Central Australia, at longitude 129° 30′ east and latitude 22° 15′ south approx. The animal was taken in the flesh, but only the skull preserved.

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[1] At anterior margin of P^4.

ROYAL SOCIETY OF SOUTH AUSTRALIA (INCORPORATED).

Receipts and Payments for the Year ended September 30, 1943.

ROYAL SOCIETY OF SOUTH AUSTRALIA (INCORPORATED)

Receipts and Payments for the Year ended 30 September 1943

RECEIPTS

	£	s.	d.	£	s.	d.
To Balance, 1st Oct. 1942				236	3	1
„ Subscriptions				133	7	0
„ Government Grant for Printing, etc. . . .				300	0	0
„ Sale of Publications and Reprints:—						
University of Adelaide	55	11	8			
Sundries	29	10	8			
				85	2	4
„ Use of Room . .	5	2	0			
Exchange ...	–	2	0			
				5	4	0
„ Interest — Transferred from Endowment Fund				196	12	8
				£956	9	1

PAYMENTS

	£	s.	d.	£	s.	d.
By Transactions (Vol. 66, Pt. 2, and Vol. 67, Pt. 1)—						
Printing	430	9	3			
Illustrating	132	4	4			
Publishing	12	3	6			
				574	17	1
„ Reprints				77	15	10
„ Librarian				35	14	0
„ Library—Bookbinding ..				58	0	0
„ Sundries—						
Lighting	4	2	0			
Printing, Postages and Stationery .	29	2	7			
Petties, Bank Fee, etc.	4	17	6			
Insurances	6	5	0			
				44	7	5
„ Balances—30 Sep. 1943—						
Savings Bank of S.A.	138	3	7			
Bank of Aust. £27 9 1 *Less* Outstanding Chqs. 4 13 11	22	15	2			
Cash at Bank	4	16	0			
				165	14	9
				£956	9	1

ENDOWMENT FUND as at 30 September 1943

(Capital—Stocks, etc., Face Value, £5,960; Cost, £5,821 4s. 10d.)

	£	s.	d.	£	s.	d.
1942—October 1						
To Balance—						
Aust. Inscribed Stocks	5,762	0	0			
Savings Bank of S.A.	36	6	1			
				5,798	6	1
„ Capital Increment— Conversion of Stock				22	18	9
„ Interest—						
Inscribed Stocks	190	11	6			
Savings Bank of S.A.	6	1	2			
				196	12	8
				£6,017	17	6

	£	s.	d.	£	s.	d.
1943—September 30						
By Revenue Account				196	12	8
„ Balance—						
Aust. Inscribed Stocks	5,812	0	0			
Savings Bank of S.A. ..	9	4	10			
				5,821	4	10
				£6,017	17	6

Audited and found correct. We have verified the Government Stocks at the Registry of Inscribed Stock, Adelaide, and the respective Bank Balances.

O. GLASTONBURY, F.A.I.S., A.F.I.A. } Hon.
F. M. ANGEL } Auditors

HERBERT M. HALE,
Hon. Treasurer

Adelaide, 12 October 1943

AWARDS OF THE SIR JOSEPH VERCO MEDAL

LIST OF FELLOWS, MEMBERS, ETC.
AS ON 30 SEPTEMBER 1943

Those marked with an asterisk (*) have contributed papers published in the Society's Transactions.
Those marked with a dagger (†) are Life Members.
Any change in address or any other changes should be notified to the Secretary.
Note - The publications of the Society are not sent to those members whose subscriptions are in arrear.

AWARDS OF THE SIR JOSEPH VERCO MEDAL

1929 Prof. Walter Howchin, F.G.S.
1930 John McC. Black, A.L.S.
1931 Prof. Sir Douglas Mawson, O.B.E., D.Sc., B.E., F.R.S.
1933 Prof. J. Burton Cleland, M.D.
1935 Prof. T. Harvey Johnston, M.A., D.Sc.
1943 Herbert Womersley, A.L.S., F.R.E.S.

LIST OF FELLOWS, MEMBERS, ETC.

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Note—The publications of the Society are not sent to those members whose subscriptions are in arrear.

Date of Election

Honorary Fellows.

1926. *Chapman, F., A.L.S., "Hellas," 50 Stawell Street, Kew E 4, Victoria.
1894. *Wilson, Prof. J. T., M.D., Ch.M., F.R.S., Cambridge University, England.

