VOL. 64 PART 1 26 JULY, 1940

TRANSACTIONS OF THE ROYAL SOCIETY OF SOUTH AUSTRALIA

INCORPORATED

ADELAIDE

PUBLISHED AND SOLD AT THE SOCIETY'S ROOMS
KINTORE AVENUE, ADELAIDE

Price - - One Guinea

Registered at the General Post Office, Adelaide,
for transmission by post as a periodical

VOL. 64 20 DECEMBER, 1940

TRANSACTIONS OF THE ROYAL SOCIETY OF SOUTH AUSTRALIA

INCORPORATED

ADELAIDE

PUBLISHED AND SOLD AT THE SOCIETY'S ROOMS

KINTORE AVENUE, ADELAIDE

Price - - One Guinea

Registered at the General Post Office, Adelaide,
for transmission by post as a periodical

CONTENTS

GEOLOGY OF HALLETT COVE AND DISTRICT WITH SPECIAL REFERENCE TO THE DISTRIBUTION AND AGE OF THE YOUNGER GLACIAL TILL

By RALPH W. SEGNIT, Assistant Government Geologist

Summary

The region to be described is situated about 15 miles in a south-south-westerly direction from Adelaide. Geologically Hallett [(1)] Cove can probably be regarded as being one of the most frequently visited localities in this State, its chief point of interest being in the glacial deposit (and striated bedrock [(2)]), which is generally referred to as being of Permo-Carboniferous age.

TRANSACTIONS OF THE ROYAL SOCIETY
OF SOUTH AUSTRALIA INCORPORATED

GEOLOGY OF HALLETT COVE AND DISTRICT WITH SPECIAL REFERENCE TO THE DISTRIBUTION AND AGE OF THE YOUNGER GLACIAL TILL

By RALPH W. SEGNIT, Assistant Government Geologist

PLATES I TO III

[Read 11 April 1940]

A INTRODUCTION AND PREVIOUS INVESTIGATIONS

The region to be described is situated about 15 miles in a south-south-westerly direction from Adelaide. Geologically Hallett[1] Cove can probably be regarded as being one of the most frequently visited localities in this State, its chief point of interest being in the glacial deposit (and striated bedrock[2]), which is generally referred to as being of Permo-Carboniferous age.

Several papers, but no general detailed geological maps of the region with the written descriptions of the formations, with one exception, have been published describing the features of this till at Hallett Cove. This exception was a small geological sketch map of the coast in the immediate vicinity of Black Cliff[1] (at

[1] See p. 4.

[2] In the discussion which followed the communication and reading of a paper by Jacob H. Lindal, at the meeting of the Geological Society, London, on 7 June 1939. Professor W. W. Watts pointed out that the use of the term "Striated Pavement" in certain recent papers was not in accord with the original definition and with the usage in Scotland, the home of the term. It should be used for striated surfaces in the drift itself and applied to the re-advance of ice over the surface of drift previously deposited (1).

the northern end of the Cove) and the "Amphitheatre," published with the results of the investigations made in the region under review by Tate, Howchin, and David (2). It was prepared for a specific purpose, namely, to prove whether the glacial beds were Pre- or Post-Miocene [3] in age.

A detailed geological map of Hallett Cove and District is therefore essential in order that the relationship of the glacial beds to the underlying and overlying formations may be studied and appreciated in the light of modern knowledge ascertained by the recent researches into the age of the geological formations in South Australia.

One of the most important problems connected with the geology of this region (and elsewhere in this State) is the age of the younger glacial beds present. Definite evidence is desired that may define more accurately the time when the glaciers moved over at least the southern portions of South Australia, and deposited the boulder material. This till has, from its earliest discovery, been regarded as being comparable with the glacial beds of Permo-Carboniferous age in Victoria and Tasmania. The writer proposes to specially discuss its age in relation to the evidence collected as a result of his observations in the region of Hallett Cove and other localities in this State where the younger [4] glacial deposits have been mapped and examined.

The first scientific investigator to recognise the formation as being of glacial origin at Hallett Cove was Tate, in 1887, who considered . . . . That the glaciation was of Post-Miocene age (3, p. 1). Amongst the subsequent investigators the name of Howchin is outstanding, and his published accounts of the till, particularly in the vicinity of Hallett Cove, have appeared in the Transactions of the Royal Society of South Australia (4 to 8). A complete bibliography of Howchin's papers has been published in the Transactions in 1933 (9).

The writer has in this paper, as in all works published by him, sought official sanction for all place names within the area under review. The Director of Lands has intimated that the following names have been approved by the Nomenclature Committee:

"Hallett's" Cove, to be known as Hallett Cove.

Black Cliff—was formerly referred to as "Black Point."

Hallett Creek—constantly referred to as the "Field River," particularly by Howchin: 4, p. 64; 5, p. 284; 7, p. 364; 8, p. 49; 10, p. 265; etc.[5]

Sellick Hill—formerly known as "Sellick's Hill."

---

[3] This fossiliferous sandstone has subsequently been identified as Lower Pliocene.

[4] The term "younger" is here applied to the glacial deposit (formerly referred to as Permo-Carboniferous) to distinguish it from the much older Sturtian Tillite of Upper Pre-Cambrian age, which is present also at Hallett Cove.

[5] It is of interest to note that an old plan of the "Settled Districts of South Australia," prepared by a former Deputy Surveyor-General (Mr. P. T. Finnis) in 1841, shows the "Field or Onkaparinga River." It has been noted also that the creek in question has been named "Hallett Creek" on an old Admiralty Chart dated 17 August 1874.

All bearings given in the text and shown on the geological maps in this paper are magnetic, and they have reference to the period when the declination was approximately 5° E. of True North.

The record of all heights shown thus—(66), on the geological map, have been obtained by aneroid. They have reference to approximately low water at the time of the investigation. Check height readings have been taken from survey datum points along the railway.

The system of indexing the formations present in the District of Hallett Cove is similar to that introduced by the writer in the classification of the Pre-Cambrian-Cambrian Succession: Geological Survey of South Australia, Bulletin No. 18 (11).

In the preparation of the Geological Map particular care has been taken to record the geological data as accurately as possible, but owing to the small scale used, narrow beds have had to be considerably exaggerated in order that they may be distinguishable on the map. The true thickness of the formations (where known), however, are included in the text.

B HALLET COVE AND DISTRICT

1 Physiography

Almost the entire four-mile length of coastline shown on the geological map presents steep sea-cliffs which rise in places to over 90 feet above high water. In certain localities the cliffs are perpendicular, due to the almost vertical dip (to the westwards) of old shales, slates, and quartzites which form the cliffs.

The old formations (Upper Pre-Cambrian) just mentioned are entirely absent from the central three-quarter-mile strip of coast (Hallett Cove proper), where the younger glacial deposit sweeps down at least to low water level, there passing below the sea to an unknown depth. This short strip of coastline consists mainly of a boulder and sandy beach. The northern end of the Cove with its deeply dissected and eroded retreating cliffs is generally referred to as the "Amphitheatre."

The principal drainage channel in the region is Hallett Creek,[6] which takes its rise on the western flank of the Mount Lofty Range north-east from Reynella (and across which the bank of Happy Valley Reservoir has been constructed) and joins the coast at the southern end of Hallett Cove. The course of the creek westwards from Reynella is a very sinuous one, due to the alternating beds of hard, dense limestones and quartzites, and the softer bands of slates and shales across which the creek has deeply entrenched itself.

A short creek joins the coast at the southern end of the Amphitheatre, and two larger ones join the coast in the northerly part of the region examined.

---

[6] This creek is usually referred to as the "Field River" by Professor Howchin.

Evidence of coastal erosion is afforded by the marine platform, which is visible at low tide along the full length of coastline shown on the geological map. An interesting feature noted in connection with the platform is the remarkable constancy of its width, although the rocks exposed consist of varying types, including hard, dense quartzites, thinly laminated soft shales, and glacial tillite of Upper Pre-Cambrian age, etc.

2 Geology

The examination and mapping of the Hallett Cove District has resulted in an added geological interest in the region, due to the fact that deposits of the Upper Pre-Cambrian glaciation [the Sturtian Tillite (D 1)], in addition to the well-known younger glacial till, occur in the locality.

Unfortunately, the greatest portion of the surface of the country examined and included in the geological map is covered with travertine limestone and Pleistocene to Recent deposits which effectively conceal the underlying geological structures and formations. The only outcrops available for examination occur on the lower slopes and channels of the several creeks and tributaries, the cliff faces of the coast, and the platform of marine erosion between high and low water. The examination of the latter area requires favourable weather conditions and a low tide. As the geological formations exposed between high and low water (*i.e.*, the platform of marine erosion) are considered to be important, they are shown on the geological map.

The old formations (Pre-Cambrian and Lower Cambrian) have been considerably disturbed by tectonic forces, which have caused structural folding (particularly adjacent to faults) and faulting. In some places it has been possible to identify the general direction of the fault lines, but in many instances while a fault-zone or fault-line has been recognised, its true direction has not been ascertained. Many of the faults shown on the geological map are regarded by the writer as having accompanied the general uplift (and downthrow) of the Mount Lofty Range, although evidence of faulting of much greater age has been noted. One massive block of formations (Purple Series, D 6), situated in the vicinity of Curlew Point, in the extreme south-westerly corner of the geological map, has been very highly disturbed. The shales have been severely contorted, crushed and faulted during compressional earth movements which appear to have taken place long before the Mount Lofty Uplift period.

Similarly the block of the Sturtian Tillite (Upper Pre-Cambrian) uncovered at low water, and shown in the north-western corner of the geological map, has suffered considerably from the effects of severe compressional earth movements, resulting in highly contorted beds and faulting. It is considered by the writer that the earth movements affecting the Sturtian Tillite are comparable with those described above at Curlew Point. It was noted that ferruginous quartz veins occur in the crushed zones in both localities described. During the examination of many square miles of country in the Flinders and Mount Lofty Ranges, the writer has noted that the ancient (Pre-Tertiary ?) fault zones are usually traversed by numerous ferruginous quartz veins. On the other hand, faulting which has accompanied the Mount Lofty Uplift is generally devoid of quartz veins. This distinction is an important factor in assisting to differentiate between the older and younger faults, particularly in the region under review. Further references will be made to the age of the faults when consideration is given to the probable age of the younger glacial deposit at Hallett Cove and elsewhere in this State, and the older and younger formations present in the area under review.

Normal synclinal and anticlinal folding occurs in the locality, but it was noted that the folded structures were, in all places, closely associated with strike and dip faulting. The Lower Cambrian limestones and calcareous shales and slates which outcrop on the slopes of the hills through which the Hallett Creek has cut its channel, have been gently folded into anticlines and synclines. Similar folding can be seen in the Purple Series which outcrop along the lower slopes of the tributary in Section 579 (Noarlunga).

(a) Middle Pre-Cambrian (C) — Upper Series (C 1-4)

The oldest formations present in the region under review consist of beds which are quite typical of the Upper Series Middle Pre-Cambrian (11, p. 35), which are well exposed in the banks of Hallett Creek where it crosses Sections 570 and 573 (Noarlunga), as well as in the two gullies which cross Sections 567 and 563 (Noarlunga), the latter gully being about quarter of a mile south of Hallett Cove Railway Station. The uppermost bed of the series consists of a massive greyish-green to brown, fine to coarse-grained, felspathic quartzite (C2), ranging up to about 180 feet in thickness. The most southerly exposure of this quartzite occurs on the western lower slope of Hallett Creek about a quarter of a mile (upstream) from the beach at the southern end of Hallett Cove. The strike of the formation is 15° E. of N. (magnetic), the bed dipping to the W.N.W. at a very high angle. The next outcrop occurs on the line of strike in the gully which crosses the southern part of Section 567 and joins the coast at the southern end of the Amphitheatre, where the bed strikes 20° E. of N. (magnetic) with a dip ranging from 75° to 80° W.N.W. The quartzite is exposed again in the main gully which passes adjacent to the unmade E-W road in the northern part of Sections 563 and 566 (Noarlunga), the formation cutting the extreme northwestern corner of Section 563. The strike here is 15° E. of N. (magnetic), the bed dipping W.N.W. at an angle of 85°. The quartzite also makes a very prominent outcrop on the top of the sea cliffs (Sections 251, 252, Noarlunga) and extends inland to beyond the Adelaide-Willunga Railway where the dip of the formation is very flat and in strong contrast to the normal high angle of dip of the quartzite of similar age in the exposures described above. A creek which crosses Section 250 (Noarlunga), between the railway and the coast, has cut its irregular channel deeply into this quartzite and has exposed a good section of the beds. Here the quartzite is very dense, dark greyish to light brown in colour, with numerous strong ripple-marked surfaces. The formation dips to the westward at an angle of 30°.

The railway cutting extending northwards from Hallett Cove Railway Station has also exposed this quartzite. At the northern end there is a strike fault, the dip adjacent to the disturbed zone is vertical. Several large surfaces exposed show strong slickensiding in addition to large areas showing ripple marks.

Considerable importance is attached to the outcrops and distribution of the quartzite (C 2) described, for the Sturtian Tillite [(D 1), Upper Pre-Cambrian] overlies this quartzite in the region under review.

The formations underlying the quartzite (C 2), consist of greyish siliceous slates, thinly laminated calcareous shales which are often strongly ripple marked, thinly bedded sandstones and coarse grits to fine-grained conglomerates, thin bands of light greyish dolomitic limestones, and occasional thin beds of dense quartzite (C 1-4). The beds generally alternate very rapidly and abruptly in changing from one lithological facies to another, and are very wavy-bedded or wrinkled and are usually of no great thickness. These distinctive features serve as a ready means of identification, but make it impossible to show each individual formation in correct sequence on the geological map. The several lithological types shown, therefore, are only diagrammatic. The series is very much disturbed by faulting, the earth movements having produced short, sharp drag folds adjacent to the fault-lines and fault-zones, particularly where these formations are exposed in the high banks of Hallett Creek (Sections 570, 573, Noarlunga). The southerly extension of the series from Hallett Creek is cut by an approximately E-W fault which crosses the southern portion of Section 573 (Noarlunga). A small exposure of the Upper Series occurs in the creek in the extreme south-eastern corner of Section 567 (Noarlunga), and also in the creek and tributary in the northern part of Section 563 (Noarlunga). The last outcrop of the Upper Series recorded in the region under review occurs in the banks of the deep creek which crosses Section 559 (Noarlunga).

The maximum noted thickness of the succession is about 1,250 feet, but there is a possibility that strike faulting may have occurred in the section selected for measurement, although a critical examination of the exposed beds failed to reveal any evidence of the presence of faults.

The formations described above as Middle Pre-Cambrian—Upper Series—are judged to be such, as they exhibit all of the lithological features which characterise these beds in other localities in this State, particularly in the Flinders Range (Mundallo Creek Area, 11, pp. 35-37); Mount Grainger, 11, p. 94; Burra Mines, 11, p. 108, etc.

(*b*) Upper Pre-Cambrian (D)

i sturtian tillite (D 1)

The formation that is regarded as the Sturtian Tillite by the writer overlies the felspathic quartzite (C 2) described above. The most prominent outcrops occur in the northern region under review between high and low water, where the formation forms a platform of marine erosion; and in the adjacent cliffs of the coast, which rise to over 50 feet in height.

The tillite consists principally of purplish-grey argillaceous and siliceous shales and slates, in part thinly laminated, which carry many boulders, and bands of purplish-brown argillaceous grits crowded with large and small angular, sub-angular and rounded boulders consisting principally of dolomitic limestone. Irregular elongated lenses and masses of dolomitic limestone occur in parts. Near the high water mark on the coast (western central part of Section 560, Noarlunga) is an elongated lens of dense felspathic quartzite interbedded in the tillite.

The southern extension of the tillite is cut by a cross (dip) fault, the formation being much disturbed, crushed and fractured adjacent to the fault. On the southern side of the fault are highly crushed purple shales and dense purplish-brown quartzites. The actual fault-line is extremely difficult to detect owing to the highly disturbed nature of the adjacent formations. The tillite dips westwards at an angle of 26° with the strike pitching to the south, adjacent to the fault, but the purplish-brown quartzite and purple shale dip to the east at an angle of 73°. A creek crossing the south-western part of Section 560 (Noarlunga) has cut its channel deeply into the tillite. At its junction with the coast there is a low cliff just above high water mark with a narrow breccia-zone having an average thickness of 5 feet (= strike fault-zone).

The tillite forming the sea-cliffs dips westward at an angle of about 30° and is undisturbed, but that exposed on the beach between high and low water is much crushed and disturbed with occasional zones and thin veins of very ferruginous quartz occurring in the folds. An interesting feature noted here is the presence of many thin calcite veins and small irregular clusters of calcite crystals. Dolomitic limestone boulders and pebbles are very numerous in the till. Several bold outcrops of the formation between high and low water in the immediate vicinity of the junction of the creek with the coast are regarded as being typical of the normal type of the Sturtian Tillite.

In the sides of a small tributary joining the creek a few yards upstream from the cliff face, the formation consists of a purplish-brown arenaceous mudstone, showing stratification and carrying numerous medium to small angular to rounded boulders of dolomitic limestone, and many thin veins and irregular clusters of calcite. Irregular masses and lenses of dolomitic limestone in the tillite are another feature. On tracing the tillite upstream, it tends to become more agillaceous with very few boulders, which consist mainly of dolomitic limestone and quartzite.

Its junction with the underlying formation (the quartzite C 2) is exposed in the banks of the creek on the western side of the railway line embankment, but is very imperfectly defined.

On tracing the tillite in a northerly direction, the beds forming the cliffs are very argillaceous. In the centre of the western boundary of Section 250 (Noarlunga) is an approximately N.W.-S.E. fault. On the northern side of this fault the tillite continues to outcrop with a westerly dip of 30° between high and low water, with the underlying quartzite (C 2) forming the sea cliffs. It extends in a northerly direction beyond the limits of the geological map.

A small outcrop of the Sturtian Tillite occurs in the floor and sides of the creek which crosses the southern portion of Section 567 (Noarlunga) and joins the coast in about the centre of the Cove, forming a low stepped waterfall about 200 feet from the beach. The formation consists of a purplish-grey argillaceous and arenaceous slate carrying many small masses and irregular lenses of dolomitic limestone, in addition to small boulders and pebbles of limestone. The purplish colour of the tillite is probably due to bleaching and weathering agents. On the formation being traced upstream, the boulders and pebbles are more sparsely distributed throughout the tillite. Its junction with the underlying quartzite (C2) is again ill-defined.

A very small and imperfect section of the basal bed of the tillite occurs on the western side of Hallett Creek at the approach to the gorge about 300 yards from the beach, where it overlies the quartzite (C 2).

The maximum thickness of the Sturtian Tillite recorded in the region under review is about 350 feet.

ii. PURPLE SERIES (D 6)

No outcrops of the Tapley's Hill Series (D 3) were located in the region under review. In the normal order of deposition of the Upper Pre-Cambrian System, the Tapley's Hill Series (D 3) occurs between the Sturtian Tillite (D 1) and the Purple Series (D 6).

The Purple Series consists of purple shales, purple slates, and occasional bands of purplish quartzite, sandstone and grits, and thin beds of purplish-grey argillaceous limestone, interbedded in the series.[7]. It includes the outstanding rock types which form the steeply inclined to perpendicular sea-cliffs along the coast south of Hallett Cove, and is present also at Black Cliff, at the northern end of the Cove.

Along the coast the shales are usually very thinly laminated, in part strongly ripple-marked, and have the characteristic very deep, dark purple and green banding described by the writer in a previous publication (11, pp. 44-46). Typical samples of the purple and green bands collected by the writer at Black Cliff have

---

[7] The several lithological types mentioned are not shown as individual beds to true scale on the geological map, but are all included under the general heading of Purple Series (D6).

been analysed by Mr. T. W. Dalwood, who has made the following comments in connection with the analyses of the samples:

". . . . The colouring of the slates would be due to either ferrous oxide, ferric oxide, manganous or manganic oxide, carbonaceous matter, or a combination of these materials. Assays of the samples yielded:

	Green	Purple
Ferrous oxide (FeO)	2·47%	2·23%
Ferric oxide (Fe_2O_3)	2·82%	8·01%
Manganous oxide (MnO)	0·07%	0·06%
Carbon (C)	0·06%	0·06%

"It will be seen that the only appreciable difference lies in the higher ferric oxide content of the purple slate, which is consistent with its colour. The colour of the green slate suggests the presence of minerals of the chlorite group. The purple layers deposited at a different period appear to have had their source in a more hematitic region. The sharpness of the line of demarcation between the green and purple layers precludes the possibility of infiltration of iron."

Attention has been drawn already by the writer to the highly disturbed, crushed, and folded nature of the Purple Series along the coast, particularly in those formations which are exposed in the platform of marine erosion at low water. In addition to the folding, minor faults were noted, with overlapping of the narrow beds of purplish quartzite which are interbedded in the purple slates. So complicated are many of these structures that no attempt has been made to reproduce them upon the geological map, except in a very general way. It will be noted that the severe folding and flexures are usually present in the Purple Series which form the platform of marine erosion, and that the series forming the steeply inclined sea-cliffs usually have a dip to the W.N.W. at angles ranging from 50° to vertical. Highly contorted zones in the shales do, however, occur in the cliffs, notably at and north of Curlew Point (see pl. i, fig. 1), and also at Black Cliff. The major feature at Black Cliff consists of an anticline in which the central core has been under-cut and removed by marine erosion, exposing a highly fractured zone, suggestive of a fault-plane coincident with the axis of the anticline. The adjacent purple shales are much shattered by drag-folding, with strongly marked slickensiding on thin partings of chloritic-quartz in the bedding planes of the shales. Here the purple shales extend northerly for about 200 yards, where they are cut by an approximately E.-W (dip) fault, which occurs on the southern slope of the creek near the northern boundary of Section 566 (Noarlunga). The shales along the shore between high and low water have been much disturbed by compressional earth movements along the strike of the formations, causing considerable buckling of the shales, etc.

The only other exposure of the Purple Series north of Black Cliff consists of a wedge-shaped block of the Lower Purple shales exposed at low tide opposite the south-western corner of Section 560 (Noarlunga). The shales are highly crushed and disturbed, having been faulted down into quartzites of the (Flinders Range) Sandstone-Quartzite Series (D 7) to be described.

The purple shales exposed at, and north of Black Cliff and along the coast south from Hallett Creek, are quite characteristic of the Upper Purple Group (D 6 h), whilst the purple shales, slates and thin interbedded purplish sandstones and quartzites outcropping along the coast south and north of Curlew Point appear to be the highest horizon of the Upper Purple Group—representing the transitional series from the Upper Purple shales to the overlying (Flinders Range) Sandstone-Quartzite Series (D 7).

A band of irregular wavy-bedded purple and green shales and slates is exposed in the banks of Hallett Creek in the vicinity of the north-western corner of Section 574 (Noarlunga). This formation has been faulted down between rocks of Middle Pre-Cambrian and Lower Cambrian age, and is very characteristic of the Lower Purple Group (D 6 a). An extension of the same faulted block of the shales can be seen in the banks of the creek in the vicinity of the road crossing south-east from Hallett Cove Railway Station. The strike in the latter area is 15° E. of N. (magnetic) and the formation has been folded into a syncline—the dip of the eastern limb being to the W.N.W. at an angle of 44°. The strike of the shales in the Hallett Creek is 15° E. of N. (magnetic) also, but the dip is fairly constant, being 57° W.N.W. A cross (dip) fault must exist, therefore, between the two exposures of these purple shales.

Purple shales and slates which are both calcareous and siliceous and which are regarded as being very characteristic of the Lower Purple Group (D 6 a) occur on the southern side of a major (approximately) E.-W. (dip) fault, which extends from Sections 573 to 533 (Noarlunga). A tributary of Hallett Creek crosses Section 579 (Noarlunga) from south-east to north-west, then turns north along the unmade road which passes along the western boundary of the Section. Here the Lower Purple shales, which are exposed in its banks, have been folded into gently inclined anticlines and synclines.

Owing to the highly disturbed nature of the formations included in the Purple Series in the region under review, it has not been possible to determine the maximum thickness of the series. Outcrops at several localities were measured, however, and the estimate prepared indicates that the thickness of the series is not less than 1,200 feet.

iii SANDSTONES AND QUARTZITES (D 7)

(Flinders Range Sandstone-Quartzite Series)

Sandstones and quartzites representative of the highest formation in the Upper Pre-Cambrian System (D 7) (see 11, pp. 21-23) outcrop along the shore between high and low water and form the adjacent cliffs of the coast on the western margin of Sections 562 and 561 (Noarlunga). The southern extension of the series has been faulted down against the purple shales a few yards south of the creek, which has cut its channel along the northern boundary (of the unmade road) of Section 566, etc. (Noarlunga). The fault which lies in an approximately E.-W. direction, swings down the hillside towards the creek a short distance upstream from the cliff face. The quartzite outcropping in the bed (and southern bank) of the creek adjacent to the fault is folded into an anticline with the western limb of the fold dipping W.N.W. at an angle of 40°, and the eastern limb dipping to the E.S.E. at an angle of 38°. The quartzite in the bed of the creek forms a small waterfall. The fold of the formation has been highly shattered and crushed during the period of faulting, with numerous small irregular veins of quartz traversing the quartzite. It is suggested that a strike fault occurs immediately east of the anticline, but owing to the cover of younger sediments the existence of this strike fault could not be confirmed. The E.-W. (dip) fault mentioned above is regarded as being Pre-Mount Lofty Uplift age, and is cut by the suspected strike fault east of the waterfall.

The northern extension of the formation has been faulted down against the Sturtian Tillite opposite the south-western corner of Section 560 (Noarlunga). The formation has been highly crushed and disturbed in the vicinity of the fault, a wedge-shaped block of purple shales has been faulted down or forced into the severed end of the quartzite by powerful compressional earth movements.

The Sandstone-Quartzite Series is of a purplish to brown colour, and very massive. It is characterised by strongly marked current-bedding, ripple marks, bands of coarse grit, and occasional shaped clay-casts or impressions (see 11, pp. 21-23), etc., which distinguish these quartzites from the quartzites of greater age in the district. The series is regarded as being portion of the lower-most horizon of the succession, as occasional thin beds of purple shales occur interbedded in the purplish quartzites and sandstones. Where exposed to wave action, these interbedded shales give rise to the unstable condition of the cliff face, resulting in the broken nature of the coastline in the region under review. The hard and resistant beds of quartzites form abrupt and sharp angles by the retreat of the cliff on the northern side, the underlying softer rock (the purple shale) yielding, and the next underlying hard bed of quartzite forms the cliff, until it also is truncated in its turn, with another set back of the cliff to the northward. The sea-cliffs, therefore, exhibit a succession of rock faces at right angles to the coast brought about by the retreat of the adjacent cliff.

The maximum thickness of the Sandstone-Quartzite Series noted is about 260 feet, but the writer suspects that strike faulting has occurred in the series, and may have resulted in a duplication of portion of the succession measured (a very common feature observed in the Flinders Range Sandstone-Quartzite Series in all localities where these formations have been examined). If such is the case, a reduction in the thickness stated must be made.

(*c*) Lower Cambrian (E)

The formations which have been classified as Lower Cambrian consist of calcareous and siliceous shales and slates, and massive beds of limestones. The Hallett Creek has cut its irregular channel deeply into these formations in Sections

505, 519 and 574 (Noarlunga). The beds have been considerably disturbed by folding and faulting. A strike fault occurs in the calcareous shales and slates in the north-eastern part of Section 574 (Noarlunga), the formations on both sides of the fault being folded into shallow anticlines.

The limestones are very dense, massive, and of a blue-grey colour. Occasional thin partings of light grey calcareous shale are interbedded in the limestones in which calcite veins are a common feature.

A typical sample of the limestones collected by the writer from the outcrops on the slopes of the tributary which crosses the northern boundary of Section 533 (Noarlunga) has been examined by Mr. T. W. Dalwood, and yielded on analysis:

Silica (SiO_2)	6·10%
Alumina (Al_2O_3)	1·74%
Ferric Oxide (Fe_2O_3)	1·64%
Lime (CaO)	40·55%
Magnesia (MgO)	8·35%
Water at 100° C. (H_2O)	0·20%
Water above 100° C. (H_2O)	0·47%
Carbon dioxide (CO_2)	40·63%
	99·68%

The slates and shales are in part calcareous, with beds of siliceous slates interbedded in the series. The shales are usually light grey in colour, but the slates generally assume a dark greyish colour.

No fossiliferous horizons were located in the limestones, but the general lithological features of the series are so similar to formations of Lower Cambrian age in other localities in the southern Mount Lofty Range (and elsewhere, 11, pp. 68 and 135), that the writer has no hesitation in assigning the formation described to the Lower Cambrian System.

(d) Younger Till (Lower Cretaceous?) (K)

i Introduction

One of the most interesting formations present at Hallett Cove is the well-known glacial till (and the glacially striated bedrock), which is usually referred to as being of Permo-Carboniferous age. In a recent paper Sir Douglas Mawson has described a deposit of this younger till present in the vicinity of Mount Magnificent as the Permian glacigene beds (12).

So far as is known the deposit at Hallett Cove is one of the most northerly remains (in the region of the Mount Lofty Range) of the glacial material which at one time covered a great extent of country in the southern portions of the State. The writer has located a deposit, which is strongly suggestive of being of glacial origin, in the vicinity of Mount Barker (see p. 24). If this deposit is accepted as being of glacial origin, then it will constitute the most northerly extension of the younger glaciation in the Mount Lofty Range recorded to date.

An outcrop of the younger till, which is exposed at low water in the base of the sea-cliffs north of Port Vincent (Yorke Peninsula), extends much farther north than either of the deposits mentioned above (see p. 27). The two deposits—Mount Barker and Port Vincent—will be briefly described in a later section of this paper.

The geographical positions of the three glacial deposits mentioned above are as follows:

Port Vincent (Junction of the Hundreds Curramulka-Ramsay, and the coast) -	Lat. 34° 44′ S.	Long. 137° 53′ E.
Mount Barker (south of township) - -	Lat. 35° 04′ S.	Long. 138° 52′ E.
Hallett Cove (Black Cliff) - - -	Lat. 35° 10′ S.	Long. 138° 30′ E.

ii HALLETT COVE AND DISTRICT

The lithological characteristics of the younger till present at Hallett Cove have been described in a very detailed and admirable manner by Howchin (4, 6).

It is of interest to note that the prolific assemblage of boulders and erratics which are set in a structureless arenaceous matrix exists in the lower-most beds of the younger till, particularly near the base of the deposit (which rests unconformably upon the Upper Pre-Cambrian rocks of the district), and that on passing upwards the till gradually assumes a more stratified appearance, with regular bedding planes and fewer (and much smaller) boulders and pebbles. The uppermost 10 feet or so consist of alternating bands of pale purplish and white, very thinly laminated argillaceous (soft) shale, and narrow bands of fine-grained arenaceous (soft) shales. Mawson has described the characteristic features of the fluvio-glacial beds associated with the younger till at Hallett Cove and other localities in the southern Mount Lofty Range and referred to them as "varve shales" (13, p. 160). The same author has described "barytes sand crystals" which occur in the uppermost stratified yellowish sandy horizon of the younger till, north of Black Cliff. He states: "The particular bed is only a few inches in thickness, and weathers into soft friable sand-rock, with the hard nodular barytes aggregates distributed throughout the bed" (14, p. 119). The writer did not locate the horizon described by Mawson at Hallett Cove.

The surface of the till is characterised by the presence of huge erratics and boulders of quartzite, granite, shale, etc., which are in many instances well rounded by water action. It is evident that since the close of the glacial epoch and before the deposition of the Lower Pliocene sediments a certain amount of the finer constituents of the till has been removed by erosion, with a subsequent concentration of rolled boulders and erratics on the upper surface.

Very fine samples of glacially striated bed-rock occur along the top edge of the sea-cliffs. The locations of the striated areas are shown on the geological map. Quartzites and purple shales are highly polished, grooved and striated by land ice. A very good example, measuring approximately 42 feet by 15 feet occurs on the top of the sea-cliff at Black Cliff, where the striae have been cut deeply into purple shales. The directions of the striae are 28°, 33°, 40° and 55° W. of N. (magnetic). On traversing northwards along the top edge of the sea-cliffs, the next glaciated bed-rock met with is "Tate's Rock," so named after Professor Ralph Tate, the discoverer (3). In this instance the striae are deeply cut into purplish quartzite, the prevailing direction of the striae being magnetic north. The next locality where the striated bed-rock is encountered is in the extreme south-westerly corner of Section 561 (Noarlunga), where two parallel narrow beds of purplish quartzite, about 30 feet apart, and separated by a band of purplish shales, are smoothed and deeply striated, particularly on the inner surfaces of the quartzite. The intervening soft shale has been partly removed by glacial agencies and subsequently filled with glacial material.

A very small glacially striated rock occurs on the top of the sea-cliff on the southern side of a small gutter in the extreme north-western corner of Section 561 (Noarlunga). The smoothed and striated quartzite, which has suffered considerably from recent erosive agents, represents the most northerly evidence of the younger glaciation in the Hallett Cove District noted by the writer.

A series of cross sections have been drawn through the sea-cliffs by the writer, in order to show the relative thickness of the till, and to indicate the relationship which the glacial deposit bears to the underlying and overlying formations. Text fig. 1 (Section A-A) has been drawn through the coastline in the north-westerly corner of Section 562 (Noarlunga). The formations present in the section consist of the following:

		Thickness, Feet
5	Recent to Late ? Pleistocene—Travertine limestone - -	1
4	Early ? Pleistocene—Sandy clay with angular fragments, and rounded boulders and pebbles of quartzite, limestone, purple slates, and shales, etc. - - - - - - - -	51
	Disconformity (or Unconformity?)	
3	Lower Pliocene—Highly fossiliferous calcareous sandstone -	3
	Unconformity	
2	Younger Till (Lower Cretaceous ?):	
	c Pale, purplish and white, very thinly laminated argillaceous and arenaceous shales, showing definite stratification with large, well rounded (water-worn) boulders and erratics of quartzite, granite, shale, dolomotic limestone, etc., at the top.	
	b White, very fine evenly-graded sandstone and occasional grits and small boulders showing stratification at the top, but gradually losing this structure on passing down to	
	a Yellowish and white arenaceous bed carrying large and small boulders and erratics of quartzite, dolomitic limestone, shales and slates, granite (Victor Harbour), etc., particularly near the base, but which become smaller and more sparse on passing up the formation - - - - - -	63
	Unconformity	
1	Upper Pre-Cambrian—(Flinders Range) Sandstone-Quartzite Series (D7) with narrow bands of purple shales - - -	80 (+)

The Upper Pre-Cambrian quartzites and sandstones dip to the W.N.W. at very high angles, ranging from 70° to vertical.

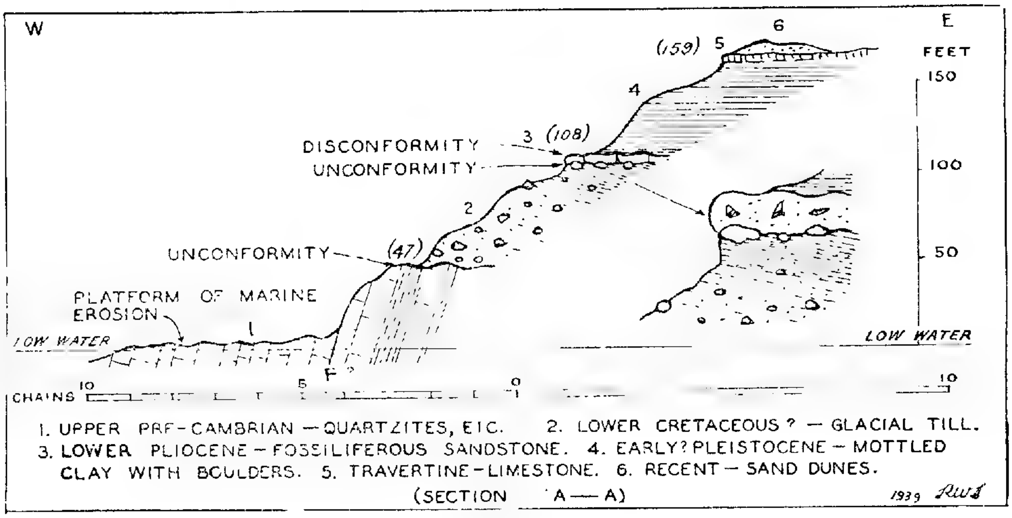


Fig. 1
Line of Section A–A of Map

The younger till has been deposited unconformably upon the Upper Pre-Cambrian quartzites, etc., and is 63 feet in thickness. The junction with the overlying Lower Pliocene sandstone is very sharply defined and represents an unconformity. The Cainozoic formations will be described in a later part of this paper.

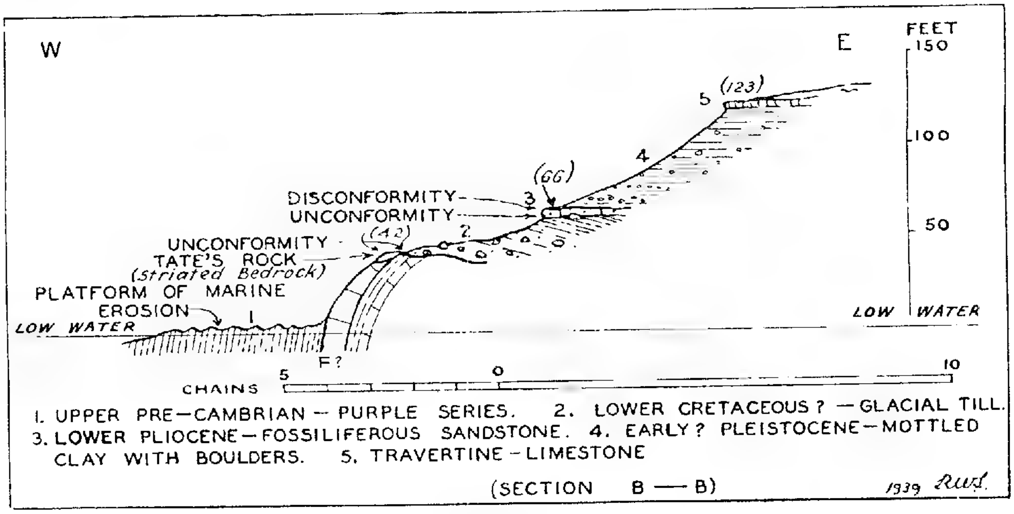


Fig. 2
Line of Section B–B of Map

The cross-section B-B (text fig. 2) has been drawn through the coastline in the north-western corner of Section 566 (Noarlunga), and in the vicinity of "Tate's Glaciated Rock." The formations present are similar in many respects to those shown in text fig. 1, with the exception that the younger till has been deposited unconformably upon purple shales, and the glacial deposit has been reduced considerably in thickness. It is interesting to note that the thickness of the Early ? Pleistocene sandy-clay is about the same as in the first section described. The thickness of the formations present in Section B-B is as follows:

		Thickness, Feet
5	Recent to Late ? Pleistocene—Travertine limestone - - -	1
4	Early?, Pleistocene—Sandy clay, etc. - - - - - -	57
3	Lower Pliocene—Fossiliferous sandstone - - - - - -	3
2	Younger Till (Lower Cretaceous?) - - - - -	24
1	Upper Pre-Cambrian—Purple shales (with narrow beds of purplish quartzite) - - - - - - - -	100 (+)

The line of the cross-section B-B (text fig. 2) has been drawn a few chains south of the east-west creek which has cut its channel adjacent to the northern boundary of Section 566. Reference has been made above to the presence of a fault which occurs on the immediate southern side of this creek, but it is partly concealed by the overlying till, clearly indicating that the fault is pre-younger till in age. The western limb of the quartzites which have been folded into an anticline (and exposed on the lower slope and in the creek, north of the fault) has been highly polished, smoothed and striated by ice action.

Definite evidence can be seen that earth movements took place in the region under review after the retreat of the glacial conditions. When standing on the upper slope of the hill on the north side of the creek, and facing southwards, it will be seen that the upper stratified horizon of the younger till shows a gentle dip of about 22° to the E.S.E., with the overlying Lower Pliocene fossiliferous sandstone, which is horizontally bedded, lying unconformably upon the glacial beds, as shown in pl. ii, fig. 1.

The critical examination of the upper surface of the younger till (or the underneath surface of the overlying Lower Pliocene sandstone) to the north of Black Cliff (as shown in text figs. 1 and 2) indicates that a period of erosion of the uppermost beds of the glacial deposit has taken place prior to the deposition of the Lower Pliocene sandstone, as evidenced by the presence of many huge erratics and boulders which are generally well rounded by water action, and lying upon the upper surface of the till. It will be shown later that many of these large (and small) boulders have been caught up by the overlying Lower Pliocene formation and can be seen on the large upturned blocks of the fossiliferous sandstone which have slipped down the face of the upper retreating cliff.

It has been stated above that the till can be seen dipping to the E.S.E. on the northern side of the east-west creek, with the overlying Lower Pliocene sandstone (horizontally bedded) resting unconformably upon the till. Unfortunately, however, the actual junction made by these two formations cannot be examined in detail along the northern slope of the hill (on the south side of the creek), owing to surface slip, alluvium, and vegetation, so that the writer was unable to determine whether the erosion of the upper beds of the till occurred before or after the earth movements which caused the tilting of the till to the eastwards. It is suggested that sub-aerial erosion of the glacial beds occurred after the glacial epoch, followed by earth movements causing the tilting of the till (and the underlying formations), with a subsequent transgression of the sea causing a further period of erosion (of short duration) before the deposition of the sandstones and the influx of a warmer climate with marine life.

One of the most interesting physiographical features in the vicinity of Hallett Cove is the "Amphitheatre," which consists of a retreating cliff formed of un-

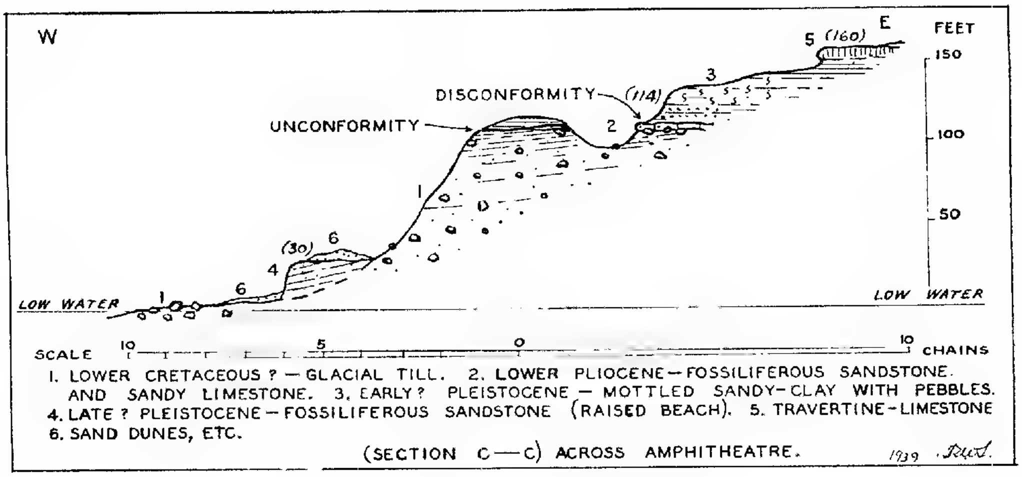


Fig. 3
Line of Section C–C across Amphitheatre

consolidated sediments in the northern half of the Cove. There are no exposures (with the exception of one doubtful small outcrop of purple shale) of the Pre-Cambrian formations between Black Cliff and the Bluff at the southern end of the Cove. The younger till swings down to the beach, and is exposed between high and low water during low tide. Many boulders and huge erratics of greyish quartzite, granite (Victor Harbour, 9 feet x 5 feet x 5 feet), dolomitic limestone carrying numerous calcite veins, Sturtian Tillite (Upper Pre-Cambrian), grey and purple shales, purplish sandstone, and boulders of Tapley's Hill ribbon slates, have been weathered out of the till and left stranded on the beach. It is the break through to low water of the till, and the subsequent erosion of the unconsolidated sediments including the younger till and overlying formations, that has formed the bay or cove.

The line of Section C-C (text fig. 3) has been drawn through the Amphitheatre to show the relationship of the Tertiary sediments to the younger till. The formations present in the line of the section consist of the following:

		Thickness, Feet
6	Recent—Low sand dunes - - - - - - - - -	-
5	Recent to Late ? Pleistocene—Travertine limestone - -	2
4	Recent to Late ? Pleistocene—Raised beach (fossiliferous sands) - - - - - - - - - -	22
3	Early ? Pleistocene:	
	e Light brownish, very fine grained argillaceous (in part calcareous) sand with occasional small pebbles. Shows stratification.	
	d Brownish sandy-clay with small boulders.	
	c Red-brown and light greyish mottled sandy clay with small pebbles.	
	b Red-brown argillaceous sand.	
	a Basal bed, 3 ft. thick, sandy clay with several narrow bands of small angular and rounded pebbles. Bed shows a horizontal banding of the pebbles or stratification - - -	46
	Disconformity (or Unconformity ?)	
2	Lower Pliocene—Fossiliferous sandstone and sandy-limestone	4
	Unconformity	
1	Younger Till (Lower Cretaceous?) - - - - - - -	106

The most outstanding feature noted in connection with the younger till at the Amphitheatre is the great increase in the thickness of the glacial formation, which is at least 106 feet. No evidence was observed of the easterly dip of the till as shown in text fig. 2 (Section B-B), but, on the contrary, near the southern end of the Amphitheatre the younger till strikes 15° W. of N. (magnetic), the bed dipping to the W.S.W. at an angle of about 18°. The strike pitches northwards at an angle of about 15°. The thickness of the till (106 feet) represents the height above high water mark of the junction of the till with the overlying Lower Pliocene, so that even though the formation has a westerly dip of 18° the true thickness of the till will still be over 100 feet, as no account has been taken of that portion of the deposit which extends under the sea below the high water mark. It is suggested that the pronounced increase in the thickness of the till is due probably to that section of the coast between Black Cliff and the headland at the southern end of Hallett Cove having been let down by faulting before the deposition of the Lower Pliocene fossiliferous beds, thus preserving a greater thickness of the till than has occurred north of Black Cliffs, as shown in text figs. 1 and 2.

An important fact which must not be overlooked, however, is that the latest fluvio-glacial stage represented by the uppermost beds of the younger till noted and described as being present to the north of Black Cliff, is present also at the Amphitheatre, which adds to the difficulty of accounting for the great difference in the thickness of the till (other than by faulting) north and south of Black Cliff, although the two deposits of the till practically butt against each other.

One of the very few localities where evidence has been observed by the writer of possible faulting in the younger glacial deposit occurs at the junction of the creek (which has cut its channel close to the southern boundary of Section 567) and the coast. The top of the till on the hillside on the northern side of the creek is 56 feet above high water and is overlain by Early ? Pleistocene beds, whereas on the southern side of the creek the junction of the Early ? Pleistocene sediments (the Lower Pliocene having been completely removed by erosion, as will be described later) and the till is only 24 feet above high water mark. The faulting is obviously Post-Early ? Pleistocene to Recent in age.

Additional evidence to support the suggestion of faulting of the younger till at the locality just described can be seen in the outcrop of the till itself along the higher levels north of the fault-line, where the formation, which dips westerly, has a pronounced pitch or drag to the northwards.

It has been stated above that evidence was noted north of Black Cliff of an erosive stage at the close of the glacial period. Additional evidence was seen of the effects of erosion of the uppermost beds of the till whilst making a traverse round the Amphitheatre at the junction of the till and the overlying formations. Many huge boulders and erratics of quartzite, granite (Victor Harbour), purple shale, etc., occur at the top of the till, and in several places the boulders occur in the overlying Lower Pliocene fossiliferous beds. The boulders are generally well rounded by water action. In the sides of deeply cut wash-out gutters in the north-easterly part of the Amphitheatre, the Lower Pliocene consists of a highly fossiliferous sandy limestone ranging up to 3 feet 9 inches in thickness, with water-worn boulders lying in the uppermost part of the bed. These boulders have been derived probably from the erosion of the younger till in the immediate vicinity during the deposition of the fossiliferous limestone.

On the large-scale detail map of the Amphitheatre it will be seen that the younger till is not always overlain by the Lower Pliocene fossiliferous beds, but that in certain parts the overlying formation consists of the sediments of Early? Pleistocene age.

Howchin has described a whitish and yellowish sand, sometimes argillaceous, which underlies the Lower Pliocene (Howchin's Miocene) at the Amphitheatre (5, pp. 288-289) and suggests that the sands may have been deposited during a late fluvio-glacial stage in the building up of the (till) sediments, or even later by running water acting on the glacial deposits by gentle currents, the clay being carried forward in suspension and the sand deposited. The writer agrees that the sands have been laid down by fluvio-glacial agencies as suggested by Howchin but at a much later date than the glacial period, and prior to the deposition of the Lower Pliocene. The sands have been derived probably from the erosion of the younger till in the vicinity of the Cove. The maximum thickness of the sands is about 10 feet. The overlying formation is an elongated thin lens of very calcareous fossiliferous sandstone ranging up to 9 inches in thickness. At its northern extension the sands pass down insensibly into the arenaceous till, but at the southern end they wedge out rather abruptly.

A small outcrop of the younger till occurs on the slope of the spur which forms the southern headland of the Cove. The deposit is in part concealed by travertine limestone. The junction of the till with the overlying formation, a very thin lens of calcareous sandstone (= Lower Pliocene), is 66 feet above high water mark.

The most southerly extension of the till in the region of Hallett Cove occurs along the edge of the sea-cliff, and between high and low water opposite the south-western part of Section 569 (Noarlunga).

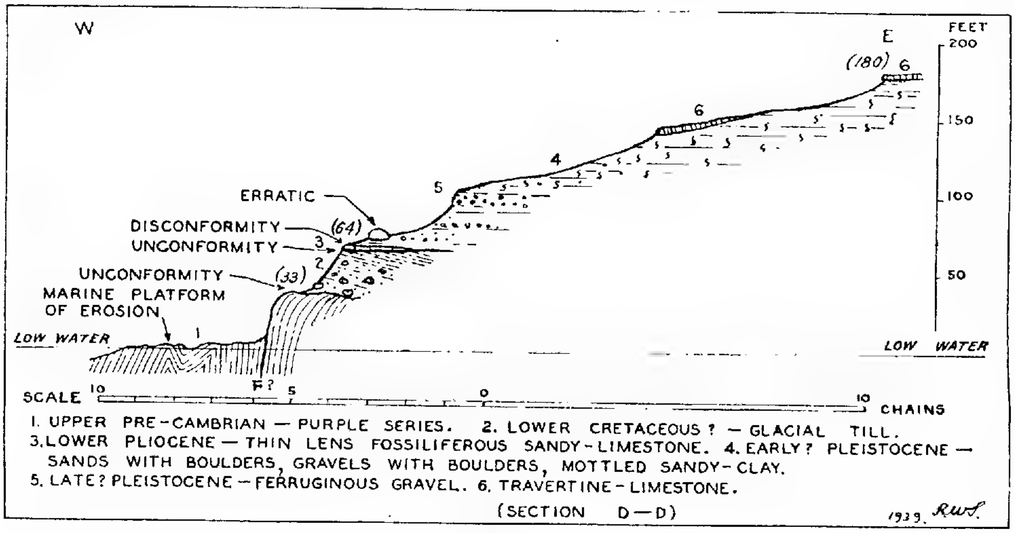


Fig. 4

Line of Section D-D of Map

The line of Section D-D (text fig. 4) has been drawn through the northern end of the glacial deposit to show the relationship of the till to the adjacent formations. The section consists of the following beds:

		Thickness, Feet
5	Recent to Late ? Pleistocene—Travertine limestone - -	1
4	Early ? Pleistocene.	
	c Brownish and greyish mottled sandy clay with boulders, angular and rounded (83 ft.).	
	b Calcareous sand with thin bands and lenses of white (arenaceous) limestone, gravel and boulders (8 ft.).	
	a Yellow and white sand, in part argillaceous with numerous small boulders and pebbles in the lower-most beds (24 ft.)	115
	Disconformity (or Unconformity)	
3	Lower Pliocene—Narrow irregular band (lens-shaped) white fossiliferous sandy limestone - - - - - - -	$\frac{1}{4}$–$\frac{1}{2}$
	Unconformity	
2	Younger Till (Lower Cretaceous ?) - - - - -	26
	Unconformity	
1	Upper Pre-Cambrian—Purple shales - - - - - -	40 (+)

The younger till consists of the unstratified arenaceous deposit, carrying numerous rounded and angular boulders and erratics. The uppermost stratified fluvio-glacial beds characteristic of the region are not present, having been either removed by erosion before the deposition of the Lower Pliocene or were never laid down in this area. The unconformable junction between the till and the Lower Pliocene is 59 feet above high water mark. The Early ? Pleistocene sediments range up to 115 feet in thickness. A large erratic consisting of a fine-grained quartzite carrying numerous thin veins of quartz is perched on the top edge of the cliffs. The erratic occurs in the basal beds of the Early ? Pleistocene, and has been derived probably from the erosion of the till in the immediate vicinity during the early stages of Pleistocene times.

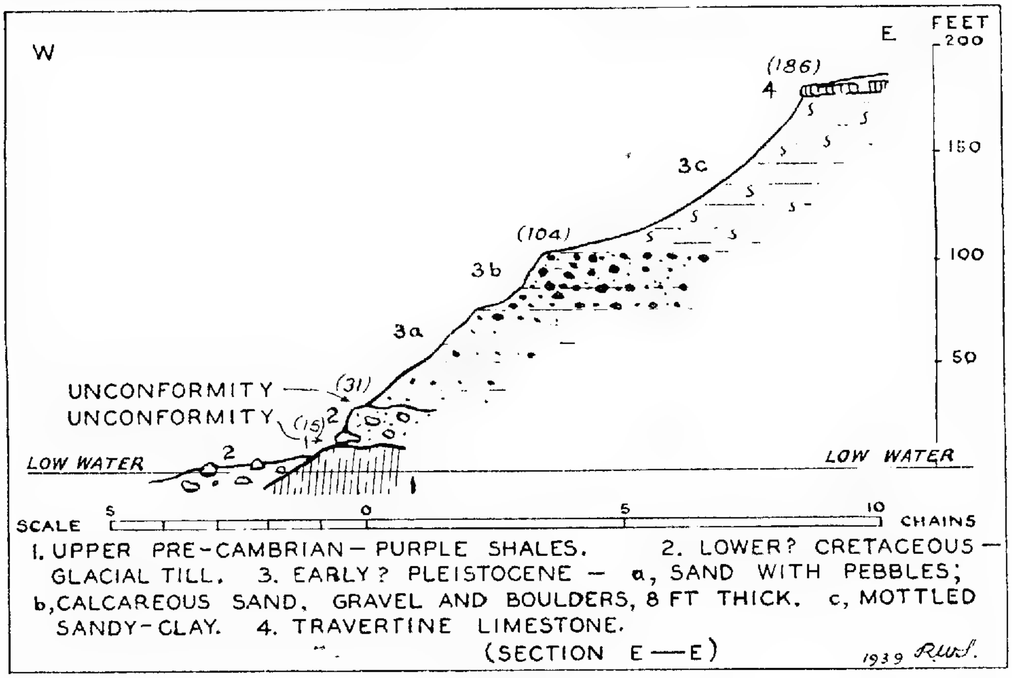


Fig. 5
Line of Section E-E of Map

The line of Section E-E (text fig. 5) has been taken through the coast about 10 chains south of Section D-D. The formations present are similar in general respects to those shown in Section D-D, but the glacial deposit dips away beneath low water. Many large boulders and erratics have been weathered out of the till, and are strewn about on the beach between high and low water. A large boulder of granite (Victor Harbour) rests upon the smooth and polished surface of the purple shales at the base of the till, just above high water mark. The Early ? Pleistocene sediments have increased in thickness to 156 feet. Numerous glacially smoothed and striated boulders can be seen in the younger till in the region just described.

The most southerly exposure of the till occurs on the southern side of a short wash-out in the extreme south-western corner of Section 569 (Noarlunga), where a huge erratic of purple shale is perched precariously upon a low cliff. The upper limit of the glacial bed is marked by a very narrow band of sandy limestone (= Lower Pliocene).

During the examination of the younger till—not only at Hallett Cove, but in all localities in the southern Mount Lofty Range where exposures of the glacial remains have been encountered by the writer, a very careful search has been made for any evidence of a palaeontological nature which may assist in establishing the age of the till, but no such evidence has been forthcoming. A carefully selected set of samples of the several horizons of the glacial formation at Hallett Cove has been examined by Mrs. Ludbrook, whose report is negative also.

(c) Areas Outside the Hallett Cove District

i MOUNT BARKER

Recently the writer located three arenaceous deposits carrying a varied assemblage of large (ranging up to 18 inches) and small angular to rounded boulders of vein quartz, quartzite, sandstone, quartz-felspar-pegmatite and granite in the valley of the Western Flat Creek and close to the Mount Barker-Macclesfield main road, which is strongly suggestive of being of glacial origin. One of these deposits occurs in Section 4474 (Hundred Macclesfield) and about 1½ miles S.S.W. from Mount Barker township. A borehole was drilled into the deposit to a depth of 103 feet, passing through "drift sands and boulders." The full thickness of the deposit was not penetrated as the borehole was abandoned owing to the drift sand entering the casing. This deposit is not referred to nor shown on the geological map which accompanies the published description of the geology of the locality by the writer, although the main details of the borehole are given (15, pp. 58, 60) and the site of the hole is shown on the geological map (15).

The second deposit occurs in part Section 3724 and 3011 (Macclesfield), a short distance south of the first-described location, and exhibits lithological features similar to those described above. A borehole drilled into the deposit is reported to have passed through nearly 130 feet of very sandy clay and drift with occasional small boulders and pebbles.

Very recently the writer inspected the sediments cut in two trial-holes sunk into the alluvium flat on the western side of the Western Flat Creek (Section 4476, Macclesfield) and opposite the eastern corner of the Section. The trial-holes were excavated on a proposed site for a storage reservoir. The section exposed in the trial-holes consists of the following sediments:

Bed No. 8	Surface – 2′ 0″	Black carbonaceous clay
,, ,, 7	2′ 0″ – 2′ 3″	Greyish-yellow clay with gravel
,, ,, 6	2′ 3″ – 8′ 3″	Argillaceous greyish-yellow very fine-grained silty clay
,, ,, 5	8′ 3″ – 8′ 8″	Greyish-yellow clay with boulders and gravel
,, ,, 4	8′ 8″ – 11′ 4″	Putty-greyish very fine-grained sandy-clay
,, ,, 3	11′ 4″ – 12′ 9″	Greyish-yellow mottled very fine-grained sand
,, ,, 2	12′ 9″ – 13′ 9″	Gravel and boulder wash
,, ,, 1	13′ 9″ – +	Decomposed micaceous slate

The formations numbered 3-7 in the above section exhibit all of the lithological characteristics of the younger till, which may, however, represent redistributed glacial material.

The formations exposed in the second trial-hole consisted almost entirely of very fine-grained sands with small pebbles, and comparable with the sediments exposed in the No. 1 trial-hole.

If the three arenaceous deposits described above are accepted as remnants of the younger till in the district of Mount Barker, then the last described deposit (as shown in the two trial-holes) constitutes the most northerly known extension of the younger till in the Mount Lofty Range.

ii SELLICK HILL

During the geological examination of the country in the vicinity of Sellick Hill township the writer noted a small deposit of the younger till perched on the lower slopes of the Willunga Range, which has been cut by faulting.

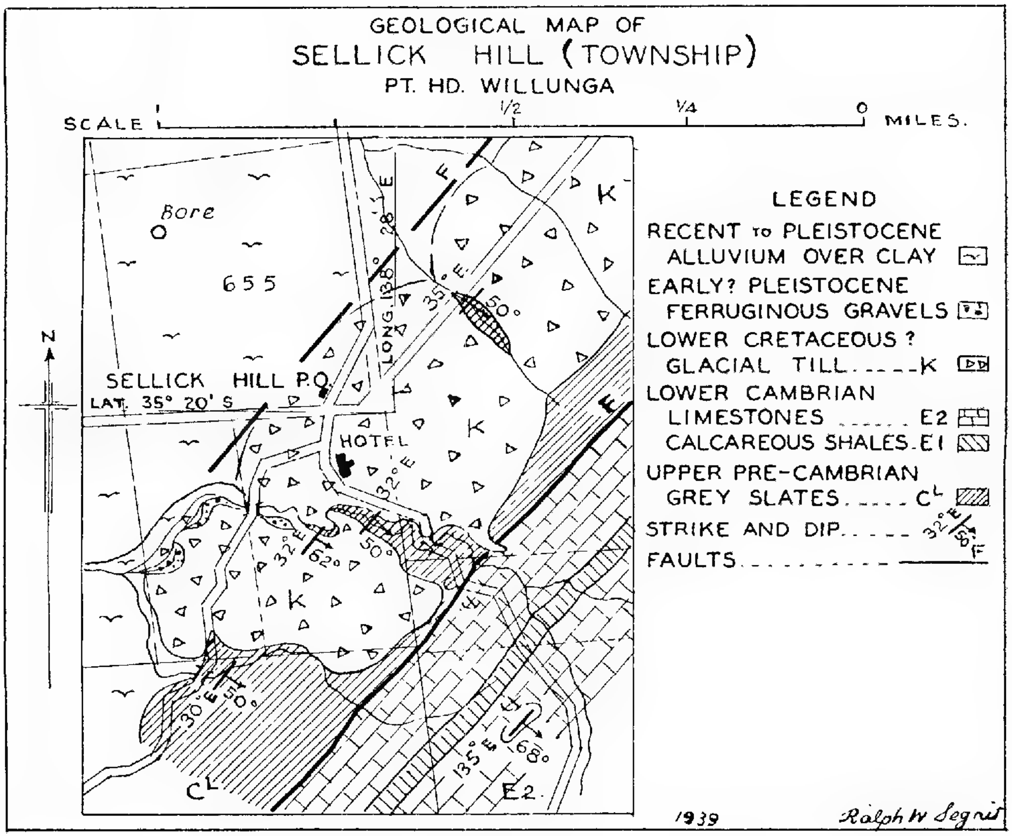


Fig. 6
Geological Map of Sellick Hill (Township)

The oldest formations in the immediate locality consist of dark grey micaceous irregular wavy-bedded slates and shales which show a faint ribbon or banded structure. This banding in association with the wavy-bedding is quite characteristic of the Lower Group Middle Pre-Cambrian (11). The strike of these old slates ranges from 30° to 35° E. of N. (magnetic) and the dip of the beds ranges from 50° to 62° E.S.E. The shales and slates are overlain by a massive series of greyish-blue limestones with interbedded light grey calcareous shales of Lower Cambrian age, which have been faulted down alongside the slates. The uppermost horizons of the limestone series (which are not shown on the geological map, text fig. 6), include remains of Archaeocyathinae (15).

The younger till has been deposited unconformably upon Middle Pre-Cambrian slates. Numerous rounded and angular boulders of sandstone and quartzite, with occasional boulders of granite, are scattered over the surface of the lower spurs of the range north-east, east, and south of the Sellick Hill Hotel, having been weathered out of the underlying arenaceous till. Good exposures of the glacial beds occur on the upper steeply-sloping sides of the creek which crosses Section 668 (Willunga), a few chains south from the hotel. The major fault scarp of the Willunga Range has cut the younger till a short distance west of the Sellick Hill Post Office. The margin of the till with the Recent alluvium, etc., of the plain, however, is not very well defined.

Samples collected from a borehole drilled recently in the north-western portion of Section 655 (Willunga) have been examined by Mrs. N. H. Ludbrook (nee Woods), who has made the following determinations:

"Surface to 170 ft.	Brown and greyish sandy-clay in part mottled, with boulders of limestone, etc.
170 ft. – 205 ft.	Dark brown clayey sand
205 ft. – 215 ft.	Brown and light grey calcareous mottled clayey sand
215 ft. – 255 ft.	Yellow argillaceous sand of Miocene (? Lower Miocene) age, with fossils as follows: *Rotalia Calcar*, *Eponides scabriculus*, *Cibicides* sp., *Cellaria rigida*, *Idmonea* spp., *Retepora* sp.
255 ft. – 260 ft.	Similar to previous sample, the following fossils being noted, chiefly Bryozoa: *Dorothea gibbosa*, *Eponides scabriculus*, *Idmonea* spp., *Hornera* sp., *Retepora* sp., Spine of an echinoid, *Cytherella lata*.
260 ft. – 265 ft.	Bryozoal limestone (Miocene) as previous samples: *Sherbornina atkinsoni*, *Cibicides* sp., *Lepralia* sp., *Retepora* sp., *Hornera* sp., *Cellaria* sp., *Membranipora* sp., Spine of an echinoid.

The occurrence of *Sherbornina* is notable, only one specimen being noted. It was found to occur numerously in a bore in the same district—that of T. H. Culley (Section 384, Hundred of Willunga), which the writer (N. H. L.) examined some months ago—some excellent specimens being obtained."

A second borehole is situated about a quarter of a mile N.N.W. from the borehole described above. The driller's log of the strata cut by the drill consisted of the following beds:

5 ft. – 79 ft.	- -	Red clay with stones
79 ft. – 96 ft.	- -	Yellow clay with stones
96 ft. – 189 ft.	- -	Soft yellow sandstone
189 ft. – 230 ft.	- -	Yellow fossiliferous rock
230 ft. – 233 ft.	- -	Red sandstone and pebbles

The sediments ranging from 5 feet to 189 feet are regarded as being Recent to Early ? Pleistocene age and the "fossiliferous rock" Miocene age. This determination is based upon some fossiliferous material collected from boreholes situated a short distance away on the north-eastern and south-western sides (Sections 433 and 665, Willunga) of the borehole just described. The red sandstone with pebbles is suspected as being the uppermost weathered horizon of the younger till. The junction between the red sandstone and the Miocene limestone is approximately 40 feet above sea level, whereas the highest point of the younger till on the slope of the Willunga Range south-east from the Sellick Hill Hotel is 495 feet above sea level, which represents a downthrow of at least 455 feet.

The writer suspects that the long, broad valley flanking the Willunga Range fault scarp, and extending inland from Sellick Beach to the north of Kangarilla is, in part, of glacial origin, or that the glaciers of the younger glacial period passed up a pre-glacial valley in the region under discussion, subsequent to the initial uplift of the Willunga Range, the valley representing a downthrown block. The retreat of the glacial conditions was followed by a transgression of the sea up, at least, part of the glacial valley when the Miocene fossiliferous beds were deposited. Subsequently faulting occurred, resulting in the downthrow of the younger till and later sediments.

iii PORT VINCENT (Yorke Peninsula)

The younger till outcrops along the coast about 1½ miles north of Port Vincent, between high and low water, and along portion of the base of the sea-cliffs. The length of outcrop is 1 mile. The deposit is arenaceous; of a greyish colour; and carries numerous boulders and very large erratics. The latter include several blocks of very coarse-grained porphyritic granite (many porphyritic crystals of felspar range up to 4 by 3 inches, and the quartz crystals exhibit the typical bluish colour characteristic of the Victor Harbour granite) ranging up to 10 feet by 8 feet, pink and greyish quartzite, grey slates, etc. The upper surface of the till exposed along the base of part of the sea-cliffs is somewhat undulating and iron-stained. The till is usually visible only at low water but in one locality the formation rises 15 feet above high water. Numerous boulders which have been weathered out of the till have been carried along the coast by tidal action and left stranded along the beach beyond the northern limit of the till. The deposit has been tilted westerly at an angle of about 18°.

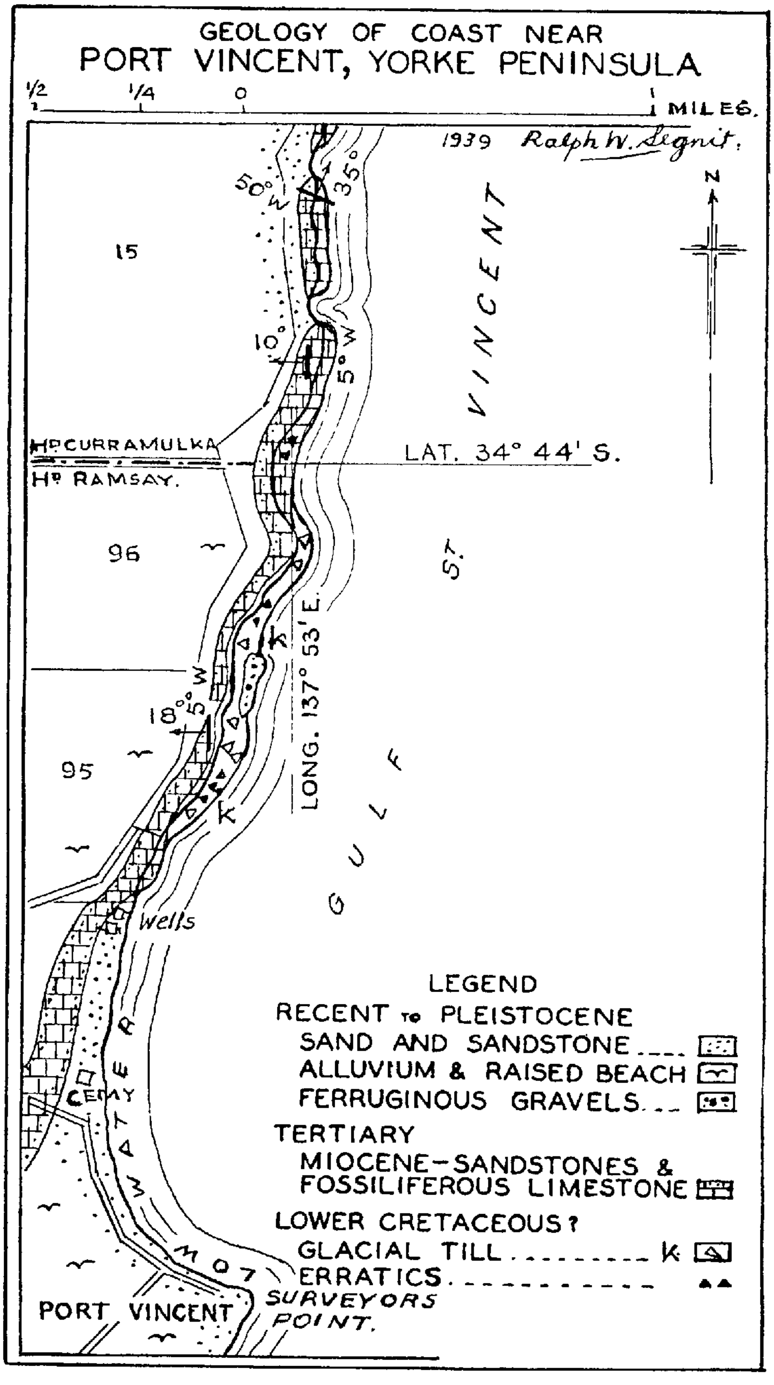


Fig. 7
Geology of Coast near Port Vincent, Yorke Peninsula

The glacial deposit is overlain (unconformably) by a bed of fine grit and coarse even-gained (partly consolidated) sandstone, 4 to 5 feet in thickness, which exhibits a strong current-bedded structure. Overlying the sandstone is a highly fossiliferous (polyzoal) limestone of Miocene age, upon which rests a partly consolidated sand, the basal beds of which are very calcareous. At Red Cliffs the sands range up to nearly 40 feet in thickness.

About 200 yards along the coast, north of the east-west Hundred boundary between Curramulka and Ramsay, the sandstone-limestone beds strike 5° W. of N. (magnetic) the formations dipping westerly at an angle of 10°, but about 200 yards still further north the strike of the beds has swung to 50° W. of N. (magnetic) the formations dipping to the north-east at an angle of 35°. The Tertiary beds have obviously been disturbed by faulting during Post-Miocene times.

(f) Probable Age of the Younger Till

Howchin has suggested that, ". . . . this extinct (referring to the younger till) glacial field is an old palaeozoic topography that has through long ages been buried under great thicknesses of morainic material as well as marine sediments of a later date, which is now being slowly uncovered and exposed by present-day atmospheric and fluviatile agencies" (8, p. 139). He has assumed that the beds are of Permo-Carboniferous age, based on an analogy, in that they resemble in many respects glacial beds which are certainly of this age in other Australian States, particularly in Victoria, where remains of typical Permo-Carboniferous[8] plants, notably *Gangamopteris* occur in sandstones, etc., intercalated in glacial beds (17).

The inference that the South Australian beds belong to the same age is based (by Howchin) on *(a)* their lithological resemblances to the beds with which they can be correlated in Victoria and Northern Tasmania, and *(b)* the absence of any other known glacial period in Australia with which they could be correlatively associated.

The results of the writer's observations of the features connected with the till under review, particularly the outcome of the detailed mapping of several sections and areas, together with a study of structural features of the underlying formations, have been, in the light of modern geological knowledge, to cast a doubt on the correctness of assigning a Permo-Carboniferous (or Permian) age to this glacial deposit, and rather to view the glacial period as being of more recent date. Undoubted evidence of a Lower Cretaceous glaciation has also been forthcoming.

If this till was deposited at the close of Upper Palaeozoic times as has been suggested by Howchin and others, then it will be necessary to make a slight revision of the generally accepted theory of the commencement of the age of the

---

[8] The *Gangamopteris* beds and till are now regarded as being of Lower Permian age (17).

Mount Lofty Period of mountain building, or an adjustment in the sequence of events which followed the initial uplift. Howchin has described the general physiographical changes which have taken place in this State since the Cainozoic Period (8, pp. 237-246). The major earth movements during this period of mountain building have been classified by him into three stages. The first stage "A" is referred to as the "Fluviatile Stage," during which time there was a central watershed in Central Australia, with great drainage channels extending southwards to the sea. Stage "B"—"The Plateau-Building Stage" (The Koscuisko Period) is described as a period when regional (epeirogenic) uplift of the land took place along the southern portions of the continent, with a corresponding warp or sag in the interior. Howchin draws attention to the "effects of this uplift, which can still be seen in the highlands of the Mount Lofty Range, the general level of which represents a peneplain of about 1,500 feet above sea level." The third stage "C" represents a "Period of Collapse" (Block Faulting and Rift Valleys). In his summing up, Howchin states: ". . . . The geological age in which these earth movements took place can be inferred from the effects produced at the same time on the Cainozoic marine sediments which also became tilted and dismembered by the block-faulting, giving evidence that these movements were Post-Miocene and to some extent Post-Pliocene (8, p. 242).

Chas. Fenner has made a special study of the major physiographical features of South Australia and has published many papers dealing with the subject. In his description of the Age of the Fault Block Movements, and the Summary of the Major Tectonic Movements he states: ". . . ., Away back in Lower Tertiary time we must picture this part of Australia (referring to South Australia) as a vast land area being slowly worn down to an almost level surface (peneplane) at or near sea level . . . . At the beginning of Miocene (mid-Tertiary) times we may picture this vast plain, climate unknown, reaching away to the south. Then occurred the great depression of the southern part of the State, when a broad sea extended up to the latitude of Port Augusta, along an irregular east-west line. All this land stayed for vast ages below the sea, with minor oscillations, and thick beds of limestones were deposited. We may still see the relics of these limestones in the Murray Cliffs, at Noarlunga, Aldinga, Yorke Peninsula, West Coast and Nullarbor Plains" (18, p. 25). In the same publication (18, p. 30) Fenner states: "As already stated, the facts as at present known regarding southern Australian physiography bring one to the inevitable conclusion that the whole of the great Cambrian and Pre-Cambrian complex, with later rocks protected in down-faulted or down-warped "pockets," had been planed down to a most perfect peneplane by the end of Oligocene time."

The writer has failed, up to date, to locate any concrete evidence to support the suggestion that the Miocene sea extended right across that portion of South Australia now occupied by the Mount Lofty Range, as suggested by Fenner. The principal evidence quoted to support the suggestion consists of a small deposit of the Miocene fossiliferous limestone present on the Hindmarsh Tiers. Howchin has described this outcrop and stated: ". . . . At the head of the Hindmarsh River there occurs a very remarkable limestone of Eocene (= Miocene) age . . . . confined to the sides of a narrow creek or land farmed by Mr. Geo. Maslin within Sections 600-601, Hundred of Encounter Bay" (19, pp. 15, 16). Howchin has indicated the location of the limestone on a map in a later publication (20), in which he estimates the outcrop to be from 900 to 1,000 feet above sea level (20, p. 56). The writer has examined the fossiliferous limestone in company with Mrs. Ludbrook, who states: ". . . . The formation is a hard semi-crystalline limestone with remains of numerous Bryozoa (Polyzoa). It is lithologically and palaeontologically related to the Point Turton limestone which Chapman and Crespin (Rep. A.N.Z.A.A.S., 1935, p. 125) assign to the Middle Miocene. Bryozoa are very numerous but difficult to identify specifically. A microscopic section revealed only Bryozoa and an echinoid spine." It is of interest to note that the Miocene limestone has been deposited upon the younger till, in an elevated glacial valley connected with the Myponga glacial region. A check reading of the height of the fossiliferous limestone was made by aneroid against a known datum level at the Hindmarsh Reservoir, and it was found to be 751 feet above low water. This occurrence is the only one known to the writer where fossiliferous beds of Tertiary age exist at any distance from the coastline (excepting the Murray basin) within the Mount Lofty Range, and even in this instance the formation has been deposited in an elevated glacial valley.

It will be noted that all of the references to fossiliferous (Tertiary) beds (with the one exception—the Hindmarsh Tiers) made by Fenner occur round the flanks or margins of the Mount Lofty Range, etc.

The writer has mapped considerable areas of this glacial till (in addition to the regions described in this paper), particularly along the margins of the deposits and has, up to date, located very few undoubted faults in the deposits. This absence of faulting may be due to the practically unconsolidated state of the arenaceous (and argillaceous) boulder beds and shales which comprise the till. Ample evidence of the extensive faulting which accompanied the initial uplift, and later period of block faulting (Howchin's Stage D—the Period of Collapse), can be seen throughout the Mount Lofty and Flinders Ranges. Examples of the highly complicated nature of this faulting have been published by the writer in Bulletins of the Geological Survey of South Australia (11, 15). Large areas (in addition to those published) have been examined and mapped by the writer, and in all places evidence has been observed of the very extensive nature of the faulting which has resulted in the formation of a very complicated and irregular mosaic of small blocks. Under such conditions it is considered by the writer highly improbable (if not impossible) that such extensive tracts of country embracing the whole length of the Inman Valley (from Encounter Bay to Gulf St. Vincent), Hindmarsh Valley, the wide expanse of country in the region of Mount Compass, Yankalilla, Currency Creek, etc., where the younger till is known to occur (see text fig. 8), should have escaped dislocation and distortion during the period of uplift and collapse, if the glacial epoch had occurred at the close of Palaeozoic times. Faulting of the old Pre-Cambrian formations (upon which the glacial till now under discussion has been deposited) is a characteristic feature of these ancient rocks, but in practically every case the faulting is pre-glacial period in age.

The writer has already expressed the opinion that many of the faults located and recorded on the geological map of Hallett Cove have accompanied the general Early ? Cainozoic (or Mesozoic?) to Recent period of block faulting of the Mount Lofty Range. The only direct evidence noted of faulting of the younger till in the vicinity of Hallett Cove has been described on p. 21. It is suggested, however, that Post-Pleistocene faulting, which bounds the coastline of Gulf St. Vincent, not only at Hallett Cove, but also at Sellick Hill, has cut the till. These suggested faults (if they exist) are concealed by the sea in the case of the coastal deposits of the till.

Definite evidence of faulting of the younger till can be seen in the vicinity of Sellick Hill township, as described on p. 26.

The writer has prepared a sketch map showing the general distribution of the younger till within the boundaries of the Southern Mount Lofty Range. The data shown on the map has been compiled from all known records, which have included geological maps defining the outcrops of the younger glacial beds. In many places the till has been examined and mapped in detail by the writer. Boundaries indicated by other investigators, however, show the same outstanding feature as the writer has stressed, namely, the generally regular and consistent unfaulted outline made by the till with the ancient bedrock upon which the glacial material has been unconformably deposited in the glacial valleys, etc. The feature described is shown clearly on the sketch map, text fig. 8.

During a recent visit to Victoria the writer examined the Lower Permian glacial beds in the vicinity of Bacchus Marsh. The most outstanding lithological feature noted in connection with the glacial till was its remarkable resemblance to the boulder beds of the Sturtian Tillite (Upper Pre-Cambrian) in this State. Exposures of the Lower Permian till adjacent to the south east abutment of the Pyke's Creek Reservoir consist of a well-consolidated mudstone carrying numerous large and small boulders (a proportion of which are well rounded), with irregular lenses and bands of hard, dense quartzite and compact sandstone. The lower-most beds of the glacial deposit which are exposed in the main-road cutting near the north-west abutment of the reservoir consist of alternating bands of very thinly laminated shales, slates and sandstones (resting unconformably upon metamorphosed sediments of Ordovician age), which pass up gradually into arenaceous beds carrying boulders characteristic of the normal till. These glacial beds show no lithological features whatsoever which can be regarded as being comparable with the younger glacial beds (referred to as Permo-Carboniferous) in South Australia, where the formations in all of the localities examined by the writer are unconsolidated with occasional irregular masses of partly consolidated sediments due to subsequent infiltration of oxide of iron.

It has been suggested by Howchin that there are no other glacial beds (other than Permo-Carboniferous) in Australia with which the till under review could be correlated.

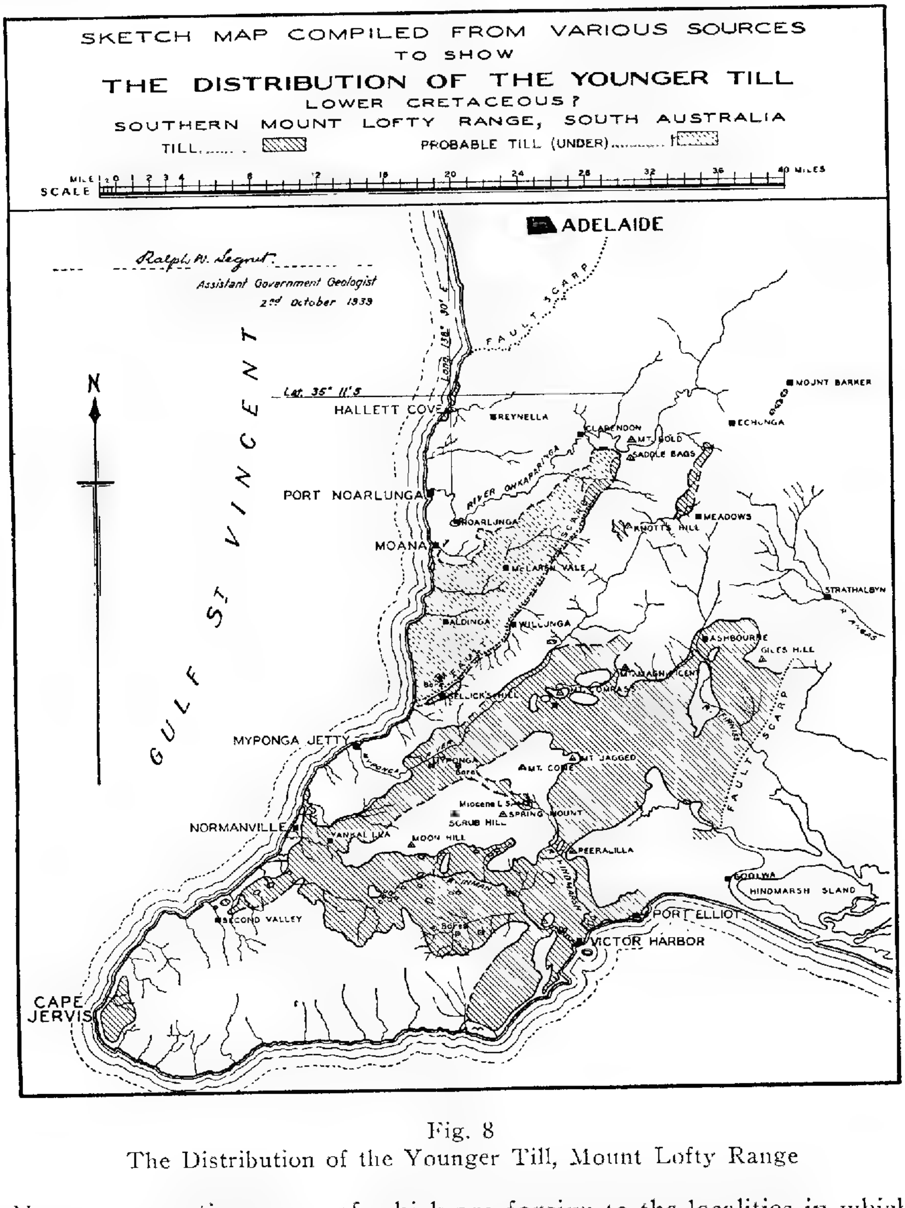


Fig. 8
The Distribution of the Younger Till, Mount Lofty Range

Numerous erratics, many of which are foreign to the localities in which they occur, are found scattered over the surface in some parts of Central Australia, and in the central region of South Australia, have been noted by H. Y. L.

Brown, who records that: ". . . . On the stony downs, gravelly plains, and tablelands of the interior of South Australia, boulders and blocks of rock are frequently seen resting on soft Cretaceous shale and silt. . . . . These, without doubt, have been transported to their present positions by ice action which seems to have, at the same time, since the Mesozoic period, been in operation all over this region" (21, 22, 23, 24).

R. Lockhart Jack has described Lower Cretaceous erratics which are strewn over the surface of the weathered Lower Cretaceous shales of Lake Phillipson borehole (25, p. 12). These Cretaceous erratics are composed of resistant quartzite, felspar-porphyry and granite. They remain on the surface as the shale is eroded beneath them. At the Glue Pot Crossing near Lake Conway, Jack records: ". . . . Large boulders were noted on the surface of the Lower Cretaceous rocks of which some were rounded and appeared to be water-worn, but one of approximately 1 cwt. was facetted. . . . It is possible that these boulders have been transported by ice action at the time of the deposition of the Lower Cretaceous shale, and that they have been exposed by denudation" (25, p. 42).

L. Keith Ward has recorded that: ". . . . The existence of erratics near Dalhousie Station has been recognised by David and Howchin, whose joint report is published in the Record of the Glacial Research Committee of the A.A.A.S. (27), where these authors express the opinion that "the glaciation was later than Lower Cretaceous, and probably Upper Cretaceous." From his own observations near the Dalhousie Mound Springs and the Duck Ponds (a few miles south-east of Blood's Creek borehole), and from more recent observations made in conjunction with R. Lockhart Jack, in the region of the Great Australian Basin and the transcontinental railway, Ward places the glaciation definitely in the later part of the Upper Cretaceous period (28, p. 74). More recently still, in the description of the Geological Map of South Australia, he has shown that: "Boulders to which a glacial origin has been attributed occur in places in South Australia at Stuart's Range, where they are associated with marine fossils, judged by F. W. Whitehouse to be on the horizon of the junction of Stages *ii* and *iii* of the Roma Series = Lower Cretaceous" (29, p. 9).

Evidence of a Mesozoic glacial period earlier than Cretaceous times (but later than Permo-Carboniferous times) in a region not far removed from South Australia has been brought forward by E. J. Kenny in connection with the study of the Geological Formations in the West Darling District, N.S.W. Kenny suggests that: ". . . . The glacial period so characteristic of Lower Cretaceous time had its commencement when the Jurassic sediments were being accumulated. The case for the transport of ice of the numerous erratics distributed so widely throughout the area occupied by Cretaceous rocks, not only in New South Wales, but also in Queensland and South Australia, is supported by the observations of a number of investigators. The Jurassic rocks (West Darling District) occupy a relatively small area in all, and phenomena indicative of glaciation are present in restricted areas at widely separated localities. Hence it would appear that ice action in this earlier period was less intense and more local than in the succeeding Cretaceous period" (30, p. 65).

From the above records it is obvious that the younger till present at Hallett Cove and elsewhere in the southern portion of this State can be correlated with a glacial period other than the Permian (also known as Permo-Carboniferous) of Victoria, as has been suggested by Howchin and others.

During a geological examination of part of the Flinders Range in the vicinity of South Creek the writer located several deposits along the lower margin of the western scarp of the range which consisted of an argillaceous and arenaceous mudstone, carrying numerous rounded and angular boulders. The formation is sub-horizontally bedded, and lying unconformably upon Upper Pre-Cambrian rocks. The deposit has every appearance of being a glacial till, but as no glacial beds other than the Sturtian Tillite (Upper Pre-Cambrian) occur in the locality, the boulder bed is regarded as probably forming part of a southerly extension of the glacial beds of Lower Cretaceous age present in Central Australia. It has been shown by the writer that the Lower Cretaceous glaciation has extended south at least as far as the Andamooka Opal Field, situated on the western side of Lake Torrens (31, p. 54; 11, p. 146). If the deposit near South Creek forms part of the Lower Cretaceous glaciation, then there is very sound reason to believe that the younger till described in this paper (and by others as Permo-Carboniferous) is synchronous with the Lower Cretaceous glaciation of Central Australia.

Several representative samples of the younger till have been collected from different horizons at Hallett Cove, the critical examination of which has failed to produce any fossiliferous evidence that may assist in defining its age. The age of the glacial beds at Bacchus Marsh has been established as Permian by the presence of interbedded *Gangamopteris* shales (17), in addition to spores, some of which closely resemble certain spores obtained in the black *Glossopteris*-bearing shales from Palaman in the Daltongunj coalfield Behar, and South Rewa Gondwana basin, Central India (32).

It is of interest to note that so long ago as 1913 Howchin appears to have been somewhat doubtful about the possibility of the younger till being so old as late Palaeozoic, for in his Presidential Address before Section C of the Australian Association for the Advancement of Science he states: ". . . . Indeed, the survival of the Permo-Carboniferous terranes would seem to imply the existence of a Mesozoic as well as a Cainozoic protecting cover to secure the preservation of these feebly coherent rocks through the long interval down to the present day; but as to the age and nature of such lost records, if they ever existed, we have no knowledge, and it would be useless to speculate" (33, p. 150).

The general sequence of events in the physiographical history of the Mount Lofty Range as suggested by the writer is briefly summarised as follows:

The initial Period of Uplift of the range commenced, at the latest, in the earliest stage of the Cretaceous period, or even in very late Jurassic times, when the old peneplaned surface of the land was raised as an extended plateau. Extensive faulting accompanied this initial uplift. This major earth movement was followed by the Lower Cretaceous glaciation, when at least the southern portion of the uplifted plateau was not only in part covered by land ice, but existing valleys were more deeply cut by glaciers having a general northerly trend. After the close of the glacial period an encroachment of the sea upon restricted portions only—mainly round the fringe of the uplifted land, and along certain of the glacial valleys occurred, when marine fossiliferous sediments (of Miocene and later of Pliocene age) were laid down. Alternations of erosion and deposition followed through the remainder of Tertiary times, accompanied by faulting, the former being restricted to the margins of the Mount Lofty Range, but the latter being general. The final phase—Howchin's Kosciusko Period of Collapse, etc., occurred in Post-Pleistocene times.

(*g*) Cainozoic—Lower Pliocene

One of the most important formations present in the region under review is the very thin bed of fossiliferous sandstone and fossiliferous sandy-limestone which has been deposited unconformably upon the (eroded ?) surface of the younger till.

In the earliest descriptions of this fossiliferous formation Tate classified it as Miocene, the determination being based upon his identification of certain of the contained marine fossils (2, p. 318).

In a more recent paper Howchin assigned a Lower Pliocene age to this fossiliferous bed. In his Geology of South Australia, 1918 edition, Howchin has drawn a section near Black (Point) Cliff (7, fig. 306, p. 410), where he shows the formation as "Miocene (Marine)," but on the next succeeding page he has reproduced a photograph of the fossiliferous sandstone and adjacent formations in which he describes the formations as "Lower Pliocene (Tate's Miocene)." Howchin's confusion is still evident in his later edition of the same publication (8, p. 135, fig. 76), in which he shows a section drawn through the Amphitheatre, where the fossiliferous bed is shown as "Marine Miocene" but in the text (8, p. 232) he describes the bed as "Lower Pliocene."

The most northerly extension of the fossiliferous bed noted by the writer in the region under review occurs in the extreme north-westerly corner of Section 561 (Noarlunga), a few chains north of Section A-A. The formation is a hard compact highly fossiliferous calcareous sandstone, ranging up to 3 feet in thickness. The northerly extension of the sandstone wedges out. Large blocks of the sandstone which have slipped down the steeply sloping side of the cliff (due to the erosion of the underlying unconsolidated younger till) have many large and small well-rounded boulders of quartzite, etc., adhering to the undersides. Many large species of *Pecten* are associated with the boulders on the undersides of the sandstone.

On tracing the sandstone in a southerly direction towards a small washout, the bed which maintains a fairly uniform thickness ranging from 2-3 feet thins out to a few inches. On the spur between the washout and the east-west creek on the boundary between Sections 562 and 566 (Noarlunga), the sandstone consists of a thin elongated wedge, and is apparently unfossiliferous. No evidence of the sandstone was noted along the northern slope of the creek, but along the southern side the fossiliferous sandstone makes a very conspicuous outcrop, which can be traced inland for a distance of nearly a third of a mile. The bed can be traced in a southerly direction round the retreating cliff, to above Black Cliff. A traverse made round the outcrop with an aneroid indicates that the bed is horizontally bedded, the upper surface being 66 feet above sea level.

The fossiliferous bed can be traced round the Amphitheatre, where a lithological change from the sandstone to an arenaceous fossiliferous limestone takes place. An enlarged scale map of the Amphitheatre has been included on the geological map to show the main physiographical features and distribution of the formations present. The highly fossiliferous sandstone swings round the cliff face above Black Cliff and gradually feathers out along portion of the northern face of the Amphitheatre, where the overlying Earlier ? Pleistocene sediments rest directly upon the younger till. The sandstone gradually comes in again in the vicinity of the washouts in the north-eastern part of the Amphitheatre, where the formation thickens rather suddenly, and changes to a very arenaceous highly fossiliferous limestone. Large boulders and erratics have been caught up on the underside and in the basal portion of the fossiliferous bed, with occasional boulders in the central and upper part of the formation, in this region. The boulders which are generally well rounded include quartzites, shales, slates and granites. Percolating (and surface) ground water has dissolved some of the calcium carbonate out of the limestone and redeposited it in the upper part of the boulder bed of the till. This feature is particularly noticeable in the immediate vicinity of the washouts. The fossiliferous bed continues to outcrop round the small washouts and intervening spurs of the Amphitheatre to a few yards south of the line of Section C-C (see enlarged map). The thickness of the formation ranges from about 12 inches to about 3 feet 9 inches, and the lithological features alternate from the calcareous sandstone to the arenaceous limestone. The southerly extension of the formation from the line of Section C-C thins out considerably, finally consisting of very thin elongated lenses of arenaceous limestone ranging up to 3-5 inches in thickness, irregularly spaced, with the last lens a few chains north of the fault-line situated in the southern part of Section 567 (Noarlunga). No further outcrops of the Lower Pliocene were observed between the last lens mentioned and the spur which forms the southern end of Hallett Cove. It is suggested that the Lower Pliocene formation was removed by erosion in the sector just referred to before the fault situated in the southern part of Section 567 (Noarlunga) occurred. A traverse made round the Amphitheatre along the top of the fossiliferous bed with an aneroid, indicates that the formation is sub-horizontally bedded with gentle undulations, the normal height of the upper surface of the bed above low water being about 114 feet.

Two very small remnants, representing the former extension of the fossiliferous bed, occur along the cliff face south of the Cove. The first outcrop is on the spur which forms the southern end of Hallett Cove (extreme south-western corner of Section 567, Noarlunga), where a very thin lens of calcareous sandstone ranging up to about 6 inches in thickness overlies the younger till at a height of 66 feet above low water. The second exposure is on the southern side of a small washout (on the line of Section D D) where the bed consists of an elongated narrow band of arenaceous limestone having a maximum thickness of 5 inches and overlying (unconformably) the younger till. The second locality described is the most southerly outcrop of the fossiliferous bed within the region under review noted by the writer.

The fossiliferous formation has been examined by Mrs. Ludbrook (in company with the writer), who states:

"The bed in question is that described by Howchin in 1923 (5, p. 289), in which he gives a list of fossils occurring in the formation. Howchin considered it to be of Lower Pliocene age, it being contemporaneous with the Upper Aldingan beds, and the bed formerly exposed behind Government House, Adelaide; also revealed in borings in or near the City.

Chapman in 1916 (Rec. Geol. Sur. Vict., *iii*, vol. iv., p. 411) correlates the South Australian beds with the Victorian Kalimnan, though later (Chapman and Crespin, 1935, Rep. A.N.Z.A.A.S., vol. xxii, p. 125) places the Upper Aldingan and the Hallett Cove beds in the Upper Pliocene, apparently on account of the occurrence of *Marginopora vertebralis*.

There seems to be a closer relationship between the South Australian deposits and the Kalimnan than between them and the Werrikooian. It is noteworthy that both the Aldingan and the Hallett Cove beds have very few fossils and those that do occur are typical of neither the Kalimnan nor the Werrikooian. They are, however, more closely related to the former than to the latter which has a far higher percentage of Recent species. It appears, therefore, more satisfactory to designate the Hallett Cove bed as Lower Pliocene. In the bed at Hallett Cove most of the fossil remains are casts and difficult to identify. They are best preserved in the Amphitheatre, where the rock is softer. Here *Ostrea* and *Chlamys* are numerous. *Marginopora vertebralis* shows plainly on weathered surfaces, and is apparently the commonest and best preserved form. Casts of ? *Anapella* are extremely numerous in some places and a large undescribed cerithioid gasteropod occurs as internal casts. The only species noticed in addition to those recorded by Howchin are *Myadora corrugata*, *Peneroplis pertusus* and *Turritella* sp."

The result of the study and distribution of the fossiliferous formation in the vicinity of Hallett Cove has brought forward several interesting facts.

(*a*) The formation has been subjected to considerable erosion, as evidenced by the smooth, gently eroded and weathered surface subsequent to its deposition—in many instances the bed has been entirely removed before the deposition of the Early ? Pleistocene mottled clays.

(*b*) The formation has been disturbed by faulting as shown by the wide range in the levels of the deposit above low water.

(*c*) All outcrops of the fossiliferous bed overlie (unconformably) the younger till only, and do not extend beyond the northern and southern extensions of the till within the region examined and shown on the geological map.

(h) EARLY ? PLEISTOCENE

The formation which has been tentatively classified as Early ? Pleistocene overlies the Lower Pliocene and generally consists of mottled reddish to olive-brown and greyish sandy clays, grits and gravels. These sediments were examined by Tate, Howchin, and David, who stated that: ". . . . No fossils as yet have been found in them" . . . . and that they . . . . "are probably of Miocene[9] age, though possibly later" (2, p. 319). The interesting feature noted in connection with this classification is that Tate, Howchin and David did not specifically mention any stratigraphical break or discordance in the normal order or deposition of sediments between the fossiliferous sandstone and the overlying sandy clays, etc.

Many years later Howchin assigned to these sandy clays, etc., a Pleistocene age, in view of his classification of the underlying highly fossiliferous bed as Lower Pliocene (8, p. 133, fig. 73, and p. 135, fig. 76).[10]

The writer has noted that the lithological characteristics of the formation under review vary considerably. A good exposure of the bed occurs in the north-western part of Section 566 and a short distance north of Black Cliff, where there is a prominent outcrop of the fossiliferous sandstone cut by a washout. On the northern side of the washout the formation consists of a coarse-grained sandy clay carrying numerous angular (with occasional rounded) boulders and pebbles, which on being traced northwards through Section 562 and 561, into the south-western corner of Section 560 (Noarlunga), feathers out against quartzites and shales on the top edge of the sea cliff. On the southern side of the washout the formation consists of mottled sandy clays with occasional small rounded boulders and pebbles, which can be traced round Black Cliff to the Amphitheatre, at the northern end of which they are mottled reddish-brown and light grey argillaceous sands with rounded (water-worn) clear and milky grains of quartz which range from fine grains to coarse pebbles. The bed has a general appearance of stratification (which is sub-horizontal). The mottled sandy-clays occupy the upper portion of the retreating cliffs of the Amphitheatre, and extend south as far as the fault adjacent to the small creek in the south-western corner of Section 567. The fault is Post Pleistocene in age, as has been described already—the Early ?

(9) This classification was based on the supposition that the underlying highly fossiliferous sandstone was of Miocene age.

(10) On the figures (73 and 76) Howchin shows the fossiliferous sandstone as "Miocene (Marine)" and "Marine Miocene," respectively, but in the text, on p. 135, he refers to the formation as Lower Pliocene.

Pleistocene sandy-clays having been faulted down (with the underlying younger till) on the southern side of the creek.

It is of interest to note that the basal three feet of the Early ? Pleistocene sandy-clays consists of a bed carrying several well-defined bands of small, rounded and angular pebbles, which show a stratification which is sub-horizontal. The bands of pebbles gradually become less prominent on passing up into the reddish-brown argillaceous sand, which is about 10 feet in thickness. The normal mottled sandy-clays overlie the argillaceous sands.

The Early ? Pleistocene sediments form a very prominent outcrop along the upper retreating slope of the sea-cliffs south of Hallett Cove, where the formation ranges up to over 150 feet in thickness. A very marked change occurs in the lithological features of the deposit on passing southwards from the bluff (at the southern end of the Cove), particularly in Sections 569 and 572 (Noarlunga). Adjacent to the bluff the lower-most beds consist of sandy grits and occasional fine gravels, which pass laterally (in a southerly direction) into extremely coarse-grained gravels and boulder beds, especially in the vicinity of the line of Section E-E (see fig. 5). The boulders consist of dense, grey quartzites (ranging up to $2\frac{1}{2}$ feet diameter), granite (over 3 feet diameter), dolomitic limestones, slates, etc. The main boulder gravel bed ranges up to about 40 feet in thickness, the upper-most portion of the formation being about 104 feet above low water. In the region of the large washout situated in the north-western corner of Section 581 (in the extreme south-westerly corner of the geological map) the Early ? Pleistocene formation consists of a white argillaceous sand rock carrying numerous small water-worn pebbles and grit with occasional larger boulders. The deposit ranges up to over 60 feet in thickness, and is horizontally bedded (see pl. iii, fig. 1).

An approximately north-south fault cuts obliquely across the Purple Series, forming the cliff and beach in Section 577 (Noarlunga), and north of Curlew Point. The Early ? Pleistocene sediments overlying this fault have been deposited subsequent to the period of faulting which has cut the Purple Series.

The Early ? Pleistocene sands and gravels were traced in an easterly direction (inland) as far as the southerly tributary of Hallett Cove along the eastern boundary of Section 576 (Noarlunga).

Although travertine limestone conceals the underlying formations to the east of the Amphitheatre, the Early ? Pleistocene mottled sandy-clays have been exposed in the Adelaide-Willunga railway cutting in Section 487 (Noarlunga), particularly in the vicinity of the Hallett Cove road bridge over the railway cutting,[11] where the beds exhibit lithological features similar to those present at the Amphitheatre. The upper-most surface of the Early ? Pleistocene clays is 396 feet above low water. The writer has not ascertained the maximum easterly extension of the Early ? Pleistocene formations in the region under review.

The reddish-brown and greyish mottled sandy-clays carrying many large perfectly smooth water-worn boulders have been exposed in the central railway

[11] The railway cutting is situated about ¼ mile east of the eastern boundary of the geological map.

cutting (Section 560, Noarlunga), where the maximum thickness of the formation is 7 feet. The clays are overlain by travertine limestone.

(j) LATE ? PLEISTOCENE TO RECENT

Sediments which are classified as being of Late ? Pleistocene to Recent age consist of the alluvium filling the floors of the valleys and gullies, and the flats bordering the lower reaches (near the outlet to the sea) of Hallett Creek.

The travertine limestone which covers a considerable portion of the high-level country in the region under review (and elsewhere) is regarded as being representative of an old land surface. The wind-blown calcareous sands and ridges are included in this classification.

A narrow raised beach occurs a few yards distant from high-water mark on the beach at the northern end of the Amphitheatre. The deposit, which consists of loosely consolidated sands and shelly fragments, dips westerly at an angle of about 20° and is from 8-10 feet in thickness. The upper surface is sub-horizontal with very gentle undulations, and has the appearance of having undergone erosion. Wind-blown sand ridges rest upon the upper surface of the deposit (see fig. 3, Line of Section C C). A representative sample of the sediments comprising the raised beach just described has been examined by Mrs. Ludbrook, who has made the following determinations and remarks:

"Red sands washing down to water-worn quartz sand with a few foraminifera identified as:

Discorbis dimidiatus, Eponides haidingeri, Cibicides ungerianus, c.f. *Cibicides refulgens,* c.f. *Elphidium* sp.

"These species indicate that the deposit is of Late Tertiary—Recent age, but in the absence of associated mollusca more restricted determination cannot be made. The material is very badly preserved."

A small deposit of gravels cemented together by oxide of iron occurs on the upper slope of the retreating cliff of the coast in Section 569 (Noarlunga). These cemented gravels represent the remains of an old river system of very Late ? Pleistocene times.

A low retreating scarp consisting of a dense sandstone ranging up to about 8 feet in thickness, crosses the eastern part of Section 565 (Noarlunga) and about $\frac{5}{8}$ of a mile south east from the Amphitheatre. The sandstone has been tilted towards the south at a shallow angle, as shown by the aneroid readings taken during a traverse along the upper surface of the formation and recorded on the geological map. At the northern end of the outcrop the upper surface of the bed is 318 feet above low water but at the southern end on the Hallett Cove (beach) road, the sandstone is 291 feet above low water. No fossils were observed in the sandstone. Howchin has described the sandstone as an elevated retreating scarp of Lower Pliocene age, but the writer has observed the presence of the mottled sandy-clays of the Early ? Pleistocene age beneath this sandstone, so that the formation is now regarded as Late ? Pleistocene in age.

3 SUMMARY AND CONCLUSIONS

The geological formations present in the region of Hallett Cove and immediate district have been critically examined and mapped in detail.

The oldest formations present consist of a series of rapidly alternating beds of quartzite, shale, dolomitic limestone and sandstones with grits, of the Upper Series (C 1-4), Middle Pre-Cambrian, the upper-most bed being a dense massive quartzite (C 2). The quartzite is overlain by the Sturtian Tillite (D 1) of Upper Pre-Cambrian age. Faulting has considerably disturbed these old formations, as a wide gap in the normal succession of sediments of Upper Pre-Cambrian age occurs, as the next formation noted consists of purple slates, shales, etc., of the Purple Series (D 6), the Tapley's Hill Series (D 3) being completely absent. The purple shales pass up conformably to the highest horizon of the Upper Pre-Cambrian succession the quartzites of Flinders Range Sandstone—Quartzite Series (D 7). These formations exhibit all of the characteristic lithological features associated with the rocks of similar age examined in the Flinders Range, etc., indicating the very extensive nature of the Pre-Cambrian seas. Lower Cambrian rocks are represented by massive beds of limestones and calcareous shales and slates.

One of the most important formations present is the well-known glacial till which is usually regarded as being of Permo-Carboniferous age. The general distribution and lithological characteristics of the till are described and references made to new localities in the Mount Lofty Range (Mount Barker and Sellick Hill township) and near Port Vincent (Yorke Peninsula), where the till has been examined and mapped by the writer.

In the present paper this glacial deposit is referred to as the "Younger Till" to distinguish it from the older Sturtian Tillite of Upper Pre Cambrian age, which is present also in the district. The writer discusses the probability of this till being comparable with the Lower Cretaceous glaciation of Central Australia and Northern South Australia, and states his reasons why he regards the deposit as being much younger in age than late Palaeozoic.

The evidence to support the suggestion that the younger till is of Lower Cretaceous age is briefly summarised as follows:

(a) Although the known exposed area of the till in the Southern Mount Lofty Range covers at least 280 square miles of country (the suspected concealed area amounting to approximately an additional 65 square miles), portion of which formation extends across the range from coast to coast (Victor Harbour-Normanville), there is an almost entire absence of faulting in the glacial material, with the exception of certain Post-Pleistocene faults near the margins of the coast and glacial valleys (see fig. 8). The underlying formations, however, are highly disturbed by both folding and faulting, many of the faults being regarded as having accompanied the initial general uplift of the Mount Lofty Range.

(*b*) The fact that the deposits of the younger till are but little disturbed, being generally sub-horizontally bedded, a feature which is characteristic also of the overlying Tertiary sediments (Miocene to Pleistocene). The only faulting noted in the younger till being apparently comparable with the Post-Pleistocene faulting which has accompanied the late tectonic movements (uplift and downthrow) of the Mount Lofty Range.

(*c*) From the examination and distribution of the deposits of the younger till in the Southern Mount Lofty Range, the fact has now been well established that the younger glaciation consisted almost entirely of land ice. This fact, together with the evidence of (*a*) and (*b*) obviously suggests that the initial general uplift of the Mount Lofty Range occurred prior to the glacial epoch.

(*d*) The entire lack of evidence to support the suggestion that the younger till (if of Late Palaeozoic age?) was protected by a thick cover of Mesozoic and Tertiary sediments which would appear to be necessary to preserve the loose unconsolidated glacial material from complete erosion during the long interval of time between the Permian period and the present day.

(*e*) It is considered by the writer that the younger till bears no lithological features, whatsoever, comparable with the undoubted Permian glacial beds of Victoria (Bacchus Marsh).

(*f*) The failure to locate any palaeontological evidence such as spores, etc., in many samples of the till collected from widely separated localities in the Southern Mount Lofty Range and critically examined, although ample palaeontological evidence has been obtained from the Permian glacial beds at Bacchus Marsh (Victoria); the *Glossopteris* bearing shales from South Rewa Gondwana Basin, Central India (32); and well-preserved impressions of *Gangamopteris* immediately below the Dwyke Tillite, South Africa. (Leslie, Proc. Geol. Soc. S. Africa, 1921, pp. 19-30).

(*g*) The evidence of a Lower Cretaceous glaciation over a very wide region in the north of South Australia, and in Central Australia, with which the younger till present in the southern portion of the State can be correlated.

The Lower Pliocene, Early ? Pleistocene and Late ? Pleistocene to Recent sediments are described.

Unconformities occur at the base and the top of the younger till, and it has been suggested that a disconformity (if not an unconformity) exists at the top of the Lower Pliocene. An old land surface of Late ? Pleistocene to Recent age occurs at the top of the Early ? Pleistocene, as evidenced by the travertine limestone scarps.

A brief and general outline of the writer's interpretation of the physiographical history of the Mount Lofty Range is included in the text.

Attention is drawn to the presence of faults in the region, practically all of which are pre-younger glacial epoch in age. It has been shown that the east-west fault situated in the southern portion of Section 567 (Noarlunga) is Post-Early? Pleistocene in age. The tilting of the formations on the northern side of this fault is probably due to an uplift movement rather than a downward movement. When consideration is given to the present positions of the several outcrops of the younger till in particular in relation to sea level, both uplift and downthrow of the faulted blocks are evident.

List of References

1 Abstracts of the Proceedings of the Geological Society, London, No. 1.361, 16 June, 1939

2 Tate, Ralph; Howchin, W.; David, T. W. E. 1895 "Evidences of Glaciation at Hallett's Cove," A.N.Z.A.A.S., **6**, 315-320

3 Tate, Ralph 1878 Exhibited a glaciated rock from Hallett's Cove at Ordinary Meeting of the Philosophical Society of Adelaide, Trans. Philos. (Roy.) Soc. S. Aust., **2**,

4 Howchin, W. 1895 "New Facts bearing on the Glacial Features of Hallett's Cove," Trans. Roy. Soc. S. Aust., **19**, 61-69

5 Howchin, W. 1923 "A Geological Sketch-section of the Sea-cliffs on the Eastern Side of Gulf St. Vincent, from Brighton to Sellick's Hill, with Descriptions," Trans. Roy. Soc., S. Aust., **47**, 279-315

6 Howchin, W. 1924 "Further Discoveries of Permo-Carboniferous Glacial Features near Hallett's Cove," Trans. Roy. Soc. S. Aust., **48**, 291-302

7 Howchin, W. 1918 "The Geology of South Australia"

8 Howchin, W. 1929 "The Geology of South Australia," 2nd Ed.

9 Howchin, W. 1933 "A List of Original Papers and Other Works Published by," Trans. Roy. Soc. S. Aust., **57**, 242-249

10 Howchin, W. 1904 "The Geology of the Mount Lofty Range, Part 1—The Coastal District," Trans. Roy. Soc. S. Aust., **28**, 253-280

11 Segnit, Ralph W. 1937 "Pre-Cambrian–Cambrian Succession. The General and Economic Geology of these Systems in Portions of South Australia." Geo. Sur. S. Aust., Bull. 18

12 Mawson, Sir D. 1939 "The First Stage of the Adelaide Series: As illustrated at Mount Magnificent," Trans. Roy. Soc. S. Aust., **63**, (1), 69

13 Mawson, Sir D. 1926 "Varve Shales Associated with the Permo-Carboniferous Glacial Strata in South Australia," Trans. Roy. Soc. S. Aust., **50**, 160-162

14 Mawson, Sir D. 1907 "Minerological Notes 1 Barytes Sand Crystals," Trans. Roy. Soc. S. Aust., **31**, 119-120

Fig. 1 Contorted strata—Purple Series, coast looking south (north of Curlew Point) and platform of marine erosion.

Fig. 2 Sturtian Tillite (Upper Pre-Cambrian). Outcrop on beach between high and low water (platform of marine erosion) opposite Section 560 (Hundred Noarlunga).

Photo, R. W. S.

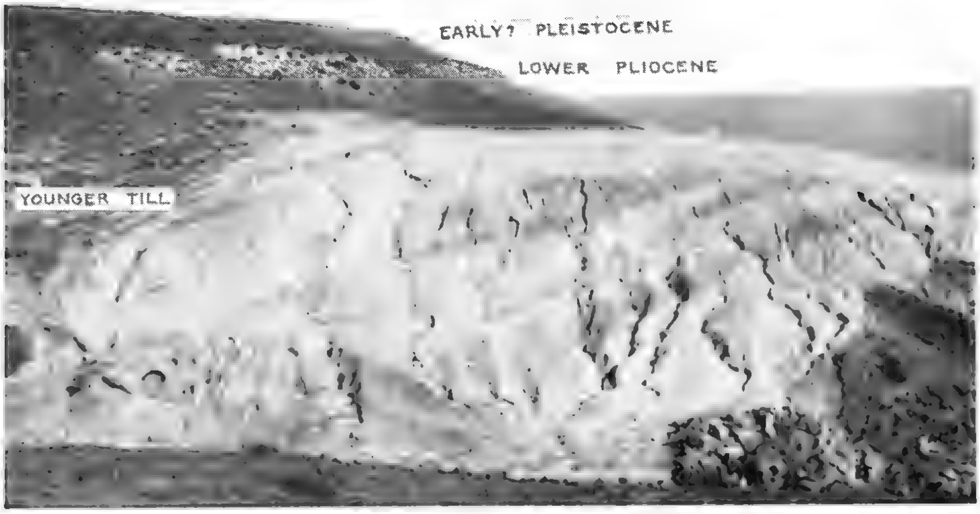


Fig. 1 Looking south across creek (boundary between Sections 562-566, Hundred Noarlunga), showing Early ? Pleistocene sediments overlying (disconformably Lower Pliocene fossiliferous sandstone, which has been deposited unconformably upon gently dipping Younger Till (Lower Cretaceous?). Strong unconformity between Till and Upper Pre-Cambrian Quartzites (D7).

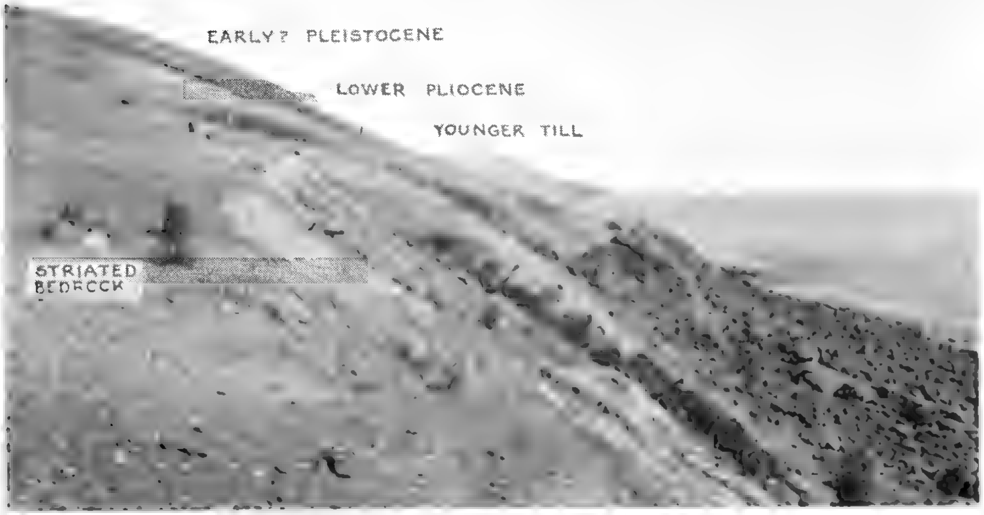


Fig. 2 Younger till overlying Purple shales and thin bands of Purplish quartzite. Striated bedrock in foreground. Coast looking south, Section 561 (Noarlunga).

Photo, R. W. S.

Fig. 1 Horizontally-bedded Early ? Pleistocene sands and fine-grained gravels. Washout near coast, north-western corner, Section 581, (Hd. Noarlunga).

Basal bed of Early ? Pleistocene sands, gravels and boulders, showing large water-worn erratic of quartzite derived from the erosion of the younger till, resting on smoothly polished surface of Purple shales. Cliff-face, coast in west centre of Section 575 (Hd. Noarlunga).

Photo, R. W. S.

15 SEGNIT, RALPH W. 1937 "Geology of the Northern Part, Hundred of Macclesfield," Geo. Sur. S. Aust., Bull. 16

16 MADIGAN, C. T. 1927 "The Geology of the Willunga Scarp," Trans. Roy. Soc. S. Aust., **51**, 396-409

17 JACOBSON, R., and SCOTT, T. R. 1937 "The Geology of the Korkuperimul Creek Area, Bacchus Marsh," Trans. Roy. Soc. Vict., **50**, (1), (N.S.), 110-156

18 FENNER, CHAS. 1931 "South Australia, a Geographical Study"

19 HOWCHIN, W. 1898 "Further Discoveries of Glacial Remains in South Australia," Trans. Roy. Soc. S. Aust., **22**, 12-17

20 HOWCHIN, W. 1911 "Description of a Disturbed Area of Cainozoic Rocks in South Australia, with Remarks on its Geological Signification," Trans. Roy. Soc. S. Aust., **35**, 47-59

21 BROWN, H. Y. L. 1894 "Annual Report, Government Geologist—From Strangways to Mount Paisley," 10

22 BROWN, H. Y. L. 1898 "Government Geologist's Report on Explorations in the Western Part of South Australia," Parl. Paper, No. 46, 5

23 BROWN, H. Y. L. 1902 "Record of Mines of S.A., Tarcoola and North-West District," 11

24 BROWN, H. Y. L. 1905 "Report on Geological Exploration in the West and North-West of South Australia," 5

25 JACK, R. LOCKHART, 1930 "Geological Structure and Other Factors in Relation to Underground Water Supply in Portions of South Australia," Geo. Sur., S. Aust., Bull. 14

26 JACK, R. LOCKHART 1915 "The Geology and Prospects of the Region to the South of the Musgrave Range, and the Geology of the Western Portion of the Great Australian Basin," Geo. Sur. S. Aust., Bull. 5

27 DAVID, SIR T. W. E., and HOWCHIN, W. 1923 "Report of the Glacial Research Committee," Proc. A.N.Z.A.A.S., **16**, 79-94

28 WARD, L. KEITH 1925 "Notes on the Geological Structure of Central Australia," Trans. Roy. Soc. S. Aust., **49**, 61-84

29 WARD, L. KEITH 1928 "A New Edition of the Geological Map of South Australia," Geo. Sur. S. Aust.

30 KENNY, E. J. 1934 "West Darling District—A Geological Reconnaissance with Special Reference to the Resources of Sub-Surface Waters," Min. Res., No. 36, Geo. Sur. Dept. Mines, N.S.W.

31 SEGNIT, RALPH W. 1935 "Andamooka Opal Field," S. Aust. Min. Rev., No. 62, 51-56

32 VIRRKI, C. 1939 "On the Occurrence of Similar Spores in a Lower Gondwana Glacial Tillite from Australia and in Lower Gondwana Shales in India," Proc. Indian Act. Sc., **9**, (1), Sec. B

33 HOWCHIN, W. 1913 "The Evolution of the Physiographical Features of South Australia,' Pres. Add. Sec. C., A.N.Z.A.A..S., **14**, 148-178

A NEW SPECIES OF METAPHYCUS (HYMENOPTERA, ENCYRTIDAE) FROM AUSTRALIA PARASITIC IN ERIOCOCCUS CORIACEUS MASKELL

By HAROLD COMPERE
University of California, Citrus Experiment Station, Riverside, Calif.
(Communicated by H. Womersley)

Summary

Metaphycus memnonius n. sp.
A distinctive species, largely black in colour, without lines on mesoscutum indicative of parapsidal furrows ; maxillary palpi four segmented, labial palpi three segmented; scape not expanded; frontovertex wide; ocelli in slightly less than a right angle; wings hyaline, uniformly ciliated.

A NEW SPECIES OF METAPHYCUS (HYMENOPTERA, ENCYRTIDAE) FROM AUSTRALIA PARASITIC IN ERIOCOCCUS CORIACEUS MASKELL

By Harold Compere
University of California, Citrus Experiment Station, Riverside, Calif.
(Communicated by H. Womersley)

[Read 11 April 1940]

Metaphycus memnonius n. sp.

A distinctive species, largely black in colour, without lines on mesoscutum indicative of parapsidal furrows; maxillary palpi four segmented, labial palpi three segmented; scape not expanded; frontovertex wide; ocelli in slightly less than a right angle; wings hyaline, uniformly ciliated.

Female: general colour black, the mesoscutum and axillae with the sides narrowly orange or testaceous in sharp contrast. Head partly orange or testaceous with the ocellar area and occiput black, the cheeks and the area between scrobes more or less brown or blackish. Antennae largely brown with the distal one or two funicle segments, apex of pedicel and part of the scape testaceous or sordid white. Concealed part of the pronotum black, the collar grading from white to testaceous. Tegulae white on basal portion and brown on apical portion. Pleura and sternum of thorax grading from black to dark brown, except the prepectus which is whitish, and sometimes the anterior portion of the mesopleura adjacent to the prepectus also whitish. Abdomen black. Legs partly white with extensive black to dark brown markings; middle and hind tibiae with two distinct wide bands; front tibiae less distinctly banded; front femora brown ventrally and blotched on dorsal margin near apex; middle femora either dirty white or variously suffused with brown; hind femora largely suffused with brown; fore and hind tarsi brownish; middle tarsi and tibial spur whitish; coxae grading from blackish or brown to whitish. Head, thorax and abdomen with fine, white hairs. Eyes not visibly hairy under ordinary magnifications. Notum of thorax very closely and strongly sculptured.

Frontovertex about one and one half times as long as wide. Posterior ocelli about once their own diameter from the occipital margin and close to the orbits. Antennae rather short; scape about four times as long as wide; pedicel twice as long as wide, almost as wide as the scape; first funicle segment about as wide as long, asymmetrical, the ventral margin longer than the dorsal margin; succeeding funicle segments symmetrical, very slightly increasing in size distad, all about as wide as long, and the sixth almost twice the size of the first; club about two and one-half times as long as wide, as long as the four preceding funicle segments combined.

Forewings large, slightly more than twice as long as wide, very finely and densely hairy distad of speculum; marginal fringe composed of hairs not much larger than those on the blade; a rather distinct triangular hairless spot at narrowest part of blade between basal part of submarginal vein and the posterior marginal hairless area. Speculum interrupted by three rows of hairs, the cut-off portion large, semi rounded and separated by one row of hairs from the posterior marginal hairless area. Veins dark brown; marginal vein about as long as wide; post-marginal vein extending distad almost as far as apex of stigmal vein, and plainly much longer than the marginal vein; submarginal vein furnished with about eighteen coarse hairs and slightly widened from near the middle to apex.

Abdomen short, rotund, about as long as the thorax. Ovipositor short, not exserted, the shaft extending about one half the length of abdomen, and the sheaths about twice as long as greatest width.

Length ranging near 1·0 mm.

Male: face, cheeks, and ventral half of posterior aspect of head pale yellow or whitish, except for the area between the scrobes which is brown. Scape concolorous with cheeks; pedicel blotched with brown on dorsum; funicle and club slightly dusky. Funicle segments, each with two whorls of long curved hairs.

Scape short, slightly more than twice as long as wide. Pedicel about one and one-half times as long as wide, plainly narrower than scape, subequal to first funicle segment in size. Funicle segments subequal, each about one and one-half times as long as wide. Club solid, as long as the preceding two funicle segments.

Described from 20 females and 11 males, holotype, allotype and paratypes, reared from *Eriococcus coriaceus* on *Eucalyptus* collected at Adelaide, South Australia, by L. J. Dumbleton, 1936. Types to be deposited in the British Museum and paratypes in the United States National Museum.

A NEW FLINDERSIAN CHITON

By B. J. WEEDING

Summary

In the Proc. Roy. Soc. Tasmania of March 1912 the late Dr. W. G. Torr described and figured as *Callocchiton mayi Acutoplax* collected by himself in a rock pool at Stanley, Tasmania.

A NEW FLINDERSIAN CHITON

By B. J. Weeding

Plate IV

[Read 11 April 1940]

In the Proc. Roy. Soc. Tasmania of March 1912 the late Dr. W. G. Torr described and figured as *Callochiton mayi* an *Acutoplax* collected by himself in a rock pool at Stanley, Tasmania.

In September of the same year he described, in Trans. Roy. Soc. S. Aust., another specimen under the same name, dredged by Sir Joseph Verco in Spencer Gulf, South Australia. This was done because the South Australian shell differed from the description he had given of the Tasmanian specimen.

The material collected in recent years proves that the two forms are specifically distinct, and the South Australian species is here described as:

Acutoplax cottoni n. sp.

(Pl. iv, figs. 1, 1a)

Shell medium, elongated oval, very highly elevated, carinated. Colour usually pinkish with dark red splashes. Measurement of dried specimen, 13 x 7 x 5·5 mm.

Anterior valve—erect and smooth, except for growth lines. Median valves—lateral areas prominently raised, nusculptured but corrugated with growth lines and sprinkled with numerous small ocelli; pleural areas with ten or twelve short sulci partly crossing the area and becoming shorter towards the beak, making the jugal area triangular and smooth. Posterior valve—anti-mucronal area grooved, post-mucronal area raised and corrugated with growth lines.

Girdle, teeth and internal features generic. Gills—fourteen each side, extending from valve three to eight.

Station—Dredged in shallow water.

Habitat—Spencer Gulf and Gulf St. Vincent, South Australia.

The specimen described and figured was dredged from the Fisheries Launch "Whyalla" in Spencer Gulf, March 1938. It is named after Mr. Bernard C. Cotton, Conchologist of the South Australian Museum, whose unfailing courtesy and ready helpfulness make the study of our Molluscan Fauna a pleasure.

A few other specimens from South Australia, listed in the Museum Collection under the name of *Acutoplax mayi* Torr, are conspecific with the above.

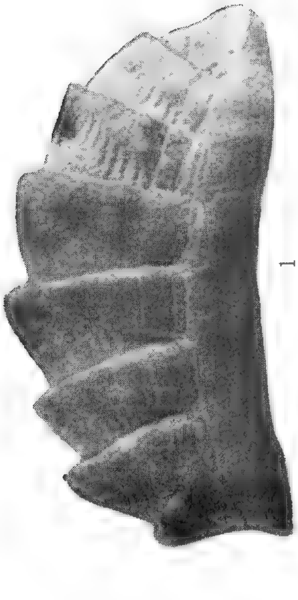
All species of this genus are still very rare. They may be compared as follows:

Acutoplax mayi Torr (pl. iv, figs. 2, 2a), which is a Tasmanian species, is figured for comparison. It is less elevated, the sulci are fewer, wider and more

2

2a

Acutoplax mayi



1

1a

Acutoplax cottoni

irregularly spaced. The lateral areas have two latitudinal ribs absent or obsolete in the South Australian species and the colour is quite distinct.

Acutoplax rufa Ashby is a red oval shell with a few weak, thin sulci partly crossing the pleural area. The granulation of the tegmentum is coarser than that of the preceding species.

Acutoplax klemi Ashby has not yet been recovered. It was founded upon a small worn valve with five very short sulci on the pleural area; it could not be confused with the species here described.

The Key to the Genus can be adjusted as follows:

Genus Acutoplax

Key to Species

a Shell highly elevated .. .. **cottoni** n. sp.
aa Shell normally elevated.
  b Some sulci extending across the pleural area .. .. .. *mayi* Torr
  bb No sulci crossing the pleural area.
    c Sulci extending half-way across the pleural area .. .. *rufa* Ashby
    cc Sulci extending one fourth of the pleural area .. .. .. *klemi* Ashby

A REVISION OF THE AUSTRALIAN GRACILARIIDAE (LEPIDOPTERA)

By A. JEFFERIS TURNER, M.D., F.R.E.S.

Summary

This interesting family, which contains some of the smallest and most delicate, as well as some of the most beautiful of the Lepidoptera, at present consists of about one thousand species referred to twenty-two genera. Its distribution is world-wide, but with the exception of the genus *Lithocolletis* the principal genera are more numerous in tropical and subtropical regions. Owing to their small size they do not attract the casual collector, and the number of species is destined to be very largely increased. With the exception of a few described by Stainton, our knowledge of the Australian species dates from a paper by Meyrick in the Proceedings of the Linnean Society of New South Wales in 1880. To him we owe the present classification of the family, which was given in the Genera Insectorum in 1912, with the exception of the genus *Phyllocnistis*, which was included in this family in his Revised Handbook of the British Lepidoptera in 1927. My own interest in the family commenced early; in fact, it was the main subject of my first entomological essay published in these Transactions in 1894.

A REVISION OF THE AUSTRALIAN GRACILARIIDAE (LEPIDOPTERA)

By A. Jefferis Turner, M.D., F.R.E.S.

[Read 11 April, 1940]

This interesting family, which contains some of the smallest and most delicate, as well as some of the most beautiful of the Lepidoptera, at present consists of about one thousand species referred to twenty-two genera. Its distribution is world-wide, but with the exception of the genus *Lithocolletis* the principal genera are more numerous in tropical and subtropical regions. Owing to their small size they do not attract the casual collector, and the number of species is destined to be very largely increased. With the exception of a few described by Stainton, our knowledge of the Australian species dates from a paper by Meyrick in the Proceedings of the Linnean Society of New South Wales in 1880. To him we owe the present classification of the family, which was given in the Genera Insectorum in 1912, with the exception of the genus *Phyllocnistis*, which was included in this family in his Revised Handbook of the British Lepidoptera in 1927. My own interest in the family commenced early; in fact, it was the main subject of my first entomological essay published in these Transactions in 1894.

To those who contemplate the study of the smallest Lepidoptera the *Gracilariidae* can be commended, as the family and genera are easy of recognition. In most cases their attitude of rest with the fore part of the body elevated and the legs displayed is characteristic. The presence in most of three-segmented maxillary palpi aids in their recognition, but in some these are minute. The larvae, which in the majority of species mine blotches beneath the cuticle of leaves, are not difficult to find and rear.

Family GRACILARIIDAE

Head smooth or more or less rough-scaled. Tongue well developed. Labial palpi moderate or long, straight or curved, usually slender and pointed. Maxillary palpi three-segmented, filiform, porrect; seldom minute or rudimentary. Antennae as long as or longer than forewings, seldom shorter. Forewings lanceolate or narrowly elongate; cell long, 7 to costa, 8 usually separate or absent, upper margin of cell usually obsolete in basal third. Hindwings narrowly lanceolate or linear; neuration sometimes much reduced; cilia 2 to 8. The scaling of the tibiae gives good generic characters. The family is probably an off-shoot from the *Plutellidae*.

Larvae with prolegs on segments 7, 8, 9 and 13, but not on 10; in *Phyllocnistis* almost apodal; with few exceptions mining blotches in leaves, but sometimes in the latest stages leaving the mines.

Key to Genera

1	Posterior tibiae with dorsal series of bristles		2
	Posterior tibiae without dorsal series of bristles		6
2	Antennae with small basal eye-cap	2 *Phyllocnistis*	
	Antennae without eye-cap		3
3	Middle tibiae with dorsal series of bristles	3 *Cuphodes*	
	Middle tibiae without dorsal series of bristles		4
4	Middle tibiae elongate and thickened with dense scales	4 *Cyphosticha*	
	Middle tibiae not thickened		5
5	Head rough or loose-haired on crown	5 *Epicephala*	
	Head smooth	6 *Acrocercops*	
6	Forewings with 11 absent; maxillary palpi minute	1 *Lithocolletis*	
	Forewings with 11 present; maxilliary palpi moderately long		7
7	Head rough haired		8
	Head smooth		9
8	Face smooth; middle tibiae thickened with scales and hairs	8 *Timodora*	
	Face rough-haired; middle tibiae smooth	7 *Aristaea*	
9	Middle tibiae smooth	9 *Parectopa*	
	Middle tibiae thickened throughout with dense scales	10 *Gracilaria*	

1 Gen. Lithocolletis

Hb. Verz., p. 423; Meyr., Proc. Linn. Soc., N.S.W., 1907, p. 51; Gen. Ins. Grac., p. 4.

Head rough or loose-haired on crown; face smooth. Labial palpi short or moderate, porrect or drooping, filiform, pointed. Maxillary palpi minute or rudimentary. Posterior tibiae hairy or smooth. Forewings narrow; 3, 4, 6, 8 and 11 absent. Hindwings linear-lanceolate or linear; cilia 4/5; 3, 4, and 6 absent.

Type *L. alnifoliella* Dup. from Europe. Larvae leaf-miners; pupae within the mines. A genus of about 250 species almost confined to North America and Europe, but with a few stragglers in India and Australia.

1 *L. stephanota* Meyr., *ibid.* 1882, p. 199. Larvae mining blotches in the leaves of *Desmodium* sp. and *Kennedya rubicunda (Leguminosae).* N.S.W.: Sydney.

2 *L. aglaozona* Meyr., *ibid.* 1907, p. 51. N.S.W.: Sydney.

3 *L. desmochrysa* Low., *ibid.* 1897, p. 23. *Nepticula nigricansella* Tepper. Trans. Roy. Soc. S. Aust., 1899, p. 280. N.S.W.: Broken Hill; S. Aust.: Adelaide. Larvae mining leaves of *Hardenbergia ovata (Leguminosae).*

4 *L. acares* Turn., Proc. Roy. Soc. Tasm., 1938, p. 100. Tasm.: Mount Wellington (4,000 feet).

2 Gen. Phyllocnistis

Zel. Lin. Ent., iii, p. 244 (1848); Meyr., *ibid.* 1880, p. 173.

Head smooth. Labial palpi moderate, porrect or drooping, filiform, slender, smooth, pointed. Maxillary palpi obsolete. Antennae with basal segment slightly dilated and concave beneath to form a small eye-cap. Posterior tibiae with a series of long bristles on dorsum. Forewings narrowly or very narrowly lanceolate; 3 and 4 absent, 6 and 7 stalked, 8 absent, 11 from beyond middle of cell. Hindwings linear-lanceolate, less than $\frac{1}{2}$, cilia 5 to 8; 3 and 4 absent, 6 and 7 stalked.

A genus of over 60 species represented in all continental areas. Some of the species are, as stated by Meyrick, amongst the smallest and most delicate of the Lepidoptera. Larvae apodal, mining leaves. Pupae in cocoons within the mines.

5 *P. leptomianta* Turn., Trans. Roy. Soc. S. Aust., 1923, p. 175. Qld.: Brisbane.

6 *P. atractias* Meyr., *ibid.* 1906, p. 64. Qld.: Brisbane. N.S.W.: Sydney.

7 *P. diplomochla* Turn., *ibid.* 1913, p. 175. Qld.: Bundaberg, Brisbane.

8 *P. diaugella* Meyr., *ibid.* 1880, p. 173, and *ibid.* 1906, p. 63. N.S.W.: Sydney.

9 *P. acmias* Meyr., *ibid.* 1906, p. 62. N.S.W.: Katoomba.

10 *P. psychina* Meyr., *ibid.* 1906, p. 62. W. Aust.: Albany.

11 *P. eurymochla* Turn., *ibid.* 1923, p. 175. N. Qld.: Cairns, Atherton.

12 *P. iodocella* Meyr., *ibid.* 1880, p. 174. N.S.W.: Sydney.

13 *P. hapalodes* Meyr., *ibid.* 1906; p. 63. W. Aust.: Albany.

14 *P. triortha* Meyr., *ibid.* 1906, p. 63. W. Aust.: Carnarvon.

15 *P. citrella* Sttn., Tr. Ent. Soc., 1856, p. 302; Fletch. Mem. Dept. Agr. Ind., vi (7), p. 171, and (9), p. 214; *minutella* Snel, Tijd. v. Ent., 1903, p. 87; *citricola* Nitobe., Formosa Agr. Rep., (8), p. 330. A pest on citrous trees in cultivation. N. Aust.: Darwin. Also from the Archipelago, Ceylon, India, China, Japan.

16 *P. ephimera* Turn., *ibid.*, 1926, p. 149. N. Qld.: Cairns; Qld.: Macpherson Range (3,000 feet).

17 *P. atranota* Meyr., *ibid.*, 1906, p. 64. N.S.W.: Sydney.

18 *P. enchalca* Turn., Proc. Roy. Soc. Tasm., 1938, p. 100. Tasm.: Hobart. The larvae were discovered by Dr. V. V. J. Hickman mining the leaves of *Plagianthes sidoides (Malvaceae)*.

3 Gen. CUPHODES

Meyr., P.L.S. N.S.W., 1897, p. 314.

Phrixosceles Meyr., Journ. Bombay Nat. Hist. Soc., 1908, p. 814; Gen. Ins., Grac., p. 13.

Head smooth. Labial palpi long, curved, slender, smooth. Maxillary palpi short, filiform, porrect. Antennae over 1. Middle and posterior tibiae and proximal tarsal segments with long bristly hairs on dorsum. Forewings narrow, 8 absent. Hindwings linear-lanceolate; cilia 6 to 8.

Type *C. thysanota* Meyr. A development from *Acrocercops* containing 20 species recorded from Indo-Malaya and Australia.

KEY TO SPECIES

1	Forewings with oblique fuscous sub-basal fascia	*holoteles*	
	Forewings without oblique sub-basal fascia		2
2	Forewings with eight irregular transverse lines of fuscous irroration in basal two-thirds	*lithographa*	
	Forewings without such lines		3
3	Forewings with a fine oblique transverse line		4
	Forewings without oblique transverse line		5
4	Forewings with inwardly oblique line near middle	*lechriotoma*	
	Forewings with inwardly oblique line subapical	*niphadias*	
5	Forewings with four pairs of fuscous transverse lines	*didymosticha*	
	Forewings without four pairs of transverse lines		6
6	Forewings with fuscous apical fascia	*thysanota*	
	Forewings without apical fascia		7
7	Forewings with blackish strigulae on dorsum	*maculosa*	
	Forewings without blackish strigulae	*habrophanes*	

19 *C. holoteles* Turn., P.L.S.N.S.W., 1913, p. 185. Qld.: Nambour.

20 *C. lithographa* Meyr., Gen. Ins. Grac., p. 13. N. Qld.: Cairns.

21 *C. lechriotoma* Turn., P.L.S.N.S.W., 1913, p. 185. N. Qld.: Cardwell.

22 *C. niphadias* Turn., *ibid.* 1913, p. 186. N. Qld.: Cairns.

23 **Cuphodes didymosticha** n. sp.

διδυμοστιχος, twin-lined

♂, 6-7 mm. Head, palpi, and thorax white. Antennae whitish, towards apex grey. (Abdomen missing.) Legs whitish. Forewings narrow, apex obtuse; white; four pairs of fine pale fuscous transverse lines at one quarter, middle, three-quarters, and tornus; some fine dorsal strigulae; a fine longitudinal fuscous subterminal streak; terminal edge fuscous; cilia grey. Hindwings linear-lanceolate; grey; cilia 6, grey.

N. Qld.: Kuranda; two specimens received from Mr. F. P. Dodd.

24 *C. thysanota* Meyr., P.L.S.N.S.W., 1897, p. 314; *sophopasta* Turn., *ibid.* 1913, p. 185. Qld.: Brisbane, Rosewood.

25 **Cuphodes maculosa** n. sp.

maculosus, speckled.

♂, ♀, 8 mm. Head, palpi, and thorax white. Antennae white with pale fuscous annulations; apex of basal joint blackish. Abdomen grey-whitish. Legs white with fuscous rings. Forewings narrow, obtusely pointed; white speckled with pale ochreous; dorsal edge suffused with ochreous and with a series of minute blackish strigulae; similar strigulae towards apex and on edge of termen; cilia white, on tornus and dorsum grey. Hindwings linear-lanceolate; grey; cilia 6, grey.

Qld.: Brisbane in September, Bundaberg in June and August; nine specimens.

26 **Cuphodes habrophanes** n. sp.

ἁβροφανης, soft, gentle

♂, ♀, 9-10 mm. Head, palpi, and thorax white. Antennae white, towards apex grey. Abdomen white. Legs white with fuscous rings. Forewings moderately narrow, obtuse; white with sparsely scattered fuscous scales; a fine blackish streak on apex of costa prolonged into cilia; cilia white, on tornus and dorsum grey. Hindwings narrow-lanceolate; grey; cilia 8, grey.

Qld: Brisbane in September; Bundaberg in June and September; nine specimens.

4 Gen. Cyphosticha

Meyr., P.L.S.N.S.W., 1907, p. 61; Gen. Ins. Grac., p. 22.

Head smooth. Labial palpi long, curved, slender, acute, smooth or with a tuft of hairs on second segment. Maxillary palpi moderate, filiform, porrect. Antennae over 1. Posterior tibiae with dorsal series of bristles. Middle tibiae elongate and thickened with dense scales. Forewings narrow, apex acute or obtuse. Hindwings narrowly lanceolate; cilia 5 to 6.

Type *C. pyrochroma*. An Australian genus, of which Meyrick records one species from Ceylon. I regard this and *Epicephala* also as developments from *Acrocercops*.

Key to Species

1	Labial palpi smooth		2
	Labial palpi tufted		7
2	Forewings without dorsal streak or series of spots	*panconita*	
	Forewings with dorsal streak or series of spots		3
3	Forewings with dorsal streak or spots yellow		4
	Forewings with dorsal streak or spots white		6
4	Forewings with dorsal streak		5
	Forewings with dorsal spot only	*microta*	
5	Forewings with dorsal streak indented but continuous	*pyrochroma*	
	Forewings with dorsal streak interrupted	*pandoxa*	
6	Forewings with dorsal streak	*dialeuca*	
	Forewings with dorsal spots only	*albomarginata*	
7	Forewings whitish with fuscous dorsal streak	*zophonota*	
	Forewings with whitish dots		8
8	Forewings purple-fuscous	*ostracodes*	
	Forewings ochreous-fuscous	*bryonoma*	

27 *C. microta* Turn., Tr. Roy. Soc. S. Aust., 1894, p. 128. Qld.: Brisbane.

28 *C. Pyrochroma* Turn., *ibid.* 1894, p. 129. Qld.: Brisbane; Tweed Hds. Macpherson Range (low level). N.S.W.: Lismore.

29 *C. pandoxa* Turn., P.L.S. N.S.W., 1913, p. 186. Qld.: Stradbroke Island.

30 *C. panconita* Turn., *ibid.*, 1913, p. 187. N. Qld.: Cairns; Qld.: Brisbane; N.S.W.: Murwillumbah.

31 *C. albomarginata* Sttn., Tr. Ent. Soc., (3), i, p. 294, 1960, pl. x, f. 3. Qld.: Brisbane, Tweed Hds.

32 **Cyphosticha dialeuca** n. sp.

διαλευκος, white right through.

♂, ♀, 8-10 mm. Head and palpi white. Antennae pale grey with fuscous annulations. Thorax white; tegulae grey. Abdomen fuscous; tuft whitish. Forewings narrow, apex obtuse; fuscous-grey; a white dorsal streak from base to tornus, broadest at base and gradually attenuated, unevenly edged; costal margin pale grey with fuscous dots; a white subapical dot partly edged with blackish; cilia grey, apices dark fuscous, on tornus and dorsum wholly grey. Hindwings narrowly lanceolate; grey; cilia 5, grey. N. Qld.: Dunk Island in May; two specimens.

33 *C. bryonoma* Turn., P.L.S.N.S.W., 1914, p. 563. N.S.W.: Ebor (4,500 feet).

34 *C. ostracodes* Turn., P.R.S.Q., 1917, p. 88. Tasm.: Cradle Mount (3,000 feet), Weldborough.

35 *C. zophonota* Turn., P.R.S.Tasm., 1926, p. 159. Tasm.: Cradle Mount (3,000 feet).

5 Gen. Epicephala

Meyr., Proc. Linn. Soc. N.S.W., 1880, p. 168; Gen. Ins. Grac., p. 13.

Head shortly rough-haired on crown with longer hairs projecting anteriorly between antennae; face smooth. Labial palpi rather long, porrect or drooping, filiform, smooth, pointed. Maxillary palpi moderate, filiform, smooth, pointed. Antennae over 1. Posterior tibiae with series of dorsal bristles. Forewings narrow, pointed; 11 from before middle. Hindwings narrow-lanceolate, about ½, cilia 3 to 4; 3 sometimes absent, 5 and 6 stalked. There are some 30 species in India, Ceylon, Africa, and Australia.

Type *E. colymbetella*. As some of the Australian species are very similar and need considerable care in discrimination, I give a key to the species.

Key to Species

1	Forewings with a white dorsal streak		2
	Forewings with a series of white dorsal spots	*epimicta*	
2	Forewings with dorsal streak straight-edged or nearly so		3
	Forewings with edge of dorsal streak irregular		8
3	Head ochreous on crown	*nephelodes*	
	Head white		4
4	Forewings with slender oblique costal streaks		5
	Forewings with costal streaks very short or dot-like		7
5	Forewings with first costal streak prolonged to reach dorsal streak	*eugonia*	
	Forewings with first costal not reaching dorsal streak		6
6	Forewings with two broadly suffused pretornal streaks	*trigonophora*	
	Forewings with pretornal streaks slender, distinct	*albistriatella*	
7	Forewings with dorsal streak indented in middle	*lomatographa*	
	Forewings with dorsal streak not indented in middle	*acrobaphes*	
8	Forewings with slender oblique costal streaks	*colymbetella*	
	Forewings with costal streaks very short or dot-like	*zalosticha*	

Additional distinctive characters are given for each species. Owing to confusion of species, some of the localities previously given were incorrect.

36 *E. australis* Turn., Tr. Roy. Soc. S. Aust., 1896, p. 2. Forewings with ground-colour fuscous-grey, much darker than in the other species; costal edge white from base to four-fifths; no antemedian costal streak. Qld.: Brisbane.

37 *E. albistriatella* Turn., *ibid.*, 1894, p. 129. Forewings with costal streaks slender. This is the smallest species. N. Qld.: Magnetic Island; Qld.: Yeppoon, Bundaberg, Nambour, Caloundra, Brisbane, Stanthorpe.

38 *E. nephelodes* Turn., P.L.S.N.S.W., 1913, p. 177. *E. stephanophora* Turn., Trans. Roy. Soc. S. Aust., 1923, p. 171. Forewings with costal streaks short and broad, the two posterior dot-like. Legs white with blackish rings. N. Qld.: Cairns, Dunk Island; Qld.: Brisbane, Stradbroke Island, Toowoomba.

39 *E. eugonia* Turn., P.L.S.N.S.W., 1913, p. 175. Forewings with costal streaks very distinct, long, slender. The type is still unique. This species should not be confused with *E. albifrons* Sttn. Trans. Ent. Soc., (2), v, p. 122, 1859, from India. Qld.: Brisbane.

40 *E. trigonophora* Turn., Trans. Roy. Soc. S. Aust., 1900, p. 21. Forewings with first costal streak dot-like, the two posterior long and slender. N. Qld.: Innisfail; Qld.: Stradbroke Island, Mount Tamborine; N.S.W.: Sydney.

41 *E. lomatographa* Turn., P.L.S.N.S.W., 1913, p. 176. Forewings with costal streaks short and dot-like. Hindwings of male with blackish dorsal line from base to one quarter. Qld.: Stradbroke Island.

42 *E. acrobaphes* Turn., Trans. Roy. Soc. S. Aust., 1900, p. 22. Forewings with costal streaks short and slender. Hindwings of male blackish in posterior half. Qld.: Brisbane, Stradbroke Island.

43 *E. colymbetella* Meyr., P.L.S.N.S.W., 1880, p. 169; Gen. Ins. Grac., f. 8, *E. frugicola* Turn., *ibid.*, 1913, p. 175. Forewings with costal streaks long and slender, the first sometimes reaching dorsal streak. N. Qld.: Cairns, Herberton, Dunk Island; Qld.: Brisbane, Stradbroke Island, Mount Tamborine, Bunya Mountains. The larva feeds on the seeds of *Phyllanthus Ferdinandi (Euphorbiaceae)* and the perfect insect emerges inside the capsule, where it remains until liberated by the dehiscence.

44 **Epicephala zalosticha** n. sp.

ξαλοστιχος, white-lined, like the surf

♂, ♀, 10-12 mm. Head, palpi, and thorax white. Antennae and abdomen grey. Legs pale grey with whitish rings. Forewings grey with white markings; three short dot-like streaks at one-third, middle, and two-thirds; a broad dorsal streak deeply indented before and after a median projection, with a continuation to middle of termen, this portion being irregularly thickened and including one or two fine grey lines; a leaden-fuscous transverse line from five-sixths costa to tornus; apical area beyond this whitish with a blackish central spot surrounded by grey; cilia grey, bases and apices blackish, on tornus and dorsum wholly grey. Hindwings lanceolate; grey; cilia 4; grey. Qld.: Stradbroke Island, Tweed Hds.; N.S.W.: Sydney.

45 *E. epimicta* Turn., P.L.S.N.S.W., 1913, p. 183. N. Qld.: Cairns; Qld.: Brisbane, Toowoomba.

6 Gen. Acrocercops

Wlgrn. Ent. Tidskr., ii, p. 95; Meyr., Gen. Ins. Grac., p. 14. *Conopomorpha* Meyr., P.L.S.N.S.W., 1907, p. 54

Head smooth. Labial palpi moderately long, straight or curved, porrect or drooping, or curved upwards, usually smooth but sometimes rough-scaled or with a tuft on second segment, pointed. Maxillary palpi short or moderate, rarely minute or obsolete. Antennae as long as or longer than forewings. Middle tibiae not thickened. Posterior tibiae with a regular series of dorsal bristles. Forewings narrow; 3 sometimes absent, 6 and 7 sometimes stalked, 11 from before middle. Hindwings narrowly lanceolate or linear-lanceolate; cilia 4 to 8.

Type *A. brongniardella* Fab., from Europe.

This genus comprises about 240 species and is represented in all regions, but is most numerous in Indo-Malaya and Australia. In the latter most of the species occur in the eastern coastal region from Sydney northwards. Larvae usually mining blotches in leaves, seldom in fruits or galls. Pupae sometimes within the mines, more often in a cocoon outside.

The species may usually be easily recognised from their peculiar resting position with the anterior end raised upwards and the conspicuous maxillary palpi, but the first four species are exceptional in having these minute or obsolete. From the other nearly allied genera it is distinguished by the scaling of the middle and posterior tibiae.

Among the numerous species three natural groups may be recognised: (1) Those with minute maxillary palpi and brassy-metallic forewings with white costal and dorsal streaks. (2) Those with one or more white transverse fasciae. (3) Those with a white longitudinal streak on or near dorsum. The remaining species are diversified and not adapted for grouping.

46 *A. eupetala* Meyr., P.L.S.N.S.W., 1880, p. 160. Qld.: Nambour, Brisbane.

47 *A. cuneatella* Meyr., *ibid*, p. 160. Larvae in galls on *Acacia*. Qld.: Brisbane, Toowoomba, Warwick, Bunya Mountains (3,500 feet); N.S.W.: Sydney; Vict.: Gisborne; Tasm.: Mount Wellington (1,500 feet), Deloraine.

48 *A. heliopla* Meyr., *ibid*., 1907, p. 57. Qld.: Brisbane; Tasm.: Hobart.

49 *A. alysidota* Meyr., *ibid*, 1880, p. 161; Gen. Ins. Grac., f. 10. Larvae in phyllodia of *Acacia longifolia*. Qld.: Brisbane, Warwick; N.S.W.: Sydney; Vict.: Sale, Healesville; S. Aust.: Port Lincoln; W. Aust.: Albany, Perth.

50 *A. tricalyx* Meyr., Exot. Mocro., ii, p. 465. N. Qld.: Cairns.

51 *A mesochaeta* Meyr., *ibid.*, ii, p. 294. Qld.: Brisbane.

52 *A. ordinatella* Meyr., P.L.S.N.S.W., 1880, p. 145, and Exot. Micro, i, p. 624; Fletcher, Mem. Agr. Dep. Ind., vi, (6), p. 146. N. Qld.: Cairns, Eungella; Qld.: Gympie, Nambour, Brisbane, Mount Tamborine, Macpherson Range (3,000 feet); N.S.W.: Port Macquarie, Sydney. Also from Ceylon and India. In India the larvae have been found in the leaves of *Alseodaphne semocarpifolia* and *Litsea* sp. *(Lauraceae)*.

53 *A. irrorata* Turn., Trans. Roy. Soc. S. Aust., 1894, p. 124. Qld.: Brisbane, Beaudesert, Toowoomba, Dalby, Milmerran, Cunnamulla; N.S.W.: Sydney, Broken Hill; S. Aust.: Adelaide.

54 *A. pertenuis* Turn., *ibid.*, 1923, p. 171. Qld.: Tweed Hds.

55 *A. hedymopa* Turn., P.L.S.N.S.W., 1913, p. 181. N. Qld.: Cairns, Atherton Plateau; Qld.: Nambour.

56 *A. apoblepta* Turn., *ibid.*, 1913, p. 180. N. Qld.: Cairns.

57 *A. autadelpha* Meyr., *ibid*, 1880, p. 147; *symphyletes* Turn., *ibid*, 1913, p. 179. N. Qld.: Cairns; Qld.: Brisbane, Mount Tamborine, Macpherson Range (3,000-3,500 feet); N.S.W.: Sydney, Mittagong.

58 *A. antigrapha* Turn., Trans. Roy. Soc. S. Aust., 1926, p. 147. Differs from *A. autadelpha* in the third fascia being broader on costa, and the presence of costal and dorsal spots beyond this, sometimes uniting to form a fourth fascia. Qld.: Macpherson Range (3,000 feet), Bunya Mountains (3,500 feet).

59 **Acrocercops antimima** n. sp.

ἀντιμιμος, closely imitating.

♀, 11-12 mm. Head, palpi, and thorax white. Antennae and abdomen grey. Legs white with dark fuscous rings. Forewings narrow, apex rounded; shining snow-white; markings brownish-fuscous edged with dark fuscous; a narrow basal fascia, succeeded by three rather narrow fasciae with irregularly dentate margins, sub-basal, at two-fifths, and at three-fifths; a fifth oblique fascia from four-fifths costa to termen above tornus, its anterior edge incurved; a large apical spot extending to termen, partly confluent with fifth fascia, leaving extreme apex and a dot on termen white; cilia on apex white with dark fuscous apices, beneath apex dark fuscous on a narrow band edged beneath with white, the remainder pale grey. Hindwings linear-lanceolate; grey; cilia 4, pale grey. Nearest *A antigrapha*, from which it differs in larger size, fasciae narrow, differently shaped, and not straight-edged, and by the distinctive cilia. New South Wales: Ebor (4,500 feet) in December; two specimens.

60 *A. macaria* Turn., P.L.S.N.S.W., 1913, p. 181. Qld.: Caloundra (Bribie Island). A series reared from larvae mining the leaves of *Halfordia drupifera (Rutaceae)*. Very near the preceding, but the first three fasciae are considerably narrower, and this difference appears constant.

61 **Acrocercops chionosema** n. sp.

χιονοσημος, with snow-white markings

♂, 7-8 mm. Head whitish-grey; face white. Palpi white with fuscous rings on apex of second and middle of terminal joints. Antennae dark grey; basal joint white with fuscous apex. Thorax fuscous with a pair of white spots. Abdomen grey. Legs white with blackish rings. Forewings narrow, apex rounded; brownish-fuscous with snow-white markings; four transverse blackish-edged fasciae; first basal, very narrow; second at one-fourth, moderately broad, narrower on costa; third median, narrow, more so on costa; fourth at three-fourths, somewhat constricted in middle; a very slender interrupted blackish-edged line from costa before apex to termen; a white apical dot; cilia white, apices fuscous, on lower termen and dorsum grey. Hindwings linear-lanceolate; grey; cilia grey. Readily distinguished from *A. macaria*, to which it has a general resemblance, by the white apical spot on forewings and the different position of the fourth fascia, which in that species runs to termen. Qld.: Macpherson Range (3,000-3,500 feet) in December; two specimens.

62 *A. tetrachorda* Turn., *ibid.*, 1913, p. 180. N. Qld.: Cairns. The fourth fascia is about twice the breadth of the other three.

63 *A. zaplaca* Meyr., *ibid*, 1907, p. 54. Qld.: Caloundra, Toowoomba; N.S.W.: Sydney.

64 *A. argyrodesma* Meyr., *ibid*, 1882, p. 194. Larvae in leaves of *Grevillea linearis (Proteaceae)*. N.S.W.: Sydney.

65 *A. clinozona* Meyr., Exot. Micro., ii, p. 291. Qld.: Brisbane.

66 *A. tricuneatella* Meyr., P.L.S.N.S.W., 1880, p. 146. Larvae in blotches on upper surface of leaves of *Typha latifolia (Typhaceae)*. Pupal cocoons inside the mines. Qld.: Brisbane; N.S.W.: Sydney.

67 *A. caenotheta* Meyr., *ibid*, 1880, p. 148. Larvae mine leaves of the Waratah *Telopea speciosissima (Proteaceae)*. N.S.W.: Katoomba.

68 *A. chionoplecta* Meyr., *ibid.*, 1882, p. 195. Larvae in leaves of *Phebalium dentatum (Rutaceae)*. N.S.W.: Sydney.

69 *A. leucotoma* Turn., *ibid*, 1913, p. 180. Qld.: Brisbane.

70 *A. hoplocala* Meyr., *ibid.*, 1880, p. 149; Gen. Ins. Grac., f. 7. Qld.: Mount Tamborine, Yeppoon; N.S.W.: Sydney.

71 *A. calicella* Sttn., Tr. E. S., (3), i, p. 297, 1860; Meyr., P.L.S.N.S.W., 1880, p. 150; Turn., Trans. Roy. Soc. S. Aust., 1894, p. 124. Larvae in leaves of *Eucalyptus* sp. Qld.: Brisbane, Macpherson Range (3,500 feet); N.S.W.: Sydney, Bulli.

72 *A. albimaculella* Turn., Trans. Roy. Soc. S. Aust. Qld.: Brisbane.

73 *A. archepolis* Meyr., P.L.S.N.S.W., 1907, p. 56. S. Aust.: Wirrabara.

74 *A. euchlamyda* Turn., Trans. Roy. Soc. S. Aust., 1894, p. 126. Qld.: Brisbane, Tweed Hds.

75 **Acrocercops isotoma** n. sp.

ἰσοτιμος, equally divided

♀, 8 mm. Head and thorax white. Labial palpi whitish with two fuscous rings. Antennae fuscous; basal segment white. Abdomen whitish-grey. Legs white with blackish rings (posterior pair missing). Forewings grey-brown; seven narrow, slightly rippled, equidistant, white, blackish-edged, transverse fasciae; first sub basal; sixth incomplete, not reaching termen; seventh subapical, constricted in middle; a blackish apical dot; cilia fuscous, apices grey, on tornus and dorsum wholly grey. Hindwings almost linear; grey; cilia 8, grey. N. Qld.: Yungaburra (Atherton Plateau); one specimen from a larva mining the leaf of an unidentified shrub; imago emerged in Brisbane in July.

76 *A. pyrigenes* Turn., Trans. Roy. Soc. S. Aust., 1896, p. 1; *nitidula* Turn., *ibid.*, 1894, p. 128 (praeocc.); Qld.: Nambour, Brisbane.

77 *A. obscurella* Turn., *ibid.*, 1894, p. 125. Qld.: Brisbane, Toowoomba, Tweed Hds.

78 *A. symploca* Turn., P.L.S.N.S.W., 1913, p. 183. Qld.: Tweed Hds.

79 *A. poliocephala* Turn., *ibid.*, 1913, p. 182. Qld.: Brisbane.

80 *A. ophiodes* Turn., Trans. Roy. Soc. S. Aust., 1896, p. 2. Q.: Brisbane, Warwick; N.S.W.: Sydney.

81 **Acrocercops axinophora** n. sp.

ἀξινοφορος, carrying an axe

♀, 8 mm. Head white, ochreous-tinged on crown. Labial palpi whitish with fuscous rings. Antennae fuscous, towards base white. Thorax white. Abdomen grey. Legs whitish with numerous fuscous rings; posterior tibiae wholly whitish. Forewings moderately narrow; fuscous; markings white tinged ochreous and edged with blackish; a dorsal streak from base to one-third, thence continued as a broad slightly oblique fascia to one-third costa; a large semi-oval pretornal dorsal spot; a smaller triangular spot on midtermen, its apex connected by a very fine line with costa; two white streaks blackish-edged anteriorly from costa before apex to termen; cilia white, apices blackish opposite apex, with a blackish subapical hook, on tornus and dorsum wholly grey. Hindwings linear-lanceolate; grey; cilia 8, grey. Near *A. ophiodes*, of which it is the western representative. The forewings are proportionately broader, the head and markings ochreous-tinged, and basal marking of forewings broadly axe-shaped. W. Aust.: Margaret River in November; one specimen.

82 *A. plectospila* Meyr., Exot. Micro., ii., p. 469. N. Qld.: Cairns.

83 *A. doloploca* Meyr., *ibid.*, ii, p. 469. N. Qld.: Cairns.

84 *A. callimacha* Meyr., *ibid.*, ii, p. 293. Qld.: Brisbane.

85 *A. prospera* Meyr., *ibid.*, ii, p. 293. Qld.: Brisbane.

86 *A. leptalea* Turn., Trans. Roy. Soc. S. Aust., 1900, p. 21. Qld.: Brisbane.

87 *A. heteropsis* Low, *ibid.*, p. 1894, p. 112. Qld.: Duaringa, Charleville.

88 *A. chionochtha* Meyr., P.L.S.N.S.W., 1907, p. 59. S. Aust.: Quorn.

89 *A. nereis* Meyr., *ibid.*, 1880, p. 163; *fluorescens* Turn., Trans. Roy. Soc. S. Aust., 1894, p. 127. Qld.: Brisbane, Toowoomba; N.S.W.: Lismore, Sydney.

90 *A. chalceopla* Turn., P.L.S.N.S.W., 1913, p. 188; *chalcea* Turn., Trans. Roy. Soc. S. Aust., 1926, p. 147. N. Qld.: Kuranda; Qld.: Macpherson Range (3,000 feet).

91 *A. tristaniae* Turn., Trans. Roy. Soc. S. Aust., 1894, p. 130. Qld.: Brisbane. The larvae mine the leaves of *Tristania conferta* and *Eugenia ventenatii (Myrtaceae).*

92 *A. retrogressa* Meyr., Exot. Micro., ii, p. 467. Qld.: Brisbane; S. Aust.: Adelaide.

93 *A. parallela* Turn., Trans. Roy. Soc. S. Aust., 1894, p. 130, and *ibid.*, 1926, p. 147. N. Qld.: Cairns; Qld.: Nambour, Caloundra, Brisbane, Tweed Hds.

94 *A. grammataema* Meyr., Exot. Micro., ii, p. 468. N. Qld.: Cairns.

95 *A. laciniella* Meyr., P.L.S.N.S.W., 1880, p. 164. Qld.: Brisbane, Mount Tamborine, Toowoomba; N.S.W.: Sydney, Katoomba, Bathurst, Mount Kosciusko (5,000 feet); Vict.: Warragul, Gisborne; Tasm.: Launceston, Deloraine, Campbelltown; Hobart: Cradle Mount (3,000 feet); S. Aust.: Adelaide. Larvae mine the leaves of *Eucalyptus.*

96 *A. stereomita* Turn., *ibid.*, 1913, p. 182. Qld.: Eidsvold, Brisbane.

97 *A. plebeia* Turn., 1894, p. 131, and *ibid.*, 1926, p. 147. Qld.: Brisbane, Toowoomba, Warwick, Stanthorpe; N.S.W.: Sydney. The larvae mine the leaves of *Acacia podalyriaefolia,* a native of Queensland, much cultivated for ornamental purposes. Some years back this moth reached, or most probably was accidentally introduced into, Sydney, and multiplied to such an extent as to defoliate the trees.

98 *A. unilineata* Turn., *ibid.*, 1894, p. 131, and *ibid.*, 1926, p. 148. Qld.: Brisbane, Tweed Hds.

99 *A. leucomochla* Turn., *ibid.*, 1926, p. 148. Qld.: Yeppoon; N.S.W.: Sydney.

100 *A. didymella* Meyr., P.L.S.N.S.W., 1880, p. 164. N.S.W.: Sydney; Vict.: Melbourne; S. Aust.: Peterborough, Port Lincoln; W. Aust.: Albany. Larvae in phyllodia of *Acacia longifolia* and *A. cultriformis.*

101 *A. ochrocephala* Meyr., *ibid.*, 1880, p. 162. N.S.W.: Sydney.

102 *A. ochridorsella* Meyr., *ibid.*, 1880, p. 166. This and the following species are distinguished by the presence of a tuft of hairs on the second joint of labial palpi. N.S.W.: Sydney. Larvae mine the leaves of *Phyllanthus Ferdinandi (Euphorbiaceae).*

103 *A. aeolella* Meyr., *ibid.*, 1880, p. 167. N.S.W.: Wollongong.

104 *A. melanommata* Turn., *ibid.*, 1913, p. 184. N. Qld.: Cairns, Atherton Plateau.

105 *A. spodophylla* Turn., *ibid.*, 1913, p. 184. N. Qld.: Cairns.

106 *A. ochroptila* Turn., *ibid.*, 1913, p. 181. N. Aust.: Darwin; N. Qld.: Dunk Island, Townsville. Larvae abundant in Townsville mining leaves of *Terminalia catappa (Combretaceae).*

107 *A. mendosa* Meyr., Gen. Ins. Grac., p. 16. N. Qld.: Cairns.

108 *A. lithogramma* Meyr., Exot. Micro., ii, p. 296. Q.: Brisbane.

109 *A. hierocosma* Meyr., Gen. Ins. Grac., p. 18.; Fletch. Dep. Agr. Ind. (Ent.), vi, p. 153, pl. 38, f. 1. N. Aust.: Darwin. Also from India, where it has been bred from larvae mining the leaves of *Nephelium litchi (Sapindaceae).*

110 Acrocercops clisiophora n. sp.

κλισιοφορος, carrying a tent

♂, ♀, 6-7 mm. Head and palpi white. Antennae grey, towards base white. Thorax grey with a white central spot. Abdomen grey. Legs white with fuscous rings. Forewings narrow, obtusely pointed; ochreous-grey; a white blackish-edged sub-basal transverse line; two narrow oblique fasciae from costa at one quarter running to dorsum at one-fifth and three-fifths respectively, separating at a right angle, white with median blackish lines; a sinuate white blackish edged subcostal line from one half costa to beneath three quarters; between this and second fascia a suffused median blackish spot; a smaller blackish spot on costa at three-quarters; an oblique white subapical line edged anteriorly blackish; a white dorsal spot at two thirds connected by a sinuate white line with midtermen, both blackish edged; a white line on apical half of termen; cilia grey-whitish with a blackish subapical line, on costa greyish-ochreous, on tornus and dorsum grey. Hindwings almost linear; pale grey; cilia 8, pale grey. N. Qld.: Kuranda, near Cairns, in June; five specimens.

111 *A. habrodes* Meyr., P.L.S.N.S.W., 1907, p. 57. W. Aust.: Geraldton.

112 *A. penographa* Meyr., Exot. Micro., ii, p. 294. Qld.: Brisbane.

113 *A. antimacha* Meyr., P.L.S.N.S.W., 1907, p. 58. W. Aust.: Geraldton.

114 *A. crucigera* Meyr., Exot. Micro., ii, p. 295. Qld.: Brisbane.

115 *A. osteopa* Meyr., *ibid.*, ii, p. 292. Qld.: Brisbane.

116 *A. ennychodes* Meyr., *ibid.*, ii, p. 467. N. Qld.: Cairns.

117 *A. trisigillata* Meyr., *ibid.*, ii, p. 470. N. Qld.: Cairns.

7 Gen. Aristaea

Meyr., P.L.S.N.S.W., 1907, p. 52.

Head and face loosely rough-haired. Labial palpi long, straight, pointed; second joint with long bristly hairs anteriorly. Maxillary palpi short, filiform, porrect. Antennae 1. Middle and posterior tibiae smooth. Forewings rather narrow, dilated posteriorly, apex obtuse. Hindwings lanceolate, apex acute; ciliation 3. Probably correlated with primitive forms of *Gracilaria*. Monotypical.

118 *A. periphanes* Meyr., P.L.S.N.S.W., 1907, p. 52, Gen. Ins. Grac., f. 5. Tasm.: Mount Wellington (2,500-3,000 feet).

8 Gen. Timodora

Meyr., Tr. Ent. Soc., 1886, p. 295; Gen. Ins. Grac., p. 25.

Head roughly tufted on crown, face smooth. Labial palpi long, curved, smooth, obtusely pointed. Maxillary palpi moderate, slender, porrect. Antennae over 1. Posterior tibiae rough-scaled above. Middle tibiae thickened and with long hairs beneath. Forewings very narrow, pointed. Hindwings linear; ciliations 5. Type *T. chrysochoa* Meyr., from Tonga Island. Besides this there are only another from Fiji and the solitary Australian species, which is unknown to me. The genus differs from *Gracilaria* by the roughly tufted head.

119 *T. cyanoxantha* Meyr., Exot. Micro., ii, p. 297. Qld.: Brisbane.

9 Gen. Parectopa

Clemens, Proc. Acad. Nat. Sci. Phil., 1860, p. 210; Meyr., Gen. Ins. Grac., p. 19. *Macarostola* Meyr., P.L.S.N.S.W., 1907, p. 62.

Head smooth. Labial palpi long, curved, slender, acute, usually smooth, but sometimes rough-scaled or tufted beneath towards apex. Maxillary palpi moderate, filiform, porrect. Antennae over 1. Posterior tibiae smooth. Middle tibiae smooth, but sometimes expanded with scales at apex only. Forewings rather narrow, apex obtuse or acute. Hindwings narrowly lanceolate; cilia 3 to 6. Type *P. lespedezifoliella* Clements, from North America. Universally distributed; about 60 species have been recorded.

Larvae usually mining blotches in leaves, but sometimes in the latest stage rolling a piece of leaf into a conical chamber as in *Gracilaria*.

120 **Parectopa machaerophora** n. sp.

μαχαιροφορος, carrying a dagger

♀, 9 mm. Head and thorax white. Labial palpi white with fuscous rings on apex of second and middle of terminal joints. Antennae white annulated with grey. Abdomen pale grey. Legs white with fuscous rings. Forewings rather narrow, obtuse; whitish-grey; a broad submedian grey streak, partly suffused with ochreous, from base, terminating in a sharp point above tornus, its upper edge nearly straight, lower edge wavy; a white dorsal streak with a slight projection at one-third, broadly suffused at tornus; two white fuscous-edged streaks from costa; first at two-thirds strongly oblique, reaching middle of disc; second from five-sixths less oblique, ending in tornal suffusion; a black apical spot edged anteriorly by a white bar; an ochreous tornal dot; cilia on apex ochreous with grey apices, on each end of subapical bar white, on costa and dorsum grey; on tornus ochreous. Hindwings lanceolate; pale grey; cilia 3, pale grey. Qld.: Stanthorpe in September; one specimen.

121 *P. mnesicala* Meyr., P.L.S.N.S.W., 1880, p. 156. N.S.W.: Sydney.

122 *P. lyginella* Meyr., *ibid.*, 1880 p. 157. N.S.W.: Sydney.

123 *P. amalopa* Meyr., *ibid.*, 1907, p. 63. W. Aust.: Albany.

124 *P. clethrata* Low., Trans. Roy. Soc. S. Aust., 1923, p. 57. S. Aust.: Wayville, Adelaide.

125 *P. thalassias* Meyr., P.L.S.N.S.W., 1880, p. 158. Qld.: Stradbroke Island, Tweed Hds.; N.S.W.: Newcastle, Sydney; Vict.: Melbourne. Larvae in leaves of *Leptospermum laevigatum (Myrtaceae).*

126 *P. toxomacha* Meyr., *ibid.*, 1882, p. 197. N.S.W.: Sydney. The larvae mine the leaves of *Pultenaea* sp. *(Leguminosae).*

127 **Parectopa leucographa** n. sp.

λευκογραφος, with white markings

♀, 8 mm. Head, thorax, and abdomen fuscous. Labial palpi white; extreme apex of second joint dark fuscous. Antennae grey. Legs fuscous; tarsi with white rings. Forewings narrow, pointed; dark fuscous with white markings; a straight-edged dorsal streak from base to tornus; four very short, oblique, equidistant costal streaks, first at one-third, second at three-fourths; a white spot at apex and another larger at tornus; cilia fuscous (partly abraded), on dorsum grey. Hindwings linear-lanceolate; grey; cilia 4, grey. Qld.: Bunya Mountains (3,500 feet) in March; one specimen.

128 **Parectopa cuphomorpha** n. sp.

κουφομορφος, slightly built

♂, 7 mm. Head white. Labial palpi grey; terminal joint white. Antennae whitish-grey. Thorax and abdomen grey. Legs whitish. Forewings very narrow, apex acute; grey with white markings; a narrow straight-edged dorsal streak from base to three-fourths; six fine streaks from apical fourth of costa; first and second outwardly oblique; third and fourth less oblique; fifth and sixth transverse, subapical; an apical blackish spot; cilia grey. Hindwings linear-lanceolate; grey, cilia 6, grey. Qld.: Brisbane in December; one specimen.

129 *P. ophidias* Meyr., P.L.S.N.S.W., 1907, p. 62. S. Aust.: Quorn.

130 *P. trapezoides* Turn., Trans. Roy. Soc. S. Aust., 1894, p. 123. N. Qld.: Cairns; Qld.: Brisbane.

131 *P. actinosema* Turn., *ibid.*, 1923, p. 171. Qld.: Tweed Hds.

132 *P. thiosema* Turn., P.L.S.N.S.W., 1913, p. 188. N. Qld.: Atherton Plateau.

133 *P. eurythiota* Turn., *ibid.*, 1913, p. 189. N. Qld.: Cairns.

134 *P. tyriancha* Meyr., Exot. Micro., ii, p. 296. Qld.: Brisbane.

135 **Parectopa rosacea** n. sp.

rosaceus, rosy.

♀, 10 mm. Head, palpi, antennae, and thorax white. Abdomen grey. Legs white. Forewings rather broadly lanceolate, apex pointed; pale rosy except in costal area from near base to middle, which is grey-whitish; markings white, costal streaks partly edged with fuscous; four slender oblique costal streaks, three reaching middle of disc from one-fourth, one-half, and three-fourths, fourth from seven-eighths to termen; a streak from one fourth dorsum very oblique to fold, thence less oblique to second dorsal streak, joined by a short longitudinal streak near its end; second from mid-dorsum to third streak, dilated and suffused near its end, its basal part edged discally with fuscous; a black apical dot preceded by a small white spot; cilia pale ochreous, towards tornus grey. Hindwings grey; cilia 3, grey. New South Wales: Ebor in February; one specimen received from Mr. G. M. Goldfinch, who has the type.

136 *P. ageta* Turn, P.R.S.Q., 1917, p. 87. Qld.: Stradbroke Island, Tweed Hds.

137 *P. miltopepla* Turn., Trans. Roy. Soc. S. Aust., 1926, p. 148. N. Qld.: Cairns, Atherton Plateau.

138 *P. formosa* Sttn., Tr. Ent. Soc., (3), i. p. 291, 1860, pl. x. f. 1; Meyr., P.L.S.N.S.W., 1880, p. 153. Qld.: Stradbroke Island, Mount Tamborine, Tweed Hds., Macpherson Range, Toowoomba; N.S.W.: Lismore, Gosford, Sydney.

139 *P. polyplaca* Low., Trans. Roy. Soc. S. Aust., 1894, p. 112; Turn., *ibid.*, 1900, p. 20. N. Qld.: Atherton Plateau; Qld.: Caloundra, Brisbane, Mount Tamborine, Tweed Hds.

140 *P. ida* Meyr., P.L.S.N.S.W., 1880, p. 155. Larvae in leaves of *Eucalyptus* sp. N. Qld.: Atherton Plateau, Palm Islands: Qld.: Bundaberg, Brisbane, Toowoomba; N.S.W.: Glen Innes, Sydney; Vict., Melbourne; W. Aust.: Albany.

10 Gen. Gracilaria

Haw. Lep. Brit., p. 527; Meyr., P.L.S.N.S.W., 1907; Gen. Ins. Grac., p. 25.

Head smooth. Labial palpi long, curved, slender, acute or rather obtuse, usually smooth, but second joint sometimes loosely scaled or tufted towards apex beneath, terminal joint sometimes loosely scaled or tufted anteriorly. Maxillary palpi moderate, filiform, porrect. Antennae 1 or over 1. Posterior tibiae smooth or shortly rough-scaled. Middle tibiae thickened with dense scales. Forewings narrow or slightly dilated posteriorly, apex obtuse. Hindwings lanceolate, linear-lanceolate, or linear; cilia 4 to 8.

Type *G. syringella* Fab., from Europe. The genus is universally distributed, and about 160 species have been recorded. The larvae mine blotches in leaves, afterwards usually rolling up a portion of the leaf into a characteristic conical chamber, seldom in spun-up leafy shoots. Pupae usually in the chamber, sometimes in cocoons elsewhere.

141 **Gracilaria tessellata** n. sp.

tessellatus, set with small cubes or squares.

♂, ♀. 9-11 mm. Head and thorax pale grey. Palpi white; second joint of labial palpi with narrow apical and third joint with broad subapical fuscous rings. Antennae whitish annulated with blackish. Abdomen grey. Legs white; anterior tibiae and thickened middle tibiae fuscous. Forewings with costa straight to two-thirds, thence arched, apex obtusely pointed; white with fuscous markings; a broad very irregular streak on fold; four large roundish spots, first beneath mid-costa, second and third approximated in disc above tornus, fourth subapical; on the edges of these markings and between them and dorsum and termen are numerous fine strigulae forming a tessellated pattern; costa finely strigulated; cilia whitish sprinkled with fuscous, on termen and tornus grey. Hindwings grey; cilia 3, grey. The pattern of markings on the forewing is very peculiar, more like that of one of the Cossidae than anything I know of. The species, which has no close ally, may be put at the head of the genus. N.S.W.: Ebor and Mount Kosciusko (5,000 feet), in February; three specimens received from Mr. G. M. Goldfinch, who has the type.

142 *G. chalchoptera* Meyr., P.L.S.N.S.W., 1880, p. 151. Qld.: Brisbane; N.S.W.: Sydney.

143 *G. octopunctata* Turn., Trans. Roy. Soc. S. Aust., 1894, p. 123; Meyr., Exot., Micro., iii, p. 409, nec. Fletcher Mem. Dept. Agr. Ind., vi, p. 163. N. Qld.: Cairns; Qld.: Brisbane; N.S.W.: Sydney.

144 *G. ischiastris* Meyr., P.L.S.N.S.W., 1907, p. 66. N.S.W.: Sydney.

145 *G. loxocentra* Turn., *ibid.*, 1915, p. 194. N.S.W.: Ebor.

146 *G. lepidella* Meyr., *ibid.*, 1880, p. 145. N.S.W.: Sydney.

147 *G. albicincta* Turn., Trans. Roy. Soc. S. Aust., 1900, p. 20. Qld.: Rockhampton, Bundaberg, Brisbane, Tweed Hds.

148 *G. plagata* Sttn., Tr. Ent. Soc., (3), i, p. 292, 1860, pl. x, f. 2; Meyr., P.L.S.N.S.W., 1880, p. 144. Qld.: Brisbane.

149 *G. albispersa* Turn., Trans. Roy. Soc. S. Aust., 1894, p. 121. Qld.: Brisbane.

150 *G. chlorella* Turn., *ibid.*, 1894, p. 121. Qld.: Brisbane.

151 *G. auchetidella* Meyr., P.L.S.N.S.W., 1880, p. 143. N.S.W.: Bulli.

152 *G. cirrhopis* Meyr., *ibid.*, 1907, p. 66. Tasm.: St. Helens.

153 *G. euryenema* Turn., Trans. Roy. Soc. S. Aust., 1894, p. 122. N. Qld.: Eungella; Qld.: Brisbane, Macpherson Range (3,000-4,000 feet), Toowoomba.

154 *G. crasiphila* Meyr., Gen. Ins. Grac., p. 27. N. Aust.: Darwin.

155 *G. iophanes* Meyr., *ibid.*, p. 27. N. Qld.: Cairns.

156 **Gracilaria adelosema** n. sp.

ἀδηλοσημος, obscurely marked

♂, 10 mm. Head, palpi, thorax, and abdomen fuscous. Antennae grey with blackish annulations. Legs fuscous; tarsi whitish. Forewings narrow, obtuse; grey-brown densely sprinkled with dark fuscous; three obscure transverse fasciae formed by the absence of black scales at one-fifth, two-fifths, and three-fifths; cilia grey-brown with fuscous points, on dorsum grey. Hindwings linear-lanceolate; grey; cilia 6, grey. Qld.: Bunya Mountains (3,500 feet) in February; one specimen.

157 *G. xylophanes* Turn., Trans. Roy. Soc. S. Aust., 1894, p. 123. Qld.: Brisbane, Mount Tamborine.
158 *G. euglypta* Turn., *ibid.*, 1894, p. 122. N. Qld.: Cairns; Qld.: Brisbane.
159 *G. panchrista* Turn., P.L.S.N.S.W., 1913, p. 191. N. Qld.: Cairns, Dunk Island, Townsville.
160 *G. thiophylla* Turn., *ibid.*, 1913, p. 192; *liparoxantha* Meyr., Exot. Micro., ii, p. 297. N. Qld.: Townsville; Qld.: Brisbane.
161 *G. xystophanes* Turn., *ibid.*, 1913, p. 192. N. Qld.: Cairns.
162 *G. euxesta* Turn., *ibid.*, 1913, p. 193. N. Qld.: Cairns.
163 *G. perixesta* Turn., *ibid.*, 1913, p. 193. Qld.: Caloundra.
164 *G. megalotis* Meyr., Journ. Bombay Nat. Hist., Soc., 1908, p. 830; Turn., *ibid.*, 1913, p. 192. N. Qld.: Cairns. Also from India.
165 *G. crocostola* Turn., P.R.S.Q., 1917, p. 88. Qld.: Tweed Hds.
166 *G. aeglophanes* Turn., P.L.S.N.S.W., 1913, p. 191. N. Qld.: Cairns.
167 *G. plagiotoma* Turn., *ibid.*, 1913, p. 190. N. Qld.: Cairns.
168 *G. aurora* Turn., Trans. Roy. Soc. S. Aust., 1894, p. 127. Qld.: Brisbane.

169 **Gracilaria ecphanes** n. sp.

ἐκφανης, shining

♀, 11 mm. Head and thorax whitish-ochreous; face white. Labial palpi with a small inferior tuft on apex of second segment; white with dark fuscous rings on apex of second and before apex of terminal joints. Antennae whitish annulated with dark fuscous. Legs fuscous; tarsi white with fuscous rings. Forewings rather narrow, apex round-pointed; grey with purple gloss and a regular series of dark fuscous transverse strigulae, a large costal antemedian blotch shining yellow, its anterior edge from one-fourth costa nearly transverse and almost reaching dorsum, posterior edge from three-fifths costa and strongly oblique; cilia whitish-ochreous with basal, subapical, and apical dark fuscous lines, on dorsum grey. Hindwings narrowly lanceolate; grey; cilia 6, grey. N.S.W.: Sydney in October; one specimen.

170 *G. peltophanes* Meyr., P.L.S.N.S.W., 1907, p. 67. Qld.: Toowoomba.
171 *G. scutigera* Meyr., Exot. Micro., ii, p. 471. N. Qld.: Cairns.
172 *G. oenopella* Meyr., P.L.S.N.S.W., 1880, p. 141. Larvae in leaves of *Tetranthera ferruginea (Laurineae)*. Qld.: Stradbroke Island; N.S.W.: Sydney.
173 *G. leucolitha* Meyr., Gen. Ins., Grac., p. 30. N. Aust.: Darwin.
174 *G. pedina* Turn., Trans. Roy. Soc. S. Aust., 1923, p. 172. Qld.: Charleville.

INDEX TO GENERA

INDEX TO SPECIES

SYNONYMS IN ITALICS

TUBE-BUILDING CERCOPIDS (HOMOPTERA, MACHAERIDAE)

By J. W. EVANS, M.A., D.Sc., F.R.E.S.

Summary

The Cercopoidea or "Frog-Hoppers" are a small and distinct group of plant bugs which are poorly represented in Australia; Tillyard (1926) records only thirty species as having been described from this region, but doubtless many more occur.

TUBE-BUILDING CERCOPIDS (HOMOPTERA, MACHAEROTIDAE)

By J. W. Evans, M.A., D.Sc., F.R.E.S.

[Read 9 May 1940]

The Cercopoidea or "Frog-Hoppers" are a small and distinct group of plant-bugs which are poorly represented in Australia; Tillyard (1926) records only thirty species as having been described from this region, but doubtless many more occur.

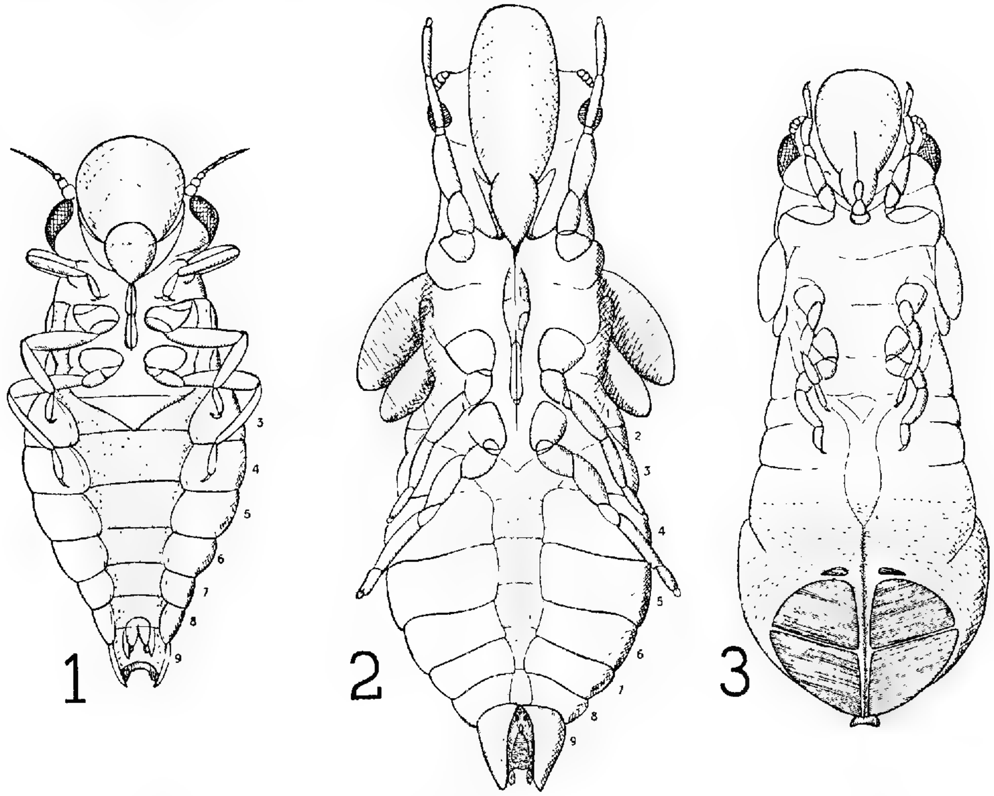
The super-family comprises four families, the Aphrophoridae, Cercopidae, Clastoperidae and the Machaerotidae. Nymphs of insects belonging to the three first-named families make and live in froth masses and are commonly known as "spittle insects," those of the Aphrophoridae and Clastoperidae living above ground, whilst nymphs of the Cercopidae are subterranean.

The Machaerotidae occur only in Australia, Malaya, the Phillipines, India and Africa, and have nymphs which construct calcareous tubes on their food-plants, in which they live head downwards immersed in excreted liquid. Baker (1927) has divided the family into two sub-families, the Machaerotinae and Hindoliinae. Representatives of both occur in Australia but the Hindoliinae are by far the more abundant, anyhow, in Eastern Australia.

The earliest recorded observations of these tube-forming insects are those of Ratte (1884), who described and figured three types of tubes which he found in the neighbourhood of Sydney. He noted the fact that two kinds of nymphs occurred, one being provided with a broad circular plate at the end of the abdomen, whilst the other lacked such a plate. Two years later Westwood (1886) described the adult of a tube-forming frog-hopper from Ceylon, giving it the name of *Machaerota guttigera*. His correspondent in Ceylon, Mr. S. Green, found the nymphs on the Suriya Tulip tree *(Adamsonia digitata)*, and wrote that the insects in the tubes seemed to be continually working the tips of their abdomens against and around the inside of the tubes, discharging at intervals clear liquid from their intestines; also, that when some of the liquid was allowed to dry on a piece of glass, practically no residue was left.

In 1906 Kirkaldy described two species from Australia and figured the nymph of one of them, *Polychaetophyes serpulida* Kirk. He drew attention to the operculum on the abdomen of nymphs of this species, and was of the opinion that it consisted of the second and third tergites. Later illustrations of nymphs or their tubes are given by Lefroy (1909), Hacker (1922), China (1927, 35), and Evans (1935). Hacker's are the most notable, as they consist of remarkable photos showing the emergence of adults of two species from their nymphal quarters. It may be seen from these photos that the nymphs of one species, *Polychaetophyes serpulida* have opercula, whilst those of the other *Pectinariophyes pectinaria* Kirk. lack them.

The purpose of the present paper is to describe and illustrate in greater detail than has previously been done the two types of Machaerotid nymphs, and to compare them with those of the Aphrophoridae.



Figs 1-3
Fig. 1, Nymph of *Bathylus albicincta* (Aphrophoridae) in ventral aspect.
Figs. 2 and 3, Machaerotid nymphs in ventral aspect.

Morphology

In fig. 1 is shown a nymph of *Bathylus albicincta* Erichs. (Aphrophoridae), in ventral aspect, as representative of the type of spittle-forming nymphs. A detailed account of the morphology of nymphs of species belonging to this family has been given by Sulc (1911), and a popular account of the method of froth-formation by China (1927).

There is a deep channel on the ventral surface of the body which extends from the apex of the abdomen, anteriorly as far as the third abdominal segment, where it branches into two, terminating on each side of the body at the anterior margin of the mesothorax. The ventral surface of the channel consists of the abdominal sterna, and its walls of the pleura internally and the overlapping terga externally. The spiracles of each segment open between the sterna and pleura, whilst a very large trachea connects with a spiracle on each side of the hind margin of the prothorax.

In the figure the channel is shown open, but it can be closed by the bringing together of the tergal-pleural flaps which overlap above it. During froth-formation it is closed, and air is drawn into it at the apex of the abdomen. The manner in which these insects form their froth is too well known to need repetition.

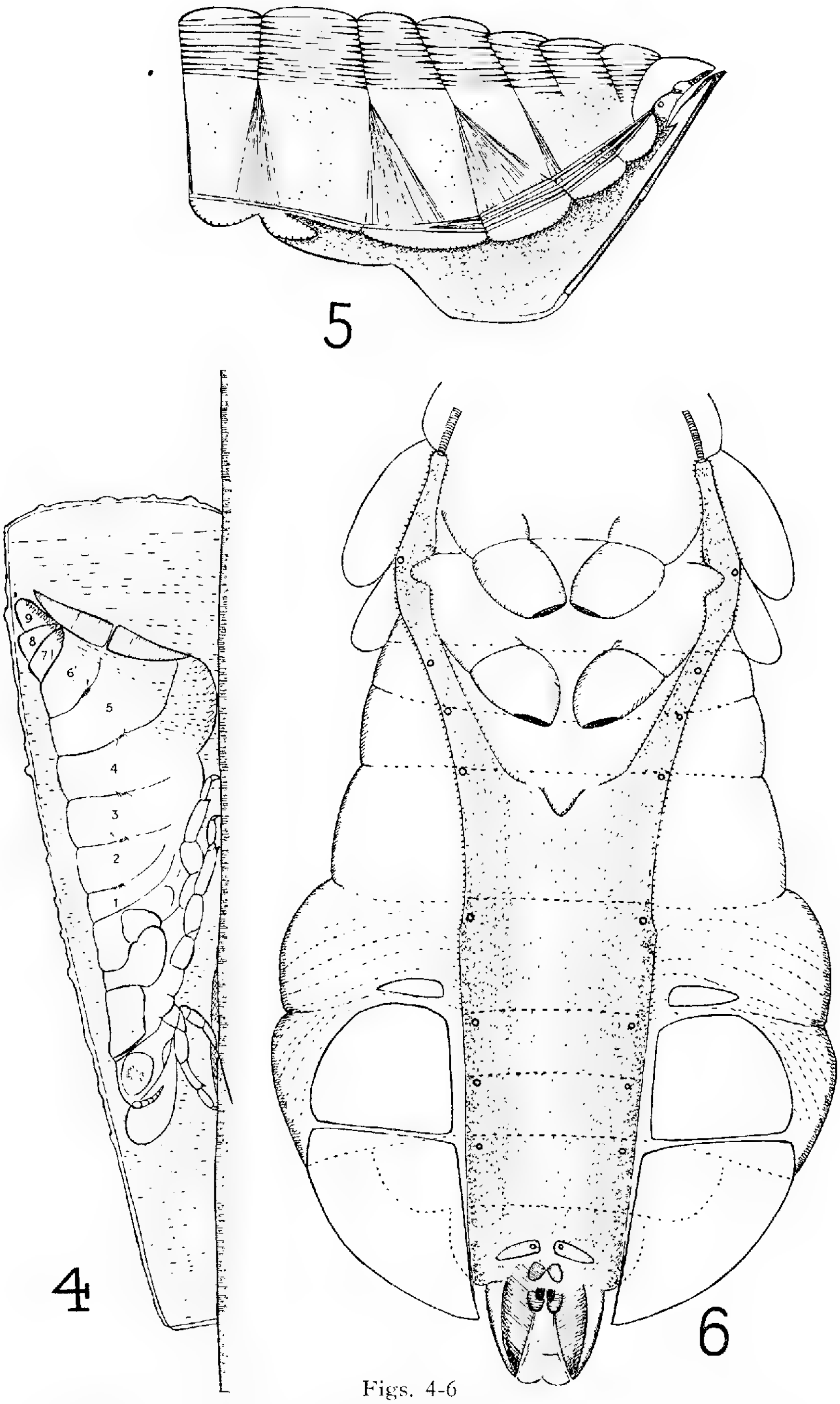
A Machaerotid nymph of the non-operculate type, of which the specific identity is unknown, is illustrated in fig. 2. It resembles the nymph figured under the name of *Pectinariophyes pectinaria* by Kirkaldy, hence probably belongs to the genus *Hindola* Stål, of which *Pectinariophyes* Kirk. is stated by Baker (1927) to be a synonym. The head differs from that of *B. albicincta* in the elongation of the fronto-clypeus and in the comparatively longer labium and maxillary and mandibular stylets. Also the antennae, instead of being freely movable, lie closely opposed to the side of the head, directed posteriorly, suggesting those of a pupa of a holometabolous insect. Only a portion of the eye is pigmented and the legs are flattened against the body; the fore legs being directed anteriorly and the other two pairs posteriorly.

The ventral air channel, which is of the same extent as with the Aphrophoridae, instead of being temporarily closed by overlapping tergal and pleural abdominal flaps, is permanently closed, except at the apex of the abdomen, by a transparent membrane which joins the ventral edges of the terga.

Figure 3 represents a nymph of the operculate type, probably of *Chaetophyes compacta* (Walk.). Another representative of the same species is shown in position in its tube in fig. 4. The operculum, which is formed from the ventral surface of the terga of the fourth, fifth and sixth abdominal segments, consists of three pairs of sclerotized plates. The pair belonging to the fourth segment is small, but this segment is larger and more distorted than the others and forms a "heel." The plates of the sixth segment overlap and conceal the three free abdominal segments. The air canal is identical in structure with that of the type of non-operculate nymph already described from its anterior branches as far as the middle of the fourth abdominal segment. Posteriorly, it is concealed, as the terga from the opposite sides of the body are joined along the mid-ventral line.

Figure 5 is a diagram of a section through the centre of a nymph and shows the air canal, which is widest in the heel of the fourth segment. Three sets of muscle fibres are indicated in the figure. These are the dorsal longitudinal tergal muscles, the ventral longitudinal sternal muscles, and the fan-shaped tergo-sternal muscles, which arise from the lateral walls of the abdomen. The points of insertion of the latter are visible externally as pits (see fig. 4).

In fig. 6 the air canal has been fully exposed by cutting the insect down the mid-ventral line and pulling apart the severed sides. There are eight pairs of abdominal spiracles; the pair belonging to the eighth sternite are close to the middle of the sclerite and not near the anterior border as in other segments. One pair of thoracic spiracles lie at the base of the hind wing-pads, the other pair are at the anterior ends of the canal and connect with very large tracheae.



Figs. 4-6

Fig. 4, Operculate form of Machaerotid nymph in its tube.

Fig. 5, Median section through the abdomen of an operculate nymph, to show the air canal.

Fig. 6, Ventral view of a tube-forming nymph with the air canal exposed.

Tube Formation

Observations made on the early stages of tube-formation by Green, and reported by Westwood, refer to the nymphs of *Machaerota guttigera* Westw. Green observed newly-hatched nymphs in the middle of drops of froth, from which the walls of the tubes gradually arose. Froth is again formed prior to the final ecdysis as recorded by Ratte and Hacker, and it is probably produced at the end of each instar, since the insects have to emerge from their tubes in order to cast their skins. It is thus evident that the liquid excreted by the young hoppers has, like that produced by spittle insects, the properties of a soap solution. Ratte found the tubes to be composed of at least 75% calcium carbonate and considered the insoluble remains to be "chitinous matter," and Professor R. A. Peters who examined some tubes made by the nymphs of an African species, *Aphrosiphon bauhiniae* China (China, 1935), found that they contained 81·3% calcium carbonate. Dr. W. A. Lamborn, who first discovered this particular species, stated that the fluid excreted by the insects was rich in mineral matter which rapidly solidifies. Whenever liquid has been collected from tubes by the present writer, and allowed to dry on a glass slide, no deposit has been left after evaporation. The tops of tubes containing living nymphs are usually soft, whilst the first-formed parts appear to be of a different consistency from the rest, resembling hardened froth.

The nymphs of Aphrophoridae have two pairs of glands, known as Batellis Glands. These lie in the seventh and eighth abdominal segments and secrete a wax-like substance through external pores. Tube-dwelling nymphs have a pair of round yellow glands in each of the sixth, seventh and eighth abdominal segments. These are doubtless homologous with Batellis glands. They have as well a large paired gland, the pseudovitellus, which lies on each side of the fifth abdominal segment.

The nymphs that have been found in Tasmania during the winter months have been in their early instars, and immersed in fluid, but on the New South Wales highlands completely dry tubes have been found in the winter, closed at the top by a membrane and containing nymphs in the pre-imaginal instar. This suggests that development may cease during the cold weather and the last instar be prolonged. At all seasons tubes are occasionally found containing no liquid and tightly closed by the insect's opercula, but the usual condition is for the insect to be totally immersed in its secretory and excretory products.

If a tube is heated, the apical segment of the contained insect is at once protruded, the stale air expelled and a fresh supply taken in. Nymphs in tubes which were subjected to a temperature of 82° F. were found to protrude their abdomens into the air for intervals of five seconds, and then to withdraw them below the surface of the liquid for periods of ten seconds. If kept forcibly emerged for periods ranging from forty-five to ninety seconds, they will withdraw their stylets from the wood and back completely out of the tubes.

Discussion

Amongst many groups of insects, structural adaptations correlated with life in specialized environments are of common occurrence, but this is not so with the Homoptera-Auchenorhyncha. Tube-dwelling nymphs belonging to the Machaerotidae are especially remarkable, since not only have they themselves created an environment of a specialized nature, but they have developed unique structural modifications to cope with their acquired environment. Wax production is of frequent occurrence amongst the Homoptera, and it is possible that the plates of the operculum are modified wax plates. Tufts of wax have been seen on the ventral surfaces of both the seventh and eighth abdominal segments of operculate and non-operculate nymphs.

It is of interest to note that the nymphs of cicadas, many cixiids and certain cercopids, are subterranean. This may well be a primitive characteristic, possibly associated with severe weather conditions that ruled for a long time at some period of geological history, in areas where the forerunners of the present-day representatives existed. A root-feeding insect is not subject to such intense evaporation from its body-surface as is one that feeds above ground, and it is probable that the spittle-forming habits of the nymphs of the Aphrophoridae, and the tube-forming habits of the nymphs of the Machaerotidae are parallel developments, both serving to prevent excessive loss of body-moisture from organisms descended from subterranean ancestors. It is doubtful whether either froth or tube formation serve to any great extent for protective purposes against insect parasites and predators.

References

Baker, C. F. 1927 Phillipine and Malaysian Machaerotidae. Phillipine Journ. Sci., **32** (4), 53

China, W. E. 1927 Some Strange Relatives of the Frog-hopper or Cuckoo-spit Bugs. Nat. Hist. Mag., **1** (3), 71

China, W. E. 1935 A New Genus and Species of Machaerotidae from Nyasaland. Proc. Roy. Ent. Soc., London, **10**, 81

Evans, J. W. 1935 Victorian Leaf-Hoppers, Tree-Hoppers and Frog-Hoppers. Vict. Nat., **52**, 91

Hacker, H. 1922 On the Emergence of Two Tube-dwelling Homopterous Insects. Mem. Qld. Mus., **7** (4), 280

Kirkaldy, G. W. 1906 Leaf-Hoppers. Hawaii Sug. Ass. Bull., **1** (9)

Lefroy, M. 1909 Indian Insect Life, 732

Ratte, F. 1884 On the Larvae and Larva Cases of some Australian Aphrophoridae. Proc. Linn. Soc. N.S.W., **9**, 1,164

Sulc, K. 1911 Ueber Respiration, Tracheen System und Schaumproduktion der Schaumcikadenlarven. Zeitschrift für Wissenschaftliche Zoologie, **99** (1), 147

Westwood, J. O. 1886 Notice of a Tube-making Homopterous Insect from Ceylon. Trans. Ent. Soc., Lond., 329

THE ENVIRONMENT OF THE AUSTRALIAN PLAGUE LOCUST (CHORTOICETES TERMINIFERA WALK.) IN SOUTH AUSTRALIA

By H. G. ANDREWARTHA
Waite Agricultural Research Institute, University of Adelaide.

Summary

Field observations have shown that *Chortoicetes terminifera* occurs as a solitary grasshopper over most of South Australia. The character of the winter inhibits the development of swarms in the agricultural areas; for several months of the year temperatures near the developmental zero are associated with a P/E ratio greater than 0.5. In the semi-arid area ("outbreak area"), further north, this condition does not apply and the insect is able to take advantage of the favourable conditions produced when rain falls in summer.

THE ENVIRONMENT OF THE AUSTRALIAN PLAGUE LOCUST (CHORTOICETES TERMINIFERA WALK.) IN SOUTH AUSTRALIA

By H. G. Andrewartha
Waite Agricultural Research Institute, University of Adelaide

[Read 9 May 1940]

Plates V to VIII

Summary

Field observations have shown that *Chortoicetes terminifera* occurs as a solitary grasshopper over most of South Australia. The character of the winter inhibits the development of swarms in the agricultural areas; for several months of the year temperatures near the developmental zero are associated with a P/E ratio greater than 0·5. In the semi-arid area ("outbreak area"), further north, this condition does not apply and the insect is able to take advantage of the favourable conditions produced when rain falls in summer.

In the outbreak area the locust is associated with local situations which experience a more humid eco-climate than the surrounding countryside. The boundaries of the outbreak area are determined largely by climate but the distribution of favourable habitats within the outbreak area is related to topography, vegetation and soil type. The most characteristic plants of locust habitats are the two perennial grasses, *Eragrostis setifolia* and *E. Dielsii*.

There is considerable evidence that favourable weather for several successive years is necessary before a major outbreak can occur. Swarms are likely to develop in the outbreak area when rain is adequate during the warm months. Two or more favourable seasons in this way may be required to produce large or dense swarms. Similar conditions are necessary for swarms to develop in the intermediate breeding areas. For the outbreak to continue its development in the agricultural districts a dry autumn is required. This whole sequence is necessary for a major plague. The cycle may be broken at any point; when this occurs the incipient outbreak will be destroyed.

I Introduction

In South Australia the Australian Plague Locust becomes a pest of major importance only when swarms occur in the agricultural areas. Such occasions are comparatively rare. The most recent outbreak occurred in the spring and summer of 1934-35; the one before that in 1890-91. Earlier records are inadequate, but probably there were major outbreaks in 1870 and 1845. Minor outbreaks may have occurred between these years; the absence of records does not necessarily mean that swarms of the locust were not present. For a discussion of the history of outbreaks of *Chortoicetes terminifera* in South Australia see Davidson (9), Andrewartha (1).

This paper deals with the ecology of outbreaks in South Australia. The problem has involved a study of the geographic distribution of the insect, and the climate, vegetation, soil and topography of the outbreak area[1] in this State.

II Methods

The distribution of the insect was studied by means of survey trips in a motor truck. The numbers in any locality were estimated by counting the individuals disturbed while walking a given distance (or time). All notes were referred to speedometer readings and later transcribed to maps. Observations and notes regarding habitats and vegetation were supplemented by photographs wherever possible.

The analyses of monthly records of total rain, mean daily temperature and humidity for the month were made for a number of stations. Rainfall records from 82 rainfall stations were used (text fig. 1). Where the temperature and humidity were not recorded, values were computed by reference to appropriate stations, by allowing 3° F. for each 1,000 feet altitude and 2 per cent. relative humidity for each 1° F.

The ratio of rainfall to atmospheric saturation deficit was used as an index of soil moisture. For discussion on the use of this index see papers by Davidson (5), (6), (7), (8), Prescott (14), (15), and Trumble (16). The relationship of saturation deficit to evaporation from a standard Australian evaporimeter may be expressed as E = 14·7 S.D. for the Adelaide evaporimeter or E = 21·2 S.D. for twelve standard Australian evaporimeters for a month of 30 days, where E is total evaporation and S.D. the mean daily saturation deficit for the month.[2]

In the present paper the critical low value for P/S.D. has been taken as 7. This corresponds to a P/E ratio of 0·5 using data from the Adelaide evaporimeter, and to 0·33 using data from the twelve standard Australian evaporimeters listed in the footnote below. For convenience, the figures for saturation deficit were converted to values for evaporation using data from the Adelaide evaporimeter. The rainfall-evaporation ratio has been expressed as P/E where P is the total rain, and E, total evaporation in points. The ratio has also been expressed as P/e in some instances, where e is the mean *daily* evaporation for the month.

Not all rain is effective in supplying to the soil adequate moisture for plant growth or the development of the eggs of the locust. In an arid region, isolated small falls of rain do not sufficiently wet the soil (4), (12). In a given area where the total monthly rain was of the order of 10 points in the winter and 25 points in the summer months, a value P/E = 0·04 was obtained. This value has been selected, for the purpose of this paper, as the zero value for soil moisture. Values for P/E less than 0·04 are therefore considered to be equivalent to zero when calculating the expression PT/½e referred to below.

---

(1) "Outbreak area" applies to all the area in which swarms may arise. This complies with the definition given in the Proc. Third International Locust Conference, London, 1934, p. 56.

(2) See Prescott (14). The evaporimeters were situated at the following stations: Perth, Brisbane, Sydney, Canberra, Dubbo, Eucla, Coolgardie, Merbein, Griffith, Waite Institute, Melbourne and Hobart.

The value P/E = 0·5 (P/S.D. = 7) is taken as the lowest value at which adequate moisture is available in the soil throughout a given month. With higher values of P/E, the excess moisture is superfluous; during heavy falls of rain some is lost as "run-off." Values above 0·5 are therefore considered as equivalent to 0·5 when calculating the expression $PT/\frac{1}{2}e$.

The choice of P/S.D. = 7 as the critical low value for soil moisture implies the assumption that evaporation from a soil surface is half that from the Adelaide evaporimeter tank. Therefore the expression $P/\frac{1}{2}e$ gives an estimate of the number of days during which soil moisture was adequate during a particular month, since P is the total rain falling during the month and $\frac{1}{2}e$ is the estimated mean daily loss of water from the soil.

Records of maximum and minimum temperature (mean daily for the month) were converted to effective temperature taking the developmental zero of *C. terminifera* as 60° F.[3] The expression $PT/\frac{1}{2}e$ has been used as an index of favourableness for the development of *Chortoicetes terminifera,* where P is the total rain in points, e the estimated mean daily evaporation in points, and T the estimated mean daily effective temperature, for each month. The expression gives a rational estimate of favourableness, since $P/\frac{1}{2}e$ is an estimate of the number of days during which soil moisture was adequate; and the rate of development is proportional to effective temperature.

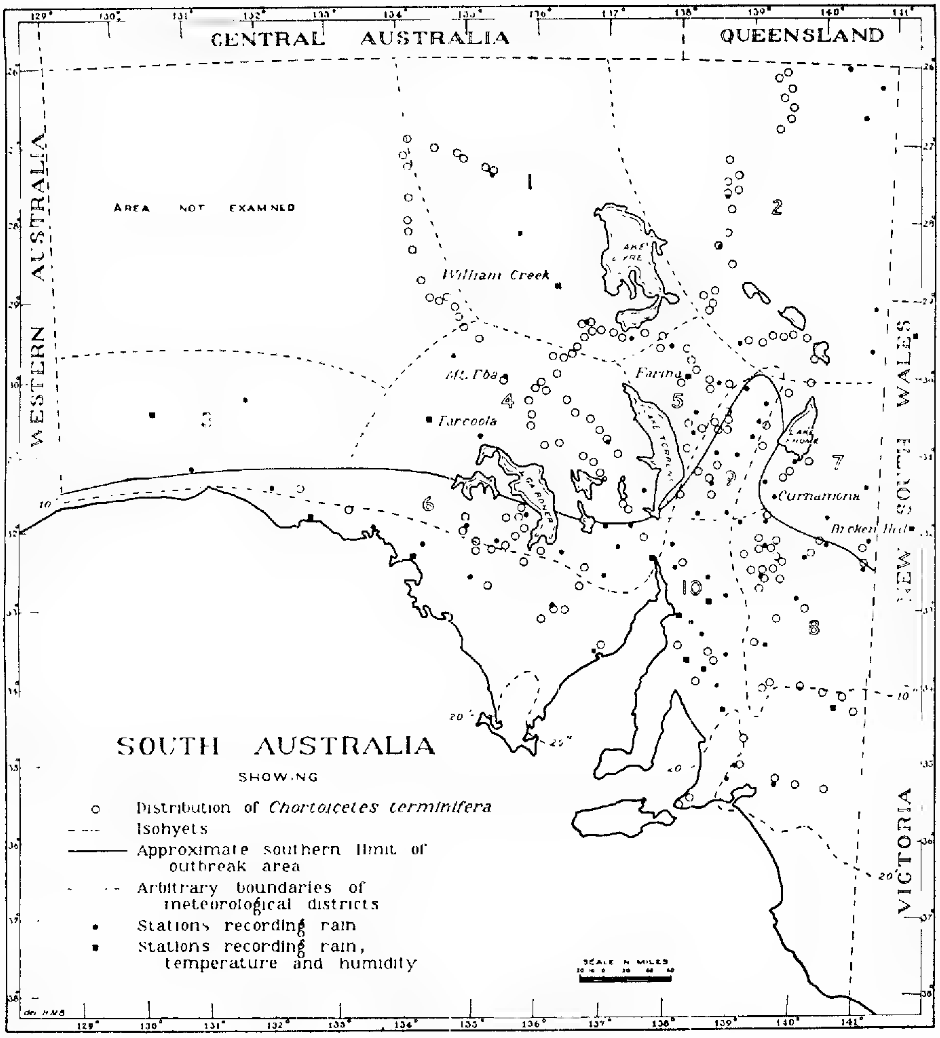
Some of the data have been expressed as graphs. Each graph represents the mean for the stations in a district (text fig. 1). Districts 9 and 10 comprise the area between the 10-inch and 20-inch annual isohyets. The southern boundaries of districts 3, 4, 5 and 7 are formed by the approximate southern limit of the outbreak area for *Chortoicetes terminifera* (see text figs. 3 and 4).

III Distribution of Chortoicetes terminifera

The Australian Plague Locust occurs as a solitary grasshopper over most of South Australia. It has been found wherever the survey trips have penetrated. The absence of records in text fig. 1 usually means that the area has not yet been surveyed, rather than that *C. terminifera* has not been found there.