Fellows.

1935. Adam, D. B., B.Agr.Sc., Waite Institute (Private Mail Bag), Adelaide -**Council,** 1939-42; **Vice-President,** 1942-; **Librarian,** 1942-.
1927. *Alderman, A. R., Ph.D., M.Sc., F.G.S., Div. Econ. Chemistry, C.S.I.R., Box 4331, G.P.O., Melbourne, Victoria—**Council,** 1937-42.
1931. Andrew, Rev. J. R., 5 York Street, Henley Beach, S.A.
1935. *Andrewartha, H. G., M.Agr.Sc., Waite Institute (Private Mail Bag), Adelaide.
1935. *Andrewartha, Mrs. H. V., B.Agr.Sc., M.S., 29 Claremont Avenue, Netherby, S.A.
1929. Angel, F. M., 34 Fullarton Road, Parkside, S.A.
1939. *Angel, Miss L. M., M.Sc., University, Adelaide.
1936. Barrien, Miss B. S., M.Sc., University, Adelaide.
1932. Begg, P. R., D.D.Sc., L.D.S., Shell House, 170 North Terrace, Adelaide.
1939. *Berndt, R. M., 5 Prescott Terrace, Rose Park.
1928. Best, R. J., M.Sc., F.A.C.I., Waite Institute (Private Mail Bag), Adelaide.
1940. Birch, L. C., B.Agr.Sc., M.Sc., Waite Institute (Private Mail Bag), Adelaide.
1934. Black, E. C., M.B., B.S., Magill Road, Tranmere, Adelaide.
1907. *Black, J. M., A.L.S., 82 Brougham Place, North Adelaide—**Verco Medal,** 1930; **Council,** 1927-1931; **President,** 1933-34; **Vice-President,** 1931-33.
1940. Bonython, Sir J. Lavington, 263 East Terrace, Adelaide.
1923. Burdon, R. S., D.Sc., University, Adelaide, S.A.
1922. *Campbell, T. D., D.D.Sc., D.Sc., Dental Dept., Adelaide Hospital, Adelaide—**Council,** 1928-32, 1935, 1942-; **Vice-President,** 1932-34; **President,** 1934-35.
1929. Christie, W., M.B., B.S., Education Department, Adelaide—**Treasurer,** 1933-8.
1895. *Cleland, Prof. J. B., M.D., University, Adelaide—**Verco Medal,** 1933; **Council,** 1921-26, 1932-37; **President,** 1927-28; 1940-41; **Vice-President,** 1926-27, 1941-42.
1929. Cleland, W. P., M.B., B.S., M.R.C.P., Dashwood Road, Beaumont.
1930. *Colquhoun, T. T., M.Sc., Waite Institute (Private Mail Bag), Adelaide—**Secretary,** 1942-43.
1938. *Condon, H. T., S.A. Museum, Adelaide.
1907. Cooke, W. T., D.Sc., A.A.C.I., University, Adelaide—**Council,** 1938-41, **Vice-President,** 1941-42.
1942. Cooper, H. M., 51 Hastings Street, Glenelg, S.A.
1929. *Cotton, B. C., S.A. Museum, Adelaide.
1924. de Crespigny, Sir C. T. C., D.S.O., M.D., F.R.C.P., 219 North Terrace, Adelaide.
1937. *Crocker, R. L., M.Sc., Waite Institute (Private Mail Bag), Adelaide—**Secretary,** 1943-
1929. *Davidson, Prof. J., D.Sc., Waite Institute (Private Mail Bag), Adelaide—**Council,** 1932-35; **Vice-President,** 1935-37, 1938-39; **President,** 1937-38; **Rep. Fauna and Flora Board,** 1940-.
1927. *Davies, Prof. E. H., Mus.Doc., The University, Adelaide.

Date of Election.