Although the species occurs so widely, it is nevertheless restricted to particular types of habitat. In the wetter zone of winter rainfall, i.e., districts 9 and 10 (see text figs. 2 and 3) the insects are reduced to low numbers between invasions. The survivors are usually associated with local situations which are more arid than the surrounding countryside, *e.g.,* hill slopes and the sides of valleys and gutters. In the more arid zones *(e.g.,* in the outbreak area) the insects are normally associated with "pockets" which are more humid than the general countryside. For a time after good rains the grasshoppers may be more widespread, but as the herbage dries up they are forced back to the local situations where ephemerals and perennial grasses may remain green for a much longer period.

(3) Based on unpublished work by Mr. D. C. Swan, who found that the developmental zero for eggs of *Chortoicetes terminifera* was 16·5° C.



Text Figure 1

Each circle on the map represents an actual survey record of the presence of *Chortoicetes terminifera.* It was impracticable to survey the north-west. The boundaries of the districts used for the analyses of meteorological records presented in text figs. 2, 7 and 8 are also shown. The outbreak area lies north of the heavy black line. Most of the agricultural districts affected by the locust are included in district 10.

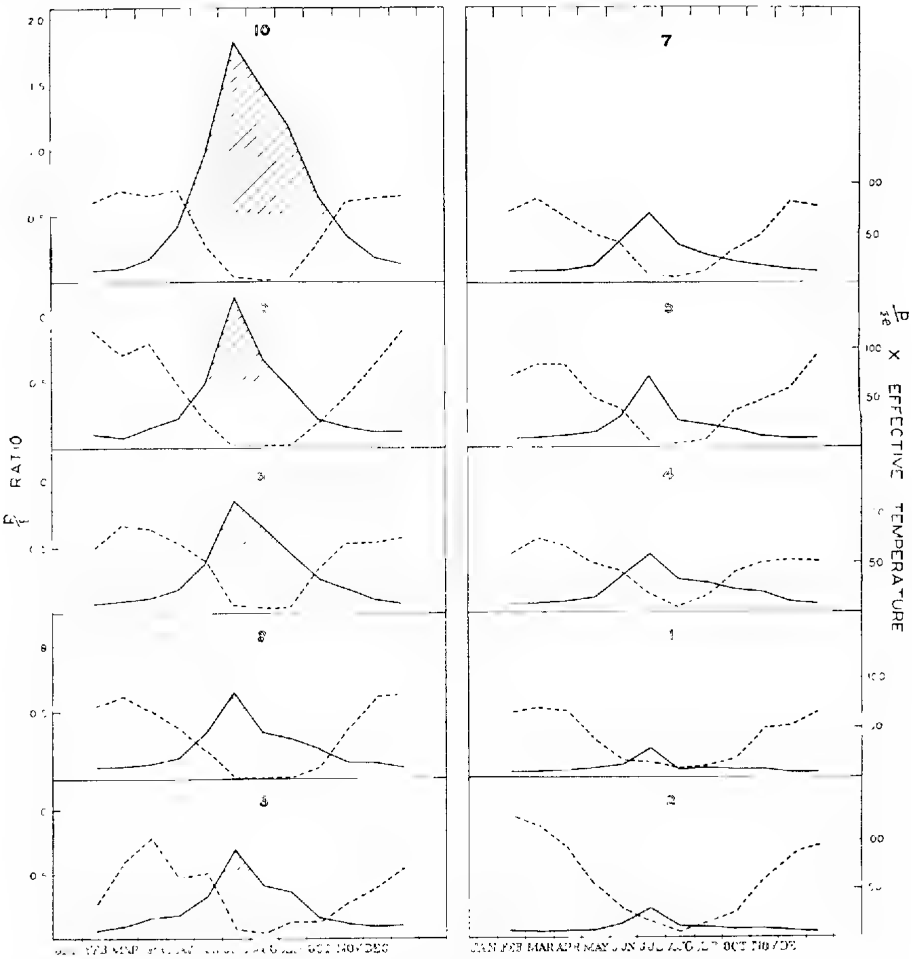
IV THE ECOLOGY OF THE OUTBREAK AREA

(a) Climate

The limits of the outbreak area are determined largely by climate. The favourableness of the summer period (measured as PT/$\frac{1}{2}$e) [4] is remarkably

[4] This index does not take into account certain factors which tend to make the summer rainfall more effective in the drier areas. These factors are associated with low rainfall, absence of winter rainfall, and variability in the amount and distribution of the rainfall in the semi arid areas (see below, p. 81).

uniform over most of the State; but there is a marked decrease in winter wetness (measured as P/E) from south to north (see text figs. 2 and 3). In text figure 2 the districts are arranged according to the wetness of the winter. Districts 9 and 10 experience high rainfall associated with temperatures near or below the developmental zero for several months of the winter. These conditions do not allow the locust to develop into swarms. Probably the winter in districts 6 and 8 is favourable to *Chortoicetes terminifera* only in the drier years.



Text Figure 2

Illustrating the relative favourableness to *Chortoicetes terminifera* of districts 1-10 in South Australia, based on figures for mean monthly rainfall, temperature and estimated evaporation. The degree of wetness (measured as P/E) is indicated by the complete line. The shaded area indicates the length of the period for which P/E was greater than 0·5. The broken line indicates values for PT/½e. High values for P/E associated with low values for PT/½e represent conditions unfavourable to *Chortoicetes terminifera*. Each graph represents the mean for all the stations in the district concerned. The boundaries of the districts are indicated in text fig. 1.

The outbreak area is characterised by lower values for P/E and higher maximum temperatures during the winter. Its southern limit may vary from year to year; it may be defined approximately by the 16° C. isotherm for maximum temperature and the northern boundary of the "semi-humid" zone for the winter months (see text figs. 3 and 4). Swarms of the locust may develop throughout the whole area north from this boundary. The climate of this area resembles the climate of adjacent zones in New South Wales, Queensland and Central Australia (8). It is to be expected, therefore, that this outbreak area of *Chortoicetes terminifera* extends into neighbouring States.

The area associated with the River Murray needs special consideration. Reports from irrigation settlements along the river indicate that small swarms of *Chortoicetes terminifera* may occur more frequently in this area than elsewhere in South Australia. Flood plains along the river may provide extensive favourable breeding grounds for the locust when soil moisture is adequate in the summer. This may occur relatively frequently since the river is normally at a high level in the spring or early summer. On the other hand, the winter in this zone is relatively unfavourable for the survival of *Chortoicetes terminifera* (see text fig. 3). Further observations are required to determine the origins of swarms in this area. It is possible that favourable conditions for breeding occur fairly often in the spring and summer, and that swarms may arise following an abnormally favourable winter. A favourable winter may be one in which precipitation was low, or temperature high, or both.

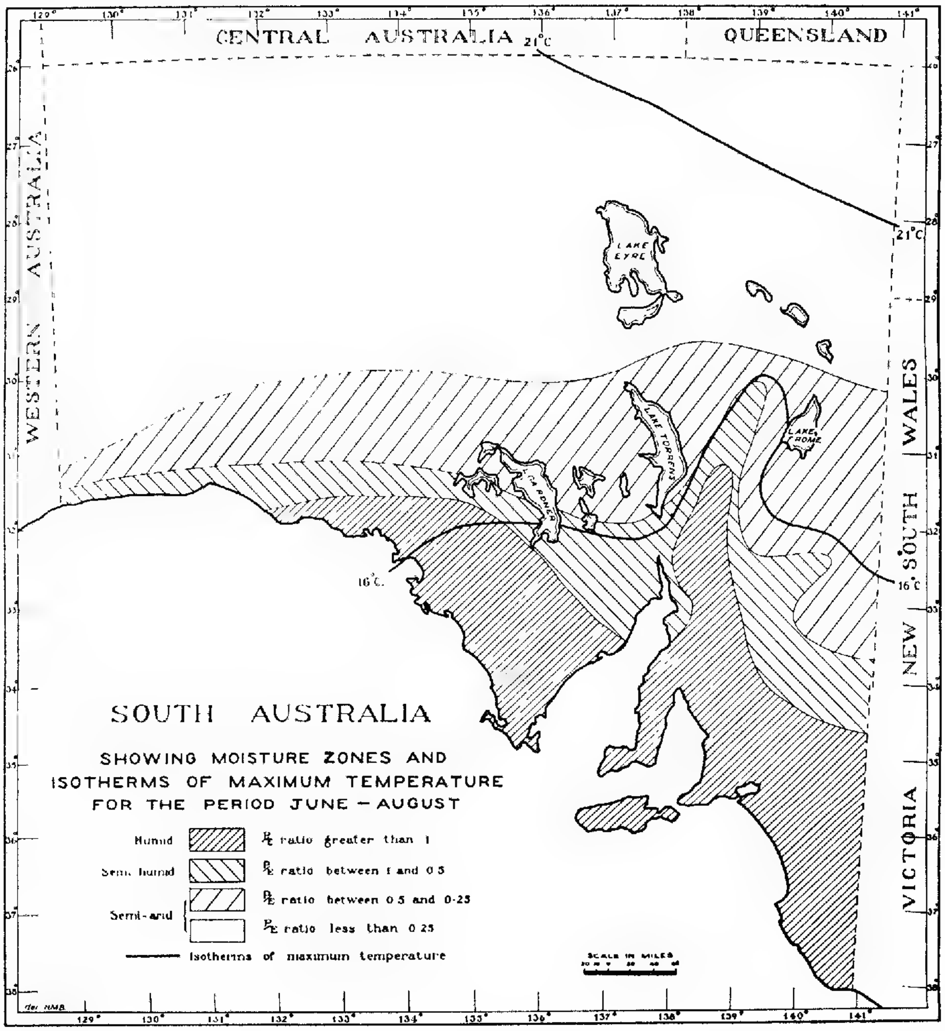
The mean monthly precipitation at six selected stations in the outbreak areas is given in Table 1. Three characteristics of the rainfall are important in relation to the ecology of *Chortoicetes terminifera*: *(a)* The low rainfall results in the absence of an organised drainage system, consequently water tends to collect in local situations after rain, thus producing restricted areas where the eco-climate is more favourable than that of the surrounding countryside. *(b)* Associated with the absence of a reliable winter rainfall, the flora of the semi-arid area includes a high proportion of species adapted to take advantage of sporadic rains. Consequently rain falling at any season of the year may produce a luxuriant growth of ephemerals and herbaceous perennials.[5] *(c)* The annual rainfall in the outbreak area is extremely variable. This may result, occasionally, in the run of good seasons necessary for the production of locust swarms.

For the analysis of "effective rain" presented in Table 2, daily records from six stations for fifteen years have been examined. The "effective" rain has been expressed as a percentage of the total precipitation. Isolated falls of less than 10 points between May to September and 25 points between October to April, also rain in excess of 150 points in one fall, have been considered as non-effective.

[5] The ephemeral and herbaceous perennial vegetation in the winter rainfall zone of South Australia consists largely of winter-growing species. Rain falling in the summer in this zone produces far less "herbage" than an equivalent fall in the northern arid districts.

The stations show no significant difference in the proportion (about 80 per cent.) of annual effective rainfall. The proportion tends to be higher in winter; but this may not be significant.

Osborn and his colleagues (12) showed that at Koonamore[6] only on one-third of the wet days did the rainfall exceed 25 points. It is not possible to discover from their figures what proportion of the total rainfall was made up from falls exceeding 25 points.



Text Figure 3

Map based on mean monthly rainfall, temperature and estimated mean monthly evaporation (for 82 stations) for the winter period June-August, inclusive. The southern limit of the outbreak area for *Chortoicetes terminifera* is defined approximately by the northern boundary of the semi-humid zone and 16° C. isotherm for maximum temperature.

---

[6] A station in district 8 just south of the outbreak area (32° 3′ S, 139° 23′ E.).

TABLE I

Monthly Rainfall in Points for six selected Stations in the Outbreak Area (see text figure 1)

Station	No. of Years Records	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total Year
William Creek	57	51	42	60	41	41	64	23	28	40	41	48	56	535
Tarcoola	28	34	71	46	36	65	82	53	71	56	71	53	62	700
Curnamona	54	67	29	49	63	92	91	35	57	49	53	56	70	711
Farina	52	51	55	66	41	64	88	37	41	47	48	49	61	648
Mount Eba	20	55	34	36	31	60	62	31	47	51	60	57	66	590
Broken Hill	42	68	88	63	63	97	119	70	84	75	80	67	84	958
Mean	—	54	53	53	46	70	84	42	55	53	59	55	67	690

TABLE II

Showing estimated Effective Rainfall for six selected Stations in the Outbreak Area (based on 15 years records) as per cent. of Total Rain

Place	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
William Creek	85·8	83·9	78·1	86·7	90·8	92·3	78·1	91·7	83·7	81·3	72·8	81·4	84·0
Tarcoola	76·2	84·0	83·5	68·4	78·5	87·2	76·9	91·1	80·8	77·8	69·5	83·1	80·8
Curnamona	86·6	87·2	67·9	45·8	94·3	90·7	95·6	89·6	90·8	69·9	85·9	76·8	82·7
Farina	94·1	84·8	79·3	61·4	92·1	93·5	86·8	80·2	93·5	76·8	80·0	85·9	83·8
Mount Eba	70·9	71·6	67·7	74·8	93·8	91·7	84·8	93·1	89·0	81·1	77·2	75·9	82·1
Broken Hill	77·4	87·9	79·2	60·5	93·0	86·0	87·9	86·1	89·1	59·2	66·3	80·9	80·4
Mean	81·8	83·2	75·9	66·2	90·4	90·2	85·1	88·6	87·7	74·4	75·3	80·7	82·3

(b) Topography, Vegetation and Soil

Apart from the elevated area associated with the Musgrave Ranges in the north-west of the State and a central tongue of highland running north from Cape Jervis to about the 30th parallel of latitude, most of South Australia is less than 1,000 feet above sea level. Districts 9 and 10 (text fig. 1) include nearly all the southern and central highlands. Practically all the outbreak area for *Chortoicetes terminifera* lies below the 1,000 feet contour line; most of the area is less than 500 feet above sea level. The surface is relatively flat. There is no seaward drainage system; after heavy rain water may run into local "swamps" or "lakes" which may be dry for the greater part of the time.

In the outbreak area *Chortoicetes terminifera* is associated with local situations which receive "run-off" after rain and thus experience a more humid eco-climate than the surrounding country. The physical features of these favourable habitats may take the form of watercourse, depression, flat or flood plain. In the terminology of this country a watercourse is distinguished from a creek in that it is usually wide and flat with no well-defined channel. The water is shallow and flows slowly; very little erosion occurs. A watercourse is an ideal situation for plant growth (see pl. v, fig. 1). A creek is more definite. It usually carries more water between well-defined banks. Erosion is evident from the presence of water-worn stones and sand in the bed. A creek bed is not normally a favourable habitat for the locust. In certain cases flood plains associated with creeks provide favourable habitats (see pl. v, fig. 2). A swamp is any situation where fresh water lies after heavy rains. A depression is a low-lying area where water tends to collect during rains but does not lie (see pl. vi, fig. 1). A flat is a level area at the base of a hill, or between two hills, and is frequently better watered than the surrounding country because it receives "run-off" from the hills (see pl. vi, fig. 2).

These local situations may vary in size from a few square chains to many square miles. They may be more numerous in areas of lighter soil. Such areas are often characterised by gentle undulations with frequent and extensive watercourses in the hollows (see pl. v, fig. 1). In "hard" country, on the other hand, drainage channels may commonly take the form of gutters or creeks which are normally less favourable for the breeding of *Chortoicetes terminifera*. Occasionally a creek flowing through "hard" country may form a favourable habitat for the locust (see pl. v, fig. 2).

The distribution of vegetation over the State is closely related to topography and soil type. The distribution in the area inside the heavy line (text fig. 5) has been simplified after Wood (17). For the rest of the State I have adopted Wood's classification of association dominants.[7] The boundaries have been determined by direct observation for those areas where the locust surveys have penetrated

[7] Further subdivisions would probably be desirable for a more detailed account of the vegetation than has been attempted in this paper. Particularly towards the northern limits of the State the typical associations tend to become modified by the presence of species characteristic of the summer rainfall areas.

(see text fig. 1); for other areas I have referred to the following sources: Prescott (13), the map of the Mackay aerial survey expeditions, and the journals of the early explorers. I am indebted to Mr. R. L. Crocker for certain information regarding the vegetation around Lake Eyre and near Birdsville. The area in the north-west of the State has not been included due to lack of information.

Text Figure 4

The approximate southern limit of the outbreak area is based on P/E ratio and maximum temperature for the winter (see text fig. 3). The probable distribution of favourable habitats for *Chortoicetes terminifera* is based on the distribution of the major vegetation types (see text fig. 9).

In the area characterised by the *Atriplex-Kochia* association the soil is usually firm and compact. In the south the soil may be a loam overlying sheet limestone. Where the soil is more shallow *Kochia* predominates; on the deeper soils *Atriplex* may be more prominent. In the far north-west this association occurs on an undulating (often stony) tableland. The soil is deeper and heavier. The community may be more open, and certain species of *Eremophila* and *Acacia tetragonophyllum* may be more prominent. In the south *Stipa* is an important grass; in the northern areas *Astrebla* becomes increasingly important on the plain, and *Eragrostis* in the washes. In the wetter situations in this zone mulga occurs, particularly in the south, while further north gidgea *(Acacia cambagei)* also grows in the drainage channels. These often take the form of steep-sided gutters which are unfavourable for *Chortoicetes terminifera* (see pl. vii, figs. 1 and 2). Restricted flats or swamps, or more extensive flood plains may provide favourable situations for the locust. On the whole, locust habitats occur rather sparingly in this zone.

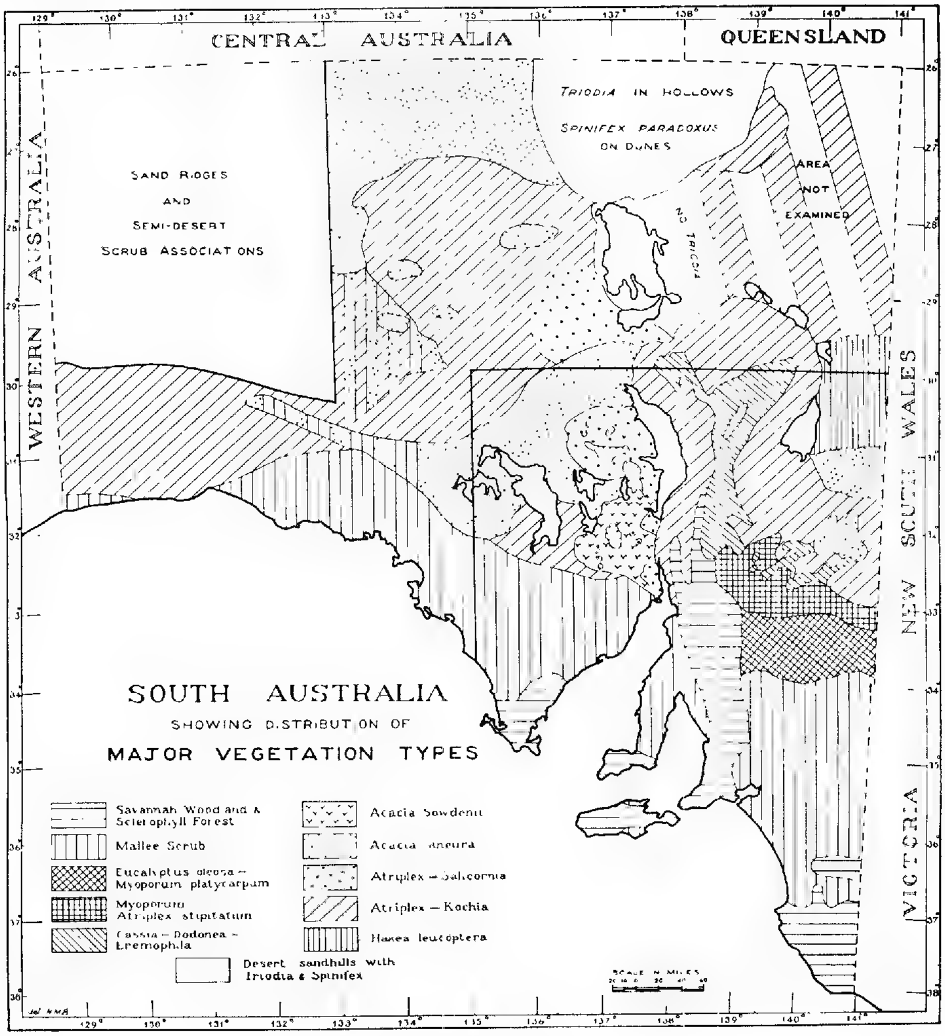
The *Atriplex-Salicornia* association occurs on characteristic soil commonly described as "gibber" tableland (11). Irregular sunken areas, known as "crab-holes," occur. They are relatively free from stones despite the essentially stony nature of the surrounding plain. Water tends to collect in the crabholes, and they support a wealth of ephemerals after rain; but they do not provide a breeding place for *Chortoicetes terminifera.* Favourable habitats for the locust may be quite rare in the *Atriplex-Salicornia* zone. Associated with the "gibber" table-land are more or less extensive islands of sandy country. The sand ridges support mostly *Acacia aneura* and *Callitris.* In between the ridges flat watercourses, which may provide favourable habitats for *Chortoicetes terminifera* (see pl. viii, fig. 1), occur.

The soil in the *Acacia Sowdenii* zone is firm and shallow, the limestone layer being normally quite near the surface. The most common undershrubs are *Kochia* spp.; where the soil is deeper *Atriplex vesicarium* also occurs. Spear-grass *(Stipa)* is prominent further south; it becomes less important towards the northern limit of this zone. Drainage channels frequently take the form of gutters or small creeks. Favourable habitats for *Chortoicetes terminifera* are not common.

The *Acacia aneura* association requires a less arid environment than the shrub steppe. In the areas south-east from Lake Frome and west from Lake Torrens this is provided by the lighter and deeper soils. Elsewhere mulga may be associated with local situations which are less arid, e.g., hill tops in the Flinders Ranges (17). Where the mulga reaches its maximum development the soil may be too loose, even in the hollows, to provide favourable habitats for the locust. Elsewhere, particularly where the *Acacia aneura* and *Atriplex-Kochia* zones merge the soil may be firmer; and favourable habitats for the locust may be widespread.

The *Hakea leucoptera* association occurs in an area of low sand-ridges. The northern part of this zone has not been examined. In the south the country is gently undulating. The dominant shrub on the rises is *Hakea leucoptera;* important undershrubs are *Atriplex vesicarium* and *Eremophila* spp. After rains *Salsola Kali* and ephemeral grasses are abundant. Between the sand-ridges extensive flat loamy watercourses may occur. Favourable habitats for *Chortoicetes terminifera* may be widespread in this area (see pl. v, fig. 1).

East from Lake Eyre drifting sand dunes (see pl. viii, fig. 2) may be interspersed with areas of stony "tableland." This area has not been adequately examined. The shrub steppe association occurs in restricted situations. Towards



Text Figure 5

The distribution of the vegetation types inside the heavy line has been simplified after Wood. The area in the far North-west has not been examined.

the Queensland border Mitchell grass *(Astrebla)* becomes increasingly important. Probably certain of the associations occurring in south-western Queensland (3) extend their boundaries into this area. The great drainage channels of the Diamantina River and Cooper's Creek modify large areas of country. Favourable habitats for *Chortoicetes terminifera* may be associated with these rivers; they may also occur in restricted situations elsewhere in this area.

The probable distribution of locust habitats in the outbreak area, based on the distribution of vegetation types is indicated in text fig. 4. Favourable situations occur most frequently in those areas where the country is undulating and the soil light. These conditions are found in the southern parts of the distribution of the *Acacia aneura* and *Hakea leucoptera* associations. In the area of desert sandhills and on the gibber tableland suitable habitats may be quite rare. Elsewhere favourable situations may occur, more or less frequently depending upon the physical features of the area. Quite extensive favourable habitats may be associated with the flood plains of certain large creeks which occur in the shrub steppe zone.

Typical situations which may provide favourable habitats for *Chortoicetes terminifera* are illustrated in pl. v, figs. 1 and 2; pl. vi, figs. 1 and 2; and in pl. viii, fig. 1. Not all the better watered situations in the outbreak area provide favourable habitats for the locust. The factors which determine favourableness are not fully understood. Probably the frequency with which the situation receives "run-off," the length of time that water may lie after rain, and the nature of the soil are important. Situations which receive "run-off" only after an abnormally heavy rain may not support a perennial vegetation suitable for the grasshoppers; situations where water lies for long periods after rain are also unfavourable. The occurrence of loose sand or the presence of a high proportion of soluble salts may render a situation unfavourable.

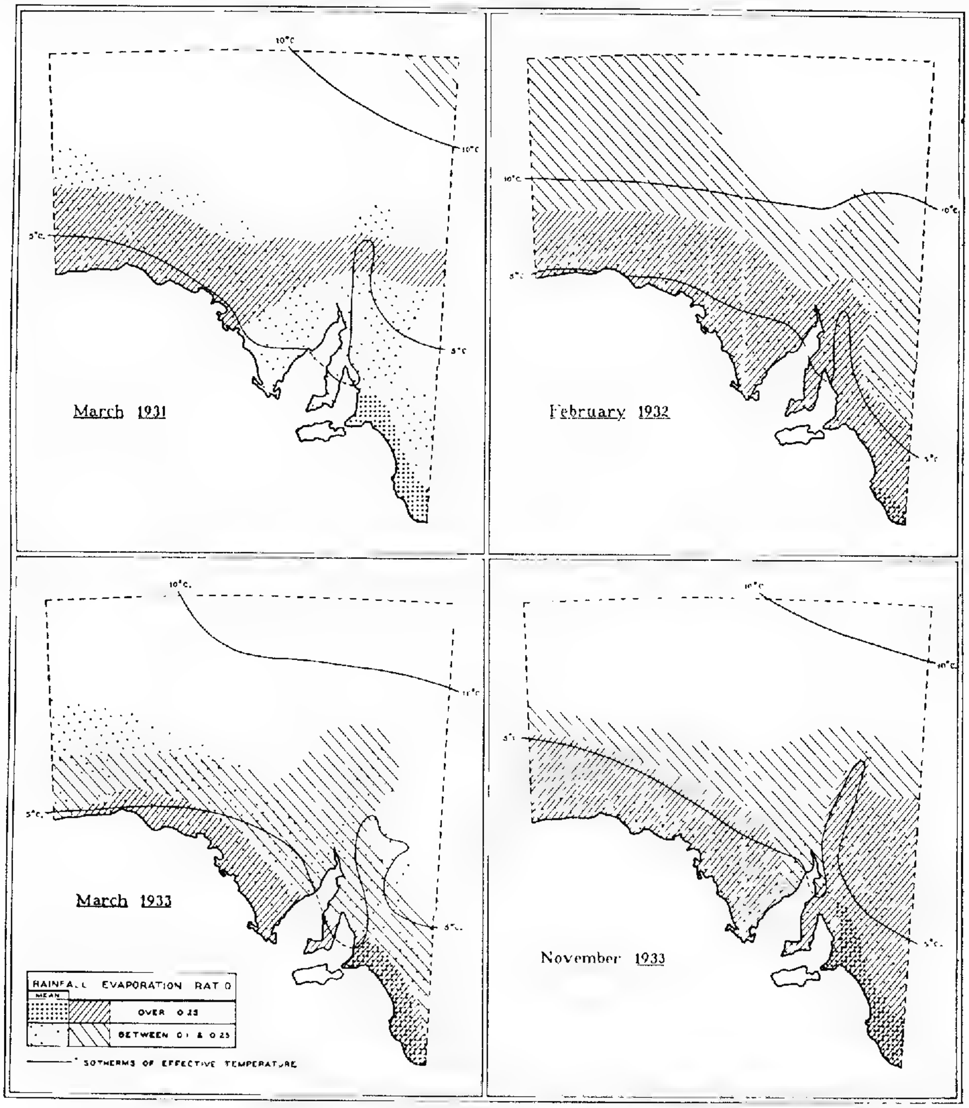
In the plant communities associated with favourable habitats herbaceous perennials, particularly grasses, are important; and ephemerals are usually abundant after rain. The latter provide adequate food in a good season and the perennials allow a few grasshoppers to persist during dry times. The nature of the perennial vegetation may indicate a favourable situation. The love grasses *Eragrostis setifolia* and *E. Dielsii* are the most characteristic and important perennials in locust habitats. Other perennials commonly present include *Panicum decompositum, Chloris divaricata, Enneapogon nigricans,* and *Psoralea patens.* In the more northerly areas *Astrebla pectinata* also occurs.

A wide range of ephemeral species has been collected from locust habitats. The more important include *Dactyloctenium radulans, Tetragonia eremaea, Calotis multicaulis, Heliotropium europeum,* and *Bassia* spp. *Atriplex angulosum* and *A. spongiosum* may also be abundant.

V Weather in Relation to Outbreaks

The history of the most recent outbreak of *Chortoicetes terminifera* in South Australia has been described by Davidson (9). In the present paper the meteorological records for the critical years before and during the outbreak are discussed. The records for the years 1931-35 for the outbreak area and for 1934-35 for the invasion area have been examined.

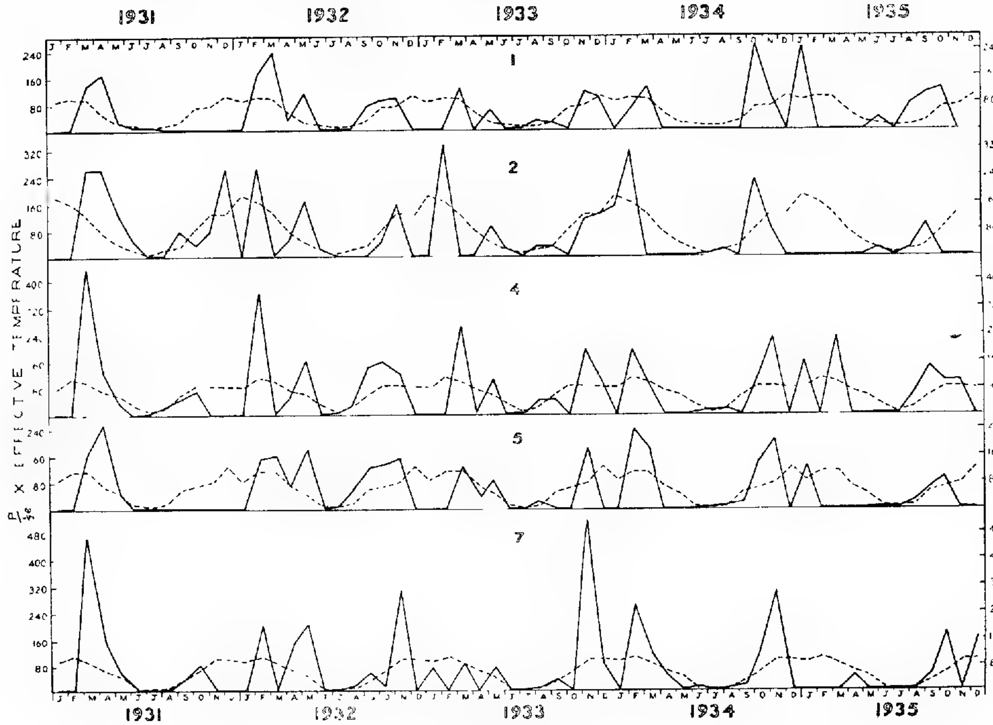
Conditions are favourable for the locust when rainfall is adequate during the summer, as high values for effective temperatures may be expected. Large parts of the outbreak area received rain well above the normal in March 1931, February 1932, March 1933, and November 1933 (text fig. 6); the values for effective temperature were also favourable during these months. Maps similar to those in text figure 6 were prepared for the remaining months during 1931 and 1934, but



Text Figure 6

Shows isotherms of effective temperature for *Chortoicetes terminifera* (developmental zero taken as 15·5° C.) and the distribution of P/E for certain significant months during the development of the 1934/35 locust outbreak in South Australia. The stippled shading illustrates the distribution of the mean P/E for the same months.

they are not presented due to lack of space; they show that favourable conditions obtained during other months. However, the data for the outbreak area have been summarised in text figure 7. The graph for each district represents the mean for all the stations in the particular district (see text fig. 1). The expression PT/½e[8] has been used as an index of favourableness for the development of *Chortoicetes terminifera*. In order to allow for "non-effective" rain, values of PT/½e less than 2·5 have been considered equivalent to zero and values greater than 30 have been considered equivalent to 30.[9] The broken line shown in the chart of each district represents the mean for all the years that records have been taken; it has been included as a basis for comparison. In this case the rainfall



Text Figure 7

The heavy black line illustrates for each of the districts 1, 2, 4, 5, 7 (text fig. 1), the values for the expression PT/½e, month by month, for the years 1931-1935. The broken line represents the mean.

figures were reduced to 80 per cent. of their recorded value to allow for non-effective rain (see Table 2, p. 83).

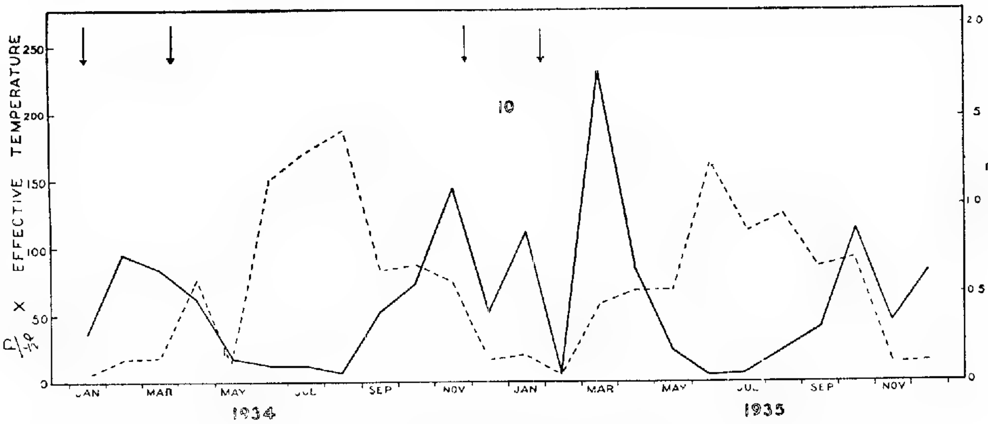
High values are obtained for the expression PT/½e when the rainfall is adequate during the warmer months. Due to the erratic rainfall in this area the same months were not always favourable over all districts, *e.g.*, in March 1932

(8) See above, p. 78.

(9) These figures correspond to values for P/E of 0·04 and 0·5 respectively (see pp. 77 and 78).

there was adequate rain in districts 1 and 5 but not elsewhere; February 1933 was dry everywhere except in district 2. Important favourable periods (in addition to those illustrated in text fig. 6) occurred in April 1931, November 1932, and February 1934. It is clear from text figure 7 that all the districts in the outbreak area experienced numerous periods favourable for the breeding of *Chortoicetes terminifera* during the years 1931-34. As a consequence swarms developed in the outbreak area during this period.

Swarms of the locust flew into the agricultural districts in South Australia and laid eggs there during the autumn of 1934. These eggs hatched in the spring of that year. The next generation laid eggs extensively in the invasion area (roughly district 10 of text fig. 1) during the summer of 1934-35. By the following spring the outbreak had died out almost completely, and the locust had been reduced to its normal status as a solitary grasshopper throughout most of the invasion area (9).

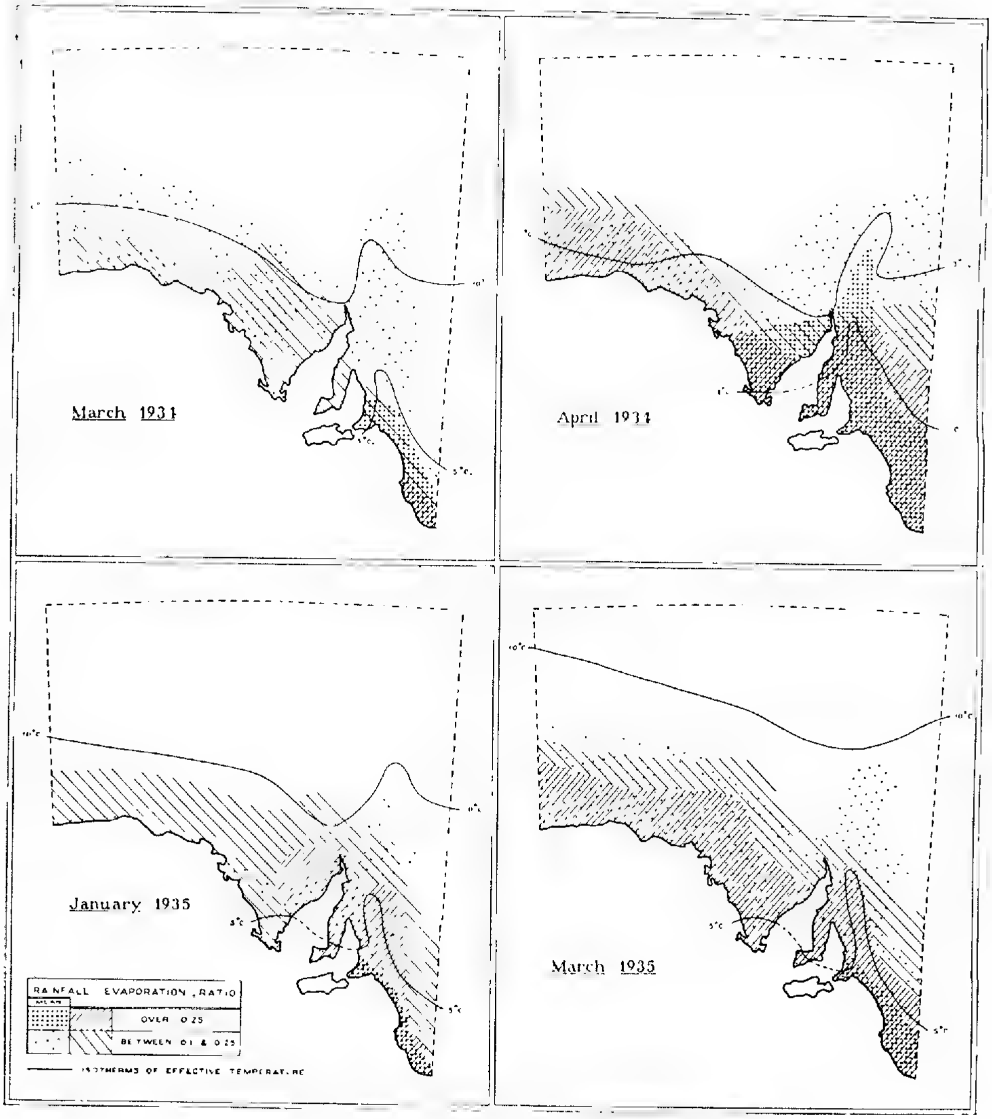


Text Figure 8

Illustrating the values for the expressions P/E (broken line) and PT/½e (complete line) month by month for the years 1934 and 1935, for district 10 (text fig. 1). The arrows indicate the approximate limits of the periods during which the locusts were ovipositing each year.

The high rate of survival of the 1934 generation and the extremely high mortality of the 1935 generation were associated with the time of oviposition and the weather. From text figure 8 it is clear that the eggs laid in the autumn of 1934 did not experience favourable conditions for hatching until the following spring, since values for PT/½e were low during the autumn and winter. Apparently the wetness (measured as P/E in text fig. 8) during July-August was not harmful to the eggs. The period March-April was important; in March the rainfall was well below normal; in April certain areas received adequate rain but temperature was too low for the development of *Chortoicetes terminifera* (see text fig. 9). Consequently the locusts remained in the egg stage during the unfavourable winter and were thus able to survive.

The eggs of the next generation were laid earlier, mostly during December-January. Summer rains fell while temperature was adequate. There were several periods during the summer and autumn when conditions were favourable for the development of the eggs (see text fig. 8). Important favourable periods occurred in January, March, and April. The areas affected by the rain in January and March 1935 are shown in text figure 9; in both these months adequate rain



Text Figure 9

Shows isotherms of effective temperature for *Chortoicetes terminifera* (developmental zero taken as 15·5° C.), and the distribution of P/E for certain significant months during the course of the 1934-1935 locust outbreak in South Australia. The stippled shading shows the distribution of the mean P/E for the same months.

fell over most of the area where eggs had been laid. As a consequence most of the eggs completed their development before the winter. Many nymphs died from starvation during the summer;[10] very few survived the winter. Prolonged exposure, under humid conditions, to temperatures near developmental zero may produce high mortality among nymphs of *Chortoicetes terminifera*.

It is clear that the locust is living in a difficult environment in South Australia. It may not develop swarms in the humid or semi-humid areas due to the marked winter incidence of the rainfall. In the outbreak area rainfall is so low that swarms may develop only when a sequence of two or three years experiencing abnormal summer rains occurs. Once swarms have been initiated in the outbreak area they may migrate to the "fringe country" and the wheat belt where further generations may be produced. But existence in these areas is precarious; swarms may persist only if a dry summer and a dry or cold autumn inhibit the development of the eggs before the spring, as in 1934. All these conditions must be fulfilled before a major outbreak (on the scale of that of 1934-35) can develop. It is not surprising that widespread plagues develop only at relatively infrequent intervals; records show that they have occurred about once in forty years since the foundation of South Australia in 1836.

These conditions are quite different from those occurring in central New South Wales, where important outbreak centres are situated in an area having an annual rainfall between 15 and 25 inches. A larger proportion of the rain falls in the summer, and the winter is warmer. Outbreaks occur more frequently than in South Australia (10).

In South Australia the area in which swarms may develop is vast and thinly populated; much of it is virtually uninhabited. Consequently it is not practicable to undertake control measures against *Chortoicetes terminifera* in the outbreak area. Nor is it practicable to attempt to modify the environment in this area to prevent swarms developing. Control measures should aim to destroy the locusts in the agricultural areas; thorough preparation for and organisation of the control campaign is essential. From this point of view it is important to know where an outbreak may be initiated and to understand the conditions required for swarms to develop in the outbreak area.

VI Acknowledgments

This work was undertaken on the suggestion of Professor J. Davidson. It was largely his advice which determined the nature of the approach which has been made to the problem. The extensive field survey work which was necessary could never have been undertaken without the generous assistance of the Commonwealth Council for Scientific and Industrial Research who provided a motor vehicle for the purpose, and the State Department of Agriculture who arranged for a special grant for travelling expenses. The helpful co-operation of Mr. N. McGilp, President of the Pastoral Board, and many pastoralists living in the

---

[10] See footnote, p. 81.

areas visited is also greatly appreciated. I am indebted to Miss C. M. Eardley who identified the plants collected on the survey trips, to Mr. R. L. Crocker for some observations regarding the vegetation around Lake Eyre and near Birdsville, and to Professor J. G. Wood for some helpful criticism. I am indebted to the officers of the Commonwealth Meteorological Bureau, both in Adelaide and in Melbourne, for much helpful co-operation in the collection of meteorological records. A great deal of the routine work connected with the examination of the weather records was done by Mr. F. Cook. Most of the diagrams and maps have been prepared by Miss H. M. Brookes. The photograph reproduced in plate viii, figure 2, was taken by my wife. The blocks for the illustrations shown in plates v-viii were kindly loaned by the Department of Agriculture of South Australia.

VII References

1 Andrewartha, H. G. 1937 Journ. Agric. S. Aust., **41**, 366-368

2 Andrewartha, H. G.; Davidson, J.; and Swan, D. C. 1938 Dept. Agric., S. Aust., Bull. No. 333

3 Blake, S. T. 1938 Proc. Roy. Soc. Qld., **49**, 156-204

4 Cannon, W. A. 1921 Carnegie Inst., Wash., Pubn. 308

5 Davidson, J. 1933 Aust. Journ. Exp. Biol. and Med. Sci., **11**, 59-66

6 Davidson, J. 1934 Trans. Roy. Soc. S. Aust., **58**, 33-36

7 Davidson, J. 1935 Trans. Roy. Soc. S. Aust., **59**, 107-124

8 Davidson, J. 1936 Trans. Roy. Soc. S. Aust., **60**, 88-92

9 Davidson, J. 1936 Trans. Roy. Soc. S. Aust., **60**, 137-152

10 Key, K. H. L. 1938 Counc. Sci. Ind. Res., Bull. 117

11 Murray, B. J. 1931 Trans. Roy. Soc. S. Aust., **55**, 91-112

12 Osborn, T. G. B.; Wood, J. G.; and Paltridge, T. B. 1935 Proc. Linn. Soc. N.S.W., **60**, 392-427

13 Prescott, J. A. 1931 Coun. Sci. and Ind. Res., Bull. 52

14 Prescott, J. A. 1934 Trans. Roy. Soc. S. Aust., **58**, 48-61

15 Prescott, J. A. 1938 Journ. Aust. Inst. Agri. Sci., **4**, 33-40

16 Trumble, H. C. 1937 Trans. Roy. Soc. S. Aust., **61**, 41-62

17 Wood, J. G. 1937 "The Vegetation of South Australia," Govt. Printer, Adelaide

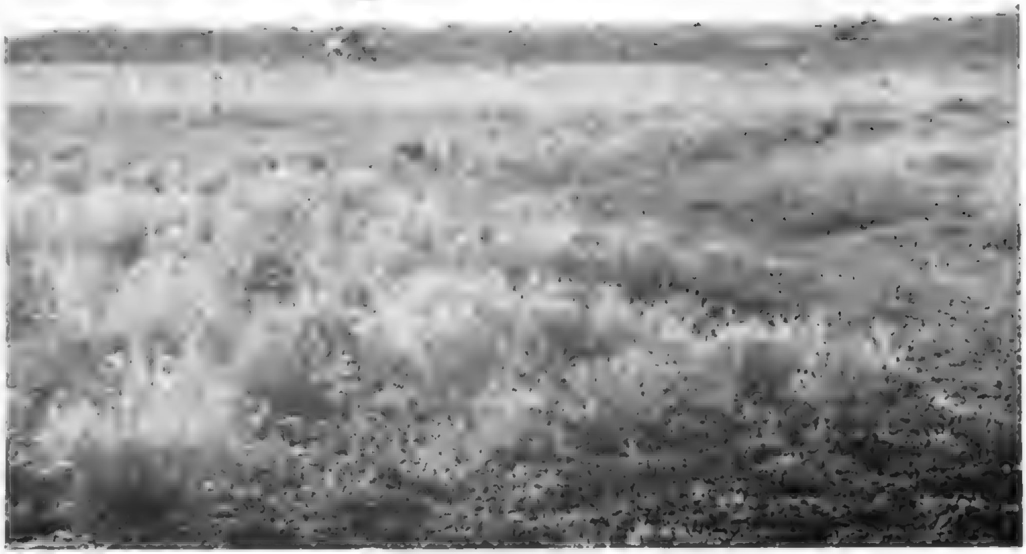


Fig. 1
Looking across a flat watercourse in the *Hakea leucoptera* zone. Several small shrubs of needlewood occur on the low sand ridges in the distance. The dominant grass is *Eragrostis setifolia*. Other plants are *Atriplex angulatum, Dactyloctenium radulans* and *Bassia uniflora*. An extensive favourable habitat for *Chortoicetes terminifera*.

Fig. 2
Flood plain of the Yerilla Creek which flows through an area where the *Atriplex-Kochia* association is predominant. Each row of Coolabahs *(Eucalyptus microtheca)* indicates a billabong. At least eight are visible in this picture. After a heavy rain the whole of this extensive flood plain may be a favourable habitat for *Chortoicetes terminifera*. Prominent plants are *Eragrostis Dielsii, Dactyloctenium radulans, Panicum decompositum*, and *Bassia* spp.

Fig. 1
A local depression with *Acacia Sowdenii* in the background. The plants in the depression include *Enneapogon avenaceum*, *Tragus racemosus*, *Dactyloctenium radulans* and *Bassia paradoxa*. A restricted favourable habitat for *Chortoicetes terminifera*.

Fig. 2
This flat is a characteristic favourable habitat for *Chortoicetes terminifera* in the *Acacia aneura* zone. The sandy hill carries *Acacia aneura*, *Acacia Burkittii* and *Callitris* sp. The principal plants in the flat are two grasses, *Eragrostis setifolia* and *Dactyloctenium radulans*.

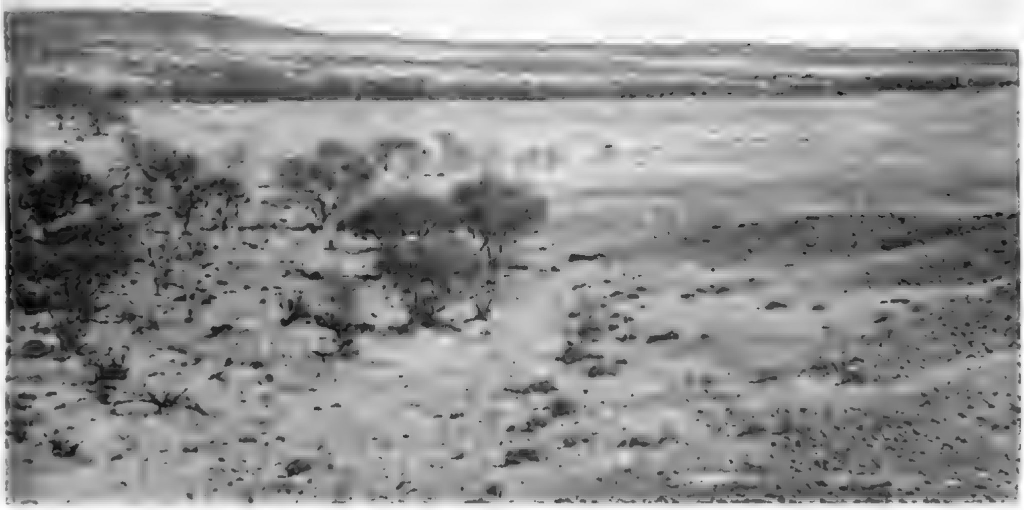


Fig. 1

A view in the *Atriplex-Kochia* zone near the northern limit of its distribution. Mulga *(Acacia aneura)* clothes the small channels that carry water away from the hills in the distance.

Fig. 2

A closer view of the drainage channel shown in fig. 1. Stony, steep-sided gutters like this do not provide favourable habitats for *Chortoicetes terminifera.*

Fig. 1
A watercourse between sandhills associated with an "island" of sandy country in the *Atriplex-Salicornia* zone. The sandy banks support *Acacia aneura*, *Melaleuca* sp. and *Callistris* sp. Important plants in the watercourse are: *Eragrostis setifolia*, *E. pilosa*, *Calotis multicaulis*, *Calocephalus multiflorus*, and *Bergia trimera*. A favourable and extensive habitat for *Chortoicetes terminifera*.

Fig. 2
A drifting sand dune in the desert zone. The tree is a stunted Coolabah *(Eucalyptus microtheca)*. The other plants are mostly ephemerals.

NEMATODES FROM SOUTH AUSTRALIAN MARSUPIALS

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

Summary

Some nematodes from South Australian marsupials have been dealt with in our earlier papers in the series. The present communication refers to material from the black-faced kangaroo, *Macropus melanops*, collected mainly by L. Dinning in the vicinity of Mundalla; the Flinders Range wallaby, *Petrogale xanthopus*; Pearson Island wallaby, *P. pearsoni* taken by Professor Wood Jones; Flinders Island wallaby, *Thylogale flindersi*, collected by H. H. Finlayson; and the Kangaroo Island wallaby, *Thylogale eugenii*. We have also included in our own study material from *Peragale minor* from Macdonald Downs in Central Australia, collected by the senior author. All the nematodes recorded in this paper, except *Dipetalonema roemeri* and *Austrostrongylus thylogale*, were taken from the stomach. The types of the new species have been deposited in the South Australian Museum. The present investigation has been undertaken with assistance from the Commonwealth research grant to the University of Adelaide.

NEMATODES FROM SOUTH AUSTRALIAN MARSUPIALS

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

[Read 9 May 1940]

Some nematodes from South Australian marsupials have been dealt with in our earlier papers in the series. The present communication refers to material from the black-faced kangaroo, *Macropus melanops*, collected mainly by L. Dinning in the vicinity of Mundalla; the Flinders Range wallaby, *Petrogale xanthopus;* Pearson Island wallaby, *P. pearsoni* taken by Professor Wood Jones; Flinders Island wallaby, *Thylogale flindersi*, collected by H. H. Finlayson; and the Kangaroo Island wallaby, *Thylogale eugenii.* We have also included in our study material from *Peragale minor* from Macdonald Downs in Central Australia, collected by the senior author. All the nematodes recorded in this paper, except *Dipetalonema roemeri* and *Austrostrongylus thylogale*, were taken from the stomach. The types of the new species have been deposited in the South Australian Museum. The present investigation has been undertaken with assistance from the Commonwealth research grant to the University of Adelaide.

Nematodes recorded in this Paper, arranged under their Hosts

Macropus melanops Gould—*Pharyngostrongylus alpha* J. & M., *P. beta* J. & M.; *Cloacina communis* J. & M., *C. parva* J. & M., *C. curta* J. & M., *C. obtusa* J. & M., *C. macropodis* J. & M., *C. australis* J. & M., *C. frequens* J. & M., *C. vestibulata* n. sp., *C. longelabiata* J. & M., *C. hydriformis* J. & M.; *Paramacropostrongylus typicus* n. gen., n. sp.; *Dipetalonema roemeri* (Linst.).

Macropus robustus Gould—*Dipetalonema roemeri* (Linst.).

Thylogale eugenii Peron and Lessueur—*Zoniolaimus eugenii* J. & M.; *Austrostrongylus thylogale* n. sp.

Thylogale flindersi Wood Jones—*Pharyngostrongylus beta* J. & M.; *Cloacina macropis* J. & M.; *C. petrogale* J. & M.

Petrogale pearsoni Thomas—*Pharyngostrongylus alpha* J. & M.; *P. beta* J. & M.; *Cloacina petrogale* J. & M.; *Zoniolaimus longispicularis* (Wood); *Macropostrongylus pearsoni* n. sp.

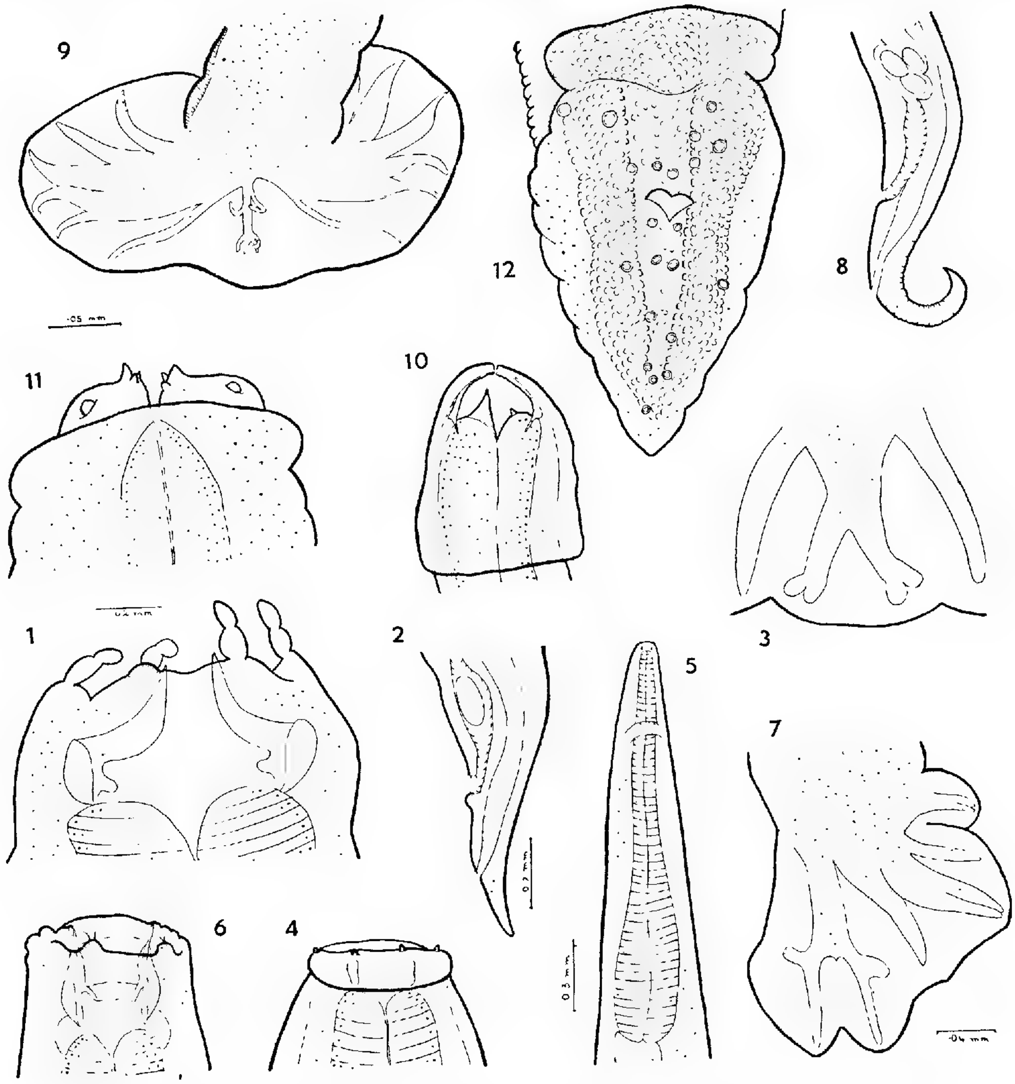
Petrogale xanthopus Gray—*Pharyngostrongylus beta* J. & M.; *Cloacina communis* J. & M.; *C. frequens* J. & M. *C. australis* J. & M., *C. curta* J. & M., *C. longelabiata* J. & M.; *Zoniolaimus longispicularis* (Wood).

Peragale minor Spencer— *Physaloptera peragale* n. sp.

Cloacina Linstow

The majority of the nematodes obtained from *Macropus melanops* and *Petrogale xanthopus* belong to this genus, and we noted a similar occurrence in

M. rufus, M. robustus and *P. lateralis* from Central Australia (1938). The genus is much less commonly represented in collections of parasites from eastern Australian marsupials. Since the genus predominates in drier regions it is probable that the eggs or larvae are more resistant. Nearly all the species now recognised from South Australian hosts were described originally from Central Australia, a fact



Figs. 1-2, *Cloacina vestibulata:* 1, head, lateral; 2, posterior end, female. Figs. 3-5, *Paramacropostrongylus typicus*: 3, externo-dorsal and dorsal rays; 4, head; 5, oesophagus. Figs. 6-8, *Macropostrongylus pearsoni:* 6, head; 7, bursa; 8, posterior end, female. Figs. 9-10, *Austrostrongylus thylogale:* 9, bursa, dorsal view; 10, head, lateral. Figs. 11-12, *Physaloptera peragale:* 11, head, lateral; 12, bursa, ventral.

Figs. 1, 6, 10 to same scale; figs. 2, 8 and 12; figs. 3, 4, 9 and 11.

which is not surprising in view of the geographical and climatic continuity of the regions. The exceptions are *C. obtusa*, originally from *M. rufus* from western New South Wales, and *C. vestibulata* n. sp. Specimens of *C. petrogale* from *Petrogale pearsoni* and *Thylogale flindersi*, both insular species of wallabies, were smaller than the types but were of similar proportions. *C. macropodis*, first described from Central Australia, and later identified from eastern Queensland (1939), is now recorded from Mundalla, Flinders Ranges, and Flinders Island; it is apparently widely distributed.

The following is a list of the species and their new host records: *C. australis, communis, curta, frequens* and *longelabiata* from *Macropus melanops* and *Petrogale xanthopus; C. hydriformis, parva, obtusa* and *vestibulata* n. sp. from *M. melanops; C. macropodis* from *M. melanops, P. xanthopus* and *Thylogale flindersi; C. petrogale* from *P. pearsoni and T. flindersi.*

Cloacina vestibulata n. sp.

Figs 1-2

From *Macropus melanops*, Mundalla. Male unknown. Female, about 2 mm. long; characterised by a peculiar development inside buccal capsule. Six low lips; two small lateral and four large, "two-segmented" submedian papillae; leaf crown arising from about half-way up buccal ring, and below its origin a continuous narrow shelf extending into mouth cavity. Buccal ring 0·056 mm. diameter, ·022 mm. deep, base ·035 mm. from anterior end of lips. Oesophagus ·7 mm. long, with indication of median bulb where it is surrounded by nerve ring, ·3 mm. from head, before widening to its posterior end. Excretory pore and cervical papillae not observed. Posterior end narrowing near vulva to terminate in narrow pointed tail, ·2 mm. long. Vagina about 1·2 mm. long; vulva ·48 from tip of tail. Eggs in vagina about ·16 by ·08 mm.

PHARYNGOSTRONGYLUS Yorke & Maplestone

P. alpha and *P. beta* were both found in *Macropus melanops* and *Petrogale pearsoni;* but only *P. beta* in *Thylogale flindersi* and *P. xanthopus.* Both of these species have a rather longer vestibule than that figured for the type, but the differences appear to be insufficient to separate them off as new species. In *P. beta* from *Thylogale flindersi* and *P. pearsoni* the bristles on the oral papillae are bifid.

ZONIOLAIMUS Cobb

Z. longispicularis (Wood) was obtained from *P. xanthopus* and *P. pearsoni;* those taken from four specimens of the latter wallaby being much smaller than typical members of the species, but the proportions are consistent with those of Wood's species.

Z. eugenii, recently described by us (1940), was recognised in material from the type host species, *Thylogale eugenii*, from Kangaroo Island.

Paramacropostrongylus n. gen.

Trichoneminae. Long stout worms. Head with cuticular collar bearing six small papillae. Buccal ring short, cylindrical. Oesophagus widening posteriorly. Male: ventral rays parallel; externo-laterals divergent from laterals, externo-dorsal arising from base of dorsal; dorsal bifurcating about mid-length, each branch bifid at tip; spicules long, fine, with narrow striated alae. Female: tail tapering, vulva short distance in front of anus. Type, *P. typicus* n. sp. from *Macropus melanops*.

The genus resembles *Cyclostrongylus* and *Macropostrongylus* in many features, but is distinguished from both in size and in the character of the externo-dorsal and dorsal rays; and from the latter by the absence of a leaf-crown. The external appearance is suggestive of *Zoniolaimus* but it differs in the structure of the head.

Paramacropostrongylus typicus n. g., n. sp

Figs. 3-5

From *Macropus melanops*, Mundalla. Female, 5·5 cm.; male, 3·6 cm. Mouth collar with six minute conical papillae; buccal ring stout, ·032 mm. diameter, ·02 mm. deep; oesophagus 1·8 mm. long, widening gradually after its mid-length to become twice as broad at posterior end. Nerve ring ·5 mm. from anterior end.

Male: Bursa large, lobes not deeply separated. Ventral rays together, cleft half their length, reaching edge of bursa. Externo-lateral ray shorter than laterals, stout; medio- and postero-laterals cleft three-quarters length, postero-lateral slightly longer, none reaching bursal edge. Externo-dorsal ray arising from base of dorsal, not reaching bursal edge. Dorsal ray stout, bifurcating after half-length, each branch bifid at tip. Spicules 3·5 mm. long, 1 : 10 of body length. Pair of prebursal papillae. Gubernaculum absent.

Female: Body tapering to pointed tail, latter ·35 mm. long. Vulva 1·3 mm from posterior end; vagina very short. Eggs 150 by 70 μ.

Macropostrongylus pearsoni n. sp.

Figs. 6-8

From *Petrogale pearsoni*, Pearson Island, Great Australian Bight, coll. Prof. Wood Jones. Male, 5·5 mm; female, 6·2 mm. long. Anterior end flattened; with four rounded submedian and two large lateral papillae, each of the former with two setae. Buccal cavity in male ·018 mm. diameter, 0·3 mm. deep, and from its walls ·02 mm. from anterior end a downwardly projecting shelf composed apparently of numerous tooth-like projections.

Male: Spicules broken, part remaining in body ·85 mm. long Dorsal part of bursa much longer than ventral. Ventral rays parallel, cleft; externo-lateral separate from laterals for whole length; laterals cleft half length; externo-dorsal arising with laterals, distal half divergent from them. Dorsal ray bifurcating after half length into two long thin branches; at point of bifurcation a pair of short laterals, also a very short conical median projection.

Female: Tail ·41 mm. long, curved dorsally. Vulva ·68 mm. from tip of tail. Eggs, ·07-·08 by ·05-·06 mm.

The species differs from any previously described in the genus in the characters of the head and buccal capsule, combined with the shape of the dorsal ray.

Austrostrongylus thylogale n. sp.

Figs 9-10

From *Thylogale eugenii,* Kangaroo Island. Small coiled worms. Males 3 mm. and females 5 mm. long. Cuticle inflated in head and neck region for ·06 mm., and marked with wide transverse striations. Behind this region six longitudinal, transversely striated ridges, lateral ridges wider than submedians. Buccal capsule 15 μ deep and 25 μ wide at base; dorsal tooth 10 μ long; ventral teeth 3 μ. Oesophagus ·23 mm. long, surrounded by nerve ring just behind its mid-length and ·15 mm. from head. Excretory pore ·19 mm. from head end.

Male: Spicules tapering, stout, ·36 mm. long, about 1:9 of body length. Bursa large, with two large lateral lobes and a small dorsal lobe. Rays slightly asymmetrical, externo-lateral and medio-lateral of one side rather stouter than those of the other, latero-ventral more slender on the former side. Ventral and lateral rays stout near base, tapering to tips. Ventro-ventrals bending ventrally, latero-ventrals more or less straight, neither quite reaching bursal edge; externo-lateral curving ventrally, medio- and postero-laterals bending dorsally at tip, all three reaching edge of bursa. Externo-dorsals long, thin, arising from base of laterals, curving to reach bursal edge. Dorsal ray slender, short, giving off pair of rather long branches near its base, and dividing near its extremity into four short rays, the outer pair longer than the inner.

Female: Body tapering to conical tail. Anus ·05 mm. and vulva ·42 mm. from posterior end. Eggs, ·06 by ·03 mm. (uterine).

The species differs from the three already known in having three pairs of branches to the dorsal ray, instead of two pairs.

PHYSALOPTERA Rud.

This genus has not been reported from kangaroos and wallabies but is common in bandicoots, occurring in the stomach. We now record a second species, the host being the rabbit bandicoot or bilby, *Peragale minor,* from Central Australia (Macdonald Downs).

. **Physalopter peragale** n. sp.

Figs. 11-12

Large stout worms. Males about 24 mm., females up to 30 mm. long. Cuticle finely striated transversely. In the four specimens available, the cervical cuticle does not cover the lips, but is wrinkled and possibly contracted. Two lateral lips each with a pair of sublateral papillae, and each with tripartite median tooth and a larger tooth external to it. Oesophagus 5·3 mm. long (in male), anterior part narrower and surrounded about its mid-length by nerve ring ·42 mm. from anterior end of head. Excretory pore ·7 mm. and short, stout cervical papillae ·6 mm. from head end.

Male: Bursa large, 1·25 mm. long, ·7 mm. in maximum width at level of anus, median portion covered with longitudinal rows of bosses, lateral parts free from them. Bursal papillae irregularly arranged; three large pre-anal papillae on one side, five on the other; then one pair immediately pre-anal, two pairs post-anal; laterally from the last pair, a pair of larger papillae; and then posteriorly six papillae arranged more or less medially, the series almost reaching tip of tail. Spicules obscured, larger probably ·6 mm. long.

Female: Tail rounded; anus ·6 mm. from tip. Vulva 9·3 mm. from anterior end. Uteri full of oval eggs, 50 by 35 μ, with very thick shells and containing embryos.

The species differs from *P. peramelis* in its shorter length and in having a larger bursa with more papillae.

DIPETALONEMA ROEMERI (Linstow)

Specimens were identified from *Macropus robustus*, Flinders Ranges (coll. H. B. Holmes), and *M. melanops*, Mundalla.

ON A NEW GENUS OF SPONGES FROM THE CAMBRIAN OF THE FLINDERS RANGE, SOUTH AUSTRALIA

By FREDERIC CHAPMAN, A.L.S., F.G.S., etc.

Summary

The specimens upon which this paper is based were recently discovered by Sir Douglas Mawson in the Flinders Range, South Australia, and I am greatly indebted to him for the opportunity of investigating this unique occurrence. These fossil sponges were Found in an horizon a little above the main Archaeocyathinae "reef," and proved to be one of the most remarkable discoveries of recent years. All previous records of sponges in the Australian Cambrian have been confined to sporadic occurrences of anchoring spicules and separated spongespicules scattered through the cherts and cherty limestones of that age.

ON A NEW GENUS OF SPONGES FROM THE CAMBRIAN OF THE FLINDERS RANGE, SOUTH AUSTRALIA

By Frederick Chapman, A.L.S., F.G.S., etc.

[Read 9 May 1940]

Plates IX to XII

Introduction

The specimens upon which this paper is based were recently discovered by Sir Douglas Mawson in the Flinders Range, South Australia, and I am greatly indebted to him for the opportunity of investigating this unique occurrence. These fossil sponges were found in an horizon a little above the main Archaeocyathinae "reef," and proved to be one of the most remarkable discoveries of recent years. All previous records of sponges in the Australian Cambrian have been confined to sporadic occurrences of anchoring spicules and separated sponge-spicules scattered through the cherts and cherty limestones of that age.

The present examples are remarkable in that they represent actual sponge-bodies, with the spicular structure more or less in position, and are, therefore, the first of their kind to afford definite evidence of their taxonomic position amongst Lower Palaeozoic sponges.

General Description

In general descriptive terms these ancient sponges are cup-shaped, varying from vase-like forms to elongate, almost cylindrical bodies. Since no other sponges comparable to these have hitherto been found in the Australian Cambrian, nor indeed in that formation elsewhere, morphological comparisons must be meagre. Their spicular structure, however, shows that they belong to the Lyssakine group of the Hexactinellida, in having the spicules of the skeleton separate, or united at a late period of growth in an irregular manner by siliceous masses or by transverse synapticulae (Minchin, 1900, p. 121). That author has also pointed out that the Family Pollakidae, to which a related form, *Hyalostelia* was referred, "has been broken up and distributed amongst other families, and it only remains for the fossil forms to be similarly treated" *(op. cit.,* p. 123). It is therefore suggested here that the present Cambrian genus, *Protohyalostelia* and other related ones, as *Hyalostelia* (Cambrian to Carboniferous), should be placed in a new Family, the Hyalostelidae.

The present type of siliceous sponges from the Flinders Range does not appear to show any structural features common to the numerous genera described by Dr. C. D. Walcott from the remarkable assemblage of Middle Cambrian organisms of the "Wapta Pool," British Columbia; except it be the species, *Protospongia hicksi,* in which exceptionally stout cruciform spicules are present. On the other hand, it seems to be closely related in skeletal features to *Hyalostelia* of the British Carboniferous, and, incidentally, to the already described *Hyalostelia australis* Eth. fil.

In the present fossils the wall is definitely densely spicular. These spicules are principally microscleres, which would naturally be held together by the flesh of the sponge in the living condition. These dermal spicules are mainly of a curved and fusiform shape (oxeote microrhabds) and occasionally acerate. The interior of these cup-shaped sponges seems to have been largely occupied by a comparatively coarse but loose spicular mesh, embedded in which, especially towards the inner dermal layer, are pin-shaped, cruciform, or even five- and six-rayed spicules, as in *Hyalostelia*, particularly in the Carboniferous examples. In places larger spicules (megascleres) are seen to fuse into a reticulate mesh, but only in rare instances, showing that they are normally loosely aggregated. The fusiform microscleres, which are an abundant feature of the outer wall of the cup, are also seen scattered throughout the inner portion, but more sparsely. All these spicular elements, when not re-crystallised, show the axial canal usually present in the Silicispongiae. The altered spicules have been changed in structure to the form of polysynthetic quartz and chalcedony, and this almost invariably obliterates the axial canal.

Where cruciform spicules can be recognised in thin sections they appear to closely resemble those of *Hyalostelia* from the British Carboniferous. As yet no anchoring spicules have been found associated with the sponges from the Flinders Range, so that no direct comparison can be made between these forms and the long rod-like spicules of *Hyalostelia australis* of Curramulka and the MacDonnell Ranges.

The cruciform spicules seen in *Protospongia*, excepting in *P. hicksi*, are more slender as compared with those in the present examples, nor do the latter show any fenestrate character essential to *Protospongia*. Moreover, the dermal layer of the cup in *Protospongia* appears to be characteristically tenuous.

The spicular mesh of the inner cup in the present form, generically defined here as the type of a new genus, *Protohyalostelia*, is remarkably close to that of the genotype of *Hyalostelia*, *H. smithii* (Young and Young), Zittel, 1878, from the Carboniferous of England, Scotland and Ireland. The spicules of that genus, by the way, are occasionally accompanied by anchoring spicules (Hinde, 1887, pl. vi, figs. 2, 2a). The actual form of the sponge in *Hyalostelia* is unknown; therefore, on this and other grounds, it seems advisable to regard the Flinders Range fossils as generically distinct.

Notes on Generic Standing of PYRITONEMA, *McCoy, 1850*

This genus, with genotype *P. fasciculus*, was founded on "a fragmentary band of spicules embedded in dark limestone of Llandeilo age" (Hinde, 1888, p. 111). These remains have usually been regarded as anchoring sponge-spicules of a form met with in the living Glass Rope Sponge *(Hyalonema)*. Similar fasciculate and elongated spicules, when occurring in the Australian Palaeozoic, have been referred to as *Hyalostelia australis* (R. Etheridge, jun., 1916). The species has occurred in the Cambrian of Curramulka, South Australia, and in the Ordovician of the MacDonnell Ranges, Central Australia. With reference to this record (Etheridge, jun., 1916, p. 149) that author says: "As a matter of priority the name *Hyalostelia* Zittel, 1878, should give place to that of *Pyritonema* McCoy, 1850. Dr. Hinde, however, has retained the former, but in the English edition of Zittel's 'Text-book of Palaeontology' by Eastman the two are separately maintained, *Pyritonema* being defined as 'fascicles of long stout spicules, supposed to be 'root tufts'; whilst in *Hyalostelia* the anchoring spicules are root tufts composed of elongated, slightly bent fibres, sometimes terminating in four recurved rays.'"

Dr. Ruedemann (1925, p. 36, *et seq.)* has placed *Pyritonema* McCoy in the Family Hyalonematidae, as Prof. Rauff has already done (1893, p. 257). This generic form has also been recorded under the name of "*Leptomitus*" *zitteli* by Walcott (1886, p. 89, pl. ii, figs. 2, 2*a)* from the Lower Cambrian of Vermont, U.S.A. *Pyritonema* is also known from the Ordovician of Britain (Tremadoc and Llandeilo beds) and Canada (Metis Shales) and the Ordovician of Scandinavia. Rauff would restrict *Pyritonema* as a Lower Palaeozoic genus and refer the Carboniferous anchoring sponge-spicules to *Hyalostelia.*

The present writer is of the opinion that *Pyritonema,* in conformity with its original definition and subsequent interpretation, as a band of spicules or "tubes" (anchoring spicules), should be retained for such, when not associated with undoubted spicules of the mesh; for, as Dr. Hinde remarked (1888, p. 111): "No hexactinellid body-spicules are as yet known in connection with this species *(Pyritonema fasciculus* McCoy), which is founded exclusively on fragments of the bundles of spicular rods forming the anchoring appendages of the sponge." The Australian form may, therefore, be regarded as a species of *Pyritonema, P. australis* (Eth. fil.).

Systematic Description

Order HEXACTINELLIDA Oscar Schmidt

Sub-order LYSSAKINA Zittel

Family **HYALOSTELIIDAE** nov. *(Pollakidae* Marshall, 1876, pars)

Genus **Protohyalostella** nov.

Siliceous sponges of Lyssakine affinities, that is, with the spicules of the skeleton either separate or united at a late period of growth, the loosely conjoined spicules held together by the flesh of the sponge. The discovery of these sponges, having a definite cup- or vase-shaped body, in so old a formation, makes it of outstanding interest. The chances of finding such fossils, in which the original skeleton was so loosely compacted, is slender indeed.

The walls of the cup usually appear to be duplicated in these specimens, with an interspace of about 2 mm., the external wall measuring about 4 mm. and the inner about 3 mm. in thickness. Spicules of the wall massed together, consisting largely of curved, fusiform microscleres.

The interior of the cup, more or less filled with disintegrated spicules, represents what was once the spongy skeleton held together by tissues since destroyed.

The external surface of the sponge, where preserved, shows a verrucose structure, resembling the surface of a gherkin. The border of the cup, forming the margin of a shallow cloacal cavity, is more or less elliptical, with, in places, an involute or vellicate (pinched up) portion.

Protohyalostelia mawsoni sp. nov.

NOTE—In view of the gradational variation in size, shape and relative proportions, it seems at present impossible to separate these fossil examples even into varieties. It may be sufficient here to regard them as conspecific and monotypical of the genus, although morphological variations are indicated.

The specimen, 4200 F (pl. ix, figs. 1 and 2) is here designated as the *Holotype*, since it is the most typical of the series, showing the cup margin, double wall, well-preserved external surface and general form of the sponge. In oral aspect the ends of the longer diameter show an angulation partly due to compression in the embedding stratum. There are also indications of an invaginated border or diverticulum, obscured, however, by weathering; these invaginated margins are also similarly to be noticed in some Cretaceous *Ventriculites* (Hexactinellida), as well as in the Calcarea.

When examined microscopically, the wall of the sponge is seen, in most cases, to be formed of a dense mass of microscleric spicules, which are gently curved and acerate. This dermal wall shows a dark, smoky staining. A somewhat similar appearance is noted by Dr. Walcott (1920, p. 308) in connection with the Burgess Shale occurrence of *Protospongia hicksi*, who states that it is due to abundant minute crystals of pyrites. In the present case this smoky tint appears to be due, when sections are examined under a high power, to finely disseminated crystals of specular iron or haematite.

The weathered surface of the cup, where it has presumably been partially filled with matrix, exhibits etched and roughly areolate depressions, appearing in consequence almost tessellated. The lateral surface of the walls over a limited area, shows a verrucose character, as though encrusted with a hydractinian; this, however, is probably due to the weathering of the skeletal structure of the sponge itself.

Length of sponge, 4200 F, 97 mm. Diameter at summit, 58 mm. x 36 mm.

Description of Paratypes:

4200 B (pl. ix, fig. 3). Forma *brevis*. Length of sponge-body, 52 mm. Surface of cup, 44 mm. x 27 mm.; with a shallow depression. Margin diverticulate at one side and generally undulate. General form apparently somewhat flattened by subsequent compression in the stratum.

4200 A (pl. ix, fig. 4). Forma *gravida*. Two adjacent sponge-bodies in the one rock specimen, indicating habit of forming small colonies. One is nearly complete in outline, the other showing about two-thirds of the rim. Cup originally nearly circular, 50 and 45 mm. in diameter. These cups have a shallow depression, bordered by a thickened rim. The blackened surface of the rim extends in this case to the matrix between the adjacent sponges. The walls in these specimens measure circ. 5 mm. in thickness.

4200 C (pl. ix, fig. 5). Forma *producta*. Length of sponge-body, 104 mm.; with marginal diameter of 39 mm. x 29 mm. A much more elongated form than the preceding specimens. Border of cup, irregularly undulate.

4200 D (Form not illustrated). Sponge-body greatly compressed; long-elliptical in section. Length unknown.

Microscope-sections for study were made from this and the following specimen (4200 E); the structures from these are shown on plates x-xii.

Sections made from 4200 D appeared to pass through the cup and base, and portions are shown in pl. x, figs. 1 and 2. In both figures the curved and fusiform microscleres are seen to predominate, and have a fairly uniform length of 0·214 mm. There are also present some occasional triactines with a length of 0·7 mm., and hexactines 1·07 mm. long.

4200 E (Form of Sponge not illustrated). A short, roundly outlined sponge-body. Micro-sections from this specimen show the spicular structure in good preservation.

The cavity of the sponge is filled with loose meshwork of spicular tissue, in which elements having from 3 to 5 rays are seen. They range from about 1 mm. to 1·5 mm. in length, and are associated with some pin-shaped spicules; whilst numerous gently-curved and fusiform microscleres, like those which make up the bulk of the sponge-wall, are sparsely scattered throughout.

A good example of a 5- or 6-rayed spicule is seen in plate xi, figure 1, where a cross section of 4200 E was taken, cutting through the cloacal cavity with its loose meshwork. The rays in this spicule are stout and have a length of 0·8 mm. Triactines, tetractines and irregularly anastomosing spicular mesh are all present in this section.

Plate xi, figure 2, taken from the same specimen, 4200 E, shows a pin-shaped spicule, with traces of an axial canal, measuring 0·8 mm. in length. There is also in this photograph a furcate spicule somewhat resembling that of *Chancelloria drusilla* Walcott, a genus which he places in the Hexactinellida. Since this type of spicule is unique in our micro-slides, it may be presumed that it is either adventitious or merely an anchor-shaped spicule of the Hyalostelian group. The portion of figure 2 containing this spicule represents the wall of the sponge, the boundary line of the cup being noted between the arrows.

The boundary between wall and cloacal cavity is also shown in plate x, figure 3, with less magnification. It is taken from a longitudinal section of 4200 E.

The darker portion is the wall, with minute acerose spicules; the lighter portion representing the loosely welded skeleton of the inner cavity.

Ecologic and Phylogenetic References

The Lyssakine Group of the Hexactinellida, to which *Protohyalostelia* undoubtedly belongs, is acknowledged by competent authorities to represent a more primitive type than the Dictyonines, such as *Ventriculites* of the Chalk. The living representatives of the deep water Lyssakines comprise *Euplectella*, *Hyalonema* and several others, most of which are furnished with anchoring spicules by which they attach themselves to the bed of the sea in abyssal areas. Some of these living species occur, indeed, at a depth of only a few hundred fathoms, whilst *Hyalonema*, the Glass Rope Sponge, ranges down to 2,550 fathoms. Remains of anchoring or tufted species are found fossil from the Cambrian to the present.

Cup-shaped sponges of the Lyssakine group, on the other hand, were also most likely to have assumed their characteristic form when living just below or above the mud-line, from the earliest times. For evidence in support of this conclusion we may cite the sponge-fauna discovered some years ago by Dr. C. D. Walcott, where, amongst the fossils embedded in the black, silty shales of the Middle Cambrian, in British Columbia, such cup-sponges as *Protospongia* and the related but dictyonine *Vauxia* occurred in association, under similar fairly shallow conditions.

Another Cambrian form that was vase-shaped is *Protospongia hicksi* Hinde (1888, pt. ii, pp. 107-108), which in dimensions and structural features, bears some resemblance to the present species. For example, robust cruciform spicules occur in both, although this character may be common to more than one genus of this ancient group. *P. hicksi* also occurred in the Middle Cambrian black shales of British Columbia, of similar age to that of its original locality at St. David's, South Wales.

The Cambrian and Ordovician genus, *Pyritonema* and Lower Cambrian *Protohyalostelia*, are therefore representatives of the ancient sponge fauna of abyssal and neritic habitats, respectively.

It was hoped that this exceptional occurrence of well-preserved siliceous sponges from so old a formation as the Lower Cambrian might have thrown more certain light on the phylogeny, if not the ontogeny of the hexactinellid group. Suffice it to say, however, that the evidence here presented demonstrates the early existence of hexactines and triaxons, having definite axial canals similar to most modern types of this group. In *Protohyalostelia* many of the spicular elements are precisely similar to those of the Carboniferous *Hyalostelia*, even to the essentially Lyssakine characters seen in the loosely welded spicular mesh of the inner wall of the sponge skeleton.

We must indeed go back in retrospect to a period long before the Cambrian in order to discover the true relationships, for example, between the Choanoflagellata (probably through forms like Proterospongia) and the most primitive frame-building sponges. This transitional period would embrace such a theoretical phase as that suggested by Prof. Haeckel—the sponges acquiring the habit of secreting a siliceous skeleton from rooting in deposits of Radiolarian ooze, whilst the Calcarea may have likewise formed the calcareous spicular skeleton from immersion in Globigerina ooze.

Bibliography

Dawson, J. W. 1896 Trans. Roy. Soc. Canada, ser. 2, **2**, sect. iv

Etheridge, R., jun. 1916 Trans. Roy. Soc. S. Aust., **40**, 148-150, pl. xviii

Hinde, G. J. 1887 and 1888 British Fossil Sponges. Palaeont. Soc.

McCoy, F. 1850 Ann. Mag. Nat. Hist., ser. 2, **6**, 273

Minchin, E. A. 1900 In Ray Lankester's Treatise on Zoologie. Part ii. Sponges

Rauff, H. 1893 Palaeontographica, **40**, Memoir on Palaeospongiae

Ruedemann, R. 1925 N.Y. State Bulletin, No. 62. The Utica and Lorraine Formations of New York, pt. 2. Systematic Palaeontology, No. 1 Plants, Sponges, etc.

Salter, J. W. 1864 Quart. Journ. Geol. Soc., **20**, 238

Schulze, F. E. 1887 Report on the Hexactinellida. Results of the "Challenger" Expedition. Zool., **21**,

Walcott, C. D. 1886 Bull. U.S. Geol. Surv., No. 50

Walcott, C. D. 1920 Middle Cambrian Spongiae. Smithson. Misc. Coll., **67**, No. 6.

Zittel, C. von 1878 Handbuch der Palaeontologie, Bd. I, Lief. 2, 85

Zittel, C. von 1913 Textbook of Palaeontology (Eastman). Second edition

---

EXPLANATION OF PLATES IX, X, XI, XII

Plate IX

Fig. 1 *Protohyalostelia mawsoni* gen. et., sp. nov. Holotype. Reg. No. 4200 F. Lower Cambrian; Flinders Range, South Australia. Viewed from side. Circ. nat. size.

Fig. 2 Ditto. Same specimen. Oral view. ¾ nat. size.

Fig. 3 Ditto. Paratype of species; forma *brevis*. A shorter form. Oral view. Reg. No. 4200 B. Slightly reduced.

Fig. 4 Ditto. Paratype; forma *gravida*. More heavily built; two cups in juxtaposition. Reg. No. 4200 A. Slightly reduced.

Fig. 5 Ditto. Paratype; forma *producta*. Elongated form. Reg. No. 4200 C. Circ. ¾ nat. size.

Plate X

Fig. 1 *Protohyalostelia mawsoni*, gen. et., sp. nov. Tectotype, from 4200 D. Section through base of cup. Showing abundant microscleres; also a stout, cruciform spicule. X 28.

Fig. 2 *P. mawsoni*. Tectotype, from 4200 D. Section near base of cup. Showing abundant microscleres (rhabds of varying lengths). Also a pentactinal spicule in centre. X 28.

Fig. 3 *P. mawsoni*. Tectotype, from 4200 E. Showing dense with microscleres of outer wall below, and lighter mesh of the inner skeleton, anastomosing as in *Hyalostelia*, above. X 14.

Plate XI

Fig. 1 *P. mawsoni.* Tectotype, from 4200 E. Thin cross section through inner portion, showing a 6-rayed spicule, as in *Hyalostelia.* Also the general structure of the inner mesh. X 28.

Fig. 2 *P. mawsoni.* Tectotype, from 4200 E. Cross section through cup. Outer dense portion of wall. Shows a comparatively large pin-head spicule with canal; immersed in a mass of microscleres (curved, acerose forms). This outer portion also shows a furcate spicule resembling *Chancelloria.* Between arrows lies the boundary between the inner and outer tissue. X 28.

Plate XII

Figs. 1-8 Three, four and six-rayed spicules from the dermal and occasionally inner layer of *Protohyalostelia.* Compare similar forms figured by G. J. Hinde (1887, pl. iv) —*Hyalostelia smithii* (Young and Young) and *H. parallela* (McCoy), from the British Carboniferous. Figs. 2, 4 and 8 are suggestive of imperfect terminals of anchoring spicules. Drawn from sections 4200 D and 4200 E.

Fig. 9 Rayed spicule partially reduced to knobs, from inner part of the wall, section 4200 D. Compare Hinde (1887, pl. v, figs. 1 f, g) in *Hyalostelia smithii* (Young and Young). Carboniferous.

Fig. 10 Transverse section of rod-like spicule (rare), with large axial canal. Section 4200. From wall.

Fig. 11 Pin-shaped spicule in wall. Section 4200 D.

Fig. 12 Accrate microsclere of the wall (mingled with smooth forms in all sections of *Protohyalostelia*). Compare similar spicules in *Geodites* of the Scottish Carboniferous (Hinde, 1887, pl. v, figs. 3, 4 c). From 4200 D. Section through walls.

Fig. 13 Anastomosing spicular structure of the inner skeleton within the cup. Section 4200 D.

Fig. 14 Coarse cancellated mesh structure of the interior of the sponge-body. Section 4200 E.

All figures magnified 37 times.

Protohyalostelia mawsoni g. et sp. nov. L. Cambrian, S. Aust.

F. C. photo

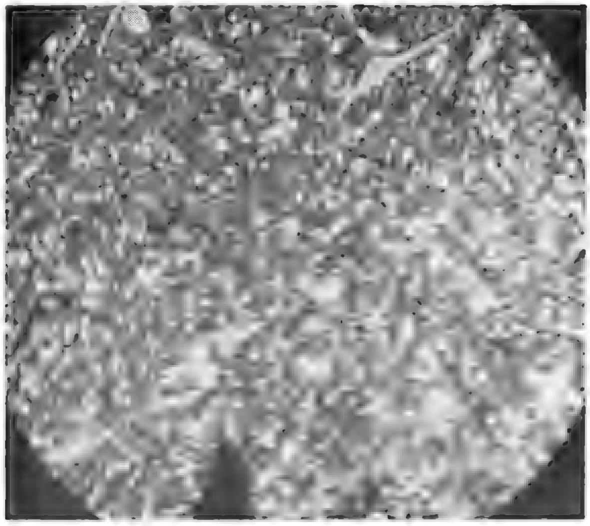


Fig. 1

Fig. 2

Fig. 3

Structure in *Protohyalostelia mawsoni* g. et., sp. nov., L. Cambrian, S. Aust.

F. C. photomicr.

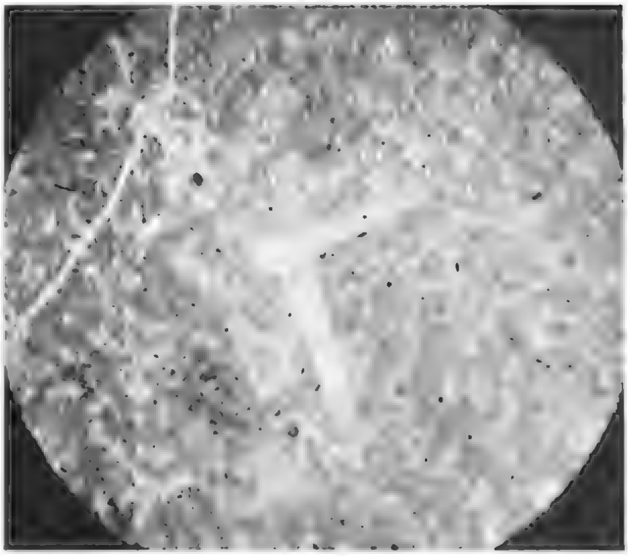


Fig. 1

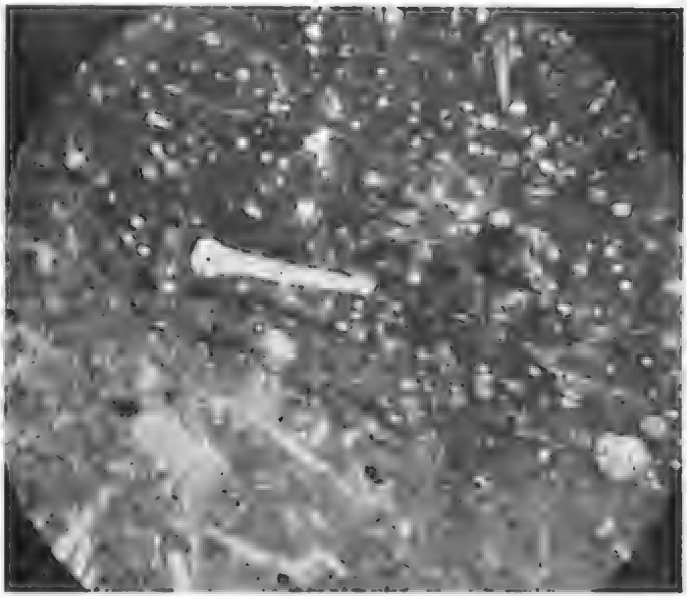
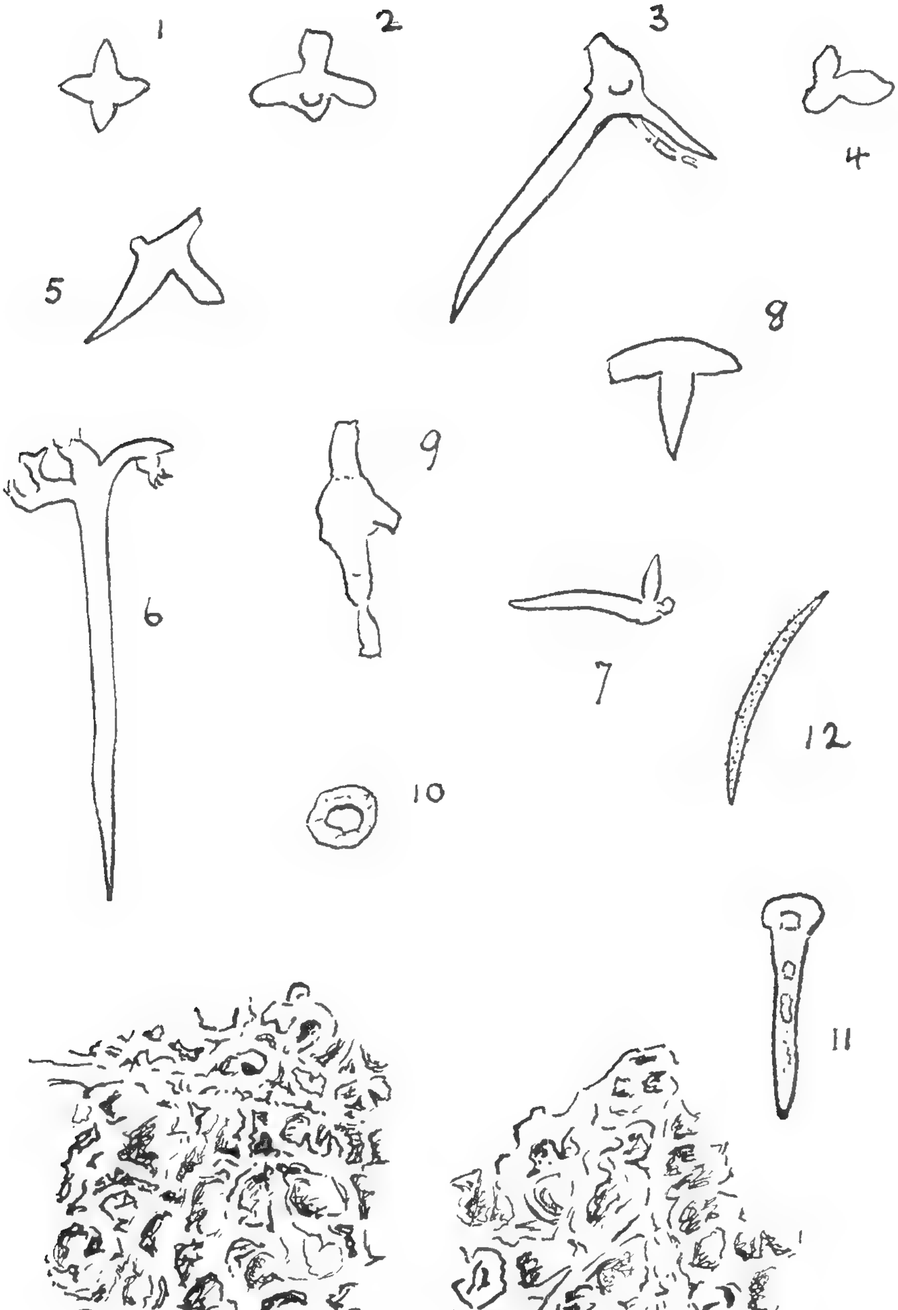


Fig. 2

Structure in *Protohyalostelia mawsoni* g. et., sp. nov., L. Cambrian, S. Aust.

F.C. photomicr.



Spicular and Skeletal Structure in *Protohyalostelia*

F. C. del. ad nat.

All figures x 37

A SIDEROLITE FROM PINNAROO, SOUTH AUSTRALIA

By A. R. ALDERMAN, University of Adelaide.

Summary

This meteorite was found in 1927 by Mr. *S.* Hamilton on his property in the south-west corner of Section 6, Hundred of Pinnaroo, about 9 miles S.S.E. from the town of Pinnaroo (latitude, 35º 17' S.; longitude, 140º 55' E.) in South Australia. It was ploughed out of the soil and brought, for identification, to Sir Douglas Mawson, who acquired it for the geological museum in the University of Adelaide.

A SIDEROLITE FROM PINNAROO, SOUTH AUSTRALIA

By A. R. Alderman, University of Adelaide

[Read 9 May 1940]

Plate XIII

This meteorite was found in 1927 by Mr. S. Hamilton on his property in the south-west corner of Section 6, Hundred of Pinnaroo, about 9 miles S.S.E. from the town of Pinnaroo (latitude, 35° 17′ S.; longitude, 140° 55′ E.) in South Australia. It was ploughed out of the soil and brought, for identification, to Sir Douglas Mawson, who acquired it for the geological museum in the University of Adelaide.

The main mass was roughly ellipsoidal in shape with many irregularities, and had dimensions of approximately 37 x 29 x 17 cms. The original weight was 87 lbs. 10 oz. (39·4 kg.) and the external colour a deep rusty-brown. Weathering has very considerably altered the surface from which crumbly rust-like material exfoliates and can be easily rubbed off with the fingers. Further evidences of the very high rate at which this meteorite alters in air will be given later. It seems obvious, therefore, that the weight and dimensions of the meteoric mass were considerably greater at the time of fall than when found.

The meteorite was cut at the South Australian Railway workshops, using the saw set up for cutting the Huckitta Pallasite (Madigan, 1939). A piece weighing about 14 lb. was thus removed from one end, and it gave a surface of about 23 x 14 cms. for polishing (pl. xiii, fig. 2). Later a piece weighing just over half a pound was sawn from this polished portion. After cutting and removing material for examination, the meteorite now exists in three masses, weighing 69¼ lb. (31·2 kg.), 13⅛ lb. (5·9 kg.), and 8½ oz. (243·25 gm.).

One sawn surface was polished and etched with dilute nitric acid, washed well in water followed by alcohol, and dried. After examination the surface, which had tarnished, was re-polished, washed and dried as before and lacquered with "duco." Some weeks later the surface was found to have altered very considerably. Veins of, apparently, lawrencite had worked into the metal, and fine crumbly material had broken through the lacquered surface in a number of places. It was afterwards found that both oldhamite and lawrencite were present, and consequently a very small trace of water produced alteration. The extremely weathered condition of the exposed surface of the meteorite is thus easily explained. In order to guard against further decomposition of the surface after etching in acid, the specimen was first washed with water, then with alcohol, followed by acetone and finally dried in a vacuum desiccator before lacquering. At the time of writing, this treatment appears to have been successful.

Structural Description

The general appearance of the cut and polished specimen seems to have similarities to both the Morristown and Estherville mesosiderites as featured by Merrill (1930). Actually, however, the Pinnaroo meteorite seems to have some structural or mineralogical differences from any other siderolite whose description was available. The photograph (pl. xiii, fig. 2) shows that most of the metal is in fine and irregularly shaped masses embedded in a dark-brown ground-mass of silicate minerals which are, for the most part, also of fine grain-size. Scattered through this finer metal and silicate are occasional blebs of nickel-iron which are frequently oval in shape and measure a centimetre or more in length. Occasionally, a number of metallic blebs have segregated into conspicuous glomeroporphyritic groups which may measure up to 4 cms. in diameter. One such large group is shown in plate xiii, figure 2, and its structure is enlarged in plate xiii, figure 1. The silicate also occurs in porphyritic individuals and crystals of olivine sometimes have a diameter of nearly 2 cms. A spheroidal cracking of the silicate around these olivine phenocrysts is usually to be seen, and a similar cracking sometimes occurs around some of the larger nickel-iron masses. Troilite, in irregular patches, is also very abundant and is frequently situated at the junction of the nickel-iron and the silicate. The relative abundance of the three main constituents, obtained from a series of linear measurements is metal 44%, silicate $51\frac{1}{2}$%, and troilite $4\frac{1}{2}$% (by volume). Much of the troilite is in very small grains, so that the figure given for this mineral is probably much too low.

Description of Metal

The structure of the metallic portion is well shown on a cut and polished slab after etching with dilute nitric acid, when a well-marked Widmannstetter structure appears. The whole of the metal is made up of broad kamacite bands, which may be as broad as 2 mm., and fine taenite lamellae. In place of normal, apparently homogeneous, plessite, the "fields" between the taenite and kamacite lamellae are filled with a very fine intergrowth of the same two alloys, and this also shows a minute Widmannstetter structure. The metallic particles are nearly always bordered by kamacite, bands of which extend inwards from the edge of each grain for a distance of from 1 to 2 mm.; this "swathing kamacite" thus outlines the shape of each metallic grain. It is only very rarely that a taenite band reaches the edge of one of the nickel-iron grains and thus abuts on the silicate material (pl. xiii, fig. 1).

The smaller metallic patches are of irregular outline and have a fairly uniform distribution throughout the silicate base. The larger metallic patches tend to be circular or oval and, as has already been mentioned, a number of these have sometimes segregated into large glomeroporphyritic groups. Plate xiii, figure 1 shows the structure of such a group. The spaces between the metallic blebs are seen to be filled with granular troilite or black olivine.

The shape of the larger metallic masses strongly suggests that they had solidified before the main bulk of the meteorite. It is possible that the finer metal and the silicate fraction solidified together and at a later stage.

Description of Silicate

In the stony portion olivine is the most obvious constituent and phenocrysts of this mineral, which may occasionally have a diameter of 2 cms., are embedded in a finer ground-mass which consists of olivine, clino-enstatite and plagioclase. All grains of these minerals are anhedral and the whole presents a brecciated structure. The olivine is positive and is thus a magnesium-rich variety. Many of the pyroxene grains show straight extinction, so that there may be some ortho-enstatite as well as clino-enstatite. The plagioclase, which shows polysynthetic twinning and contains many minute opaque inclusions, has refractive indices and extinction angles corresponding to a composition of about $Ab_{10}An_{90}$, *i.e.*, a soda-rich anorthite. It may be noted here that the normative plagioclase calculated from the analysis of the stony portion has a composition of $Ab_{14}An_{86}$. Oldhamite in yellow-brown isotropic grains with good cleavage was found only in crushed material and not in the thin sections, the grinding of which in water would decompose the CaS. It is notable that this is the first record of oldhamite in an Australian meteorite (Hodge-Smith, 1939, p. 46). The presence of this mineral was confirmed by positive tests for Ca and S made on an aqueous extract of the powdered material used for analysis. The same extract was used to confirm the presence of lawrencite.

An advanced stage of weathering is shown by much of the stony portion, which is obscured by reddish-brown rusty material which has frequently worked in from the surface along thin veins and cracks. The presence of both lawrencite and oldhamite would facilitate this process.

Analyses, etc.

Material for chemical analysis was obtained from a piece sawn from one end of the cut and polished mass. Fragments were broken from this and crushed with a hammer, the oxidised crust being avoided as much as possible. Sieving, followed by treatment with a magnet, removed practically all the metal and the residue consisting mainly of mixed silicates and troilite with some oxidized, rusty matter may now be referred to as the "non-magnetic portion."

The composition of the metallic portion was determined from a large fragment of metal which had remained on the sieve after the original crushing. This metallic fragment was well hammered to remove as much as possible of the adhering stony material.

Analysis of these two portions gave the following results:

Non-Magnetic Portion	
SiO_2	37·02%
TiO_2	nil
Al_2O_3	7·60
FeO	15·15
MgO	11·06
CaO	5·01
Na_2O	0·41
K_2O	0·04
H_2O+	0·87
H_2O-	0·34
Fe }	13·77 }
S }	7·87 }
NiO	1·02
	100·16

Metallic Portion	
Fe	86·33%
Ni	8·49
Co	0·14 (1)
Insol.	1·35
S,P,C	n.d.
Soluble SiO_2, MgO, etc.	n.d.
	96·31

Recalculating Fe + Ni + Co to 100.00	
Fe	90·91%
Ni	8·94
Co	0·15

In the statement of the analysis of the non-magnetic portion the figure given as FeO is that obtained from determining total iron and subtracting sufficient Fe to satisfy all the S in forming FeS. The figure for FeO thus includes much ferric iron present (with some NiO) in rusty matter produced by oxidation of the metal. Another point is, that although the analysis as stated above suggests that all sulphur is present as troilite, it has been noted that oldhamite is also present. If we assume (very doubtfully) that all the calcium in excess of that required to form normative anorthite is present as CaS, calculations show that 2% of oldhamite may be indicated.

The density of the bulk of the meteorite determined by hydrostatic weighing of a 243 gm. fragment is 5·05; that of the unattracted portion, determined by pycnometer, 3·36, and a fragment of metal, determined on a Joly balance, showed a density of 7·66. Linear measurements gave the relative abundance of the main portions as metal 44%, and unattracted (silicate and troilite) 56% by volume. From these figures, the weight percentages of the two portions may be calculated as metal 64·1%, and unattracted 35·9%. The bulk composition is thus recalculated as follows:

Fe		58·25	FeO	5·43
Ni		5·73	NiO	0·37
Co		0·10	MgO	3·97
Fe	4·94 }	7·76	CaO	1·80
S	2·82 }		Na_2O	0·15
SiO_2		13·27	K_2O	0·01
TiO_2		nil	H_2O+	0·31
Al_2O_3		2·73	H_2O	0·12
				100·00

(1) Co was kindly determined by Mr. D. W. Dewey, using the colorimetric method of Marston and Dewey, Biochem. Journ. (in press).

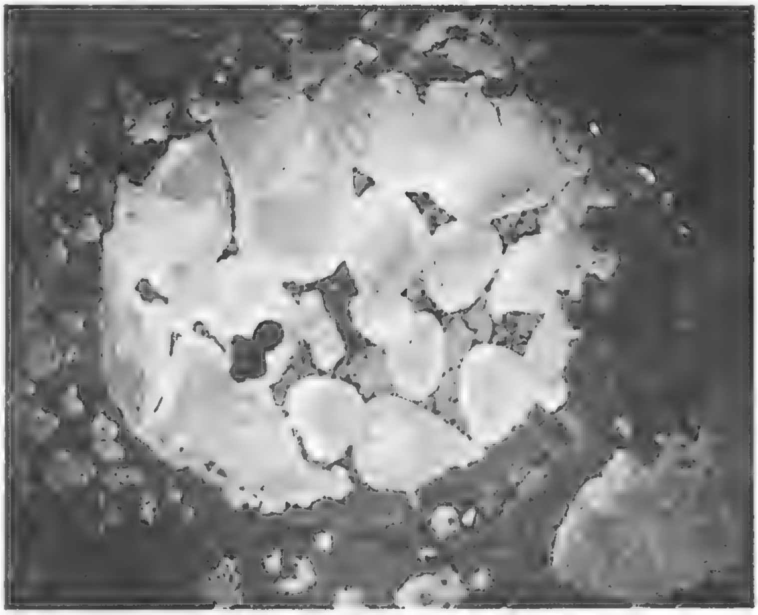


Fig. 1
Enlargement of metal-rich area shown at top of fig. 2. The filled interspaces between kamacite-taenite blebs are sometimes filled with granular troilite, or olivine which appears black. x 1½.

Fig. 2
General view of polished and etched surface.
Scale of inches is given.

Photographs by H. E. E. Brock

Owing to the presence of rusty oxidation products and the uncertainty of their composition, no attempt has been made to calculate the percentages of mineral molecules from this analysis.

Summary

This stony-iron (weighing 39·4 kg.) was found near Pinnaroo, South Australia, latitude 35° 17′ S.; longitude 140° 55′ E. in 1927 and may be classed as a mesosiderite. The metal (Fe 90·91, Ni 8·94, Co 0·15) shows Widmanstetter figures and occupies 44% by volume of the mass. Troilite is plentiful and the silicate portion is made up of olivine with clino-enstatite and anorthite. Oldhamite and lawrencite have assisted weathering, and much rusty oxidised material is also present. The main mass is in the geological museum of the University of Adelaide.

References

Hodge-Smith, T. 1939 Australian Meteorites. Austr. Mus. Mem. 7

Madigan, C. T. 1939 The Huckitta Meteorite, Central Australia. Min. Mag., **25**, 353

Merrill, G. P. 1930 Composition and Structure of Meteorites. U.S. Nat. Mus., Bull. 149

EVAPORATION FROM A WATER SURFACE IN RELATION TO SOLAR RADIATION

By J. A. PRESCOTT Waite Agricultural Research Institute.

Summary

In most studies of the evaporation from a free water surface it has been customary to consider as the two principal factors: the saturation deficit of atmospheric water vapour pressure and the wind. The work of Rohwer (1931) and of Graham Millar (1937) may be cited particularly as affording valuable discussions of the correlations between evaporation and atmospheric conditions. Graham Millar has carried the matter further by introducing turbulence into the wind factor, a feature of these discussions first introduced by Sutton (1934).

EVAPORATION FROM A WATER SURFACE IN RELATION TO SOLAR RADIATION

By J. A. Prescott, Waite Agricultural Research Institute

[Read 9 May 1940]

In most studies of the evaporation from a free water surface it has been customary to consider as the two principal factors: the saturation deficit of atmospheric water vapour pressure and the wind. The work of Rohwer (1931) and of Graham Millar (1937) may be cited particularly as affording valuable discussions of the correlations between evaporation and atmospheric conditions. Graham Millar has carried the matter further by introducing turbulence into the wind factor, a feature of these discussions first introduced by Sutton (1934).

Agricultural physicists, as for example Briggs and Shantz (1917), Angstrom (1924), and Haines (1925), have however recognised a relationship between solar radiation and evaporation and have suggested that atmometers could well be used to measure solar radiation. Briggs and Shantz (1916) considered the transpiration of plants and the evaporation from a free water surface to be influenced by the four factors: radiation, temperature, saturation deficit and wind, and give regression equations connecting evaporation with the vertical component of solar radiation and with saturation deficit during various periods of their experiments on hourly rates of transpiration by rye, lucerne and *Amaranthus*.

Although Briggs and Shantz measured both solar radiation and evaporation on cloudless days during the period of their experiments at Akron, Colorado, the radiation was measured normal to the sun's rays, so that it is not possible in the absence of any measure of sky radiation or of total radiation on a horizontal surface to correlate the radiation with the rate of evaporation from a water surface. The evaporation tank used by these workers was three feet in diameter, was blackened inside and held water to a depth of one inch. It is possible to estimate the probable radiation received at Akron from Angot's tables (Brunt, 1934) for the days of the experiments recorded and to compare this with the latent heat of evaporation required to account for the daily evaporation observed. It will be seen from the data below that such a shallow evaporimeter gives a very fair measure of radiation and that the evaporation recorded is accounted for by the solar radiation received. The solar radiation for these cloudless days is assumed to be 0·76 of that given in Angot's tables for the amount that would be received if the atmosphere were transparent.

Table I

Evaporation and Solar Radiation at Akron, Colorado.

Data of Briggs and Shantz (1916) for Cloudless Days

Period 1914	Radiation on a horizontal surface in month of 30 days — Outer limit of Atmosphere (Angot) Q_0 gm. cals. per cm.^{2}	Assumed value at earth's surface $0{\cdot}76 \times Q_0 = Q$ gm. cals. per cm.^{2}	Evaporation per month of 30 days Latent heat E gm. cals. per cm.^{2}	Ratio E/Q
7, 8, 9 July	29,500	22,400	22,900	1·022
18, 19, 20, 21 July	29,000	22,000	21,300	0·969
16, 17, 18, 19, 20 October	16,100	12,200	13,200	1·081
			Mean	1·024

The factor 0·76 has been calculated from the data published for Mount Weather Va (Kimball, 1914), which give the following regression equation relating solar radiation with hours of sunshine, a procedure suggested by Angstrom (1924).

$$Q/Q_0 = 0{\cdot}22 + 0{\cdot}54\, n/N \qquad (r = 0{\cdot}896)$$

where Q_0 = radiation on a horizontal surface with a transparent atmosphere (Angot's value)

Q = radiation measured at the earth's surface

n = actual hours of sunshine

N = maximum possible sunshine on cloudless days.

It can be assumed, therefore, that under certain conditions of evaporation and with a sufficiently high saturation deficit, evaporation may well be entirely accounted for by solar radiation. With deeper evaporimeters there is some storage of heat from day to day so that the relationship would not be expected to be perfect, but taking monthly averages, a general relationship may be anticipated. In order to investigate the matter further the records for the Australian Capital Territory have been examined. The only values for solar radiation in Australia are those for Mount Stromlo. Use was made of these in estimating the probable solar radiation at Acton, Canberra, a few miles away, where meteorological observations were made until the end of 1939. There is less sunshine at Acton than at Mount Stromlo, the mean monthly values for hours of sunshine recorded for Acton varying from 79 to 91% of those at Mount Stromlo.

The records of sunshine and radiation at Mount Stromlo were kindly made available by Mr. W. B. Rimmer, of the Commonwealth Solar Observatory, and as a first step the relationship between Angot's values, the observed values and the proportion of sunshine was calculated as for the case of Mount Weather, quoted above.

The regression equation for Mount Stromlo was found to be:

$$Q/Q_0 = 0{\cdot}25 + 0{\cdot}54\, n/N \qquad (r = 0{\cdot}796)$$

From this equation the probable solar radiation at Canberra itself has been calculated, and in Table 2 are recorded the essential data for the study of the general relationships between evaporation and radiation for this centre. The values for saturation deficit are calculated from the temperature and vapour pressures given in the Commonwealth Yearbook for 1938 (No. 31), from which source the evaporation records are also taken. The evaporimeter is the Australian standard instrument, three feet in diameter and three feet in depth.

TABLE II

Evaporation, Solar Radiation and Saturation Deficit for Canberra, A.C.T.

	Observed mean monthly evaporation; 30-day basis		Observed mean monthly saturation deficit	Calculated mean monthly solar radiation on horizontal surface; 30-day basis	Ratio
	cm.	gm. cals. per cm.²	millibars	gm. cals. per cm.²	
		E	s.d.	Q	E/Q
January	18·04	10,530	11·18	16,720	0·608
February	15·38	8,976	10·13	14,770	0·630
March	10·91	6,387	7·11	12,600	0·507
April	6·78	3,986	4·47	9,656	0·413
May	4·23	2,492	3·32	6,717	0·371
June	2·59	1,531	2·37	5,464	0·280
July	2·83	1,670	2·37	6,234	0·268
August	4·10	2,423	2·88	8,545	0·284
September	7·06	4,159	3·66	11,820	0·352
October	9·93	5,834	5·32	14,790	0·395
November	14·05	8,230	7·55	16,220	0·507
December	16·28	9,515	9·48	16,700	0·570
				Mean	0·432

From the last column it is evident that evaporation accounts for a substantial proportion of the solar radiation falling on the evaporimeter. The proportion of radiation used in evaporation varies from 27% to 63%, with a mean value of 43%. It is worth recalling that Angstrom (1920) calculated that on Lake Vassijäure, in Sweden, about one-third of the incoming net radiation is used in evaporation.

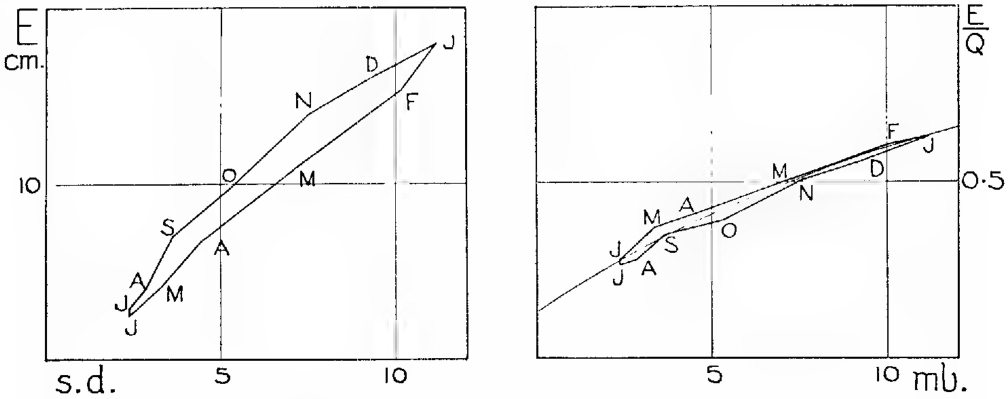
It is generally recognised that the depth of evaporation from a large sheet of water is only about 80% of that from a tank three or four feet in diameter, so that the 43% above corresponds to 34% for a large body of water, a result in close agreement with that of Angstrom.

From the above table it has proved possible to calculate a satisfactory regression equation linking evaporation with saturation deficit and solar radiation.

The most useful equation takes the form:

$$\log\left(1 - \frac{E}{Q}\right) = -0{\cdot}03303\ \text{s.d.} - 0{\cdot}0649.$$

where E and Q are expressed in gramme calories and saturation deficit in millibars. The correlation coefficient is –0·991. The relationship is exponential in form but in simple terms implies that as the values for saturation deficit increase a growing proportion of solar radiation is used in evaporation until for sufficiently high values solar radiation is used entirely in evaporation. The relationships are shown graphically in the figure.



Illustrating the relationship between evaporation, saturation deficit and solar radiation for Canberra month by month. The thinner line in the right-hand diagram is of the form $\log\left(1-\frac{E}{Q}\right) = k\,(\text{s.d.}) + c$, where k and c are constants and E and Q are both expressed in gramme calories per square centimetre.

The monthly march of evaporation in relation to saturation deficit shows a characteristic loop which is common to all recording stations and which is an expression of the lag between the combined forces controlling evaporation and those of temperature and humidity on which the values for saturation deficit are based.

When allowance is made for radiation a much better relationship is observable but with some over-correction. The calculation of radiation from the sunshine records is still subject, however, to further refinements, which it is hoped will be capable of assessment when the examination of the records of the Commonwealth Solar Observatory at present in progress at Mount Stromlo is completed.

Summary

When the saturation deficit is sufficiently high, evaporation from a free water surface tends to be limited by the net radiation falling on the water surface. The relationship between the measured evaporation, measured saturation deficit and estimated solar radiation for Canberra has been examined and a suitable equation satisfactorily applied to the data.

References

Angstrom, A. 1920 Geog. Ann., **2**, 3

Angstrom, A. 1924 Q. J. Roy. Met. Soc., **50**, 121-125

Briggs, L. J., and Shantz, H. L. 1916 J. Agr. Res., **5**, 583-649

Briggs, L. J., and Shantz, H. L. 1916 J. Agr. Res., **7**, 155-212

Briggs, L. J., and Shantz, H. L. 1917 J. Agr. Res., **9**, 277-292

Brunt, D. 1934 Physical and Dynamical Meteorology, Table 2, 100

Haines, W. B. 1925 Q. J. Roy. Met. Soc., **51**, 95-100

Kimball, H. H. 1914 Monthly Weather Rev., **42**, 474-487

Millar, F. Graham 1937 Canadian Met. Mem., **1**, No. 2

Rohwer, C. 1931 U.S. Dept. Agr. Tech., Bull. 271

Sutton, O. G. 1934 Proc. Roy. Soc. London, **146a**, 701-722

THE ADULT STAGE OF THE TREMATODE, LEUCOCHLORIDIUM AUSTRALIENSE

By T. HARVEY JOHNSTON and E. R. SIMPSON, University of Adelaide

Summary

In 1938 we gave an account of the larval stages of *Leucochloridium autstraliense* from *Succinea australis* collected at Elwomple, near Tailem Bend (Johnston and Cleland, 1938). The anatomy of the cercariaeum was shown to resemble that of *L. insigne* (Looss) and of *L. macrostomum* (Rud.), as identified by Witenberg and other authors. Szidat (1936), however, has re-examined Rudolphi's type material and has shown that the true *L. macrostomum* has the testes and ovary arranged in a linear series instead of forming a triangle, as had been described for the fluke generally regarded as belonging to Rudolphi's species. Szidat also showed that *L. holostomum* (Rud.) was a valid species whose gonads possessed the triangular arrangement; consequently *L. macrostomum* of most authors really belonged to *L. holostomum* or perhaps to some related species. Hsü (1936) discussed the relationship of *L. insigne* (Looss) of Witenberg and of some other species.

THE ADULT STAGE OF THE TREMATODE, LEUCOCHLORIDIUM AUSTRALIENSE

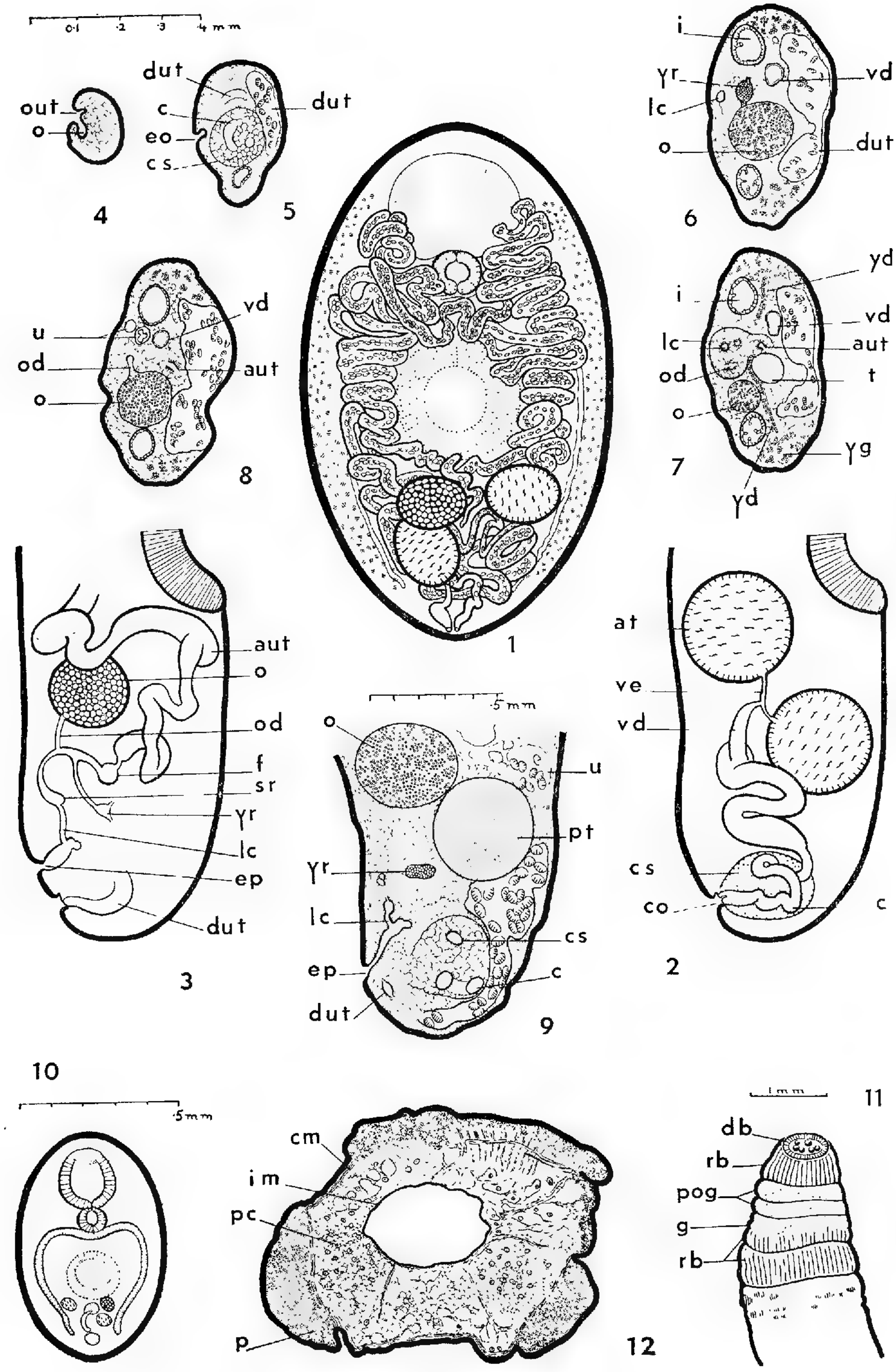
By T. Harvey Johnston and E. R. Simpson, University of Adelaide

[Read 13 June 1940]

In 1938 we gave an account of the larval stages of *Leucochloridium australiense* from *Succinea australis* collected at Elwomple, near Tailem Bend (Johnston and Cleland, 1938). The anatomy of the cercariaeum was shown to resemble that of *L. insigne* (Looss) and of *L. macrostomum* (Rud.), as identified by Witenberg and other authors. Szidat (1936), however, has re-examined Rudolphi's type material and has shown that the true *L. macrostomum* has the testes and ovary arranged in a linear series instead of forming a triangle, as had been described for the fluke generally regarded as belonging to Rudolphi's species. Szidat also showed that *L. holostomum* (Rud.) was a valid species whose gonads possessed the triangular arrangement; consequently *L. macrostomum* of most authors really belonged to *L. holostomum* or perhaps to some related species. Hsü (1936) discussed the relationship of *L. insigne* (Looss) of Witenberg and of some other species.

In August, 1938, three adult specimens of *Leucochloridium* were found in the cloaca of *Pomatostomus superciliosus*, and, in the following month, four were taken from one out of four birds of the same species, all hosts having been collected by Mr. F. Jaensch at Elwomple, the same locality as that from which the larval stages had been obtained in 1937. *Succinea* shell fragments were abundant in the gizzard and intestine of most of the birds. Eggs from some of the flukes were used in an attempt to infect *Succinea*, but the latter soon died. In August, 1938, in a specimen of *Corcorax melanorhamphus* from the same locality, six minute *Leucochloridium* flukes were obtained, all of the same size and stage of development, agreeing in all particulars with the cercariaea already described by us. These had apparently only just been liberated from a *Succinea* whose fragments were also present. The adults possessed the genital arrangement described in the larva, and we have no doubt that they belong to *L. australiense*, which is the first Australian digenetic trematode whose life cycle is known. The various stages in the life history of *Fasciola hepatica*, the liver fluke of sheep, in eastern Australia have been investigated by Bradley, McKay and Ross, but the species is not native to the Commonwealth and must have been introduced along with its domesticated hosts soon after the original settlement, as Rudolphi in 1819 recorded its occurrence in a kangaroo, *Macropus major*.

Adults of *L. australiense* measured (under coverglass but without pressure) 2·25 to 2·4 mm. long by 1·15 to 1·4 mm. wide; the anterior sucker 0·55 mm. long by ·62 to ·66 mm. broad, and the ventral sucker ·60 to ·61 mm. long by ·55 mm. wide. The two suckers are thus subequal and about one-quarter the length of the


0·1 ·2 ·3 ·4 mm
out
o
4
dut
c
eo
cs
dut
5
i
yr
lc
o
vd
dut
6
u
od
o
vd
aut
8
i
lc
od
o
yd
vd
aut
t
yg
yd
7
1
aut
o
od
f
sr
yr
lc
ep
dut
3
·5 mm
o
u
pt
yr
lc
ep
dut
cs
c
9
at
ve
vd
cs
co
c
2
10
·5 mm
cm
im
pc
p
12
1 mm
11
db
rb
pog
g
rb

worms. The ventral sucker is nearly central, but rather more of it lies in the posterior than in the anterior half of the parasite. The pharynx is nearly circular, measuring ·19 mm. long by ·2 mm. wide. The oesophagus is extremely short. The narrow, slightly wavy, caeca lie near the margins and terminate just behind the level of the posterior border of the posterior testis and near the hindmost limit of the uterine coils.

The testes and ovary are arranged as a triangle, the latter lying very close to, or touching, the posterior testis. The testes measure about ·46 by ·32 mm. The anterior is separated from the ventral sucker by the descending uterus, and from its fellow by the fecundarium and by some loops of the descending uterus. The vasa efferentia form an oblique straight line. The vas deferens is rather wide and thrown into several loops as it travels back to enter the rounded cirrus sac within which it lies twisted when at rest. The sac measures about ·2 mm. in diameter. The genital opening lies in a slight depression, somewhat dorsal, near the posterior extremity, the male duct terminating on a very slight prominence at its base. The male opening lies on the same side of the median line as the ovary; the female pore is on the other side of the depression. In one specimen the male apparatus is partly extruded, and if fully protruded the cirrus would probably measure about 0·125 mm.

The ovary is about ·32 mm. broad by ·23 mm. long. It touches the posterior testis and the fecundarium but is separated from the posterior sucker by loops of the ascending and descending uterus. The oviduct arises from the inner surface, travelling inwards, backwards and slightly dorsally to enter the fecundarium, in whose vicinity it joins the long Laurer canal. The anterior part of the latter is rather wider, forming a seminal receptacle, the remainder being narrow with a strongly chitinized wall. This canal passes back near the dorsal midline, above or near the posterior testis, to enter the dorsal aspect of the very small excretory bladder just as the latter receives its two longitudinal canals, these junctions lying just above or in front of the anterior part of the cirrus sac. The fertilizing duct travels in a coiled course through Mehlis' gland (fecundarium) which occupies a median position between the ovary and the two testes, coming into contact with

---

EXPLANATION OF FIGURES

Fig. 1, adult; 2, adult, male system, lateral view; 3, adult, female system, lateral view (figs. 2 and 3 constructed from series of longitudinal sections); 4, T.S. at level of genital apertures; 5, T.S. region of excretory pore; 6, T.S. at level of yolk reservoir; 7, T.S. showing yolk ducts; 8, T.S. across region of oviduct; 9, longitudinal section, nearly median; 10, cercariaeum; 11, sporosac; 12, T.S. pigmented band of sporosac.

References to Lettering—at, anterior testis; aut, ascending uterus; c, cirrus; cm, circular muscle; co, cirrus opening; cs, cirrus sac; db, dark brown band; dut, descending uterus; ep, excretory pore; f, fecundarium; g, green band; i, intestine; im, inner membrane; lc, Laurer's canal; o, ovary; od, oviduct; out, opening of uterus; p, pigment; pc, pigment cells; pog, pale olive green band; rb, red brown band; sr, seminal receptacle; u, uterus; vd, vas deferens; ve, vas efferens; yd, yolk duct; yr, yolk reservoir.

the three organs. The uterus passes forwards between the ovary and anterior testes and may overlie parts of these glands. It then travels between the ovary and the posterior sucker and forwards, its coils occupying most of the zone between the latter and the crura, sometimes underlying the crura. It extends forwards as a massive structure, reaching at least the mid-level of the anterior sucker and then its folds cross between the pharynx and the posterior sucker below the crura to become strongly coiled on the other side of the worm, where it extends about as far forwards as on the opposite side. Just in front of the anterior testis it crosses to the opposite side, just behind the posterior sucker and below the ascending limb of the uterus. It forms a series of loops laterally from the ventral sucker, ovary and posterior testis, lying ventral to the level of the two latter organs, and then travels below the ovary across to the opposite side of the worm to occupy the region between the anterior testis and the cirrus sac. Its terminal portion lies beside the cirrus sac and opens beside the male pore. Sometimes uterine loops lie above the crura as well as below them, and also above some of the inner vitelline follicles.

The vitellaria form a long series of rather large, irregularly shaped, closely arranged follicles lying ventrally and ventro-laterally from the intestinal crura. Posteriorly they extend almost to the end of the crura or they may reach the end on one side only. Their limit lies at about the level of the hinder border of the posterior testis. In front they reach at least half-way along the oral sucker, approximately to the same level as the foremost loops of the uterus, or they may do so on one side, being shorter on the other. As in the case of the uterus, they extend considerably in front of the crura. Each transverse yolk duct passes inwards above the corresponding ascending excretory canal and below the crus, then upwards to meet its fellow to form a yolk reservoir. One vitelline duct lies between the ovary and the posterior testis and the other behind the anterior testis. The common yolk duct travels obliquely forwards to join the oviduct near the origin of Laurer's canal. Eggs measure 22 by 13·5-14 μ.

The excretory pore is dorsal, in front of the genital apertures, and leads downwards and forwards, very soon entering a small excretory bladder into which enter almost transversely the two main collecting canals. The bladder lies above the anterior part of the cirrus sac or just in front of it. The canals pass outwards, forwards, and slightly ventrally above the descending uterus and then below and close to the crura. They travel forwards ventro-laterally from the latter, but above and inwardly from the vitellaria. Each canal extends forwards to the vicinity of the pharynx, then curving back to lie above and laterally from the ascending canal. In the posterior region the latter, as well as the descending canal lie almost directly ventrally from the corresponding crus. A delicate canal, probably the anterior branch, lies above the corresponding crus.

Our species belongs to the same group as *L. holostomum,* as figured by Szidat in regard to the arrangement of the gonads, but in that species the uterine loops are limited anteriorly by the caeca. The uterine disposition in

L. australiense resembles that in *L. macrostomum*, as illustrated by Szidat, who gave as synonyms of the latter, *L. insigne* Witenberg, 1925 (*nec* Looss), as well as *L. paradoxum* Carus of Zeller, 1874, and of Heckert, 1889, *L. insigne* (Looss) being quoted (along with *L. turanicum*) as a synonym of *L. holostomum*. If McIntosh's key (1932) be followed, our species would be placed beside *L. icteri* McInt., 1927, but the latter is a more elongate parasite, with its suckers smaller in relation to the length of the worm, and has much shorter vitellaria, a circular ovary, and gonads more remote from the ventral sucker. *L. australiense* differs from *L. actitis*, *L. variae* and *L. cyanocittae* mainly in regard to the posterior extension of the intestinal crura, vitellaria and uterine loops. McIntosh (1932, 39) referred to the similarity between *L. actitis* and *L. insigne* of Witenberg (*nec* Looss). *L. australiense* somewhat resembles *L. dasylophi* Tubangui (1928), but differs in regard to the distribution of the yolk glands and the forward extension of the uterine loops.

Leucochloridium from Succinea australis

In a snail collected in May, 1938, at Elwomple, there were found two pulsating sacs, one in each antenna. In strong sunlight the pulsation and the coloured bands could be seen through the snail's tissues. One sac measured about 7·5 mm. long and 1·4 mm. broad. The banding was different from that occurring on sporocysts previously described by us. The coloured bands on the distal third of the sac consisted of an irregular ring of brown wart-like processes proximally; then two complete reddish-brown rings, a green band occupying the more distal part of the second brown ring; then two green bands; a bright reddish-brown band; and a narrow dark brown band; and a series of six brown warts arranged at the free extremity. The other sac was similar, except that there were fewer warts in the proximal row, the colouration of the second green band was irregular, and the dark brown ring was interrupted on one side to form wart-like processes. One sac was sectioned and the structure of a coloured band (fig. 12) was seen to be similar to that described by Mönnig (1922). The cercariaea (fig. 10) resembled those of *L. australiense* in all features. The anterior sucker was ·2-·21 mm. long by ·19 mm. broad, and the posterior ·15-·17 mm. in diameter. Some of the worms were fed to a canary, but adult stages were not obtained.

The presence of both brown and green sacs in European *Succinea* has been referred to by authors and slight differences in sucker ratio in their cercariaea seem to exist (Johnston and Cleland, 1938, 32). Mönnig (1922) described and figured both kinds of sporocysts and tabulated the measurements of the organs of the cercariaea from each type, stating that the differentiation of them as specifically distinct could not be justified. His figure of the cercariaeum of *L. macrostomum* shows it to be *L. holostomum*.

Hsü (1936) described green sporocysts with brown apical spots from *Succinea putris* in Germany and fed the cercariaea to five species of birds, obtaining infection in a canary, a charadriid (*Pavoncella pugnax*), and sparrows.

Various stages in development were figured. Variation in the relation of the vitellaria to the termination of the crura was observed, and similar variation was found in natural infections. The structure of the vitelline follicles, as well as their lateral extension appeared to afford specific characters, as also did the relation of the uterine loops to the crura. He reported that the species which he obtained by feeding green sporocysts, was that erroneously identified by Witenberg as *L. insigne* and was possibly the same as that described by Zeller in 1874 as *L. paradoxum*, but was different from that described by Heckert in 1889 under the latter name. Heckert's sporocyst was green with bright red apical flecks and probably belonged to a species found by Hsü in *Vanellus*, the species being related to *L. holostomum* and being most probably *L. sime* Yamaguti. Witenberg's *L. insigne* appeared to be without a correct name. We may point out that McIntosh (1932, 39) considered Witenberg's species to be distinct from *L. insigne* Looss, but closely related to *L. actitis*. As the differences mentioned by McIntosh seem to be very slight, it is likely that the correct name for Witenberg's form may be *L. actitis*.

Literature

Hsü H. F. 1936 Studien zur Systematik und Entwicklungsgeschichte der Gattung Leucochloridium Carus, II, etc. Z. f. Parasitenk., **8,** 714-728

Johnston, T. H., and Cleland, E. R. 1938 Larval trematodes from Australian terrestrial and freshwater molluscs, pt. iii, Leucochloridium australiense. Tr. Roy. Soc. S. Aust., **62,** 25-33

McIntosh, A 1927 Notes on the genus Leucochloridium Carus (Trematoda). Parasitol., **19,** 353-364

McIntosh, A. 1932 Some new species of trematode worms of the genus Leucochloridium Carus, parasitic in birds from northern Michigan, etc. Jour. Parasit., **19,** 32-53

Mönnig, H. O. 1922 Ueber Leucochloridium macrostomum. 61 pp. Jena

Szidat, L. 1936 Studien zur Entwicklungsgeschichte der Gattung Leucochloridium Carus, I, etc. Z. f. Parasitenk., **8,** 645-653

Tubangui, M. A. 1928 Trematode parasites of Philippine vertebrates. Philipp. Jour. Sci., **36,** 351-371

Witenberg, G. 1925 Versuch einer Monographie der Trematoden-unterfamilie Harmostominae Braun. Zool. Jahrb. Syst., **51,** 167-254

ON CENTRAL AUSTRALIAN MAMMALS
PART I THE MURIDAE

By H. H. FINLAYSON

Summary

During the summers of 1931-1935 the writer made collections of mammals in that portion of South-west Central Australia lying between latitudes 23° 30' and 28° 0' south (approximately) and longitudes 136° 30' and 128° 10' east (approximately). The material personally taken has since been increased by the efforts of friends in the area, and in working it out I have included in the examination specimens acquired by the South Australian Museum at various times from the same or adjacent parts of the country.

ON CENTRAL AUSTRALIAN MAMMALS
PART I THE MURIDAE

By H. H. Finlayson

[Read 13 June 1940]

Plates XIV and XV

During the summers of 1931-1935 the writer made collections of mammals in that portion of South-west Central Australia lying between latitudes 23° 30′ and 28° 0′ south (approximately) and longitudes 136° 30′ and 128° 10′ east (approximately). The material personally taken has since been increased by the efforts of friends in the area, and in working it out I have included in the examination specimens acquired by the South Australian Museum at various times from the same or adjacent parts of the country.

Notomys alexis Thomas

This species, after a period of confusion with *mitchelli,* was recognised by Thomas in 1922 at Alexandria in approximately 19° S and 136° 50′, and has since been proved to have a range, from east to west, extending from 144° to at least 124° E. longitude. The occurrences now recorded provide an extension of its range to the south of nearly 700 miles. While three races have been defined, they are distinguished by comparatively trivial differences, and over the whole of this enormous tract it maintains a notable constancy in its essential distinctions from allied species.

It is the "dargawarra" of the Pitchenturra natives, and though they speak of another allied animal, the Wilchimba, it is the only species of the genus personally taken in the area worked over, and greatly predominates also in all other collections of *Notomys* from the same region, which I have examined.

It was taken chiefly in the more grassy areas of the loamy mulga flats between the main ranges, but also in flat valleys within the ranges, particularly in the Musgraves; it was less frequent in sandhill areas. Like all the small mammals of the centre its occurrence is sporadic and fluctuating, and areas in which it was very plentiful in one season were found to be destitute of it in the next, though conditions were often apparently unchanged. It eats a small amount of green vegetation, and at permanent camps in the Everard hills where vegetables were grown near the soaks, it became for a time in 1932 a nuisance owing to its depredations on the young shoots of cucumbers and beets, etc. Ordinarily, however, there is little doubt that seeds are its staple diet, and the movements of its colonies are conditioned probably more by the abundance of seeds than of green vegetation. This is clearly shown by the frequent prevalence of dargawarras in areas of seeding spinifex. In January, 1933, a few miles east of Mount Conner, a considerable area of *Triodia* was crossed which had made luxuriant growth after a local rain and upon which the seeding tops were rapidly ripening. Around the base of nearly every clump was strewn a mat of severed stalks from which the seed had been removed and the sand was reticulated with *Notomys* tracks, though no doubt other murids participated in the harvest also.

According to the blacks, the large round woody seeds of the quondong *(Eucarya acuminata)*, which have a rich fatty kernel, are also eaten by this species; the seed case is neatly drilled on one side only with a small hole, and the contents extracted. Under almost any quondong tree a proportion of such drilled and emptied seeds may be found, though the fact that so many are left untouched, suggests that it is an emergency food rather than a staple diet. In trapping it, both fat and bread were found effective.

The burrow is usually comparatively simple; one completely excavated on a loamy flat on Tietkens Birthday Creek in the Musgraves was six feet long and about one foot deep, with a single exit and entrance hole and no side passages; in other less completely examined systems, a series of side passages with independent pop-holes seemed to have been developed from a simple straight drive such as the above. In neither case was any of the excavated soil brought to the surface, and the array of pebbles about the exits and entrances which has been recorded for other species was not seen.

In summer it is very seldom seen in the day time, except momentarily, when one may be dislodged from a surface shelter while travelling. But at night it is a frequent visitor to camps and does not seem at all embarrassed by firelight or even an electric torch. At Walthajalkanna, on the northern front of the Everards, the southern race was very plentiful in February, 1933, and came boldly into the camp in numbers every night, and if given bread and cautiously approached could be freely examined by torchlight at a distance of a few feet. When moving about slowly, they go on all fours like the less specialized murids and look rather ungainly, the long brushed tail being carried always well clear of the ground and frequently arched over the back. When startled they resort at once to saltation; the action in doing so is appreciably different from that of the macropods, the trunk being thrown far forward out of the vertical with the tail almost straight out behind. In trapping them a light set is necessary, as they remove the bait with remarkable gentleness and finesse; frequently I watched individuals completely remove the bait from a trap without springing it, though it would probably have caught a house mouse. Buckets of water left two-thirds full proved very effective traps, and the only completely undamaged examples suitable for skeletons were secured in this way; those dug out by the blacks are nearly always mutilated in some way in the handling.

At Chundrinna, also near the Everard Range, several living examples were kept for a few days for observation. In aspect they are quite like *cervinus* of the Lake Eyre Basin. They took a miscellaneous diet freely and appeared quite comfortable and reconciled. With pleasing recollections of the gentleness of fresh caught examples of *N. aistoni* at Appamunna, I made free to handle these *alexis*-

in the same way, but was startled to find a great difference in temperament; all advances being repulsed with vigorous biting and squealing.

The animal is almost odourless. A *Laelaps* occurs very freely and another flea-like parasite, unfortunately not preserved.

The material examined comprises an excellent series of 132 specimens, of which 34 are skins and the rest alcoholic preserved. The bulk of the material belongs to properly localized and dated collections, and the following list gives the data on reproduction and sex ratios which can be extracted from the records.

(1) February, 1932. Between Wollara and Basedow Range. Approximately 24° 55′ south and 132° 25′ east, about six weeks after heavy rain; 11 ♂, 10 ♀, and 2 unsexed. Of the series 11 are adult, 10 subadult or immature and 2 nestlings. Several males have well developed scrotal testes, and of 5 adult females examined 4 are pregnant.

(2) February, 1932. Ayers Rock. Approximately 90 miles west-south-west of the above. One adult male.

(3) January, 1933. Erliwunyawunya and adjacent points on the south side of the Musgrave Range, at approximately 26° 23′ south and 131° 40′ east; two months after good rains; 4 ♂ and 5 ♀, and 2 unsexed; 7 are immature of half to two thirds growth. One adult ♀ only examined, and this pregnant; two subadult males show gonad activity, but the adult male with testes completely retracted.

(4) Winter months of 1931. From unspecified localities on the same latitude as the above, but beginning further west and extending from the Tomkinson through the Mann to the Musgrave Range; 7 ♂, 5 ♀, and 9 unsexed. Two examples only, fully adult, and of the remaining subadults 8 are nestlings. Two females were pregnant, but none of the males showed scrotal testes.

(5) February, 1933. Chundrinna, between the Musgrave and Everard Ranges at approximately 26° 50′ south and 132° 15′ east; 10 ♂ and 10 ♀. All adult or nearly so, and reproduction entirely suspended; no trace of gonad activity in any male, and all females non-pregnant with nipples so strongly retracted as to be difficult to find.

(6) February, 1933. Walthajalkanna, in the northern outliers of the Everard Range, about 15 miles E.S.E. of the above; 10 ♂, 13 ♀, all adult or near adult and with reproduction quiescent as above. Of 8 males examined 2 only show a slight development of testes in the scrotal site.

(7) Winter of 1915. Wantapella, at approximately 65 miles E.S.E. of the above; 6 ♂ and 2 ♀. Two only are adult or nearly so, and the remainder represent almost as many litters descending in size to small nestlings. Evidently a time of active reproduction; the adult female is lactating and several subadult males show signs of gonad enlargement.

(8) Winter of 1930. Wells 24 and 26 on Canning Stock Route, in approximately 23° 15′ south and 123° east. Two ♂, 1 ♀, 3 unsexed. Reproduction evidently active; of the females one is lactating and the other pregnant.

(9) Miscellaneous specimens, including the Elder Expedition material, not properly localized but from as far west as Mount Squires at 26° 17′ south and 127° 24′ east, and others from south of Oolarinna water, ca. 27° 35′ south and 132° 50′ east, Idracowra on the Fincke at 25° 0′ south and 133° 45′ east, Mount Burrell 50 miles north-west of Idracowra, and Charlotte Waters 25° 55′ south and 134° 55′ east.

The most northerly and westerly records in the collection are given by the Alroy topotypes and the Canning Stock Route material, respectively, the most southerly by the south of Oolarinna specimens, and the most easterly that from Charlotte Waters.

The data is sufficient to show that the incidence of reproduction is not seasonal, since highly active groups are to be found in both winter and summer, but in two cases, at least, follows upon periods of good rains. An interesting feature is the high incidence of sexual activity amongst young males as compared with full adults; in most collections the maximum development, both of gonads and of the sympathetically responding gular gland, is to be found in definitely subadult material.

The number of embryos in unmutilated uteri varies from 2 to 5, with 3 as the most frequently occurring number. In the combined collection which can be sexed, the ratio is 54 ♂ : 55 ♀.

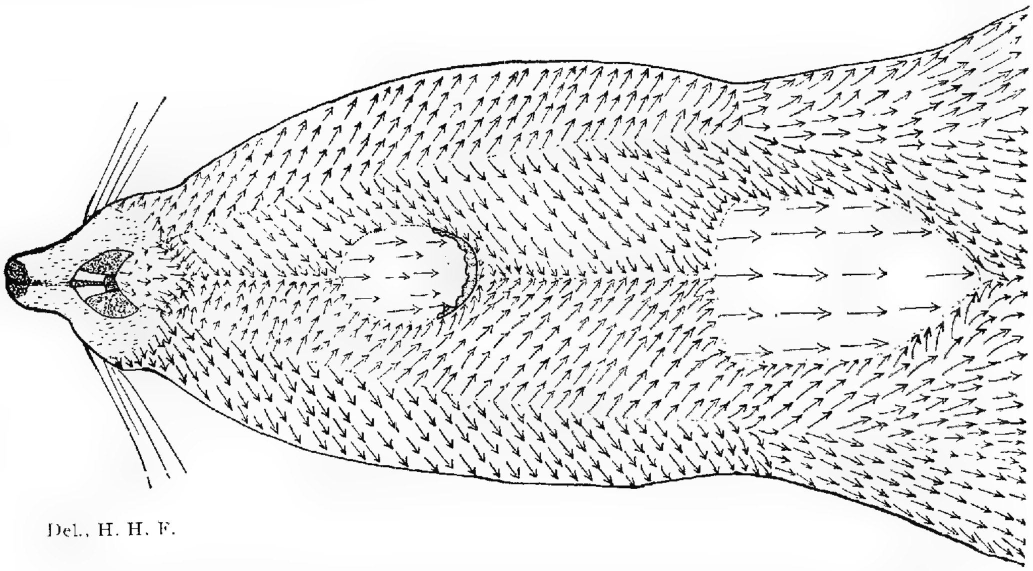
External Characters

Within the area defined, two races, overlapping in distribution and intergrading in pelage characters coexist. In all collections north of the Musgrave Range, the dominant form can apparently be reconciled with the typical *N. alexis* Thomas of Alexandria in the Northern Territory. South of this line in the area of huge granite intrusions, a second form becomes increasingly numerous until in the Everard Range it is so dominant over the typical race as to form almost pure communities. With two minor exceptions which will be noticed later, all characters other than pelage are either constant or show similar variations having no geographical concentration, so that they may be dealt with by reference to the entire series *en bloc*.

Size, build and general appearance much as in *N. cervinus* of Waite *et auct.* of the Lake Eyre Basin. Mysticial vibrissae rather weaker, 45-55 mm. Ear conspicuously short and narrow, 21-24 mm. with a mean of about 22 mm.

The *gulo sternal glandular* area (pl. xv, fig. E) is highly characteristic and presents a combination of a distinct gular pit as in *cervinus* Waite with a well marked sternal tract of specialized hair as in *mitchelli*. In the sexually active male the gular pit at its maximum development is deeper and more pouch-like than in any of the forms I have reviewed; the area involved by it, however, is smaller than in others and the feature correspondingly conspicuous. The floor of the recess slopes caudad and anteriorly merges indefinitely with the mental area without the interposition of labia or skin folds, but laterally and posteriorly these are well developed and fleshy and tend to overhang the cavity which reaches a depth of 4 mm. and has a diameter at the surface of 5-6 mm. The greater part of the labia and the anterior part of the floor of the recess are well haired, though the hair is not strongly contrasted with that of the surrounding areas, while the deeper parts of the recess and sometimes the posterior parts of the labia are naked.

In inactive males and females the pit is much less deep but the structures remaining are essentially similar and show a circular sunken area, naked and creased posteriorly and with more or less developed lateral and posterior skin folds. In the unsunken condition this small circumscribed area of nude skin is especially characteristic, and in well made skins it shows up as a conspicuous naked disk. The degree of invagination of the pit is definitely linked to the sexual cycle,



Del., H. H. F.

Diagram of the hair tracts about the gulosternal glandular area in an adult male of *Notomys alexis everardensis*. Drawn from fresh material before preservation. (The gland sites are somewhat more posterior than indicated.)

just as the raising of the presternal gland is in "*aistoni*" but there appear to be marked individual variations in the degree of response. The site is plainly indicated in furred nestlings.

The sternal patch is present in all males and in a small proportion of females. In its maximum development it takes the form of a shield-shaped area on the chest 12 mm. wide by 15-16 mm. long, densely covered by short, rather stiff specialized hairs separated from the gular pit by a band of ordinary ventral fur. In the dark-bellied southern race the area is very conspicuous as in *mitchelli* *macropus,* but in the pale-bellied northern form and intermediates it is much less so, though the glistening of the area is usually apparent if the specimen is suitably held, and the increased density of hairing is usually obvious also, on close inspection. Its condition does not vary with gonad develpment. No example of the southern race with well-developed scrotal testes has yet been examined, and none of the 40 or more examined show a deeply invaginated gular pit such as occurs in the pale-bellied form, though the surface structures are precisely similar. Whether there is a racial difference in the degree of development of the gland in the south is not determinable with the present material.

The *manus* varies considerably in absolute size and is frequently unequally developed on the two sides; the length from base of outer carpal pad to tip of third apical pad, from 7-8 mm., and the width at base of digits 2-5, from 3-4 mm. The third digit to 4 mm. The size and proportion of pads also very variable; usually the length of outer carpal > 2nd interdigital > 1st = 3rd. The elongation of the outer carpal is greater than in *cervinus* Waite and *"aistoni"* and resembles *mitchelli macropus,* but examples in which the carpals are subequal are numerous. The palm is pink.

The *pes* is conspicuously short, 32-34 mm. with a mean of 33 in fully adult examples, but frequently as low as 30 in subadults of nearly full growth. The maximum width of foot across pads at the base of digits 2-4 is 3·5-4·5 mm., and the length of third digit, 7 mm. The pads very much as in *cervinus* of Waite, though the interdigitals average somewhat wider; 3 > or = 2 > 4 > 1. The hallucal pad is present in 43, absent in 34. The undersurface of the toes is lightly haired, about as in *mitchelli macropus,* not obscuring the apical pads. The sole is slate or bluish pink in life, the digits a lighter pink.

The *tail* varies in length within wide limits in individuals at the same growth stage, and tends to be slightly shorter in females than males. In a few individuals there is a slight tendency towards incrassation of the basal third.

The clitoris is very small. The posterior mammary nipples are about 10 mm. from the clitoris and the anterior about 11 mm. from the posterior; when not functioning they are very strongly retracted. The scrotum is lightly pigmented at the posterior extremity only.

Pelage

(a) In the form which predominates in the batches from north of the Musgrave Range individual variation is considerable both in the colour of the subterminal band of the dorsum (as given by Brazenor), in the degree of grizzling of the coat by dark guard hairs and consequently in the texture and general external colour, and in the basal colour of the belly fur, which is usually pale plumbeous but frequently white. The latter character, which has been claimed as the exclusive possession of *cervinus* Waite, occurs in about 48% of subadults otherwise quite normal and is occasionally retained until nearly full growth is reached. The moult changes are very pronounced also, more so than in any of the other three species of the genus reviewed in these papers, though they are fore-

shadowed by certain anomalous pelages in the large *"aistoni"* series from the Lake Eyre Basin. The incidence of the moult is highly irregular but is obviously responsible for the considerable proportion of thin dull and fluffy pelages devoid of guard hairs, which are to be found in most of the batches, on individuals having precisely the same skull and external characters, as normally clad individuals. The covering of the tail is particularly variable, dark blackish-brown upper surfaces well contrasted with a pure white undersurface, being varied capriciously by others in which the upper surface is a pale uncontrasted greyish-brown. The brush is generally inferior in development to that in *cervinus*, *"aistoni"* and *mitchelli macropus*, but there is great variation and the difference is sometimes slight. Sexual differences almost nil; age differences chiefly shown by a tendency to duller colours in immature stages.

The characters of the original series from Alroy and Alexandria have not been adequately reviewed and the range of variation there is not defined, but three topotypes kindly made available by Mr. Glauert of the Western Australian Museum can be very closely matched in the northern part of the present area.

(b) As indicated above almost the entire collection from the Everard Range area and a proportion of those from the Musgrave Range differ from those from more northerly localities in certain pelage characters, which may be thus summarized:

(1) the pelage is denser and longer on all surfaces and frequently reaches 16 mm. on the posterior back, where it is more heavily grizzled;

(2) the basal colour on all surfaces is much darker, particularly on ventrum and inner surfaces of limbs where the basal colour is deep plumbeous to almost black, the gulo-sternal tract alone excepted;

(3) while the dorsal colour varies as in the north, the dark based ventrum is quite constant, and in 50 examples examined white or pale-bellied variants analogus to those so numerous in the north have been quite absent.

The effect of alcohol immersion upon the colouration of this species has been very fully investigated, a series of closely matched individuals having been selected in the field and a portion of them then skinned and the rest alcohol preserved. In the majority of individuals the change is striking; in two years the original yellow and orange buffs of the subterminal band changed to a pinkish rust colour, and after six years to a deep brown rust; at the same time the black guard hairs and the basal fur faded to rusty brown greatly reducing the effect of grizzling, and the pure white of the belly became yellow. The individuals which have changed least are those at the thin dull moult phase noted above.

Skull and Dentition

An excellent series of 40 skulls, all derived from individuals of known characters in the flesh and representing a wide range of growth stages has been examined.

The skull resembles *cervinus* Waite *et auct.* of the Lake Eyre Basin but is less specialized, has a smaller braincase and less tapered zygomatic outline. There is so much variation, however, that many examples could scarcely be separated from that species by inspection.

The range of linear skull dimensions of individuals which have attained average bulk and which are free from obvious immaturity in externals is not excessive, but, as in some murid series recently reviewed from the Lake Eyre Basin, there is a wide individual variation in structural characters, and considerable disproportion of parts in examples at approximately the same growth stage. Individual capricious variation involves particularly the antorbital fossa, the mesopterygoid fossa, anterior palatal foramina and lachrymals, while disproportion is shown largely in the muzzle region and anterior zygomata. The retention of juvenile characters of slender muzzle and narrow anterior zygomata in otherwise advanced skulls is responsible for some marked contrasts in the shape of some of the largest examples of the series derived from individuals, precisely similar externally. Much of the variation is undoubtedly due to varying pressure of ecological conditions on the life cycle of individuals, though direct demonstration of such a relation is rarely possible. An accessory cingular cusp on the anterior lamina of the upper M^1, very much as in *N. cervinus* Waite *et auct* of the Lake Eyre Basin and *N. mitchelli macropus* of Ooldea, is well developed in 10 examples. The anterior lamina of the first upper molar is usually bicuspid even when unworn, but a distinct third buccal cusp is present in a small proportion of individuals as in most of the species.

The variations noted are shown by both races in about the same degree, but there is a distinct tendency for the skull of the southern race to be stouter, and with relatively broader muzzle and squarer zygomatic outline, though the presence of numerous exceptions renders it difficult to illustrate the difference by measurement. The only important difference from the type skull of *alexis alexis* from Alexandria shown by the whole series is the inferior zygomatic width; the 17 mm. quoted for the type seems excessively large and is possibly an aberration if correctly recorded, though a single very large skull of the present series approaches it with 16·5 mm.; the value for this measurement, quoted independently by Brazenor, agrees with the present series.

Flesh Dimensions

As the values for the two races are in complete agreement, no segregation is made in the following figures which give the range of dimensions and true mean in (1) 7 ♂ and ♀ subadults, and (2) 10 ♂ and 13 ♀ fully adult. The means are in brackets.

	1		2	
Head and body -	95-102 (99);	95–100 (97)	101-109 (103);	97-112 (104)
Tail - - - -	131–142 (136);	120–132 (128)	141–150 (145);	130–139 (134)
Pes - - - -	31–32 (31·5);	30–31 (31)	32–34 (33);	32–34 (33)
Ear - - - -	19–23 (22);	19–20 (19·5)	21–24 (22·5);	21-23 (22)
Weight in grammes -	27–37 (30);	27–34 (29)	30-45 (40);	31–47 (36)

Skull Dimensions

The following figures give the range and true mean of the skull dimensions of adults of *Notomys alexis* vars. in (1) 3 ♂ and 3 ♀ of the typical race from Wollara, (2) 8 ♂ and 8 ♀ of the southern race from the Everard Range. All skulls show wear on all laminae of the upper M^1 and are extracted from individuals free from any obvious immaturity in external characters.

Greatest length - -	28·8 39·2 (29·5);	30·0–30·8 (30·3)	29·0–30·4 (29·7);	29·1–31·6 (30·1)
Basal length - - -	23·8–24·5 (24·1);	23·8–24·6 (24·3)	23·7–25·5 (24·4);	23·8–26·0 (24·7)
Zygomatic breadth -	15·0–15·6 (15·3);	14·5–15·8 (15·1)	15·0–15·7 (15·3);	15·0–16·5 (15·4)
Braincase breadth - -	14·1–14·7 (14·4);	14·4–14·6 (14·2)	14·0–14·9 (14·5);	13·6–15·0 (14·4)
Interorbital breadth -	5·0–5·1 (5·1);	5·1–5·7 (5·4)	5·2–5·5 (5·4);	5·0–5·6 (5·3)
Nasals, length - -	10·2 10·8 (10·6);	10·7–10·9 (10·8)	10·5–11·2 (10·8);	10·7–11·4 (11·0)
Nasals, greatest breadth	2·8–3·0 (2·9);	2·8–3·0 (2·9)	3·0–3·4 (3·1);	2·8–3·1 (3·0)
Palatal length - -	15·2–15·3 (15·2);	15·0–15·7 (15·3)	15·0–16·0 (15·4);	15·0–16·2 (15·7)
Ant. Pal. Foram., length	5·0–5·6 (5·3);	5·3–5·5 (5·4)	5·0–5·7 (5·3);	5·0–5·5 (5·2)
Ant. Pal. Foram., breadth	1·6–1·9 (1·8);	1·7–1·8 (1·7)	1·5–2·0 (1·7);	1·6–1·9 (1·7)
Bulla length - - -	5·9–6·0 (5·9);	5·6–5·8 (5·7)	5·5–6·0 (5·7);	5·9–6·3 (5·9)
Upper molar series -	5·0–5·0 (5·0);	5·0–5·0 (5·0)	4·9–5·1 (5·0);	4·9–5·0 (5·0)
Incisive angle - -	63°–68° (65°);	60°–60° (60°)	58°–60° (59°);	58°–65° (62°)

Definition of the Southern Race

The form of *Notomys alexis* occurring in the area about the Everard Range and representing the southern limit of the distribution of the species, I would propose to recognise as distinct, under the name **Notomys alexis everardensis.**

General characters, flesh dimensions and range of external colourations as in the typical race, but the pelage differing as indicated above. The skull is somewhat heavier in build and in general has a wider muzzle, stouter zygomata, and squarer zygomatic outline. The gular gland site in males is probably less invaginate than in males of the northern race of comparable gonad development.

Cotypes: in the South Australian Museum, M.3685 Adult ♂, skin[1] without skull (original number 1649HHF), and M.3673 Adult ♀, skin with skull (original number 1609HHF).

Type Locality: Approximately 26° 50′ south and 132° 15′ east; about the waters of Chundrinna and Walthajalkanna north of the Everard Range in the north-west of the State of South Australia, and about 650 miles south-west of the type locality of the northern race. The cotypes are selected from a series of 40 examples collected by the writer at the above camps in February, 1933, 20 of which are deposited in the South Australian Museum.

An unexpected result of the examination of the large collection of *Notomys* from this portion of the centre, has been the proof of the complete absence of *Notomys cervinus* of Waite *et auct* (*nec* Gould) as I have recently defined it

---

(1) The skins are from alcohol preserved material and are to be interpreted as representing individuals in which the original subterminal colour of the dorsum was near Ridgway's Ochraceous Tawny, the terminal dorsal colour about Fuscous Black, and the general effect near Prout's Brown.

from Mulka in the Lake Eyre Basin. While this may be no more than a coincidence, it arouses a suspicion that Waite's identification of the entire Horn Expedition material of the smaller *Notomys*, from Charlotte Waters and adjacent areas, as *N. cervinus* may have been mistaken, and that the dark-bellied form which, according to Brazenor, is numerous in these collections, is, at least in part, *alexis*. Two other circumstances tend to confirm this. Firstly, although the skulls figured by Waite (6) almost certainly represent *cervinus* as it occurs also at Mulka, some details of his measurements and figures, especially the gular "pouch," are more suggestive of *alexis*. Secondly, a series from Wantapellya, which was recorded by Waite (8) in 1915 as *Ascopharynx cervinus* has been carefully re-examined during this review and undoubtedly represents *alexis in toto*.

In view of this uncertainty it may be well, therefore, to briefly restate the characters which, in my view, separate the two species. *Dimensions:* both ear and foot in *alexis* are distinctly shorter; the short narrow ear is highly characteristic. *Pelage: alexis*, though very variable in external colour, is always browner and usually more distinctly grizzled and the dorsal coat crisper. Pure white belly fur, however, although more characteristic of *cervinus* than any other species, is not an infallible distinction as it occurs in *alexis* and *"aistoni,"* usually as a juvenile or early moult character, but occasionally in adults also. Conversely dark-bellied examples of *cervinus* occur. The *gulosternal area: alexis* differs from *cervinus* in the constant possession in the male of a well-developed tract of specialized glistening sternal hairs as in *mitchelli macropus*. The gular pit in its maximum development in *alexis* is smaller, deeper, with more fleshy but less well-defined labia, and the posterior floor of the pit differs in having a more conspicuous area of naked creased skin. *Skull:* individuals of both may be found which are indeterminable by inspection, but in series *alexis* is seen to be less specialized, more *Pseudomys* like, with a less globular braincase and normally with squarer zygomatic outline, especially in the var. *everardensis*.

The Status of Ascopharynx fuscus *Wood Jones* (9)

It has been suggested (1) that this is synonymous with *N. alexis alexis* Thomas. Unfortunately, no type was designated for this animal, and the only specimen available here which might reasonably be supposed to represent it, is in the collection of the Zoology Department of the University of Adelaide. It is stated to have been from Ooldea and to have formed part of the collection of Professor Wood Jones, though the original label is no longer attached. It is a nearly adult male, greatly faded, but represents an animal very close to *N. cervinus* of Waite *et auct.* of the Lake Eyre Basin, the sunken gular gland site in particular being identical. The pes is 34 mm., with a maximum width of 4 mm. (as measured in these papers across the pads of digits 2-4); the tail 127 mm.; the ear 25 mm.

There is no trace of a sternal patch, and the animal clearly has nothing to do with *alexis*.

Notomys mitchelli var.

Since Spencer's (4) misapplication of this name to *longicaudatus* and Waite's (7) correction of the same, the opinion has prevailed that this form is somewhat coastal in distribution and does not occur in the centre. Recently, however, Brazenor *(op. cit.)* has published a record of his *N. mitchelli alutacea* from an unspecified locality in "Central Australia." No form of *mitchelli* was taken during the field work of 1931-1935, nor is it present in any recent collection from the centre which I have examined, but in the old collections of the South Australian Museum are two mounted skins, much faded but apparently reconcilable with *alutacea.* They are labelled, respectively, "Alice Springs" and "Central Australia 1879." The gulosternal tract is exactly as in *N. mitchelli macropus,* and the foot length is 35 and 38 mm., respectively.

The colouration of the type series of *alutacea,* as recorded, is rather suggestive of alteration by alcohol.

Notomys "aistoni" Brazenor

This species which probably represents the true *cervinus* of Gould and Sturt *(nec* Waite *et auct.),* is represented by numerous imperfectly localized examples in the older Museum collection from "Central Australia." There is some reason to believe that the bulk of them are from Cowarie in the Lake Eyre Basin, and are, therefore, topotypical. Four of the remainder are definitely from Ooldea, however, and have already been recorded (3), and the other two from Charlotte Waters, whence they were received in company with *alexis.* They do not differ in any important respect from those of the large series recently reviewed. One originally represented the clear buff Type 1 pelage, and the other is an intermediate. These two records from Ooldea and Charlotte Waters are of value in proving the presence of this very distinct species, west of the Lake Eyre Basin.

Notomys longicaudatus Gould

Most of the Central Australian examples of this species, so far examined, have come from north central localities beyond the Macdonnells. It was not obtained in the area worked over personally, but there is a specimen in the South Australian Museum from Mount Burrell, 50 miles north-west of Idracowra on the Fincke. This is a male with: Head and body 127 mm.; Tail, 205; Pes, 44 x 6; Ear, 29.

As pointed out by Brazenor *(op. cit.),* the presternal gland is exactly as in "*aistoni*" and the general structure of manus and pes appear also to be nearer this species than to *mitchelli* or *cervinus* or *alexis.* The propriety of using these features in erecting a genus, however, seems strongly contra indicated by the circumstance that the actual range of structural diversification in manus and pes in the group is very slight, while the individual variation is extraordinarily high; and secondly by the fact that glandular structures (however useful in the discrimination of species) frequently occur in confusingly similar form in widely sundered groups and in consequence are notoriously unreliable as criteria of affinity.

The current nomenclature of this large Central Australian form can scarcely be considered as more than provisional, until detailed comparison of series with topotypes from the south-west of Western Australia can be made.

References

1 Brazenor, C. W. 1934 Mem., Nat. Mus., Melb., **8**, 80

2 Finlayson, H. H. 1939 Trans. Roy. Soc. S. Aust., **63** (1), 108

3 Finlayson, H. H. 1939 Trans. Roy. Soc. S. Aust., **63** (2), 358

4 Spencer, B. 1896 Rept. Horn Expd., **2**, 10

5 Thomas O. 1922 Ann. Mag. Nat. Hist., Ser. 9, **9**, 315

6 Waite, E. R. 1897 Proc. Roy. Soc. Vict., **10**, pl. vi, fig. 3 a-f

7 Waite, E. R. 1897 Proc. Roy. Soc. Vict., **10**, 117

8 Waite, E. R. 1915 Trans. Roy. Soc. S. Aust., **39**, 735

9 Wood Jones, F. 1925 Recds. S. Aust. Mus., **3** (1), 3

EXPLANATION OF PLATES

Plate XIV

Fig. A Dorsal aspect of the skull of an adult ♀ of *Notomys alexis everardensis*, to show the retention of juvenile characters in muzzle and zygomata. x 2·2 ca.

Fig. B Dorsal aspect of a normally developed skull of an adult ♀ of *Notomys alexis everardensis*, extracted from an individual having external characters identical with A. x 2·2 ca.

Fig. C Lateral aspect of B. x 2·2 ca.

Fig. D Palatal aspect of B. x 2·2 ca.

Fig. E Right manus of an adult ♂ of *Notomys alexis everardensis*. x 3·4 ca.

Fig. F Right manus of an adult ♂ of *Notomys* cf. *longicaudatus* from Mount Purrell. x 3 ca.

Plate XV

Figs. A, B, C Aspects of the skull of *Notomys longicaudatus*, ♂. (The example figured by Waite. Proc. Roy. Soc. Vict., 1897, pl. v, fig. 2). x 1·7 ca.

Fig. D Right Pes of *Notomys longicaudatus*. ♂, adult. (id., pl. xiv, fig. F.) x 1·8 ca.

Fig. E General aspect of the gular glandular area as seen in alcohol preserved material of *Notomys alexis alexis* from Basedow Range area, Central Australia. Adult, ♂. x 1·2 ca.

Fig. F Right Pes of *Notomys alexis everardensis*. Adult, ♂. x 2·3 ca. (id., pl. xiv, fig. E).

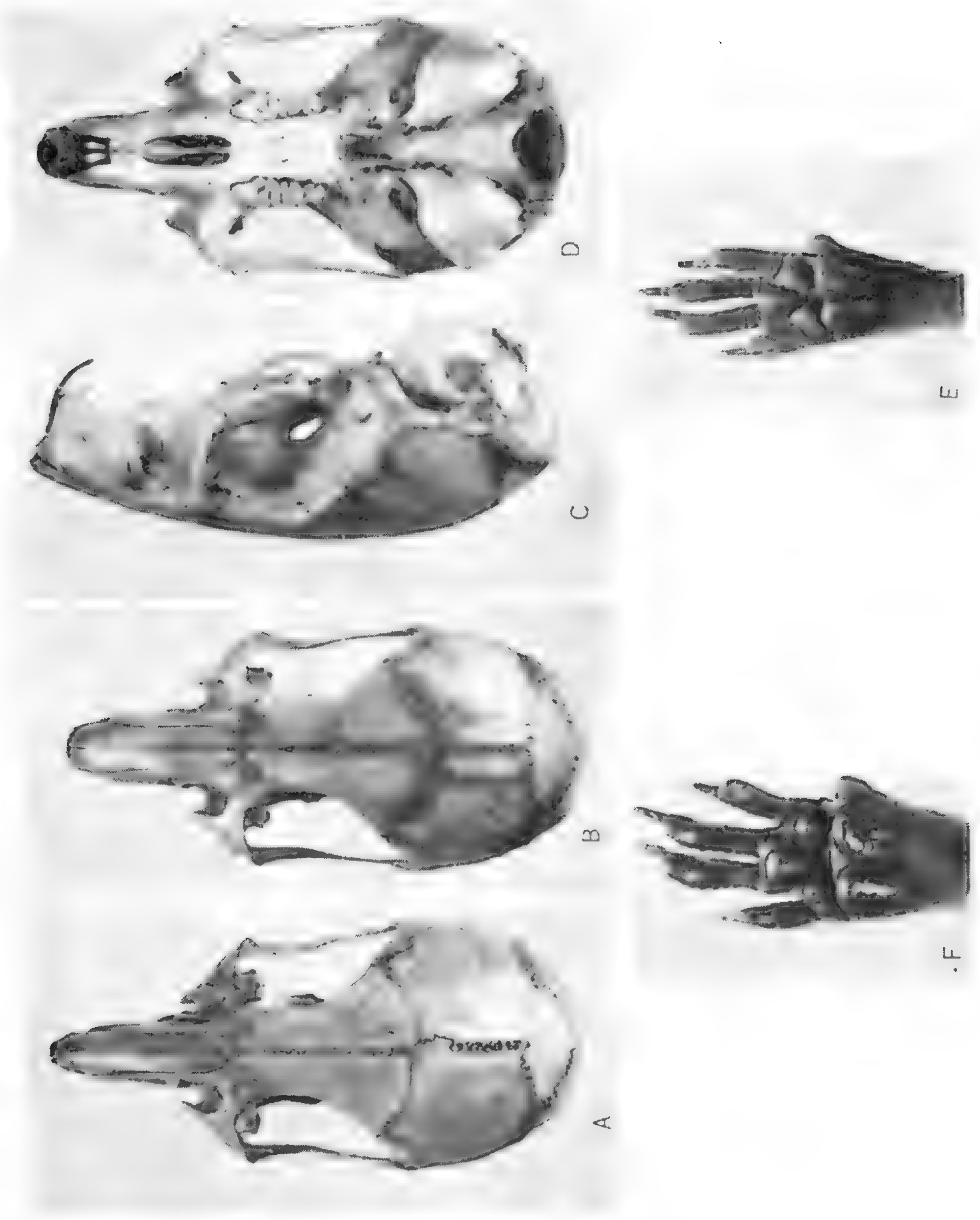


Photo by H. H. Finlayson

Photo by H. H. Finlayson

A NEW SPECIES OF CERATRIMERIA (COLLEMBOLA) FROM TASMANIA

By H. WOMERSLEY, South Australian Museum.

Summary

The following new species of *Ceratrimeria* has recently been sent to me by Dr. J. W. Evans, of the Department of Agriculture, Hobart, Tasmania.

A NEW SPECIES OF CERATRIMERIA (COLLEMBOLA) FROM TASMANIA

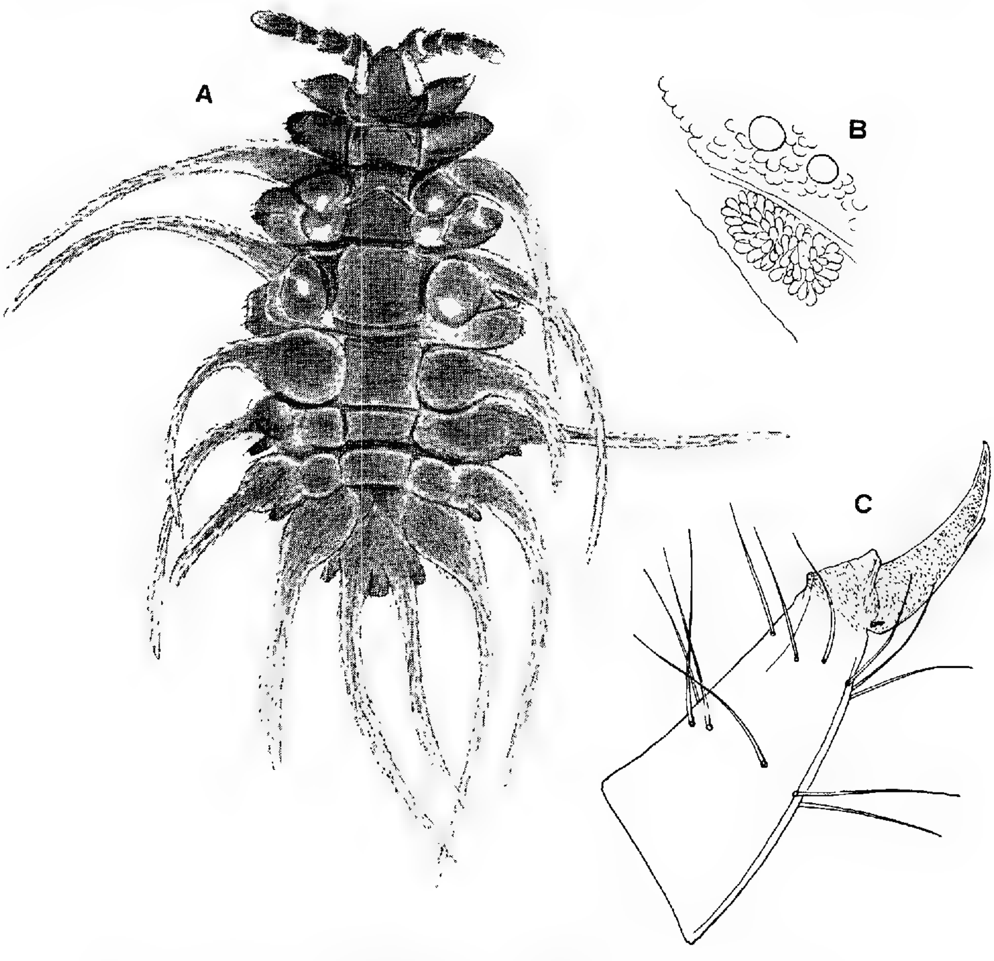
By H. Womersley, South Australian Museum

[Read 13 June 1940]

The following new species of *Ceratrimeria* has recently been sent to me by Dr. J. W. Evans, of the Department of Agriculture, Hobart, Tasmania.

Ceratrimeria bicornis n. sp.

Description—Superficially with the facies of *C. dendyi* (Lubb.) but the dorsal spine-like prominences much longer and upturned. Length of animal 4·0 mm., width slightly less than 2 mm. Colour black, except for the pair of dorsal horns on the



Ceratrimeria bicornis n. sp.

A, entire dorsal view. B, postantennal organ and anterior ocelli. C, claw and tibiotarsus.

head, three pairs of spots on the meso- and metathorax, and the tips of the dorsal prominences which are yellow. Antennae as long as head, ratio of segments 1·5 : 1·0 ; 1·1 : 2·0. Ocelli 8 on each side on dark patches of pigment. Postantennal organ subelliptical and consisting of an irregularly arranged cluster of tubercles. Abdomen VI hidden under V, as in the genus. The dorsal prominences are: a pair of short horn-like ones on the head and a pair of long upwardly curved ones on each segment from the mesothorax. Legs rather longer than in *dendyi;* claws strongly granulate, without inner teeth but with a pair of dorsolateral outer teeth at $\frac{3}{4}$ from base, and extreme base on each side with a short spine-like seta. Clavate tibiotarsal setae and furca absent. Clothing of very fine short hairs as in other Tasmanian species.

Locality—Two specimens from Ida Bay, Tasmania, collected by Dr. V. V. Hickman in November, 1939; a half-grown specimen from Belgrave, Victoria, in March, 1940 (O. W. T.) ; another full-grown specimen from Olinda, Victoria, 26 May 1940 (F. E. Wilson).

Remarks—This interesting species is very closely related to *C. dendyi* and belongs to the Tasmanian group of the species of the genus. It differs, however, in the form of the postantennal organ, in this respect showing relationship to species of the Indo-Malayan and African groups. From *dendyi* it also differs in the structure of the claws and the position and lengths of the dorsal prominences. The paratergites are otherwise as in the rest of the Tasmanian species.

CONTRIBUTIONS TO THE ORCHIDACEOUS FLORA OF AUSTRALIA

By R. S. ROGERS, M.A., M.D., D.Sc., etc.

Summary

Pterostylis allantoidea, n. sp

A very slender plant, about 6-10 cm. high. Leaves rosulate at the base of the stem on rather long petioles, ovate, reticulate, margins slightly crenulate; a subulate bract a little above them. Flower single, erect, about 10 mm. long; galea markedly acute and decurved, green with dark purple longitudinal stripes and markings ; the junction of the lateral sepals dark coloured and very gibbous, their segments produced into filamentous points erect or reflexed greatly exceeding the galea. Labellum mobile unguicule, semicylindrical, fleshy, channeled above, slightly curved, pubescent in the anterior part and protruding a little at the sinus, about 4.5 mm. long; appendage trifid.

CONTRIBUTIONS TO THE ORCHIDACEOUS FLORA OF AUSTRALIA

By R. S. Rogers, M.A., M.D., D.Sc., etc.

[Read 13 June 1940]

Pterostylis allantoidea, n. sp

A very slender plant, about 6-10 cm. high. Leaves rosulate at the base of the stem on rather long petioles, ovate, reticulate, margins slightly crenulate; a subulate bract a little above them. Flower single, erect, about 10 mm. long; galea markedly acute and decurved, green with dark purple longitudinal stripes and markings; the junction of the lateral sepals dark coloured and very gibbous, their segments produced into filamentous points erect or reflexed greatly exceeding the galea. Labellum mobile unguiculate, semicylindrical, fleshy, channelled above, slightly curved, pubescent in the anterior part and protruding a little at the sinus, about 4·5 mm. long; appendage trifid.

Planta gracillima, circa 6-10 cm. alta. Folia radicalia, 4-5, petiolata, ovata, reticulata, marginibus crenulatis. Prope basin bractea subulata. Flos solitarius, erectus, circa 10 mm. longus; galea acutissima, subviridis, cum notationibus atratis longitudinalibus, decurvissima; segmenta lobii inferius erecta vel recurva filamentosa galeam multo excedentia; junctio gibbosissima; labellum carnosum, semicylindricale, leviter curvata, superne canaliculatum, anteriori pubescente.

This interesting little plant bears a superficial external resemblance to three other Australian species, *viz.:*

(1) *P. concinna,* R. Br.
This orchid has a markedly emarginate labellum, a character which readily excludes error in determination. It has doubtfully been reported from Bugle Ranges, South Australia, but not further west.

(2) *P. pedunculata,* R. Br.
No inflexed tooth separating the two segments of the lower lip. The labellum is neither fleshy nor pubescent; the galea is not decurved. More than one stem-bract present. Not reported west of this State. Not gibbous.

(3) *P. nana,* R. Br.
Inflexed tooth separating segments of lower lip. Labellum is neither fleshy nor pubescent. Galea rather blunt. More than one stem-bract present, Doubtfully reported from Western Australia. Not gibbous at base of flower.

The plant was discovered by Horbury, in September, 1938, at Kumarl, near Salmon Gums, Western Australia, and was forwarded by Colonel B. T. Goadby.

It derives its name from the somewhat sausage-like shape of the labellum.

RESULTS OF THE HARVARD-ADELAIDE UNIVERSITIES ANTHROPOLOGICAL EXPEDITION, 1938-1939

DISTRIBUTION OF AUSTRALIAN ABORIGINAL TRIBES: A FIELD SURVEY

By NORMAN B. TINDALE, Ethnologist, South Australian Museum.

Summary

The following paper is one of the first fruits of the joint expedition organised by the Department of Anthropology, Harvard University, and the University of Adelaide, under a research grant from the Carnegie Corporation of New York. The field work was materially assisted by grants from the South Australian Government and the University of Adelaide, while the services of the present writer were made available to the expedition by the authorities of the South Australian Museum.

RESULTS OF THE HARVARD-ADELAIDE UNIVERSITIES ANTHROPOLOGICAL EXPEDITION, 1938-1939

DISTRIBUTION OF AUSTRALIAN ABORIGINAL TRIBES: A FIELD SURVEY

By Norman B. Tindale, Ethnologist, South Australian Museum

With One Map

[Read 13 June 1940]

The following paper is one of the first fruits of the joint expedition organised by the Department of Anthropology, Harvard University, and the University of Adelaide, under a research grant from the Carnegie Corporation of New York. The field work was materially assisted by grants from the South Australian Government and the University of Adelaide, while the services of the present writer were made available to the expedition by the authorities of the South Australian Museum.

A preliminary field report by Tindale and Birdsell was in press late in 1939 but the reference has not yet been received. The present paper deals with data regarding tribes obtained during the field work, and forms a basis for further studies in social and physical anthropology by both observers. Results have been included of other field work accumulated in past years.

Introduction

In the present paper and accompanying map an attempt has been made to give a list of all established tribes, and, where possible, a concise account of the known boundaries and a précis of recent natural tribal displacements that have occurred. As far as possible, new information, principally from present enquiries in the field, was the basis of the map, and where this failed, published data obtained by other professional research workers in recent years, have been preferred. In the absence of both these sources, attempts have been made to assimilate the mass of less critical data available in the general literature. The method of setting out will, it is hoped, enable the new data to be distinguished from those culled from published sources. Much information has been obtained about the component hordes and minor groupings within these tribes; this data must be considered separately.

Utilised Sources of Information

Fourteen months were spent in the field by the Harvard-Adelaide Expedition, principally along the eastern and southern portions of Australia, from north of Cairns to Perth. Survivors of many aboriginal tribes were interviewed, often in their own country, and the data may be said to have been acquired during the course of interviews with approximately 2,450 people (the total number subjected to anthropometric examination). First-hand data have also been added from material obtained during the past nineteen years on journeys in the Western (Great Victoria) Desert, in Central and Western Australia, on Cape York Peninsula and in Arnhem Land; a total of forty-eight months of field work.

Having recently interviewed a lone survivor of the ['Puŋandi:tj] tribe, the writer has, for example, now obtained direct information regarding former tribal distributions and boundaries for nearly every tribe in South Australia. In the sole exception, the extinct ['Nauo] tribe of Port Lincoln district, information supplied by ['Paŋgkala] individuals has had to suffice.

Despite objectiveness of approach, the methods employed in gathering the new material may be considered to introduce a personal bias into the data. This may be outweighed by the possible advantage that the information has been collected in a uniform manner, has been transcribed phonetically by the one hand, and hence represents a synoptic view of a large mass of information relating to tribal units in Australia.

When compared with the independent results of other recent field workers, it may be seen that there is a high degree of correlation between the results obtained. There is less agreement with the results of brief surveys and the scattered data obtained from relatively casual enquiries and through the agency of questionnaires. The material from the last-named often requires considerable sifting and analysis before it can be utilised. As stated above, the data that has been used to fill in gaps in personal observation is, as far as possible, derived from the published work of, and in some cases from personal contact with, other research workers. Where there are over-lappings between the data from two independent sources, the degree of corresondence evident is such as to engender confidence in the methods adopted. Differences do occur, but these are often mere variations in details of phonetic transcription and occasional lapses. Some seeming contradictions can be clarified only by further field work.

With regard to the earlier data, those of the elder Strehlow, Spencer and Gillen, and Howitt proved most helpful. Mathews' data is of unequal merit, their value depending on the nature of the varied sources from which it was gleaned. Generally, less satisfactory tribal details occur in the writings of Basedow, Bates, and Spencer.

Roth's work, based entirely on field researches, is of exceptional clarity; his spelling is a trap to those who do not keep his system (1897, p. 1) in mind. He admits inability to adequately reproduce the nasal sounds.

Davidson (1937, 1938) has summarised the literature and published a map, without indicating boundaries. The only previous attempt of any consequence was that of Roheim (1925), which likewise suffers from lack of field data and controls.

In sifting and discarding earlier published terms purporting to be tribal, increasing knowledge of native vocabulary and practice is of some help.

Most tribes have a term which they apply to themselves; usually it is a proper name derived from their own language, or, more rarely, it is a name adopted from members of some neighbouring tribe who have applied it to differentiate their neighbours from themselves. When genuine variations, synonyms and alternatives, terms of opprobrium, etc., given by others, and erroneous or mistakenly applied terms are taken into account, it may be readily understood there is present in the literature many more tribal names than there are valid tribes. Where possible, such terms have been equated and indicated in the synonymy. In a few cases it has been difficult to ascertain a real tribal name; thus only after over a century of casual contact and several visits by field workers has Hart (1930) suggested a name ['Tiwi] for the Melville Islanders.

As might be expected, tribal names take many forms, among which may be recognised the following:

(a) *Proper nouns without known meaning.*

(b) *Words meaning "man," "men," or "people."* Sometimes these may denote only a nebulous aggregate of tribes.

(c) *Words derived from peculiarities in the language spoken.* Differences in vocabulary may be seized upon to provide some key term to separate one's own tribe from neighbouring ones. In parts of Victoria, for example, there are names derived from the duplicated terms for "no," as in [Wemba'wemba], ['Ji:ta'ji:ta] or modifications of it as in [Be'rap:e'ra:pe]. In the Western (or Great Victoria) Desert the terms of enquiry "what is it?" ['naŋata-], ['ŋana-] and ['ŋa:da-] are utilised to make names such as Nangatadjara, Ngadadjara, etc.

(d) *Terms based on ecological and/or geographical differences.* ['Anjimatana] "hill people," ['Ba:rindji] "forest people," ['Wirameju] "gum forest people," and ['Ba:kendji] "river people." Such names are commonly found as terms applied by neighbours since, surprisingly enough, it is not always as easy to recognise the unity of one's own ecological or geographical niche as to summarise another's.

(e) *Words incorporating a term for "language" or "speech."* A widespread root word, *e.g.*, ['woŋa], ['waŋga], ['woŋka], meaning "talk" or "speech" may be combined with qualifying adjectives similar to "good," "clean," "smooth," etc., to denote the members of a tribe. In such tribes, cognate terms are apt to be used to describe the "hard-," "rough-," "incomprehensible-," "stupid-," speech of neighbours. The latter terms must usually be rejected when seeking a valid term for a tribe.

(f) *Names derived from compass directions.* In South-western Australia, terms such as ['Ko:reŋ] (literally east, or easterners), ['Kaneaŋ] (westerners), ['Min:aŋ] (southerners) seem to be valid tribal names, and no more suitable terms have been suggested for these tribes. In many other places, names incorporating compass directional terms are seemingly invalid. Thus, in a large part of Western Australia the term ['Kaieli] is used to denote any tribe situated to the north or north-west of the informant. This term generally means "north-west," and is not applicable to specific groups. In the same area, and extending well into western South Australia, and the Northern Territory, words meaning, respectively, "north," "south," "east," "west," have been reported. These are not tribal names, although they have been treated as such. Their adoption would be confusing. As a rule, they do not refer to specific ethnic groups. What is east to one is west to another.

Some terms for cardinal points which have been mistaken for tribal names in West-Central Australia and elsewhere, together with several of the invalid derivatives, are given in the following list. Several of these are merely words for the cardinal points disguised by cumbersome methods of transcription:

		Examples
['alindjara]	North	Alinjerra, Yallingarra
['ulparara] ['julbari]	South	Ulbaritja, Ullparidja, Ulpara, Yoolbarie, Julbari, Julbara
['kakarara] ['kakara]	East	Kakaringa, Karkurerra, Kakararu, Kakarrura, Karkar, Kar-Kar, Kogara, Kikkar, Kugara, Kokar
['wilurara] ['aldo:la] ['wiljaru]	West	Wilrurrerra, Wilruddidda, Willewroo, Willeuro, Wilrunerra, Willara, Willuro, Willuri, Hilleri; Aldorla, Alduling, Aldolinga

(*g*) *Names in Queensland terminating in [-'bara] to be excluded.* Numerous names with terminations -bara, -bura are to be found in the earlier literature of Central Queensland from Gympie north to Townsville and west to Winton. They usually denote horde-like units of local organisation and can seldom if ever be given the status of tribes. In the present map only one has been admitted, the ['Kabelbara], from west of Isaacs River, and it is suspected that another term may have originally existed even here. In a second case, the ['Koinjmal] of Broad Sound, the appellation ['Koinjmurbare] belonging also to a single horde living at Torilla, was once given to me as a name for the whole tribe, but another native assures me this is strictly incorrect.

Other Excluded Terms

All general and descriptive terms (such as Wepulprap ['wepur] = south, ['prap] = people, applied by Tangane to all people of the south-east of South Australia) have been omitted from our lists.

Terms which relate to loose or indefinite agglomerations of tribes, *e.g.*, the ['ŋarindjeri] (Narrinyeri, etc., of the Lower Murray River), have been omitted, as well as all terms which apply to supposed supernatural tribes or beings. For example, at Ooldea, Madutara are a legendary folk of dwarf-like dimensions who are believed to live in the Western Desert and have magical powers. Maduntara (Madutara) is also a general Pintubi and Pitjandjara term for people who live to the south-east of their country, and it has been passed over, for it does not apply exclusively to one tribe and is not an endemic term.

Where the native language is little understood, errors are apt to creep in. Thus ['jagaŋko], (['jaga] = mother, and [-nko] suffix meaning "to" or "towards") applied in the form Jagangu to some people north west of Ooldea seems likely to have arisen from some misunderstanding of a native's explanation about his mother's people.

Other terms winnowed out (principally from the earlier literature) are obviously generalised terms, lapses and misunderstandings, such as: *wambandi*, "I don't know"; *bardu*, *bardoak* and *bardok*, "circumcised people," and *minma*, "women." The word ['ŋatari], "stranger," is often used by natives in Western Australia; it is obviously not a tribal proper term.

A combination of words such as ['Kata'buŋata], meaning "head pad people," does not form a tribal term; in this instance it is a descriptive reference to the peculiar head pad or coiffure worn by males of most Western (Great Victoria) Desert tribes. Similarly, ['jawaŋilambaluk], "people of the mountains," and the previously mentioned ['anjimatana], "hill dwellers," and ['wirameju], "people of the gum forest," are descriptive labels and must often be passed over in favour of other terms. Similar objections have been raised to ['Kokata], on the score that ['Kokata] was derived from ['koka] = meat; the name being interpreted to mean "meat-eaters" or "cannibals." More recent field studies have shown that the majority of ['Kokata] natives themselves prefer this term to any other and that the suggested derivation is not acceptable to ['Kokata] people, even if it be so ascribed by others. Similarly [Ba:kendji] has no serious rival as a tribal term. Occasionally, subclass and moiety terms may be confused with tribal names, *e.g.*, ['kurabana], ['korakulu] and ['kuraminja] in North Queensland are moiety terms. There are also doubtful cases such as *Ibarga* and *Jaruru*, which are thought probably to be subclass terms ['I:paruka] and ['Taroro], but first-hand information is lacking.

An important source of past confusion in tribal nomenclature has been the presence, often in widely separated areas, of discrete tribal groups which have the same or markedly similar tribal names. In some cases prehistoric tribal continuity could, perhaps, be postulated. They are at present real tribal groupings. In other cases the resemblances are likely to be mere coincidence. Because of their importance, and to prevent possible confusion, the principal ones may be listed. When phonetically transcribed, it will be noticed there are often differences which may not be appreciated when they are more casually written.

['Bidie, 'Biria] Lower Thomson River, circumcising tribe.
['Biria] Non-circumcising tribe, Bowen River, coastal Queensland.
['Wiri, 'Widi] Highlands behind Mackay, Queensland.

['Widi] Lake Monger district, Western Australia.
['Jaŋga] Sutton River, Queensland.
['Jaŋa:] Upper Gilbert River, Queensland.
['Ku:ŋkari, 'Ku:ŋka:i] Thomson River, near Stonehenge, Queensland.
['Kuŋgari] Upper Nebine Creek, Queensland.
[Pitjare] Non-circumcising, Warrego River, Queensland.
['Bitjara] Circumcising people at Bulloo Downs, South-west Queensland.
['Badjiri] South of Cunnamulla, Queensland.
[Kutjel] Einasleigh River, Queensland.
[Kutjale] Basalt River, Queensland.
['Maikuduŋ] Circumcising tribe, Upper Leichhardt River, Queensland.
['Maikulan, 'Maikulun] Non-circumcising, head waters of Norman River, Queensland.
['Jukam'be] Boonah district, South Queensland.
[Jukembal] New England Plateau, New South Wales.
[Kutebal] Upper Staaten River, Queensland.
[Kitabal] Upper Richmond River, New South Wales.
['Kukatji] Non-circumcising tribe, Gulf of Carpentaria, Queensland.
[Kukatja] Eight class circumcising tribe in Western McDonnell Range, Central Australia.
['Kokata] No-class tribe, north of Wynbring, South Australia.
[ŋalia] Eight-class tribe north-west of McDonnell Range, Central Australia.
[ŋalea] No-class tribe north-west of Ooldea, South Australia.
['Min:eŋ] (means south); applied to non-circumcising tribe at Albany, Western Australia.
[Mi*r*niŋ, Mi:niŋ] (means man) applied to circumcising tribe near Eucla, Western Australia.
['Jukul] Leichhardt Bar at head of tidal waters of Roper River, North Australia.
['Jokula] Mainland opposite Wellesley Islands, Queensland.
['ŋandi] North of Roper River, North Australia.
['ŋandji] = ['Kotandji] Headwaters of McArthur River, North Australia.

A distinction must also be made between similarly sounding names with entirely different meanings. Thus, the name ['Min:eŋ] is applied to people around Albany, South-western Australia. The root of this term means "south" and their word for man is ['njuŋa]. It thus must not in any way be confused (as has, unfortunately, happened in the literature) with the ['Mi*r*niŋ] = ['Mi:niŋ], a circumcising-and-subincising tribe of the coast between Eyre and the Head of the Great Australian Bight, among whom the root ['mi*r*niŋ] means "man."

Where extended and contracted forms of a name occur, the more usual one has been adopted if knowledge is sufficient to enable a fair assessment to be made of native usage. Sometimes the penultimate syllable of a name tends to be lost, *e.g.*, ['Wilja:li] for ['Wiljakali], ['Ku:ŋka:i] for ['Ku:ŋkari], ['Wai:pi] for

['Wailpi]. In such cases, the vowel preceding the elided syllable is often extended. Usually the more clearly enunciated form is preferred. In a few cases, *e.g.*, ['Jaŋkundjara], instead of ['Jaŋkundjadjara], which are about equally commonly employed, the shorter form has been arbitrarily chosen because it is less cumbersome.

The last-named example brings up the vexed question of synonyms and the contradictory results occasionally obtained by different workers using varied methods of approach. In 1933 the term Jangkundjara was obtained for the people whose ancestral home was about the eastern Musgrave and Everard Ranges. In 1934 a similar term was independently volunteered by members of a group of the same tribe who, having left the Everard Range country in 1917 (date fixed by eclipse), were then living at Ooldea. The term has validity, since it is independently known to two groups of the same tribe. It is paralleled by a term, Pitjandjara, used by a neighbouring people to the west. More recently (1937) another worker heard, but has not yet published, a word ['Wirtjapa-'kandja] as the tribal term for the same folk. In 1939 the last-named term was unknown to another individual consulted, estimated to be eighty-five years of age, who used the term Jangkundjara.

An explanation which occurs is that new tribal designations may arise in some areas, and old ones may fall into disuse. If a new word has arisen since the break-up of this tribe in 1917, it may not be known to all the dispersed survivors. It is also likely that more than one term may be in use concurrently. Thus at Hermannsburg Mission, elderly ['Kukatja] people still dislike the derisive term ['Loritja] applied to them by the ['Aranda]. Nevertheless, members of a younger generation are apparently becoming reconciled to it, especially as it has become customary to use it on the mission in preference to the real term ['Kukatja].

Method of Setting Out Catalogue of Tribes

In the following catalogue of tribes, a phonetic rendering is first given on the left side of the page, followed, where considered desirable, by phonetic transcriptions of alternatives, extremes of native usage, etc. A brief description of the location of the tribe is then given in terms of *present-day* names of places on the maps. It is hoped that most place names mentioned in the list may be found on the map. A non-phonetic list of the principal forms current in the literature is also given at the end of the description of localities to assist in the tracing of references, the more important of which are cited. Exhaustive treatment could not be considered within the limits of space in these Transactions. In the list of old spellings the data has, as far as possible, been arranged in order of departure from the accepted form, so that aberrant renderings, when they occur, are usually placed near the last.

To extend the tribal list to embrace all names, synonyms and variations applied to them by other surrounding tribes would tend to swell the list overmuch; important ones are given in the following form:

Loritja (Aranda term) Maduntara (of southern tribes).

Owing to printing difficulties it has not usually been possible to give close transcriptions of some of the less important synonyms relegated to the list of alternatives, even when new; they can usually be distinguished by the remarks which follow them in brackets. For general writings, where close phonetic renderings are unnecessary or difficult owing to typographical and other difficulties, the form shown at the extreme right of the page is recommended for use. All tribes of which the names and new data have been obtained during field work are indicated in the catalogue by being shown without brackets. The capital letter "T" is added at the end of list of references to show that the sources include new data in the present author's possession. Fresh information is given for the distribution of about 400 tribes. Where the information given has been derived from published or manuscript sources without field control the tribal name is indicated in the catalogue by the deduced and rather generalised phonetic equivalent being placed in *round brackets*.

Phonetic Transcription Employed

The phonetic transcription employed is an adaptation of the International Phonetic Alphabet arranged by a Language Committee at the University of Adelaide, with additions (Tindale 1935 (2) and 1937, Capell 1940). For convenience, the symbols employed may be summarised as follows:

Consonants

	Labial	Interdental	Alveolar	Palatal	Cerebral	Velar	
Plosives - -	b p	**d**[1] **t**	d t	dj tj	*d* *t*	g k	
Fricatives -	v w		θ ð	j	*r*	w	h
Nasals - -	m	**n**	n	nj	gn	ŋ	
Rolled - -			r				
Lateral - -			l	lj	*l*		

Vowels

[i]	it, machine	[u]	full, food
[e]	there	[o]	comme (Fr.), almost not
[*e*]	allez (Fr.) almost they	[*o*]	obey, almost oak
[e]	earth, nurse	[ei]	they
[a]	father, Mann (Ger.)	[ai]	light
[*a*]	cat	[au]	Haus (Ger.), almost house
[a]	cut	[oi]	boy
[′]	stress mark	[:]	indicates lengthened vowel or consonant.
[ʻ]	glottal stop	[ ]	indicates isolated word in general text is phonetically transcribed.

(1) In the accompanying map letters with a vertical stroke beneath them correspond to those shown in **black letters** here; those with a dot beneath them are indicated in this text by *italics*.

A median course has been chosen in the differentiation of the vowel sounds. This may have led to the perpetuation of some errors, but these are perhaps of less importance, since the pronunciation of the vowels is subject to variation in the mouths of the aborigines themselves. In the main list the terms shown in phonetic script have been transcribed after personal contact with one or more individuals of the tribe concerned. For names of tribes of which the author has no first-hand information to offer, the form given in round brackets as a phonetic equivalent is merely an attempt to give a broad approximation to the pronunciation, and may be regarded as of the value of a personal opinion.

Mistakes introduced by absence of accurate phonetic renderings are responsible for many seeming duplications of tribal terms. The use of unnecessary or misleading prefixes and suffixes may also prove a source of confusion. There are also undoubtedly wide variations of current usage within even a single tribe, as instanced by Tindale 1935 (2), p. 264.

The Queensland tribal term ['Maiðakari], which tends to ['Maidakadi], is an illuminating example of the range of error introduced by imperfect attempts at transcription. The normal variation of [r] to [d], which is indicated in the above phonetic transcription, has perhaps added to the confusion. Some attempted spellings of this tribal name are: Mitakoodi, Mitakudi, Mitro(o)-goordi, Mit(t)agurdi, Maitakudi, Mayatagoorri, Mythuggadi, Mythaguddi. In the four first-named the first vowel, written "*i*," should evidently be given the value of [ai]. The [**d**] sound has been variously attempted. It is evident that it is lack of a sure phonetic vehicle that has been responsible for the majority of the seeming differences, for each transcriber has had confidence in his own rendering. On the basis of the literature, without field control, Davidson (1938) preferred *Mitakudi* which, read phonetically, is likely to perpetuate an error, originally caused by bad phonetics.

A glaring fault in old Australian vocabularies and among the older cartographers, often affecting tribal terminology, is the defective hearing and transcription of nasal sounds. This is marked in the rendering of [ŋ] (as in singer) by *gn*, thus *Gnuin* for ['ŋewin], a tribal name; *gnamma* for ['ŋama], meaning a rock-waterhole; *Wongkongnuru* for ['Woŋkaŋuru], a tribal name. Some of these errors of hearing are so confirmed in popular use that critical observations to the contrary are apt to be ignored and decried. The error is the more insidious since occasional field workers have found difficulty in discriminating between [ŋ] and [gn], habitually using [gn] in speaking native words, especially those with initial [ŋ]. The cerebral nasal [gn] does occur but is rare.

Differentiation between the various nasal sounds is important in Australia, and aberrant transcription of [**n**] and related sounds has been the cause of some errors and apparent synonyms. Thus *Yunga* is written for ['Njuŋa:] = [**N**uŋa:]. In this case, the interdental [**n**] which tends towards [nj] has been mistakenly rendered as [j].

Physiographic and Ecological Controls apparent in Tribal Distribution

The principles of human geography apply with particular force in the distribution of primitive aboriginal tribes. Without technical aids other than spear, boomerang, fire and canoe, the Australian aborigine has had relatively little power to transgress barriers set by ecological and geographical position. Living, as he often does, near the borderline between adequate nutrition and starvation, his personal skill and his very detailed knowledge of nutritional sources in his own territory are often the only assets separating him from starvation and thirst. With feeble resources for transport and restricted means for preservation of food, he is limited in his wants by the immediate availability of the primary stuffs of life, water, firewood, vegetable foods and game. If he camps too near to water, game will be disturbed, and there will be no firewood, for this will have been already used by his ancestors; if he remains too far away there will be transport difficulties. He must observe a nice balance between these factors, bearing in mind also the importance of visibility in ensuring safety from enemies, and the inability of his only burden bearers, his wives, to travel more than three to five miles away from camp, gather root foods and return in the day.

When accurately plotted on large scale maps, it is thus not very surprising to find often there is a high degree of correlation between tribal limits and ecological and geographical boundaries. Divides, mountain ranges, rivers, general ecological and plant associational boundaries, microclimatic zone limits, straits and peninsulas often furnish clear-cut and stable boundaries. Some of these are evident even on the small scale of the present map. In the deserts, cluster distributions of hordes around the few permanent waters are equally clear and waterless tracts effectively delimit many tribal boundaries. Other seemingly waterless areas possess tree-root water resources sufficient to maintain communities which have become adapted to the utilisation of such specialised sources.

So also lines of communication and migration routes have tended to follow natural lines of least resistance across Australia, often clinging to open plains, creeks and rivers, and to lines of waters along ranges, shunning dense forests and rugged mountains. There are migration trend-lines running away from areas of easy access in the north into areas of isolation and refuge in the east, south and south-west.

In considering these ecological facts, it must be remembered that while an advanced agricultural economy demands heavily watered country and timbered areas may be desirable and attractive, the reverse is likely to be the case for the aborigines—the most attractive areas are often open and preferably grassy plains wherever there is some water and much game. Dense wet forests become refuge areas, only to be sought by those less fortunate tribes whose physical and material inferiorities condemn them to the least desirable parts of primitive man's environment. Previously Tindale (1937) has commented on some geographical factors involved in tribal distributions and boundaries; many examples can be noted on the accompanying map.

The general reverse relationship between size of tribal area and rainfall is marked. The dry belt west of Townsville contrasts with the wetter country north and south. Note also the wide-ranging desert tribes whose areas increase to a maximum size in the sterile Western (or Great Victoria) Desert. Notable exceptions seem to be: (1) the fisher-folk of the Murray River who enjoy special food advantages; (2) areas of postulated culture clash, such as in North-east Arnhem Land, Daly River and Boulia District, Queensland, where fragmentation seems to have taken place; and (3) possibly among the Kamilaroi and Wiradjuri, where especially widespread communities seem to have developed in relatively fertile country. In the last-named areas we seem to discern the beginnings of a more advanced type of political organisation.

Where boundaries for a tribe seem to be well established, the fact is indicated on the accompanying map by heavy broken lines. Where this boundary is based on good but insufficiently detailed information, dots indicate a probable boundary, while the absence of any indication points to absence of data. Two thicker lines, the one indicating the limits of dispersion of the custom of circumcision and the other of the less widespread rite of subincision, are also shown. The boundary for the last-named rite is fixed in the east, but is less satisfactorily established in the west, and is possibly not the same as the rather well-established line indicating the limits of circumcision rites.

Since there have been gross changes of boundaries in Post-European times, every endeavour has been made to indicate all these boundaries as they were immediately preceding the advent of white interference. The detailed subject of recent historic tribal movements may be discussed more fully elsewhere. Some tribal movements which at first sight seem entirely natural may have been brought about by release of population pressure through white interference, the change having its reaction in movements far beyond areas of white occupation.

In the Great Western Desert, there are seeming incoherencies imposed on tribal aggregation by the long and frequent dispersal of hordes and single families over a wide area. This dispersal alternates with irregularly occurring temporary contacts with other units of the tribe brought about by the necessity for finding succour at common watering places whenever the drying up of wells, etc., forces small parties to diverge from their normal beats. On the border of the tribal areas there may be a temporary mingling of tribes. This occasional necessity for making common cause with others in obtaining water and food supplies tends to develop or keep alive the widespread community of language, modes of living, and customs among the Desert tribes. It also leads to some fighting. It might be well argued that the groups called tribes in the Western Desert are not of the same political value as those found in other parts of Australia. Careful enquiry, however, suggests that they are equally valid, that the areas occupied are discrete and that the distributions are based on physiographic realities. Among the ['Pitjandjara] there is a native term meaning "anywhere is a camp," denoting that rare and brief period after heavy general rain when temporary waters are abundant. At this time the uttermost confines of the Desert may be visited, and the tribal territories might even seem to interdigitate or overlap. As soon as drier weather arrives, the people fall back on more permanent supplies of water. The most permanent are jealously husbanded against a dry period. The ['Pitjandjara] turn to deep sand soaks and rock-sheltered pools in the Mann and Petermann Ranges, the ['Jaŋkundjara] always returned towards the Everard Range waters (prior to the 1914 drought and the onset of pastoral settlement in 1919), for these had never previously in living memory failed them. Many ['ŋa:dadjara] go to Warupuju Spring in the Warburton Range which, they also claim, has never failed. Thus in ordinary dry times the tribal limits are rather rigidly defined, and it is only when unusual droughts occur that the limits are transgressed by other than native travellers. In this category may be included men carrying trade parcels, new songs, or dances, or accompanied by youths seeking potential fathers-in-law to initiate them by means of the rites of circumcision and subincision.

At Warburton Range our 1935 Anthropological Expedition unexpectedly witnessed the arrival of a horde of [Nan:a] or ['ŋan:adjara] folk who, having been driven east from the country about Lake Carnegie by lack of water, had made their first important eastward contact in a generation. A few of the visitors were known to the local ['ŋa:dadjara], the rest were strangers; the languages show dialectic differences. An inter-marriage had at one time occurred, but the bride had been a stolen one.

The well-timbered and mountainous areas of eastern Australia, cut into numerous isolated areas by the vagaries of the Great Dividing Range and its erosion planes and surfaces, have been responsible for the development of many tribal groupings; some of these have been seemingly preserved for relatively long periods of time.

In another place, Tindale and Birdsell have drawn attention to the presence of an important rain-forest or rain-scrub refuge area in the Cairns hinterland in Queensland where mixed peoples, whose physical type tends toward that of the primitive Tasmanians, have survived. They appear even to retain some cultural elements found principally in those extinct people. Of these Tasmanoid peoples about a dozen small tribes are now known.

Notes on Some North Australian Tribes

Tribes in the vicinity of Darwin became disrupted and dispersed before adequate enquiries were made, so that uncertainty exists regarding the status of some within the area north of a line joining Fog Bay, Mount Bundey, Mount Daniels, and Liverpool River, where tribes not practising circumcision formerly occurred.

Several foci of very early disturbance of the aborigines existed, such as on Melville Island, where a British military establishment was present at Fort Dundas for five years (from 1824 to 1829). At Raffles Bay from 1827, and later at Port Essington in 1838, there were also settlements which were later abandoned. Along the north coast of Arnhem Land there was much interference through the trading and fishing voyages of Malays. Earl (1846) indicates that every prau carried one or more aborigines among its crew, leading to early inter-tribal intercourse and changes on a scale not found elsewhere on the continent until modern times.

Accounts of the Malays and of the results of their visits have been given by Tindale (1925, 1928), Jennison (1927), and Warner (1933 and 1937). Slave-making raids from Portuguese Timor are believed to have occurred before 1818 (King, 1827), and occasional individuals of probable mixed Malay origin were reported among them when first noticed by European voyagers.

Stanner (1933 and 1937) has discussed tribes from the Daly River district, but there are synonyms among his names and he has not yet given adequate data to enable them to be differentiated. Tribes of the southern parts of North Australia are, on the whole, better known, except in a region west of Tennant Creek where the western limits of several are not defined.

For Arnhem Land tribal data are so conflicting that reference to original papers is recommended. In north-eastern Arnhem Land, neither Webb (1933) nor Warner (1931, 1937) have seemingly disentangled the skeins of hordes, languages, tribes, and sub-tribes. Warner, partly for convenience, chose a term Murngin for the people occupying the area east of a line drawn from Goyder River to Blue Mud Bay. He regarded the major unit as a tribe. Webb (1933) suggested that Murngin was a term applicable only to people belonging to the Jiritja moiety, and that it could not be regarded as a tribe in the sense acceptable in other parts of Australia. Warner (1937) did not directly discuss Webb's conclusions, and some uncertainty still exists. Meanwhile an historical interpretation of the published data may be indicated as follows:

Legends indicate that the focus of Murngin life formerly lay at Blue Mud and Caledon Bays. May we not, therefore, assume that a recent expansion of the former inhabitants of this district has occurred? During this period some of the Caledon Bay folk have moved out into surrounding areas, where there has been an absorption of surrounding tribes. In the process, some of the primitive Caledon Bay hordes have grown so large that each has become in effect a super-horde (the *mala* of the aborigines), thus developing virtually a new type of local organisation. Some of the horde elements still remain in the *mala*, although it is so much larger than the normal horde. Within the *mala* a more restricted organisation is now developing by the expansion of single families. In the place of the normal hordes there are now superfamilies.

During this postulated expansion of the Caledon Bay people, elements of several formerly distinct peripheral tribes may have been partly ingested in the *mala*, including the Ritarngo, Djinba, Jandjinung, Dai. They were relegated to the local organisation as parts of the *mala*. It may be noticed that in the case of the Djinba, one of these suggested peripheral tribes, the *mala* is coextensive with the tribal term as applied by Mara and other southern people.