1941. *Dickinson, S. B., B.Sc., Mines Department, Flinders Street, Adelaide.
1930. Dix, E. V., Hospitals Department, Adelaide, S.A.
1932. Dunstone, H. E., M.B., B.S., J.P., 124 Payneham Road, St. Peters, Adelaide.
1921. Dutton, G. H., B.Sc., 12 Halsbury Avenue, Kingswood, Adelaide.
1931. Dwyer, J. M., M.B., B.S., 25 Port Road, Bowden. (A.I.F. abroad.)
1933. *Eardley, Miss C. M., B.Sc., Waite Institute (Private Mail Bag), Adelaide.
1902. *Edquist, A. G., 19 Farrell Street, Glenelg, S.A.
1938. *Evans, J. W., M.A., D.Sc., Government Entomologist, Hobart, Tasmania.
1917. *Fenner, C. A. E., D.Sc., 42 Alexandra Av., Rose Park, Adelaide—**Council**, 1925-28; **President**, 1930-31; **Vice-President**, 1928-30; **Secretary** 1924-25; **Treasurer**, 1932-33; **Editor**, 1934-37.
1935. *Fenner, F. J., M.B., B.S., 42 Alexandra Avenue, Rose Park. (A.I.F. abroad.)
1927. *Finlayson, H. H., 305 Ward Street, North Adelaide—**Council**, 1937-40.
1923. *Fry, H. K., D.S.O., M.D., B.S., B.Sc., F.R.A.C.P., Town Hall, Adelaide **Council**, 1933-37; **Vice-President**, 1937-38, 1939-40; **President**, 1938-1939.
1932. *Gibson, E. S. H., B.Sc., 297 Cross Roads, Clarence Gardens, Adelaide.
1935. *Glastonbury, J. O. G., B.A., M.Sc., Dip.Ed., Armament School, R.A.A.F., Hamilton, Victoria.
1919. †Glastonbury, O. A., Adelaide Cement Co., Grenfell Street, Adelaide.
1927. Godfrey, F. K., Robert Street, Payneham, S.A.
1935. †Goldsack, H., Coromandel Valley.
1939. Goode, J. R., B.Agr.Sc., Waite Institute (Private Mail Bag), Adelaide. (A.I.F. abroad.)
1925. †Gosse, J. H., Gilbert House, Gilbert Place, Adelaide.
1910. *Grant, Prof. Kerr, M.Sc., F.I.P., University, Adelaide.
1930. Gray, J. T., Orroroo, S.A.
1933. Greaves, H., Director, Botanic Gardens, Adelaide.
1904. Griffith, H. B., Dunrobin Road, Brighton, S.A.
1934. Gunter, Rev. H. A., 10 Broughton Street, Glenside, S.A.
1922. *Hale, H. M., Director, S.A. Museum, Adelaide—**Council**, 1931-34; **Vice-President**, 1934-36, 1937-38; **President**, 1936-37; **Treasurer**, 1938-.
1939. Harvey, Miss A., B.A., Dequetteville Terr., Kent Town, Adelaide.
1927. Holden, The Hon. E. W., B.Sc., Dequetteville Terrace, Kent Town, Adelaide.
1933. Hosking, H. C., B.A., 24 Northcote Terrace, Gilberton, Adelaide.
1924. *Hossfeld, P. S., M.Sc., 132 Fisher Street, Fullarton, S.A.
1928. Ifould, P., Kurralta, Burnside, S.A.
1942. Jenkins, C. F. H., Department of Agriculture, St. George's Terrace, Perth, W.A.
1918. *Jennison, Rev. J. C., 7 Frew Street, Fullarton, Adelaide.
1910. *Johnson, E. A., M.D., M.R.C.S., "Tarni Warra," Port Noarlunga, S.A.
1921. *Johnston, Prof. T. H., M.A., D.Sc., University, Adelaide—**Verco Medal**, 1935; **Council**, 1926-28, 1940-; **Vice-President**, 1928-31; **President**, 1931-32; **Secretary** 1938-40; **Rep. Fauna and Flora Board**, 1932-39.
1939. †Khakhar, H. M., Ph.D., M.B., F.R.G.S., Khakar Buildings, C.P. Tank Road, Bombay, India.
1933. *Kleeman, A. W., M.Sc., University, Adelaide.
1939. Leask, J. C., A.M.I.E., 9 Buller Street, Prospect, S.A.
1922. Lendon, G. A., M.D., B.S., F.R.C.P., North Terrace, Adelaide. (A.I.F. abroad.)
1930. *Louwyck, Rev. N. H., 85 First Avenue, St. Peters, Adelaide.
1938. *Love, Rev., J. R. B., M.C., D.C.M., M.A., Ernabella, via Oodnadatta, S.A.
1931. *Ludbrook (Mrs. W. V.), N. H., M.A., Elimatta Street, Reid, A.C.T.
1938. Madern, C. B., B.D.S., D.D.Sc., Shell House, North Terrace, Adelaide.
1922. *Madigan, C. T., M.A., B.E., D.Sc., F.G.S., University of Adelaide—**Council**, 1929-33; **Vice-President**, 1933-35, 1936-37; **President**, 1935-36.
1933. Magarey, Miss K. de B., B.A., B.Sc., 19 Ashbourne Avenue, Mitcham, S.A.
1932. Mann, E. A., C/o Bank of Adelaide, Adelaide.
1923. Marshall, J. C., Mageppa Station, Comaum, S.A.
1939. Marshall, T. J., M.Agr.Sc., Ph.D., Waite Institute (Private Mail Bag), Adelaide.
1929. Martin, F. C., M.A., Technical High School, Thebarton, S.A.
1905. *Mawson, Prof. Sir Douglas, O.B.E., D.Sc., B.E., F.R.S., University, Adelaide—**Verco Medal**, 1931; **President**, 1924-25; **Vice-President**, 1823-24, 1925-26; **Council**, 1941-.
1938. *Mawson, Miss P. M., M.Sc., University, Adelaide.
1926. Mayo The Hon. Mr. Justice, LL.B., K.C., Supreme Court, Adelaide.
1943. McCarthy, Miss D. F., B.A., B.Sc., 70 Halton Terrace, Kensington Park.
1934. McCloughry, C. L., B.E., A.M.I.E. (Aust.), Town Hall, Adelaide.
1929. McLaughlin, E., M.B., B.S., M.R.C.P., 2 Wakefield Street, Kent Town, Adelaide.

Date of Election.

1907. MELROSE, R. T., Mount Pleasant, S.A.
1939. MINCHAM, V. H., Willaloo, via Hallett, S.A.
1925. †MITCHELL, PROF. SIR W., K.C.M.G., M.A., D.Sc., Fitzroy Ter., Prospect, SA.
1933. MITCHELL, PROF. M. L., M.Sc., University, Adelaide.
1938. MOORHOUSE, F. W., M.Sc., Chief Inspector of Fisheries, Flinders Street, Adelaide.
1940. MORTLOCK, J. A. T., 39 Currie Street, Adelaide.
1936. *MOUNTFORD, C. P., 25 First Avenue, St. Peters, Adelaide.
1930. OCKENDEN, G. P., Public School, Norton's Summit, S.A.
1913. *OSBORN, PROF. T. G. B., D.Sc., University, Oxford, England—**Council,** 1915-20, 1922-24; **President,** 1925-26; **Vice-President,** 1924-25, 1926-27.
1937. *PARKIN, L. W., M.A., B.Sc., c/o Nth. Broken Hill Ltd., Box 20 C, Broken Hill, N.S.W.
1929. PAULL, A. G., M.A., B.Sc., Eglinton Terrace, Mount Gambier.
1928. PHIPPS, I. F., Ph.D., B.Agr.Sc., c/o The Flax Production Committee, 409 Collins Street, Melbourne, Victoria.
1926. *PIPER, C. S., D.Sc., Waite Institute (Private Mail Bag), Adelaide—**Council,** 1941-.
1925. *PRESCOTT, PROF. J. A., D.Sc., A.I.C., Waite Institute (Private Mail Bag), Adelaide—**Verco Medal,** 1938; **Council,** 1927-30, 1935-39; **Vice-President,** 1930-32; **President,** 1932-33.
1926. PRICE, A. G., C.M.G., M.A., Litt.D., F.R.G.S., 226 Melbourne Street, North Adelaide.
1942. PUGSLEY, A. T., B.Ag.Sc., M.Sc., Waite Institute (Private Mail Bag), Adelaide.
1937. *RAIT, W. L., M.Sc., Medical School, University of Melbourne, Carlton N. 3, Victoria
1925. RICHARDSON, A. E. V., C.M.G., M.A., D.Sc., 314 Albert Street, East Melbourne.
1933. SCHNEIDER, M., M.B., B.S., 175 North Terr., Adelaide.
1924. *SEGNIT, R. W., M.A., B.Sc., Assist. Govt., Geol., Flinders St., Adelaide—**Secretary,** 1930-35; **Council,** 1937-38; **Vice-President,** 1938-39, 1940-41; **President,** 1939-40.
1925. *SHEARD, H., Nuriootpa, S.A.
1936. *SHEARD, K., Fisheries Research Div. C.S.I.R., Cronulla, N.S.W.
1934. SHINKFIELD, R. C., Salisbury, S.A.
1942. SIMMONDS, H. W., 130 Fisher Street, Fullarton, S.A.
1938. *SIMPSON, MRS. E. R., M.Sc., Warland Road, Burnside.
1924. SIMPSON, F. N., Pirie Street, Adelaide.
1941. SMITH, J. LANGFORD, B.Sc., Waite Institute (Private Mail Bag), Adelaide. (R.A.A.F.)
1942. SNOWBALL, G. J., B.Sc., Waite Institute (Private Mail Bag), Adelaide.