This theory of the expansion of the horde to form a *mala* or superhorde might account for the retention among more southern tribes such as the Ngandi, Nungubuju, Ingura, and Mara of patterns of thought which regard the Ritarngo, Djinba, Dai, etc., as tribes equivalent to their own, even though these original tribal units may have become absorbed in the expansion of the people whom they now know as Balamumu.

Of the aggressiveness of the Balamumu there can be no doubt, and the present writer was, in 1920-21, witness of the fears of the Ingura men on Groote Eylandt when, for many months, they were under threat of invasion by Balamumu raiders.

Of the causes of the suggested expansion little is known, but Warner attributes the breaking down of older levels of Murngin culture to the stress of impact with the Malays.

Warner says that clans of both Dua and Jiritja moieties are present among the historical Balamumu, so that even today it could be regarded as a tribe in the normal Australian sense; nevertheless, the boundary between it and Murngin territory is poorly defined, and Webb, by applying the term Balamumu merely to one superfamily of one *mala* (the Djiring) belonging to the Dua moiety, shows that the available data are inconclusive and our knowledge is not yet sufficient for an understanding of the status of these "tribes."

Since Warner (1937) has not discussed Webb's (1933) data, the matter rests until further studies have been undertaken. For convenience, Warner's 1937 views are placed on the map.

Notes on Some Queensland Tribes

In 1939 Sharp gave a list of tribes in the north-eastern part of Queensland without definite localization beyond numbers on a sketch-map, of which the scale is too small to ensure correct placings. For most of the tribes he lists from south of the Nassau River the present writer had independent field data as to boundaries, etc. The present map was first compiled in August, 1939. In 1940 McConnel published additional data for Cape York with an excellent map, and also gave data for a coastal strip between Cooktown and Cairns. Most of her southern tribes are detailed also in the report of the present expedition. This was forwarded to Harvard for printing in September 1939; the reference is not yet to hand. Miss McConnel's new data has been taken into consideration as far as possible in the final stages of compiling this text. For detailed studies of Northern Cape York tribes original papers should be consulted, since the statements of Sharp, McConnel and Thomson seem to be in some ways conflicting. For about half the tribes the present writer has some independent information, chiefly obtained from dispersed members of these tribes; he has also visited the Princess Charlotte Bay district.

Acknowledgments

The author is indebted to Mr. and Mrs. J. B. Birdsell and Mrs. N. B. Tindale, his companions on the Harvard-Adelaide Universities Expedition, for their co-operation with him in these studies, which formed one section of the programme of the Expedition.

He is indebted to Professor E. A. Hooton who perceived the desirability of detailed studies of the full- and mixed-blood peoples of Australia, and whose interest made the expedition possible. Mr. S. J. L. Simmons, the draughtsman of the South Australian Lands Department, redrew the accompanying plan for reproduction, and its clarity is due to his painstaking care.

Summary

This paper gives a tribal map of Australia and a catalogue of the established tribes, based principally on recent field-work with additions from the literature. Wherever known the boundaries of each tribe are given, together with some of the more important references. The paper is an outcome of the combined Anthropological Expedition of the Department of Anthropology, Harvard University, and the University of Adelaide, 1938-1939.

QUEENSLAND TRIBES

'Ankamuti — Ankamuti

Loc.: From Cape York south-west to Vrilya Point; inland almost to head of Jardine River.

Alt.: Yumakundji (probably Jathaikana term).

Ref.: McConnel 1940, T.

'Arebe, 'A : rap — Araba

Loc.: At Retreat, Miranda Downs and Vanrook; south to Gilbert River; north to Staaten River and beyond; not further east than Emu Creek.

Alt.: Aripa, Ngariba (Walangama term).

Ref.: Sharp 1939, T.

'Atjinuri, 'Atjinadi — Atjinuri

Loc.: Upper Ducie River south to Upper Batavia River. The 'Ulwauwutyana (or Ebawudjena) are probably a part of this tribe.

Alt.: Adjinadi, Itinadyand.

Ref.: Sharp 1939, McConnel 1940, T.

'Ajabaða — Ajabatha

Loc.: From near Coen south to Upper Morehead River; east to Musgrave; west to headwaters of Coleman and Holroyd Rivers; at Ebagoola.

Alt.: Aiabadu, Aiyaboto, Koka Ai-ebadu.

Ref.: Thomson 1935, Sharp 1939, McConnel 1940, T.

''Ba : berem, 'Ba : baram — Barbaram

Loc.: Great Dividing Range, north to Mareeba, south to Mount Garnet; west to Alma-den (formerly a rain scrub dwelling people; now on sterile and rugged granite ranges).

Alt.: (Um)Barbarem, Wumbabaram (Tjapukai term), Woombarbarram, Booburam.

Ref.: Mathews 1898 (2), Richards 1926, Sharp 1939, McConnel 1940, T.

'Badjiri — Badjiri

Loc.: From Hungerford to Eulo on Paroo River; east to Barringun, Tinnenburra, Tuen and Cunnamulla; at Caiwarro and eastern side of Currawinya. Not west of Paroo River or at Thargomindah. (Not to be confused with Pitjara of headwaters of Warrego River).

Alt.: Baddyeri, Byjerri, Baderi, Poidgerry, Badjedi.

Ref.: Myles in Curr 1886, Looker in Curr 1886, Mathews 1898 (2), 1904, Kelly 1935, T.

(Baiali) — Baiali

Loc.: At mouth of Fitzroy River; on Curtis Island; at Keppel Bay, south to Calliope River and Gladstone.

Alt.: Byellee, Bieli, Byellel, Orambul.

Ref.: Curr 1887, Howitt 1904.

'Bakanambia, 'Wanbara, Kokolamalama — Bakanambia

Loc.: Southern and western shores of Princess Charlotte Bay; inland to tidal limits of Normanby and North Kennedy Rivers, at about Lakefield.

Alt.: Wanbara (alternative term), Kokolamalama (of southern tribes).

Ref.: Roth 1901, Hale and Tindale 1933, T.

(Bakanu) — Bakanu

Loc.: Upper Edward River.

Ref.: Sharp 1939.

'Bandjin, 'Bijai — Bandjin

Loc.: Hinchinbrook Island (but not on adjoining mainland).

Alt.: Bijai (language name).

Ref.: Tindale.

'Barada — Barada

Loc.: On Boomer Range from Fitzroy River north to Nebo; west to Mackenzie and Isaacs Rivers, and Bombandy.

Ref.: Tindale.

'Bar:ne, 'Parnabal — 'Barna

Loc.: Headwaters of Isaacs River, west to Denham Range; south to Cotherstone; at Grosvenor Downs.

Ref.: Tindale.

'Baruŋgam, 'Baruŋgama — Barunggam

Loc.: Head-waters of Condamine River east of Jackson to about Dalby; north to Dividing Range about Wongongera; south to Tara; at Chinchilla.

Alt.: Murrungama, Murrum-ningama.

Ref.: Mathews 1898 (1), T.

'Baruŋguan — Barunguan

Loc.: West side of Princess Charlotte Bay north to Cape Sidmouth.

Alt.: Baka (Kandju term), Banjigam (Bakanambia term), Entjinga (native name of place at mouth of Stewart River), Yintjangga, Yintyingga.

Ref.: Hale and Tindale 1933, Thomson 1933, 1934, McConnel 1940, T.

'Batjala, 'Batala — Batjala

Loc.: Fraser or Great Sandy Island. (Name means *sea folk;* the majority were transferred to Yarrabah, near Cairns, about 1902.) (Curr apparently does not distinguish between real inhabitants of Fraser Island and Kabi Kabi mission residents from the adjoining mainland.) (N.B.—On map Fraser Island is joined to mainland in error.)

Alt.: Badjela, Patyala.

Ref.: Curr 1886, Mathew 1910, Kelly 1935, T.

'Bidie, 'Biria — Bidia

Loc.: Western side of Thomson River and Cooper Creek, from Jundah to near Gilpeppie; east to Keeroongooloo; west to Whitula Creek (must not be confused with Biria of Bowen River).

Alt.: Birria, Piria.

Ref.: Curr and Fraser in Curr 1886, Mathews 1898 (1), T.

'Bigambul — Bigambul

See New South Wales List.

'Bindal — Bindal

Loc.: From mouth of Burdekin River north to Cape Cleveland; inland to Leichhardt Range; at Ayr.

Ref.: Tindale.

'Biria, 'Birigaba — Biria

Loc.: Bowen River north to junction with Burdekin River; east to Clarke Range; west to Leichhardt Range; south to Netherdale. (Not to be confused with Bidia of South-west Queensland.)

Alt.: Birigaba, Breeaba.

Ref.: Hodgkinson in Curr 1886, Kelly 1935, T.

'Bitjara — Bitjara

Loc.: At Bulloo Downs; north to Orient, west to Grey Range; east to Clyde, south to Bulloo Lake floodplain. (Not to be confused with Pitjara of Upper Warrego River, C. Queensland, or Badjiri of Paroo River.)

Alt.: Bithara.

Ref.: Myles in Curr 1886, T.

'Buluwai, 'Buluwandji — Buluwai

Loc.: East of Tolga on crest of Coast Range; north to Kuranda (rain forest dwellers).

Alt.: Bulwandji.

Ref.: McConnel 1940, T.

'Dal:a, 'Djal:a — 'Dalla

Loc.: Sandgate north to Noosa; inland to Woodford; at Nambour.

Alt.: Mooloola (place name, now Mooloolabar).

Ref.: Westaway and Landsborough in Curr 1887, T.

'Darembal — Darambal

Loc.: Arthur Point along east side of Normanby Range (Pine Mount) to mouth of Fitzroy River and Keppel Bay; inland to Boomer Range (other information suggests an extinct tribe at foot of Range); at Marlborough, Yeppoon, Yaamba, Rockhampton and Gracemere.

Alt.: Tarumbal, Tarumbul, Charumbul.

Ref.: Archer in Curr 1887, Roth 1901, Howitt 1904, T.

(Djagaraga) Djagaraga

Loc.: Cape York south to Escape River.

Alt.: Dyagaraga, Gudang (horde name), Kekosino (horde name).

Ref.: Jardine in Curr 1886, Sharp 1939, McConnel 1940.

'Djaku:nde Djakunda

Loc.: Between Upper Boyne and Auburn Rivers; north to Hawkwood; south to Dividing Range.

Ref.: Tindale.

'Djankun, 'ŋaikuŋu Djankun

Loc.: From Mount Mulligan south to Alma-den; east to Dimbula near head of Walsh River; west to Mungana.

Alt.: Chungki, Chunkunbura, Chunkunberry, Shanganburra, Koko-tjangun (Koko-jelandi term), Kokomutju (northern term), Mutju, Ngaikungo.

Ref.: Mathews 1898 (2), Richards 1926, Sharp 1939, McConnel 1940, T.

'Djiru:, I:mba Djiru

Loc.: Clump Point and vicinity; north to Murdering Point; south to mouth of Tully River (rain forest dwellers with social organisation of dual type; not to be confused with inland Djirubal).

Ref.: Tindale.

'Djirubal Djirubal

Loc.: Herberton south to headwaters of Herbert River north of Cashmere; at Ravenshoe, Millaa Millaa and Woodleigh; east to Tully Falls. (Plateau rain forest dwellers with social organisation of four-class type; not to be confused with the coastal Djiru; erroneously placed on Davidson's map.)

Alt.: Tjirbal, Chirpalji.

Ref.: Roth 1910 (18), Sharp 1939, T.

E'wamin, ''Gwamin, E'gwamen Agwamin

Loc.: Head of Einasleigh and Copperfield Rivers; north to Georgetown, east to Dividing Range, west to Oak Park and Forsayth. (Sharp's fragmentary data apparently did not permit his recognition of the unity of this tribe.)

Alt.: Ak Waumin, Wamin, Wommin, Waumin, Wawmin, Walamin.

Ref.: Roth 1897, Sharp 1939, T.

'Gia Gia

Loc.: Bowen to St. Helens; inland to Clarke Range; at Proserpine, Cape Gloucester and Repulse Bay; not at Cape Conway.

Alt.: Kia, Bumbarra (place name; probably a horde).

Ref.: Shea in Curr 1886, Roth 1903 (5, p. 22), T.

'Giabel, 'Gomaiŋguru Giabal

Loc.: Between Allora and about Dalby, east to Gatton; west to Millmerran. (Data from adjoining tribe only; compare Kwiambal in N.S.W. List.)

Ref.: Tindale.

'Goeŋ Goeng

Loc.: From south end of Port Curtis to Kolan River, inland to Lowmead, Miriam Vale and Baffle Creek.

Alt.: Goonine, Meeroni, Maroonee.

Ref.: Palmer 1884, Mathews 1898 (1), T.

'Gulŋai Gulngai

Loc.: Tully River below Tully Falls, and Murray River; south to range above Kirrama. (Inland rain forest dwellers.)

Alt.: Mallanpara, "Tully blacks."

Ref.: Roth 1910 (18), T.

'Idindji Idindji

Loc.: Babinda north to Gordonvale; inland to Lake Barrine; a lowland strip fronting Main Range from Gordonvale north to near Cairns; east to Prior Range. (Rain forest dwellers).

Alt.: Yidindji, Yidindyi.

Ref.: Roth 1910 (18), Sharp 1939, McConnel 1940, T.

'I:lba Ilba

Loc.: On Cape River west to Dividing Range; north probably to Goldsborough; east to about Suttor River; south to Lake Buchanan and beyond; at Natal Downs.

Alt.: Yukkaburra, Mungerra (horde names); Eneby (said to be language name).

Ref.: Armstrong, Tompson and Chatfield in Curr 1887, T.

'Indjilindji Indjilindji

See North Australian List.

'Iniŋai Iningai

Loc.: West of Dividing Range to Maneroo Creek and Longreach; south to Mexico or beyond; north to Muttaburra, Bowen Downs and Aramac (some moved west to Alpha in later years; the Wadjabangai may be a subtribe; the Yankibura of Howitt are probably a horde of Kungkari and placed too far east on his map).

Alt.: Muttaburra (horde name), Moothaburra, Mootaburra.

Ref.: Bennett 1877, Palmer 1884, Mathews 1898, Howitt 1904, T.

'Irukandji Irukandji

Loc.: Narrow coastal strip from Cairns to Port Douglas (Mowbray River); on tidal waters of Barron River at Redlynch.

Alt.: Yirkandji.

Ref.: Richards 1926, Sharp 1939, McConnel 1940, T.

'I:tu Ithu

Loc.: Noble Island and islands off Barrow Point (data scant; possibly a horde of Mutumui).

Alt.: Wurkuldi.

Ref.: Hale and Tindale 1933, T.

'Kabelbara Kabalbara

Loc.: West of Mackenzie and Isaacs Rivers to Peak Range; north nearly to Cotherstone (Howitt's term, written Jeti-marala, might be the proper name; my informant knew only the above, which appears to be one applied to a horde of the tribe).

Alt.: ? Yetti-maralla.

Ref.: Howitt 1904, T.

'Kabi'kabi — Kabikabi

Loc.: Maryborough district; north to Childers and Hervey Bay; south to head of Mary River and Cooroy: west to Coast Range and Kilkivan; at Gympie; not at Fraser Island.

Alt.: Kabi, Karbi, Dippil (general term embracing several tribes in S.E. Queensland).

Ref.: Ridley 1866, Mathew in Curr 1887, Howitt 1904 (horde names only), Mathew 1910, 1914, T.

'Kairi — Kairi

Loc.: Springsure north to Capella; west to Drummond Range; east to Comet and Mackenzie Rivers [the Khpararya (Kelly, 1935) are shown in about the same position as is this tribe].

Ref.: Tindale.

'Kalali — Kalali

Loc.: Eulo west to Thargomindah and Bulloo River; upstream to Norley; south to Orient, Clyde and Currawinya.

Alt.: Kullalli, Kullally.

Ref.: Mathews 1905 (2), Kelly 1935, T.

'Kalibamu — Kalibamu

Loc.: Between Leichhardt River and Morning Inlet; inland to Floraville and Punchbowl.

Ref.: Tindale.

'Kalkaduŋe, 'Kalkeduŋ — Kalkadung

Loc.: West of Cloncurry to Mount Isa; south to Duchess and Selwyn Range; at head of Cloncurry River; north to Glenroy.

Alt.: Kalkatongo, Kalkadoon, Kulkadoon, Kalkaladoona, Muntaba (Maithakari term for southern Kalkadung), Rungkari (Maithakari term for northern Kalkadung), Roongkari.

Ref.: Palmer 1884, Urquhart in Curr 1886, McGillivray in Curr 1886, Roth 1897, T.

'Kambuwal, 'Gambabal — Kambuwal

Loc.: Inglewood to Bonshaw, N.S.W.; north to Millmerran; on western Slope of Dividing Range.

Alt.: Kambuwal, Kaoambal.

Ref.: MacPherson 1905, Kelly 1935, T.

'Kandju — Kandju

Loc.: Headwaters of Archer River; on tableland from Coen north to head of Lockhart and Batavia Rivers; east to coastward slope of McIlwraith Range; west to Geikie Range and edge of plateau.

Alt.: Kanju, Kandyu, Kantju, Kanyu, Karnju, Karntju, Karnyu, Karnu, Kamdhue.

Ref.: Mathews 1900 (5), McConnel 1932, 1940, Hale and Tindale 1933, Thomson 1933, T.

'Ka:ŋulu Kangulu

Loc.: Dawson River south to Banana and Theodore; west to Mackenzie River, Comet River and northern end of Expedition Range; north to junction of Isaacs and Mackenzie Rivers; at Blackwater and Dingo. The Don River, Mount Morgan, east of Banana and about Rannes may have belonged to a separate tribe (east of Gogango Range, west of the Coast Range).

Alt.: Kaangooloo, Khangalu, Kongulu, Kongalu, Konguli.

Ref.: McIntosh in Curr 1887, Howitt 1904, Kelly 1935, T.

'Karendala Karendala

Loc.: On Cooper Creek at Durham Downs; north to Mount Howitt, east to McGregor Range and to Eromanga. (The Kurnandaburi of Howitt probably this tribe, but may be the Kungadutji.)

Alt.: Kurnanda buri, Kunanda-buri.

Ref. Howitt 1891, 1904, Mathews 1905, T.

'Karanja Karanja

Loc.: At Bedourie and King Creek; south to Cluny; west to Mount David (Moorabulla); on Georgina River.

Alt.: Kurrana (['karana] = man), Mooraboola, Moorloobullo, Ooloo pooloo, Ngulubulu.

Ref.: Machattie in Curr 1886, Roth 1897, Elkin 1931, T.

'Karawa Karawa

See North Australian List.

'Karbuŋga Karbungga

Loc.: Jeannie River (data scant; may be a horde of Mutumui, which see).

Ref.: Tindale.

'Kariŋbel Karingbal

Loc.: Headwaters of Comet River from below Rolleston to the Carnarvon Range; west to Consuelo; east to Expedition Range and Bedourie (separate from Kangulu; Davidson's placings of this and neighbouring tribes are based only on Kelly's sketch map showing Emerald fifty miles out of position with respect to Springsure).

Alt.: Kaingbul, Karranbal, Kanoloo.

Ref.: Josephson in Curr 1887, Kelly 1935, T.

'Karundi Karundi

Loc.: Mouth of Norman River; west of Normanton to Flinders River, inland to Milgarra.

Alt.: Karunti, Kurandi, Karrandee, Kutanda (alternative name; also a "local group" t. Sharp).

Ref.: Armit in Curr, 1886, Sharp 1939, T.

'Karuwali Karuwali

Loc.: Farrar Creek from near Connemara south to Beetoota, Haddon Corner and Morney Plains; west to Durri and Monkira on Diamantina River; east to Beal Range. (The Tunberri of Curr are probably part of the same tribe.)

Alt.: Karawalla, Kurrawulla, ? Karorinje.

Ref.: Anon. in Curr 1886, Mathews 1898 (1), Elkin 1931, T.

'Kaura'reg — Kaurareg

Loc.: Prince of Wales Island and south-western islands of Torres Straits.

Alt.: Kowrarega, Kauralaig.

Ref.: Haddon 1904, Sharp 1939, McConnel 1940, T.

'Ka: wadji — Kawadji

Loc.: Night Island and on coast opposite (may include the Ombila, which see).

Alt.: Yankonyu, "Night Island." Kawadji (Kandju term also).

Ref.: Hale and Tindale 1933, Thomson 1934, T.

'Keinjen — Keinjan

Loc.: Stanthorpe north to about Hendon, east to Dividing Range; west to beyond Thane.

Alt.: Gee-enyun.

Ref.: McPherson 1905, T.

'Keramai — Keramai

Loc.: Rockingham Bay south to Cardwell; north to near Murray River, west to Cardwell Range (open forest dwellers).

Alt.: Kiramai, Wombelbara (Warkamai term).

Ref.: Cassady in Curr, 1886, Mathew 1926, T.

'Koa, 'Goamalku — Koa

Loc.: Headwaters of Diamantina north to Kynuna, west to Middleton and Hamilton River divide; east to Winton and Sesbania; south almost to Cork.

Alt.: Goa, Goamulgo.

Ref.: Bennett 1877, Curr 1887, Roth 1897, Kelly 1935, T.

'Koamu, 'Oamu — Koamu

Loc.: South of St. George on Balonne River, to Angledool and Brenda; west to Bollon and Nebine Creek; at Dirranbandi. (Macpherson confused this tribe with portion of Kamilaroi).

Alt.: Kuam, Kaoambal.

Ref.: Macpherson 1905, Kelly 1935, T.

'Koenpel, 'Djandai — 'Koenpal

Loc.: Southern two-thirds of Stradbroke Island. (The Nunukul, which see, occupy northern portion.)

Alt.: Goenpul, Jandai, Tchandi, Jundai.

Ref.: Watkin in Curr 1887, Roth 1901 (1), T.

'Koinjmal, 'Koinjmurbare — Koinjmal

Loc.: West of Normanby Range (Pine Mt.) to Styx; on Broad Sound north to Cape Palmerston along a narrow coastal strip; inland to Coast Range; south to Marlborough (misprinted as Maryborough in Curr).

Alt.: Kooinmerburra, Kungmal, Kungalburra.

Ref.: Budgeman, Bucas and Muller in Curr 1887, Mathew 1898 (2), Kelly 1935, T.

'Koko'bididji Koko-bididji

Loc.: Headwaters of East Normanby River; at King Plains, south to headwaters of Daintree River.

Alt.: Kokobididyi, Koko Piddaji.

Ref.: Roth 1910 (18), McConnel 1931, 1940, Sharp 1939, T.

'Koko'bujundji Koko-bujundji

Loc.: Annan River; south to Rossville; west to Annan-Normanby Divide. N.B.—Accidentally omitted from map; occupies northern half of area indicated as for Jungkurara.

Alt.: Kokonyungal.

Ref.: Roth 1910 (18), McConnel 1931, 1940, T.

'Kokodaue Koko-daua

Loc.: North of Staaten River (boundaries not well defined).

Ref.: Sharp 1934, 1939, T.

'Koko'imudji Koko-imudji

Loc.: From Endeavour River (Cooktown) north to south side of Cape Flattery; inland to Battle Camp and Welcome; at Cape Bedford.

Alt.: Kokojimoji, Kokoyimidir.

Ref.: Roth 1910 (18), McConnel 1931, 1940, T.

'Koko'kuluŋgur Koko-kulunggur

Loc.: Mossman north to Daintree; inland to Mount Carbine.

Alt.: Koko-yalung.

Ref.: McConnel 1940, T.

'Koko'mini, A'kunkun Koko-mini

Loc.: Middle Palmer and Mitchell Rivers west to about their junction; east to Mount Mulgrave and Palmerville.

Alt.: Koko-minni, Kookaminnie, Koogaminny, Mirkin, Akunkun, Akoon-koon, Akoonkool.

Ref.: Palmer 1884, Palmer in Curr 1886, Roth 1910 (18), Richards 1926, McConnel 1931, Hale and Tindale 1933, Sharp 1939, T.

'Koko'njekodi Koko-njekodi

Loc.: Starcke River; west nearly to Port Murdoch; south-east to Cape Flattery; at Munburra. N.B.—On map name is a little too far south.

Alt.: Koko-negodi.

Ref.: Roth 1910 (18), Hale and Tindale 1933, T.

'Koko'patun Koko-patun

Loc.: East of Great Dividing Range, south of Mount Garnet; east to Burdekin River; south to Dry River.

Ref.: Sharp 1939, T.

('Koko'pera) Koko-pera

Loc.: About north of mouth of Nassau River.

Ref.: Sharp 1939.

'Koko'walandja — Koko-walandja

Loc.: Head of East Normanby River; west to Dividing Range (scant data only).
Alt.: Koko Katji (of Koko-jelandji).
Ref.: McConnel 1940, T.

'Koko'wara — Koko-wara

Loc.: Normanby River from Lakefield south to Laura and Laura River (the proper name has probably not been determined; Kokowara means "rough speech").
Alt.: Kookoowarra, "Laura-Deighton" tribe.
Ref.: Mathews 1898 (2), Roth 1910 (18), McConnel 1931, Hale and Tindale 1933, Sharp 1939, T.

'Koko'jawa, 'Djauen, 'Koko'rarmul — Koko jawa

Loc.: East of Morehead River to Laura; south to Great Dividing Range; Upper Hann and Kennedy Rivers.
Alt.: Jouon, AkuRarmul.
Ref.: Roth 1897, Hale and Tindale 1933, T.

'Koko'jelandji — Koko-jelandji

Loc.: Head of Palmer River, east of Palmerville; south and west of Dividing Range to Upper Mitchell River; east to Byerstown.
Alt.: Kokoyellanji, KokoYerlandji, Koko-yerlantji, Koko-yerlantchi.
Ref.: Roth 1910 (18), McConnel 1931, 1940, Sharp 1939, T.

'Kona'ni : n, 'Koko'papuŋ — Konanin

Loc.: South of Nassau River mouth (boundaries not yet defined).
Alt.: Gunanni, ? Goonamon, Kokopapung, Kokopapun (misprint).
Ref.: Mathews (1899), Roth 1910 (18), Sharp 1934, 1939, T.

'Koŋabula, 'Oŋebula — Kongabula

Loc.: Headwaters of Injune and Dawson Rivers above their junction; east and north of Dividing Range; south of Carnarvon Range.
Alt.: Khungabula.
Ref.: Kelly 1935, T.

'Koŋkandji — Kongkandji

Loc.: Cape Grafton Peninsula west of Prior Range, south to mouth of Mulgrave River.
Alt.: Kunggandyi, Kungganji, Kungandji
Ref.: Mathews 1898 (2), Roth 1910 (18), McConnel 1935, 1940, T.

'Koreŋgoreŋ — Korenggoreng

Loc.: West bank of Upper Burnett River from Mundubbera north to Monto and Many Peaks; west to Dawson River; at Theodore and Hawkwood (not to be confused with Goeng).
Alt.: Curang gurang, Gurang-gurang, Goorang goorang, Koreng-koreng.
Ref.: Marrett 1910, Mathews 1914, 1926, Brown 1918, Kelly 1935, T.

'Kukatji Kukatji

Loc.: From Donor Hills north to Gulf of Carpentaria; at Inverleigh and Tempe Downs.

Alt.: Kukatja.

Ref.: Sharp 1939, T.

'Kulumali, 'ŋule'ŋulanji Kulumali

Loc.: Near and east of Windorah. This is the easternmost circumcising tribe in Queensland.

Ref.: Tindale.

'Kuŋadu:tji Kungadutji

Loc.: Cooper Creek north of Durham Downs, east to Mount Howitt and Kyabra Creek; north to near Lake Yamma Yamma.

Alt.: Kungaditji, Kungarditchi, Kunatatchee.

Ref.: Heagney in Curr 1886, Mathews 1898 (1), Elkin 1931, T.

Kuŋgere Kunggara

Loc.: From Karumba north to Delta Downs; inland to Midlothian and Lotus Vale.

Alt.: Koonkurri, Ungorri.

Ref.: Palmer in Curr 1886, Roth 1903 (5, p. 39), Sharp 1939, T.

'Kuŋgari Kunggari

Loc.: Upper Nebine and Mungallala Creeks north of Bonna Vonna and Bollon, to Morven. Extended eastward and absorbed the Mandandanji in early historic times; not to be confused with the Kuungkari of Barcoo River.)

Alt.: Kungeri, Kungri, Ungorri.

Ref.: Ridley 1875, Kelly 1935, T.

'Kuŋkalenja Kungkalenja

Loc.: On Georgina River north of Bedourie; from Moorabula west to near Mulligan River; north to about Talaera Springs (scant data only available).

Alt.: Kunkulenje, Koonkoolenya, Koomkoolenya.

Ref.: Roth 1897, T.

'Ku:ŋkari, 'Kuŋhari, 'Ku:ŋka:i Kuungkari

Loc.: On Thomson and Cooper (Barcoo) Rivers west to Jundah; north to Westland and near Longreach; east to Avington, Blackall and Terrick Terrick; south to Cheviot Range, Powell Creek and Welford. Not to be confused with Kunggari of Upper Nebine Creek. N.B.—On map final i of Ku:ŋkari has been misprinted in green.

Alt.: Koonkerri, Kungeri, Koongerri; Yangeeberra, Yankibura.

Ref.: Ahern and Heagney in Curr 1886, Mathews 1898 (1), Howitt 1904, Kelly 1935, T.

'Ku:nja Kunja

Loc.: Warrego River from Cunnamulla north to Augathella and Burenda; west to Cheepie; east to Morven and Angellala Creek.

Ref.: Tindale.

'Kutebal Kuthabal

Loc.: Middle Staaten River; south to about Emu Creek (not to be confused with Kutjal).

Ref.: Tindale.

'Kutjel, 'Kuritja:l — Kutjal

Loc.: Upper Staaten and Middle Einasleigh Rivers; north to about Lynd River, south to about Lane Creek (not to be confused with Kutjala, which were probably originally a detached segment of this tribe).

Alt.: Koochulburra, Okuntjel.

Ref.: Mathews 1898, Sharp 1939, T.

'Kutjale — Kutjala

Loc.: Mount Sturgeon, Mount Emu Plains; Lolworth and Reedy Springs along both sides of Dividing Range; eastern boundary not defined (moved south to Hughenden and Pentland in early days of settlement).

Ref.: Tindale.

'Laia — Laia

Loc.: North of Palmer River, east to Dividing Range; west to head of Alice River.

Alt.: Koko Laia, Kokowara (Koko-jelandji term; means *poor* or *bad* speech), ? Koogobatha, Koogobathy.

Ref.: Palmer 1884, Mathews 1898 (2), Sharp 1939, T.

'Lardi:l, 'Kun:e'na — Lardil

Loc.: Mornington Island and Forsyth Islands.

Alt.: Laierdila, Kunana (native name for Mornington Island).

Ref.: Sharp 1935, 1939, T.

(Lo:tiga) — Lotiga

Loc.: Upper Dulhunty River and McDonnell.

Alt.: ? Okara.

Ref.: Sharp 1939, McConnel 1940.

'Maikuduŋ — Maikudung

Loc.: Upper Leichhardt River; north to Augustus Downs; south to Mount Cuthbert; western boundary not well defined. (Similarities between the name of this tribe and Maikulung and Maithakari have been sources of confusion.)

Alt.: Mygoodan, Mayagoondoon, Mikoolun (*sic* Roth 1897; probably misprint).

Ref.: Armit in Curr 1886, Palmer in Curr 1886, Roth 1897, T.

'Maikulan, 'Maikuluŋ — Maikulung

Loc.: Middle Norman, Yappar and Clara Rivers; north to Milgarra; east to Gregory Range. (In early historic times moved partly to the coast about Normanton, where they have been thought to be indigenous).

Alt.: Mygoolan, Mykoolan, Micoolan, Mikkoolan.

Ref.: Armit in Curr 1886, T.

'Maiðakari, 'Maidakadi — Maithakari

Loc.: From Cloncurry north to Canobie on Cloncurry River; east to Julia Creek junction, and Mount Fort Bowen.

Alt.: Maitakudi, Mayatagoorri, Mythugadi, Mythuggadi, Mythaguddi, Mit(t)agurdi, Mitagurdi, Mitakoodi, Mitro(o)-goordi, Mitakudi.

Ref.: Palmer 1884, Palmer in Curr 1886, Roth 1897, Strehlow 1910, Sharp 1939, T.

'Maijabi — Maiabi

Loc.: On Cloncurry River south to Canobie, north to just above Donor Hills, at Numbera (Conan Downs); east to midway between Flinders and Saxby Rivers; west to Upper Dismal Creek and Leichhardt-Cloncurry Divide.

Alt.: Myabi, Miappe, Myappe, Miubbi.

Ref.: Armit and Palmer in Curr 1886, Roth 1897, T.

'Malunnde — Malununda

Loc.: Bentinck Island (these people have remained free from contact with Europeans; the name given is as from a Lardi:l informant at Palm Island. Sharp's information is similar).

Alt.: Marlanunda, Maldanunda.

Ref.: Sharp 1939, T.

'Ma:mu — Mamu

Loc.: Johnstone River; at Innisfail; inland to Nerada and Coast Range; south to Murdering Point (rain forest dwellers).

Ref.: Tindale.

'Mandandanji — Mandandanji

Loc.: Maranoa and Balonne Rivers north of St. George; west to Bollon and Wallan Creek; north to Donnybrook, Orallo, Yuleba and Dividing Range; east to Alton and Glenmorgan. (Amalgamated with Kunggari in early days of white occupation; now not always distinguished.)

Ref.: Tindale.

'Mare'ŋanji, 'Marukanji — Marnganji

Loc.: Quilpie to Cheepie and Beechal, thence Paroo River to Eulo; on Bulloo River south to Thargomindah; at Dynevor Downs and Ardoch.

Alt.: Murngain, Murgoin, Murgoan.

Ref.: Myles in Curr 1886, Mathews 1898 (1), Kelly 1935, T.

'Marulta — Marulta

Loc.: At Lake Barrolka; south to Lake Yamma Yamma; west to Beal Range; north-east towards Opalville and Cooper Creek, eastern boundary uncertain. (The place name Barrolka may be an anglicisation of Marulta.)

Alt.: Marula.

Ref.: Howitt 1904, Strehlow 1910, Elkin 1931, T.

'Maule — Maula

Loc.: Roxborough Downs north to Carandotta and Urandangie on the Georgina River; on Moonah Creek to near Rochedale, south-west to Pituri Creek; at Wolga.

Alt.: Wolga (locality name), Waloo-kera, Wollegarra, Elookera, Yunnalinka (? horde at Carandotta).

Ref.: Curr 1886, Roth 1897, T.

'Majuli — Majuli

Loc.: On Diamantina River from Davenport Downs and Diamantina Lakes to Cork; Mayne River and Vergemont Creeks east to Tocal and Carella; west to Springvale.

Alt.: Miorli.

Ref.: Roth 1897, T.

(Mbeiwum) Mbeiwum

Loc.: Upper Watson River; at Merluna.

Alt.: KokMbewam.

Ref.: Sharp 1939, McConnel 1940.

'Mian Mian

Loc.: Lower Belyando River north to Mount Douglas; at Bulliwallah; west to Dividing Range; south to somewhere beyond Labona. (mian = men).

Alt.: Munkibura.

Ref.: Bennett 1877, Howitt 1883, 1888, 1904, T.

'Min'gin (not Miŋin) Mingin

Loc.: Barkly (Barclay) River south of Burketown; west of Leichhardt River; south to Gregory Downs. (Sharp said this tribe was extinct; a few are still living, having migrated to the east coast).

Alt.: Minkin, Myngeen.

Ref.: Palmer 1884, E. Curr in Curr 1886, Sharp 1939, T.

'Minjeŋbal Minjangbal

Loc.: From Southport south to Cape Byron, New South Wales; inland to Murwillumbah and Nerang Creek. (minjang = *what*, lit. "people who say minjang." mi:bin = man).

Alt.: Minyung.

Ref.: Bray, Fowler, O'Connor and Prior in Curr 1887, Schmidt 1919, T.

'Mitaka Mittaka

Loc.: From Durri north to Cluny; east to Monkira; about Lake Machattie.

Alt.: Mittuka.

Ref.: Reese 1927 (ms), T.

'Mitjamba, 'Kumbulmara Mitjamba

Loc.: On Woolgar and Stawell Rivers; north to Gledswood, west to Saxby Downs, east to Chudleigh Park; south to Cambridge Downs.

Ref.: Tindale.

'Morowari Morowari

See New South Wales List.

'Muluridji Muluridji

Loc.: Headwaters of Mitchell River, north to Mount Carbine, east to Rumula; south to Mareeba; west to Woodville.

Alt.: Molloroiji, Mularitchee, Koko-moloroitji (Koko kulunggur term), Koko-moloroiji.

Ref.: Mathews 1898 (2), McConnel 1931, 1940, Sharp 1939, T.

(Mu:tjati) Mutjati

Loc.: Shelburne Bay north to about Orfordness.

Alt.: Mutyati.

Ref.: McConnel 1940.

'Mutumui, 'Baulam, 'Basθom Mutumui

Loc.: From Bathurst Bay and Cape Melville south to Starcke River.

Alt.: Baulam (Bakanambia term), Basthom (Bakanambia variation, ? individual).

Ref.: Hale and Tindale 1933, T.

'Newegi — Nawagi

Loc.: South-west of Herbert River; principally on high ranges (rain forest dwellers; contrast with Warkamai who live in coastal "dry" forest country).

Ref.: Tindale.

'ŋandaŋara — Ngandangara

Loc.: Upper Wilson River; north to Eromanga and beyond; south to Nockatunga.

Alt.: Eromarra (? place name).

Ref.: Myles in Curr 1886, T.

'ŋaro, 'ŋalaŋi — Ngaro

Loc.: Whitsunday Island; ranging over Cumberland Islands; also to mainland at Cape Conway and on mountains east of Proserpine; (ironbark canoes used for journeying between the islands).

Ref.: Tindale.

(ŋathokudi) — Ngathokudi

Loc.: South side of Upper Ducie River.

Alt.: (Ng)uthukuti, Athokurra.

Ref.: Thomson 1932, Sharp 1939, McConnel 1940.

'ŋatjen — Ngatjan

Loc.: From Atherton east to Upper Russell River; at Malanda and Millaa Millaa (rain forest dwellers, principally on plateau).

Alt.: Ngachanji, Ngaitjandji.

Ref.: Roth 1910 (18), Sharp 1939, McConnel 1940, T.

ŋaun — Ngaun

Loc.: At Iffley, Taldora and Millungera; east to Gregory Range and Saxby Downs; on upper Norman River; west to Julia Creek. (In early historic times many migrated towards Cloncurry district).

Alt.: Nouun, Naungaun.

Ref.: Roth 1897, Armit in Curr 1886, T.

(ŋgerikudi) — Nggerikudi

Loc.: From Dulhunty River north to about Vrilya Point (Cockatoo Creek); at Skardon Creek.

Alt.: Ngkamadyi, Ngammatti, Gamete, Gamiti, Gametty.

Ref.: Roth 1910 (18), Thomson 1933, McConnel 1940.

(ŋgerikudi) — Nggerikudi

Loc.: Between Pennefather and Batavia Rivers (for discussion of a polyglot series of allied hordes or small subtribes between Pennefather and Watson Rivers, see McConnel, *l.c.* p. 61-62).

Alt.: Ngerikadi, Yupngit, Yupungati, Yopngadi.

Ref.: Roth 1903 (1), 1910 (18), Sharp 1939, McConnel 1940.

(ŋoborundji) — Ngoborundji

Loc.: Southern headwaters of Gregory River, at Morstone and Mount Margaret.

Alt.: Ngoborindi, Ngoboringi, Oboroondi, Obor-indi.

Ref.: Roth 1897, Sharp 1935.

'ŋoera Ngoera

Loc.: Head-waters of Brisbane River; at Nanango; east to Durundur (ten miles east of Kilcoy); south probably to south of Toogoolawah; west to Haden and Bell; on Bunya Mountains.

Alt.: Njalbo (northern term for this and other Moreton Bay tribes), Kaiabara.

Ref.: Landsborough and Curr 1887, Howitt 1888, 1904, Mathews 1898 (1), T.

'ŋundjen, 'Koko'kuntjan Ngundjan

Loc.: South of Alice River; on lower Mitchell River; at Dunbar.

Alt.: Koonjan, Okundjain, ? Koko Wansin.

Ref.: Mathews 1899, Roth 1910 (18), Sharp 1934, 1939, T.

'ŋurawola Ngurawola

Loc.: At Arrabury and Durham Downs and western vicinity (data scant).

Ref.: Strehlow 1910, T.

'ŋuri Nguri

Loc.: Upper Maranoa River from Donnybrook north to Merivale on west side of Dividing Range; west to Hillside and Redford. (Not on Upper Warrego, as stated by Mathews.)

Alt.: Gnoree.

Ref.: Mathews 1898 (1), T.

(ŋwataiŋeti) Ngwataingeti

See Winduwinda.

'ŋugi: Ngugi

Loc.: Moreton Island.

Alt.: Wogee, Goowar, Gooar.

Ref.: Watkin in Curr 1887, T.

(Nunukul), 'ŋundjen Nunukul

Loc.: Northern portion of Stradbroke Island (an informant, not of the tribe, gave name as Ngundan). N.B. Name omitted from map.

Alt.: Noonukul, Moondjan.

Ref.: Watkin in Curr 1887, (T).

(Njuwathai) Njuwathai

Loc.: Middle Batavia River. N.B.—Name omitted from map.

Alt.: Nyuwathayi.

Ref.: McConnel 1940.

(Oikand) Oikand

Loc.: Probably about Old Koolatah.

Alt.: KokoWanggara (term applied by other tribes).

Ref.: Sharp 1934, 1939.

(Okerlika) Okerlika

Loc.: Probably about Lotus Vale.

Ref.: Sharp 1939.

'Olkulo, 'Olkolo Olkulo

Loc.: Middle Coleman River; south to Crosbie Creek.

Alt.: Koko Olkolo, Olkolo.

Ref.: McConnel 1932, 1940, Thomson 1933, Sharp 1939, T.

'Ombi:le Ombila

Loc.: Cape Sidmouth and north nearly to Night Island. (This is probably only a horde of the Kawadji, of Night Island, which see.)

Alt.: Ompeila, Ompela, Umpilo.

Ref.: Thomson 1933, 1934, Sharp 1939, McConnel 1940, T.

'O:tati Wotati

Loc.: Southern part of Shelburne Bay; east and south to Macmillan River.

Alt.: Wotati, Otati, Wutati, Wotadi.

Ref.: Roth 1903 (5, p. 26), Thomson 1933, 1934, Sharp 1939, McConnel 1940, T.

'Pakadji Pakadji

Loc.: Cape Weymouth, Pascoe River and ? Temple Bay.

Alt.: Koka-yao (term applied by southern tribes), Yao.

Ref.: Thomson 1934, T.

'Pitapita Pitapita

Loc.: Boulia and fifty miles to south and west. Under this is grouped an indeterminable series of sub-tribes or other groups. Roth is the principal authority. He suggests tribal fragmentation and reintegration as having been formerly in progress; the situation may be comparable with that in the Murngin area of Arnhem Land and the Daly River district. Among the groupings not indicated on the map are the Boinji, Dungadungara, Kwokwa, Rungo Rungo, Tinkatinki, Weelko, Njuntauntaya; other peripheral ones about which there is more information, are marked.

Alt.: Pittapitta, BittaBitta.

Ref.: Eglinton in Curr 1886, Roth 1897, T.

'Pitjare Pitjara

Loc.: Head-waters of Nogoa and Warrego Rivers; south to Caroline; east to Killarney and Chesterton; west to Nive River. (Not to be confused with Badjiri of Lower Warrego River or Bitjara of south west Queensland. Some evidence suggests that late prehistoric eastward movement of tribes south of Charleville caused division of Pitjara and Badjiri; they are now separate tribes.)

Alt.: Bidjera, Peechera.

Ref.: Conn, Playford and Hollingworth in Curr 1887, Kelly 1935, T.

'Po:ntunj Pontunj

Loc.: From Cape Weymouth south to coast near Night Island.

Alt.: Yankonya, Yankonyu.

Ref.: Thomson 1934, McConnel 1940, T.

'Puntamara, Puntemara Punthamara

Loc.: East of Grey Range on creeks running from Orient north to near Quilpie; on west side of Grey Range to Mount Margaret and Congie (pre- or proto-historic movement was across Grey Range from the west).

Alt.: Bunthomarra, Buntamara, Banthamurra, Buntha-burra.,

Ref.: Myles in Curr 1886, Mathews 1898 (1), 1905 (2), Howitt 1904, T.

('Rak : aie) Rakkaia

Loc.: Coorabulka to Springvale.

Alt.: Rukkia.

Ref.: Roth 1897.

'Riŋu'riŋu Ringuringu

Loc.: On Hamilton River south of Warenda; west to Boulia; on Burke River, south-west to Marion Downs; east to Lucknow.

Alt.: Ringoringo, Ringa-ringa, Ringa-ringaroo, (not RungoRungo).

Ref.: Collins and McLean in Curr 1886, Roth 1897, T.

'Tagalag, 'Dagalaŋ Tagalag

Loc.: Middle Gilbert River, north nearly to Einasleigh River, south-west to Abingdon Downs; south to Gregory Range; at Forest Home; east to near Georgetown and Glenora; west to near Croydon.

Alt.: Takalak, Targalag.

Ref.: Sharp 1939, T.

('Taior) Taior

Loc.: Probably about mouth of Coleman River (not well defined).

Alt.: Kokkotaijari.

Ref.: Sharp 1939.

'Taribeleŋ Taribelang

Loc.: Vicinity of Bundaberg; inland to about Walla; at north to Avondale; along Kolan River (believed extinct; scant data only).

Alt.: Tarribelung, ? Yawai.

Ref.: Howitt 1904, (T).

('Tepiti) Tepiti

Loc.: Middle Ducie River.

Alt.: Tepithiki.

Ref.: Sharp 1939, McConnel 1940.

'Tereila Thereila

Loc.: South from Nockatunga and Nocundra to Grey Range, west to Bransby and lower Warriwarri Creek.

Alt.: Thiralla.

Ref.: Myles in Curr 1886, T.

'Tja : pukai, 'Tjapukandji Tjapukai

Loc.: Barron River from south of Mareeba to Kuranda; north to Port Douglas on plateau (rain forest dwellers).

Alt.: Tja : pukanja, Tjabogai tjandji, Tjabogaijanji, Koko-njunkulu (northern term), Koko-ŋyungalo, KokoTjumbundji (Kokojelandji term), Hileman *(lapsus calami)*, Njakali (Buluwai term), Nyakali.

Ref.: McConnel 1931, 1940, Hale and Tindale 1933, Sharp 1939, T.

'Tjoŋkandji Tjongkandji

Loc.: Cullen Point; west of mouth of Batavia River.

Alt.: Tyongandyi, Chongandji, Tjongangi, Tjuungundji, Joongoonjee, Joongoonjie, Joonkoonjee, Chunkunji, Chinganji.

Ref.: Mathews 1900 (4), 1906, Roth 1910 (18), Radcliffe-Brown 1930, McConnel 1936, 1940, Sharp 1939, T.

(To:tj) Totj

Loc.: Upper Mission River and Cox Creek (Middle Batavia River); at York Downs.

Alt.: ? Kauwala.

Ref.: Sharp 1939, McConnel 1940.

(Tulua) Tulua

Loc.: Calliope River to Port Curtis; inland to Coast Range and headwaters of Boyne River; at Many Peaks (may be a part of the Goeng).

Alt.: Dandan (dan = man).

Ref.: Police Commissioner in Curr 1887.

(Ulaolinja) Ulaolinja

Loc.: At Carlo Springs on Upper Mulligan River.

Alt.: Ulaolinya, Yoolanlanya.

Ref.: Roth 1897, Mathews 1901 (2).

(Unjadi) Unjadi

Loc.: Upper Dulhunty River (boundaries not known).

Alt.: Unyadi, Onyengadi, Oyungo (Tjongkandji term), Empikeno (Jathaikana term).

Ref.: Thomson 1933, Sharp 1939, McConnel 1940.

'Wadje, 'Wadjaiŋgo, 'Wainjago, 'Waiŋgo Wadja

Loc.: Streams on east side of Expedition Range; south to Bigge Range; east nearly to Dawson River (closely related to Kangulu).

Alt.: ? Maudalgo.

Ref.: McIntosh in Curr 1887, T.

'Wadjebaŋai Wadjabangai

Loc.: South of Glenbower, boundaries fixed only by those of neighbouring tribes (data scant).

Alt.: ? KunGait (but this may be Iningai, which see).

Ref.: Kelly 1935, T.

'Wadjelaŋ Wadjalang

Loc.: Headwaters of Bulloo and Langlo Rivers from Quilpie north to Northampton Downs and near Blackall and Tambo; east to Cheepie, Burrandilla and Nive Downs; at Ambathalla and Minnie Downs.

Ref.: Tindale.

'Wakamen Wakaman

Loc.: Head of Lynd River; north to Mungana, east to Alma-den and Dividing Range; west to Dagworth; south to Mount Surprise (near Brooklands).

Alt.: Warkaman, Warkeeman, Warkamin, Warkeemon.

Ref.: Mathews 1898 (2), Richards 1926, T.

'Wakara Wakara

Loc.: Southern side of Upper Mitchell River; east to Mount Mulligan, west to Wrotham Park and Blackdown. (Apparently placed too far to north-east by McConnel.)

Alt.: Wakura, Wakoora, Koko-wogura.

Ref.: Sharp 1939, McConnel 1940, T.

'Wakawaka, 'Wa: Wakawaka

Loc.: Nanango north to Mount Perry behind Coast Range; west to Boyne River, Upper Burnett River and Mundubbera; at Kingaroy, Murgon and Gayndah. (The Wulili of Mathews are probably a western horde. Mathew (1926) includes under this name several tribes with kindred languages.)

Alt.: Wakka-wakka, Waka, Woga, Wokka, Wogga, Wokkari, ? Nukunukubara.

Ref.: O'Connor in Curr 1887, Howitt 1904, Mathew 1910, 1926, T.

'Wakaja Wakaja

See Central Australian List.

'Walaŋame Walangama

Loc.: On Carron River and Walker Creek; west to Normanton; east to Croydon, south to Belmore Creek; north to Stirling.

Alt.: Wollangama, Wollongurmee, Wallankammer.

Ref.: Roth 1897, Armit, Poigndestre and Palmer in Curr 1886, T.

'Walmbaria Walmbaria

Loc.: Flinders Island Group and extensive reefs north of Princess Charlotte Bay; on mainland at Bathurst Head.

Alt.: Walmbar.

Ref.: Roth 1910 (18), Hale and Tindale 1933, T.

'Wanamara Wanamara

Loc.: Headwaters of Flinders River, east to Richmond; south to the Divide and Kynuna; west to near Cloncurry; north to Cambridge Downs and Dalgonally.

Alt.: Wunamara, Woonamurra, Unamara, Oonoomurra.

Ref.: McGillivray in Curr 1886, Roth 1897, 1905 (5, p. 34), Kelly 1935, Sharp 1939, T.

'Wangan Wangan

Loc.: Capella north to near Blair Athol, east to Peak Range; west to Drummond Range.

Ref.: Tindale.

'Waŋgare Wangara

Loc.: South of mouth of Staaten River to about Gilbert River (scant data only from Koko-mini and Konanin informants).

Ref.: Tindale.

'Wa:nji Wanji

Loc.: South of Nicholson River; on Spring and Lawn Hill Creeks; east to Barkly (Barclay) River; at Lawn Hill and Bannockburn.

Alt.: Wanyi, Wanyee, Wanee.

Ref.: Mathews 1901, Power in Basedow 1907, Spencer 1914, Sharp 1935, T.

'Wanjuru Wanjuru

Loc.: Mouth of Russell River; inland to Babinda (rain forest dwellers).

Ref.: Tindale.

'Warekemai — Warkamai

Loc.: Coast at Halifax Bay; inland to slope of Coast Range; north to Ingham and Lucinda Point; south to Black River, twenty miles north of Townsville (seven hordes are mentioned in literature).

Ref.: Cassady and Johnstone in Curr 1886, T.

'Waruŋu — Warungu

Loc.: Head-waters of Burdekin River, south probably to about Clarke River; west to Dividing Range; east to inland foot of Coast Range.

Ref.: Tindale.

'Wik– — Wik–

Aggregate of subtribes from Watson River south to Edward River; east to Rokeby. (For detailed map see McConnel 1940, p. 55; see also notes under Wikmunkan.)

(Wikampama) — Wikampama

Loc.: Middle Archer River; north to Watson River.

Alt.: Kokala (probably a place name).

Ref.: Sharp 1939, McConnel 1940.

(Wikapa:tja) — Wikapatja

Loc.: Mangrove islands of Archer River delta (extinct). N.B.—Not marked on map.

Ref.: McConnel 1940.

(Wikatinda) — Wikatinda

Loc.: Coast from Archer River south for about eight miles; extinct. N.B.—Not marked on map.

Ref.: McConnel 1940.

(Wikepa) — Wikepa

Loc.: Near Cape Keerweer (extinct).

Ref.: McConnel 1940.

(Wikmean) — Wikmean

Loc.: Inland from Cape Keerweer.

Ref.: McConnel 1940.

'Wik'muŋkan — Wikmunkan

Loc.: From Edward River north to Archer River; inland. This is the dominant Wik tribe; the Wikianji and Bakanu are southern subtribes in process of separating from rest.

Alt.: Munkanu (Ajabatha term), Monkanu.

Ref.: Thomson 1933, McConnel 1931, 1940, T.

(Wiknantjara) — Wiknantjara

Loc.: Between mouths of Edward and Holroyd Rivers. N.B.—Not marked on map.

Ref.: McConnel 1940.

(Wiknatanja) — Wiknatanja

Loc.: Coast at mouths of Kendall River.

Ref.: McConnel 1940.

'Wik'ŋatara — Wikngatara

Loc.: Coast north of Cape Keerweer.
Alt.: Wiknatara.
Ref.: McConnel 1940, T.

'Winduwinda — Winduwinda

Loc.: East of Duifken Point to Watson River; inland to head of Embley River; thirteen or more hordes or subtribes each with a name terminating in [ŋit]; Winduwinda is a valid name apparently equivalent to one of lower Gulf tribes (see McConnel 1940 for horde names).
Alt.: Windawinda.
Ref.: Roth 1910 (18), T.

'Wiri, 'Widi — Wiri

Loc.: On Coast Range behind Mackay; inland to Nebo and heads of Suttor and Bowen Rivers; inhabitants principally of rain scrub country.
Alt.: Wierdi.
Ref.: Kelly 1935, T.

(Woŋkadjera) — Wongkadjera

Loc.: At Glenormiston and Herbert Downs; Malvina Creek.
Alt.: Wonkatyeri.
Ref.: Roth 1897.

'Woŋkumara, 'Waŋkumara — Wongkumara

Loc.: Cooper Creek east of Oontoo to Wilson River at Nocundra; at Chastleton and Narcowlah. (Tribal disruption took some to Thargomindah where they mixed with uncircumcised Kalali.)
Alt.: Wonkamara, Wonkomarra, Wonka-marra, Wonkamura, Wonka murra, Wonkubara.
Ref.: Myles in Curr 1886, Mathews 1904 (1), Elkin 1931, Kelly 1935, T.

(Workabunga) — Workabunga

Loc.: Upper Leichhardt River and Gunpowder Creek (data scant).
Alt.: Workoboongo, Wakobungo, Waggabundi (name of a cattle station).
Ref.: Roth 1897.

'Wulgurukaba — Wulgurukaba

Loc.: On Palm Islands and Magnetic Island; on Ross River; east nearly to Cape Cleveland; west for about twenty miles beyond Townsville; ['wulguru] = man.
Ref.: Tindale.

'Wulpure — Wulpura

Loc.: Head of Daintree River on high Mount Windsor Tableland (rain forest dwellers).
Alt.: Wulurara, Kokowaldja.
Ref.: Roth 1910 (18), McConnel 1940, T.

(Jaðaikana) — Jathaikana

Loc.: Escape River south probably to about Orford Ness.
Alt.: Yathaikeno, Yaraidyana.
Ref.: Sharp 1939, McConnel 1940.

'Jagaliŋu — Jagalingu

Loc.: Headwaters of Belyando River south to Avoca; north to about Laglan; west to Dividing Range; east to Drummond Range. (Six or more hordes; Howitt's map indicates that the attribution of his "Wakelbara" to "west of the Great Dividing Range" was probably in error).

Alt.: Wakelbara (a horde name; arbitrarily adopted as tribal term).

Ref.: Howitt 1904, T.

'Jagara — Jagara

Loc.: Brisbane River inland to Dividing Range about Gatton; north to near Toogoolawah; at Ipswich. (Several hordes; compare Jiegera of New South Wales.)

Alt.: Yagara, Turrubul, Yackarabul.

Ref.: Ridley 1866, Mathews 1898 (2), Brown 1918, Radcliffe-Brown 1931, T.

'Jaleŋe — Jalanga

Loc.: On Wills River from south of Duchess to Fort William; on Burke River north to Chatsworth; at Noranside and Buckingham Downs.

Alt.: Yellunga, Yelina.

Ref.: Eglinton in Curr 1886, Roth 1897, T.

(Jambi:na) — Jambina

Loc.: Logan Creek south of Avon Downs; east to Denham Range; west to about Elgin Downs. (Some new indirect data.)

Alt.: Yambeena.

Ref.: Wilson in Curr 1887 (T).

(Janda) — Janda

Loc.: Head of Hamilton River, north of Warenda.

Ref.: Eglinton in Curr 1886, Roth 1897.

'Jaŋa: — Jangaa

Loc.: Head of Gilbert River, south of Forsayth to Gledswood and Gregory Range; east to near Oak Park; west to Glenora. (Distinguish from Jangga of Upper Suttor River.)

Ref.: Tindale.

'Jaŋga — Jangga

Loc.: Eastern headwaters of Suttor River; south to Glen Avon; at Yacamunda and Hidden Valley; northern boundary unknown. (Not to be confused with Jangaa of Upper Gilbert River.)

Ref.: Tindale.

'Jaroiŋa — Jaroinga

See Central Australian List.

'Jeljendi — Jeljendi

See South Australian List.

'Jet:eneru — Jeteneru

Loc.: Saltwater Creek (south-west corner of Princess Charlotte Bay); inland towards Musgrave.

Ref.: Hale and Tindale 1933.

'Ji:man Jiman

Loc.: From Bigge Range south to Great Dividing Range; east to Theodore, Cracow and Cockatoo Creek; west to Baroondah and Durham Downs; at Wandoan and Taroom.

Alt.: Iman, Emon.

Ref.: Howitt 1904, Kelly 1935, T.

(Jinwum) Jinwum

Loc.: Upper Batavia River south of Moreton.

Alt.: Yinwum.

Ref.: McConnel 1940.

'Ji:randali Jirandali

Loc.: West of Great Dividing Range from near Mount Sturgeon south to Caledonia, west to near Richmond, Corfield, and near Winton; on Torrens and Landsborough Creeks; at Lammermoor, Hughenden and Tangorin.

Alt.: Yerrunthully, Irendely, Dalebura.

Ref.: Howitt 1904, Kelly 1935, T.

('Jir'joront) Jirjoront

Loc.: About mouth of Coleman River.

Alt.: KokoMindjin, KokoMandjoen, KokoMinjen.

Ref.: Roth 1910 (18), Thomson 1933, Sharp 1939.

'Jokula Jokula

Loc.: From Burketown to west of Cliffdale Creek on coast; inland nearly to Nicholson River.

Alt.: Yukula, Yookala, Eugoola.

Ref.: Armit in Curr 1886, Mathews 1901, Sharp 1935, T.

(Juipera) Juipera

Loc.: At Mackay; St. Helens south to Cape Palmerston; inland to Connor Range.

Ref.: Bridgeman and Bucas in Curr 1887, Mathews 1898 (2), Howitt 1904.

'Jukambe, 'Jukem, 'Jampal Jukambe

Loc.: Logan River from Rathdowney to mouth, south to Southport; west to Boonah and Dividing Range.

Alt.: Yukum. (Apparently separate tribe from Jukambal of New England Tableland.)

Ref.: Radcliffe Brown 1931, T.

'Juŋkurara Jungkurara

Loc.: Bloomfield River; south to beyond Cape Tribulation. (This term appears to embrace the Yanyu of McConnel.)

Alt.: Yungkarara, Kokojalanja, Kokoyalunyu, KokoIaluniu, KokoIaliu, Kokobaldja.

Ref.: Roth 1910 (18), McConnel 1931, 1940, Sharp 1939, T.

'Juru Juru

Loc.: From Bowen north to Burdekin River at Home Hill; west to Bogie River; at Upstart Bay; south to Mount Pleasant and Clarke Range.

Ref.: Tindale.

SOUTH AUSTRALIAN TRIBES

'Anta'kirinja, 'Ande'keriŋa — Antakirinja

Loc.: Head-waters of Hamilton, Alberga, Wintinna and Lora Creeks north to Erldunda, Central Australia; south to Stuart Range; at upper limits of Lilla Creek, but not extending down to the Finke River, which is Aranda country. (Movements since 1917 have taken portion of tribe south to Ooldea. Earlier movement was from west after massacre by them of some previous inhabitants of Mount Chandler district; closely related to Jangkundjara.)

Alt.: Antakerrinya, Andekarinja, Antekarinja, Andigirinji, Andigarina, Andingiri, Antigerinya, Andjirigna, Unterrgerrie (ms.), Tangara, Yandairunga, Mbenderinga, Madutara.

Ref.: Giles in Taplin 1879, Krichauff 1886, Howitt 1891, Helms 1896, Mathews 1900 (1), Bates 1918, Elkin 1931, 1940, Tindale in Fenner 1936, T.

'Arabana — Arabana

Loc.: West side of Lake Eyre to Stuart Range, Macumba Creek to Coward Springs.

Alt.: Arabuna, Arrabunna, Arrabonna, Arapani, Urapuna, Urabuna, Urabunna, Ngarabana, Rabuna, Wangarabana, Wongkurapuna, Wangarabunna.

Ref.: Helms 1896, Spencer and Gillen 1899, Mathews 1900 (1), Howitt 1904, Eylmann 1908, Strehlow 1910, Spencer 1912, Bates 1918, Basedow 1925, Tindale in Fenner 1936, Elkin 1931, 1940, T.

Aranda — Aranda

See Central Australian List.

'Buŋanditj, 'Puŋandaitj, 'Buanditj, 'Buandik — Buandik

Loc.: Glenelg and Wannon Rivers, Victoria; at Dartmoor, Sandford, Western Grampians, Hamilton and Discovery Bay; west to Mount Gambier, Penola, Robe and coast south to Cape Jaffa. (Under pressure of Jardwa were contracting southwards towards Casterton about time of first white contacts. The Burhwundeirtch of Smyth were possibly the same people. Their word for man was ['trua:l].)

Alt.: Bungandaitj, Bungandaetch, Bungandaetcha, Pungantitj, Pungatitj, Pungandik, Booandik, Boandik, Boandiks, Borandikngolo, ? Burhwundeirtch.

Ref.: Fisher in Taplin 1879, Smith 1880, Curr 1887, East 1889, Mathews 1900 (1), Howitt 1904, Campbell 1934, T.

Daŋga:li — Danggali

See New South Wales List.

'Dieri — Dieri

Loc.: Cooper Creek between Killalapaninna and near Coongie; at Cowarie, Lake Howitt, and Lake Hope; south to Lake Gregory and Clayton River and low country north of Mount Freeling.

Alt.: Diari, Diyeri, Dieyerie, Deerie, Dieyrie, Dthee-eri.

Ref.: Gason 1874, Howitt 1891, 1904, Helms 1896, Eylmann 1908, Strehlow 1910, Elkin 1931, Tindale in Fenner 1936, Berndt and Vogelsang 1939, T.

'Erawiruŋ, 'Jirau — Erawirung

Loc.: Eastern bank of Murray River from Loxton to above Paringa and about fifteen miles south, away from river.

Alt.: Eraweerung, Erawirrangu, Erawiruck, Yerraruck, Yirau, Yiran (misprint).

Ref.: Shaw in Taplin 1879, Brown 1918, Tindale 1939 (2), T.

'Karaŋuru — Karanguru

Loc.: South of Alton Downs on Mulligan River; east to Pandi Pandi, south to Goyder Lagoon.

Alt.: Karangura, Kurangooroo.

Ref.: Paull in Curr 1886, Howitt 1904, Eylmann 1908, Strehlow 1910, T.

'Kaurna, 'Widniŋa — Kaurna

Loc.: Rapid Head to Wakefield along eastern shore of Gulf St. Vincent, inland to Crystal Brook, Blyth, Hoyleton, Hamley Bridge, Yatala, Clarendon, Gawler and Myponga; on east side of Hummock Range to Red Hill.

Alt.: Kaura (? misprint), Coorna, Koornawarra, Nganawara, Kurumidlanta (Pangkala term, lit. "evil spirit"), Milipitingara (ms.), Widninga (Ngadjuri term applied to Kaurna of Port Wakefield and Buckland Park), Winnaynie, Meyu (['meju] = man).

Ref.: Teichelmann and Schürmann 1840, Cawthorne (ms. 1844), Wyatt 1879, Stephens 1889, Howitt 1904, Strehlow 1910, Tindale 1936, T.

'Kokata, 'Kukata — Kokata

Loc.: At Tarcoola, Pimba and McDouall Peak; west to Ooldea, north to Stuart Range and Lake Phillipson (southward migratory movements were in progress before 1850. Earliest historic boundaries are indicated on map).

Alt.: Kukatha, Kukata, Kokatha, Koogatho, Kugurda, Koogurda, Koocatho, Kokit-ta, Kukataja, Maduwonga (Arabana term), Madutara, (Antakirinja term).

Ref.: Schürmann 1844, 1879, Provis in Taplin 1879, Curr 1886, East 1889, Mathews 1900 (1), Eylmann 1908, Elkin 1931, T.

'Kujani — Kujani

Loc.: From Parachilna north to Marree on west side of Flinders Range; around north end of Lake Torrens, west to Turret Range, north east to Murnpeowie.

Alt.: Kuyanni, Kwiani, Kwiana, Kooyiannie, Cooyiannie, Kooyeeunna, Kooteeunna, Koonarie.

Ref.: Jessop 1862, Kingsmill in Curr 1886, Helms 1896, Mathews 1900 (1), Howitt 1904, Eylmann 1908, Strehlow 1910, Hale and Tindale 1925, Elkin 1931, T.

'Maljaŋapa — Maljangapa

See New South Wales List.

'Maraura — Maraura

See New South Wales List.

'Marditjali — Marditjali

Loc.: Naracoorte, S.A., to Goroke, Vict.; Mosquito Creek and Apsley north to Bangham and Kaniva; at Edenhope and east to Mount Arapiles (['ba:ŋg] = man).

Ref.: Tindale.

'Meint'a:ŋk Meintangk

Loc.: Lacepede Bay; north to Granite Rocks twelve miles north of Kingston; south to Cape Jaffa; east to Blackford and Naracoorte; inland from Lake Hawdon to Mosquito Creek (with at least seven hordes).

Alt.: Meintank, Painbali (Tangane term).

Ref.: Tindale 1937, T.

Mirniŋ, 'Mi:niŋ, 'ŋandaða, 'Wanbiri Mirning

See Western Australian List.

'Nar:aŋga, 'Naraŋga Narangga

Loc.: Yorke Peninsula; north to Port Broughton, east to Hummock Range; at Bute, Wallaroo, Ardrossan, Cape Spencer (four hordes are recognised).

Alt.: Narranga, Narrang-gu, Narrang-u, Adjahdurah (lit., my people), Turra.

Kühn in Fison 1880, Kühn in Curr 1886, Sutton 1889, Mathews 1900 (1), Howitt 1904, Strehlow 1910, Tindale 1936 (3), 1939 (2), T.

'Nauo, 'Njao, 'Njau Nauo

Loc.: Southern half of Eyre Peninsula; west to Cape Radstock; north to beyond Minnipa; east to near Darke Peak, Cleve and half-way between Carrow and Franklin Harbour; at Port Lincoln, Mount Hope, Coffin Bay, and Elliston (principally inhabiting coastal gum tree country; pressure from Pangkala was causing contraction to south-west at time of early white contacts; their proto-historic boundary ran from about the Gawler Ranges to Port Augusta; extinct; data from Pangkala informants).

Alt.: Nawo, Naua, Nowo, Gnowoo, Battara (['bat:ara] = scrubby gum).

Ref.: Schürmann 1844, Angas 1847, Bull 1878, East 1889, Howitt 1904, Strehlow 1910, (T).

'ŋadjuri, 'Wirameju, 'Manuri Ngadjuri

Loc.: From Angaston and Freeling north to Crystal Brook, Gladstone, Carrieton and north of Waukaringa; east to Mannahill; in Orroroo, Peterborough, Burra and Robertstown districts; inhabitants of the gum forest areas.

Alt.: Ngadluri, Ngaluri, Aluri, Alury, Eeleeree, Wirameju, (['wira] = gum tree, ['meju] = men, lit. gum forest men), Wirrameyu, Wirramayo, Wirramaya, Wiramaya, Wirra, Weera, Eura, Manuri (Nukunu term, lit. inland people), Manu, Monnoo, Manuley.

Ref.: Angas 1847, Noble in Taplin 1879, Le Brun in Curr 1886, Mathews 1900 (1), Hossfeld 1926, Gray 1930, Elkin 1931, Tindale 1937, T.

'ŋaiaweŋ, 'ŋaijawa, 'Aiawuŋ, 'Birta Ngaiawang

Loc.: Along Murray River from Herman Landing to Penn Reach, west to scarp of Mount Lofty Range (about ten hordes listed, including Molo, not previously recognised. Moorhouse carried southern limits of tribe too far downstream).

Alt.: Ngaiawung, Ngaiyau, Aiawung, Aiawong, Iawung, Nggauaiyo-wangko, Birta (Kaurna and Ngadjuri term), Pitta, Pieta, Peeita, Meru (term for man).

Ref.: Eyre 1845, Moorehouse 1846, Ewens in Taplin 1879, Fulford in Curr 1886, East 1889, Tindale in Parkhouse 1935, Tindale 1939 (2), T.

'ŋalea — Ngalea

Loc.: Salt Lake districts in Western (or Great Victoria) Desert north-west of Ooldea, including Lakes Auwuru, Maurice, Wyola, Nurrari, Forrest, Waigen and Wright; also mallee scrub belt north of Nullarbor Plains, where water supplies are obtained almost solely from mallee roots, at Leisler Hills. Not to be confused with the four class tribe, Ngalia, of Mount Davenport, Central Australia.

Alt.: Ngalia.

Ref.: Elkin 1931, 1940, T.

'ŋameni, 'ŋamini, 'A:mini — Ngameni

Loc.: South side of Goyder Lagoon; on Warburton River to Lake Howitt and Berlino; north to Pandipandi, Birdsville and Miranda.

Alt.: Gnameni, Ngaminni, Ngnaminni, Aumini (of northern tribes and casual variant), Aumine, Amini, Ominee, Ahminnie, Uminnie, Agaminni, Awmani.

Ref.: Gason 1874, Howitt 1891, 1904, Helms 1896, Eylmann 1908, Strehlow 1910, Elkin 1931, Tindale in Fenner 1936, T.

'ŋaŋuruku — Nganguruku

Loc.: On Murray River from Mannum to South Rhine River junction; west to scarp of Mount Lofty Ranges.

Ref.: Brown 1918, T.

'ŋaralte — Ngaralta

Loc.: On Murray River from Wood Hill to Port Mannum; west to Bremer Creek, Palmer, and eastern scarp of Mount Lofty Ranges.

Alt.: Wanaulun, Wanjakalde (Jarildekald terms), Wanyakalde, Wunyakalde, Wanakald, Ngaralt, Ngaraltu.

Ref.: Brown 1918, T.

'ŋarket, 'ŋeruketi, 'Beripuŋ, 'Me:kani, 'Maŋkaru:pi — Ngarkat

Loc.: Mallee scrub belt east of Murray River; south of Alawoona to Taunta, Keith and Coonalpyn; east to Tatiara and about Murrayville, Victoria. (Water supplies principally from mallee roots and, therefore, camps widely dispersed.)

Alt.: Merkani (Jaralde and Tangane term), Merkanie, Mangkarupi Jarildekalde term), Buripung (['berip] = man), Booripung (ms.), Boripar, Duwinbarap (eastern term, ['barap] = man), Doenbauraket, Tjakulprap (south eastern term, ['prap] = ['brab] = man), Jakalbarap, Jackalbarap, Jackegilbrab, Jakel-baluk (Wotjobaluk term), Ngeruketi (Maraura, term), ? Wragarite.

Ref.: Smyth 1878, Humphries in Taplin 1879, East 1889, Howitt 1904, Eylmann 1908, Tindale 1939 (2), T.

ŋawait, ŋawaitjiŋ, 'Njawatjurk, 'Eritark — Ngawait

Loc.: Banks of Murray River from between Boggy Flat and Penn Reach to near Loxton; a small tribe with three or more hordes.

Alt.: Nauait, Nanait (misprint?), Niawoo, Ngawaijung, Ngawijung, Narwejung, Eritark (Nganguruku term), Njawatjurk (Maraura term).

Ref.: Angas 1847, Taplin 1879 (p. 30), Brown 1918, Tindale 1939 (2), T.

'ŋintait | Ngintait

Loc.: Principally on southern bank of Murray River from above Paringa, to near Mildura, Vict., southern limit approximately fifty miles from river; at Ned Corner, Vict., and Salt Creek, N.S.W.

Alt.: Inteck, Nutcha.

Ref.: Pegler in Curr 1886, Mathews 1898 (2), Brown 1918, Tindale 1939 (2), T.

'ŋurawola | Ngurawola

See Queensland List.

'Nukunu | Nukunu

Loc.: Eastern side of Spencer Gulf from mouth of Broughton River and near Crystal Brook north to Port Augusta; east to Melrose, Gladstone and Quorn; at Baroota.

Alt.: Nukunnu, Nukuna, Nookoona, Noocoona, Nokunna, Pukunna (misprint ?), Wongaidya, Tyura, Doora, Warra.

Ref.: Teichelmann and Schürmann 1840, Schürmann 1844, Hack in Taplin 1879, Valentine in Curr 1886, Mathews 1900 (1), Black 1917, Gray 1930, Elkin 1931, T.

'Paŋkala, 'Baŋgala | Pangkala

Loc.: East side of Lake Torrens south of Edeowie and west of Hookina and Port Augusta; west of Lake Torrens to Island Lagoon and Yardea; at Woorakimba, Hesso, Yudnapinna, Gawler Ranges; south to Kimba, Darke Peak, Cleve and Franklin Harbour. (Pre- and proto-historic pressure from the Kokata was modifying their northern boundary, causing a shift of their southern limits also from between Port Augusta and the Gawler Ranges down towards Franklin Harbour.)

Alt.: Banggala, Bahnga-la, Pankalla, Parnkala, Punkalla, Bungela, Bungeha, Kortabina (place name).

Ref.: Schürmann 1846, Angas 1847, Green in Curr 1886, Eylmann 1908, Strehlow 1910, Hale and Tindale 1925, Elkin 1931, Cleland and Johnston 1939, T.

'Peramaŋk, 'Merildekald, 'Waŋarainbula | Peramangk

Loc.: In Mount Lofty Ranges from Myponga north to Gawler and Angaston; east to Wright Hill, Strathalbyn, Kanmantoo, and along the eastern scarp of the range to near Towitta. N.B.—On map area enlargement must be utilised in ascertaining distribution of this tribe; on small scale eastern limit is wrongly delineated and boundary line for circumcision rite should run south of Strathalbyn.

Alt.: Peramarma, Mereldi (Ramindjeri term), Merildakald (Tanganekald term), Marimejuna (['mari] = east, ['meju] = man, Kaurna term), Wangarainbula (['waŋara] = hill, Ngaiawang term), "Mount Barker Tribe."

Ref.: Angas 1847, T.

'Pilatapa, 'Pidlatapa | Pilatapa

Loc.: North-east of Northern Flinders Range; north of Lake Frome, east to Callabonna and almost to Tilcha; north-west to Lake Blanche and Blanchewater; south to Wooltana and Hamilton Creek.

Alt.: Piladapa, Pillatapa (ms.), Pillidappa (ms.), Pulladapa, Berluppa, Pilliapp.

Ref.: Mathews 1898 (2), 1900 (1), 1904 (3), Strehlow 1910, Morgan (ms.) 1930, Elkin 1931, T.

'Pitjandjara — Pitjandjara

Loc.: Mann and Tomkinson Range north-west to beyond Rawlinson Range, W. Aust.; west to Cavanagh, Finlay and Bedford Ranges, also in W. Aust.; south to Birksgate Range and near Lake Wright; east to Mounts Kintore and Caroline, Butler Dome, and Stevenson Peak; north to Lakes Amadeus and Hopkins; in Western Musgrave Range only to Opparina. Basedow (1914) refers to several tribes in this area by terms meaning north, south, east and west.

Alt.: Pitjandjadjara, Pitjindjatjara, Pitjindjara, Pitjinjara, Pitjinjiara, Pitjanzazara (z = editorial substitute in journal Oceania for "dj" symbol), Wongapitjira, Wongapitcha.

Ref.: Strehlow 1910, Tindale 1933, 1935 (1) and (2), T.

'Porta'ulun — Portaulun

Loc.: Western bank of Murray River from Wood Hill to Wellington and Pomanda Point; west to Grote Hill.

Alt.: Warawalde.

Ref.: Brown 1918, T.

'Po:taru'wutj, 'Wepulprap, 'Potaŋola — Potaruwutj

Loc.: Naracoorte west to within ten miles of the sea along the third inland dune range of the Coorong; at Taratap; north to Tatiara, Bordertown, Wirrega and Keith (eight or more hordes), ['wutj] = man).

Alt.: Potangola (alternative term), Woychibirik, Wepulprap (Meintangk term), Yaran, Tatiara (a place name, also a horde), Tattayarra, Tyatyalli, Tyeddyuwurru, Wirigirek (a northern horde; Wirrega, a place name), Wereka-tyalli.

Ref.: Angas 1847, Lawson in Taplin 1879, Haynes in Curr 1887, Mathews 1904 (3), Tindale 1935 (2), 1937, T.

'Ra:mindjeri, 'Ra:minjeri, 'Ramoŋ, 'Tarbanawalun — Ramindjeri

Loc.: At Encounter Bay; west to Cape Jervis, Mount Hayfield, Inman Valley; east to Middleton, thence across to Goolwa and Currency Creek; not along coast sandhills east of Middleton (five or more hordes).

Alt.: Ramong, Raminyeri, Ramindjerar, Ramingara, Tarbanawalun (Jarildekald term).

Ref.: Meyer 1840, 1846, Angas 1847, Wyatt in Woods 1879, Newland 1895, Brown 1918, Tindale 1935 (2), 1937, 1938, T.

'Taŋane'kald, 'Taŋ'alun, 'Teŋgi, Taŋani'kald — Tanganekald

Loc.: Narrow coastal strip along Coorong from Middleton south to Twelve Mile Point (north of Kingston); inland only to about inner margin of first inland dune terrace (usually five to eight miles); on islands in Lake Alexandrina, except eastern and western extremities of Hindmarsh Island; at Meningie, south end of Lake Albert, Salt Creek and Taratap (Ten Mile Point).

Alt.: Tenggi (Potaruwutj term), Tangane, Tanganalun, T(h)unga, Thungah, Milmenrura (a clan name only; often used in early days for whole tribe, owing to notoriety associated with their murder of survivors of the wreck "Maria").

Ref.: East 1889, Brown 1918, Tindale 1937, 1938, T.

'Tirari, 'Terari — Tirari

Loc.: Eastern shore of Lake Eyre from Muloorina north to Warburton River; east to Killalapaninna; a small tribe now extinct; not a horde of Dieri.

Ref.: Howitt 1904, Strehlow 1910, 1931, T.

'Wadikali — Wadikali

Loc.: Yandama and Callabonna Creeks; east to Milparinka and Naryilco; at Lake Pinaroo and Tilcha.

Alt.: Wadigali.

Ref.: Hale and Tindale 1925, Elkin 1931, T.

'Wailpi — Wailpi

Loc.: At Umberatana and Mount Serle; south to Parachilna Gorge only in Flinders Range; east to above Wooltana on range; west to western scarp of range.

Alt.: Nuralda, Binbarnja (Wadikali terms, ['binba] = *Callitris* "pine tree"), Kanjimata, Anjimatana, Benbakanjamata (Kujani terms; lit. "hill people" and "pine hills people"), Anjiwatana (misprint), Anjamutina, Anyamatana, Unyamootha, Kudnamietha, Kutchnamootha, Keydnjamarda, Mardala (Dieri terms), Mardula, Wipie, Umbertana (contraction of Umberatana, a place name), Nimbalda, Nimbaldi (? misprint), Nimalda.

Ref.: Smith in Taplin 1879, Phillipson, Gason and Wills in Curr 1886, Howitt 1891, Mathews 1904 (3), Hale and Tindale 1925, Tindale 1937, Moutford 1938, Cleland 1939, Elkin 1940, T.

'Warki, 'Warkend — Warki

Loc.: North and west of Lake Alexandrina from Grote Hill to Currency Creek; on eastern and western extremities of Hindmarsh Island (eight or more clans).

Alt.: Koraulun (Jarildekald term), applying principally to one clan, the Korowalde).

Ref.: Brown 1918, T.

'Wiljakali, 'Wilja:li — Wiljakali

See New South Wales List.

'Wiraŋu — Wirangu

Loc.: Coast between Head of Bight (White Well), and Streaky Bay; inland to Ooldea, Kokatha, Kondoolka and almost to Yardea (in earliest historic times were contracting southward before Kokata people).

Alt.: Wirrung, Wirrunga.

Ref.: Mathews 1900 (1), Black 1916, Elkin 1931.

'Woŋga:i — Wonggai

See Western Australian List.

'Woŋkaŋuru, 'Woŋkoŋuru — Wongkanguru

Loc.: On Stevenson Creek north to Mount Daer; at Blood Creek, east of Macumba Creek; on lower Finke; in southern portion of Arunta Desert; south to Kallakoopah Creek; at Atna Hill.

Alt.: Wongkongaru, Wonkanguru, Wonkonguru, Ongkongura, Wongkaooroo, Wonkgongaru, Wonkongaru, Wonkaoora, Wongonooroo, Wonkongnuru, Wonkagnurra.

Ref.: Gason 1874, Paull in Curr 1886, Helms 1896, Mathews 1900 (1), Howitt 1904, Eylmann 1908, Strehlow 1910, Spencer 1912, Elkin 1931, Tindale in Fenner 1936, T.

'Jadliaura — Jadliaura

Loc.: Eastern side of Northern Flinders Range from Wertaloona south to Carrieton; east to Frome Downs; on Siccus River; west to Arkaba, Hawker and Quorn.

Alt.: Yadliaura, Arkaba-tura (['Arkaba] place name, ['tura] = man), Wonoka (place name).

Ref.: Green in Curr 1886, Elkin 1931, 1938, T.

'Jandru'wanta — Jandruwanta

Loc.: South of Cooper Creek from Innamincka to Carraweena; on Strzelecki Creek.

Alt.: Yandruwunta, Yantruwunta, Jendruwonta, Yandrawontha, Yanderawantha, Yanduwulda, Endawarra.

Ref.: Gason 1874, Mathews 1898 (2), 1900 (1), 1905 (1), Howitt 1904, Eylmann 1908, Strehlow 1910, Elkin 1931, T.

'Jaŋkundjara, 'Jaŋkundja'djara — Jangwundjara

Loc.: Musgrave Range east of Opparinna, on Officer Creek; north to Lake Amadeus, Mount Olga, Ayers Rock and Mount Connor; in Everard Ranges. (The Everard Range tribe of Helms (1896) and White (1916); in 1917 (dated by eclipse), a portion of tribe moved south to Ooldea in company with some Antakirinja; western limits now usurped by Pitjandjara).

Alt.: Jangundjara, Jankunzazara (z = editorial substitute in the journal Oceania for "dj" symbol), Wirtjapakandja.

Ref.: Tindale and Hackett 1933, Love 1938 (ms.), Elkin 1940, T.

'Jarildekald, 'Jaralde — Jarildekald

Loc.: East side of Lake Alexandrina and Murray River from Loveday Bay to Mobilong; on Narrung Peninsula; east to Meningie (more than fifteen clans).

Alt.: Yarilde, Yaralde, Yarrildie.

Ref.: Taplin 1873, 1879, East 1889, Eylmann 1910, Brown 1918, Tindale 1935 (2), T.

'Jauraworka — Jauraworka

Loc.: North of Cooper Creek to Haddon Downs and Cadelga; west nearly to Goyder Lagoon; east to about Arrabury; south-east nearly to Innamincka.

Alt.: Yauroworka, Yarrawaurka, Yaurorka, Yauarawaka, Jaurorka, Yaurorka, Yerawaka, Yowerawoolka, Yowerawarrika.

Ref.: Gason 1874, Cornish in Curr 1886, Mathews 1900 (1), Howitt 1904, Eylmann 1908, Elkin 1931, T.

Jeljendi — Jeljendi

Loc.: Mulligan River south of Annandale to Alton Downs; east to Birdsville and Diamantina River; west to near Atna Hill.

Alt.: Jeljujendi, Yelyuyendi, Yarleeyandee.

Ref.: Paull in Curr 1886, Howitt 1904, Strehlow 1910, T.

CENTRAL AUSTRALIAN TRIBES

'Andekerebina — Andakerebina

Loc.: Tarlton Range east to Togo Range; head waters of Field River; south-western range uncertain, probably to about Lake Caroline.

Alt.: Undekerebina, Walwallie, Willi-willi, ? Yanindo.

Ref.: Curr 1886, Roth 1897, Mathews 1901 (2), T.

'Anmatjera, 'Nmatjera, 'Unmatjera — Anmatjera

Loc.: Forster Range, Mount Leichhardt, Conistan, Stuart Bluff Range east of Central Mount Wedge, Burt Plain north of Mount Zeil, Connor Well, Harper Springs, Woolla Downs; at Hann and Reynolds Ranges.

Alt.: Anmatjera, Unmatjera, Imatjera, Urmitchee.

Ref.: East 1889, Spencer and Gillen 1904, Strehlow 1910, Spencer 1912, Tindale 1931, T.

'Aranda — Aranda

Loc.: Mount Zeil; Finke River to Idracowra, Blood Creek, and Mount Dacr; north-east to Intea on Lower Hale River in Arunta (Simpson) Desert, thence north to Ilbala on Plenty River, west to Inilja and Hart Range; in Central MacDonnell, James and Ooraminna Ranges. (The Aranda south of Engcordina have almost the status of a separate tribe with a four class social organisation, while the northern hordes are divisible into eastern and western portions.)

Alt.: Arunta, Arrinda, Urrundie, Herrinda.

Ref.: East 1889, Spencer and Gillen 1899, 1904, Basedow 1908, 1927, Strehlow 1910, Strehlow T.G. ms., T.

'Iliaura — Iliaura

Loc.: Sandover, Bundey, Ooratippra, and Fraser Creeks; Mount Swan, northern face of Hart Range, Plenty River north and west of Ilbala, Jervois Range, Mount Playford, Elkedra River; at MacDonald Downs and Huckitta.

Alt.: Il(l)iaura, Iljauara, Ilyauarra, Illyowra.

Ref.: Spencer and Gillen 1899, Eylmann 1908, Strehlow 1910, T.

'Kaititj, 'Kaititje — Kaititj

Loc.: Elkedra, Gastrolobium Creek, Frew River, Whistleduck Creek, Davenport Range, Murchison Range, Mount Singleton, and westward into sand desert; Taylor and Barrow Creeks; Forster Range.

Alt.: Kaititj(a), Kaititja, Kaititje, Kaitije, Katitja, Katitch a, Kat-tit-ya, Kaitish, Kadda-kie.

Ref.: East 1889, Spencer and Gillen 1904, Eylmann 1908, Strehlow 1910, Spencer 1912, T.

CENTRAL AUSTRALIAN TRIBES—CONTINUED

'Kukatja — Kukatja

Loc.: Western side of Finke River from Western MacDonnell Range south to Idracowra; west to Basedow Range, Lake Amadeus, George Gill Range, Cleland Hills, and Mount Solitary; on Palmer, Walker and Rudall Creeks. (Not to be confused with Kokata of South Australia.)

Alt.: Kukatja, Kukacha, Luritja (Aranda term), Luritcha, Loritja, Loritcha, Lurritji, Aluridja, Loorudgie, Loorudgee, Juluridja, Maduntara (Pintubi and Pitjandjara term). Maiulatara (? Antakirinja term).

Ref.: Spencer and Gillen 1899, Mathews 1901 (2), Eylmann 1908, Strehlow 1910, Elkin 1931, T.

'ŋalia — Ngalia

Loc.: North of Stuart Bluff Range from Central Mount Wedge west to Mount Cockburn; about Ethel Creek, Mounts Farewell and Singleton; at Mounts Saxby and Doreen, Cockatoo Creek, Treuer Range, and Mount Davenport. (Not to be confused with Ngalea of western South Australia.)

Alt.: Ngallia, Nambuda.

Ref.: Strehlow 1910, Tindale 1931, 1933, T.

'Pintubi, 'Pi:ntupi — Pintubi

Loc.: Lake Mackay, Mount Russell, Ehrenberg Range, Kintore Range, Warman Rocks; an unknown distance to west.

Ref.: Tindale 1932, 1933, Fry 1933, T.

'Pitjan'djara — Pitjandjara

See South Australian List.

Waiaŋara — Waiangara

See Western Australian List.

'Wakaja, 'Workaia — Wakaja

Loc.: Soudan, Avon Downs, Camooweal, Yelvertoft, Flora Downs, Austral Downs and country to the west; on Buckley, James, Rankine and Georgina Rivers, north of Lake Nash.

Alt.: Waggaia, Wagai, Waagai, Waagi, Warkya, Worgaia, Worgai, Workia, Lee-wakya, Ukkia.

Ref.: Roth 1897, Glissan in Mathews 1899, 1901 (2), Spencer and Gillen 1899, Eylmann 1908, Strehlow 1910, T.

'Walmala — Walmala

Loc.: At Tanami and the Granites; boundaries not yet defined.

Alt.: Wulmala, ? Wommana.

Ref.: Spencer and Gillen 1904, Strehlow 1910, T.

'Walpari, 'Ilpira — Walpari

Loc.: Lander Creek below Mount Leichhardt, sandplain north of Mounts Turner, Saxby and Singleton; north-west towards the Granites; northern boundary not yet well defined.

Alt.: Walpiri, Wolperi, Wolpirra, Ilpira (chiefly Anmatjera and Aranda term), Ilpir(r)a, Ilpirra, Ulperra, Ilpara, Elpira.

Ref.: Spencer and Gillen 1899, Eylmann 1908, Strehlow 1910, Spencer 1912, T.

'Woŋkamala — Wongkamala

Loc.: North-west of Annandale, at Kaliduwarry, lower portions of Field and Hay Rivers, and in eastern segment of Arunta (sometimes called Simpson) Desert, including the areas carrying *pitjuri (Duboisia)* shrubs.

Alt.: Wonkamala, Wonkamudla.

Ref.: Mathews 1900 (1), Howitt 1904, Strehlow 1910, Elkin 1931, T.

'Jaŋkundjara — Jangkundjara

See South Australian List.

'Jaroiŋa — Jaroinga

Loc.: At Urandangie, Bathurst, Headingly, north to Lake Nash and east towards Mount Ida, Qld.; west to about Mount Hogarth.

Alt.: Yaroinga, Yarroinga, Yorrawinga, Yarrowin.

Ref.: Roth 1897, Mathews 1900, 1901 (1), Spencer 1912, T.

'Jumu — Jumu

Loc.: Western MacDonnell Range from Mount Russell east to Mount Zeil; north to Central Mount Wedge and Lake Bennett, south to Mounts Solitary and Udor; at Haast Bluff and Mounts Liebig and Peculiar.

Ref.: Strehlow 1910, Tindale, 1932, 1933, T.

NEW SOUTH WALES TRIBES

(Anaiwan) — Anaiwan

Loc.: New England Tableland from near Glen Innes south to Uralla; west to Tingha.

Alt.: Anaywan, Anewan, Nowan, Enni-won, Yenniwon, En-nee-win. Eneewin, Inuwon, Nee-inuwon.

Ref.: Mathews 1897, MacPherson 1905, Radcliffe-Brown 1931.

'Ar'a:kwal — Arakwal

Loc.: From Lismore and northern bank of Richmond River to Cape Byron.

Ref.: Tindale.

(Awabakal) — Awabakal

Loc.: Lake Macquarie, south of Newcastle, N.S.W. (not Port Macquarie).

Ref.: Threlkeld 1892, Howitt 1904.

'Badjelaŋ. 'Widje — Badjelang

Loc.: From northern bank of Clarence River to Richmond River; at Ballina, inland to Tabulam. Coastal hordes (Widje) go only to Rappville. N.B.—On map the northern boundary excludes Widje hordes; it should run to about Ballina.

Alt.: Bunjellung, Bundela, Bundel, Watchee.

Ref.: Mathews 1897, MacPherson 1905, T.

'Ba:kendji — Barkindji

Loc.: Darling River from Wilcannia downstream to Avoca and twenty to thirty miles each side of the river. Teulon's account shows them as at Bourke, but his remarks probably apply specifically to the Naualko.

Alt.: Barkinji, Barkunjee, Bahkunji, Bahkunjy, Parkungi, Parkengee, Bakanji, Bakandi, Bargunji.

Ref.: Bonney 1884, Teulon and others in Curr 1886, Newland 1889, Mathews 1898 (2), Howitt 1904, Brown 1918, T.

(Ba : nbai) Banbai

Loc.: A circumscribed area embracing Ben Lomond, Glencoe, Marowan, Mount Mitchell and Kookabookra (MacPherson).

Alt.: Banbai, Bahnbi, Ahnbi, Dandai (sic).

Ref.: MacPherson 1905, Brown 1918, Radcliffe Brown 1931.

'Barenbinja Baranbinja

Loc.: Bourke to Brewarrina on northern bank of Darling River.

Alt.: Burranbinya, Burrunbinya, Barrumbinya.

Ref.: Ridley 1875, Mathews, 1903, Howitt 1904, T.

'Barindji Barindji

Loc.: In mallee, swamp and sand country parallel to and east of Darling River from Moira to within thirty miles of Euston; at Ivanhoe, Manara Range, Carowra, Kilfera and Manfred (term means forest people).

Alt.: Barrengee, Berri-ait (not the Barinji of Cameron).

Ref.: Cameron 1885, Newland 1889, T.

'Berap : e'ra : pe Baraparapa

Loc.: Between Murrumbidgee River above Hay, N.S.W., and Kerang, Vict.; at Cohuna, Gunbower, Brassi, Conargo and across river from Carrathool.

Alt.: Burrabura ba, Baraba-baraba, Barraba-barraba, Boorabirraba, Burappa, Burabura, Boora-boora, Burapper, Karraba (sic), Boort (a place name).

Ref.: Parker, 1843; Smyth, 1878, Curr 1887, Mathews 1898 (1), Howitt 1904, T.

'Bidewel Bidawal

See Victorian List.

'Bigambul, 'Bigabul Bigambul

Loc.: Weir and Moonie Rivers, east of Nindigully, Qld.; at Talwood, Qld.; MacIntyre River from east of Boomi to Texas; at Yetman, Boggabilla and Middle Creek.

Alt.: Pikambul, Bigambal, Bee-gum-bul, Pikambal, Pikum bul, Pickumbul, Picum-bul, Pickumbil.

Ref.: Ridley 1875, Threlkeld 1892, Mathews 1902 (1), Howitt 1904, T.

'Birpa : i Birpai

Loc.: Mouth of Manning River at Taree, inland to near Gloucester; principally on south side of river. (According to Radcliffe-Brown at Hastings River.)

Alt.: Birripai, Bripi, Birrapee.

Ref. Curr 1886, Mathews 1898 (1), Radcliffe-Brown 1931, Enright 1932, T.

'Daiŋgati, 'Djaingadi, 'Burugadi — Dainggati

Loc.: At Bowraville; Nambucca River and its watershed; south to Macleay River, Kempsey and Bellbrook; inland to Dividing Range, Walcha and Armidale (according to MacPherson, the south-western area around Walcha and Ingleba was occupied by the "Himberrong").

Alt.: Dang-getti, Dhangatty, Thangatti, Thangatty, Dangati, Thangatty, Tang-gette, Burgadi, Boorkutti.

Ref.: Mathews 1898, 1901, 1904 (3), MacPherson 1905, Radcliffe-Brown 1931, T.

'Daŋga : li — Danggali

Loc.: Plains north-east of Broken Hill from near Gnalta, south-westwards to near Morgan, S. Aust., in the arid country, eastwards to within a few miles of Darling River.

Alt.: Tungarlee, Tung-arlee, ? Tongaranka.

Ref.: Bonney 1884, T.

'Darkinuŋ — Darkinung

Loc.: South of Hunter River, from Jerry Plains towards Maitland, south to Wollombi Brook, at Putty, and including Macdonald, Colo, and Hawkesbury Rivers (Mathews); western boundary on divide east of Rylstone (based on Wiradjuri tribe data).

Ref.: Mathews 1897, (T).

(Daruk) — Daruk

Loc.: Mouth of the Hawkesbury River; inland to Mount Victoria, Campbelltown, Liverpool, Camden and Penrith.

Alt.: Dharruk, Dharrook.

Ref.: Mathews and Everitt 1900, Mathews 1901.

(Gandaŋara) — Gandangara

Loc.: At Goulburn and Berrima; down Hawkesbury River to about Camden. N.B.—On map Goulburn should be further to east where a town is indicated.

Alt.: Gundungurra.

Ref.: Mathews and Everitt 1900, Mathews 1901 (4).

(Geawegal) — Geawegal

Loc.: Valley of Hunter River above Glendon, Muswellbrook, Scone and lower part of Goulburn River.

Alt.: Geawegal, Gweagal.

Ref.: Rusden in Fison 1880, Howitt 1904.

'Kalibal — Kalibal

Loc.: Macpherson Range from Unumgar, N.S.W., to Christmas Creek, Qld., east to Upper Nerang and south to Mount Cougal, Tyalgum, and the Richmond River at Kyogle.

Ref.: Tindale.

Kambuwal — Kambuwal

See Queensland List.

(Kameraigal) Kameraigal

Loc.: Northern shores of Port Jackson (Collins). Perhaps a horde of Thurawal.

Alt.: Camera-gal, Cammerray-gal.

Ref.: Hunter 1793, Collins 1804, Howitt 1904.

'Kamila'roi Kamilaroi

Loc.: Walgett, N.S.W., to Nindigully, Qld., Talwood, Garah, Moree, Bingara, Tamworth, Quirindi, Bundella, Gwabegar, Come-by-Chance.

Alt.: Kamilarai, Kamilroi, Kamalarai, Koomilroi, Gumilroi, Gummilroi, Gummilray, Comleroy.

Ref.: Ridley 1886, 1875, Fraser 1892, Mathews 1898, 1900 (4), 1904 (3), Howitt 1904, MacPherson 1905, Brown 1918, T.

'Kareŋgapa Karenggapa

Loc.: Mount Bygrave, Qld., Tibooburra, N.S.W.; at Yalpunga and Connulpie Downs. Bulloo River about Bulloo Lakes; south to Milparinka.

Alt.: Karrengappa, Kurengappa.

Ref.: Curr 1886, Mathews 1898, T.

'Kitabal Kitabal

Loc.: Head-waters of Richmond and Logan Rivers on Main Dividing Range; Killarney to Urbenville, Woodenbong, Unumgar; at Rathdowney and about Spicer Gap, Qld.

Alt.: Kidabal, Kit(t)a-bool, Kitapul, Gidjoobal, Kuttibul.

Ref.: Mathew 1926, Radcliffe-Brown 1931, T.

(Koinberi) Koinberi

Loc.: Upper Castlereagh River and part of Liverpool Plains (may be part of Weilwan, which see).

Alt.: Koinberri.

Ref.: Ridley, 1875.

'Ku:la, 'Gu:nu Kula

Loc.: Western bank of Darling River from near Bourke to Dunlop, Warrego River to Enngonia, and Barringun; at Yantabulla.

Alt.: Kurnu, Guerno, Kornu, Cornu, Koonoo, Kuno.

Ref.: Taplin 1871, Ridley 1875, Fraser, 1892, Mathews, 1906, Brown 1918, T.

'Kumbaiŋgiri, 'Kumbaingir Kumbainggiri

Loc.: Head-waters of Nymboida River and across the range towards Urunga, Coff (Korff) Harbour and Bellingen; at Grafton and Glenreagh.

Alt.: Kumbaingeri, Kombaingheri, Koombanggary, Koombanggherry, Koombainga, Coombangree, Kombinegherry.

Ref.: Palmer 1884, Mathews 1898, 1901, 1904 (3), McDougal 1901, Howitt 1904, T.

'Kureinji, Kareiŋi Kureinji

Loc.: From Euston on Murray River downstream to Wentworth; on northern bank.

Alt.: Karin, Kerinma, Karinma, Karingma, Orangema, Keramin, Kemendok, Pintwa.

Ref.: Cameron 1885, Curr 1886, Howitt 1904, Brown 1918, T.

(Kwiambal) Kwiambal

Loc.: Lower Severn River, Fraser Creek and Ashford.

Ref.: MacPherson 1905, Radcliffe-Brown 1931.

'Maljaŋapa Maljangapa

Loc.: Milparinka, N.S.W., to eastern shores of Lake Frome, south to Eurinilla Creek, S. Aust., on western side of the Barrier and Coko Ranges (located too far to the east in early accounts).

Alt.: Malya-napa, Mulya-napa, Mulyanappa, Milya-uppa, Muliaarpa, Malynapa, Malyapa, Nalyanapa.

Ref.: Bonney 1884, Reid and Morton in Curr 1886, Elkin 1931, T.

'Maraura, 'Mare'aura Maraura

Loc.: From Wentworth on northern bank of Murray River downstream to Chowilla and Ral Ral, S. Aust.; on western anabranch of Darling River to Popilta Lake; on Darling River upstream to Avoca.

Alt.: Maroura, Marowera, Jakojako, Yaako-yaako, Waimbio.

Ref.: Holden in Taplin 1871, Fison and Howitt 1880, Bulmer in Curr 1886, Brown 1918, Tindale 1939, T.

'Minjaŋbal Minjangbal

Loc.: From Byron Bay north to Southport, Qld.; inland to Murwillumbah.

Alt.: Minyung, Minyowa.

Ref.: Livingstone in Threlkald 1892, Mathews 1901 (1), T.

'Morowari, 'Murawari Morowari

Loc.: Barringun, N.S.W., and Enngonia on Warrego River; Brenda Bokhara, Weilmoringle and Milroy on Birrie and Culgoa Rivers, chiefly in N.S.W.; north to Mulga Downs and Weelamurra, Qld.

Alt.: Murawari, Murrawarri, Muruwurri, Moorawarree, Moorawarrie, Marraa-waree.

Ref.: Ridley 1862, Mathews 1898 (1), 1903, Richards 1903, T.

'Muti'muti Muthimuthi

Loc.: On Lower Lachlan River at Balranald; west to Murray River.

Alt.: Muthi muthi, Matimati, Mataua. N.B.—On map the second t is not shown as an interdental.

Ref.: Cameron 1885, Brown 1918, T.

'Naualko, 'Nawalko Naualko

Loc.: Compodore to Murtee on Upper Darling River; on lower Paroo River north to Lake Tongo. Probably only a northern portion of the Barkindji, which see.

Alt.: Ngunnhalgri, Unelgo, ? Bungyarlee (of Bonney 1884), ? Mil-pulko, Mailpurlgu.

Ref.: Mathews, 1898 (2), T.

'Na:ri'na:ri Narinari

Loc.: Southern bank of the Lachlan River from Booligal to Balranald, up the Murrumbidgee River to Hay.

Ref.: Cameron 1885, T.

'ŋa : ku — Ngaku

Loc.: From Macleay River to Rolland Plains, inland to Kemp Pinnacle Mountain.

Ref.: Radcliffe-Brown 1931, T.

'ŋamba — Ngamba

Loc.: From Manning River north to Rolland Plains.

Ref.: Radcliffe-Brown 1931, T.

'ŋarigo — Ngarigo

Loc.: Monaro Tableland; Bombala River from Delegate to Nimmitabel; west to divide of the Australian Alps.

Alt.: Ngarigo, Ngarego, Ngarago, Garego, Ngarrugu, Bemeringal (of eastern tribes).

Ref.: Bulmer in Curr 1887, Mathews 1908 (2).

'ŋe : mba — Ngemba

Loc.: South bank of Barwon and Darling Rivers from Brewarrina to Yanda Creek; south to head of Mulga Creek; on Bogan River.

Alt.: Ngeumba, Ngiamba, Ngiumba, Ngaiamba, Gai-amba.

Ref.: Ridley 1862, Fraser 1892, Mathews 1904 (3), T.

(ŋunawal) — Ngunawal

Loc.: Queanbeyan to Yass, Tumut to Boorowa and across to Gundagai.

Alt.: Ngunawal, Ngoonawal, Nungawal, Yarr.

Ref.: Curr 1887, Mathews 1902 (2), 1908 (2).

Paŋgeraŋ — Pangerang

See Victorian List.

'Paru : ndji, 'Paruindji — Parundji

Loc.: Paroo River and Kulkyne Creek from Murpa, north to Brindingabba, Berawinnia Downs and Hungerford, Qld.

Alt.: Paruindi, Paruinji, Parooinge, Barungi, Barinji, Bahroonjee, Baroongee, Bahroongee, Barrengee, Parooinge, Barunga.

Ref.: Bonney 1884, Scott in Cameron 1885, Scrivener in Curr 1886, Mathews 1898 (2), Howitt 1904, Brown 1918, T.

'Tatitati — Tati-tati

See Victorian List.

'Taua, 'Tauaira — Thaua

Loc.: From Cape Dromedary south to Green Cape; west to crest of Dividing Range; at Twofold Bay, Bega, Cobargo and Narooma.

Alt.: Thawa, Thauaira, Thoorga, Thurga, Tadera-manji, Guyangal (lit. Southerners), Guyangal-yuin.

Ref.: Mathews 1902 (2), 1903 (1), Howitt 1904, T.

(Turawal) — Thurawal

Loc.: Port Hacking to Shoalhaven River (may include also Kameraigal of Port Jackson, and Wodiwodi of Wollongong to Shoalhaven River).

Alt.: Thurawal, Thurrawal, Thurrawall, Turuwul, Turrubul, Turuwull.

Ref.: Ridley 1875, Mathews 1901 (4), 1904 (3).

U'alarai — Ualarai

Loc.: North-eastwards from Narran Lake (Terrewah) to Angledool; east to Walgett; on Narran and Bokhara Rivers.

Alt.: Yualarai, Uollaroi, Yualai, Yerraleroi. (Often confused with a different tribe, Weraerai, with which synonymy seems to have become almost inextricably mixed).

Ref.: Ridley 1875, Hammond in Curr 1887, Mathews 1898 (2), 1903, Brown 1918, T.

'Wadikali — Wadikali

See South Australian List.