1941. SOUTHCOTT, R. V., M.B., B.S., 12 Avenue Road, Unley Park, S.A.
1936. SOUTHWOOD, A. R., M.D., M.S. (Adel.), M.R.C.P., Wootoona Terr., Glen Osmond, S.A.
1936. *SPRIGG, R. C., B.Sc. (Hons.), "Delamere," Delamere Avenue, Springfield.
1938. *STEPHENS, C. G., M.Sc., Waite Institute (Private Mail Bag), Adelaide.
1935. STRICKLAND, A. G., M.Agr.Sc., 11 Wootoona Terr., Glen Osmond, Adelaide.
1932. SWAN, D. C., M.Sc., Waite Institute (Private Mail Bag), Adelaide—**Secretary,** 1940-42.
1934. SYMONS, I. G., Murray Street, Mitcham.
1929. *TAYLOR, J. K., B.A., M.Sc., Waite Institute (Private Mail Bag), Adelaide—**Council,** 1940-43.
1943. TESCH, J. E., B.Agr.Sc., 3 Mitchell Street, Hyde Park.
1940. THOMSON, J. M., 135 Military Road, Semaphore South.
1923. *TINDALE, N. B., B.Sc., South Australian Museum, Adelaide—**Secretary,** 1935-36. (R.A.A.F.)
1937. *TRUMBLE, PROF. H. C., D.Sc., M.Agr.Sc., Waite Institute (Private Mail Bag), Adelaide.
1894. *TURNER, A. J., M.D., F.R.E.S., Dauphin Terr., Brisbane, Qld.
1925. TURNER, D. C., National Chambers, King William Street, Adelaide.
1933. WALKLEY, A., B.A., B.Sc., Ph.D., Div. Industrial Chemistry, C.S.I.R., Box 4331, Melbourne, Victoria.
1912. *WARD, L. K., B.A., B.E., D.Sc., Govt. Geologist, Flinders Street, Adelaide—**Council,** 1924-27, 1933-35; **President,** 1928-30; **Vice-President,** 1927-28.
1941. *WARK, D. C., M.Agr.Sc., Waite Institute (Private Mail Bag), Adelaide.
1942. WATSON, R. H., Central Wool Committee Testing House, 572 Flinders Lane, Melb., C1.
1936. WATERHOUSE, MISS L. M., 35 King Street, Brighton, S.A.
1939. WEEDING, REV. B. J., Hamley Bridge, S.A.
1931. WILSON, C. E. C., M.B., B.S., "Woodfield," Fisher Street, Fullarton, Adelaide.
1938. *WILSON, J. O., Animal Nutrition Laboratory, University, Adelaide.
1935. WINKLER, REV. M. T., B.A., D.D., 20 Austral Terrace, Malvern, Adelaide.
1930. *WOMERSLEY, H., F.R.E.S., A.L.S., Museum, Adelaide—**Secretary,** 1936-37; **Editor,** 1937-43; **President,** 1943-; **Verco Medal,** 1943.
1923. *WOOD, PROF. J. G., D.Sc., Ph.D., University, Adelaide—**Council,** 1938-40; **Vice-President,** 1940-41; **Rep. Fauna and Flora Board,** 1940-; **President,** 1941-42.

GENERAL INDEX.

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GENERAL INDEX

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CONTENTS

PART I

PART II