'Walbaŋa — Walbanga

Loc.: Cape Dromedary north to Ulladulla; at Braidwood, Araluen, and Moruya.

Alt.: Thoorga, Thurga (part), Bugelli-manji (Bargalia, a place name near Moruya).

Ref.: Mathews 1902 (2), Howitt 1904, T.

(Wandandian) — Wandandian

Loc.: Ulladulla to Shoalhaven River and Nowra.

Alt.: Wandandian, Tharumba, Kurial-yuin (lit., northern men).

Ref.: Ridley 1875, Mathews 1903, Howitt 1904.

'Wanjiwalku, 'Wainjawalku — Wanjiwalku

Loc.: Milparinka to White Cliffs, west to Coko Range and nearly to Mount Arrowsmith, east to near Tongo Lake; at Yancannia and Lake Bancannia.

Alt.: Weyneubulkoo, Wonipalku, Wanyabalku, Wonjimalku, Pono.

Ref.: Bonney 1884, Crozier in Curr 1886, T.

'Watiwati — Wati-wati

See Victorian List.

'Weilwan — Weilwan

Loc.: Southern side of Barwon River from Brewarrina to Walgett; south along Castlereagh, Marthaguy and Macquarie Rivers to Warren, Trangie, Dubbo, and Coonabarabran. (Equated with Ngemba by Ridley, who places the Koinberi on upper Castlereagh River and on part of Liverpool Plains).

Alt.: Wailwan.

Ref.: Ridley 1875, Curr 1886, Mathews 1898 (2), 1904 (3), T.

'Wemba'wemba, 'Wamba'wamba — Wembawemba

Loc.: From Kerang, Vict., to Swan Hill on Loddon River; on Avoca River south to Charlton, Vict.; northwards to Booroorban and Moulamein, N.S.W.; at Barham, Lake Boga and Boort.

Alt.: Wamba-wamba, Womba, Weumba, Waamba, Yamba-yamba, Yamba.

Ref.: Smyth 1878, Curr 1887, Mathews 1898 (2), Howitt 1904, T.

'Weraerai Weraerai

Loc.: Gwydir River from Moree to Bingara, north to Warialda and Gilgil Creek.

Alt.: Wiraiarai, Wallaroi, Wolroi, Walarai, Walari, Wolaroi, Wollaroi, etc. (often confused with a different tribe, Ualarai).

Ref.: (See references mixed with those under Ualarai.) T.

'Widjebal Widjabal

Loc.: Upper Richmond River from Kyogle south to Casino, east to Coraki; an inland tribe.

Ref.: Tindale.

'Wiljakali, 'Wilja:li Wiljakali

Loc.: Barrier Range; west to Olary, S. Aust.; at Boolcoomatta; east to Wilcannia.

Alt.: Wilyakali, Wilya, ? Willoo.

Ref.: Shaw in Taplin 1879, Bonney 1884, Dix in Curr 1886, Howitt 1904, T.

'Wiradjuri, 'Wiraduri Wiradjuri

Loc.: Neckarboo Range, Ivanhoe, St. Andrews, Carrathool, Wagga-wagga, Mudgee, Parkes, Trundle; headquarters along the Lachlan River; east to Gundagai, Boorowa and Rylestone; south to Howlong on Upper Murray; at Albury and east to about Tumbarumba.

Alt.: Wiradhuri, Wiraduri, Wiradjeri, Wira-dhari, Wirraidyuri, Wiiratheri, Wira-shuri, Werogery, Woradjera, Woradjerg, Wirra-Athoorree, Wirrajeree, Wirrai-yarrai, Wirrach-aree.

Ref.: Ridley 1875, Smyth 1878, Lane in Smyth 1878, Howitt 1882, 1904, Cameron 1885, Rouse in Curr 1887, Fraser, 1892, Threlkeld 1892, Mathews 1897, 1904 (3), Richards 1902, Brown 1918, T.

(Wodiwodi) Wodiwodi

Loc.: North of Shoalhaven River to Wollongong.

Ref.: Ridley 1875.

(Wolgal) Wolgal

Loc.: Head-waters of the Hume (Murray), Murrumbidgee, and Tumut Rivers; at Kiandra.

Alt.: Walgalu.

Ref.: Howitt 1883.

(Won:arua) Wonarua

Loc.: Upper Hunter River from ten miles above Maitland; west to Dividing Range.

Alt.: Wannerawa.

Ref.: Miller in Curr 1887, Mathews 1898.

'Woŋaibon Wongaibon

Loc.: Head-waters of Bogan River, Yanda, and Crowal Creeks. At Trundle, Narromine, Nyngan, Girilambone, Abbotsford, Tiltagara and Gilgunnia.

Alt.: Wongai-bun, Wonghibon, Wonghi, Wombungee.

Ref.: Ridley 1875, Cameron 1884, Howitt 1904, Mathews 1904 (3), Brown 1918, T.

'Worimi, 'Kata:ŋ, 'Katja:ŋ — Worimi

Loc.: Hunter River to near Tuncurry, along coast; inland to about Glendon Brook and head of Myall Creek.

Alt.: Warrimee, Kattang, Kutthung, Guttahn.

Ref.: Enright 1899, Radcliffe-Brown 1931, Firth 1932, Elkin, T.

(Jiegera) — Jiegera

Loc.: Lower Clarence River.

Alt.: Yiegera.

Ref.: Radcliffe-Brown 1931.

'Jitejite, 'Tjuop — Jita-jita

Loc.: Northern side of Lachlan River from Booligal to Balranald.

Alt.: Ita-ita, Ithi-ithi, Eetha-eetha, Yit-tha, Yitsa.

Ref.: Macdonald in Curr 1886 (note correction in his list of errata, v. 3), Mathews 1898 (1), T.

'Jo:ti'jo:ta — Joti-jota

Loc.: Murray River from Cohuna to Echuca and a point twenty miles west of Tocumwal; at Shepparton and Nathalia, Vict., Tuppal, N.S.W., Conargo, and Deniliquin.

Alt.: Yotayota.

Ref.: Mathews 1898 (2), 1904 (3), T.

'Jukembal, 'Jukambil — Jukambal

Loc.: From Inverell north eastward across New England to Tabulam and Wallangarra. (The western portion, including Upper Severn River, Beardy River, Stonehenge, and Bolivia, is sometimes called Ngarabal.)

Alt.: Yukambal, Yukumbil, Yookumbul, Yookumbill, Ukumbil, Yookumble, Yurimbil (misprint), Ngarabal, Ngarrabul ? Preagalgh.

Ref.: Myles in Curr 1887, Mathews 1898 (1), 1902 (2), MacPherson 1905, Brown 1918, Radcliffe-Brown 1931, T.

VICTORIAN TRIBES

'Berap:e'ra:pe — Baraparapa

See New South Wales List.

'Bidewel — Bidawal

Loc.: Coast between Green Cape, N.S.W., and Cape Everard; inland to Delegate, N.S.W., and on head-waters of Cann and Bemm Rivers.

Alt.: Bidwell, Bidwill, Bidwelli, Biduelli, Beddiwell, Birdhawal, Birtowall.

Ref.: Parker 1843, Smyth 1878, Curr 1887, Howitt 1904, Mathews 1898 (1), 1908 (2), T.

'Brabraluŋ — Brabralung

Loc.: Mitchell, Nicholson and Tambo Rivers; south to about Bairnsdale and Bruthen. This is one of the five Gippsland tribes often grouped together as the Kurnai ['Ga:nai, 'Ka:nai].

Alt.: Brabrolung, Brabrolong, Brabriwoolong, Tirthung, Tirtalowakani (? horde name).

Ref.: Smyth 1878, Curr 1887, Howitt 1904, T.

'Braiakau'luŋ — Braiakaulung

Loc.: Providence Ponds, Avon and Latrobe Rivers; west of Lake Wellington to Mounts Baw Baw and Howitt.

Alt.: Brayakaulung, Braiakolung, Brayakau.

Ref.: Smyth 1878, Curr 1887, Howitt 1904, T.

'Bratauoluŋ — Bratauolung

Loc.: From Cape Liptrap east to mouth of Merriman Creek; inland to about Mirboo; at Port Albert and Wilson Promontory.

Alt.: Bradowoolong, Brataualung, Bratanolung (sic), Tarrawarracka, Tarrawarrachal.

Ref.: Smyth 1878, Curr 1887, Howitt 1904, T.

'Buneroŋ — Bunurong

Loc.: From Melbourne south-east to west side of Cape Liptrap; on Mornington Peninsula; a coastal tribe; inland to Dandenong Range; at Mirboo, Warragul, Neerim, Upper Latrobe River.

Alt.: Boonurrong, Boonoor-ong, Bunwurung, Bunwurru.

Ref.: Smyth, 1878, Mathews 1904 (3), Howitt 1904, T.

'Buŋanditj — Bunganditj

See South Australian List.

'Gu:nditjmara, 'Ku:nditjmara — 'Gurnditj'mara

Loc.: At Cape Bridgewater and Lake Condah in west, Caramut and Hamilton in north; Hopkins River in east; at Warrnambool, Woolsthorpe, Port Fairy and Portland.

Alt.: Gournditch-mara, Kuurn-kopan-noot, Kirurndit.

Ref.: Smyth 1878, Dawson 1881, Howitt 1904, T.

'Ka:nai, 'Ga:nai — Kurnai

An agglomeration of tribes See Brabralung, Braiakaulung, Bratauolung, Krauatungalung and Tatungalung.

('Kir:ae, 'Kirawiruŋ) — Kirrae

Loc.: Warrnambool to about Princetown on coast; inland to Lake Boloke, Darlington, east to beyond Camperdown; eastern boundaries uncertain; several hordes speaking slight dialects.

Alt.: Kirraewuurong.

Ref.: Smyth 1878, Dawson 1881, Howitt 1904.

(Kolakŋat) — Kolakngat

Loc.: Vicinity of Lake Colac and Lake Corangamite. Data concerning this tribe very uncertain.

Alt.: Kolac-gnat, Coligan.

Ref.: Smyth 1878, Dawson 1881.

'Krauetuŋa'luŋ — Krauatungalung

Loc.: Cape Everard to Lakes Entrance; Buchan and Snowy Rivers; inland to about Mount Cobberas.

Alt.: Kroatungolung, Krow-ithun koolo.

Ref.: Smith 1878, Howitt 1904, T.

('Kuruŋ) Kurung

Loc.: West side of Port Phillip Bay between Werribee River and Geelong; inland to Dividing Range; westwards towards Ballarat, but boundary not defined; at Ballan.

Alt.: Kurung-jang-baluk.

Ref.: Howitt 1904.

'Latje'latji Latjilatji

Loc.: Chalka Creek to Mildura on western bank of Murray River, ranging about twenty miles back from river. (On Smyth's map the name of this tribe is apparently transposed with that of his "Darty Darty.")

Alt.: Laitchi-Laitchi, Litchy-Litchy, Leitchi-Leitchi, Latjoo-Latjoo, Lutchye-Lutchye, Latyoo-Latyoo, Litchoo-Litchoo, Laci-Laci, Laitu-Laitu, Laitu.

Ref.: Smyth 1878, Corney in Curr 1887, Mathews 1898 (2), Howitt 1904, Brown 1918, T.

'Marditjali Marditjali

Loc.: Between Naracoorte and Mount Arapiles; south to Struan, north to Bangham, Kaniva and Servicetown; at Edenhope; a small tribe but distinct from Jardwa; [ba:ŋg] = man.

Alt.: "Lake Wallace Tribe," Keribial-barap.

Ref.: Hartmann in Smyth 1878, Curr 1887, T.

'ŋintait Ngintait

Loc.: Ned Corner, Vict., to Salt Creek, N.S.W., chiefly on southern bank of Murray River; west to about Paringa, S. Aust., southwards about fifty miles.

Alt.: Inteck.

Ref.: Mathews 1898 (2), Brown 1918, T.

'Paŋgeraŋ Pangerang

Loc.: Between Lower Goulburn and Murray Rivers, east of Shepparton; at Tocumwal and Albury; north towards Narrandera; south to Violet Town and Mansfield; in Wangaratta and Benalla districts. (Howitt's localization was probably too far west. There were well defined hordes, names of which terminate in [-pan].)

Alt.: Pangorang, Pangurang, Pine-gorine, Bangerang.

Ref.: Eyre 1845, Smyth 1878, Curr and Le Souef in Curr 1887, Howitt 1904, T.

'Tati'tati, 'Tuŋgut Tati-tati

Loc.: From eight miles below Euston to fifteen miles above Murrumbidgee junction; chiefly on southern bank of Murray. Smyth has, on his map, apparently transposed this name with "Litchy-Litchy."

Alt.: Tataty, Tatatha, Tata(h)i, Ta-ta-thi, Taa-tatty, Darty-Darty, Nimp-mam-wern (lit., light lip).

Ref.: Smyth 1878, Cameron 1885, Threlkeld 1892, Mathews 1898 (2), T.

'Tatuŋaluŋ Tatungalung

Loc.: Coast along Ninety Mile Beach and about Lakes Victoria and Wellington from Lakes Entrance west to mouth of Merriman Creek.

Alt.: Tatungolung, Tatoongolong, Tatunga, Boulboul (? horde name).

Ref.: Smyth 1878, Howitt 1904, T.

('Tauŋguroŋ) Taungurong

Loc.: Goulburn River Valley upstream from Murchison; at Violet Town, Mansfield, Kilmore and Alexandra; west to Heathcote.

Alt.: Thagunworung, Thaguwurru, Taguniourung, ? Dhauhurtwurru, Ngooráialum, Nguralung-bula, Mouralung-bula, Gnurellean, Oorallim, Butherabaluk, Yawang-illam, Yauung-illam, Yowang-illam.

Ref.: Ridley 1875, Smyth 1878, Curr 1887, Howitt 1904, Mathews 1904 (3).

(Tjapwuroŋ) Tjapwurong

Loc.: At Mount Rouse; west to Hamilton, east to Hopkins River and Wickliffe; north to near Mount William, Stawell, Ararat, and Dividing Range; several hordes speaking slight dialects.

Alt.: Tyapwurru, Chaapwurru, Pirt-kopan-noot (a dialect), Purteet-chally, Punoinjon, Kolor (place name of Mount Rouse).

Ref.: Smyth 1878, Dawson 1881, Mathews 1904 (3).

'Warke'warke 'Werke'werke, Warkawarka

Loc.: Tyrrell Creek and Lake Tyrrell south to Warracknabeal and Birchip; west to Hopetoun; on Morton Plains.

Alt.: Waikywaiky, Weki-weki, Mirdiragoort, Boorong.

Ref.: Smyth 1878, Curr 1887, Howitt 1904, T.

(Wataurуŋ) Wathaurung

Loc.: South of Geelong to Cape Otway; west to about Princetown and Upper Barwon River; also north-east of Geelong (relationship to Kurung not defined).

Alt.: Wadthaurung, Waitowrung, Wudthaurung, Wudjawurung, Witowurung, Witowur(r)ong, Witowro, Witoura, Wuddyawurru, Wiityawhuurong.

Ref.: Parker 1843, Smyth 1878, Dawson 1881, Howitt, 1904, Mathews 1904 (3).

('Wati'wati) Wathiwathi

Loc.: Murray River between a point fifteen miles above Murrumbidgee Junction and Swan Hill, extending northwards to about Moolpa, N.S.W.

Alt.: Wathiwathi, Watthiwatthi, Watty-watty, Wotti-wotti.

Ref.: Smyth 1878, Howitt 1883, Threlkeld 1892, Mathews 1898 (2), Howitt 1904.

'Wembawemba Wembawemba

See New South Wales List.

'Wotjobalek Wotjobaluk

Loc.: Wimmera River, Lakes Hindmarsh and Albacutya; Outlet Creek; south to Dimboola, Kaniva and Servicetown; west to about Yanac; east to Warracknabeal and Lake Korong.

Ref.: Mathews 1903 (1), Howittt 1904, Mathews 1904 (3), T.

('Wurundjeri, Woiwurung) Wurundjeri

Loc.: Yarra and Saltwater Rivers; at Melbourne; north-west to Macedon, Woodend and Lancefield, east to Mount Bawbaw; at Healesville.

Alt.: Wurunjeri, Wurrunjeri, Woiwurru, Woiworung, Woeworung, Woeewoorong, Wawurong, Wawoorong, Oorongir, Gunung-willam, Ngaruk-willam, Kurunjang.

Ref.: Smyth 1878, Curr 1887, Howitt 1904.

'Ja:dwe, 'Mukja:dwen, 'Ja:rewe Jardwa

Loc.: Horsham and Upper Wimmera River; south to Grampians, west to Mount Arapiles; east to beyond Glenorchy and Stawell. (Tribal movements were towards the south, reaching almost to Casterton and Hamilton at time of first white contacts.)

Alt.: Yardwa tyalli, Knindowurrong, Djappuminyou (? horde).

Ref.: Parker 1843, Smyth 1878, Howitt 1904, Mathews 1904 (3), T.

('Jaitmathang) Jaitmathang

Loc.: Head-waters of Mitta-mitta and Tambo Rivers; some of sources of the Ovens River; the Indi River to "Tom Groggin Run" (Howitt).

Alt.: Ya-itma-thang, Theddora-mittung (Mitta-mitta horde), Thar-a-mirttong, Theddora, Dhudhuroa, Jandangara, Gundanora.

Ref.: Smyth 1878, Mitchell in Curr 1887, Howitt 1904.

'Ja:re Jaara

Loc.: Upper Loddon, Avoca and Campaspe Rivers, east to Seymour, west to St. Arnaud and Lake Buloke, north to about Boort; south to Daylesford and Dividing Range. (Not to be confused with Jardwa.)

Alt.: Yaura, Yayaurung, Jajaurung, Jajowurrong, Jajowrung, Jajow(e)rong, Jajoworrong, Ja jow-er ong, Djadjawurung, Jurobaluk, Nira-baluk, Niraba-baluk, Panyool?, Knenknenwurro.

Ref.: Parker 1843, 1954, Smyth 1878, Curr 1887, Howitt 1904, T.

('Jari'jari) Jari-jari

Loc.: Western bank of Murray River from above Chalka Creek to Annuello; south to Lake Korong (Hopetoun).

Alt.: Yari-yari, Yarre-yarre, Yerri-yerri, Yerre-yerre, Yairy yairy, Yariki-luk (Wotjobaluk term).

Ref.: Smyth 1878, Mathews 1898 (2), Howitt 1904.

'Jo:tijo:ta Joti-jota

See New South Wales List.

WESTERN AUSTRALIAN TRIBES

A'maŋu, E'maŋu, 'Jiŋ Amangu

Loc.: From southern vicinity of Geraldton to Hill River; at Champion Bay; inland to Mullewa.

Alt.: Ying (= no), "Geraldton Tribe."

Ref.: Goldsworthy in Curr, 1886, T.

(Andedja) Andedja

Loc.: Upper Forrest River, chiefly on the southern tributaries.

Alt.: Kular (kular = west).

Ref.: Elkin 1933, Kaberry 1935.

(Arawari) Arawari

Loc.: King River.
Alt.: Arawodi.
Ref.: Elkin 1933, Kaberry 1935.

(Arŋga) Arnga

Loc.: South side of lower reaches of Forrest River. N.B.—Not marked on map.
Ref.: Elkin 1933, Kaberry 1935.

'Ba:de, 'Ba:d Bard

Loc.: Cape Leveque Peninsula, Cape Borda and Cygnet River. This is the tribe first encountered by Dampier, 14 January 1688. His is probably the first reference to Australian aborigines.
Alt.: Barda, Bardi.
Ref.: Bates 1914, Elkin 1933, Lavis ms., Capell 1940, T.

(Ba:gu:) Bagu

Loc.: Lower Drysdale River.
Ref.: Elkin 1933, Capell 1940.

'Bailko Bailko

Loc.: Head of the De Grey and Oakover Rivers; north east of Upper Fortescue River.
Alt.: Bailgu, Balgu, Balgoo, Pulgoe, Boolgoo.
Ref.: Yabaroo 1899, Withnell 1901, Clement 1903, Brown 1912, Bates 1914, Connelly 1932, T.

(Baioŋ) Baiong

Loc.: Lower Lyndon and Minilya Rivers.
Alt.: Baiong, Baiung, Biong.
Ref.: Yabaroo 1899, Brown 1912, Bates 1914, Connelly 1932, Fowler 1940.

(Balardoŋ) Balardong

Loc.: York district and east of it (to the east of them are circumcising peoples) at Beverley and along Avon River; north to Wongan Hills.
Alt.: Ballardong, Ballerdokking, Waljuk, Toode-nunjer (['Tu:de] = place name = Toodyay, ['njuŋa] = men; a name applied by coastal people).
Ref.: Hackett in Curr 1886, Bates 1906.

('Bedeŋo) Bedengo

Loc.: Godfrey Tank and dry country to the west; boundaries uncertain (Worms); "desert east of Marble Bar" (Connelly). N.B. Probably shown too far south on map.
Alt.: Pedong, Peedong, Pidunga, Peedona, Pardoo.
Ref.: Harper in Curr 1886, Connelly 1932, Worms (ms.).

('Bemba) Bemba

Loc.: Near Mount Casuarina, Joseph Bonaparte Gulf. N.B.—Omitted from map.
Ref.: Elkin 1933.

(Binigura) Binigura

Loc.: Duck Creek; south to Ashburton River; north-east to Hamersley Range; head-waters of Robe and Cane Rivers.

Alt.: Binnigoora, Biniguru, Binnigora.

Ref.: Yabaroo 1899, Bates 1914, Connelly 1932.

'Buluguda Buluguda

Loc.: Hamelin Pool and Peron Peninsula.

Ref.: Sheard (ms.), (T).

('Bunaba) Bunaba

Loc.: Hann River, Warton Range, Bamumbah Downs, Eastern King Leopold Ranges; more recently at Fitzroy Crossing and Gogo Station (*fide* Worms).

Alt.: Bunapa, Punaba.

Ref.: Kaberry 1932, Elkin 1933, Capell 1940, Worms (ms.).

('Bu: duna) Buduna

Loc.: Henry River and Upper Lyndon River.

Alt.: Burduna, Budoona, Poordoona.

Ref.: Yabaroo 1899, Bates 1914, Connelly 1932.

(Buna: ra) Bunara

Loc.: Sturt Creek south to Gregory Salt Sea.

Alt.: Boonarra.

Ref.: Terry 1926 and ms., Capell 1940.

(Djaberadjaber) Djaberadjaber

Loc.: Cape Boileau north nearly to Beagle Bay.

Ref.: Bischofs 1908, Elkin 1933, Worms ms.

(Djaru, Djaro) Djaru

Loc.: Hall Creek and southern vicinity. The "Ruby Creek Tribe," *fide* Worms.

Alt.: Jaruru, Jaroo.

Ref.: Mathews 1901, Bates 1914, Elkin 1933, Kaberry 1937, Worms (ms.), Capell 1940.

(Djaui) Djaui

Loc.: Sunday Island and Buccaneer Archipelago.

Alt.: Tohawi, Tohau-i, Ewenu (name for Buccaneer Islands), Ewenyoon.

Ref.: Bird 1909, Bates 1914, Elkin 1933, Capell 1940.

(Djerag) Djerag

Loc.: Durack Range.

Alt.: Durackra (? confusion with map label for Durack Range).

Ref.: Elkin 1933, Capell 1939, 1940.

(Djiwali) Djiwali

Loc.: Capricorn Range; Ashburton River south and east of junction with Hardey River.

Alt.: Jiwali, Jivali.

Ref.: Brown 1912, Connelly 1932.

('Djugun) Djugun

Loc.: At Broome; northern shores of Roebuck Bay.
Alt.: Djukan, Jukan.
Ref.: Bischofs 1908, Connelly 1932, Elkin 1933, Capell 1940.

(Gadjeroŋ) Gadjerong

Loc.: East of Cambridge Gulf; west of mouth of Victoria River (see also Kadjerawang in North Australian List).
Alt.: Kadjerong, Kadjeroen.
Ref.: Spencer 1914, Kaberry 1935, Capell 1940.

(Galumburu) Galumburu

Loc.: Drysdale River.
Ref.: Capell 1940.

(Gambre) Gambre

Loc.: Admiralty Gulf.
Ref.: Capell 1940.

(Gidja) Gidja

Loc.: Near Turkey Creek.
Ref.: Capell 1940.

(Gogoda) Gogoda

Loc.: Delta of Sturt Creek in Gregory Salt Sea and country to the east.
Ref.: Worms (ms.).

(Guidj) Guidj

Loc.: East of Mount Barnett.
Ref.: Capell 1940.

(Guluwarin) Guluwarin

Loc.: Lower Ord River.
Ref.: Capell 1940.

(Gunan) Gunan

Loc.: No locality given. N.B.—Not marked on map.
Ref.: Capell 1940, p. 244.

(Gwini, Gwi:ni) Gwini

Loc.: North of Forrest River.
Ref.: Kaberry 1935, Capell 1940.

(Ibarga) Ibarga

Loc.: Throssell and Gregory Ranges; upper Oakover River.
Alt.: Ibarrga, Ibargo.
Ref.: Brown 1912, Bates 1914, Connelly 1932.

(Inawoŋga) Inawonga

Loc.: Ashburton River between about Seven Mile Creek and Angelo River Junction; on Turee Creek.
Ref.: Brown 1912.

(Indjibandi) Indjibandi

Loc.: Fortescue River inland from about Mount Pyrton; north to upper Yule River; east to Mungaroona Range. The westerly (not easterly) part of tribe is called Karama, which see.
Alt.: Injibandi, Ingibandi, Yingiebandie.
Ref.: Withnell 1901, Clement 1903, Brown 1912, Connelly 1932.

'Iŋga : da Ingarda

Loc.: Coast at Shark Bay between Gascoyne and Wooramel Rivers; inland to Red Hill.

Alt.: Ingarda, Ingara, Ingarrah, Inparra ("p" is probably misprint), Kakarakala (general term applied to several tribes).

Ref.: Barlee in Curr 1886, Gribble 1903, Bates 1914, Connelly 1932, Fowler 1940, T.

'Kala : ko Kalarko

Loc.: Grass Patch to north of Widgemooltha; Golden Ridge and Burbanks; east to the red ochre deposit approximately fifteen miles west of Fraser Range; west to Bremer Range, Barker Lake and Koongorin; a boundary camp about three miles south of Coolgardie; at Norseman and Salmon Gums.

Alt.: Malba (lit. circumcised ones; name applied by Wudjari).

Ref.: Tindale.

Ke'la : mai, 'Njindaŋo, Takala : ko Kalamai

Loc.: At Boorabbin and Southern Cross; east to Bulla Bulling, north to Youanmi, Lake Barlee and Pigeon Rocks; west to Burracoppin, Mukinbudin, Kalannie and Lake Moore; south to about Parker Range. A term Jawan is applied to north-western portion of tribe from north of Mukinbudin.

N.B.- On map stress mark is wrongly placed in name of this tribe.

Alt.: Takalako (Njakinjaki term), Njindango, Natingero.

Ref.: Adam in Curr 1886, T.

'Kaneaŋ Kaneang

Loc.: West of a line joining Katanning, Tambellup, Cranbrook and Tenterden; at Kojonup, Collie, Donnybrook, Greenbushes, Bridgetown; headwaters of Warren and Frankland Rivers; south bank of Collie River to Collie, thence to coast; north to Harvey. Northern limit of tribe corresponds with change from place names with "-up" termination to ones with "-ing."

Alt.: Kunyung, Jabururu (Minang term; lit., north-westerns), Yobberore. "Urduc, Harvey tribe."

Ref.: Nind 1831, Small in Curr 1886, T.

'Karadjeri, 'Karedja : ri Karadjeri

Loc.: From south point of Roebuck Bay south west to a place ten miles north of Anna Plains Station; inland about seventy miles.

Alt.: Garadjeri, Karadhari.

Ref.: Bates 1914, Connelly 1932, Elkin 1933, Capell 1939, 1940, Worms ms., T.

'Kerama Karama

Loc.: Valley of Fortescue River east of Millstream. This is also regarded as a westerly (not easterly) subtribe of the Indjibandi, which see.

Alt.: Karama, Korama.

Ref.: Brown 1912, 1914, T.

(Kariera) Kariera

Loc.: Yule River; Port Hedland; Turner River. (Barlee (l.c., p. 291) transposed the relative positions of this and the Widagari with respect to Ngarla tribe.)

Alt.: Karriara, Karriarra, Kyreara, Kaierra.

Ref.: Barlee in Curr 1886, Yabaroo 1899, Withnell 1901, Clement 1903, Brown 1912, 1914, Bates 1914.

'Ko : ara — Koara

Loc.: Between Lawlers and Leonora; west to Mount Ida and Lake Barlee; east to Mount Sir Samuel, Woodarra, Mount Zephyr and Morgans; north western boundary probably near Sandstone.

Ref.: Tindale.

'Konejandi — Konejandi

Loc.: On Margaret River; west to about Fitzroy.

Alt.: Kunian, Kunan, Gunian.

Ref.: Elkin 1933, Kaberry 1937, Capell 1940, T.

'Konin — Konin

Loc.: At Lake Nabberoo, east of Gascoyne River head waters; on Negrara Creek; at Windich Spring.

Ref.: Tindale.

'Ko : reŋ, 'Ko : reŋi, 'Kalcep — Koreng

Loc.: From Gairdner River to Pallinup (Salt) River; inland to Jeramungup, Pingrup, Nampup (= Nyabing), Badgebup and Kibbleup near Broome Hill; south to Stirling Range; at Gnowangerup and Ongerup; not originally at Kojonup. Northern limit marked by change of terminations of place names from "-up" to "-ing."

Alt.: Kuriny, Corine, Qualup, "Kojonup and Stirling Tribe."

Ref.: Nind 1831, Hassell 1936, T.

(Kurduwoŋga) — Kurduwonga

Loc.: West of Robinson Range; at Mount Gould, Macadam Plains; country between Gascoyne and Murchison Rivers.

Alt.: Kurduwonga.

Ref.: Bates 1914.

(Luŋga) — Lungga

Loc.: North of Hall Creek; head-waters of Ord River.

Alt.: Lunga, Loonga.

Ref.: Terry 1926, Elkin 1933, Kaberry 1937, Capell 1940.

'Ma : doi : tja — Madoitja

Loc.: West of Carnarvon Range; north of Lakes King and Nabberoo (boundaries only approximately defined). Not to be confused with Mardo.

Alt.: ? Wainawonga.

Ref.: Connelly 1932, T.

'Madu'woŋga, 'Jindi — Maduwonga

Loc.: From Pingin west to Mulline; from just south of Menzies to Kalgoorlie, Coolgardie, Kanowna, Kurnalpi, Siberia (statements suggest protohistoric movement from east).

Ref.: Tindale.

('Maia) Maia

Loc.: Cape Cuvier; Salt Lake; from Minilya River south to Gascoyne River.

Alt.: Maia, Miah.

Ref.: Yabaroo 1899, Barlee in Curr 1886, Brown 1912, Bates 1914, Connelly 1932.

(Maialŋa) Maialnga

Loc.: Glenelg River. (According to other statements, this area is part of Worora territory, which see.)

Alt.: Maialnga.

Ref.: Bates 1914.

('Maldjana) Maldjana

Loc.: Shark Bay, south of Wooramel River; southern boundary near Hamelin Pool.

Alt.: Majanna, Malgana (Ingarda terms).

Ref.: Barlee in Curr 1886, Brown 1912, Connelly 1932.

Mal'ŋin Malngin

See South Australian List.

'Mandjindja, 'Mandjindjara Mandjindja

Loc.: Sandhill country south of Warburton Range (not extending to this range), west to Lake Gillen and Throssell, south to Amy Rocks and Saunders Range; east to point south of Livesey Range (recorded as from Laverton district, where they are recent visitors only).

Alt.: Mandjindjara, Manjinjiwonga.

Ref.: Bates 1914, Elkin 1940, T.

(Maŋala) Mangala

Loc.: Jurgurra Creek; Edgar Range.

Alt.: Mangala, Manala, Minala.

Ref.: Elkin 1933, Kaberry 1937, Capell 1940, Worms (ms.).

(Ma:nungu) Manungu

Loc.: Berkeley River.

Alt.: Mande, Manda (? a horde name).

Ref.: Elkin 1933, Kaberry 1937, Capell 1940.

'Mardo Mardo

Loc.: North of Brassey Range; along Canning Stock Route (boundaries not defined and few particulars known).

Ref.: Tindale.

(Mardudunera) Mardudunera

Loc.: Mouth of Fortescue River: Robe and Cane Rivers.

Alt.: Mardudhoonera, Mardatunera, Mardathoni, Mardatuna, Maratunia.

Ref.: Yabaroo 1899, Clement 1903, Brown 1912, 1914, Bates 1914.

'Min:eŋ Minang

Loc.: King George Sound; north to Stirling Range, Tenterden, Lake Muir, Cowerup and Shannon River. On coast from West Cliff Point to Boat Harbour at Pallinup (Salt) River; at Mount Barker, Nornalup, Wilson Inlet and Porongurup Range. (['Minaŋ] = south. Nind's identification of *Mearn-anger* as *mearne anger* not confirmed.)

Alt.: Minung, Meenung, Mearn-anger.

Ref.: Nind 1831, Graham in Curr 1886, Spencer and others in Curr 1886, T.

Mirniŋ. 'Mi:niŋ, 'ŋandaða, Wanbiri — Mirning

Loc.: From east of Port Culver to White Well, S. Aust., at head of Great Australian Bight; inland normally only to southern edge of treeless karst plateau of Nullarbor Plain; two or more hordes named after localities; including Wonunda- and Jirkla-mirning (mirning = man, Wonunda = Eyre Sand Patch, Jirkla = Eucla).

Alt.: Mining, Meening, Wanbiri, Warnabirrie, Warnabinnie, Wanmaraing (ms.), Yirkla, Ikala, Ikula.

Ref.: Graham in Curr 1886, Mathews 1900, Howitt 1904, Elkin 1931, 1940, T.

(Miriwun) — Miriwun

Loc.: Central Ord River.

Alt.: Mirung.

Ref.: Elkin, 1933, Kaberry 1937, Capell, 1940.

(Muliar:a) — Muliarra

Loc.: North of Sanford (sometimes Sandford) River; on Roderick River.

Alt.: Malleyearra (given as word for "east").

Ref.: Perks in Curr 1886, Gifford in Curr 1886.

(Munumburu) — Munumburu

Loc.: Upper Drysdale River.

Ref.: Capell 1940.

'Murunitja — Murunitja

Loc.: Northern margin of Nullarbor Plain from Naretha to about north of Loongana; northwards for about 150 miles; at Rawlinna and Walawuluna Rockhole.

Alt.: Mooroon.

Ref.: Williams in Curr 1886, T.

'Nan:a, 'ŋan:adjara — Nana

Loc.: North-east of Lakes Carnegie and Wells; west of Lake Gillen, probably to about Timperley Range; southwards to Ernest Giles Range; northward boundary unknown.

Alt.: Nganadjara (Ngadadjara term).

Ref.: Tindale.

'Nanda, 'Jau — Nanda

Loc.: South of Murchison River; at Tjinbarda near Northampton and Wilugabi near Geraldton.

Alt.: Yau, Eaw (J. Forrest, note in British Museum).

Ref.: Goldsworthy and Barlee in Curr 1886, Brown 1912, Radcliffe-Brown 1931, Connelly 1932, T.

(Naŋamada) — Njangamada

Loc.: Eighty Mile Beach north of Cape Keraudren to Anna Plains; inland about eighty miles.

Alt.: Njangamada, Nyangamada, Nangamada, Nangamurda.

Ref.: Bates 1914, Piddington 1932, Connelly 1932, Capell 1940.

'Naŋatadjara, 'ŋalapita — Nangatadjara

Loc.: East of Lake Carey and Burtville to about Plumridge Lakes; north-east to Bailey, Virginia and Newland Ranges. At Lakes Yeo and Rason and Bartlett Soak. Moved westwards, between 1890 and 1900 to Burtville and Laverton.

Alt.: Nangandjara, Nganandjara, Dituwonga, Ditu.

Ref.: Bates 1914, Elkin 1940, T.

(ŋadawoŋga) — Ngadawongga

Loc.: Meekatharra north to Gascoyne River; at Mount Maitland and Robinson Ranges; east to about Lake King; at Peak Hill and Murchison West. (Not to be confused with Ngadadjara of Warburton Range.)

Alt.: Ngadhawonga, Ngargawonga.

Ref.: Bates 1914, Connelly 1932.

'ŋa : dadjara — Ngadadjara

Loc.: At Warburton Range; south-east to Livesey Range and Mount Blyth; eastward to just west of Cavanagh Range; Barrow Range, north-eastwards to Bedford Range; north-western boundary unknown.

Ref.: Tindale 1936, T.

'ŋadjunma, 'ŋadunma, 'ŋadju:, 'ŋadjun'pekara — Ngadjunma

Loc.: Goddard Creek south to Israelite Bay and Port Malcolm; west to Fraser Range; east to Naretha and west of Point Culver; at Mount Andrew, Russel Range and Balladonia.

Alt.: Ba:donjunga (lit., subincised men; Wudjari term), Fraser Range Tribe.

Ref.: Helms 1896, T.

(Ngalawoŋga) — Ngalawonga

Loc.: Ophthalmia Range west of Fortescue River; west to Ashburton River.

Ref.: Brown 1912, Connelly 1932.

'ŋalea — Ngalea

See South Australian List.

'ŋaluma — Ngaluma

Loc.: Roebourne and vicinity; at Sherlock River; inland for about seventy miles; islands off Nickol Bay but not those off Hampton Harbour; west almost to Maitland River.

Alt.: Ngaluma, Gnalooma, Gnalouma, Gnalluma, "Nickol Bay Tribe."

Ref.: Richardson in Curr 1886, Yabaroo 1899, Withnell 1901, Clement 1903, Bates 1914, Connelly 1932, T.

'ŋerla — Ngarla

Loc.: Mouth of De Grey River, chiefly on the south side, but extending northwards towards Cape Keraudren (were contracting westward in early historic period).

Alt.: Ngurla, Ngirla, Ngala, Gnalla.

Ref.: Harper in Curr 1886, Yabaroo 1899, Brown 1912, Bates 1914, Connelly 1932, T.

(ŋormbal) Ngormbal

Loc.: Vicinity of Barred Creek; south from Cape Boileau nearly to Broome.

Ref.: Bischofs 1908, Elkin 1933, Worms ms., Capell 1940.

'ŋurlu Ngurlu

Loc.: Menzies to Malcolm; west to Mount Ida; east to Lake Raeside and Edjudina. After 1890 overwhelmed by westward movement of Waljen and Nangatadjara tribes.

Ref.: Tindale.

('Nimanboro) Nimanboro

Loc.: West side of King Sound from Disaster Bay, south of Cygnet Bay, to Fraser River.

Ref.: Worms ms.

(Noala)

Loc.: Mouth of Ashburton River and south-westward to Giralia; east to Cane River; inland to Parry Range; at Onslow.

Alt.: Noella, Noanamaronga (Mardudunera term), Nooanamaronga.

Ref.: Yabaroo 1899, Brown 1912, 1914, Connelly 1932.

'Njaki'njaki, 'Koka:r Njakinjaki

Loc.: East of Lake Grace; at Newdegate, Mount Stirling, Bruce Rock, Kellerberrin; west to Jitarning, south to Kangaroo Soak, Lake Magenta and Mount Madden; east to Lake Hope and Mount Holland.

Alt.: Kokar (Koka:r = east), Karkar, Kikkar, "Eastward Tribe."

Ref.: Graham in Curr 1886, Goldsworthy in Curr 1886, T.

(Njamal) Njamal

Loc.: Upper Shaw and Coongan Rivers; Marble Bar, Nullagine, Hillside; Bamboo and Warrawoona.

Alt.: Nyamal, Nyamel, Namel, Gnamo (Leiden Museum ms.).

Ref.: Withnell 1901, Clement 1903, Bates 1914, Connelly 1932.

'Njikena, 'Njigena Njikena

Loc.: Lower Fitzroy River; west of Jurgurra (native name 'Tjirka:li) Creek; at Roebuck Downs.

Alt.: Njigina, Nyigina, Nyi-gini.

Ref.: Bates 1914, Kaberry 1937, Capell 1940, T.

Njiniŋ Njining

See North Australian List.

'Njulnjul, 'Njol'njol Njul-njul

Loc.: Beagle Bay, Pender Bay.

Alt.: Nyul-nyul, Niol-niol, Nyolnyol.

Ref.: Bischofs 1908, Bates 1914, Elkin 1933, Kaberry 1937, Nekes 1939, Worms ms., T.

(Pandjima) Pandjima

Loc.: Eastern portion of Hamersley Range about Mulga Downs.

Alt.: Panjima.

Ref.: Brown 1912, Connelly 1932.

'Pi : belmen — Piblemen

Loc.: Lower Blackwood River; chiefly on the hills in country between the Blackwood and Warren Rivers; inland to Manjimup and Bridgetown.

Alt.: Peopleman, Bibu: lmoun, Bebleman (ms.), Meeraman (of Ko: reng), Murram (of Minang).

Ref.: Nind 1831, Gifford in Curr 1886, Graham in Curr 1886, T.

'Pindjarep — Pindjarup

Loc.: Pinjarra to Harvey: lower reaches of Murray River. The real name of this tribe has evidently been lost: its members are extinct. Data from Kaneang sources.

Alt.: Pinjarra (place name), "Murray Tribe."

Ref.: Grey 1839, (T).

'Pini. Birni — Pini

Loc.: West of Lakes Carnegie and Wells to Barlow and Woodarra; at Erlistoun Creek and Lake Darlot.

Ref.: Tindale.

'Pitjandjara — Pitjandjara

See South Australian List.

(Talaindji) — Talaindji

Loc.: Head of Exmouth Gulf; North-west Cape; inland to Ashburton River about Nanutarra.

Alt.: Tallainji, Talainji, Talanji, Talanjee, Tallainga (? misprint) Taloinga.

Ref.: Yabaroo 1899, Brown 1912, Bates 1914, Connelly 1932, Fowler 1940.

'Ta : mela — Tamala

Loc.: Edel Land Peninsula; Tahmahlee Well (named after tribe), southern boundary not known.

Ref.: Sheard ms., (T.).

('Targari) — Targari

Loc.: Kennedy Range, Upper Minilya River and lower Lyons River.

Alt.: Dargari, Tarkarri.

Ref.: Yabaroo 1899, Brown 1912, Bates 1914, Connelly 1932.

(Targudi) — Targudi

Loc.: North-west of Robertson Range; headwaters of Oakover River.

Alt.: Targoodi.

Ref.: Brown 1912, Connelly 1932.

(Tenma) — Tenma

Loc.: Head of Henry River; Kenneth Range; Frederick River.

Ref.: Brown 1912, Connelly 1932.

'Tjalkadjara, 'Tjalkakari, 'Talkumara — Tjalkadjara

Loc.: North-east of Morgans to Lake Throssell; west nearly to Darlot; north to Lake Wells. Driven north-westward to Darlot after 1900 by pressure from Nangatadjara.

Alt.: ? Barduwonga.

Ref.: Bates 1914, T.

'Tjeraridja:l Tjeraridjal

Loc.: At Queen Victoria Spring; west to about Kurnalpi, Pingin and Karonie; on Ponton and Goddard Creeks; east to Naretha.

Ref.: Tindale.

'Tjitijamba Tjitijamba

Loc.: North of Lake Carnegie and west of Timperley Range; at Charles Wells Creek; northern boundaries uncertain.

Ref.: Tindale.

('Tjuroro) Tjuroro

Loc.: Hardey River, north of Ashburton River.

Alt.: Churoro, Chooroto, Chooraroo.

Ref.: Yabaroo 1899, Brown 1912, Connelly 1932.

('Uŋarinjin) Ungarinjin

Loc.: Isdell and Charnley Rivers east of Walcott Inlet; north to about Prince Regent River, east to Mount Barnett; south to King Leopold Ranges (about 40 hordes listed).

Alt.: Ungarinyin, Narrinyind.

Ref.: Elkin 1933, Capell 1940.

(Wadjeri) Wadjeri

Loc.: Head of Lyons River, Teano Range, Mount Isabella, Waldburg Range; Upper Gascoyne River; at Erivilla; (probably not Wajari of Bates = Wardal).

Alt.: Wajeri, Waianwonga.

Ref.: Brown 1912, Bates 1914, Connelly 1932.

'Waiaŋara, 'Wa:iaŋadi Waiangara

Loc.: About Lake Hazlett; north towards Musgrave Ranges, North W. Aust. (Not to be confused with Musgrave Ranges, S. Aust., as is done in Roheim's map.)

Alt.: Ngadi.

Ref.: Strehlow 1910, Kabarry 1937, Capell 1940, T.

(Waladjaŋari) Waladjangari

Loc.: About Durack Range, probably on western side.

Ref.: Capell 1940.

(Wa:lar) Walar

Loc.: Between Drysdale and Forrest Rivers.

Alt.: ? Wulu.

Ref.: Elkin 1933, Kaberry 1935, Capell 1940.

(Walki) Walki

Loc.: Between Upper Margaret and Ord Rivers.

Ref.: Davidson 1938.

(Wandjira) Wandjira

Loc.: Between Upper Baines River and Ord River.

Ref.: Capell 1940.

'Wa:ljen — Waljen

Loc.: East of Lake Raeside from Malcolm and Morgans south-east to Edjudina and Lake Lightfoot; at Lake Carey.

Ref.: Tindale.

'Wardal — Wardal

Loc.: At Cue, Nannine, Mount Magnet; south-west almost to Yalgoo. West to Sanford (Sandford) River.

Alt.: Wajari (wa:dji '= no).

Ref.: Bates 1914, T.

(Warieŋga, Wariwoŋga) — Warienga

Loc.: Upper Lyons River; about Bangemall.

Alt.: Warianga, Wooriengа, Woorenga, Wari-wonga, Warriwonga.

Ref.: Yabaroo 1899, Brown 1912, Bates 1914, Connelly 1932.

('Watjandi) — Watjandi

Loc.: Mouth of Murchison River and northward. N.B.—Name accidentally omitted from map.

Alt.: Watchandi (watju = west).

Ref.: Oldfield in Curr 1886.

'Wa:dandi — Wardandi

Loc.: From Bunbury to Cape Leeuwin, chiefly along the coast; at Geographe Bay, Nannup, and Busselton.

Alt.: Wardandi (wa:da = no), Wadarndee, Wardandie, "Geographe Bay and Vasse Tribe," "Bunbury Tribe," Kardagur (lit., "between," *i.e.*, "between the two seas."

Ref.: Barlee in Curr 1886, Bates 1906, T.

(Warwa) — Warwa

Loc.: Derby District.

Alt.: Warwai, Warrwai.

Ref.: Bates 1914, Capell 1940.

'Waula — Waula

Loc.: At Wiluna and Sandstone; west to about Mount Magnet and Meekatharra; south to Mount Sir Samuel, east to Lake Maitland.

Alt.: Ngaiuwonga (Bates).

Ref.: Bates 1914, T.

('Wembria) — Wembria

Loc.: Northern side of the upper Forrest River.

Ref.: Elkin 1933.

'Whadjuk, Juadjek, 'Minalnjuŋa: — Whadjuk

Loc.: Swan River and northern and eastern tributaries inland to beyond Wongan Hills; at Northam, Newcastle, Victoria Plains, Toodyay, York, Perth; south along coast to Pinjarra (extinct; some new indirect data only).

Alt.: Whajook (['whad] ~ ['wade]), = ['juad] = no), Yooard, Yooadda, Minalnjunga (Juat term: ['minaŋ] = south, ['njuŋa:] = man), Minnal Yungar.

Ref.: Grey 1839, Parker, Scott, Whitfield, Knight, Morgan and others in Curr 1886, (T.).

('Widagari) Widagari

Loc.: Upper De Grey River, about Muccanoo and Warrawagine, and eastward to an unknown extent. (Barlee, *l.c.*, 1886, p. 291, seems to have transposed the relative positions of Kariera and Widagari with respect to the Ngarla.)

Alt.: Widagari, Widagaree, Weedokarry, Weedookarry.

Ref.: Barlee in Curr 1886, Mathews 1900 (6), Brown 1912, Bates 1914, Connelly 1932.

'Widi, Wiri Widi

Loc.: From between Lakes Monger and Moore north to Billybillong; west to Mullewa and Morawa; east to about Mount Magnet; at Yalgoo, upper Greenough River and Cheangwa.

Alt.: Cheangwa (a place name).

Ref.: Perks in Curr 1886, T.

(Wilawila) Wilawila

Loc.: Upper Drysdale River.

Ref.: Capell 1940.

'Wi:lmen Wiilman

Loc.: At Wagin and Narrogin; on Collie, Hotham and Williams Rivers west to Collie, Wuraming north to Gnowing, Dattenning, Pingelly; east to Wickepin, Dudinin and Lake Grace; south to Nyabing (= Nampup), Katanning, Woodanilling, Duranilling. (Southern and western boundary corresponds with change in place name terminations from [-iŋ] to [-'ep].

Alt.: Wheelman, Weel, Weal, Weil, Will, Jaburu (Ko:reng term; lit., "north-westerners"), "Williams Tribe."

Ref.: Nind 1831, Browne 1856, Curr 1886, Bates 1923, Hassell 1936, T.

('Wirdinja) Wirdinja

Loc.: Robertson Range west to Ophthalmia Range; south to heads of Ashburton and Ethel Rivers.

Alt.: Wirdinya, Woordinya.

Ref.: Brown 1912, Bates 1914, Connelly 1932.

(Wirngir) Wirngir

Loc.: Northern side of Lower Lyne River (also called subtribe and horde; possibly valid inclusive name for about nine hordes in Lyne River area). N.B.—Name not marked on map.

Ref.: Elkin 1933, Kaberry 1935.

(Woljamidi) Woljamidi

Loc.: King and Pentecost Rivers; west towards Durack River.

Alt.: Wolyamiri, Molyamidi, ? Yamandil.

Ref.: Roheim 1925, Elkin 1933, Kaerry 1935, Capell 1940.

'Wonga:i Wonggai

Loc.: Northern margin of Nullarbor Plain from north of Hughes, S. Aust., to north of Loongana; northward from plain margin for about 150 miles.

Alt.: Wongaii.

Ref.: Tindale.

'Woŋkomi:, 'Uŋgumi — Wongkomi

Loc.: North of Fitzroy River; west of Fitzroy Crossing; not extending to coast. N.B.—Name accidentally omitted from map.

Alt.: Unggumi, Ungami.

Ref.: Elkin 1933, Capell 1940, T.

(Worora) — Worora

Loc.: At Walcott Inlet; Collier Bay to Prince Regent River (but see Maialnga who are stated to occupy area about Glenelg River).

Alt.: Wororra, Wurara.

Ref.: Love 1915, Elkin 1933, Capell 1940.

'Wudjari, 'Widjere, 'Waraŋu, 'Njoŋa:, 'Nuŋa: — Wudjari

Loc.: From Gairdner River east to Point Malcolm; inland to edge of coastal slope (approximately 50 miles); at Kent, Ravensthorpe, Fanny Cove, Esperance and Cape Arid.

Alt.: Wudjari, Widjara, Warrangoo, Warranger, Warrangle, Ngokwurring, Ngokgurring, Nonga:, Nunga, Yunga (njonga = njunga = man), ? Daran (name applied at Perth to eastern men who see sun rise from the sea. Moore, 1884).

Ref.: Nind 1831, Moore 1884, Chester in Curr 1886, Taylor in Curr 1886, Helms 1896, Tindale 1939, T.

'Wulumari — Wulumari

Loc.: South of Fitzroy Crossing (at "Tjandu" Billabong, not located); desert region south-west of Christmas Creek.

Alt.: Wolmeri, Wolmera, Walmaharri, Wolmaharry.

Ref.: Mathews 1900 (5), 1901 (2), Elkin 1933, Kaberry 1937, Capell 1940, Worms ms., T.

(Wunambal) — Wunambal

Loc.: York Sound; coast north of Brunswick Bay.

Alt.: Unambal, Wumnabal (? typographical error), Wunambullu.

Ref.: Bates 1914, Elkin 1933, Capell 1940.

(Jauor) — Jauor

Loc.: Roebuck Bay, east of Broome; a small tribe.

Alt.: Yauor, Yauera, Djauor.

Ref.: Bates 1914, Elkin 1933, Capell 1940.

(Jeidji, Jeithi) — Jeidji

Loc.: Northern bank of Forrest River in its tidal reaches and on both sides, above these.

Alt.: Yeidji, Yeithi.

Ref.: Elkin 1933, Kaberry 1935.

'Juet — Juat

Loc.: At Gingin, Moora, New Norcia, Moore River and Cape Leschenault; north to about Hill River; inland to Wubin (juat = no).

Alt.: "New Norcia" Tribe.

Ref.: Tindale.

(Julbre) — Julbre

Loc.: West of Sturt Creek, probably near Black Rocks.

Ref.: Capell 1940

(Agikwala) Agikwala

Loc.: Pine Creek district and southwards (sometimes regarded as a horde of Wulwulam, which see).

Alt.: Agiqwolla.

Ref.: Eylmann 1908.

(Airiman) Airiman

Loc.: Head of Fitzmaurice River (Spencer), but Davidson equates with Ngarinman, which see.

Ref.: Spencer 1914, Davidson 1935.

'Al:awa Allawa

Loc.: Southern tributaries of Roper River from mouth of the Hodgson west to Roper Valley; south to Mount Mueller and Hodgson Downs; at Mountain Creek. N.B.—Written as Alawa on map.

Alt.: Allaua, Allua, Allowa, Alowa, Leealowa, Kallaua, Allowiri, Allaura.

Ref.: Stretton 1893, Spencer and Gillen 1904, Power in Basedow 1907, Eylmann 1908, Spencer 1914, Tindale 1925, T.

(Al:ura) Alura

Loc.: Northern bank of Lower Victoria River from mouth eastwards nearly to Bradshaw.

Alt.: Allura, Hallurra, Nallura.

Ref.: Spencer 1914, Basedow 1925.

(A'war:ai) Awarai

Loc.: From ten miles north of Rum Jungle southwards to Brock Creek (also regarded as subtribe of Wulwulam, which see).

Alt.: Warrai, Awarrai, Awarra.

Ref.: Parkhouse 1895, Mathews 1901, Eylmann 1908, Spencer 1914.

(Awinm*u*l) Awinmul

Loc.: From Brock Creek to south of Pine Creek; recently have amalgamated with Wulwulam, which see.

Alt.: Awinmul, Awinmull.

Ref.: Parkhouse 1895, Eylmann 1908.

('Barera) Barera

Loc.: Blyth River, Cape Stewart and coast east to Wallamungo, westernmost of the Crocodile Islands. Also called Djikai, according to Jennison, who indicates their extension to all but two northernmost of the Crocodile Islands.

Alt.: Barera, Baurera, Burera, Jikai, Tchikai.

Ref.: Warner 1937, Shepherdson (ms.), Jennison (ms.), Capell 1940.

'Balamumu Balamumu

Loc.: At Caledon Bay, Cape Shield and Wyonga River, from Point Alexander west to centre of Peninsula, thence south-west to Koolatong River (see qualifying remarks in discussion, *antea*, p. 152).

Alt.: Barlamomo, Barlamumu, Marlark.

Ref.: Tindale 1925, Warner 1932, Webb 1933, Warner 1937, Jennison (ms.), T.

(Be'rinken, Marithiel) Brinken

Loc.: Port Keats and adjacent western coast of Arnhem Land. (Marithiel and Brinken are separate tribes according to Stanner, 1933.)

Alt.: Berinken, Berringin, Brinken, Brinkan, Marithiel.

Ref.: Basedow 1907, Stanner 1933, 1936, Davidson 1935, Capell 1940.

'Binbin'ga Binbinga

Loc.: South from Bauhinia Downs; McArthur River Station; Campbell Camp; head-waters of McArthur River (placed too far north by Tindale 1925).

Alt.: Binbingha, Binbinka, Leepitbinga.

Ref.: Mathews 1900 (3), 1904, 1908, Basedow 1907, Eylmann 1908, Spencer 1914, Tindale 1925, T.

('Biŋ'goŋgena) Bingongina

Loc.: West of Lake Woods; east of Upper Victoria River; boundaries not yet defined.

Ref.: Spencer and Gillen 1904, Mathews 1908, Spencer 1914.

('Boun) Boun

Loc.: Vicinity of head waters of Phelp, Rose and Hart Rivers.

Ref.: Warner 1937.

('Bulinara) Bulinara

Loc.: Moray Range, Gregory and Aroona Creeks; Delamere.

Alt.: Bilinurra, Bilyanarra, Bilyanurra, Plinara, Biilianera.

Ref.: Mathews 1901, Eylmann 1908, Spencer 1914, Terry 1926, Davidson, 1935.

'Dai: Dai

Loc.: Shores of Blue Mud Bay and in the country immediately to the north-west (see qualifying remarks in discussion).

Alt.: Dai, Taii.

Ref.: Tindale 1925, Warner 1937, T.

(Djalakuru) Djalakuru

Loc.: Coast from west of Goulburn Island to about Mount Norris Bay; also inland.

Alt.: Jalakuru.

Ref.: Earl 1846.

('Djamindjuŋ) Djamindjung

Loc.: Upper Fitzmaurice River.

Alt.: Jaminjang, Tjaminjun, Djamundon, Murinyuwen.

Ref.: Stanner 1933, 1936, Capell 1940.

'Djauen Djauan

Loc.: Katherine River and head-waters; south to Maranboy, west to about Katherine.

Alt.: Tjauen, Djauun, Jawin, Chau-an, Adowen, Charmong.

Ref.: Parkhouse 1895, Mathews 1900 (4), 1906, Eylmann 1908, Spencer 1914, Davidson 1935, Jennison (ms.), T.

'Djerait Djerait

Loc.: Northern shores of Anson Bay; northwards along coast to Port Patterson.

Alt.: Cherait, Cherite, Sherait, Scherits, Tjiras.

Ref.: Mackillop 1893, Basedow 1907, Eylmann 1908, Stanner 1933.

('Djerimaŋa) Djerimanga

Loc.: Coast at mouth of Adelaide River; east to Woolner; possibly related to Puneitja, which see.

Alt.: Jermangel, Woolna (place name), Woolner.

Ref.: Eylmann 1908.

'Djinba Djinba

Loc.: Upper Goyder River (west, not east, of the Ritarngo).

Alt.: Jinba, Djimba (typographical error), Outjanbah.

Ref.: Tindale 1925, Warner 1937, Davidson 1938, Jennison (ms.).

('Djowei) Djowei

Loc.: East of Adelaide River (Spencer); probably an inland tribe, between Awarai and Djerimanga and extending to South Alligator River.

Alt.: Kumertuo.

Ref.: Spencer 1914, 1928.

(Geimbio) Geimbio

Loc.: Upper reaches of East Alligator River and the mountainous country to the east.

Alt.: ? Gimbarlang = Warlang (Jennison, ms.); but compare Gunbalang.

Ref.: Spencer 1914, 1928.

(Gunavidji) Gunavidji

Loc.: Valley of Liverpool River; east to Cadell River.

Alt.: Gunabidji.

Ref.: Jennison (ms.), Capell 1940.

(Gunba:lang) Gunbalang

Loc.: Mouth of Liverpool River; not marked on map.

Ref.: Capell 1940.

'Gunwiŋgu Gunwinggu

Loc.: Coast west of Liverpool River to King River, and inland. (Recent historic movements have carried them west to the Alligator River, where they have replaced the declining Kakadu.)

Alt.: Gunwingu, Gunwingo, Gunawitji, Witji, Kulunglutji, Kulunglutchi, Koorungo.

Ref.: Spencer 1914, 1928, Warner 1937, Capell 1940, T.

('Indji'lindji) Indjilindji

Loc.: Barkly Tableland about Buchanan and Twelve Mile Creeks.

Alt.: Indkilindji, Inchalachee, Inchalanchee.

Ref.: Mathews 1899, 1904, Sharp 1935.

'Iŋura Ingura

Loc.: Groote Eylandt, Bickerton and Woodah Islands.

Ref.: Tindale 1925, Warner 1937, T.

'Iwaidji — Iwaidji

Loc.: Eastern portion of Cobourg Peninsula.

Alt.: Iwaiji, Iwaidja, Eiwaja, Eaewardja, Eaewarga (in ms.), Uwaidja, Eac-warge-ga, Unalla, Limbakaraja, Limba Karadjee.

Ref.: Earl 1846, 1853, Foelsche in Curr 1886, Spencer 1914, Jennison 1927, Hart 1930, Capell 1940, T.

('Kadjerawaŋ) — Kadjerawang

Loc.: Fitzmaurice River. (See also Gadjerong in Western Australian List.)

Alt.: Kujera.

Ref.: Basedow 1907, Stanner 1933.

'Kakadu — Kakadu

Loc.: Between East and South Alligator Rivers, inland from shores of Van Diemen Gulf; east to mountain ranges.

Alt.: Kakata, Karkardoo; Gagadu, ? Abedal.

Ref.: Eylmann 1908, Spencer 1914, Capell 1940, T.

(Kamor) — Kamor

Loc.: North of Central Daly River (the status of this and of some other Daly River tribes is doubtful).

Alt.: ? Murra-Kamangee.

Ref.: Stanner 1933, Davidson 1938.

('Karaman) — Karaman

Loc.: South-west of Katherine, on the Daly River.

Ref.: Davidson 1938.

'Karawa, 'Garewa: — Karawa

Loc.: From Upper Nicholson River northwards; at Westmoreland and Wollogorang, Qld.; on head-waters of Calvert River; at Robinson River, Walabunji, and Calvert Hills, N.A.

Alt.: Karrawar, Kurrawar, Korrawa, Leearrawa.

Ref.: Stretton 1893, Spencer and Gillen 1899, Mathews 1901, Power in Basedow 1907, Spencer 1914, Sharp 1935, T.

'Kotandji, 'ŋandji — Kotandji

Loc.: Head of coastal slope from Tanumbirini south-east to about head of McArthur River, Kilgour River, Walhallow; west to head of Newcastle Creek; south to Anthony Lagoon.

Alt.: Koodanjee, Godangee, Koodangie, Kudenji, Gnanji, Nganji, Ngangi, Nandi, Angee, Anga.

Ref.: Mathews 1901 (1), 1902 (3), Power in Basedow 1907, Spencer 1914, T.

('Kuŋarakan) — Kungarakan

Loc.: North of Mount Litchfield, south of Finnis River; an inland tribe on western side of the Divide.

Alt.: Guneıakan, Kangarraga.

Ref.: Basedow 1907, Mathews 1901 (1), Stanner 1933.

(Kunindiri) Kunindiri

Loc.: Barkly Tableland along head-waters of Calvert, Robinson and Nicholson Rivers; south to Anthony Lagoon.

Alt.: Goonanderry, Leecundundeerie.

Ref.: Stretton 1893, Power in Basedow 1907.

Kwarandji Kwarandji

Loc.: Daly Waters district; west to about Illawarra Springs and Mount Wollaston; south to about Lake Woods. ("Stationmaster's" account probably contains an error of transposition since Kakaringa means "easterners.")

Alt.: Kwaranjee, Koorangie, Kooringee, Coorinji, Goarango.

Ref.: Stationmaster 1895, Mathews 1900 (3), 1901, Eylmann 1908, Terry 1926.

'Larakia Larakia

Loc.: From Finnis River north-east to mouth of Adelaide River; inland to a point ten miles north of Rum Jungle; at Darwin, Southport, Bynoe Harbour, Howard River.

Alt.: Larrakia, Larrakeah, Larrakeeyah, Larrakiha, Laragia, Larragea, Larrekiya, Larreekeeyah, Larikia, Larrikia, Larrikiya, Larriquia.

Ref.: Foelsche 1881, Coppinger 1883, Mackillop 1893, Parkhouse 1894, Basedow 1907, Eylmann 1908, Spencer 1914, Capell 1940, T.

('Madngela) Madngela

Loc.: Hermit Hill and country west of Daly River, south of the Pongo-pongo.

Alt.: Madngella, Muttangulla, Matngelli. "Hermit Hill Tribe."

Ref.: Mackillop 1893, Dahl 1895, Mathews 1901 (1), Eylmann 1908, Stanner 1933, Capell 1940.

('Malŋin) Malngin

Loc.: South-west of mouth of Victoria River; probably extending to Ord River, W. Aust.

Alt.: Malgin.

Ref.: Elkin 1933, Davidson 1935, Kaberry 1937, Capell 1940.

'Maŋarai Mangarai

Loc.: Middle and upper courses of Roper River east of Mataranka and Maranboy; at Elsey; north to Mount Elsey; not further downstream than about Mount Lindsay.

Alt.: Mungarai, Mungerry.

Ref.: Mathews 1900 (4), Spencer 1914, Tindale 1925, Capell 1940.

(Manu) Manu

Loc.: Inverway; head of Victoria River.

Alt.: Manoo.

Ref.: Terry 1926.

'Mara Mara

Loc.: Tidal reaches of Roper River nearly to mouth of Hodgson River, south to Spillen Creek, eastward to coast and Maria Island, north to Edward Island.

Alt.: Marra, Leelalwarra (after Jalwara, a place name, an important lagoon south of Roper River).

Ref.: Spencer and Gillen 1904, 1912, Power in Basedow 1907, Spencer 1914, Tindale 1925, Sharp 1935, T.

('Maranuŋgo) Maranunggo

Loc.: Vicinity of Hermit Hill and eastward towards Daly River.

Alt.: Marranunga.

Ref.: Basedow 1907, Stanner 1933.

('Marimanindji) Marimanindji

Loc.: South of Hermit Hill, Central Daly River. N.B.—Wrongly written as Marimanindu on map.

Alt.: Murinmanindji, Maramanindji.

Ref.: Stanner 1933, Capell 1940.

('Maringar) Maringar

Loc.: Timor coast near the Murinbata tribe.

Alt.: Murrinnga, Muringa, Yaghanin.

Ref.: Stanner 1933, 1936.

Marithiel Marithiel

See Brinkin.

('Mariu) Mariu

Loc.: South of Victoria River, near mouth.

Alt.: Mayu, Mayoo.

Ref.: Mathews 1902 (5), Davidson 1935, 1938.

'Mauŋ Maung

Loc.: Goulburn Islands and coast opposite; east to King River; North Goulburn people are called Manangari.

Alt.: Maung, Mau, Manangari.

Ref.: Jennison 1927 and ms., Warner 1937, Capell 1940.

'Moi:l Moil

Loc.: South-east of Port Keats; inland.

Alt.: Moyl.

Ref.: Stanner 1933, 1937, Davidson 1935.

('Mudbara) Mudbara

Loc.: Armstrong River and upper Victoria River east of Victoria River Downs.

Alt.: Mudburra, Moodburra, Mootburra.

Ref.: Mathews 1901, Davidson 1935, Stanner 1936, Capell 1940.

('Mul:uk'mul:uk) Mullukmulluk

Loc.: Northern bank of Daly River inland from coastal Djerait; boundary upstream at about sixty miles from mouth.

Alt.: Mulluk-mulluk, Malack-malack, Mullik-mullik, Mollak-mollak.

Ref.: Mackillop 1893, Dahl 1895, Eylmann 1908, Stanner 1933, Capell, 1940.

(Murinbata) Murinbata

Loc.: Port Keats, south to mouth of Fitzmaurice River; coastal tribe.

Ref.: Stanner 1936.

('Murngin) Murngin

Loc.: North-eastern Arnhem Land and coastal islands east to Napier Peninsula, south to Point Alexander and head of Buckingham River (see discussion for further details).

Alt.: Tjambarupingu, Djambarpingu, Djambarbingo (one of several language terms), Tchambarupi, Koparpingu, Gababingo, Jamunda.

Ref.: Tindale 1925, 1928, Webb 1933, Warner 1937, Jennison (ms.).

('Naka:ra) Nakara

Loc.: Boucaut Bay; south-west of Blyth River.

Alt.: Naga:ra.

Ref.: Warner 1933, 1937, Capell 1940.

('Naŋgumiri) Nanggumiri

Loc.: South of Central Daly River; along Flora River to its junction with Daly River.

Alt.: Nangumiri, Nangimera, Nangimeri, Mariwumiri.

Ref.: Stanner 1933, 1936, Capell 1940.

('Naŋor) Nangor

Loc.: South of Port Keats; inland tribe.

Ref.: Stanner 1933.

'ŋalakan Ngalakan

Loc.: North of Roper River; east of the Wilton River to Maiwok and Flying Fox Creeks (Spencer displaces this tribe to the south of the Roper River).

Alt.: Nullakun, Nullikan, Nullikin, Ngalbon, Hongalla.

Ref.: Spencer 1912, Tindale 1925, Warner 1937, T.

('ŋaliwuru) Ngaliwuru

Loc.: Victoria River, south of Bradshaw.

Ref.: Capell 1940.

'ŋandi Ngandi

Loc.: Upper Wilton River; Mainoru River; east to near sources of the Rose River. (Not to be confused with Ngandji = Kotandji.)

Ref.: Tindale 1925, T.

'ŋardok Ngardok

Loc.: Field Island in Van Diemen Gulf and coastal belt of scrub country from South Alligator River to within a few miles of mouth of East Alligator River. N.B.—On map an arrow indicating this tribe runs too far to north.

Alt.: Ngadok, Ad-dok, Gnaruk, ? Bimbirik.

Ref.: Earl 1846, Spencer 1928, T.

('ŋarinman) Ngarinman

Loc.: Victoria River, about Jasper Creek.

Alt.: Ngainman, Ngainmun, Ngrainmun (also Airiman t. Davidson).

Ref.: Spencer 1914, Davidson 1935, Capell 1940.

ŋewin Ngewin

Loc.: Limmen Bight River (*i.e.*, Upper Spillen Creek); south-east to Bauhinia Downs.

Alt.: Gnuin, ? Leeillawarrie.

Ref.: Stretton 1893, Spencer 1914, Tindale 1925.

'ŋormbur — Ngormbur

Loc.: Between West and South Alligator Rivers. N.B.—On map an arrow indicating position of this tribe runs too far to the east.
Alt.: Ngorm-bur, Gnornbur, Ngorbur, Oorm-bur, Koarnbut.
Ref.: Spencer 1914, 1928, T.

('Nordaniman) — Nordaniman

Loc.: North of Fitzmaurice River; an inland tribe.
Alt.: Maridan.
Ref.: Stanner 1933, 1936.

(Norweilemil) — Norweilemil

Loc.: South coast of Van Diemen Gulf; west of West Alligator River.
Alt.: Lemil, ? Noalanji.
Ref.: Spencer 1914.

(Nungali) — Nungali

Loc.: Between Fitzmaurice and Upper Daly Rivers.
Ref.: Capell 1940.

'Nuŋubuju — Nungubuju

Loc.: From Cape Barrow south to mouth of Phelp River; west towards head-waters of Rose and Hart Rivers.
Alt.: Nungubuyu, Nungabuyu, Nungabuya, Nugubuyu (? misprint).
Ref.: Tindale 1925, 1928, Warner 1937.

'Njaŋga, 'Njaŋkala — Njangga

Loc.: Coast east of Robinson River; at Skeleton Creek; Calvert River; extending into Queensland only to about Tully Inlet; inland to Wollogorang. (Tully Inlet area is stated in literature formerly to have belonged to Wilungwara Tribe; see note under Wilingura.)
Alt.: Iangkala, Yangkala, ? Yuggamurra, Yuckamurri.
Ref.: Mathews 1900 (5), Sharp 1939, T.

('Njiniŋ) — Njining

Loc.: Stirling and Upper Sturt Creeks; Negri and Baines Rivers (extending into Western Australia).
Alt.: Njinin, Nining, Neening.
Ref.: Mathews 1901, 1904, Capell 1940.

(Oitbi) — Oitbi

Loc.: South coast of Cobourg Peninsula; Sir George Hope Islands. (Schmidt's error in placing this tribe at West Alligator River on his map is corrected in an addendum.)
Alt.: Heutbi, Bijnalumbo.
Ref.: Earl 1846, Eylmann 1908, Schmidt 1919.

('Poŋo'poŋo) — Pongopongo

Loc.: South bank of Daly River, inland from coastal Wogait.
Alt.: Pongo-pongo, Ponga-ponga.
Ref.: Mackillop 1893, Eylmann 1908, Stanner 1933.

(Puneitja) Puneitja

Loc.: "East of Adelaide River"; the Punaka "on western side of South Alligator River, about fifty miles inland"—data unsatisfactory.

Alt.: Peneitja, Minnitji, Punuurlu, ? Punaka (ms.).

Ref.: Eylmann 1908, Spencer 1914, 1928, and old ms. sources.

Rembaruŋa Rembarunga

Loc.: Mann River; head-waters of Cadell and Wilton Rivers.

Alt.: Rainbarngo.

Ref.: Tindale 1925, 1928, Warner 1937, T.

'Ritar:'ŋo Ritarungo

Loc.: Head-waters of the Goyder and Walker Rivers.

Alt.: Rittarungo, Ritarungo, Ritaringo, Ritarngo.

Ref.: Tindale 1925, 1928, Warner 1937, Jennison (ms.), T.

('Tagoman) Tagoman

Loc.: Between Daly and Katherine Rivers.

Ref.: Davidson 1935.

(Tiwi) Tiwi

Loc.: Melville and Bathurst Islands.

Alt.: Wunuk (Iwaidji term).

Ref.: Spencer 1914, 1928, Hart 1930.

(Tjial) Tjial

Loc.: Probably between Lower Victoria River and Upper Baines River. N.B.—Name omitted from map.

Alt.: Checal, Jeelowng, Geelowng.

Ref.: Mathews 1900 (3), 1901 (1).

'Tjiŋgili Tjingili

Loc.: Mount Grayling (Renner Springs) in the south to Newcastle Waters in the north, Ashburton Range in the east (westward boundary unknown).

Alt.: Tjingilli, Tjingalli, Chingalli, Chingalee, Tjingale, Tchingalee, Leechunguloo.

Ref.: Ravenscroft 1892, Stationmaster 1895, Mathews 1901, Spencer and Gillen 1904, Basedow 1907, Eylmann 1908, T.

'U:laki Wulaki

Loc.: Inland tribe; Goyder River district (area not yet defined).

Alt.: Ullaki, Wulaki.

Ref.: Tindale 1925, Warner 1937.

(Umoriu) Umoriu

Loc.: Eastern shores of Van Diemen Gulf, about head-waters of Cooper Creek and towards East Alligator River.

Alt.: Umoriu, Umoreo (ms.), ? Monobar.

Ref.: Earl 1846, Spencer 1914.

Wadere Wadere

Loc.: From north of Batten Creek along coast to Spillen Creek, Gulf of Carpentaria.

Ref.: Tindale 1925

'Wagoman — Wagoman

Loc.: About Dorisvale; south-west of Daly River, above Oolloo.
Alt.: Wagaman.
Ref.: Stanner 1933, Davidson 1935.

('Walu) — Walu

Loc.: Vanderlin Island.
Alt.: Walloo, Leewalloo.
Ref.: Stretton 1893.

'Wambaia — Wambaia

Loc.: Barkly Tableland, west to Eva Downs, Anthony Lagoon in north, Mount Morgan in east, Alroy Downs in south; at Corella Lagoon, Brunette Downs and Alexandria.
Alt.: Wombaia, Wom-by-a, Wombya, Yumpia, Umbaia.
Ref.: Mathews 1898, 1900 (4), Power in Basedow 1907, Spencer and Gillen 1904, Spencer 1914.

'Wandaran — Wandaran

Loc.: Phelp River, inland from coast.
Ref.: Tindale 1925, 1928.

(Wandjira) — Wandjira

See Western Australian List.

'Wa:nji — Wanji

See Queensland List.

'Waramaŋa, 'Warumuŋu — Waramanga

Loc.: Mount Grayling (Renner Springs) in the north; south to headwaters of Gosse River, east to Alroy and Rockhampton Downs, western boundary unknown.
Alt.: Warramunga, Warramonga, Warrmunga, Waramunga, Leenaranunga.
Ref.: Stretton 1893, Stationmaster 1895, Mathews 1901, Eylmann 1908, Spencer 1914.

('Wardaman) — Wardaman

Loc.: Heads of western branches of Upper Daly River; south towards Victoria River.
Alt.: Wartaman, Warduman, Wadderman, Wordaman, Waduman.
Ref.: Mathews 1901, Spencer 1914, Davidson 1935, Capell 1940.

('Wat:a) — Waṭṭa

Loc.: On eastern bank of South Alligator River, inland tribe (Spencer).
Alt.: ? Marigian birik (general term).
Ref.: Earl 1846, Spencer 1914.

('Wiliŋgura) — Wilingura

Loc.: Between Cox River and Nutwood Downs; west to Pine Creek (Birdum). (? Same tribe as Wulungwara, which is stated to have formerly occupied an area on coast about Tully Inlet on Queensland-North Australian border.) Stretton's locality reference (*l.c.*, p. 249, appendix, line 10) is evidently transposed with that mentioned on previous line.

Alt.: Wilingura, Willongera, Leewillungarra, Willangan.

Ref.: Stretton 1893, Spencer and Gillen 1904, Power in Basedow 1907, Spencer 1914.

'Wo:gait — Wogait

Loc.: On coast at Anson Bay, from Cape Ford north to mouth of Daly River; inland for about twenty miles.

Alt.: Wogait, Worgait, Worgite, Waggait, Waggite, Waggote, Waggute, Wagatsch, Wa(o)gatsch, Wogite.

Ref.: Mackillop 1893, Basedow 1907, Eylmann 1908, Stanner 1933, Capell 1940.

'Wul'wulam, Wulwaŋga — Wulwulam

Loc.: Head of Mary River; west to Pine Creek (the western hordes, Agikwala and Awinmil, were apparently formerly separate tribes which have amalgamated since the decline of their numbers after contact with Europeans).

Alt.: Wulwuliam, Agiwallem, Agrikondi, Aggrakundi, Wulwongga, Wulwanga, Wulwonga, Woolwonga, Oolwunga, Oolawunga.

Ref.: Curr 1886, Smith 1894, Parkhouse 1895, Basedow 1907, Eylmann 1908, Spencer 1914, T.

Wureŋo — Wurango

Loc.: Western end of Cobourg Peninsula. 'Iji and 'Ja:lo are probably older subtribal or tribal designations, the former at western end of Cobourg Peninsula, and the latter at Port Essington. (Earl 1846, p. 242, gives evidence of early nineteenth century tribal pressure and movements from the south.)

Alt.: Wurruga, Wurrago, Warooka, Iyi, Yarlo.

Ref.: Earl 1846, Jennison 1927 and ms. (T).

(Jaernuŋo) — Jaernungo

Loc.: Wessel Islands; Elcho Island, Drysdale Island; Marunga and Rabuma Islands in Crocodile Group; Banyan Island at mouth of Goyder River.

Alt.: Yaernungo, Kokolango, Kokolango-mala (a super horde).

Ref.: Jennison 1927, Warner 1937.

('Ja:ko) — Jaako

Loc.: Croker Island and a small area of Cobourg Peninsula opposite the island and at Raffles Bay (originally two tribes which amalgamated before 1840). Jennison gives this term as Margo.

Alt.: Yaako, Terutong, ? Ajokoot, Ma:go (native name of Croker Island).

Ref:. Earl 1846, 1853, Jennison (ms.).

('Jandjinuŋ) — Jandjinung

Loc.: Western bank of Goyder River and upper part of Blyth River; coast east of Crocodile Islands; two central islands of Crocodile Group.

Alt.: Yandjinung.

Ref.: Warner 1933, 1937.

('Jaŋmen) Jungman

Loc.: Elsey Creek and its head-waters west of Elsey Station; south of Mataranka.

Alt.: Yungman, Yungmun, Yungmunni, Yungmanni, Yungmunee, Yungmunnee, Jongman.

Ref.: Mathews 1900 (4), Eylmann 1908, Spencer 1914, Davidson 1935.

'Janjula Janjula

Loc.: Macarthur River from near Boroloola to the coast and on the Sir Edward Pellew Islands (excluding Vanderlin Island).

Alt.: Yanula, Anyoola, Aniula, Anula, Leeanuwa.

Ref.: Stretton 1893, Power in Basedow 1907, Spencer 1914 Sharp 1935, T.

(Jilŋali) Jilngali

Loc.: West of Macadam Range.

Ref.: Capell 1940.

'Jukul Jukul

Loc.: Vicinity of Leichhardt Bar (Urapunga) on south side of Roper River.

Alt.: Yukul, Jokul, Yikil, Yookull, Yookala, Yookil.

Ref.: Mathews 1900 (4), Eylmann 1908, Spencer 1914, T.

(Juŋgor) Junggor

Loc.: Between Hermit Hill and Daly River.

Ref.: Stanner 1933.

References Cited

Angas, G. F. 1847 Savage Life and Scenes in Australia. London

Angas, G. F. 1847 South Australia Illustrated. London

Basedow, H. 1907 Trans. Roy. Soc. S. Aust., **31**

Basedow, H. 1914 Journ. of Govt. N.W. Expedition. Adelaide

Bates, D. M. 1906 Vict. Geog. Journ., **33-34**

Bates, D. M. 1914 Rept. Aust. Assoc. Adv. Sci., **14**

Bates, D. M. 1918 Trans. Roy. Soc. S. Aust., **42**

Bates, D. M. 1923 Rev. d'Eth., **4**

Bennett, M. M. 1877 Journ. Roy. Anth. Inst., Lond., **7**

Berndt, R. M., and Vogelsang, T. 1939 Trans. Roy. Soc. S. Aust., **63**

Bird, W. H. 1909 Anthropos, **6**

Bischofs, J. 1908 Anthropos, **3**

Black, J. M. 1916 Trans. Roy. Soc. S. Aust., **40**

Bonney, F. 1884 Journ. Anth. Inst., Lond., **13**

Brown, A. R. 1912 Man., **12**

Brown, A. R. 1914 Journ. Roy. Anth. Inst., Lond., **43**

Brown, A. R. 1918 Journ. Roy. Anth. Inst., Lond., **48**

Browne, J. 1856 Petermann's Mittheilungen, **2**

Bull, J. W. 1878 Early Experiences of Colonial Life in South Australia. Adelaide

CAMERON, A. L. P. 1885 Journ. Anth., Inst., Lond., **14**
CAMPBELL, T. D. 1934 Trans. Roy. Soc. S. Aust., **58**
CAPELL, A. 1939 Oceania, **10**
CAPELL, A. 1940 Oceania, **10**
CAWTHORNE, A. 1844 Ms. No. 558, Archives Dept., Adelaide
CLELAND, J. B., and JOHNSTON, T. H. 1939 Trans. Roy. Soc. S. Aust., **63**
CLELAND, J. B., and TINDALE, N. B. 1936 Centenary History of South Australia, Adelaide, Chapter 2
CLEMENT, E. 1903 Intern. Archiv. f. Ethnol., **16**
COLLINS, D. 1798-1802 Account of the English Colony in New South Wales. London
CONNELLY, J. F. 1932 Mankind, **1**
COPPINGER, R. W. 1883 Cruise of the *Alert*. London
CUDMORE, A. F. 1893 Rept. Aus. Assen. Adv. Sci.
CURR, E. M. 1886-1887 Australian Race. Melbourne, 4 vols.
DAHL, K. 1895 Trans. Roy. Soc. S. Aust., **19**
DAVIDSON, D. S. 1935 Journ. Roy. Anth. Inst., Lond., **65**
DAVIDSON, D. S. 1938 (1) Proc. Amer. Philos. Soc., **79**
DAVIDSON, D. S. 1938 (2) Preliminary Register of Australian Tribes and Hordes. Philadelphia
DAWSON, J. 1881 Australian Aborigines. Melbourne
EARL, G. W. 1846 Journ. Roy. Geog. Soc., Lond., **16**
EARL, G. W. 1853 Native Races of the Indian Archipelago. London
EAST, J. J. 1889 Aborigines of South and Central Australia. Pamphlet. Adelaide
ELKIN, A. P. 1932 Oceania, **2**
ELKIN, A. P. 1933 Oceania, **3**
ELKIN, A. P. 1933 Oceania, **4**
ELKIN, A. P. 1937 Oceania, **7**
ELKIN, A. P. 1938 Oceania, **8**
ELKIN, A. P. 1940 Oceania, **10**
ENRIGHT, W. J. 1932 Mankind, **1**
ENRIGHT, W. J. 1939 Mankind, **2**
EYRE, E. J. 1845 Journal of Expeditions into Central Australia. London
FENNER, F. J. 1936 Trans. Roy. Soc. S. Aust., **60**
FISON, L., and HOWITT, A. W. 1880 Kamilaroi and Kurnai. Melbourne
FOELSCHE, P. 1881 Trans. Roy. Soc. S. Aust., **5**
FOWLER, H. L. 1940 Aust. Journ. Sci., **2**
FRY, H. K. 1933 Oceania, **3**, 247-256
GASON, S. 1874 Dieyerie Tribe of Australian Aborigines. Adelaide. (Reprinted in Curr 1886)
GRAY, J. 1930 S. Aust. Naturalist, **12**, 4

GREY, G. 1839 Vocabulary of the Dialects Spoken by the Aboriginal Races of South-West Australia. Perth
GREY, G. 1840 Same, Second Edition (with some corrections). London
GRIBBLE, E. R. 1903 Science of Man, Sydney, **6**
HALE, H. M., and TINDALE, N. B. 1925 Rec. S. Aust. Mus., **3**
HALE, H. M., and TINDALE, N. B. 1933 Rec. S. Aust. Mus., **5**
HART, C. M. 1930 Oceania, **1**
HASSELL, E. 1936 Anthropos, **31**
HELMS, R. 1896 Trans. Roy. Soc. S. Aust., **16**
HOSSFELD, P. S. 1926 Trans. Roy. Soc. S. Aust., **50**
HOWITT, A. W. 1888 Journ. Roy. Anth. Inst., Lond., **18**
HOWITT, A. W. 1891 Journ. Roy. Anth. Inst., Lond., **20**
HOWITT, A. W. 1904 Native Tribes of South-east Australia. London
HUNTER, J. 1793 Historical Journal of the Transactions at Port Jackson
JENNISON, J. C. 1927 Trans. Roy. Soc. S. Aust., **51**
JENNISON, J. C. ms.
JESSOP, W. R. H. 1862 Flinders Land and Sturt Land. London
JUKE, J. B. 1847 Narrative of the Surveying Voyage of *H.M.S. Fly*. London
KABERRY, P. M. 1935 Oceania, **5**
KABERRY, P. M. 1937 Oceania, **7**
KELLY, G. T. 1935 Oceania, **5**
KING, P. P. 1827 Narrative of a Survey of the Intertropical and Western Coasts of Australia. London
KRICHAUFF, F. E. H. W. 1886 Customs of the . . . . Aldolinga or Mbenderinga Tribe. Pamphlet. Adelaide
LOVE, J. R. B. 1915 Trans. Roy. Soc. S. Aust., **41**
LOVE, J. R. B. 1938 ms.
McCONNEL, U. H. 1935 Art in Aust. Journ. Sydney. Ser. 3, No. 59
McCONNEL, U. H. 1936 Oceania, **7**
McCONNEL, U. H. 1940 Oceania, **10**
McDOUGAL, — 1901 Science of Man, **4**
MACGILLIVRAY, J. 1852 Narrative of Voyage of *H.M.S. Rattlesnake*
MACKILLOP, D. 1893 Trans. Roy. Soc. S. Aust., **17**
MACPHERSON, J. 1905 Proc. Linn Soc., N.S.W., **29**
MARRETT, R. R. 1910 Folklore, London, **21**
MATHEW, J. 1910 Two representative Tribes of Queensland. London
MATHEW, J. 1914 Rept. Aust. Asscn. Adv. Sci., **14**
MATHEW, J. 1926 Rept. Aust. Assen. Ad. Sci., **18**
MATHEWS, R. H. 1897 Journ. Roy. Soc. N.S.W., **31**
MATHEWS, R. H. 1898 (1) Proc. Amer. Philos. Soc., **37** (3 papers)
MATHEWS, R. H. 1898 (2) Journ. Roy. Soc. N.S.W., **32** (3 papers)
MATHEWS, R. H. 1899 Proc. Amer. Philos. Soc., **38**
MATHEWS, R. H. 1900 (1) Proc. Amer. Philos. Soc., **39** (3 papers)

MATHEWS, R. H. 1900[2] Qld. Geog. Journ., **15**
MATHEWS, R. H. 1900[3] Amer. Anthrop., 2 ms. (2 papers)
MATHEWS, R. H. 1900[4] Journ. Roy. Soc. N.S.W., **34**
MATHEWS, R. H. 1901[1] Qld. Geog. Journ., **16** (2 papers)
MATHEWS, R. H. 1901[2] Journ. Roy. Soc. N.S.W., **35**
MATHEWS, R. H. 1902[1] Journ. Roy. Soc. N.S.W., **36**
MATHEWS, R. H. 1902[2] Qld. Geog. Journ., Brisbane, **17**
MATHEWS, R. H. 1903[1] Qld. Geog. Journ., Brisbane, **18**
MATHEWS, R. H. 1903[2] Proc. Amer. Philos. Soc., **1**
MATHEWS, R. H. 1904[1] Qld. Geog. Journ., Brisbane, **19**
MATHEWS, R. H. 1904[2] Zeitsch. für Ethn., **36**
MATHEWS, R. H. 1904[3] Journ. Roy. Soc. N.S.W., **38**
MATHEWS, R. H. 1905[1] Journ. Roy. Soc. N.S.W., **39**
MATHEWS, R. H. 1905[2] Qld. Geog. Journ., **20**
MATHEWS, R. H. 1906 (1907) Proc. Roy. Soc. N.S.W., **40**
MATHEWS, R. H. 1907[1] Qld. Geog. Journ., **22**
MATHEWS, R. H. 1907[2] Journ. Roy. Soc. N.S.W., **41** (2 papers)
MATHEWS, R. H. 1908[1] Man., **8**
MATHEWS, R. H. 1908[2] Journ. Roy. Soc. N.S.W., **42**
MATHEWS, R. H., and EVERITT, M. M. 1900 Journ. Roy. Soc. N.S.W., **34**
MEYER, H. A. E. 1840 Vocabulary of the Language Spoken by the Aborigines of South Australia. Adelaide
MEYER, H. A. E. 1846 Manners and Customs of the Encounter Bay Tribe. Adelaide
MOORE, G. F. 1884 Descriptive Vocabulary of . . . .. Aborigines of Western Australia. London
MOORHOUSE, M. 1846 Vocabulary and Outline of the Grammatical Structure of the Murray River Language. Adelaide
MORGAN, A. M. 1930 ms.
MOUNTFORD, C. P. 1938 Vict. Naturalist, **56**
NEWLAND, S. 1889 Proc. Roy. Geog. Soc. S. Aust.
NEWLAND, S. 1895 Proc. Roy. Geog. Soc. S. Aust.
NIND, S. 1831 Journ. Geog. Soc., Lond., **1**
PALMER, E. 1884 Journ. Anth. Inst., Lond., **13**
PARKER, E. S. 1843 N.S.W.: Votes and Proceedings Legislative Council for 1843
PARKER, E. S. 1854 Aborigines of Australia. Pamphlet
PARKHOUSE, T. A. 1895 Trans. Roy. Soc. S. Aust., **19**
PARKHOUSE, T. A. 1935 Reprints . . . . relating to the Autochthones of Australia. Adelaide. **2**
PIDDINGTON, M., and PIDDINGTON, R. 1932 Oceania, **2**
RADCLIFFE-BROWN, A. R. 1931 Oceania, **1**
RAVENSCROFT, A. G. B. 1892 Trans. Roy. Soc. S. Aust., **15**

REESE, A. 1927 ms.
RICHARDS, C. 1902 Science of Man, Sydney, **5**
RICHARDS, C. 1903 Science of Man, Sydney, **6**
RICHARDS, F. 1926 Mem. Qld. Mus., **8**
RIDLEY, W. 1866 Kamilaroi, Dippil, and Turrubul. Sydney
RIDLEY, W. 1875 Kamilaroi and other Australian Languages. Second Ed. Sydney
ROHEIM, G. 1925 Australian Totemism. London
ROTH, W. E. 1897 Ethnological Studies among . . . . Queensland Aborigines. Brisbane
ROTH, W. E. 1901-1910 Nth. Q'ld. Ethn. Bull., 1-18. Brisbane and Sydney
RUSDEN, G. W. 1883 History of Australia, **1**, 345
SCHMIDT, P. W. 1919 Die Gliederung der Australischen Sprachen. Wien
SHARP, L. 1934 Oceania, **4**
SHARP, L. 1935 Oceania, **6**
SHEARD, K. 1940 ms.
SMITH, P. W. 1894 Journ. Anth. Inst., **23**
SMYTH, R. B. 1878 Aborigines of Victoria. Melbourne
SPENCER, B. 1914 Native Tribes of the Northern Territory of Australia. Lond.
SPENCER, B. 1928 Wanderings in Wild Australia. London
SPENCER, B., and GILLEN, F. J. 1899 Native Tribes of Central Australia. Lond.
SPENCER, B., and GILLEN, F. J. 1904 Northern Tribes of Central Australia. London
STANNER, W. E. H. 1933 Oceania, **3**
STANNER, W. E. H. 1936 Oceania, **7**
STATIONMASTER, *pseud.* 1895 Journ. Anth. Inst., Lond., **24**
STEPHENS, E. 1889 Journ. Roy. Soc. N.S.W., **23**
STREHLOW, C. 1910 Die Aranda und Loritja-stämme, *iii*
STREHLOW, T. G. 1940 ms.
STRETTON, W. G. 1893 Trans. Roy. Soc. S. Aust., **17**
SUTTON, T. M. 1889 Proc. Geog. Soc. of Aust., S. Aust. Branch
TAPLIN, G. 1871 Journ. Anth. Inst., Lond., **1**
TAPLIN, G. 1873 The Narrinyeri. Adelaide
TAPLIN, G. 1879 Folklore . . . . of the South Australian Aborigines. Adelaide
TEICHELMANN, C. G., and SCHÜRMANN 1840 Outlines of a Grammar . . . . of . . . . Natives . . . . around Adelaide. Adelaide
TERRY, M. 1926 Man, **129**
THOMSON, D. F. 1933 Journ. Roy. Anthr. Inst., Lond., **53**
THOMSON, D. F. 1934 Journ. Roy. Anthr. Inst., Lond., **54**
THRELKELD, L. E. 1892 Australian Language . . . . Awabakal. Sydney
TINDALE, N. B. 1925 Rec. S. Aust. Mus., **3**
TINDALE, N. B. 1928 Trans. Roy. Soc. S. Aust., **52**
TINDALE, N. B. 1931 Medical Journ. Aust., 795-796

TINDALE, N. B. 1932 Manuscripts, a Misc. of Arts and Letters, Adelaide, **3**, 38-42
TINDALE, N. B. 1933 Medical Journ. Aust., 323
TINDALE, N. B., and HACKETT, C. J. 1933 Oceania, **4**, 101-105
TINDALE, N. B. 1935 (1) Oceania, **6**
TINDALE, N. B. 1935 (2) Rec. S. Aust. Mus., **5**
TINDALE, N. B. 1935 in Parkhouse, T. A. Reprints . . . . relating to the Autocthones of Australia, **2**. Adelaide
TINDALE, N. B. 1936 (1) Oceania, **6**
TINDALE, N. B. 1936 (2) Oceania, **7**
TINDALE, N. B. 1936 (3) Trans. Roy. Soc. S. Aust., **60**
TINDALE, N. B. 1937 Trans. Roy. Soc. S. Aust., **61** (2 papers)
TINDALE, N. B. 1938 Trans. Roy. Soc. S. Aust., **62**
TINDALE, N. B. 1939 (1) Rec. S. Aust. Mus.
TINDALE, N. B. 1939 (2) S. Aust. Naturalist, Adelaide, **20**
TINDALE, N. B., and BIRDSELL, J. B. 1939-1940 "Tasmanoid Tribes in North Queensland." (Reference not yet to hand)
WARNER, W. L. 1931 American Anthropologist, **32**
WARNER, W. L. 1932 American Anthropologist, **33**
WARNER, W. L. 1933 American Anthropologist, **35**
WARNER, W. L. 1937 Black Civilization. New York
WEBB, T. T. 1933 Oceania, **3**
WHITE, S. A. 1916 In the Far North-West; an Expedition to Musgrave and Everard Ranges. Adelaide
WITHNELL, J. G. 1901 Customs and Traditions of the Aboriginal Natives of North-Western Australia. Roebourne
WOODS, J. D. Editor 1879 Native Tribes of South Australia. Adelaide
WORMS, E. 1940 ms.
"YABAROO" 1899 Aborigines of North-West Australia. Perth

VOL. 64 PART 2 20 DECEMBER, 1940

TRANSACTIONS OF THE ROYAL SOCIETY OF SOUTH AUSTRALIA

INCORPORATED

ADELAIDE

PUBLISHED AND SOLD AT THE SOCIETY'S ROOMS
KINTORE AVENUE, ADELAIDE

Price - - One Guinea

Registered at the General Post Office, Adelaide,
for transmission by post as a periodical

STUDIES IN AUSTRALIAN ACARINA
TETRANYCHIDAE AND TRICHADENIDAE

By H. WOMERSLEY, South Australian Museum.

Summary

The mites belonging to these two families constitute one of the most important economic problems with which the gardener, horticulturalist and fruitgrower have to contend, and at times some species may become so numerous as to be really serious pests.

STUDIES IN AUSTRALIAN ACARINA
TETRANYCHIDAE AND TRICHADENIDAE

By H. Womersley, South Australian Museum

[Read 11 July 1940]

The mites belonging to these two families constitute one of the most important economic problems with which the gardener, horticulturalist and fruit-grower have to contend, and at times some species may become so numerous as to be really serious pests.

Popularly they are known as "red spiders," "fruit tree mites" and "spinning mites," the last name having reference to their habit of spinning silken threads on the underside of the leaves on which they occur. It is only within recent years, due to the researches and publications of Banks, Hirst, Oudemans, MacGregor, Trägårdh, and, more recently, Geijskes, that our systematic knowledge of the different species has acquired an importance commensurate with their economic status. That their taxonomy now stands on a sound basis is due to a realization of the necessity for critical high power examination of the finer morphological characters found in the terminal segments of the palpi, the tarsal appendages, the shape of the tracheae, of the penis and the arrangement of the dorsal setae.

In Australia little, except occasional economic notes in various agricultural journals, has been written upon these acarids. In his "Synopsis of the Australian Acarina," Records Australian Museum, vol. 6, pt. 3, p. 145, 1906, Rainbow lists only the following species: *Bryobia praetiosa* Koch, *Bryobia* sp. Tryon, *Tetranychus telarius* Linn., *Tetranychus telarius* var. *cinnabarinus* Boisd., *Tetranychus cucumeris* Boisd., and *Tetranychus rosarum* Boisd. Of these species the first is recognised as a good species, but *Bryobia* sp. of Tryon, besides being unnamed, is so inadequately described as to be unrecognisable and should be ignored. At the present time all the other names are regarded as synonyms of *telarius* Linn, a species now placed in the genus *Eotetranychus*. As examination of a large amount of material from all States of the Commonwealth has failed to reveal the occurrence of *E. telarius* and shown that our common red-spider is *Tetranychus urticae* Koch (*altheae* v. Handstein), it seems probable that all early records should be regarded as the latter species.

The present paper, besides being a critical examination of Australian material, should help economic workers to recognise the precise species with which they are called upon to deal. It would, however, have been impossible to present such a survey as this without the very generous assistance of the Division of Economic Entomology, Canberra, and of the various Departments of Agriculture of the different States. To the heads of all these bodies I extend my sincere thanks.

Family TETRANYCHIDAE

The following key lists the known genera of Tetranychidae and the known Australian species.

1 Maxillary palpi slender, with or without tibial claw. Leg-segments usually wrinkled and legs short to much shorter than body. 2

Maxillary palpi stout, with distinct tibial claw. Legs of normal length, little if at all shorter than body, or else excessively long. Leg-segments not wrinkled. 6

2 Palpi short but slender, without tibial claw. 3

Palpi longer, with distinct tibial claw. Ornate species with fan-shaped setae. Empodium as a pair of claw-like processes thinner than the true claws. Legs short.

Genus **Tuckerella** nov.
ornatus Tucker

3 Mouth-parts completely hidden from above under propodosoma. Palpi 2-segmented, last segment and apex of tarsi I and II with a stout cylindrical rod-like seta. Legs very short.

Genus **Tegopalpus** nov.,
conicus n. sp.

Mouth-parts not so hidden. 4

4 Palpi and hypostome fused together; palpi 1-segmented (or perhaps 2-segmented). Legs short and thick. Lives in galls.

Genus *Phytoptipalpus* Trägårdh
(not Australian)

Palpi and other mouth-parts normal. 5

5 Eyes distinct, 2 on each side. Leg-segments very much wrinkled and femora much constricted at base, then suddenly widening. Tarsi with 2 claws, with 2 or more tenent hairs; empodium with two series of tenent hairs.

Genus *Tenuipalpus* Donnadieu
phoenicis Geijskes
californicus Banks
vitis n. sp.

Eyes indistinct or absent. Leg-segments normal; tarsi with 2 simple claws and a ciliated pad-like empodium.

Genus *Tetranychoides* Banks
(not Australian)

6 Empodium vestigial, connate at base dorsally to tarsus forming a mere protuberance. Claws forming two pairs of tenent hairs and arising dorsally from tarsus, not apically.

Genus *Anychus* MacGregor
(not Australian)

Both empodium and claws well developed, modified or not, and attached to tarsus apically. 7

7 Claws normal, unmodified, with or without a pair of lateral tenent hairs. Empodium not claw-like. 8

Claws modified so as to form a lobe or pad ending in two tenent hairs. Empodium more or less claw-like, with or without a double series of tenent hairs. 11

8 Front of propodosoma 4-lobed, each lobe tipped with a scale-like seta. Dorsal setae also scale-like. Peritreme produced as a sausage-like chamber on each side of gnathosoma. Legs not excessively long, except I, which in female is rather longer than body and in male quite twice as long. Claws with a pair of lateral tenent hairs.

Genus *Bryobia* Koch
praetiosa Koch

Front of propodosoma not as above. 9

9 Tarsi distinctly or very much shorter than tibiae. At least legs I and IV longer than body. 10

Tarsi about as long as tibiae. Legs slightly shorter than body. Dorsal setae long, strongly ciliated and arising from strong papillae. Peritreme produced on each side of gnathosoma as a tube- or sausage-like chamber.

Genus *Tetranychopsis* Canestrini
(not Australian)

10 Tarsi very much shorter than tibiae. All legs excessively long. Peritreme not produced. Dorsal setae strong, curved, spine-like, but not arising from papillae. Claws without lateral tenent hairs. Genus *Neophyllobius* Berlese
ornatus n. sp

Tarsi about three-fourths length of tibiae. Leg I longer than body, IV only slightly so. Peritreme produced on each side of gnathosoma. Dorsal setae normal and relatively short. Genus *Tetranobia* Banks
(not Australian)

11 Front and hind legs excessively long, 2-3 times as long as body. Apex of peritreme slightly produced as a small round compound chamber. Empodium with two series of numerous tenent hairs. Dorsal setae long, stout, blunt ended, ciliated and arising from strong papillae. Genus **Tenuicrus** nov.
errabundus n. sp.

No legs excessively long, only I, if any, but little longer than body. 12

12 Peritreme produced apically as a tube or a large globular swelling. 13

Peritreme not produced. 15

13 Peritreme produced as a large globular swelling or chamber. Empodium claw-like with a single tenent hair on each side. Dorsal setae long, slender and ciliated, but not arising from papillae. Genus **Schizonobia** nov.
sycophanta n. sp.

Peritreme produced sausage-like. 14

14 Dorsal setae very strong and spine-like, with ciliations and arising from strong papillae. Empodium claw-like with double series of numerous tenent hairs.
Genus **Aplonobia** nov.
oxalis n. sp.

Dorsal setae less strong or spine-like, not on papillae. Empodium as above.
Genus *Petrobia* Murray
latens O. F. Müll.

15 Dorsum not strongly convex. Dorsal setae thin, finely ciliated and not arising from papillae. 16

Dorsum strongly convex, setae strongly ciliated and arising from warts or papillae. 24

16 Seven transverse rows of dorsal setae: 2 . 4 . 4 (6) . 4 . 4 . 4 . 2, *i.e.*, "setae clunales" present. 17

Six transverse rows of dorsal setae: 2 . 4 . 4 (6) . 4 . 4 . 4, *i.e.*, "setae clunales" absent. 23

17 Peritreme short, straight, with swollen end-chamber. Empodium claw-like, not split into six needles but ventrally with or without a proximal basal process. 18

Peritreme long, V-shaped, with 2 or more chambers. 20

18 Empodium Y-shaped, no ventral basal process.
Genus *Schizotetranychus* Trägårdh
(not Australian)

Empodium a simple claw with ventral basal process. 19

19 Ventral basal process of empodium with 2 reflexed and haired appendages. Legs short and thickly haired.
Genus *Oligonychus* Berl.
(not Australian)

Ventral basal process of empodium consisting of 6 straight downward directed needles.
Genus *Eurytetranychus* Oud.
(not Australian)

20 Empodium without basal ventral process. 21

Empodium claw-like, with basal ventral process of 4-6 needles; claw of empodium shorter than needles.
Genus *Septanychus* MacGregor
(not Australian)

21 Empodium a simple claw. Peritreme ∧-shaped, arms of equal width, apex slightly swollen.
Genus **Anatetranychus** nov.
hakea n. sp.

Empodium bent downwards and split into 4-6 needles. 22

22 Dorsal setat long and fine ,with normal basal ring. Genus *Eotetranychus* Oud. (not Australian)

Dorsal setae spindle-like, with roots in a spherical cavity. Genus *Apotetranychus* Oud. (not Australian)

23 Apex of peritreme simple. The dorsal striations forming a rhombic field between the inner setae of the fifth and sixth transverse rows (lumbales and sacrales).
Genus *Tetranychus* Dufour
urticae Koch

Apex of peritreme complex and anastomosed. Dorsal striations not showing above rhombic field.
Genus *Amphitetranychus* Oud. (not Australian)

24 Peritreme short and straight with swollen apical chamber. Empodium claw-like with ventral basal process of needles.
Genus *Paratetranychus* Zacher
unungnis Jacobi

Peritreme long, V-shaped and many chambered. Empodium split into 4-6 needles, without ventral basal process. 25

25 Seven transverse rows of dorsal setae: 2 . 4 . 4 (6) . 4 . 4 . 4 . 2., *i.e.*, "setae clunales" present. 26

Six transverse rows of dorsal setae: 2 . 4 . 4 (6) . 4 . 4 . 4, *i.e.*, "setae clunales" absent. Tarsus of palp with terminal club. Dorsal setae shorter than distance between transverse rows.
Genus *Platytetranychus* Oud. (not Australian)

26 Peritreme short, straight, with swollen apical chamber. Empodium with basal ventral process of six needles.
Genus *Metatetranychus* Oud.
ulmi Koch = *pilosus* Can. et F.

Peritreme long, V-shaped, swollen at bend and distal arm the wider. Empodium simple, claw-like, without ventral basal process.
Genus *Neotetranychus* Trägårdh
hakea n. sp.

Genus Tenuipalpus Donnadieu 1875

Tenuipalpus Donnadieu, 1875: Recherches pour servir à l'histoire de Tetranyques. Diss. Lyon, p. 111.
Brevipalpus idem, ibid., p. 115.

Minute reddish mites with oval or egg-shaped body or with the opisthosoma strongly contracted behind coxae IV and rectangular. Dorsal and ventral surfaces often reticulated. Setae generally small, variable in form, simple to leaf-like. Legs short and thick, femora strongly constricted at base then suddenly widening, segments strongly wrinkled. Claws 2, with tenent hairs; empodium not claw-like, modified, with two series of tenent hairs. End of tarsus truncate, apex ventrally with two broadened and laterally serrate setae, dorsally with a long hair. Tarsus I and II with a sensory seta. Palpi long and slender, without tibial claw, apically with 1-2 long hairs. Front margin of propodosoma somewhat overlapping base of gnathosoma, mostly pointed at apex.

These mites infest a great variety of plants, both in glass-houses and out of doors. Although generally not supposed to spin silk to any appreciable extent, yet one species in Australia is responsible for the webbing together of grape vines.

Approximately twenty species appear to have been described but the three following only are as yet known from Australia. The South African species *Tenuipalpus ornatus* Tucker also occurs here, but as this species does not fit into the genus *Tenuipalpus* s. str. it is in this paper removed to a new genus, *Tuckerella*.

TENUIPALPUS PHOENICIS Geijskes 1939

Meded. Landbouwhoogeschool, Wageningen, **42**, (4), 1939.

This species had only recently been described as infecting date-palms in Holland. It was, however, regarded as an introduction, for it was stated that the country of origin was unknown.

It may seem, therefore, somewhat dubious to relate the following Australian material to the above species, but as will be seen from the figures given, there is complete agreement with those given by Geijskes. In Australia the species appears to occur on a variety of hosts, and is undoubtedly an economic one.

Description—Colour in life, red. Female length, 250 μ, width 148 μ (the dimensions given by Geijskes are somewhat greater, *viz.*, 0·284 mm. by 0·151 mm.). Body egg shaped, the widest part on a level with the dorsal suture between the propodosoma and the hysterosoma, thereafter tapering and rounded apically. Dorsal suture distinct, anterior and posterior dorsal shields strongly reticulated. Anterior margin of propodosoma as figured, overlapping base of gnathosoma. Propodosoma with three pairs of setae arranged around the margin; hysterosoma with 18 setae arranged in three transverse rows of four, then six setae around the margin; all these setae are short, narrow, leaf-like, serrated and slightly curved as figured, none of the apical setae overreach the edge of the hysterosoma. Mouthparts: mandibles styliform, palpi 3-segmented, without tibial-claw, apical segment with several straight setae.

Ventral surface, as shown, strongly reticulated, coxae I with two setae, II-IV with one seta each; anterior shield three-sided, median shield with two pairs of setae, anterior pair short, posterior pair three to four times length of anterior pair, posterior part of hysterosoma with two shields, anterior quadrate with a pair of short posterior setae, posterior shield rounded with three indeterminate angles, as wide as anterior shield and with four short setae. Legs moderately long, IV somewhat over-reaching apex of abdomen; femora of I and II dorsally with a stout seta which, upon high magnification, is similar to dorsal setae. Tarsi with paired claws, each carrying two to four lateral tenent hairs, empodium with paired pads carrying series of tenent hairs; tarsi dorsally with a long seta. Eyes, two on each side.

The Australian material does not appear to differ from Geijskes' species, although while he figures and states that the dorsal seta of femora I and II is stout and rod-like, high magnification shows it as somewhat serrate. This is a common species on a wide variety of plants in Australia. The members of the genus have generally been regarded as free-living, non silk-spinning forms, but

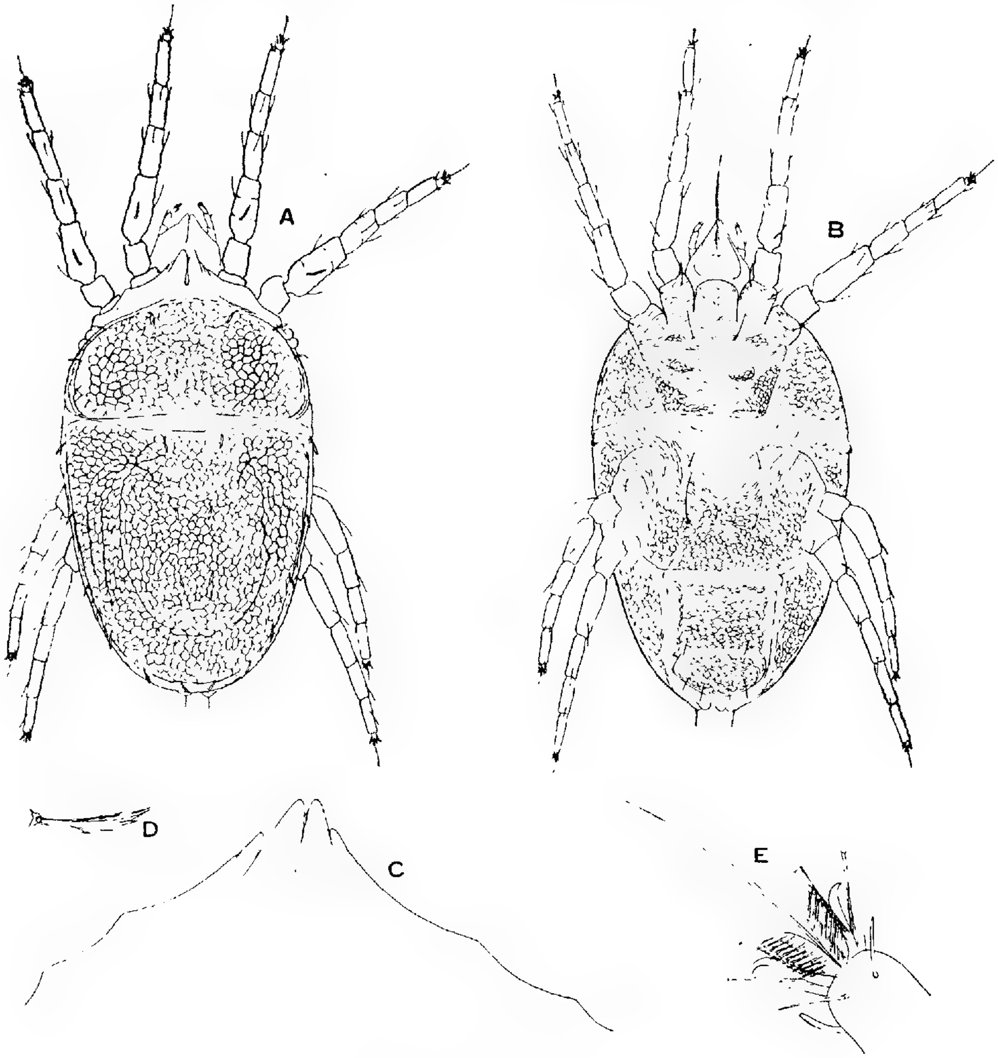


Fig. 1
Tenuipalpus phoenicis Geijskes
A, dorsal view; B, ventral view; C, front of propodosoma;
D, dorsal seta; E, tip of tarsus

on two occasions this species has been found to cause considerable webbing of grapes and vine-leaves.

N.B.—All figures, unless specified, refer to the females

Localities and Hosts:

South Australia: on sage, Adelaide, February 1940, (H. W.); webbing grapes and vine leaves, Waikerie, 5 April 1940, (D. C. S.).

Victoria: webbing grapes, Swan Hill, 5 March 1940 (R. T. M. P.); on citrus, Burnley, 13 August 1936 (R. T. M. P.).

Western Australia: on lemons, Spearwood, July 1935 (L. J. N.); on banana fruit, Carnarvon, 9 January 1939 (L. J. N.).

Queensland: on passion-fruit, Rockhampton, 1939 (A. R. B.).

New South Wales: on big-leaved Privet, Sydney, 3 September 1934; on Camelia bud, Sydney, 16 May 1939; on *Vitis clematidea*, Avalon, 15 July 1934; on *Clematis*, Parramatta, 3 September 1934; on *Hibbertia volubilis*, Avalon Beach, 15 July 1934; on Privet, Mosman, 8 August 1934; on *Clematis*, Cabramatta, 3 September 1934.

Northern Territory: on *Datura* leaves from Darwin, 15 April 1940.

Probably the same species is that recorded in the "Agricultural Gazette of New South Wales," vol. 45, 1934, p. 386, as damaging grapes by webbing in the Hunter River, Liverpool and Griffiths districts.

TENUIPALPUS CALIFORNICUS Banks 1904

Journ. New York Entom. Soc., 1904, p. 55.

There seems little doubt that the material before me can be correctly referred to the above species. The following description and the figures, however, are from Australian material.

Description—Female, length 190 μ, width 135 μ. Body: propodosoma + metapodosoma rounded, opisthosoma much narrowed by a comparatively sharp constriction behind fourth pair of legs, then somewhat rectangular and almost quadrate but rounded apically. Dorsal suture indistinct, but a series of irregular lines on the level of legs IV divides the body into two distinct shields corresponding to the propodosoma + metapodosoma and the hysterosoma. Neither dorsum nor venter reticulated or patterned. Propodosoma + metapodosoma with three pairs of setae (fig. 2, A) arranged around the margin and two pairs of similar median but much shorter setae and two simple setae; opisthosoma with eight marginal setae (fig. 2, A), one pair just posterior of leg IV and three pairs at equidistances around the apical margin, and one pair of anterior fine small setae; there is also another pair of marginal setae between legs III and IV; the longer setae are moderately broad, leaf-like and serrate as in fig. 2 C and 13·5 μ long, The three pairs of apical setae overreach the body margin. Mouth parts, palpi and mandibles as in the genus. Eyes, two on each side.

Ventral surface: coxae each with a single small fine seta; just posterior of and between coxae I is a pair of long fine setae and there is a similar pair between coxae IV; medially in the field between coxae II and III is a pair of fine short setae. On each side of the anal opening are three very small fine setae, and anterior of it, but further apart, is another pair. Legs very short, IV not reaching apex of body; claws and empodium as in the genus; femora I and II showing but little contraction at base and femora II without an apophysis.

My specimens differ from Banks' figure as given by Quayle (1912) in several details, but one assumes that his figures were not drawn under sufficiently high magnification. No dorsal setae, apart from the six apical marginal ones are shown by Quayle, and he only figures a single eye on each side. More important perhaps is his figure of the tarsus, where he shows four similar claws, instead of two claws and a median empodium. Such a structure does not appear to have been figured for any other species.

It was described from California as infesting lemons, but occurs in Australia on a variety of hosts and has been taken quite frequently, but not always, along

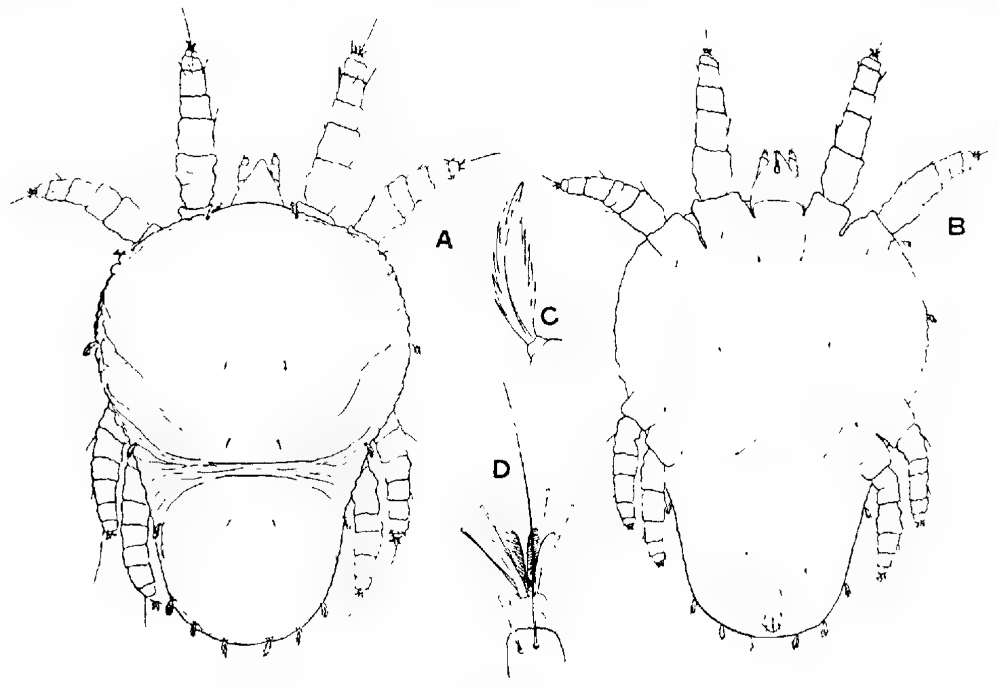


Fig. 2
Tenuipalpus californicus Banks
A, dorsal view; B, ventral view; C, dorsal seta; D, tip of tarsus II from above

with the preceding. It does not appear, however, from the relative numbers examined to be as common.

Localities and Hosts:

South Australia: on Fuchsia in green-house, Botanic Gardens, Adelaide, 26 February 1940 (H. W.).

New South Wales: on Big-leaved Privet, Sydney, 5 July 1934; on Camellia bud, Sydney, 16 May 1939; on *Vitis clematidea*, Avalon, 15 July 1934; on *Clematis*, Cabramatta, 3 September 1934; on *Hibbertia volubilis*, Avalon Beach, 15 July 1934.

Victoria: on grapes, Swan Hill, 5 March 1940 (R. T. M. P.); on citrus, Burnley, 13 May 1936 (R. T. M. P.).

Northern Territory: on *Datura* leaves from Darwin, 15 April 1940.

Tenuipalpus vitis n. sp.

The following species does not agree with any previous description that I am aware of. It is closely related to the preceding but differs in a number of important details as well as in size.

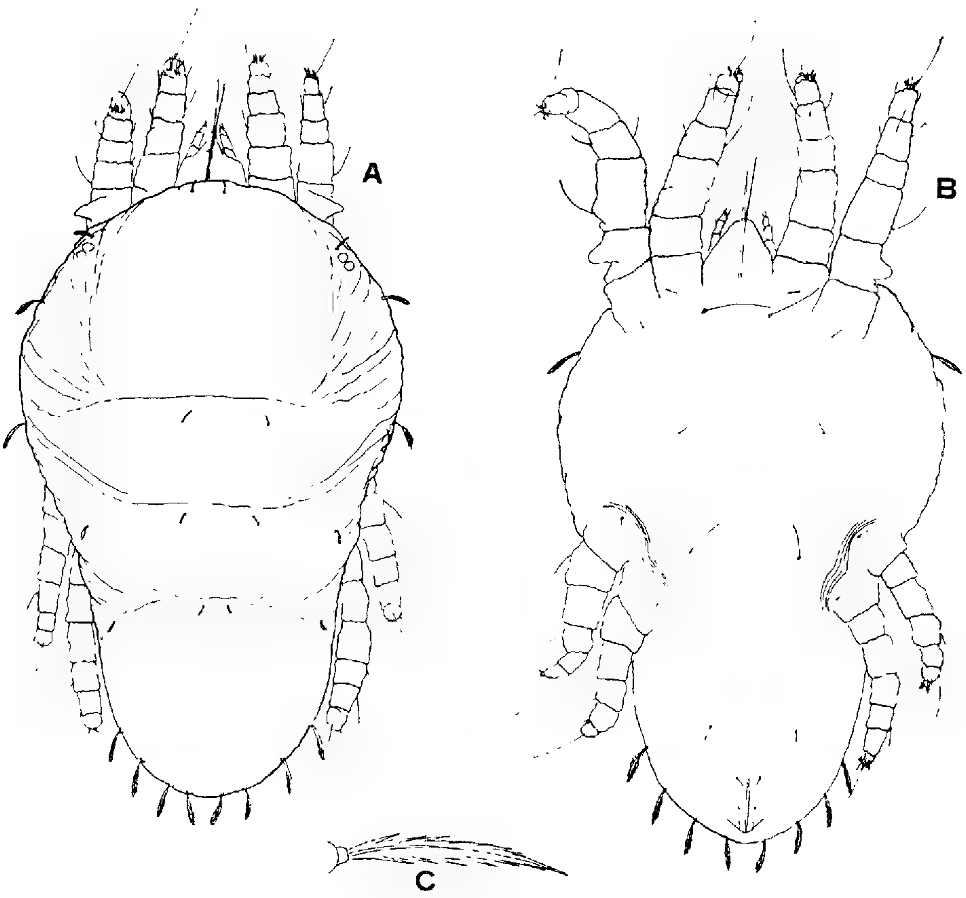


Fig. 3
Tenuipalpus vitis n. sp.
A, dorsal view; B, ventral view; C, apical dorsal seta

Description—Female, length 248 μ, width 140 μ, shape much as in preceding species, but propodosoma + metapodosoma rather longer than wide and with an indistinct suture between; posteriorly the body is constricted from leg IV, somewhat rectangular and rounded apically; there are indistinct transverse sutures or lines on level of leg III and just posterior of leg IV. Neither dorsally nor ventrally are there reticulations or patterning. Eyes, two on each side. Mouth parts, palpi, etc., as in the genus.

On the propodosoma there are three pairs of marginal setae, the anterior pair being very small, the second pair larger and the posterior pair the largest; on the metapodosoma are two pairs of lateral setae, the anterior large, the posterior smaller, medially are two pairs of smaller and (?) fine setae; on the opisthosoma anteriorly are a pair of small lateral setae and a pair of median smaller (?) fine setae; around the apical margin are four pairs of equidistant long narrow serrated, leaf-like setae (fig. 3, C) 16·2 μ long. Ventrally the setae are as in the preceding species. Legs strong and short as in the genus, but with little or no constriction at the base of the femora I and II, femora II with a pronounced lateral triangular apophysis. Claws and empodium as in the genus.

This species differs from the preceding in the size and shape and in the lengths and arrangements of the dorsal setae, as well as in the apophysis on femora II.

Locality and Host:

Western Australia: on lemons, Perth, May 1934 (L. J. N.).

Genus **Tegopalpus** nov.

Description—Elongate-oval in form with the mouth-parts hidden under the propodosoma. Palpi 2-segmented without tibial claw, tarsus with a long seta and a stout cylindrical appendage. Legs very short, tarsi of I and II with a stout cylindrical seta. Claws normal with a pair of lateral tenent hairs, empodium split to form a pair of fine, somewhat slender claw-like processes.

Tegopalpus conicus n. sp.

Description — Sex ?, probably female. Shape an elongate oval, greatest width just before the middle; length 324 μ, width 162 μ. Eyes, two on each side. Dorsal and ventral surfaces not reticulated, but finely striated. Indistinct sutures present between propodosoma and metapodosoma and between metapodosoma and opisthosoma. Mouth-parts hidden beneath propodosoma; mandibles styliform, palpi only 2-segmented without tibial claw, apical segment small and rounded with a long seta and a long, stout, cylindrical seta. Legs very short, tarsi I and II with a similar cylindrical seta to that of palpi; claws simple but with a pair of lateral tenent hairs, empodium divided into two fine prongs which are somewhat claw-like. Dorsal setae: on propodosoma three pairs of lateral serrated leaf-like setae, on metapodosoma two pairs of similar setae laterally, a median similar pair anteriorly, and a pair of median fine and small setae posteriorly, opisthosoma with four pairs of lateral leaf-like setae, and an anterior pair of small fine ones. Ventral setae: coxae each with a small fine seta, between legs II and legs IV and in field between legs II and III a pair of long fine setae, on each side of anus are four small fine setae.

This very interesting and rather aberrant species is only known from four specimens from New South Wales collected on *Casuarina* at Avalon Beach on 26 August 1934 and submitted by the Department of Agriculture. In the structure of the claws and empodium it is related to the next genus.

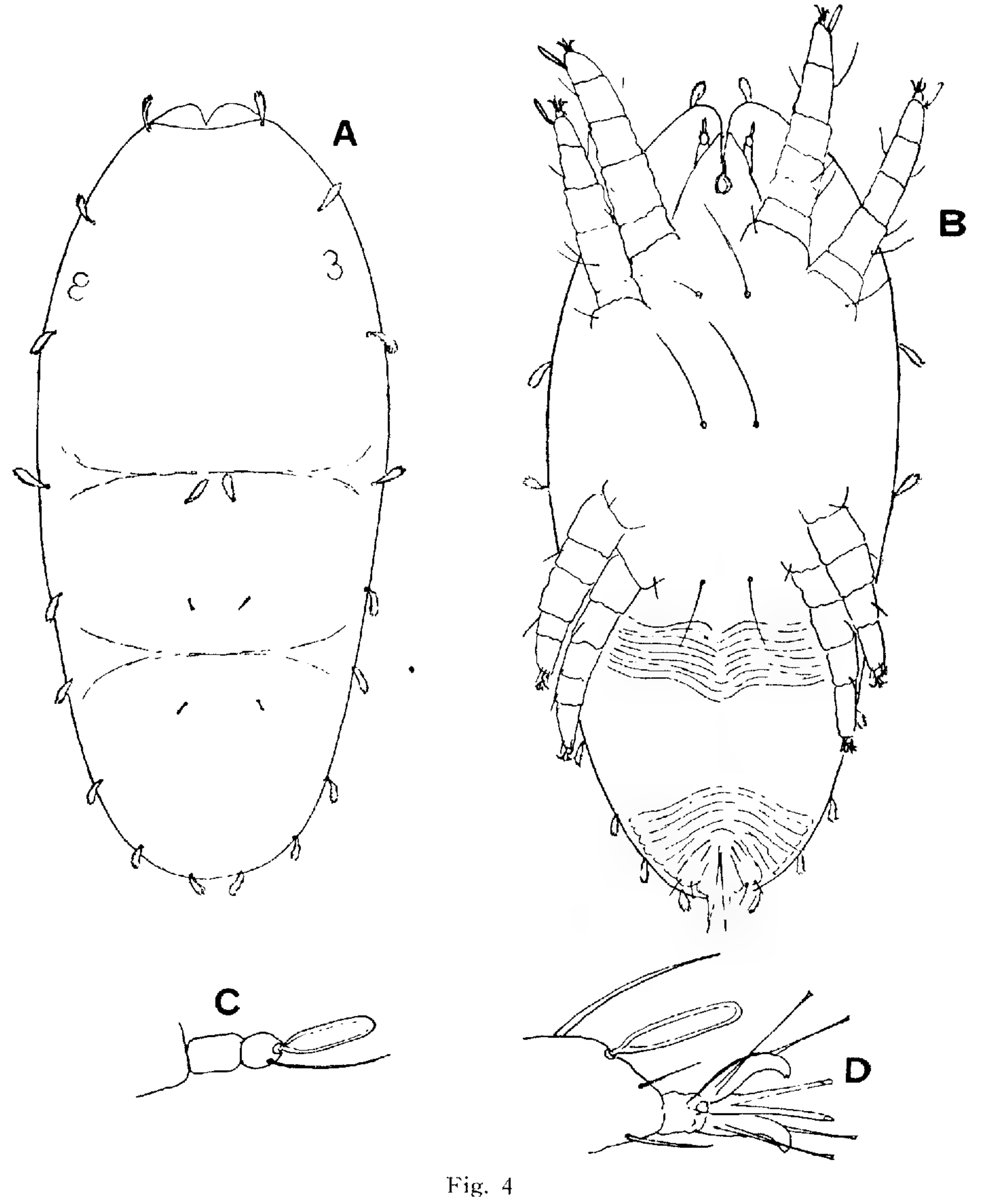


Fig. 4
Tegopalpus conicus g., et sp. n.
A, dorsal view; B, ventral view; C, palp; D, tip of tarsus I

Genus **Tuckerella** nov.

This genus is erected for the species *Tenuipalpus ornatus* described by Tucker from South Africa. It differs from *Tenuipalpus* as in the key to genera and the following generic description.

Description—Elongate-oval in shape. Eyes, two on each side. Mouth-parts elongate, mandibles not so styliform as in *Tenuipalpus.* Palpi long, 4-segmented, tibia with a strong claw, tarsus over-reaching slightly tip of claw, cylindrical with four long pointed setae and a cylindrical rod. Claws normal and strong with paired lateral tenent hairs and the empodium split into two fine processes resembling claws. Dorsum divided into propodosoma, metapodosoma and opisthosoma, reticulated and furnished with fan-like setae and apically with a bunch of long ciliated setae. Legs short.

Tuckerella ornata (Tucker 1926)

Tenuipalpus ornatus Tucker, Dept. of Agric., S. Afr., Memoir, No. v, 1926, p. 4, pl. ii.

Description—Female, length to front of propodosoma 337 μ, gnathosoma 135 μ, width 216 μ. Colour in life, red. Body roundish-oval, widest on line of propodosomal-metapodosomal suture. Dorsum strongly reticulated with sutures indistinctly shown between propodosoma and metapodosoma and between metapodosoma and opisthosoma. Mouth-parts elongate, mandible piercing, stylet-like, palpi elongate, 4-segmented, tibia with well-developed claw, tarsus cylindrical, slightly over-reaching tip of claw and furnished with four setae and one cylindrical rod. Eyes, two on each side. Dorsum furnished with over 40 large, fan-shaped setae, propodosoma with two anterior-marginal, two postero-lateral and four submarginal, metapodosoma with an anterior row of eight, a subposterior row of six and four lateral on each side; opisthosoma with six marginal and eight smaller dorsal setae; at the apex of the opisthosoma is a tuft of 10-12 long ciliated setae; the largest dorsal setae are 54 μ long and the apical ciliated setae 350 μ long (in the figures these setae have been abbreviated). Legs short, IV not reaching apex of body, furnished with similar but smaller fan-like setae; claws strong, furnished with a pair of lateral tenent hairs; empodium divided into two processes, resembling but more slender than the claws. Ventral setae: coxae each with one slender fine seta, between coxae I, coxae IV and in field between coxae II and III a pair of fine setae, those between coxae I the longest.

Remarks:

In the presence of the palpal claw and the pronounced mouth-parts this species obviously cannot fit into *Tenuipalpus.* The mandibles and tarsal claws and empodium will also exclude it.

There seems little doubt that it is the same as that described by Tucker (1926) as infesting citrus fruits in South Africa, and it was quite recognisably figured by Froggatt from galls on Privet at Sydney, New South Wales, in the Agricultural Gazette of New South Wales for 2 September 1916. It was,

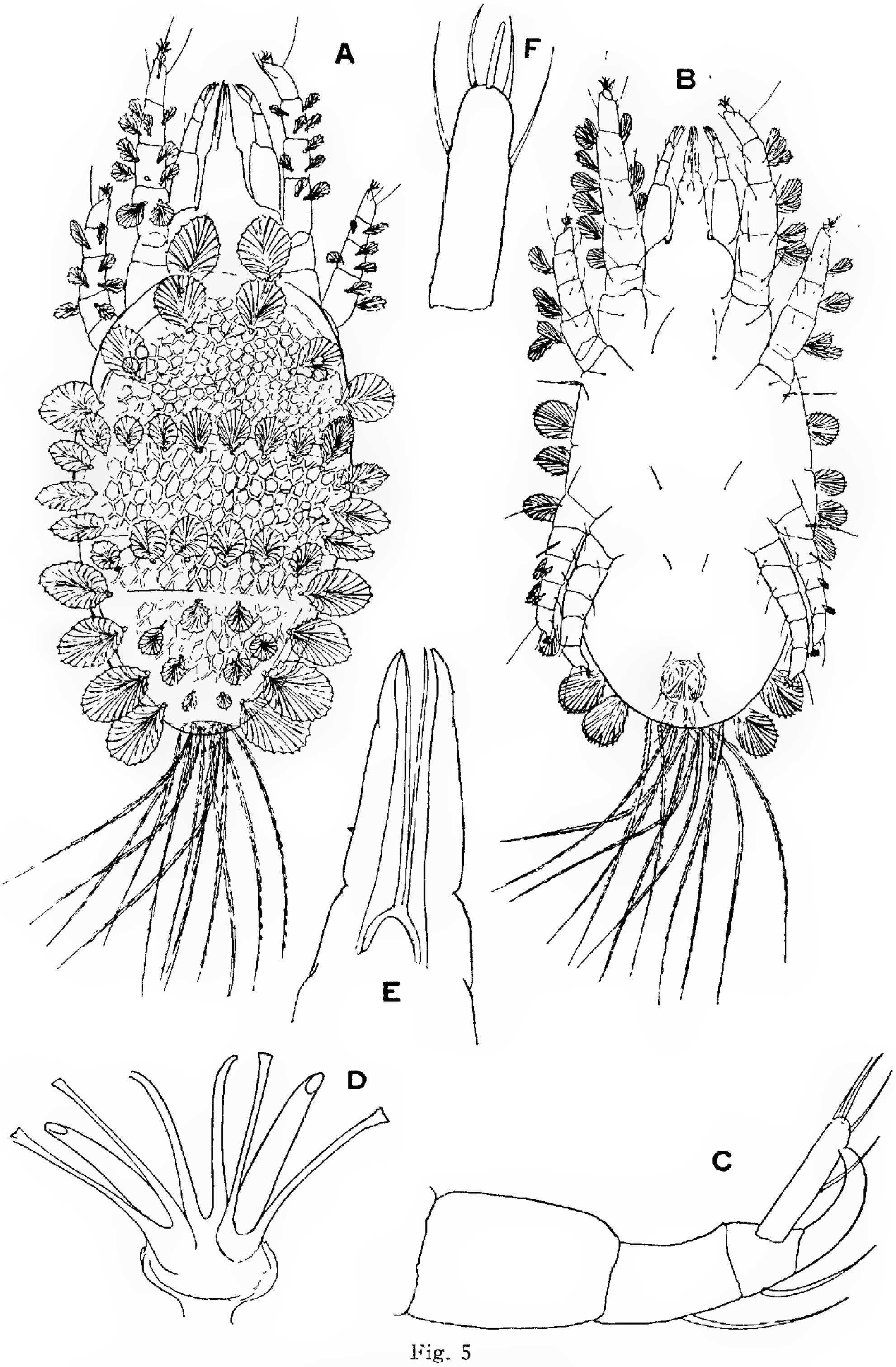


Fig. 5

Tuckerella ornatus (Tucker)

A, dorsal view; B, ventral view (terminal abdominal setae abbreviated); C, palp; D, claws and empodium; E, mandibles; F, tip of palpal tarsus however, mistakenly regarded by him as the gall-maker and referred to the Oribatidae and near to *Leiosoma* Nicolet.

Localities and Hosts:

New South Wales: on Privet, Sydney, October 1916 (W. W. Froggatt); Mosman, 7 August 1934; on Cypress Pine, Castle Hill, 23 August 1934; on *Apiomorpha* gall on Eucalypt, Boomi, 16 August 1934.

Genus Bryobia Koch 1836

Bryobia Koch, 1836: Deutsch Crust. Myr. Arachn., f. I, t. 8-9.

Body flat, broad and oval in female, egg-shaped in male. Cuticle irregularly wrinkled and with small tubercles. Front margin of propodosoma 4-lobed, each lobe tipped with a seta. Body setae fan-like, apically over-reaching edge of body. Front legs longer than the rest and slightly longer than body in female, much more so in male. Tarsi about as long as tibiae. Claws normal with lateral tenent hairs, empodium with two series of tenent hairs. Palpi stout with tibial claw. Mandibles styliform, with distinct mandibular plate. Peritreme opening externally in a pair of sausage-shaped processes. Eyes, two on each side, the anterior smaller than posterior.

Bryobia praetiosa Koch 1836

Bryobia praetiosa Koch 1836: Deutsch. Crust. Myr, Arachn., f. I, t. 8-9.

Description—Female, length to 700 μ, width 500 μ; male, length 460 μ, width 320 μ. Colour in life reddish with grey or greenish-grey to black body, gnathosoma and legs red. Front of propodosoma with four lobes, the median pair the longer, and each tipped with a leaf-like seta. Body oval, broad and flat in female, more elongate and egg-shaped in male. A distinct sutural line between proterosoma and hysterosoma. Eyes, two on each side, the anterior the smaller. The proterosoma with a pair of setae just medial to the eyes. Hysterosoma with an anterior row of six setae, two pairs in middle and 14 setae situated around the margins; all these dorsal setae are leaf-like. The arrangement of setae in the male is similar, but there seems to be an additional pair of lateral setae posteriorly on the proterosoma. Ventrally the setae are long and fine, there are two on coxae I and one on coxae II-IV; between coxae II, coxae IV and in field between coxae II and III and posterior of coxae IV is a pair, and there are several small ones around the anus. The mandibles are styliform, with a distinct mandibular plate, slightly incised at apex. Tracheal tubes opening externally on each side of mandibular plate as sausage-like processes. Palpi stout with distinct tibial claw. Legs I in female about as long as body, others shorter; in male I about twice as long as body, 665 μ. Claws with lateral tenent hairs, empodium with two series of tenent hairs; leg setae fine and ciliated. Penis long and slender, slightly curved.

Remarks:

This species, frequently known as the "clover mite," is of almost cosmopolitan distribution. It is a frequent pest of apple and other fruit trees, the young stems of which are often decidedly red in colour due to the covering of eggs of the mite.

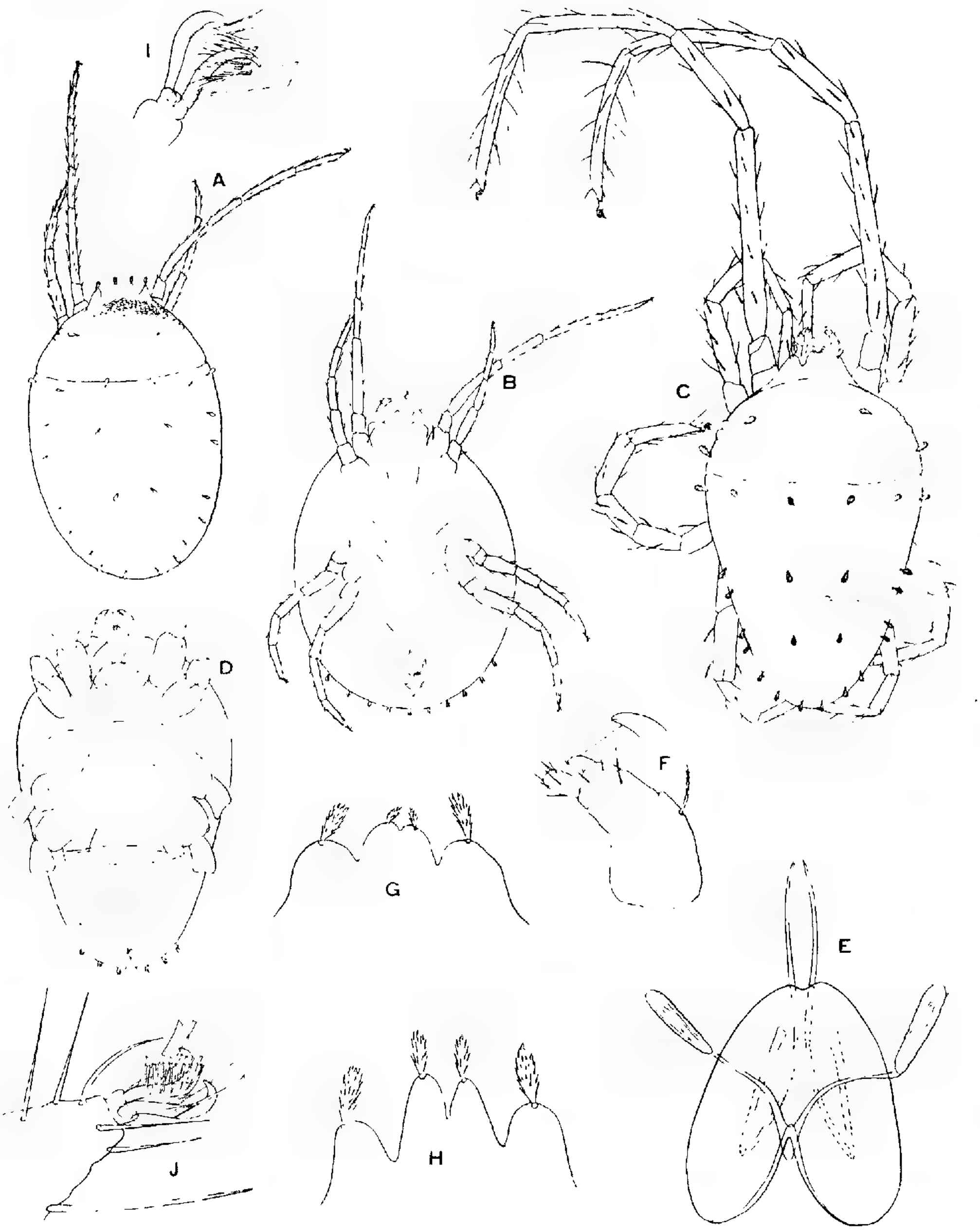


Fig. 6
Bryobia praetiosa Koch
A, dorsal view of female without posterior legs; B, female, ventral view; C, dorsal view of male; D, ventral view of male; E, mandibles and peritreme; F, palp; G, front of propodosoma of male; H, same of female; I, lateral view of claws and empodium of leg I; J, same of legs II-IV

It has gone under a number of synonyms and it seems probable that most, if not all the different species of *Bryobia* described are but one and the same species.

Localities and Hosts:

South Australia: on *Lolium perenne* in glasshouse, Waite Institute, Glen Osmond, 5 October 1933 (D. C. S.); on apple foliage, Waite Institute, 30 October 1932 (D. C. S.); on rye grass and clover, Waite Institute, 9 November 1933 (D. C. S.); Glen Osmond, July 1934 (R. V. S.); Brown Hill Creek, 6 August 1933 (H. W.).

Western Australia: on almonds, Perth, 16 January 1939 (P. N. F.); on apples, Mount Barker, 29 September 1932; Karrogullen, 9 March 1940 (C. F. H. J.); Narrogin, 20 October 1938 (K. R. N.); in grass, Crawley, 27 June 1935 (K. R. N.).

Victoria: Mildura, 24 February 1939; Beechworth, 23 August 1939; Frankston, 23 February 1939; Wantirna, 23 February 1929; Bendigo, 23 February 1939; Geelong, 23 February 1939; Warragul, 25 February 1939; Amphitheatre, 27 February 1939; Heidelberg, 23 February 1939.

New South Wales: Bathurst, June 1932; on *Amaranthus*, Sydney, 14 June 1934.

Genus NEOPHYLLOBIUS Berlese 1886

Neophyllobius Berlese 1886: Acari dannosi alle piante coltivate, p. 19.

Description—Body roundish oval, without sutural line between proterosoma and hysterosoma. Dorsal setae strong, curved, often on small tubercles. Palpal tibia without claw, with two setae and an apical stout curved rod. Legs very long, all much longer than body, especially I and IV, genu of III and IV often with a long whip-like seta; tarsi very much shorter than tibiae; claws normal, without tenent hairs, empodium with two series of tenent hairs. Eyes, two on each side.

This genus is found in Europe (four species), in North America (two species), and now a further species is described from Australia. They are small reddish mites occurring under stones, in moss, etc.

Neophyllobius ornatus n. sp.

Description—Female (?), body rounded, length 250 μ, width 175 μ. Colour in life reddish. Dorsum without suture. Eyes, two on each side. Mandibles styliform, palpi short but slender, 4-segmented, tibia without claw but with two setae and a long curved stout rod, tarsus short and rounded with four setae. Dorsal setae 54 μ, on small papillae, ciliated, coarse, curved, and pointed, arranged in transverse rows of 4 . 4 . 4 . 4 . 4 . 4 . 2, *i.e.*, mid-dorsally with seven pairs. Ventral setae long and fine, one on each coxa, one pair between coxae I and another between coxae III and a pair on the gnathosoma; legs very long, longer than body; genu of all legs with a long whip-like seta, finely ciliated, tarsi shorter than tibiae; claws simple without tenent hairs, empodium with two series of tenent hairs. Length of leg I 445 μ, II 391 μ, III 391 μ, IV 432 μ; of genual seta I 148 μ, II 148 μ, III 175 μ, IV 175 μ; tarsi somewhat swollen.

Fig. 7
Neophyllobius ornatus n. sp.
A, dorsal view; B, ventral view; C, palp; D, claws and empodium

Remarks:

This new species differs from all others in the arrangement and number of dorsal setae. It is closest to *saxatilis* Halbert, but differs in the nature of the dorsal setae. No species is known to be of economic importance.

Locality:

On *Apiomorpha* gall on *Eucalyptus,* Boomi, New South Wales, 16 August 1934.

Genus **Tenuicrus** nov.

Description—Roundish oval forms. Dorsum irregularly striated, furnished with long, thick, blunt, ciliated and almost straight setae arising from strong

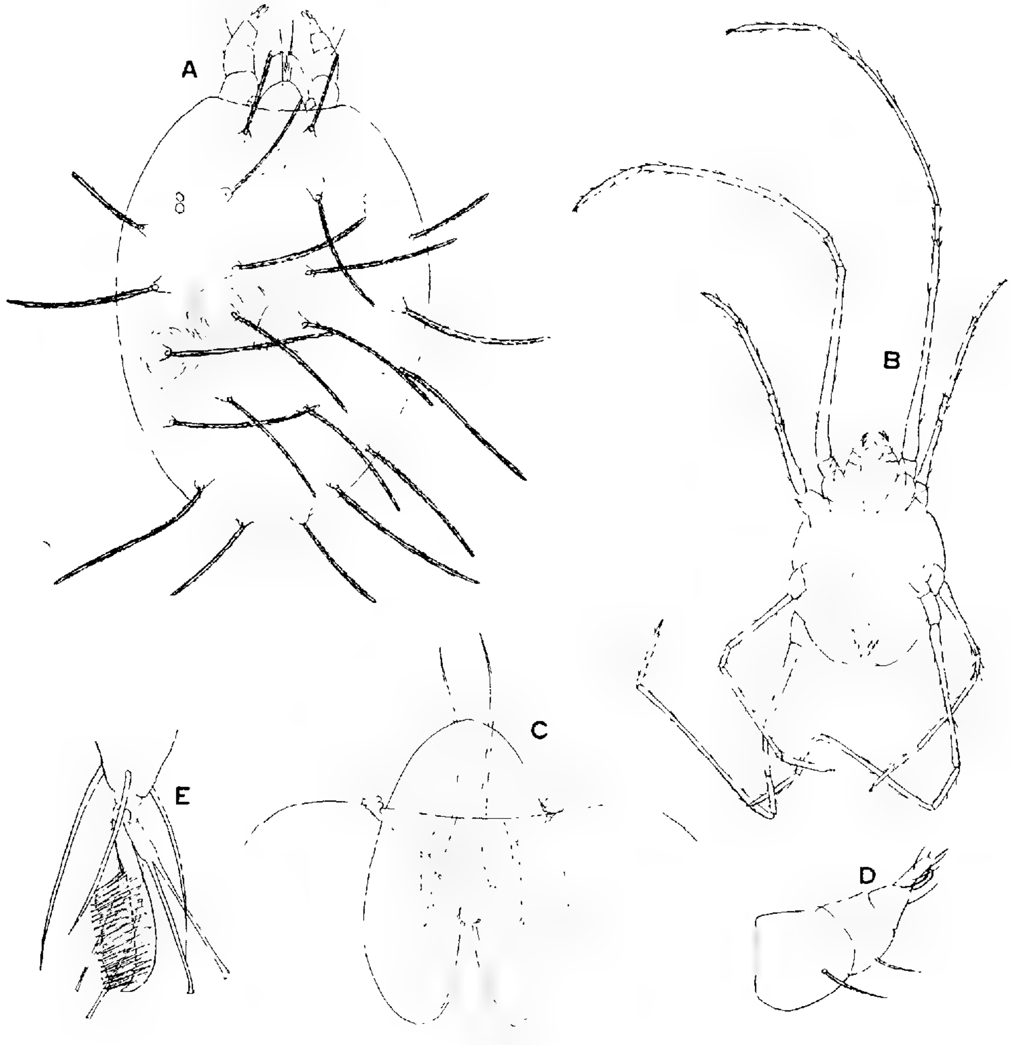


Fig. 8

Tenuicrus errabundus g., et sp. n.

A, dorsal view without legs; B, ventral view; C, mandibles and peritreme; D, palp; E, claws and empodium

papillae. Mandibles styliform with distinct mandibular plate. Peritreme straight, opening externally on each side of mandibular plate in a small compound globular process. Palpi stout with distinct tibial claw. Legs very long and slender, II and III about half as long again as body, I and IV three to four times as long; tarsi much shorter than tibiae; claws modified to pads furnished with two tenent hairs; empodium claw-like with two series of tenent hairs.

Tenuicrus errabundus n. sp.

Description—Female, length 513 μ, width 350 μ. Colour in life, ? Dorsum irregularly striated, the striae forming circles around the papillae. Dorsal setae long, 190 μ, stout, blunt-ended and ciliated, arising from strong papillae, arranged 2 . 4 . 4 . 4 . 4 . 4. Mandibles styliform, with distinct mandibular plate which is entire at apex; palpi stout, 4-segmented with strong apical claw, tarsus cylindrical, over-reaching tip of claw. Ventral setae long and fine, one on each coxa, a pair between coxae II and between coxae IV and a few small ones around anus. Legs very long and slender, all exceeding body length, I and IV three to four times; tarsi very much shorter than tibiae, claws modified to form pads ending in two tenent hairs, empodium claw-like with two series of tenent hairs. Eyes, two on each side.

Remarks:

This very striking animal resembles the species of *Neophyllobius* in the very long legs, but differs in the dorsal setae and generically in the structure of the tarsal claws and empodial appendage.

Locality:

A single specimen from ground at Concord West, New South Wales, 27 March 1935 (S. L. A.).

Genus **Schizonobia** nov.

Description—Roundish species, dorsally strongly convex with strong dorsal setae arising from papillae. Mandibles styliform with distinct mandibular plate. Palpi stout with strong tibial claw. Peritreme almost straight but ending externally in a very large globular chamber. Legs not excessively long, tarsi about two-thirds length of tibiae, claws modified as two pads ending in paired tenent hairs, empodium claw-like but only with one pair of lateral tenent hairs.

Schizonobia sycophanta n. sp.

Description—Female, colour in life reddish. Length of female 870 μ, width 610 μ. Body strongly convex and roundish, dorsum furnished with very strong ciliated and pointed setae, 148 μ long, arranged 2 . 4 . 4 (6) . 4 . 4 . 4 in transverse rows. Mandibles styliform, mandibular plate distinct, slightly incised at apex. Peritreme short, but ending externally as a large globular chamber. Palpi stout, as figured, with strong tibial spur, tarsus stout, cylindrical, over-reaching tibial claw. Legs not or only slightly longer than body, tarsi about two-thirds length of tibiae; claws modified as pads ending in two tenent hairs, empodium claw-like, with a lateral tenent hair on each side. Ventral setae: long and fine, 81 μ, except the shorter ones around anus, coxae I and II with three subapical setae, the outer one indistinctly ciliated, III and IV with only one simple seta, gnathosoma with one pair, between coxae I one pair, between III one pair, IV one pair, around anus six pairs.

Locality and Host:

Attacking couch grass, Hobart, Tasmania, 1939 (J. W. E.). The eggs were thickly congregated around the stems.

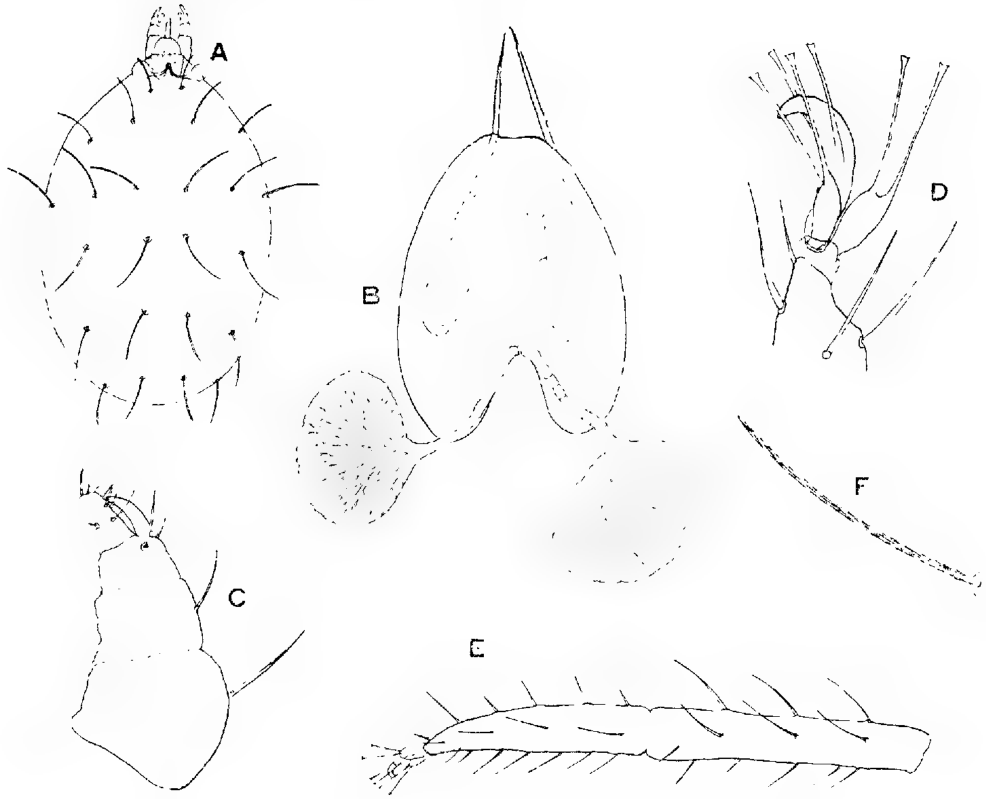


Fig. 9

Schizonobia sycophanta g., et. sp. n.

A, dorsal view without legs; B, mandibles and peritreme; C, palp; D, claws and empodium; E, tibia and tarsus of leg I; F, dorsal seta

Genus **Aplonobia** nov.

Description—Rounded, very convex species, dorsum furnished with strong, long, blunt and serrated setae arising from strong papillae, arranged in seven rows: 2 . 4 . 4 (6) . 4 . 4 . 4 . 2, *i.e.*, setae clunales present. Mandibles styliform, mandibular plate present, palpi stout with distinct tibial claw. Peritreme ending externally in a sausage-shaped chamber. Eyes, two on each side. Legs only slightly, if at all, longer than body, except I which is distinctly longer. Claws modified as pads ending in two tenent hairs, empodium claw-like with series of tenent hairs.

Aplonobia oxalis n. sp. (Sour-sob Mite)

Description—Female, colour in life dark reddish. Length 920 μ, width 700 μ; dorsally strongly convex, furnished with seven transverse rows of strong, blunt, slightly curved and serrate setae, 122 μ long and arranged: 2 . 4 . 4 (6) . 4 . 4 . 4 . 2, *i.e.*, setae clunales present, all setae arising from large prominent papillae. Eyes,

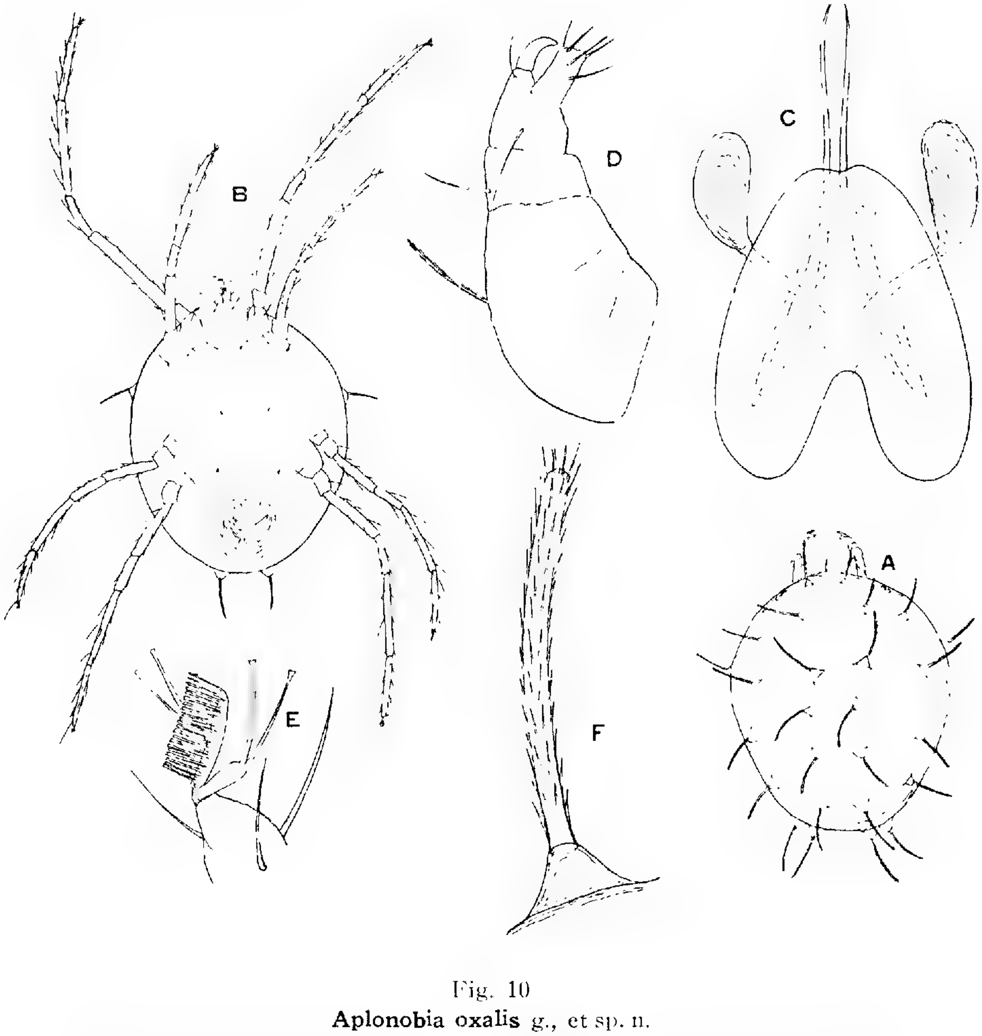


Fig. 10
Aplonobia oxalis g., et sp. n.
A, dorsal view without legs; B, ventral view; C, mandibles and peritreme; D, palp; E, claws and empodium; F, dorsal seta

two on each side, but difficult to discern. Mandibles styliform, mandibular plate slightly incised apically. Palpi stout, tibia with strong claw reaching tip of the shortly cylindrical tarsus. Legs not much if at all longer than body, except I; tarsi only slightly shorter than tibiae, claws pad-like with two tenent hairs, empodium claw-like with series of tenent hairs. Ventrally the setae are long and fine, gnathosoma with one pair, coxae I and II with two, III and IV with one, a pair between coxae I and coxae IV, and a pair in the field between coxae II and III.

Remarks:

This very interesting species seems to be of some economic importance. In many localities in South Australia it occurs on the Sour-sob *(Oxalis cernua),* a noxious weed probably introduced to Australia from the Mediterranean Region. Its attack results in the leaves turning yellow and withering. It has also been found affecting fruit trees. The eggs are laid in clusters under bark and twigs lying on the ground. The name of "Sour-sob mite" has been given to this species by agricultural workers in South Australia.

Localities and Hosts:

South Australia: on *Oxalis,* Balaklava, 24 August 1933 (H. W.); on *Oxalis,* Lockleys, September 1933 (D. C. S.); Adelaide, August 1938 (H. W.); Glen Osmond, August 1934 (R. V. S.).

New South Wales: Bathurst, 27 April 1939, on peach (probably only for the purpose of egglaying on the bark).

Genus Petrobia Murray 1877

Petrobia Murray, 1877: Econ. Ent. Apt., p. 118.

Description—Roundish convex animals, dorsum furnished with relatively short, stiff, finely ciliated setae not arising from papillae, arranged in seven transverse rows, *i.e.*, setae clunales present; dorsal suture distinct. Mandibles styliform, mandibular plate present. Peritreme ending externally in a horn- or trumpet-like chamber. Palpi stout, tibial claw present. Claws modified to pads ending in two tenent hairs, empodium claw-like with series of tenent hairs. Legs not longer than body, except I which exceeds body length. Tarsi shorter than tibiae.

Remarks:

Geijskes, in his recent paper, synonymises Banks' genus *Tetranobia* with the above, but a scrutiny of the description of *T. longipes* Banks 1912 shows that the claws are of normal form and, therefore, *Tetranobia* falls into quite a different section of the key to the genera.

Petrobia latens (O. F. Müll. 1776)

Acarus latens Müll., O. F., 1776: Zool. Dan. Prodr., p. 187.
Trombidium lapidum Hammer, 1804: in Hermann, Mem., p. 49.
Petrobia lapidum Murray, 1877: Econ. Ent. Apt., p. 118.
Petrobia lapidum Oudemans, 1915: Arch. für Naturg., **81** (5), p. 49.
Petrobia latens Oudemans, 1939: Krit. Hist. d. Acarol., II, 1759-1804, p. 285.

Oudemans, in his monumental work, has critically reviewed the synonymy of this species, which should now stand under the above name.

Description—Female; colour in life, dark reddish. Dorsum convex, furnished with short stiff ciliated setae of 54 μ length; body 520 μ long, 300 μ wide. The dorsal setae are arranged in seven transverse rows of 2 . 4 . 4 (6) . 4 . 4 . 4 . 2, *i.e.*, setae clunales present. Mandibles styliform, mandibular plate slightly incised at apex. Peritreme ending externally in a horn- or trumpet-like chamber. Palpi stout with strong tibial claw. Eyes, two on each side. Legs II and III shorter than body, IV as long as, I longer than body; tarsi about two-thirds length of

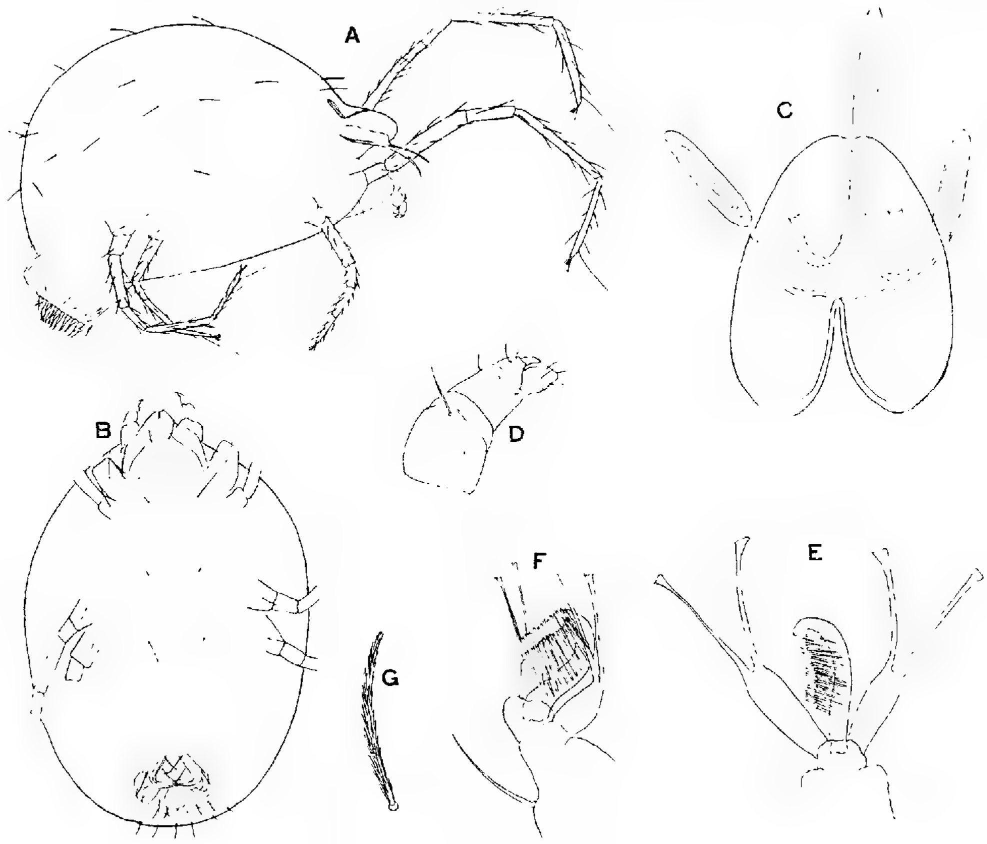


Fig. 11
Petrobia latens (O. F. Müll.)
A, lateral view; B, venter; C, mandibles and peritreme; D, palp; E, claws and empodium; F, same, another view; G, dorsal seta

tibiae; claw modified to pads ending in two tenent hairs, empodium claw-like with series of tenent hairs. Ventral setae: on gnathosoma a pair, on all coxae one, between coxae I, coxae IV and in field between coxae II and III a pair, some smaller ones around the anal and genital openings.

Remarks:

This species is well known in Europe and is undoubtedly an introduction to Australia, where it is of economic importance.

Localities and Hosts:

New South Wales: on wheat, Inverell, 10 October 1929.

Western Australia: on apples along with *Bryobia*, Narrogin, 20 October 1938 (K. R. N.).

Genus TETRANYCHUS Dufour 1832

Tetranychus Dufour, 1832: Ann. Sci. Nat., 25, pp. 276-283.
Epitetranychus Zacher, 1916: Mitt. Kais. Biol. Anst. f. Land- und Forstwirthsch., H. 16, p. 22.
Tetranychus Oudemans, 1931: Ent. Berl., Dl. 8, No. 178, pp. 221-222.

This genus, in its strict sense, includes the true "red-spiders" or "spinning mites," all of which are of considerable economic importance as plant pests.

Description—Dorsum with only six transverse rows of setae, *i.e.,* setae clunales absent; the setae are long and thin, at most with fine indistinct ciliations. Peritreme simple, bent V-shaped, with several chambers, but not broadened. In the female the dorsal cuticular striations form a rhomboidal figure between the last two transverse rows of dorsal setae. Empodium, except on leg I of male, split into six downwardly and somewhat backwardly directed needles. Penis with an end barb or hook.

Type—*Tetranychus lintearius* Duff.

TETRANYCHUS URTICAE Koch 1836

Tetranychus urticae Koch, 1836; Deutsch. Crust. Myr. Arachn., F. 1, t. 10.
Tetranychus altheae v. Handstein, 1901: Zeitschr. f. Wissenschaftl. Zool., 70 (1), p. 74.
Tetranychus urticae Oudemans, 1930: Ent. Berl., Dl. 8, No. 176, pp. 163 166.

This species is the common "red-spider" in Australia, occurring on a wide variety of cultivated plants, in gardens, fields and hot-houses. All the records hitherto published in Australian literature can almost with certainty be referred here, for examination of recent material has failed to show the presence of any other species.

The true *telarius* Linn. is now transferred to the genus *Eotetranychus*, of which neither that nor any other species can be authoritatively claimed as yet having been found in Australia.

Description—In life greenish, with lateral dark spots during the summer, but in the autumn and winter reddish. Legs and setae whitish. Length of female to 600 μ, width 250 μ, male to 400 μ, width 150 μ. Body roundish-oval. Cuticle finely striated. Dorsum with six rows of long fine and finely ciliated setae arranged 2 . 4 . 4 (6) . 4 . 4 . 4, *i.e.*, setae clunales absent. Eyes, two on each side. Mandibles long and styliform, distinct mandibular plate present, slightly incised at apex. Peritreme long and slender, V-shaped, with several chambers. Palpi stout, tibia with strong claw, tarsus short with thick terminal thumb and thinner lateral rod; in male, femora with a stout curved spine. Claws as two pads ending in a pair of tenent hairs, empodium split into six downwardly directed needles, in male on I the needles are short and stumpy. In the male the penis is short, curved apically and ending in a hollow expanded collar resembling a barb or hook from a lateral view.

Remarks:

The synonymy of this species has been very much confused, and it is only comparatively recently that Oudemans has definitely separated it from the true

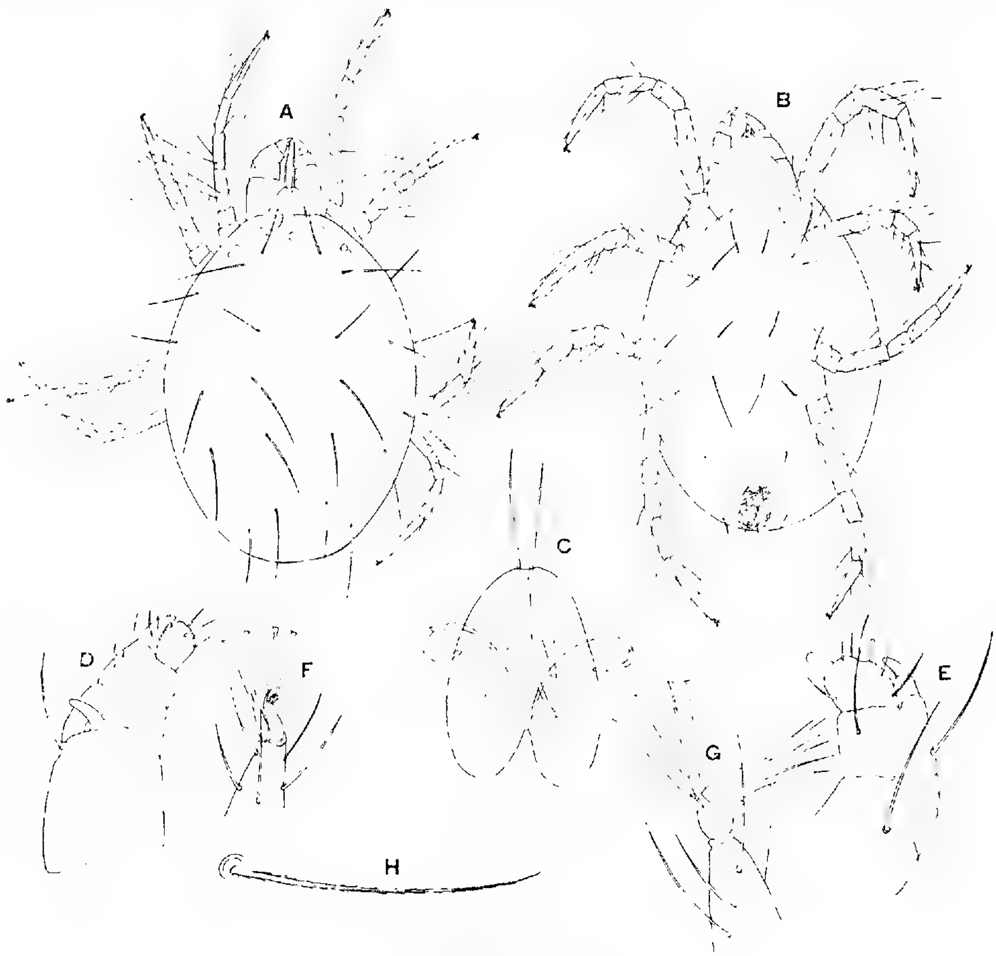


Fig. 12
Tetranychus urticae Koch
A, dorsal view; B, ventral view; C, mandibles and peritreme; D, palp of male; E, palp of female; F, claws and empodium of leg I of male; G, same of female, all legs; H, dorsal seta

telarius as *altheae*, and still more recently synonymised the latter name with *urticae* Koch.

In examining Australian material from time to time, I have referred that from certain localities to *E. carpini* Oudemans. Further study shows this determination to be in error, all the specimens being referable to *T. urticae*.

Localities and Hosts:

South Australia: on sunflowers, Waite Institute, Glen Osmond, 16 February 1934 (D. C. S.); on melons, Hectorville, 27 February 1933; on beans, Murray Bridge, 26 February 1938, Fullarton, March 1940; on hollyhocks, Adelaide, 1939 (H. W.); on lilies, Glen Osmond, September 1935 (R. V. S.).

Queensland: on dahlia, Nambour, March 1936; on cornflower, Brisbane, August 1939; on *Cupressus*, Brisbane, February 1940 (A. R. B.); on strawberries, Nambour, 21 September 1938.

Western Australia: on marigolds, Claremont, 8 May 1935 (L. J. N.); on beans, Perth, 1 November 1931 (B. A. O'C.); on Cape gooseberry, Perth, 17 May 1931; on convolvulus, Guildford, 15 December 1931 (B. A. O'C.); on tobacco, Manginup, 23 March 1939 (A. J. L.).

Victoria: Kyabram, 25 February 1939.

New South Wales: on beans, Sydney, 18 July 1934; on grape leaves, Sydney, 14 December 1934; on Orchids from quarantine *ex* Java, Sydney, 3 April 1939; on rose leaves, Roseville, 9 July 1934; on dahlia, Concord West, Sydney, 5 April 1939.

Australian Capital Territory: on tobacco, Canberra, 3 April 1939, 23 March 1940; on *Datura*, Canberra, 15 March 1940; on Night-shade, Canberra, 15 March 1940; on beans and mallows, Canberra, 15 March 1940; on peach and lemons, Black Mount, Canberra, 15 March 1940; on oak, Canberra, 29 July 1937.

Genus PARATETRANYCHUS (Zacker 1913) Trägårdh 1915

Paratetranychus Zacker, 1913: Mitt. Kais. Biol. Anst. f. Land- und Forstw., H. 14, p. 39 (pars).

Paratetranychus Trägårdh, 1915: Medd., No. 109, Centralanst. f. Försökv. på jordbruksomr; Ent. avdeln. No. 20, pp. 18-56.

Paratetranychus Oudemans, 1931: Ent. Ber., Dl. 8, No. 178, pp. 222-3, No. 181, p. 291.

Description—Empodium as a simple claw; on the under side basally with a process of fine needles in two series of four and six. Claws modified to pads ending in two tenent hairs. Peritreme straight, apically swollen in a small chamber. Dorsal setae in six transverse rows of 2 . 4 . 4 (6) . 4 . 4 . 4, *i.e.*, setae clunales absent; setae long, not arising from papillae. Eyes, two on each side. Mandibles styliform, mandibular plate distinct. Palpi stout, tibial claw present.

PARATETRANYCHUS UNUNGUIS Jacobi 1905
(The pine-tree spinning mite)

Tetranychus ununguis Jacobi, 1905: Naturw. Zeitschr. Land- und Forstw., Bd. 3, pp. 239-257.

Paratetranychus ununguis Zacker, 1913: Mitt. Kais. Biol. Anst. f. Land- und Forstw., H. 14, p. 39.

Paratetranychus ununguis Trägårdh, 1915: Medd. No. 109, Centralanst. f. Försökw. på jordbruksomr. Ent. avdeln, No. 20, pp. 29-32.

Description—Female, body short and broad, with convex dorsum. In life brownish-red to dark green. Length to 350 μ, width to 250 μ. Cuticle finely striated. Eyes red, two on each side. Mandibles styliform, plate distinctly present;

incised at apex. Palpi stout, tibia with strong claw, over-reaching tip of tarsus. Peritreme slender and straight, ending in a small swollen chamber. Dorsal setae in six rows, setae clunales absent. Legs not longer than body, claws pad-like, ending in two tenent hairs; empodium a simple claw, ventrally with a process of four to six needles in two series. Ventrally the setae are: on coxae I and II two, on coxae III and IV one, on gnathosoma one pair, between coxae III, II and IV

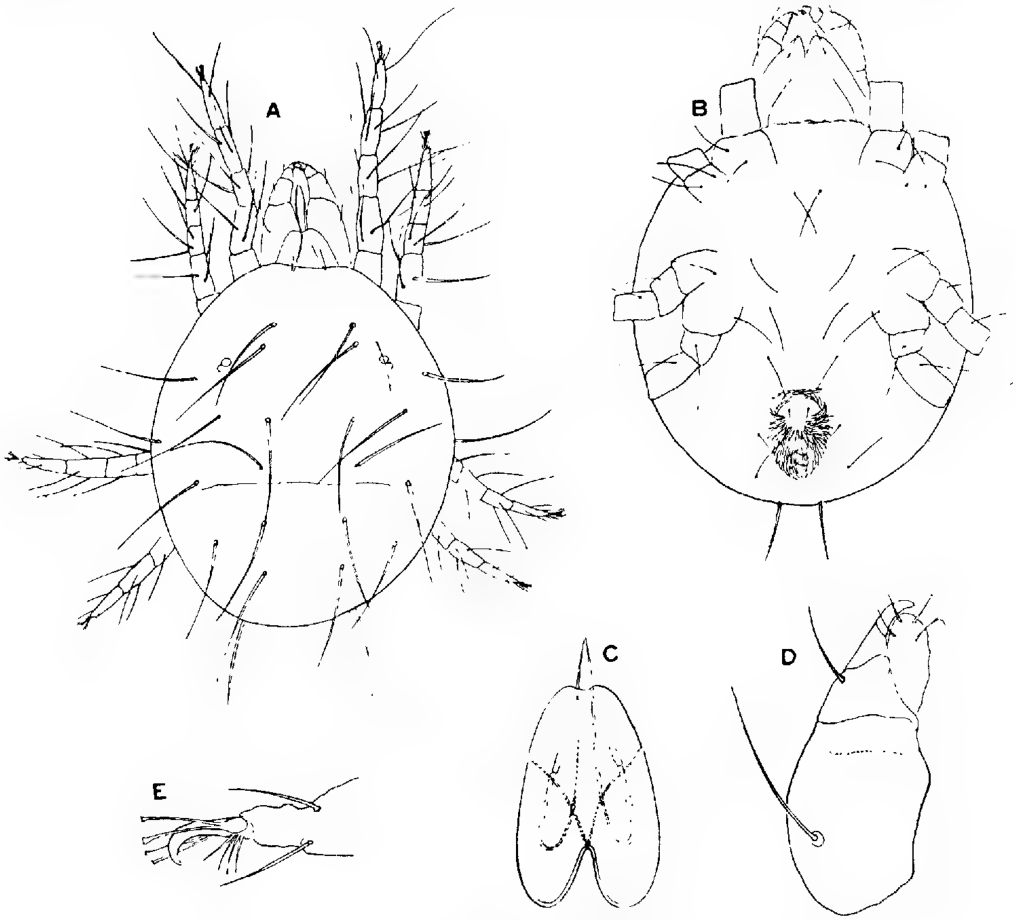


Fig. 13
Paratetranychus ununguis Jacobi
A, dorsal view; B, venter; C, mandibles and peritreme;
D, palp; E, claws and empodium

one pair, in front of genital opening one pair, around genital and anal openings five pairs.

Remarks:

This is a well known species in Europe and, as its popular name implies, is a minor pest of pine trees. It has been found in Australia as follows:

Locality and Host:

Queensland: on *Pinus* sp., Passchendale, near Stanthorpe, 20 May 1938 (A. R. B.).

Genus Metatetranychus Oudemans 1931

Metatetranychus Oudemans 1931: Ent. Ber., viii, No. 177, pp. 198-199; No. 178, p. 224.

Description—Body strongly curved dorsally, dorsal setae in seven transverse rows, *i.e.*, setae clunales present, arising from papillae. Empodium a simple claw with a basal ventral process of four to six needles. Peritreme straight, short, ending in a small swollen chamber.

Type: Metatetranychus ulmi (Koch).

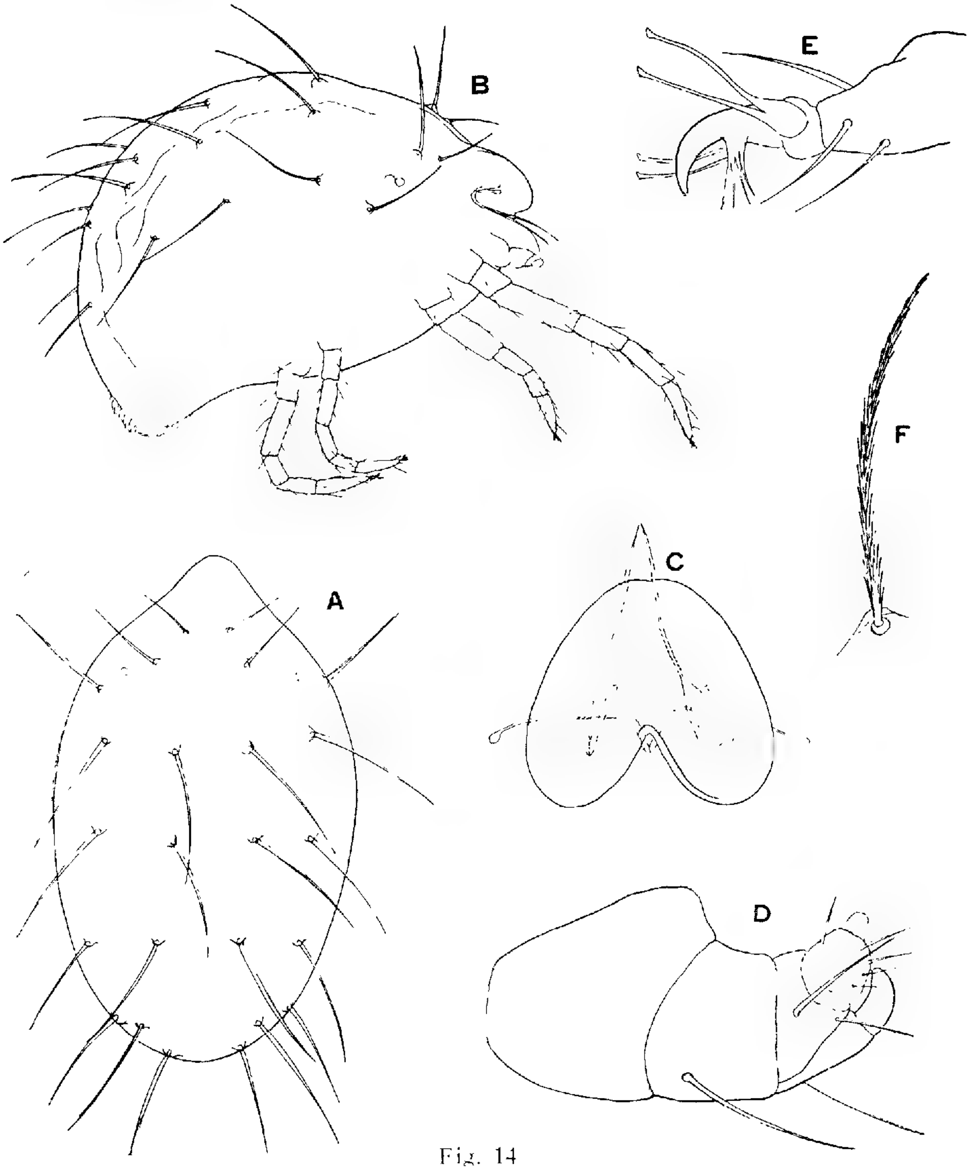


Fig. 14
Metatetranychus ulmi Koch
A, dorsum; B, lateral view; C, mandibles and peritreme; D, palp of female; E, claws and empodium; F, dorsal seta

METATETRANYCHUS ULMI Koch 1836

(The fruit-tree spinning mite)

Tetranychus ulmi Koch, 1836: Deutsche. Crust. Myr. Arachn., H. 1, No. 11.
Tetranychus pilosus Canestr. e Fanzo, 1876 (1): Atti Soc. Ven. Trent., v, pp. 133-134.
Tetranychus mytilaspidis Ewing, 1912: J. Econ. Ent., v, pp. 414-415.
Paratetranychus pilosus Zacker, 1913: Berlin Mitt. Biol. Anst., H. 14, pp. 38 39.
Oligonychus ulmi Hirst, 1920: Proc. Zool. Soc. Lond., pp. 58-59.
Oligonychus alni Oudemans, 1929, male: Ent., Ber., viii, No. 169, p. 19.
Metatetranychus ulmi Oudemans, 1931, female: Ent. Ber., viii, No. 177, pp. 189-199.
Metatetranychus alni Oudemans, 1931, male: Ent. Ber., viii, No. 178, pp. 231-232.

Description—Strongly convex, oval species. In life, dark red. Female, length to 700 μ, width to 350 μ. Dorsal setae thick, pointed, and strongly ciliated, arising from papillae and arranged in seven transverse rows: 2 . 4 . 4 (6) . 4 . 4 . 4 . 2, *i.e.*, setae clunales present. Mandibles styliform, mandibular plate present, indistinctly incised at apex. Palpi stout, tibial claw strong, not reaching tip of tarsus, tarsus with apical thumb that is slightly longer than broad. Peritreme short, straight, ending in small swollen chamber. Legs not longer than body; claws pad-like with two tenent hairs, empodium a simple claw with basal ventral process split into four to six needles. Male: length to 500 μ, body more tapering.

Remarks:

This species is well known in Europe and America, affecting many species of fruit trees. The red spherical eggs are laid on the twigs and branches, often imparting a red hue to the trees. In Europe the eggs hibernate, hatching in the spring. It also occurs in New Zealand, but has only comparatively recently been found in Australia.

Locality:

Tasmania: Margate, 11 February 1939 (J. W. E.).

Genus **Anatetranychus** nov.

Description—Allied to *Neotetranychus* Trägärdh 1915, but differing in that the dorsal setae do not arise from papillae and are not so thick, and that the peritreme, while V shaped, is (?) inversely so, with equally thin arms, and ends apically in a small rounded swelling. It agrees with *Neotetranychus* in that the empodium is a simple claw without ventral process and the claws are pad-like, ending in two tenent hairs. Mandibles styliform, mandibular plate present, rounded at apex. Palpi stout, tibia with strong claw. Eyes, two on each side.

(1) Oudemans' Zool. Anz., 1 Aug. 1939, Bd. 127, Hft. 3/4, p. 78, states that *pilosus* C. & F., 1876, is not *T. pilosus* of Donnadieu, 1875, and for the latter species gives a new name of *Metatetranychus canestrinii*.

Anatetranychus hakea n. sp.

Description—Short, roundish or slightly tapering species, not very convex dorsally. Colour in life, reddish. Dorsal setae fairly thick, pointed and finely ciliated, arranged in seven transverse rows: 2 . 4 . 4 (6) . 4 . 4 . 4 . 2, *i.e*, setae

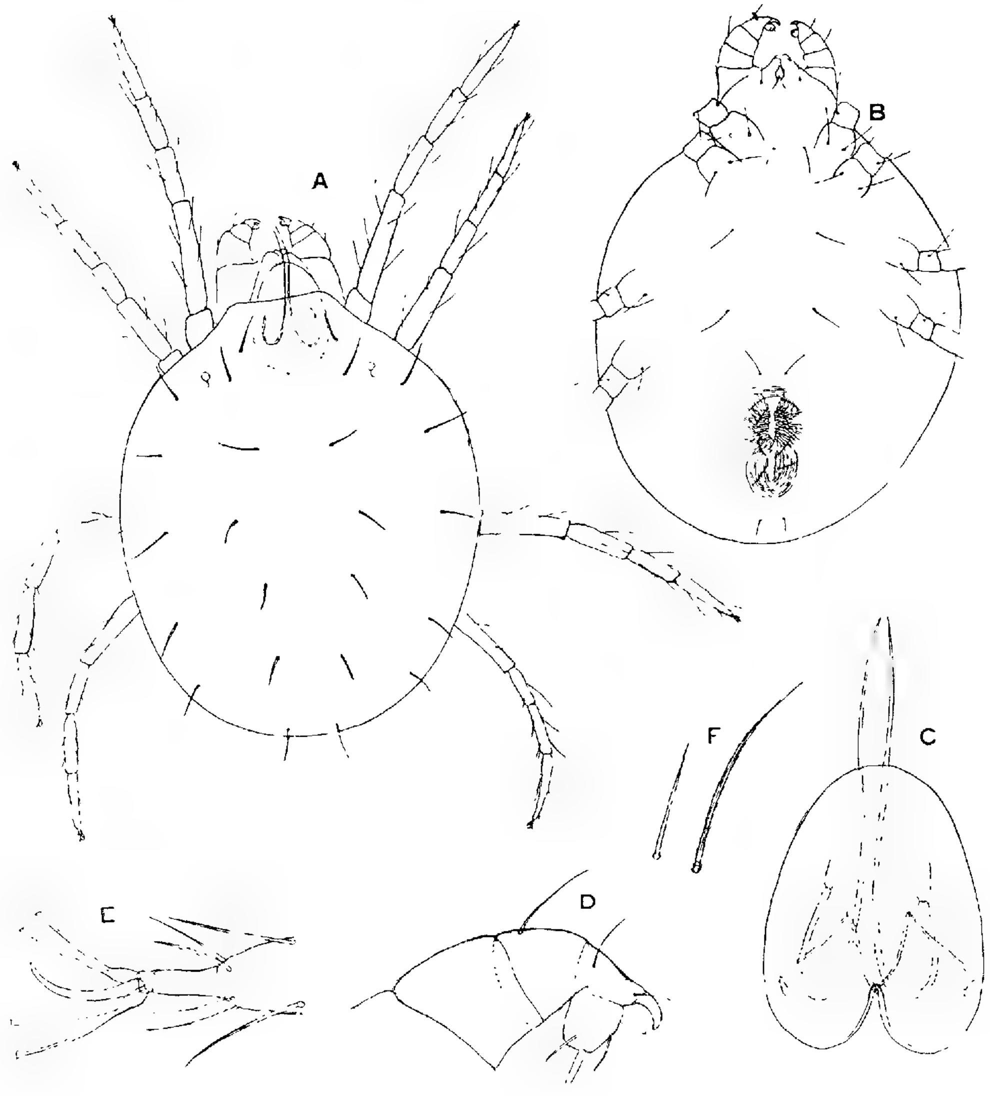


Fig. 15
Anatetranychus hakea g., et sp. nov.
A, dorsal view; B, venter; C, mandibles and peritreme; D, palp; E, claws and empodium; F, dorsal (large) and ventral (small) setae

clunales present. Mandibles styliform, mandibular plate distinct, rounded at apex. Palpi stout, tibia with strong claw, tarsus a little longer than wide, with long terminal rod and another rod basally. Peritreme an inverted V, with equally thin arms and apically slightly swollen. Eyes, two on each side. Legs barely as long as body, tarsi with a simple claw-like empodium and claws pad-like with long paired tenent hairs. Ventral setae: on coxae I and II two, on coxae III and IV one; on gnathosoma one pair; between coxae I, III and IV one pair; anteriorly and posteriorly of genital and anal opening one pair, and around these openings four pairs. Length, female, 380 μ, width 310 μ.

Locality and Host:

Western Australia: on *Hakea* sp., Claremont, 21 May 1932 (H. W.).

Family TRICHADENIDAE Oudemans 1938

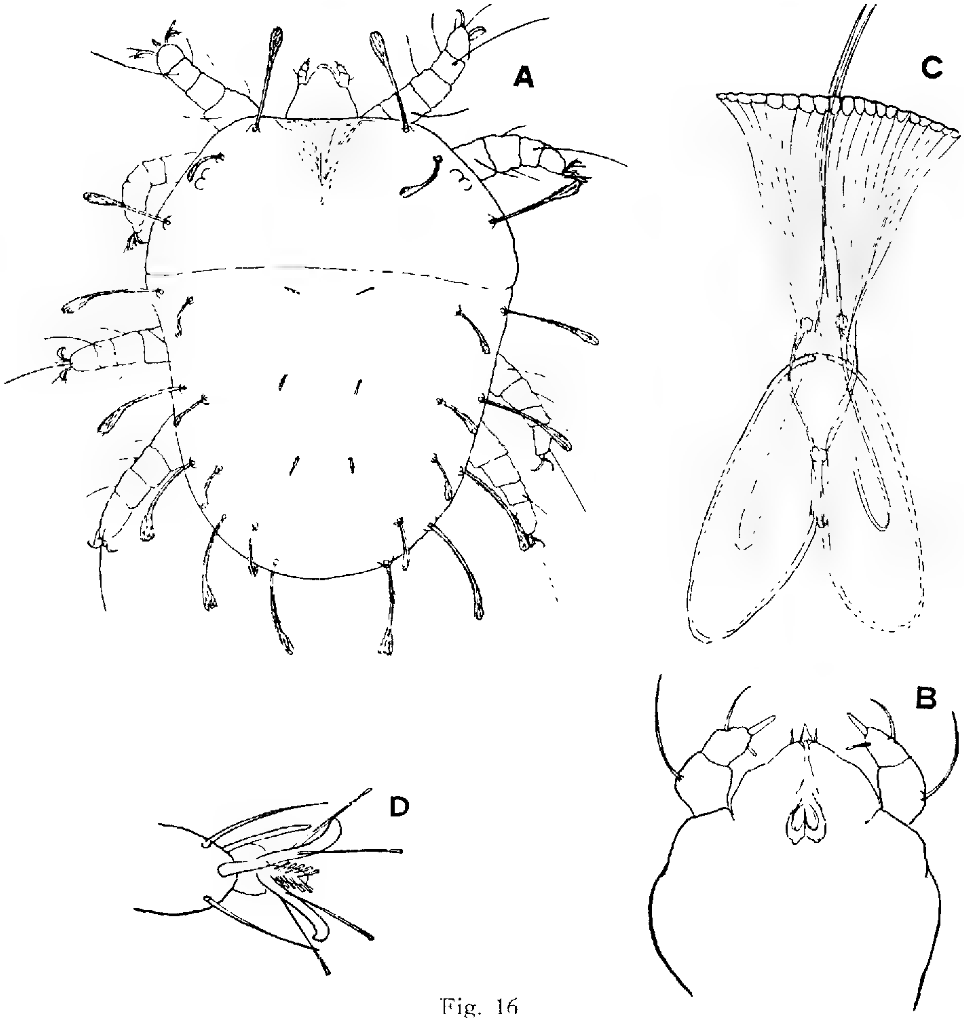


Fig. 16

Raoiella australica n. sp.

A, dorsal view; B, gnathosoma; C, mandibles and peritreme; D, claws and empodium of leg I

Genus Raoiella Hirst 1924

Raoiella Hirst 1924: Ann. & Mag. Nat. Hist., (9) **14**, p. 522, pl. xvi, figs. 1-6.

Description—Round to rectangular species, not excessively convex, with distinct suture. Eyes, two on each side. Mandibles styliform, mandibular plate present. Peritreme complex, as figured. Palpi small, 2-segmented, without tibial claw. Legs short, claws two with paired lateral tenent hairs, empodium with two series of tenent hairs.

Genotype—*Raoiella indica* Hirst.

Raoiella australica n. sp.

Description—Small, red, roundish to squarish or pentagonal in form, not strongly convex dorsally. Dorsal setae mainly clavate and ciliated, on the propodosoma three pairs around the margin, on hysterosoma quite marginal five pairs equally spaced setae, and just inside margin four pairs of similar but smaller setae, while medially are three pairs of very short non-clavate setae. Mandibles styliform, plate present. Peritreme complex (fig. 16 C). Palpi small, 2-segmented, without tibial claw, apical segment with a terminal rod-like seta, a smaller inner lateral rod and a fine curved pointed seta. Eyes, two on each side. Legs short, tarsi with two claws, each with a pair of lateral tenent hairs, empodium with two series of tenent hairs. Ventral setae not determined. Female—Length 382 μ, width 313 μ.

Remarks:

This is apparently the second species to be described of this interesting genus. It differs from the genotype mainly in the length of the outer dorsal setae and the different nature of the median dorsal setae.

Localities and Hosts:

New South Wales: on eucalypts, Dee Why, 28 July 1932 (A. L. A.).

Queensland: on *Eucalyptus andrewsiana*, Passchendale, 20 May 1938; on *E. tereticornis*, Maryborough, 30 September 1938.

SPECIES INQUIRENDAE

In *Redia*, vol. vi, fasc. 2, 1910, in a List of New Genera and Species of Acarina, Berlese briefly described *Tetranychus pantopus* sp. n. from *Ficus* sp., Moreton Bay, Brisbane (Froggatt) and *Tetranychus histricinus* n. sp. from fruit trees, New South Wales (Froggatt). He therein stated that the species would be described in more detail and figured in his *Manipoli* vii, viii and ix, to be published soon.

The Librarian of the Australian Museum, Mr. Rainbow, has very kindly searched through the later volumes of *Redia* for me, but has been unable to find any further reference to the figures, nor could he trace them in the indices to vols. i-x and xi-xx of that journal.

It seems certain, therefore, that no further details were ever published by Berlese. The brief descriptions given in vol. vi are too indefinite to recognise the species and they must, therefore, for the present, be regarded as uncertain, especially as Berlese does not appear to have returned any type or other material to the Department of Agriculture at Sydney.

Translations of Berlese's descriptions are as follow:

"Tetranychus pantopus

Female—Triangular, with stout humeri and rather short, thick rough setae; all legs (especially I and II) at least twice as long as body. Length 250 μ, width 220 μ (with legs, from tip of legs I to legs III, 1,000 μ long).

Habitat: on *Ficus* sp., Moreton Bay, Brisbane (Froggatt)."

"Tetranychus histricina

Colour, ?. Resembles *T. horridae,* but not or only slightly excavate dorsally and with dorsal setae much thinner, apically with smooth hairs arising from small tubercles. Length 550 μ, width 360 μ.

Habitat: on fruit trees, Australia, New South Wales (Froggatt)."

N.B.—This latter species does to some extent suggest the species here described as *Aplonobia oxalis.*

A NEW FOSSIL CRYPTOPLAX FROM THE PLIOCENE OF SOUTH AUSTRALIA

By EDWIN ASHBY, F.L.S.

Summary

Mr. B. C. Cotton, of the South Australian Museum, has placed this specimen in my hands for description. It is the first fossil *Cryptoplax* from South Australia, and the third record of the occurrence of a fossil Chiton valve in this State.

A NEW FOSSIL CRYPTOPLAX FROM THE PLIOCENE OF SOUTH AUSTRALIA

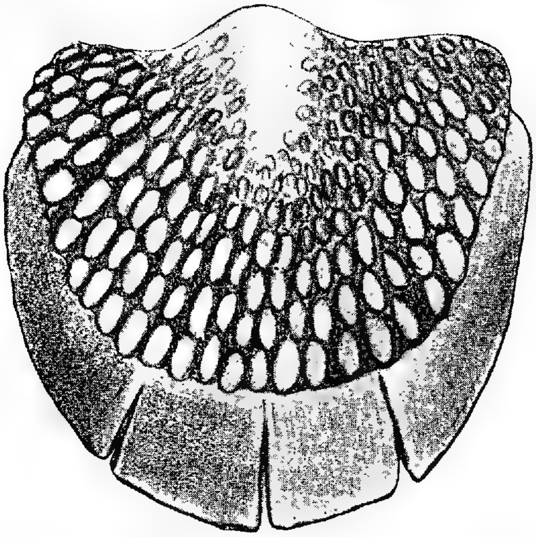
By Edwin Ashby, F.L.S.

[Read 11 July 1940]

Mr. B. C. Cotton, of the South Australian Museum, has placed this specimen in my hands for description. It is the first fossil *Cryptoplax* from South Australia, and the third record of the occurrence of a fossil Chiton valve in this State.

Cryptoplax ludbrookae sp. nov.

One head valve only, in an excellent state of preservation; 1·2 mm. in length, and 1·3 mm. in width; cream coloured, evenly arched, slope convex and shallow. Tegmentum: the sculpture consists of granules somewhat irregularly arranged



in longitudinal rows; the beak which overhangs is almost smooth or, at most, subgranular, the grains on either side and immediately anterior to the apex circular and sub-rounded, narrowly spaced and increasing in size anteriorly, in the central anterior portion flattened, elliptical or oblong, and some particular grains are three to four times as long as wide suggesting that, in older specimens, they may be longer and fused into riblets. Articulamentum: insertion plate extending well forward beyond the tegmentum for one-third of the width of the latter, colour white, three well-defined slits.

Holotype from a bore at Holden's Motor Body Works, Woodville, South Australia, 335-380 feet Pliocene. (Reg. No., P.4285, S.A.M.)

The excellent preservation is astonishing when compared with the valves of other species of *Cryptoplax* from the Pliocene of Muddy Creek, Hamilton, Victoria, of which only one per cent. of the specimens show any sculpture at all. I have pleasure in naming it after the finder, Mrs. Ludbrook.

NOTES ON THE SIGN-LANGUAGE OF THE JARALDE TRIBE OF THE LOWER RIVER MURRAY, SOUTH AUSTRALIA

By R. M. BERNDT, Hon. Assistant in Ethnology, South Australian Museum

Summary

While at Murray Bridge, South Australia (January-February 1940), the writer had the opportunity to observe a demonstration of the sign-language used by the Jaralde ['Jarildekald] natives. The geographical situation of this tribe has been referred to in a recent paper (I) by the present writer. On his first visit he was accompanied by Mr. James Wigley, who kindly prepared the rough sketches illustrating this paper.

NOTES ON THE SIGN-LANGUAGE OF THE JARALDE TRIBE OF THE LOWER RIVER MURRAY, SOUTH AUSTRALIA

By R. M. Berndt
Hon. Assistant in Ethnology, South Australian Museum

[Read 11 July 1940]

Introduction

While at Murray Bridge, South Australia (January-February 1940), the writer had the opportunity to observe a demonstration of the sign-language used by the Jaralde ['Jarildekald] natives. The geographical situation of this tribe has been referred to in a recent paper (1) by the present writer. On his first visit he was accompanied by Mr. James Wigley, who kindly prepared the rough sketches illustrating this paper.

Our informant, for the matter noted here, was Karloan (Albert) who is of the [Manaŋki] clan. He is seventy-five years of age, had been fully initiated as a youth, and is now living at Murray Bridge. An extremely virile man for his age, the excitement and gratification he derived from once more using the signs and relating their meanings was indeed delightful to behold. The existence of such a system among the Jaralde does not appear to have been previously recorded. It is no longer in general use, being preserved only in the memory of old people.

Sign Language

According to one recent writer (Mountford) (5) on this subject, the gesture language of the Australian aborigine is of considerable complexity and, in some form, appears to be used over the whole of the continent. This writer has compared some elements of the gesture language of the Ngadadjara tribe of the Warburton Ranges, Western Australia, with those of some tribes in North-West Central Queensland, and Central Australia.

The same author states that among the Ngadadjara natives this type of language was in general use, being employed extensively when hunting and during circumcision ceremonies.

Roth (7) states that the signs used by the North-West Central Queensland natives were of great value to individuals who were forced to travel over country in which they were strangers to the spoken language. This would most probably occur during expeditions along known "trade routes." Spencer and Gillen (8) state that the use of sign language was associated with periods of mourning, during which certain women would be compelled to observe long silences.

The use of gestures is sometimes developed into a more or less systematic sign-language (6), in which objects and ideas are represented by postures and movements of the hands, arms, head and body, imitating the most conspicuous outlines of an object or the most striking features of an action. These signs may be abbreviated or conventionalized in use to make them more readily intelligible at a distance.

Among the Jaralde, the sign-language did not appear to be highly developed, but this is only a conjecture since the tribe is now almost extinct, and only a little knowledge has survived.

Although used as a means of communication between visiting tribes from Yorke Peninsula (2) and the Upper Murray (3), signs were most generally used amongst themselves while out hunting, or between friends who were some distance apart. They were steps or moves calculated to evoke response from another. It may be noted that Karloan and his son often communicate between themselves, in this manner, when one or the other has forgotten an object and has to be reminded of it.

Each sign is accompanied by a spoken word or phrase, which cannot, of course, be heard by the other.

The following signs (except the last five) are in the form of a conversation carried on between two people some distance apart.

Description of Signs

Fig. 1, A The man stands upright, looking towards the other who is walking away. The hand is held, palm outwards, and at the same time an exclamation of attraction [a] or [er] is made. The other, attracted not by sound or by having seen the sign, but because he "feels he is being wanted," turns and observes his friend.

Fig. 1, B The first places his hand to his head and then extends the arm sideways, with the palm of the hand facing outwards. The other answers, as in Fig. 1, C, thereby asking what the first is wanting; he places the hand to the head, and then extends the arm sideways, so that the hand is turned. At the same time he exclaims, [" 'a?"] "What?"

The first, thinking that he will not bother the other, responds by placing his hand behind his head and then extending the arm outwards, so that the palm of the hand is open and faces outwards as in Fig. 1, D, saying ["Ma ŋop:eilu"] "Go walk on."

The other continues his walk. However, the first-named, on further consideration, realizes that he would like to know where the other is going. He again uses the sign as in Fig. 1, A. The responses are again as in the signs illustrated in Fig. 1, B. Continuing the conversation the first man, placing his hand, fingers close together and palm downwards, in front of his face, and then extending his arm sideways with the palm of the hand facing outwards, signals as in Fig. 1, E, and says, [" 'Jalwund?"] "Where you go?"

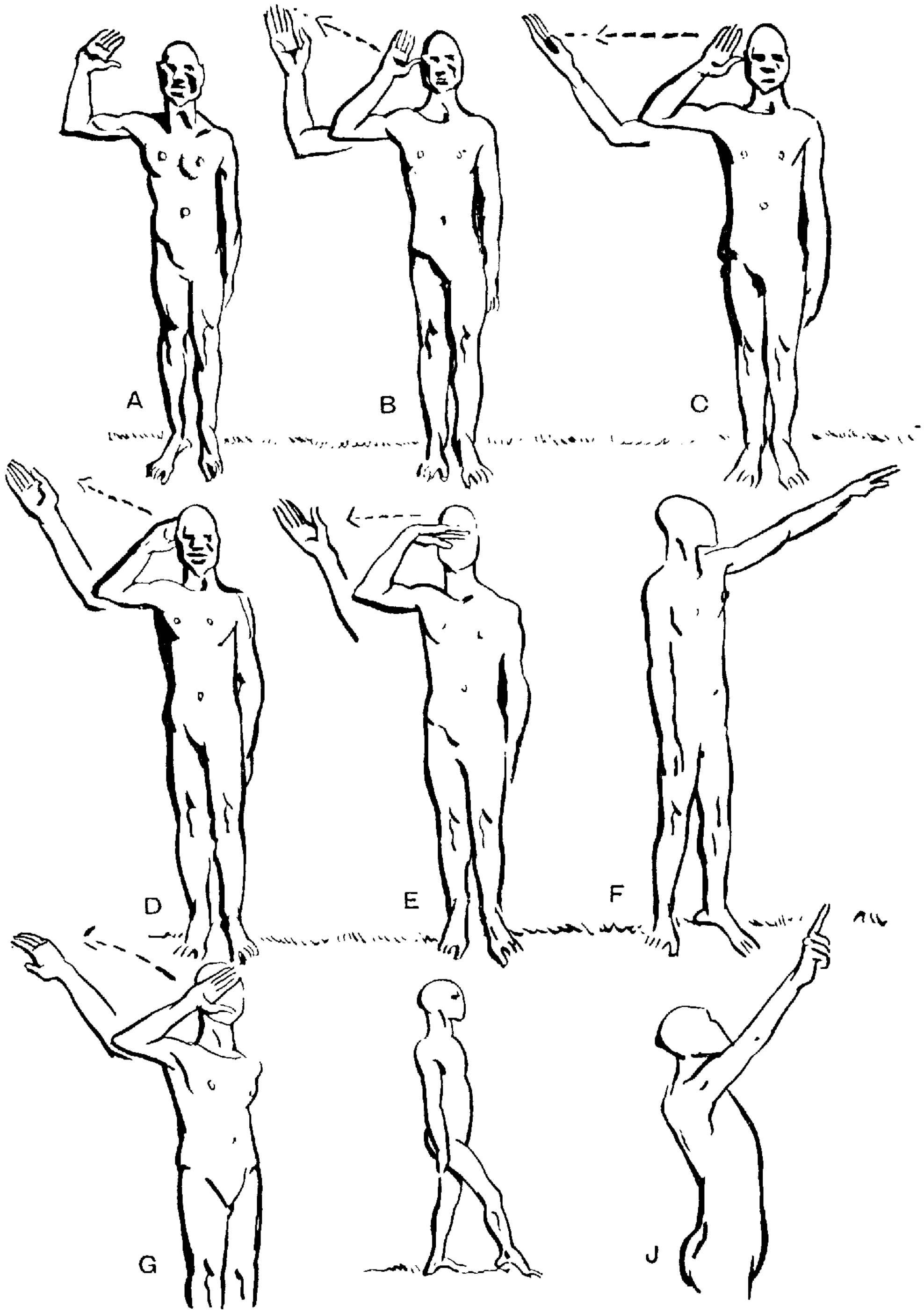


Fig. 1

The other, in replying, may fully extend his left arm (Fig. 1, F) (in all the other movements the right arm is used) and points in the direction he intends going, saying, ["ŋuwi"] "Over there," or "down there."

Information having been received, a different sign is used to express an ending. The first, flexing the arm, places his hand in front of his face, thumb extended; the arm is then fully extended, a little to the back, and the hand turned inward. At the same time he says, [" ′Ma"] "Go on."

Thereupon the departing one turns and walks away (Fig. 1, H). After going a short distance the traveller may see something to which he wishes to draw attention. He uses the sign illustrated by Fig. 1, A, transmitting at the same time the "idea" so that the first should "feel he is wanted." This man, when attracted, will respond with a sign as in Fig. 1, C. The other then extends his arm upwards, Fig. 1, J, with the index finger pointing, the others folded back, and says, ["Na′rindjera"] "Many (people)."

The first, not quite understanding, will then use the sign in Fig. 1, C, saying, ["′a?"] "What?"

Thereupon the informant again extends his arm upwards, as in the position shown in Fig. 1, J, and brings it downwards, with the hand drawn in so that the thumb is at the back and fingers loose as in Fig. 2, A, saying to himself, ["Na′rindjera lari"] "Many (people) coming down (the river)."[1]

The first holds his arm up, as in Fig. 2, B, the palm of the hand facing outwards, and then brings it down so that the palm now faces the ground, saying ["Kal′lur"] "All right (or very well)."

This is the end of the particular conversation detailed to the writer. The following are separate movements.

Fig. 2, C. The hand is held up a little above the head, and then loosely dropped so that the fingers point groundwards and the following question asked, [" ′Er minian?"] "Are there (any) women?"

The query, [" ′Miŋitj?"] "What's there?" is asked and indicated by the sign shown in Fig. 2, D, the arm being flexed, the hand held in front of the face, with the palm held downwards.

The attitude shown in Fig. 2, E, with the arm held upwards, so that the hand, facing outwards, is a little above the head, asks the question, ["Nuŋgitj ′uin?"] "Who is there?" this question being verbally expressed at the same time.

The man asked answers by bending down (Fig. 2, F) and pretending to pick up a net, which as in position, Fig. 2, G, he places round his shoulders, in the manner in which women stand when they put their baby [′porli] on their back and then throw a [′kundari] or net over the child. This net, when worn, is tied round the shoulders and neck, so that the infant's legs remain free. This action would indicate to the questioner that it was a woman who was approaching.

[1] Referring to the River Murray; *lari*, down.

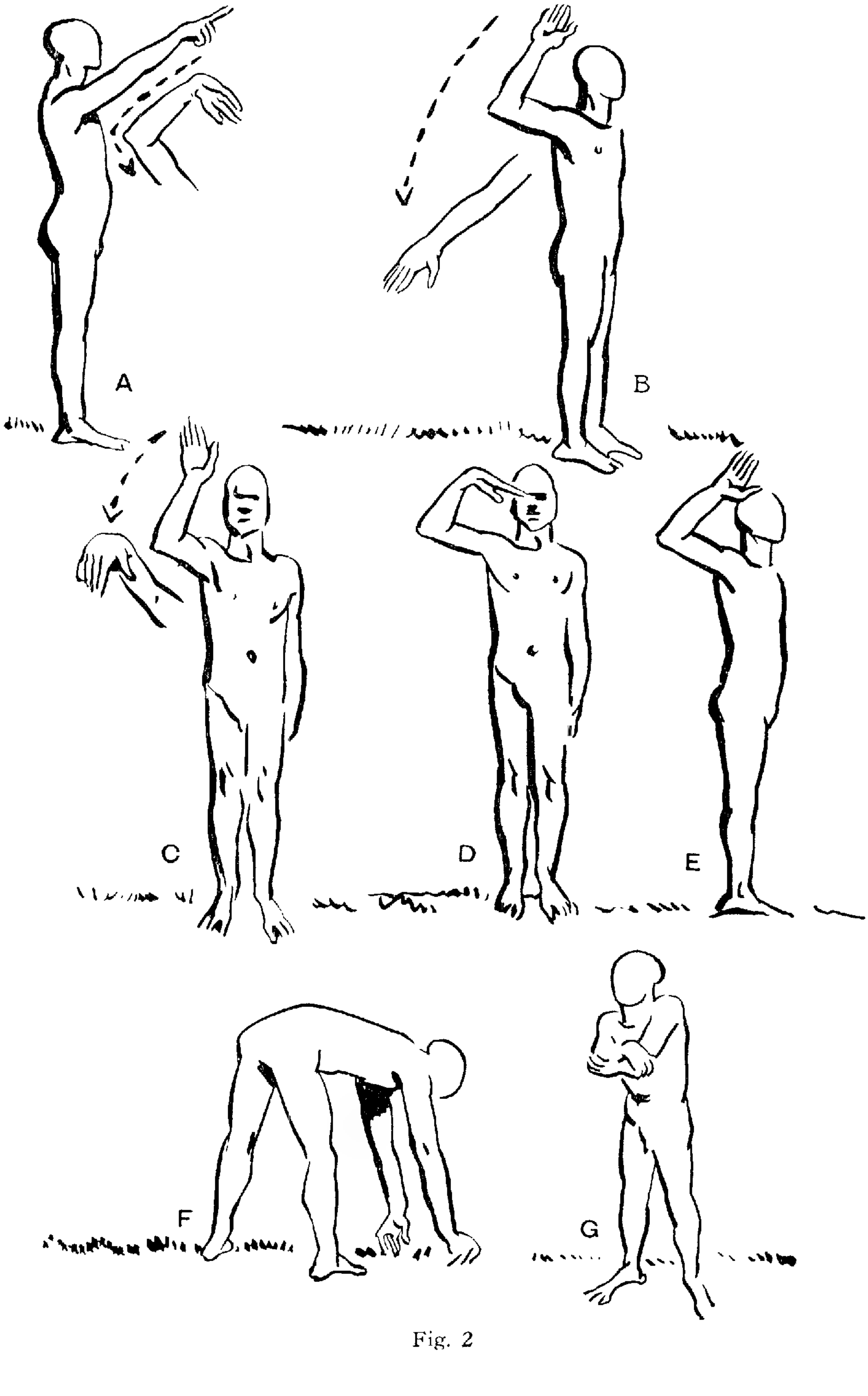


Fig. 2

Notes on the above Signs

The attraction of a person at a distance by sending one's idea or desire, other than by a sign or a sound, is interesting. This is a psychic experience, which is claimed to frequently occur. These psychic powers seem to be possessed generally, and not specifically to belong to endowed individuals such as medicine-men. Most often the "message" is "felt" in the vicinity of the stomach. Elkin (4) suggests that the explanation may either lie along the line of meditation and a state of receptivity, or that it may require some explanation as mental telepathy.

Some further aspects of this subject, insofar as it concerns the Jaralde people, may be discussed in a later paper.

References

1 Berndt, R. M. 1940 Some Aspects of Jaralde Culture, South Australia. Oceania, **10** (4)

2 Berndt, R. M. 1940 A Curlew and Owl Legend from the Narunga Tribe, South Australia, *ibid.*

3 Berndt, R. M. 1940 The Bark-Canoe of the Lower River Murray, South Australia. Mankind, **2** (9)

4 Elkin, A. P. 1937 Notes on the Psychic Life of the Australian Aborigine. Mankind, **2** (3), 56

5 Mountford, C. P. 1938 Gesture Language of the Ngada Tribe of the Warburton Ranges, Western Australia. Oceania, **9** (2), 152-155

6 Notes and Queries on Anthropology, Fifth Edition, Roy. Anthrop. Instit., 1929, 351

7 Roth, W. E. 1897 Ethnological Studies Nth.-West Central Queensl. Aborigines, 71

8 Spencer and Gillen 1904 Northern Tribes of Central Australia, 525

THE ANATOMY AND LIFE HISTORY OF THE TREMATODE, CYCLOCOELUM JAENSCHI N. SP.

By T. HARVEY JOHHNSTON and E. R. SIMPSON, University of Adelaide.

Summary

Adults of Cyclocoelum jaenschi n. sp. were found during 1937 in the abdominal air sacs of two species of small grebes, *Podiceps poliocephalus* Jardine and Selby, and *P. novaehollandiae* Stephens (P. ruficollis novaehollandiae), taken by Messrs. G. and F. Jaensch at Tailem Bend, Lower Murray River. The parasites measured from 7 to 9 mm. long by 2·3 to 3 mm. broad. The succeeding measurements were taken from a mounted specimen which had been compressed, its dimensions then being 11 mm. in length and 3·7 mm. in maximum width, with the anterior fourth narrower and with both ends broadly rounded. The oral sucker was nearly as wide as the pharynx (0-5 nm.). The narrow oesophagus was thrown into one or two curves partly above the genital apertures. The rather narrow intestinal crura had an uneven lumen, somewhat wider in their most anterior part and in the posterior quarter. The excretory bladder was transversely elongate, lying just behind the united crura, its pore being dorsal and practically terminal. The well-developed lymph system consisted of a great number of flattened anastomosing canals, some wide, others narrow, above and below the crura, with branches extending laterally from the latter as well as into the intercrural region, and in addition anteriorly, beside the pharynx and anterior sucker. The details were not worked out. Willey (1935) gave an account of the system in Cyclocoelidae. The testes were subequal, the posterior 1 mm. and the anterior ·9 mm. in diameter. The cirrus sac was slightly oblique, just behind and partly below the intestine. Entering its posterior end was a very narrow, thin-walled vas deferens, which then widened into a large elliptical seminal vesicle, ·45 by ·25 mm., followed by the narrow twisted (when resting) male duct. The male pore, together with the much wider uterine aperture, was surrounded by a mass of sphincter fibres. The genital openings were directly below the oesophagus in the posterior half of its length

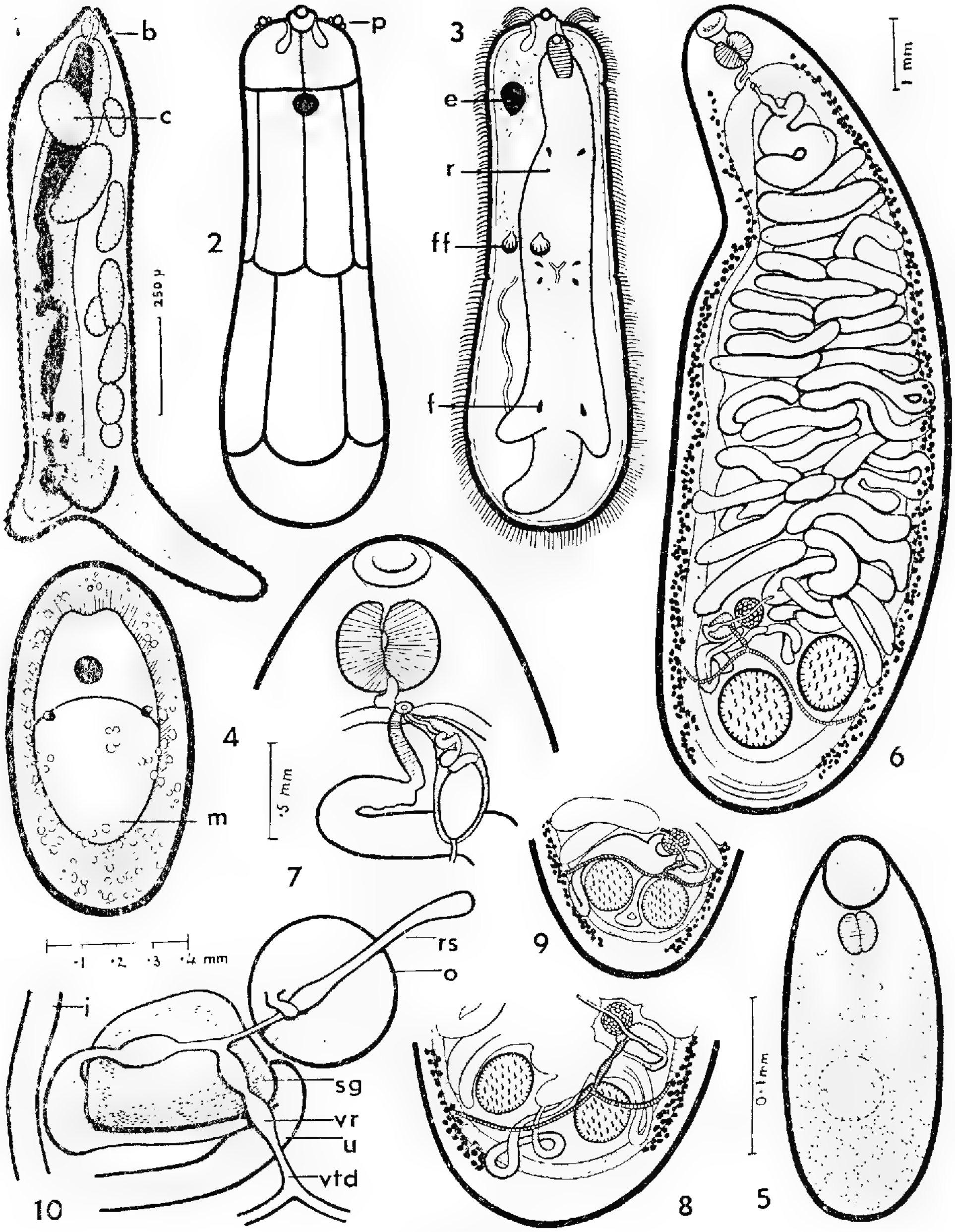
THE ANATOMY AND LIFE HISTORY OF THE TREMATODE, CYCLOCOELUM JAENSCHI N. SP.

By T. Harvey Johnston and E. R. Simpson, University of Adelaide

[Read 11 July 1940]

Adults of **Cyclocoelum jaenschi** n. sp. were found during 1937 in the abdominal air sacs of two species of small grebes, *Podiceps poliocephalus* Jardine and Selby, and *P. novaehollandiae* Stephens *(P. ruficollis novaehollandiae)*, taken by Messrs. G. and F. Jaensch at Tailem Bend, Lower Murray River. The parasites measured from 7 to 9 mm. long by 2·3 to 3 mm. broad. The succeeding measurements were taken from a mounted specimen which had been compressed, its dimensions then being 11 mm. in length and 3·7 mm. in maximum width, with the anterior fourth narrower and with both ends broadly rounded. The oral sucker was nearly as wide as the pharynx (0·5 mm.). The narrow oesophagus was thrown into one or two curves partly above the genital apertures. The rather narrow intestinal crura had an uneven lumen, somewhat wider in their most anterior part and in the posterior quarter. The excretory bladder was transversely elongate, lying just behind the united crura, its pore being dorsal and practically terminal. The well-developed lymph system consisted of a great number of flattened anastomosing canals, some wide, others narrow, above and below the crura, with branches extending laterally from the latter as well as into the intercrural region, and in addition anteriorly, beside the pharynx and anterior sucker. The details were not worked out. Willey (1935) gave an account of the system in Cyclocoelidae. The testes were subequal, the posterior 1 mm. and the anterior ·9 mm. in diameter. The cirrus sac was slightly oblique, just behind and partly below the intestine. Entering its posterior end was a very narrow, thin-walled vas deferens, which then widened into a large elliptical seminal vesicle, ·45 by ·25 mm., followed by the narrow twisted (when resting) male duct. The male pore, together with the much wider uterine aperture, was surrounded by a mass of sphincter fibres. The genital openings were directly below the oesophagus in the posterior half of its length.

The small rounded ovary, about 0·4 mm. in diameter, was just in front of the level of the anterior testis and separated from the latter by uterine coils. The very short oviduct arose dorsally from its outer region. Lying postero-laterally from the ovary and in contact with it was the shell gland, which was slightly wider. The yolk follicles extended from a point just behind the level of the base of the pharynx to the corners of the excretory bladder, and lay ventrally and laterally from the crura, overlying part of the latter in some places. The main duct on each side passed backwards below the intestine. The transverse yolk duct of one side travelled inwards behind the anterior testis and then forwards



Figs. 1-10

Fig. 1, mature redia; 2, miracidium, showing epithelial cells, etc.; 3, miracidium with redia; 4, egg, with miracidium; 5, cercariaeum; 6, adult; 7, anterior end; 8, 9, variations in position of genital organs and ducts; 10, female system.

Figs. 2-5 drawn to scale beside fig. 5.

Lettering—b, birthpore; c. cercariaeum; e, eye; f, flame cell of redia; ff, flame cell of miracidium; i, intestine; m, miracidium; o, ovary; p, papilla; r, redia; rs, receptaculum seminis; sg, shell gland; u, uterus; vr, vitelline reservoir; vtd, vitelline duct.

in the intertesticular zone to meet its fellow which passed inwards in front of the posterior testis. In front of the latter, the short common yolk duct curved upwards and forwards to pass above the uterus and shell gland, becoming swollen to form two vitelline reservoirs and then meeting the fertilising canal lying at right angles to it. This latter extended inwardly above the ovary to receive the oviduct and then continued, ending blindly as a seminal receptacle a little distance from the midline of the worm. The ootyp travelled outwards through the shallow shell gland, and on leaving it, widened considerably, then curved ventrally between the shell gland and the intestine and bent inwards below the former to reach the border of the ovary. It then curved outwardly under the common yolk duct to become thrown into several loops in the region between the shell gland, the posterior testis and the intestine, penetrating to a varying distance between the two latter. The uterine coils then crossed into the zone between the ovary and the anterior testis and usually, between both testes, to reach the intestine. The rest of the uterus constituted a fairly uniform tube, greatly looped and occupying all the intercrural region in front of the testes (except the zone occupied by the ovary and shell gland). In the posterior half of the worm, many of the loops extended laterally above the crura into the vitelline zone. Just behind the intestinal bifurcation the duct dipped downwards and forwards, rapidly narrowing to terminate at the female aperture adjacent to the male pore. The terminal part of the uterus was well provided with circular muscle fibres. Eggs were amber-coloured, elliptical, 195 by 94 μ, with an operculum with a serrated edge. The eggs in the anterior half of the uterus contained each a miracidium with a conspicuous eye-spot, as well as a redia.

In specimens subjected only to cover-glass pressure the posterior testis measured 0·5 to ·6 mm., the anterior testis ·45 to·52 mm., and the ovary ·2 to ·3 mm. in diameter; the cirrus sac ·8 to 1 mm. long and ·28 to ·35 mm. in maximum width; the oral sucker ·4 to ·45 mm. broad; and the pharynx ·5 mm. long by ·55 mm. broad.

Variations were observed in the positions of the testes, uterine loops, and transverse yolk ducts as well as in the extent of the vitelline glands. The testes were sometimes almost symmetrically placed. Sometimes the earlier uterine loops extended backwardly only as far as the most anterior part of the posterior testis; but in other cases the extension almost surrounded the latter, the uterus extending through the intertesticular to meet the intestine. The uterus also invaded, to a greater or less extent, the zone between the anterior testis and the intestine. Sometimes the anterior limit of the yolk glands did not reach as far as the base of the cirrus sac, and in several cases the extension was different on the two sides of the worm. The usual disposition of the transverse yolk ducts was that described above, but in one instance they both lay in front of the two testes; while in another case one travelled behind the displaced anterior testis and the other crossed the posterior testis to join its fellow above the latter.

The species is named in acknowledgment of the generous assistance given us for some years past by Messrs. George and Fred. Jaensch of Tailem Bend. The type, a mounted specimen from *Podiceps novaehollandiae*, has been deposited in the South Australian Museum, Adelaide. Our investigation has been assisted by the Commonwealth Research Grant to the University of Adelaide. The arrangement of the testes and ovary and their relation to each other, the position of the genital pore in relation to the pharynx and oesophagus, the disposition of the uterine loops in relation to the testes and the intestine, as well as the disposition of the vitellaria, serve to differentiate *C. jaenschi* from all other described species of the genus. The organisation of the region adjacent to the genital apertures closely resembles that indicated in Harrah's figure of the similar region in *C. elongatum.*

Our species shows characters belonging to the two tribes Haematotrephea and Cyclocoela as diagnosed by Witenberg, more particularly the former in regard to the arrangement of the gonads. Some of our specimens would fall into his genus *Corpopyrum,* but the others could not be accommodated in *Cyclocoelum* in the restricted sense in which Witenberg proposed to restrict it. Those specimens which would fall into *Corpopyrum* resemble *Cyclocoelum tringae* (Stossich), *C. brasilianum* (Stossich), *C. wilsoni* Harrah, and, in some features, *C. halli* Harrah, but they differ from these species as figured by Kossack (1911), Harrah (1922), and Witenberg (1926) in some of the features mentioned above. It seems to us preferable, in view of our observations regarding variations in organography, to suppress *Corpopyrum* as a synonym of *Cyclocoelum,* as Joyeux and Baer (1927) have already suggested, and to use the older conception of the latter. Witenberg's subgenus *Antepharyngeum* must also be suppressed as it includes *C. mutabile,* generally regarded as the type of *Cyclocoelum.*

Life History

The eggs hatched in tap water within a few hours. The miracidium bears long cilia, especially elongate on a collar surrounding the head lobe, but absent from the latter and also from the boundary lines of the epithelial cells. These cells were arranged in four rows; their number was not ascertained, but there were probably 15 to 20. Two small glands, one on each side, open at the base of the protrusible head lobe and pour out their secretion immediately prior to the extension of the lobe. Just in front of the ciliate collar there are, on each side, a large and two small papillae. The miracidium was phototropic, with a large eyespot situated near the junction of the first and second rows of epithelial cells. Two large flame cells were observed near the centre of the body, but only one excretory tube was seen continuing posteriorly. Lying free in the cavity of the mature miracidium is a relatively large active redia with a well-developed pharynx and two ambulatory processes, as well as four pairs of flame cells, two anterior and two posterior. These flame cells, together with the main excretory tubule and its two branches, were seen near the midregion of the larva.

Eggs obtained in December 1937 hatched next day and were placed in contact with pond snails, *Planorbis isingi, Limnaea lessoni* and *Ameria pyramidata.* About three weeks later several specimens of the first-named were dissected, but larval trematodes were absent. The *Limnaea* snails died within a few days, and examination failed to reveal any stages of the parasite. One specimen of *A. pyramidata* died thirty-eight days after contact and was found to contain four large rediae near the albumen gland and numerous cercariaea lying free in the adjacent tissues. A week later an *Ameria* was dissected and three large rediae were found near the head, the largest being 1·65 mm. by ·50 mm., and the smallest ·96 by ·21 mm. The largest may have been a mother redia and the others daughter rediae, unless multiple infection had occurred and one of the larvae had become located in a more favourable situation than the others. The latter view is the more probable, since Szidat (1932) and Stunkard (1934) did not observe a second generation of rediae in allied monostomes. The redia figured by us (fig. 1) was obtained from a dead *Ameria* and measured 1·75 by 0·3 mm. It contained developing germ balls and cercariaea and possessed a tail-piece and two well-marked ambulatory processes in its posterior third. The birthpore lay near the mouth. The pharynx measured 44 μ long by 40 μ broad. The long intestine contained dark brown material and, when the redia was placed in water, the organ was observed to contract and, on relaxation, might pass back into one of the foot processes or into the tail piece. The body covering possessed an irregular net-work of cuticular ridges or papillae, so that a spiny appearance was presented in side view.

Tail-less cercariaea were very thin and transparent, measured (average of five preserved specimens) ·225 mm. long by ·116 mm. broad. They lived only a few minutes in water. The anterior sucker and the pharynx were about 40 μ and 20 μ in diameter respectively. The intestine was largely obscured by the abundant cystogenous glands. A very weak posterior sucker lay in the posterior half of the worm. A number of cysts, apparently belonging to the species, occurred in the snail's tissues.

Our observations appear to be the first published relating to the life cycle of a species of *Cyclocoelum.* Szidat (1932) indicated that Siebold in 1835 and Wagner in 1858 had reported the occurrence of a bud (*i.e.,* a redia) in the miracidium of *Monostomum mutabile* Zeder and *M. flavum* Mehlis. These worms are *Cyclocoelum mutabile* and *Typhlocoelum cucumerinum* (Rud.) respectively. Szidat (1932) gave a detailed account of the life cycle of *Tracheophilus sisowi* Skrj., a parasite of East Prussian ducks, the intermediate host being a species of *Planorbis.* He drew attention to the presence of a ventral sucker in the cercariaeum in the gastropod and in the wandering metacercaria from the lung tissues of the duck. Stunkard (1934) gave an account of the life history of *Typhlocoelum cymbium* (Dies.) from a grebe, *Podilymbus podiceps,* the intermediate host being *Helisoma trivolvis* in North America. *Tracheophilus sisowi* was considered to be a synonym. Stunkard fed a few cysts to a domestic duck but did not obtain later stages.

The life cycle seems to be similar in *Cyclocoelum, Tracheophilus* and *Typhlocoelum.* We have observed that the egg of *Haematotrephus adelphus* S. J. Johnston, whilst still in the uterus, contains a miracidium enclosing a well-developed redia essentially similar to that described above. It seems to us likely that all members of the Cyclocoelidae have a life history as follows: the egg, before laying, contains a miracidium within which is a redia; the egg hatches soon after access to water; some species of freshwater pulmonate gastropod acts as intermediate host; there is neither sporocyst nor secondary redia stage; the cercaria is tail-less and encysts within the host in which it has developed; the final stage is reached when the appropriate species of bird eats the infected mollusc; all the cercariaea have ventral suckers.

References

Harrah, E. C. 1922 North American Monostomes. Illinois Biol. Monogr., 7 (3)

Joyeux, C., and Baer, J. 1927 Note sur les Cyclocoelidae (Trématodes). Bull. Soc. Zool., France, **52**, 416-434

Kossack, W. 1911 Ueber Monostomiden. Zool. Jahrb. Syst., **31**, 491-553

Skrjabin, K. I. 1913 Tracheophilus sisowi n. sp. C. Bakt. Orig., **69**, 90-94

Stunkard, W. H. 1934 Life Cycle of Typhlocoelum cymbium. Jour. Parasit., **20**, 336

Stunkard, W. H. 1934 The Life History of Typhlocoelum cymbium, a contribution to the phylogeny of the monostomes. Bull. Soc. Zool., France, **59**, 447-466

Szidat, L. 1922 Zur Entwicklungsgeschichte der Cyclocoeliden. Der Lebenzyklus von Tracheophilus sisowi Skrj. 1913. Zool. Anz., **100**, 205-213

Willey, C. H. 1935 The Excretory System of the Trematode, Typhlocoelum cucumerinum, with notes on lymph-like structures in the family Cyclocoelidae. Jour. Morph., **57**, 461-471

Witenberg, G. 1926 Die Trematoden der Familie Cyclocoelidae Kossack. Zool. Jahrb. Syst., **52**, 103-186

ABORIGINAL STONE STRUCTURES

By C. P. MOUNTFORD, Hon. Assistant Ethnologist, South Australian Museum.

Summary

Aboriginal buildings in stone, either in the form of cairn-like structures, or piles of pebbles, have been known in Australia for over a century (fig. 1). Sir George Grey, in 1838, found two heaps of stones near Hanover Bay, north Western Australia: one, twenty-two feet five inches in length, fourteen feet in width and four feet high; the other, twenty-two feet in length, sixteen feet in width and six feet high.

ABORIGINAL STONE STRUCTURES

By C. P. Mountford, Hon. Assistant Ethnologist, South Australian Museum

[Read 11 July 1940]

Plates XVI and XVII

Aboriginal buildings in stone, either in the form of cairn-like structures, or piles of pebbles, have been known in Australia for over a century (fig. 1).

Sir George Grey, in 1838, found two heaps of stones near Hanover Bay, north Western Australia: one, twenty-two feet five inches in length, fourteen feet in width and four feet high; the other, twenty-two feet in length, sixteen feet in width and six feet high.

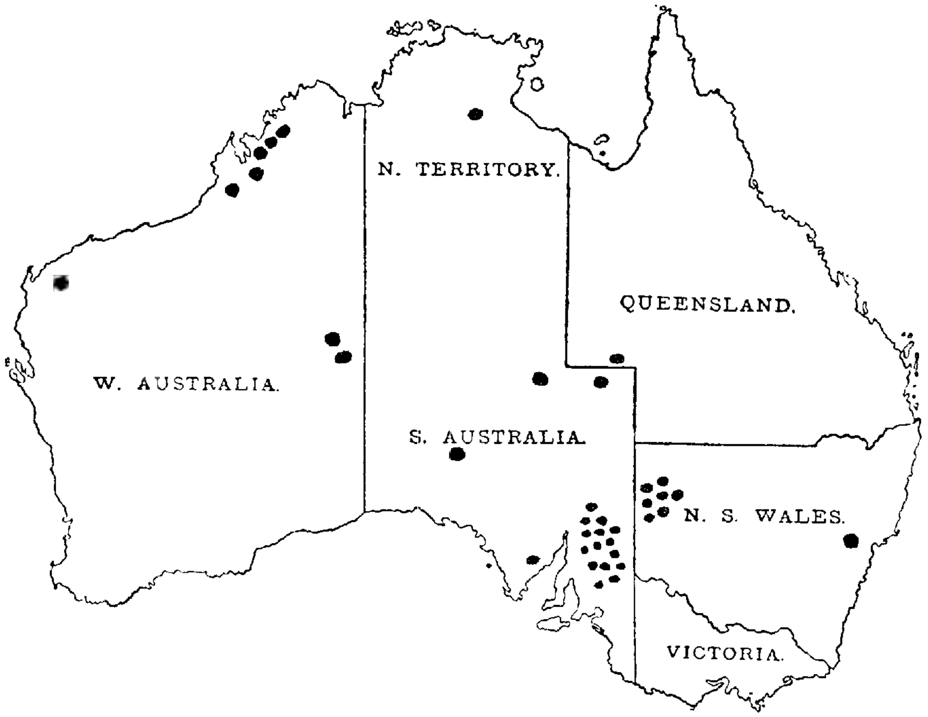


Fig. 1 Locality of Stone Structures and Pebble Mounds

Crossland (1902, p. 14) saw a cairn on Mount Agnes, in the Glenelg River district of north Western Australia. He writes: "In this gap was a low cairn . . . . surmounted by an upright pillar of sandstone, of which about three feet was visible."

Withnell, 1901, writes of cairns in the Roeburne district of Western Australia associated with totemic beings and increase ceremonies.

Mathews (1901, p. 76) gives a complete description of a hollow stone building used as a hawk trap. According to him this type of building is used over a large area in Central and north Western Australia. No other observer has, as yet, noted similar structures.

Love (1939) gives a detailed description of three types of stone monuments of the Worora tribe in north Western Australia.

The first example (p. 139, pl. xC) shows seven cairns of stone near the Sale River. They were known as "sneezing places". Love writes: "Should a man, when hunting, pass this way and fail to place a stick or a spear on one of these piles, he will be troubled with sneezing for the rest of the day." The second type (p. 141, pl. xiii A) is a small cairn at the foot of a bottle tree, which marks the spot where a mythical ancestor died. The third type (p. 139, pl. xivD) is a stone pile with a large boulder placed on the apex. This represents a mass of cooked and pounded grape vine roots.

Knut Dahl (1926, p. 225) when travelling through Arnhem Land ". . . . observed a mound of stones, obviously built by human hands, a sort of cairn where grass and stones filled the intervals between. Our guides said that the blacks had built it . . . ."

Giles (1875, p. 171) observed stone structures at Gordon Springs, Rawlinson Ranges, Western Australia. He writes: ". . . . saw small mounds of stones placed at even distances apart . . . . There was also a large piece of rock placed in the centre of most of these strange heaps." The same author (1889, p. 94) found piles of stones and a cleared path leading to them.

Dow (1939, p. 210) describes six stone piles, or pebble mounds, varying from two to twenty-two feet in diameter. They were situated near Koonawarra, in the Broken Hill District, New South Wales. In an earlier paper (1938, p. 33) Dow described two other groups, a single mound at Mulga Springs, and three at The Ramparts on the Waterbag Holding.

Towle (1939, p. 200) records several cairns on the summit of Mount Foster, on the lower Macquarie River, New South Wales. One, on the apex of the mount, was nine feet in diameter, four feet six inches in height, and was built of slabs of stone laid horizontally. Three other heaps of loosely piled stones were adjacent.

In 1935 local station owners in Central Australia told the author that the aborigines often built cairn-like structures on the hill-tops.

Stone Structures in South Australia

Gregory's record (1884, p. 206) referring to the stone piles on the banks of the Coopers Creek, is the earliest in South Australia. He writes: ". . . . We found a well-beaten native track . . . . the loose stones had been cleared from the tracks and piled into heaps."

Wood Jones (1926, p. 125) recorded an example of arranged stones and cairns on the Gungra Clay Pan, about ten miles north-east of McDoualls Peak.

He described the cairns thus: "The central portion of this maze-like area had been marked by a series of cairns about four feet high, and solidly compacted —very much like the cairns erected by surveyors on prominent spots. Of these only four are now standing, but the sites of many more can be detected by the mass of disordered stone caused by their collapse."

The present author (1927, p. 169) described six stone structures which were grouped together on one of the low northern foothills of the Waroonee Range. The structures were unusual in form, and had been constructed from the long narrow slates that had weathered out from the adjacent hillsides. The most complete example of this group has since been presented to the South Australian Museum (pl. xvi, fig. 4).

When the paper was presented verbal statements were made by certain members of the Royal Society expressing doubt that these structures had been built by aborigines. At the suggestion of the Council of the Society, and in order that the criticisms should be recorded, the author added a footnote suspending judgment. While then, and since, no evidence has been forthcoming that these stone structures were other than the work of the Australian native, the additional data here produced show that similar structures were known and recorded by some of the first explorers, and, as shown in this paper, are definitely the work of aborigines.

Stapleton (1931, p. 23), whilst investigating rock engravings in the Blinman district, found four structures on the Alpana Station similar to those at Waroonee. He also ascertained from a local aborigine that the structures were built "for fun" by the local natives and were known by the name of *juraka*.

Whilst attached to the 1937 Adelaide University Anthropological Expedition to the Northern Flinders Ranges the author observed a number of stone structures. Enquiries among the natives of the Adnyamatana tribe, who inhabited the surrounding country, elicited the fact that these buildings were the work of boys, or adolescent youths, and, like the Blinman examples, had been built "for fun." One half-caste aborigine, about thirty years of age, pointed out a structure which he himself had built (pl. xvi, fig. 3). The old men of the tribe also admitted that they had built similar piles when they were boys.

Campbell and Mountford (1939, p. 19) recorded groups of arranged stones at Weelina, on the edge of the Simpson Desert in South Australia, in which cairns similar to those of the Wood Jones examples were present. They write: "The most obvious (cairn) of which is a fairly intact pile of large stones, about ten feet in diameter and three feet six inches in height."

At present there are four groups recorded in South Australia, and in this paper fifteen new localities are described.

A Waroonee (pl. xvi, fig. 4). Six stone structures of the square, hollow type, described by the author (1927, p. 169-172). They are situated on the low foothills of the Waroonee Ranges.

B Waukaringa. A single example of the square, hollow "Waroonee" type, four feet six inches high, and one foot six inches square. This is situated on a low rocky ridge, about four miles south of Waukaringa.

C Old Tooth Knob Station (pl. xvii, fig. 1). A single example of the "cairn" type, situated on the ridge of a hill to the west of a gap near the deserted

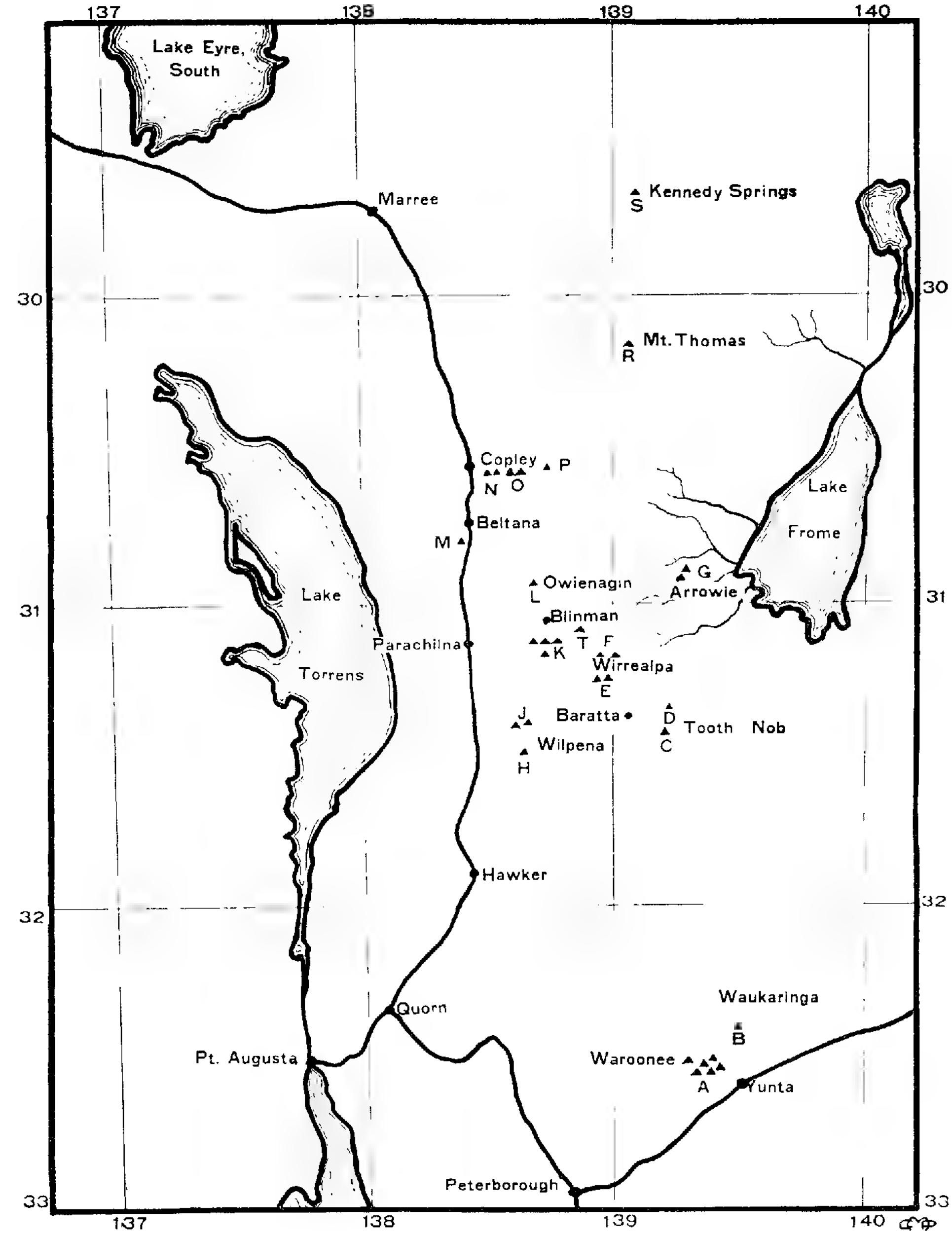


Fig. 2

station. The building is approximately three feet six inches high, and square in section.

D Emu Springs. A collapsed cairn on the crest of a low hill, a few hundred yards north-east of the springs.

E Wirrealpa Station. Mr. Arthur Rudall, of the above station, pointed out two stone structures on the summit of a hill three miles south of Wirrealpa. He had seen the aborigines build these examples. They were inspected by the author through field glasses; time did not allow a fuller investigation.

F Wirrealpa Station. Mr. J. Windsor, who had spent about forty-five years of his life on this station, had seen two stone structures, slightly west of the homestead. He said that they were the work of aborigines, and that he had often seen native boys build similar miniature structures whilst tending the cattle.

G Arrowie Station. The same informant also knew of two similar buildings about a mile north of the above station, which also had been built by the local aborigines.

H Wilpena Station. Mr. H. M. Hale found this example on the side of a hill, about a mile from the station. The building was of the cairn type, about six feet high, and two feet square at the base. Mr. J. Hunt, the owner of the station, informed the author that a number of similar cairns existed in various parts of his property.

J Oraparinna. These are situated on the tops of hills, a few miles north of the station, on the Blinman track. They were inspected through field glasses, and appeared to be of the 'Waroonee" type. The one on the east of the track was about two feet high, and partly collapsed, while that on the west was five feet high, and appeared to be complete.

K Alpana Station (pl. xvii, fig. 2). This group of four, three of the "Waroonee" and one of the "cairn" type, were found by Mr. P. Stapleton (1931, p. 23). They were situated on the sides and crests of adjacent hills in this station property. Alpana is about two miles south of Blinman. The "Waroonee" examples were about five feet in height, and particularly well built from long, narrow slates. Stapleton records the aboriginal name of these buildings as *juraka*.

L Owienagin Pound. This structure was found by Mr. H. M. Hale, and figured by Mountford (1927, pl. x, fig. 2). It is about four feet six inches high, and of the "Waroonee" type.

M Beltana. Situated about two miles south of Beltana, on the western side of the road. Mr. P. Stapleton found this example in 1926, and the author figured his photograph in 1927 (pl. x, fig. 1). The structure is about two feet in height and built of stone slabs.

N Leigh Creek Station. Mr. V. G. Hurst, the owner of this property, told the author that there were a few small cairns on his holding, which had been built by aboriginal children.

O Four miles east of Leigh Creek Station. The author examined three structures in this locality. They were similar to the Beltana examples, about two feet high and made of flat slates.

P Patsy Springs (pl. xvi, fig. 3). This structure is on the northern side of the road, and about two miles west of Patsy Springs. A half-caste aborigine, Rufus Wilton, pointed out this example to the author, and said that he had built it when an adolescent youth, and that such buildings were common in the neighbourhood, all the work of aboriginal boys. They had no ceremonial significance, and were built purely for amusement. The native name was *adnya juri* (*adnya* = stone, *juri* = high).(1)

R Mount Thomas. Mr. H. Greenshields of the Surveyor-General's Department, examined this structure whilst on a survey. It was of the "Waroonee" type, about two feet six inches square at the base and six feet high. It was situated on a hill-top, about a mile south-west of Mount Thomas.

S Kennedy Springs. The same informant also saw a number of low buildings (apparently similar to the Beltana example) adjacent to the above springs. They were all about two feet in height.

T. Between Wirrealpa and Blinman. These are situated on the northern side of the track between the two stations, about thirteen miles west of Wirrealpa. The largest of the group was circular, and flat-topped in form, of the "cairn" type, about four feet three inches high, and three feet six inches in diameter (pl. xvi, fig. 2). Two small examples (pl. xvi, fig. 1), similar to those at Beltana, about a foot square, and the same height, were built about five feet from the base of the structure on the northern side.

Apart from the groups of stone structures shown on fig. 2, two others were examined by the author at Mount Hill, west of Pt. Neil. Two collapsed piles were on the mount itself, and a complete structure of the "cairn" type was on the ridge of a hill to the east.

Pebble Mounds

Hale and Tindale (1925, p. 53) quoted the following paragraph from a letter written by Mr. E. G. Waterhouse to the South Australian Museum. He writes: "On some parts of the Outalpa run there are large mounds of stones built by the natives, but for what reason, up to now, I have not been able to ascertain."

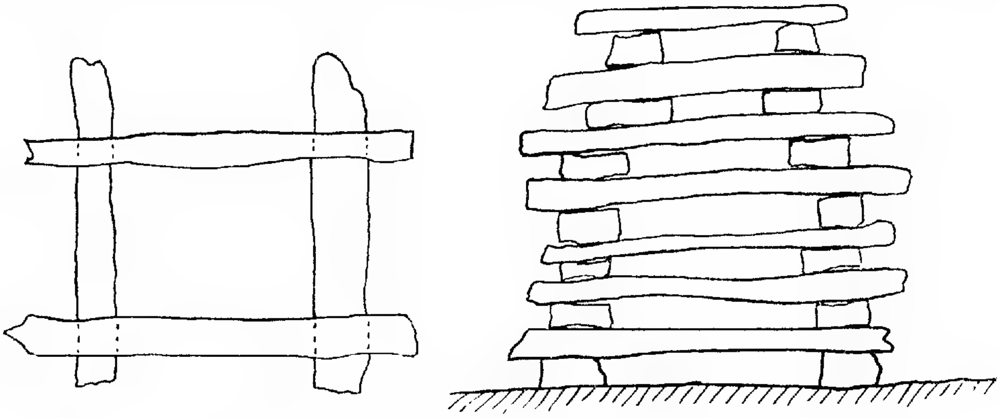
Mawson and Hossfeld (1926, p. 23) described two pebble mounds in the Outalpa district. They are probably the same as those mentioned by Waterhouse, and appear to be similar to the mounds recorded by Gregory (1884, p. 206), Giles (1875, p. 171; and 1889, p. 94), and Dow (1938, p. 33; and 1939, p. 210) in the country adjacent to Broken Hill.

(1) Compare with the name of the Alpana example, *i.e.*, *juraka*.

In answer to an enquiry regarding stone structures, Mr. W. G. Conrick, of Nappa-merrie Station, sent the author the following interesting letter and photograph (fig. 4, pl. xvii).

The letter is quoted almost in full: "The enclosed photo was taken twenty-five miles south of here. There are a number of these cairns on the run, and in all cases they are on old native roads. When my father first came out here they were plain beaten roads, like well-worn cattle pads. That was in 1871. The old pad is still plain in the photo enclosed." (Marked with an X.)

"I don't know whether these cairns have any particular meaning. I think they are only the means of clearing the road. This one in the photo, known as Kowah-ri *(kauari)*, had stones as well as wood on it—although most of the wood



A B

Fig. 3

Plan and Side Elevation of "Waroonee" Type Aboriginal Stone Structures

has rotted away now—and was on the main road for the blacks coming from the Wilson to the Kopramingie quarries.

"The wood, so the blacks told my father, was put to show the number of blacks that had passed, as each one was supposed to place a stick on in passing.

"Thirty miles east, on the same old road, there are four or five more of these piles of stones, although not so big. They are on a rough stony hill. There is also another of these cairns on the north side of the river, about thirty-two miles from here. It, like the Kowah-ri has been tampered with. In each case people have shifted the stones to see what was underneath."

The pebble mounds and native roads described by Mr. Conrick are apparently similar to those found by Gregory in 1858 on the banks of Coopers Creek.

Marinduna, an old aborigine of the Adnyamatana tribe, told the author that stone piles were present on almost every saddle of the Baratta Station. He said that the local natives attributed their origin to an ancestral lizard, *iti*. He knew nothing of either their real use or origin.

Discussion

In the light of our present knowledge on the subject, the stone structures of Australia can be divided into two main classes:

I Cairn-like buildings.

II Pebble mounds.

Both types occur in north Western Australia, Central and South Australia, New South Wales and Queensland, and, in the first three places at least, they are part of the present-day aboriginal culture.

I Cairn-like Structures

In South Australia cairn-like structures can be divided into the following three types, the particular structure being probably determined by the material available.

(a) The "Waroonee" type, in which the structure is square and hollow.

These have been built in the following manner: Two long, thin, narrow stones have first been laid on the ground, parallel to each other, and about half the length of the stones apart. Two similar stones were then laid at right angles across the first two (A, fig. 3). The stones are then laid on in pairs until the building is from three to five feet high (B, fig. 3, and pl. xvi, fig. 4). A, B, J, K, L, P, and R belong to this class.

(b) Solid buildings, smaller but similar to those constructed by surveyors on trigonometrical stations. The Tooth Nob and Mount Hill structures (pl. xvii, figs. 1 and 3) are typical of this class. C, D, H, T, and one of the structures at Mount Hill are similar.[2]

(c) Low buildings, up to about two feet in height, usually constructed from thin, flat stones. T (pl. xvi, fig. 1) is typical. M, N, O, two on Mount Hill, and possibly S, are of the same class.

From the enquiries made among the aborigines by Stapleton and the author, it would appear that the stone structures, particularly of the Northern Flinders, have been built by adolescent aboriginal boys as a form of amusement. It is likely, at the same time, that the building of these structures is the survival of a custom that has had much greater significance. Our present culture has many such remnants.

II Pebble Mounds

The pebble mounds on Coopers Creek (Gregory 1884) and Outalpa (Hale and Tindale, 1925, and Mawson and Hossfeld, 1926) are the only recorded examples in South Australia. From the description of these authors, and the

---

(2) The resemblance of the buildings to surveyor's trigs, and the fact that they are usually placed on ridges or hill-tops has often led observers to attribute them to the work of survey parties. In most cases, however, they are neither placed on the summit of prominent hills, nor in positions of any importance to surveyors.


Fig. 1


Fig. 2


Fig. 3


Fig. 4

Aboriginal Stone Structures

Fig. 1, Low structure between Wirrealpa and Blinman Fig. 2, Large structure at same location as fig. 1
Fig. 3, Patsy Springs Fig. 4, Waroonee

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Aboriginal Stone Structures and Pebble Mounds, South Australia
Fig. 1, Tooth Nob Fig. 2, Alpana Fig. 3, Mount Hill
Fig. 4, Pebble Mount, Nappa-merrie

letter from Conrick (quoted in the present paper), it seems to have been the custom to deposit a stick or stone in passing. Possibly this action is associated with some belief, similar to that recorded by Love (1939). In the case of the Baratta mounds, their use and origin seems to have been lost, so the latter has been attributed to a mythical source.

Summary

This paper reviews the stone structures of Australia, and describes in detail, fifteen new groups in South Australia. The positions of the latter have been plotted on the map, their significance and origin discussed, and the relevant literature quoted.

Literature

Crossland, C. 1902 Report on Exploration of North-west Kimberley by F. S. Brockman. Appendix B. Perth.

Campbell, T. D., and Mountford, C. P. 1939 Trans. Roy. Soc. S. Aust., **63** (1)

Dahl, Knut. 1926 In Savage Australia. London

Dow, Edmund B. 1938 Oceania, **9** (1)

Dow, Edmund B. 1939 Mankind, **2** (7)

Giles, Ernest 1875 Geographic Travels in Central Australia, 1872-1874. Melbourne

Giles, Ernest 1889 Australia Twice Traversed. London

Gregory, A. C. and F. C. 1884 Journals of Aust. Explorations, 1846-1858. Brisbane.

Hale, H. M., and Tindale, N. B. 1925 Rec. S. Austr. Mus., **3**, (1), 53

Love, J. R. B. 1939 Rec. S. Aust. Museum, **6** (2)

Mathews, R. H. 1901 Queensland Geog. Journ., **16**

Mountford, C. P. 1927 Trans. Roy. Soc. S. Aust., 51

Mawson, D., and Hossfeld, P. S. 1926 Trans. Roy. Soc. S. Aust., **50**

Stapleton, P. S. 1931 South Australian Naturalist, 12 (2)

Towle, C. C. 1939 Mankind, **2** (7)

Withnell, J. G. 1901 Customs and Traditions of the Aboriginal Natives of North Western Australia. Roeburne

Wood Jones, F. 1926 Journ. Roy. Anthro. Inst., **55**

REPORT ON THE CYMOTHOID ISOPODA OBTAINED BY THE F.I.S. "ENDEAVOUR" ON THE COASTS OF QUEENSLAND, NEW SOUTH WALES, VICTORIA, TASMANIA, AND SOUTH AUSTRALIA

By HERBERT M. HALE, Director, South Australian Museum
(Contribution from the South Australian Museum)

Summary

FAMILY CYMOTHOIDAE

The material herein dealt with was originally sent to New Zealand for examination by the late Dr. Chas. Chilton, but pressure of other work prevented him from reporting on it. When Dr. Chilton died the specimens were returned to the Australian Museum, and the Director of that Institution has been good enough to refer them to me for study. The "E" numbers cited refer to the registrations of the Australian Museum, where the specimens are housed.

REPORT ON THE CYMOTHOID ISOPODA OBTAINED BY THE F.I.S. "ENDEAVOUR" ON THE COASTS OF QUEENSLAND, NEW SOUTH WALES, VICTORIA, TASMANIA, AND SOUTH AUSTRALIA

By Herbert M. Hale, Director, South Australian Museum
(Contribution from the South Australian Museum)

[Read 8 August 1940]

Plate XVIII

FAMILY CYMOTHOIDAE

The material herein dealt with was originally sent to New Zealand for examination by the late Dr. Chas. Chilton, but pressure of other work prevented him from reporting on it. When Dr. Chilton died the specimens were returned to the Australian Museum, and the Director of that Institution has been good enough to refer them to me for study. The "E" numbers cited refer to the registrations of the Australian Museum, where the specimens are housed.

SUBFAMILY CIROLANINAE

Cirolana Leach

Cirolana woodjonesi Hale

Cirolana woodjonesi Hale, Trans. Roy. Soc. S. Aust., 48, 1924, p. 71, pl. v, and text fig. 2; and *loc. cit.*, 49, 1925, p. 137, fig. 5.

This species superficially resembles *C. rossi* Miers, which attains a length of over 30 mm. In Miers' species, however, the eyes when viewed from the side are narrower, the flagellum of the second antennae is longer and composed of a greater number of segments, while the furrows of the coxal plates are more oblique and on the last four pairs extend right to the inner (or dorsal) edge, just as in *C. tenuistylis* Miers (see Hale, *ut supra*, 1925, fig. 4); in *C. woodjonesi* these furrows terminate abruptly some distance from the edge.

Localities—A large number of individuals from Queensland: Norwest Island, Capricorn Group, 9 July 1910, "Brought up on bait while line fishing" (E. 4843). Tasmania: Eliott Cove, West Coast, 5 fathoms (E. 5349).

Cirolana victa Hale

Cirolana victa Hale, Trans. Roy. Soc. S. Aust., 49, 1925, p. 150, fig. 11.

Twenty specimens, the largest 20 mm. in length. One is wrinkled obliquely as in the type, and others are less distinctly so marked, but in the majority the surface bears only fine transverse striae and punctures.

The oblique grooving may be due to the action of strong alcohol soon after an ecdysis, but the finer striae are distinctive, so that the specific name is not inapt.

The telson, which is damaged in the single type female, has a median longitudinal carina, and the apex is produced to a sharp point. In the male, the

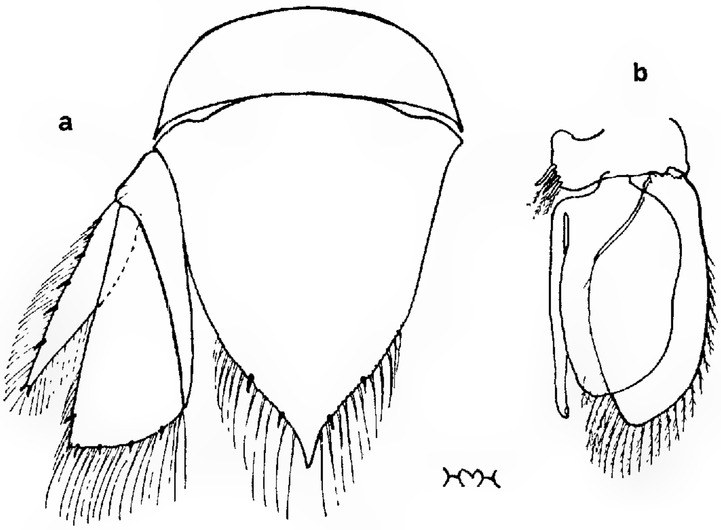


Fig. 1
Cirolana victa, male: a, telson and uropod; b, second pleopod.

antennae are longer than in the female, and extend well beyond the end of the pleon.

Localities—South Australia: Sleaford Bay, 25 fathoms, 28 August 1909 (E. 4856); south of St. Francis Island, 35 fathoms (E. 4838); Loc. ? (E. 6600).

Cirolana corpulenta Hale

Cirolana corpulenta Hale, Trans. Roy. Soc. S. Aust., 49, 1925, p. 134, fig. 3.

A single female. Only one other specimen—the type female—has been recorded. The "Endeavour" example now examined is 5 mm. in length, but has the flagellum of the second antennae relatively longer than in the type, composed of 17 segments and a terminal style, and reaching back to beyond the hinder margin of the third peraeon segment. The colour markings are much as in the type.

Locality—Tasmania: Eliott Cove, West Coast, 5 fathoms (E. 6757).

In January 1933, Mr. T. G. Roughley, Economic Zoologist at the Technological Museum in Sydney, reported that a sea-louse had appeared in great numbers in New South Wales, and was causing deaths of sharks and rays, eating into the coelome, and attacking the liver. The little predators temporarily held up the shark industry. Specimens sent to me for examination proved to be *C. corpulenta*.

Cirolana valida sp. nov.

♀ Form suboval, two and one-half times longer than wide. Surface sparsely and finely punctate, the tiny pits for the greater part arranged in irregular transverse lines. Cephalon rather deeply immersed in first peraeon segment, less than twice as wide as medial length; anterior margin emarginate, with an exceedingly minute, downbent, median process, not separating the first antennae; dorsum with a furrow extending along inner margins of eyes and continued across front of head, subparallel to anterior margin. Eyes pale, elongate, occupying antero-lateral portions of cephalon, barely visible in dorsal view, with the upper (inner) margin concave, nearly straight. First antennae reaching to end of fourth article of peduncle of second pair; proportions of articles of peduncle 5:3:7; flagellum short, twelve-segmented. Second antennae reaching back to beyond hinder angles of second peraeon segment; first two articles of peduncle short, subequal in length, together as long as fourth article; proportions of third to fifth segments 7:6:10; flagellum composed of 28 articles. Frontal lamina linear, more than three times longer than greatest width, slightly widened near anterior apex, which is acute. Clypeus wider and much shorter than labrum. Maxilliped rather stout, the marginal hairs stiff. First peraeon segment longer than second; second to fifth successively increasing slightly in length; seventh shorter than any of the others. Coxal plates of second and third free peraeon segments each with an oblique, curved furrow (in addition to the usual "submarginal" furrow); plates of fourth segment with obsolescent furrow and remainder without furrow, although some punctures faintly outline what would appear to be the sites of obsolete grooves; last four pairs extending beyond level of hinder margins of their respective segments, the last pair reaching to beyond the postero-lateral angles of the second pleon segment. All segments of pleon exposed; first largely concealed beneath last peraeon segment and with postero-lateral angles almost hidden by last pair of coxal plates; postero-lateral angles of second segment subacute, those of third and fourth acute, those of fifth concealed. Telsonic segment subtriangular with apex rather angularly rounded, furnished with plumose hairs and about 20 short spines; its length less than three-fourths basal width. Uropods not quite reaching to end of pleon; exopod narrow, lanceolate, more than four times longer than wide and barely more than one-half greatest width of endopod, which is two and one-half times as long as wide, with apex rounded, outer margin fairly straight, and inner, behind protopodal process, rounded. Peraeopods stout; third joint of first three pairs expanded distally and armed with stiff setae on distal and inner margins, and with three or more spines near inner distal angle; outer distal angle of fourth segment of first three pairs forwardly produced almost to middle of length of sixth segment, with the apex armed with setae and two or more strong spines; fourth, fifth and sixth segments of anterior peraeopods with compound spines on inner margin. (fig. 2 e). Second segment of posterior limbs widened (that of the seventh one-half as wide as long). On the seventh peraeopods the

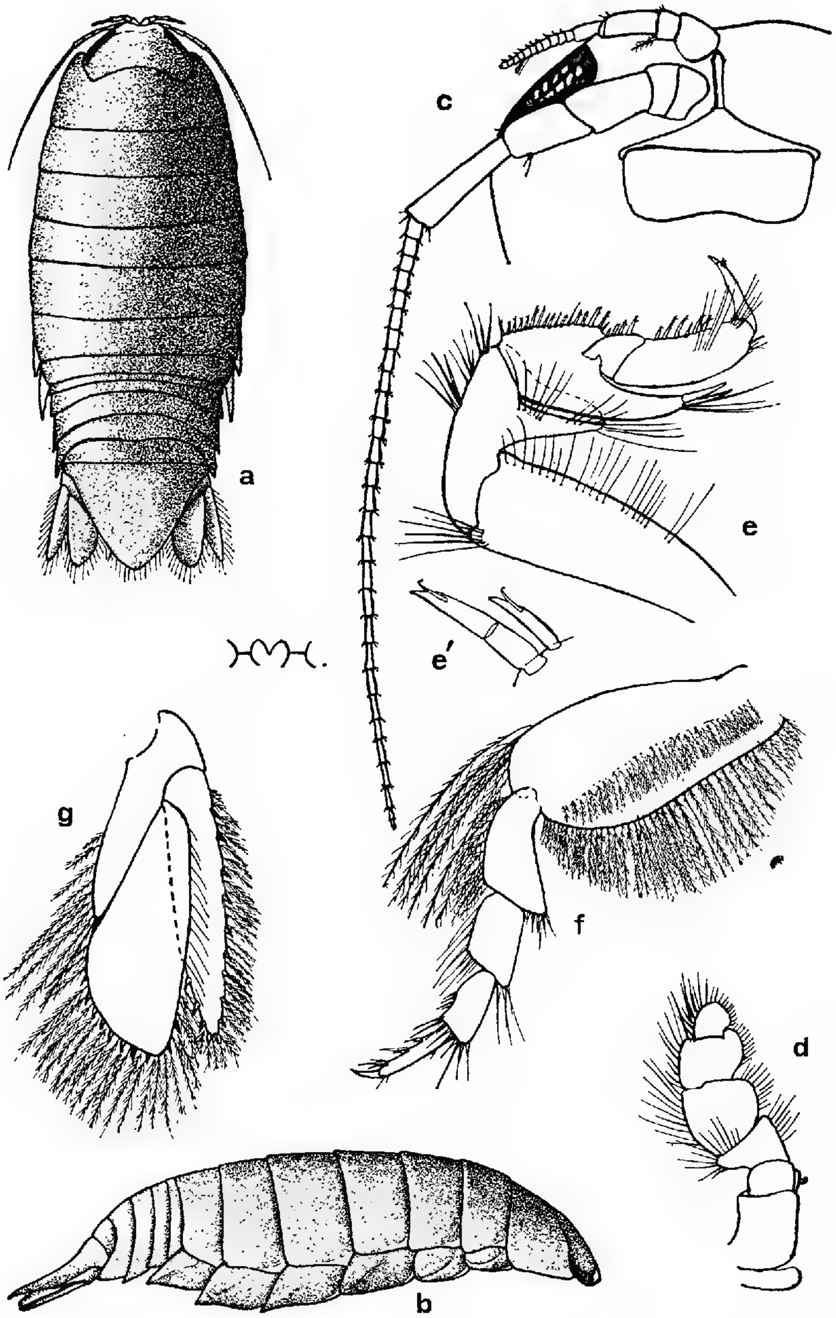


Fig. 2

Cirolana valida, type female: a and b, dorsal and lateral views; c, antennae, frontal lamina, clypcus and labrum; d, maxilliped; e, first peraeopod; e′ spines of first peraeopod; f, seventh peraeopod; g, uropod.

inner margin is not set with plumose natatory hairs, but the inner distal margin has a dense plume almost equal in length to the segment; the outer margin bears dense plumose hairs for its whole length, as does also the inferior longitudinal ridge

Colour, in alcohol, greyish white. Length, 31 mm.

Locality—East of Flinders Island, Bass Strait, 200-300 fathoms, December 1913. (Type in Australian Museum, Reg. No. E. 4814.)

This large species in some respects resembles the New Zealand *C. rossi* Miers,[1] but differs in that the posterior coxal plates have no distinct oblique grooves, the form is stouter, the first antennae are relatively slightly longer, and the uropoda are different. It is close to *C. borealis* Lilljeborg,[2] but has the eyes more elongate (although less visible in dorsal view) and even straighter on the upper margin, while the first two pairs of coxal plates have a distinct oblique furrow, not merely "a short rudiment of an impressed line"[3] and the others obsolete traces of grooves. Further, *C. borealis* has a fringe of dense hair on both inner and outer margins of the second segment of the posterior peraeopods (whereas most of the inner margin is bare in the new species) and the uropoda are different, the endopod being more parallel-sided.

In some respects, *C. valida* is close to *C. hirtipes* M. Edwards, but the last-named species differs in having well-marked furrows on all the coxal plates, in the narrower endopod of the uropods, and in the number of spines on the legs.

I have to express my grateful thanks to Dr. Keppel H. Barnard who kindly sent me a specimen of *C. hirtipes* from East London, South Africa, for comparison with *C. valida*.

Bathynomus A. Milne Edwards

Bathynomus ? affinis Richardson

(Pl. xviii)

Bathynomus affinis Rich., Bur. of Fish. Doc. No. 736, Washington, 1910, p. 4, fig. 1.

There is before me a single specimen, 119 mm. in length and 45 mm. in greatest width; unfortunately, it is abnormal insofar as the telson and uropoda are concerned. While undoubtedly close to *B. doderleini* Ortmann,[4] it differs from that species in the following characters. The body is relatively narrower, and the eyes are not so deep in lateral view, appearing more narrowly subtriangular than as figured by Milne Edwards and Bouvier for *B. doderleini*. The telson is proportionately narrower and apparently had nine (instead of seven) teeth in the posterior margin (pl. xviii, fig. 2) while the exopod of the uropoda is not subtriangular, but subrectangular. The last four pairs of coxal plates bear conspicuous carinae, and the second antennae extend only to the hinder margin of

(1) Miers, Ann. Mag. Nat. Hist., (4) 17, 1876, p. 228.

(2) Lilljeborg, Ofvers. Vet. Akad. Förh., 1851, p. 23.

(3) Hansen, Journ. Linn. Soc., 29, 1905, p. 342.

(4) M. Edw. and Bouvier, Mem. Mus. Comp. Zool., Harvard, 27, 1902, p. 159 pl. vii-viii.

the second thoracic segment (to or beyond posterior edge of fourth segment in *B. doderleini*,[5]) and consist of less than 50 segments. In the conspicuous coxal carinae, and shape of the exopod of the uropoda and telson, the specimen agrees with *B. affinis;* the posterior margin of the endopod of the uropod, however, is not almost straight, and the outer postero-lateral angle is not "abruptly produced in an acute process or tooth," although the absence of this last character may be due to damage.

Locality—Victoria: South of Gabo Island, 200 fathoms (E. 6215).

SUBFAMILY CORALLANINAE

Argathona parca sp. nov.

♀ Form suboval, narrow, more than three times longer than greatest width. Surface smooth. Cephalon twice as wide as medial length, with a small process which does not separate first antennae. Eyes well separated. First antennae reaching to end of fourth article of peduncle of second; peduncle two-segmented, the second article three-fifths as long as the first; flagellum with eleven articles and a tiny sub-segment at base between lash and peduncle (fig. 3 c). Second antennae slender, reaching to middle of length of fourth peraeon segment; proportions of segments of peduncle (in cleared mount, taking greatest lengths) 3:2:3:7:7; flagellum half as long again as peduncle, composed of 19 articles. Frontal lamina narrow, almost spatulate in shape. Clypeus wide, ∧-shaped. Mandibles with molar process moderately prominent (fig. 3 d); palp with first article more than one-half as long as second and a little longer than the third. Outer lobe of first maxilla terminating in the usual strong claw, at the base of which is a spinule; inner lobe apically subtruncate and somewhat expanded. Second maxillae shorter, with simple apex capped with two feeble spines. Palp of maxillipeds four-segmented; structure shown in fig. 3 g. Coxal plates each with the usual pair of furrows; posterior angles of only the last two pairs subacute and reaching back beyond hinder margins of peraeon segments. First pleon segment almost concealed beneath last thoracic segment; lateral portions of fifth segment overlapped by fourth. Telsonic segment long, its medial length almost equal to basal width; evenly tapering to the rounded extremity. Uropods not reaching to end of pleon; protopod with inner process rather short and stout, extending to middle of length of endopod, which is wide, subtriangular in shape, rounded with posterior margins somewhat flattened. Peraeopods terminating in a single claw; anterior pairs armed with relatively few spines.

Colour, in alcohol, brownish-yellow. Length, 8 mm.

Locality—Queensland: off Hummocky Island, 30 July 1910, from eye of Queensland Groper. (Type in Australian Museum, Reg. No. E. 6787.)

---

(5) Rich., Proc. U.S. Nat. Mus., 37, 1910, p. 78.

The single specimen described above was taken in company with eight examples of *Aega cyclops* on the eye of the abovementioned fish. The mandibles resemble those of *A. reidi* Stebbing[6] but, in general, the new form is easily separated from any of the other eight members of the genus.

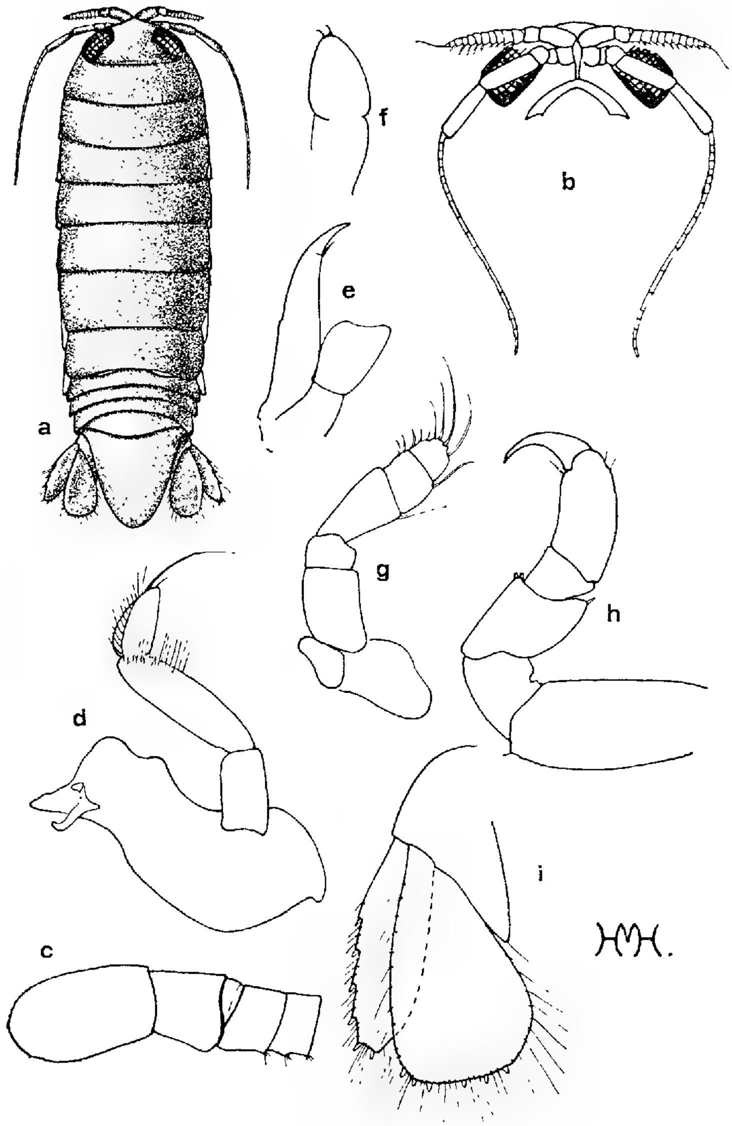


Fig. 3
Argathona parca, type female: a and b, dorsal view; b, antennae, frontal lamina and clypeus; c, peduncle and base of flagellum of first antenna; d, mandible; e and f, first and second maxillae; g, maxilliped; h, first peraeopod; i, uropod.

(6) Stebb., Trans. Linn. Soc., 14, 1910, p. 100, pl. ix, A.

SUBFAMILY AEGINAE

Aega Leach

Aega deshaysiana (H. Milne Edwards)

Rocinela deshaysiana M. Edw., Hist. Nat. Crust., 3, 1840, p. 243.

Aega deshaysiana Sch. and Mein., Naturh. Tidssk., (3) 12, 1879, p. 360, pl. viii, fig. 7-9; Norman, Ann. Mag. Nat. Hist., (7) 14, 1904, p. 434, pl. xii, fig. 1-4, and pl. xiii, fig. 10 11; Rich., Proc. U.S. Nat. Mus., 27, 1904, p. 674.

Aega antillensis Sch. and Mein., *loc. cit.*, p. 361, pl. viii, fig. 10-13; Rich., Proc. U.S. Nat. Mus., 23, 1901, p. 521, and Bull. U.S. Nat. Mus., 54, 1905, p. 170, fig. 149; Thielemann, München Abh. Akad. Wiss., 2, Suppl. 3, 1911, p. 26, pl. i, fig. 1-2; Hale, Trans. Roy. Soc. S. Aust., 49, 1925, p. 176, fig. 24.

Aega excisa Rich., Wash. Bur. of Fish., Doc. No. 736, 1910, p. 11, fig. 11.

Five examples, the largest 57 mm. in length. I have also recently seen a specimen in the Australian Museum from "Ontong", Java, near British Solomons, collected by H. Hogbin, 22 June 1918.

Localities—New South Wales: Byron Bay, from cloaca of Tiger Shark (E. 4858). Victoria: off Gabo Island, 80 fathoms and 200 fathoms (E. 4763 and 4837). Tasmania: off coast (E. 5353). South Australia: off Marsden Point, Kangaroo Island (E. 4865).

Aega serripes H. Milne Edwards

Aega serripes M. Edw., Hist. Nat. Crust., 3, 1840, p. 241; Sch. and Mein., Naturh. Tidsskr., (3) 12, 1879, p. 355, pl. viii, fig. 1-4; Hale, Trans. Roy. Soc. S. Aust., 49, 1925, p. 171, fig. 21.

Localities. Seven examples from the following—Tasmania: off Falmouth, 60-70 fathoms (E. 6596); Oyster Bay, gill-parasite of Skate (E. 4844); off east coast of Flinders Island, Bass Strait (E. 5673).

Aega angustata Whitelegge

Aega angustata Whitel., Mem. Aust. Mus., 4, 1901, p. 232, fig. 21a-21f; Hale, Trans. Roy. Soc. S. Aust., 49, 1925, p. 170, fig. 20.

This species is rather close to *A. dofleini* Thielemann[7] but, according to the description, the last-named species has the frontal lamina subtruncate in front (whereas in *A. angustata* it is rounded anteriorly) and the first antennae are very different.

I have recently examined further specimens of *A. angustata* taken from Saw-sharks in New South Wales, and now in the Australian Museum. Eight examples were secured by the "Endeavour", the largest being 29 mm. in length. In a specimen only 10 mm. in length, the serrations of the telson and uropoda are relatively more pronounced than in larger representatives.

Localities—Victoria: off Gabo Island, 80 fathoms (E. 6778). Tasmania: Oyster Bay (E. 6774); "Tasmanian coast" (E. 6779); Flinders Island, Bass Strait, from a shark (E. 4840, 2 May 1909). Great Australian Bight: 60-80 miles west from Eucla, 80-120 fathoms (E. 6763).

(7) Thielemann, München Abh. Akad. Wiss., ii, Supp. 3, 1911, p. 28, fig. 28-34.

Aega fracta sp. nov.

♂ Form broadly oval, little more than twice as long as wide. Cephalon two and three-fourths times as long as medial length; anterior margin rounded, with a tiny median triangular process extending downwards and back between the bases of the first antennae and meeting the very small frontal lamina. Eyes large, oblong, contiguous (four facets being in contact) occupying the greater part of dorsum of cephalon but leaving a space anteriorly and a larger area posteriorly. First antennae reaching well beyond end of peduncle of second antennae; proportions of segments of peduncle 13:10:23; flagellum slightly longer than peduncle, composed of eleven articles and a terminal style. Second antennae reaching back to slightly beyond hinder margin of second peraeon segment; the first and second segments of the peduncle are subequal in length; the proportions of the second to fifth (in a cleared mount) are 2:3:4:5; flagellum one-half as

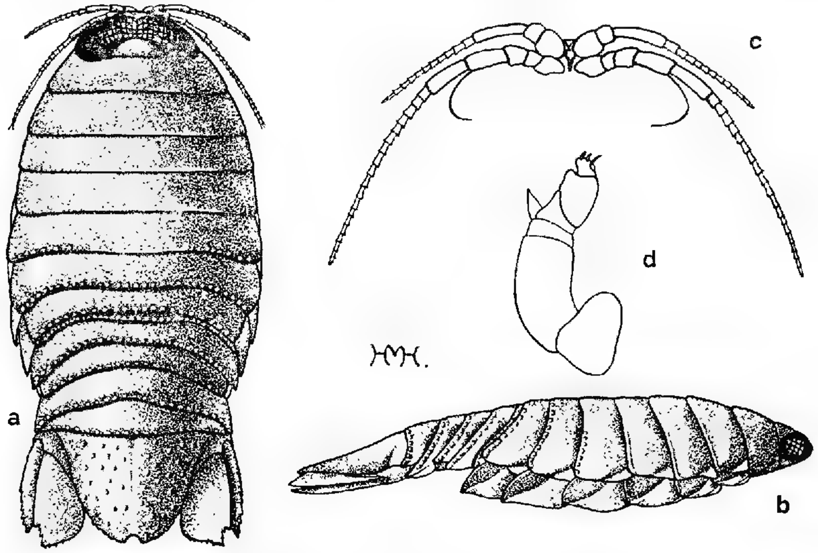


Fig. 4
Aega fracta, type male: a and b, dorsal and lateral views; c, antennae and frontal lamina; d, maxilliped.

long again as peduncle and composed of 19 articles. Segments of peraeon with surface punctate, subequal in length; seventh shorter than any of the others. Coxal plates each with two furrows, the inner (upper) of which runs from the postero-lateral angle to a point just posterior to the inner anterior angle in the first pair, and successively further back from this angle in remainder; postero-lateral angles of first three pairs obtuse, of fourth pair subacutely rounded, and of last two pairs acute. Last two peraeon segments and first five pleon segments with hinder margins finely beaded. First pleon segment partly concealed. Telson one-half as wide again as median length; rounded with margin serrulate and with a small U-shaped terminal incision; surface studded with minute tubercles. Exopod of uropod a little shorter than endopod (which attains to level of end of telson), suboval in shape, pointed apically, and with five small spines (set in tiny notches) on outer margin and two to three on inner; endopod truncate, with inner posterior angle rounded and outer subacute; hinder margin crenulate, with several short, stout spines; outer margin with a shallow but distinct incision at third fourth of its length; posterior to this notch the edge is crenulate and bears two spines. The peraeopods (fig. 5, a-b), call for no special comment.

Colour, in alcohol, white. Length, 14·5 mm.

Locality—"Off Tasmanian Coast" (type in Australian Museum, Reg. No. E. 6747).

Several other species of the genus have a small terminal incision in the telson, but only two also have the eyes contiguous. These are *A. approximata*

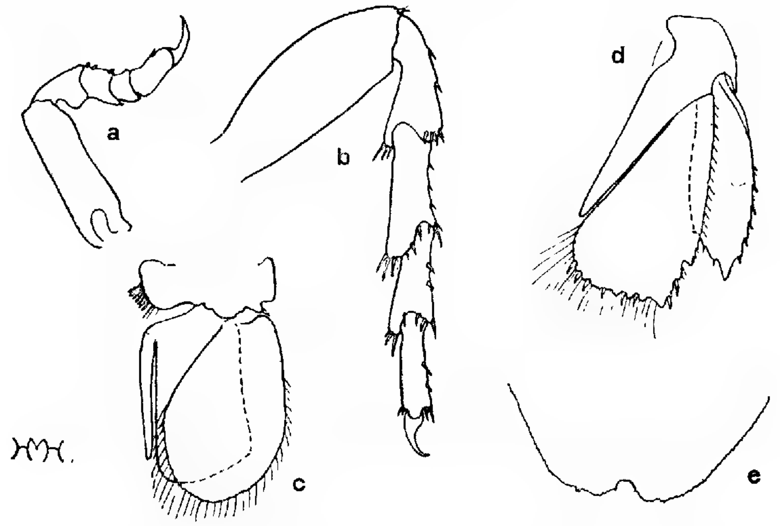


Fig. 5
Aega fracta, type male: a and b, first and seventh peraeopods; c, second pleopod; d, uropod; e, apex of telson.

Richardson[8] and *A. incisa* Schioedte and Meinert[9]. *A. fracta* differs from Richardson's species in having fewer segments in the flagellum of the first antennae, in the U-shaped incision of the telson ("V-shaped" in *A. approximata*) and in not having the "outer post-lateral angles of all the epimera acute"—indeed, in *A. fracta*, only the last three pairs can be said to be at all acute. *A. incisa* also has more segments (16) in the flagellum of the first antennae, while the posterior angles of the last three pairs of coxal plates are very acute and the body is relatively narrower; further, in the new species, the carinae of the first three pairs of coxal plates (as shown in fig. 4b) do not extend from the postero-lateral angle to the antero-lateral angle as in *A. incisa*.

(8) Rich., Wash. Bur. Fish., Doc. No. 736, 1910, p. 15.
(9) Sch. and Mein., Naturh. Tidsskr., (3) 12, 1879, p. 373, pl. x, fig. 1315.

Aega cyclops Haswell

Aega cyclops Hasw., Proc. Linn. Soc., N.S.W., 6, 1881, p. 192, and Cat. Aust. Crust., 1882, p. 285; Hale, Trans. Roy. Soc. S. Aust., 49, 1925, p. 180, fig. 26, a-f, and *loc. cit.*, 50, 1926, p. 233, fig. 20, a-d.

A series of eleven specimens of this little species shows that apparently there is some slight variation in the relative size of the head and slenderness of the body, although this appearance may be due, in part at least, to differences of extension between the segments. The eyes vary in size, but the extreme conditions may well be illustrated by my two figures (*ut supra*).

Localities—Victoria: off Gabo Island, 80 fathoms (E. 6776). Eastern Slope, Bass Strait (E. 6752). Tasmania: Hummocky Island, taken from eye of a Groper, 30 July 1910 (E. 4839); off Maria Island, 78 fathoms (E. 6602).

Aega concinna sp. nov.

♂ Body oval, two and one-half times as long as greatest width. Dorsum with evenly punctate surface; an impressed punctate, longitudinal median line on telson. Cephalon twice as wide as medial length, with a median frontal process, which almost separates the first antennae dorsally, and is keeled below, the keel (not the point) meeting the frontal lamina. Eyes large, well separated, the narrowest interocular space being equal to one-half the greatest diameter of an eye. First antennae reaching to middle of last segment of peduncle of second pair; with first two segments of peduncle subequal in length, flattened and considerably expanded, the width of the first being greater than its length; inner anterior portion of second segment produced to level of two-thirds of length of the third, which is slender, not expanded, slightly shorter than either the first or second segments, and equal in length to the nine-segmented flagellum. Second antennae reaching to a little beyond middle of length of first peraeon segment, proportions of segments of peduncle 5:5:5:11:16; flagellum shorter than peduncle, 14-segmented. Frontal lamina about as wide as long, broadest and roundly subtruncate in front; ventral face concave.

First, fourth, fifth and sixth peraeon segments subequal in length, each longer than any of others, and about same length as cephalon. Coxal plates slightly visible in dorsal view; each with two furrows, the inner of which reaches to the inner anterior angle in the first two pairs only (see fig. 6 b); fourth to sixth pairs successively reaching a little further back beyond level of hinder margins of their segments; more markedly acute and produced. All segments of pleon conspicuous, postero-lateral angles of first four subacute. Telsonic segment a little wider than long; margin evenly rounded, finely and rather irregularly crenulate posteriorly. Uropods not reaching quite to level of apex of pleon; protopod produced to end of inner edge of endopod, which is obliquely truncate posteriorly, with outer and inner posterior angles rounded; exopod suboval, barely shorter, but narrower, than endopod. Second and third pairs of peraeopods with propodus produced, the process extending to middle of length of dactylus.

Colour, in alcohol, greyish-brown. Length, 30 mm.

Locality—Tasmania: Entrance to Oyster Bay, 30 July 1909. (Type in Australian Museum, Reg. No. E. 6740.)

In the shape of the first antennae and the propodal processes of the second and third peraeopods this species approaches *A. angustata* Whitelegge,(10) but in

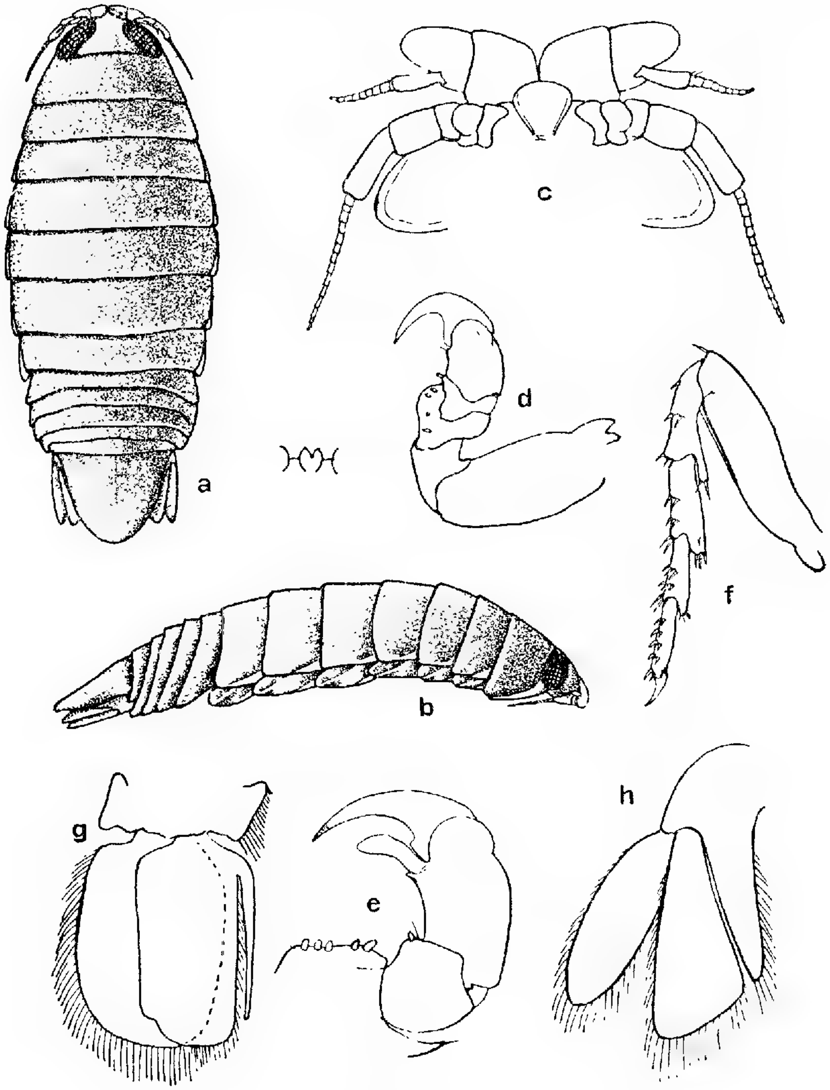


Fig. 6

Aega concinna, type male: a and b, dorsal and lateral views; c, antennae and frontal lamina; d, first peraeopod; e, distal portion of third peraeopod; f, seventh peraeopod; g, second pleopod; h, uropod.

(10) Whitel. Mem. Aust. Mus., 4, 1901, p. 232, fig. 21 a-21 f.
(11) Whitel., *loc. cit.*, p. 229, fig. 20 a-20 f.

other respects is entirely different. It resembles *A. australis* Whitelegge(11) in some characters, but differs in the two abovementioned characters, in the larger eyes, shorter second antennae, shape of frontal lamina and telson, uropods, etc.

Aega nodosa Schioedte and Meinert

Aega nodosa Sch. and Mein., Naturh. Tidsskr., (3) 12, 1879, p. 367, pl. ix, fig. 1-3; Hale, Trans. Roy. Soc. S. Aust., 49, 1925, p. 178, fig. 25, a-g.

Schioedte and Meinert described a male, while previously the writer has examined only a female. There is now before me a male, 16 mm. in length, from the type locality, but which diffiers from the type in having mere traces of tubercles on the hinder margin of either the sixth or seventh peraeon segments; they are more distinct, however, near the posterior edges of the first five pleon segments, but even there, are not very conspicuous.

Larger nodes (absent in the female described by me) are present as in the type male, but their disposition is slightly different, in that on each side of the elevation of the sixth peraeon segment is a less conspicuous node; there is the merest indication of a median elevation on the fourth pleon segment, but on the fifth there is a moderately large tubercle on each side of the hinder edge.

The uropods resemble those of the type male more than of the female previously described. The appendix masculina is five-sixths as long as the inner branch of the second pleopods.

Locality—Tasmania: Eastern Slope, Bass Strait (E. 6751).

Aega vigilans Haswell

Rocinela vigilans Hasw., Proc. Linn. Soc., N.S.W., 5, 1881, p. 472, pl. xvi, fig. 2, and Cat. Aust. Crust., 1882, p. 285; Miers, Zool. "Alert", 1884, p. 304; Rich., Proc. Amer. Philos. Soc., 37, 1898, pp. 9-10.

Aega dubia Rich., Wash. Bur. Fish., Doc. No. 736, 1910, p. 12, fig. 12.

Aega vigilans Hale, Trans. Roy. Soc. S. Aust., 49, 1925, p. 174, fig. 23 a-g; Nierstrasz, Mem. Mus. Roy. d'Hist. Nat. Belgique, 3, 1930, p. 4, fig. 2, and "Siboga" Exped., Leiden, Mon., 32 c, 1931, p. 180.

A single immature specimen, 13·5 mm. in length, was taken in Queensland waters.

Locality—Queensland: 20 miles N.N.E. of Double Island Point, 30 fathoms (E. 6317).

Subfamily Cymothoinae

Nerocila Leach

Nerocila laticauda Schioedte and Meinert

Nerocila blainvillei Sch. and Mein., Naturh. Tidsskr., (3) 13, 1881, p. 78, pl. vi, fig. 11-12 (*nec* M. Edw.).

Nerocila laticauda Sch. and Mein., *loc. cit.*, p. 81, pl. vi, fig. 14-15; Whitel., Mem. Aust. Mus., 4, 1901, p. 235; Hale, Trans. Roy. Soc. S. Aust., 50, 1926, p. 203, fig. 2-3.

Locality—South Australia: 50 miles south of Cape Wiles, 75 fathoms (E. 6758).

Nerocila orbignyi (Guérin)

Ichthyophilus orbignyi Guérin, in Bory de St., 5, Exp. Morée (Crust.), 1832, p. 47.

Nerocila maculata M. Edw., Hist. Nat. Crust., 3, 1840, p. 253; Sch. and Mein., Naturh. Tidsskr., (3) 13, 1881, p. 50, pl. iii, fig. 7-8; Bonnier, Bull. scient. dip. du Nord, (2) 10, 1887, p. 137.

Nerocila affinis M. Edw., *loc. cit.*, p. 253.

Cilonera macleayi White and Doubleday, in Dieffenbach, Travels in New Zealand, 1843, p. 268.

Nerocila latiuscula Dana, Rep. Crust. U.S. Expl. Exped., 13, 1853-55, p. 758, pl. 1, fig. 7 a-b; Sch. and Mein., *loc. cit.*, p. 76, pl. vi, fig. 9-10.

Nerocila brasiliensis Dana, *loc. cit.*, p. 759, pl. 1, fig. 8 a-e.

Nerocila aculeata Dana, *loc. cit.*, p. 760, pl. 1, fig. 9 a-c (*nec* H. M. Edw.).

Nerocila falclandica Cunningham, Trans. Linn. Soc., 27, 1871, p. 500, pl. lix, fig. 2.

Nerocila imbricata Miers, Cat. Crust. N. Zeal., 1876, p. 107.

Nerocila neopolitana Sch. and Mein., *loc. cit.*, p. 41, pl. ii, fig. 9-16; Norman and Scott, Crust. Devon and Cornwall, 1906, p. 39.

Nerocila adriatica Sch. and Mein., *loc. cit.*, p. 45, pl. iii, fig. 1-4.

Nerocila orbignyi Sch. and Mein., *loc. cit.*, p. 55, pl. v, fig. 1-2; Monod, Rev. Zool. and Bot. Africanes, 21, 1931, p. 10, fig. 5-11; Barnard, Ann. S. Afr. Mus., 32, 1940, p. 403.

Nerocila cephalotes Sch. and Mein., *loc. cit.*, p. 60, pl. iv, fig. 16-18; Van Name, Bull. Amer. Mus. Nat. Hist., 43, 1920, p. 53, figs. 6-9; Monod, Bull. Com. Etud. Hist. Sci. Afr. Occident. Franc., 9, 1924, p. 436.

Nerocila novae-zelandiae Sch. and Mein., *loc. cit.*, p. 70, pl. v, fig. 10-11.

Nerocila trailli Filhol, Rec. Mem. passage de Venus, 3, 1882, p. 451.

Nerocila macleayi Miers, Rep. Zool. "Alert", 1884, p. 301; Chilton, Trans. N. Zeal. Inst. (6) 23, 1891, p. 68, pl. xi, fig. 1 a-c, 2 a-b; Hale, Trans. Roy. Soc. S. Aust., 50, 1926, p. 206, fig. 4-5.

Nerocila laticeps Bovallius, Bih. K. Svenska Vet.-Akad. Hand., 12, 1887, p. 10, pl. ii, fig. 23-26, and pl. iii, fig. 27-28.

Nerocila rhabdota Monod, *loc. cit.*, 1924, p. 437 (*nec* Koelbel).

Nerocila armata Barn., Ann. S. Afr. Mus., 20, 1925, p. 390.

Locality—Tasmania: off Storm Bay, 17 July 1909 (E. 5677) and on Elephant Shark—*Callorhynchus milii* (E. 4848) and "off Tasmanian coast" (E. 6745).

Nerocila monodi sp. nov.

Nerocila serra Hale, Trans. Roy. Soc. S. Aust., 50, 1926, p. 208, fig. 6 (*nec* Sch. and Mein.).

Dr. T. Monod has very kindly communicated to me the following facts and comments, supplementary to a note sent by him to Dr. Nierstrasz.(12) Schioedte and Meinert, when describing *N. serra*,(13) overlooked the fact that Bleeker(14) had previously described the same species under the name of *N. trivittata*.

Dr. Monod has examined specimens of *N. trivittata* from Malaysia and India, and finds that these agree with *N. serra* of Schioedte and Meinert, and differ from the examples described by me as *N. serra*, in having the epimerae of the posterior thoracic segments narrower and the endopod of the uropoda serrated on the outer edge only. He further states that in the British Museum there are three specimens similar to the Australian examples; two of these, respectively, 22 mm. and 28 mm. in length, are from Dume Island, New Guinea, and the third is from the mouth of a fish taken in the Louisiade Archipelago. Comparing the

(12) Nierstrasz, Siboga Exped., Mon., 32 c, p. 124 (footnote).

(13) Sch. and Mein., Naturh. Tidsskr., (3) 13, 1881, p. 17, pl. i, fig. 12-14.

(14) Bleeker, Verh. Naturk. Ver. Nederlandsch Indië, 2, 1857, No. 5, p. 24.

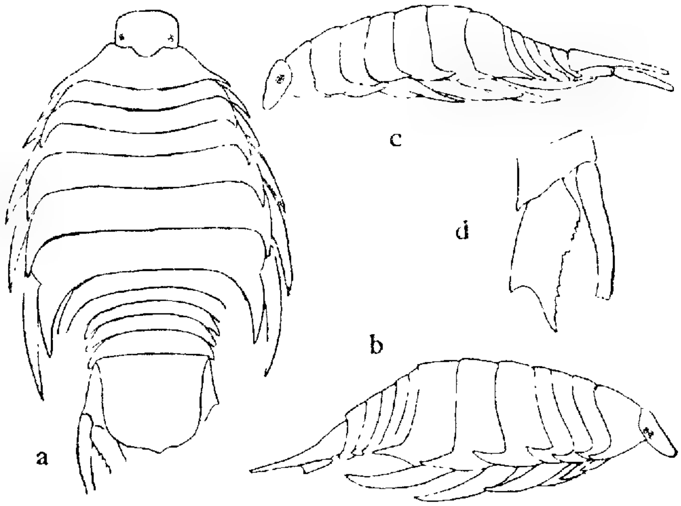


Fig. 7
Nerocila trivittata: a and b, dorsal and lateral views of 20 mm. ovigerous female from Malaysia; c and d, lateral view and uropod of 24 mm. non-ovigerous female from India (British Museum, *del* T. Monod).

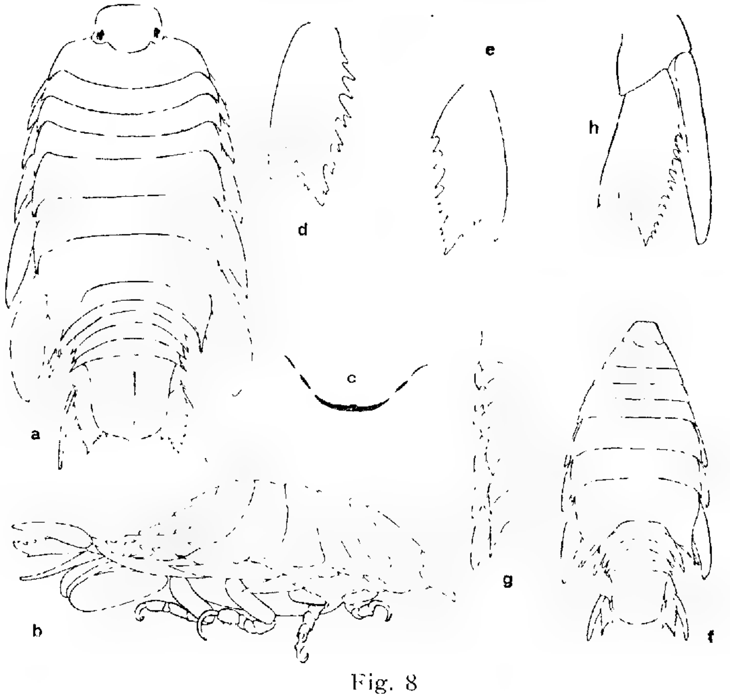


Fig. 8
Nerocila monodi: a and b, dorsal and lateral views of 28 mm. ovigerous female from New Guinea; c, transverse section of caudal fan of same; d and e, endopoda of uropoda of 22 mm. ovigerous female from New Guinea; f, dorsal view of 23 mm. female from Louisiade Archipelago; g and h, side plates and uropod of same (British Museum, *del* T. Monod).

28 mm. female with a female of *N. trivittata*, he found also that in the former the telson is concave, whereas in *N. trivittata* it is flat. Dr. Monod was good enough to send me a number of figures (here reproduced) of the specimens he discusses, and these leave no doubt as to the correctness of his diagnosis.

There are now before me three adult females, 22 mm. to 26 mm. in length. In these, the hinder angles of the posterior peraeon segments are more produced than in the specimen figured by me in 1926, and in one example they extend back to the level of the postero-lateral angles of the fifth pleon somite. As in the other Australian examples examined by me, the telsonic somite is very slightly convex or flat dorsally, with a low but distinct median carina and with the sides a little upturned, producing the effect of slight lateral gutters.

Locality—Queensland: 27° south-east of Pine Peak, 1 Aug. 1910 (E. 4861).

Range—Queensland: Great Palm Island, from *Lutianus* sp. (type ovigerous female, in South Australian Museum, Reg. No. C. 290; see Hale *ut supra*, p. 208); Brisbane; Cairns. New Guinea: Dume Island (British Museum, *fide* Monod). Louisiade Archipelago (British Museum, *fide* Monod).

Codonophilus Haswell

Codonophilus imbricatus (Fabricius)

Codonophilus imbricatus Hale, Trans. Roy. Soc. S. Aust., 50, 1926, p. 223, fig. 15 a-k and 16 a-f (*syn.*).

Localities—New South Wales: Shoalhaven Bight, 15-45 fathoms (E. 6599). South Australia: South-east of Flinders Island, 37 fathoms (E. 6744) and 15 miles north-west of Cape Jervis, 16 March 1909 (E. 4841).

Livoneca Leach

Livoneca raynaudii H. M. Edwards

Livoneca raynaudii Hale, Trans. Roy Soc. S. Aust., 50, 1926, p. 215, fig. 10 (*syn.*).

Twenty-eight examples of this common form. The largest is 50 mm. in length.

Localities—New South Wales: Shoalhaven Bight, 14-45 fathoms, 16 March 1909, one from opercle of *Zeus australis* (E. 288, E. 4854, and E. 6598). Victoria: off Gabo Island, about 200 fathoms (E. 4762 and E. 4836); Gabo Island to Cape Everard Ground, 20-250 fathoms (E. 6319); 40 miles south to south-west of Mount Cann, 70-100 fathoms (E. 6318 and E. 5433). South Australia: 50 miles south of Cape Wiles, 75 fathoms (E. 4864); south-east of Flinders Island, 37 fathoms, 30 August 1909 (E. 6743). Tasmania: off Tasman Head, Bruni Island, 80-100 fathoms, 21 March 1914 (E. 6597); Entrance to Oyster Bay 30 August 1909 (E. 5684); off Tasmanian coast (E. 6746); off west coast, 77 fathoms, on Banded Perch (E. 5354); off east coast of Flinders Island, Bass Strait (E. 6737); Eastern Slope, Bass Strait (E. 6750).

Ourozeuktes H. Milne Edwards

Ourozeuktes bopyroides (Lesueur)

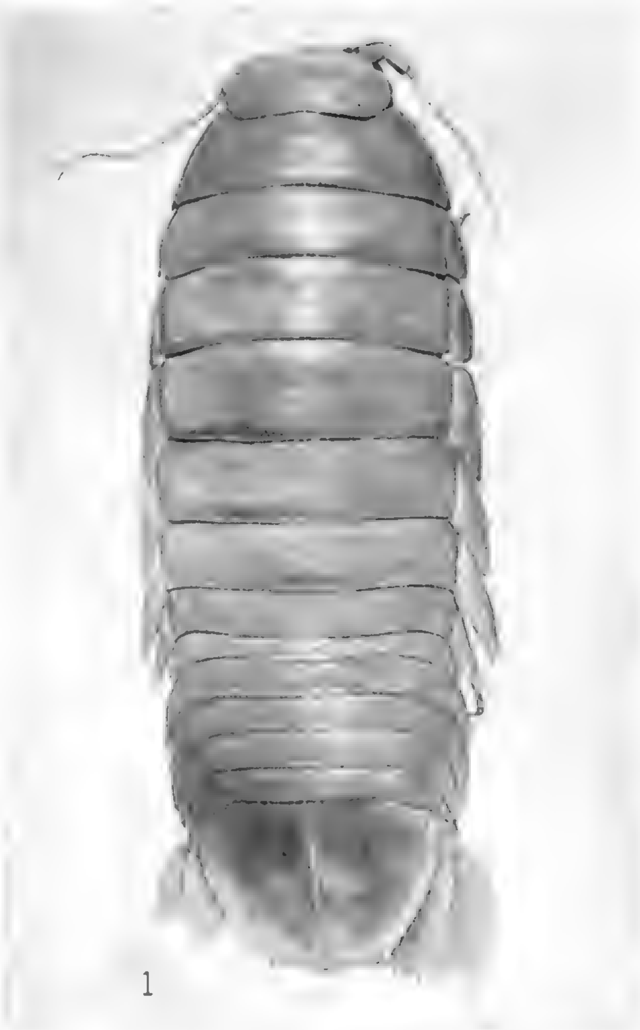
Cymothoa bopyroides Lesueur, Bull. Sci. Soc. Philom. Paris, 1814, p. 46, pl. ii, fig. 12 a-l.

Ourozeuktes owenii M. Edw., Hist. Nat. Crust., 3, 1840, p. 276, pl. xxxiii, fig. 8; Hale, Trans. Roy. Soc. S. Aust., 50, 1926, p. 227, fig. 17-19 (*syn.*).

Lesueur's paper "Sur une nouvelle espece d'insecte du genre *Cymothoa* de Fabricius" is not available in Australia, but Dr. T. Monod informs me that the figures of *Cymothoa bopyroides* leave no doubt whatever as to the identity of the species. It was found in a "Balistopode de la terre de Whit (Nouvelle Hollande)".

Three specimens are included in the "Endeavour" collection. One is larger than any previously examined by me, being 60 mm. in length and 40 mm. in width.

Localities—Victoria: Gabo Island to Cape Everard Ground, 20-250 fathoms (E. 6780). Great Australian Bight: 127° east, 80-120 fathoms (E. 3743), and 60-80 miles west from Eucla (E. 6759).



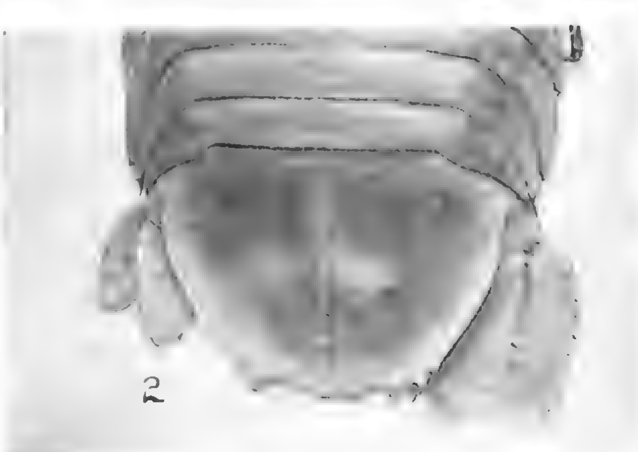


Fig. 1 Dorsal view of *Bathynomus* ? *affinis*.
Fig. 2 Telson and uropoda of *Bathynomus* ? *affinis*, enlarged.

AUSTRALITES, PART IV - THE JOHN KENNETT COLLECTION WITH NOTES ON DARWIN GLASS, BEDIASITES, ETC.

By CHARLES FENNER, University of Adelaide.

Summary

Pressures of other duties has prevented me from completing this paper as early as I should have done, and has made it impossible for me to elaborate all of the interesting points that have arisen in my enquiries. I accordingly present a succinct description of the John Kennett Collection and I take the opportunity to add skeleton notes concerning austalites and other tektite groups in a way that I trust may be of value, but which does not do them full justice.

AUSTRALITES, PART IV — THE JOHN KENNETT COLLECTION WITH NOTES ON DARWIN GLASS, BEDIASITES, ETC.

By Charles Fenner, University of Adelaide

[Read 8 August 1940]

Plate XIX

Contents

I INTRODUCTORY

Pressure of other duties has prevented me from completing this paper as early as I should have done, and has made it impossible for me to elaborate all of the interesting points that have arisen in my enquiries. I accordingly present a succinct description of the John Kennett Collection, and I take the opportunity to add skeleton notes concerning australites and other tektite groups in a way that I trust may be of value, but which does not do them full justice.

The increasing body of information that has now become available concerning tektites confirms the conclusion that we are as yet far from knowing the story of their origin. That is all the more reason why we should continue to accumulate facts, and to correlate them where possible. Nor is it any reason why we should suppress speculation and theory regarding their origin. Theories might well progress, step by step, with the accumulation of information.

II CHEMICAL AND PHYSICAL FACTORS

Dr. L. J. Spencer (Min. Mag., 25, 167, 1939, pp. 425-440) has published a record of certain specific characters of "Tektites and Silica Glass," particularly of their chemical analyses, specific gravity, and refractive indices, with the inter-relations of these factors where material is available. In this paper Dr. Spencer mentions the lack of data concerning chemical composition, specific gravity, and refractive index from the same sample of australite material. There is an abundance of reliable chemical analyses of australites, almost all of which have been published; there is also a great number of determinations of specific gravity, of which only a relatively small proportion has been published. Spencer can find only seven cases where both refractive index and specific gravity have been determined for the same australite samples, three by Tilley, three by Lacroix, and one other. There appears to be no case where all three factors have been determined for one australite.

Perhaps it is that Australian workers feel that sufficient is known of the chemical compositions and specific gravities of australites to serve the purpose of enquiry into their origin. Those who have studied the internal structure of australites, with their tiny bubbles and cavities, may not be disposed to spend their time determining specific gravities to two or three places of decimals. It is to be hoped that Australian workers will fill up the gaps in our knowledge concerning the specific gravity, chemical composition, refractive index, and other correlated facts concerning the same individual specimens of australites.

Accepting the australites as a series of objects, composed of black glass, of approximately similar chemical composition, specific gravity, and refractive index, spread over an area of some two million square miles, the writer would stress the importance of further studying their distribution (with possible variations from place to place), numbers, forms, and relative proportions of form types. It is to the latter enquiry that the author has particularly devoted his attention in a series of papers of which this is the fourth.(1)

III DESCRIPTION OF THE JOHN KENNETT COLLECTION

Some four years ago I came in touch with Mr. John W. Kennett, then in charge of the Police Station at Charlotte Waters, Central Australia. He had for some time been collecting australites in the area surrounding Charlotte Waters, aided by the aborigines there. He continued collecting until he was transferred to Alice Springs, Central Australia. Alice Springs is beyond the boundary of the strewnfield, and, although there are many potential aboriginal collectors at Alice Springs, the collecting by Sergeant Kennett came to an end, except for one specimen found in the street at Alice Springs, obviously carried and dropped.

In February 1939 Mr. Kennett brought to my home in Adelaide, in a large number of boxes, his remarkable collection. For over twelve months I have been engaged upon the classification and measurement of the specimens. It transpired that the total number of pieces was 7,184, nearly twice as many as the Shaw Collection (3,920). What is more significant is that while the average weight of the Shaw Collection was just under one gram per piece, the average weight of the Kennett Collection was over six grams per piece. The possible significance of this fact is discussed later.

---

(1)Australites, Part I—Shaw Collection, Proc. Roy. Soc. S. Aust., **58**, 1934, 62-79, 6 pl.

" Part II—Number, forms, distribution. Proc. Roy. Soc. S. Aust., **59**, 1935, pp. 125-140.

" Part III—Problem of Origin, etc., Proc. Roy. Soc. S. Aust., **62** (2), 1938, pp. 192 216, 2 pl.

Error—In Part III of this series the bibliography contained a serious error which was kindly pointed out to me by Dr. L. J. Spencer. I gave the date of Dufrénoy's "Treatise on Mineralogy" as 1787, whereas it was published in 1844-47, second edition in 1856-59.

Sergeant Kennett gives the following account of his collection:

"I was transferred from Katherine, Northern Territory, to Charlotte Waters at the beginning of September 1932. I had not been at the Station very long when an aboriginal brought to me about a dozen curious black stones, different from anything which I had seen before. Among them was a damaged stone of the flanged button type. I enquired by what name he called that one, and he replied, 'Emu Eye.' I became very interested and, after further questioning my black-tracker, Mick Doolan, who is an aboriginal above average intelligence, I was told that these glassy stones were meteorites. I scoffed at the idea, but later more were brought in of all sizes and shapes. I became more interested and eventually decided to make a collection. Very often I would accompany two or three aborigines, seeking over the gibber plains for tektites. It was exasperating when the aborigines would pick them up while I could not sight one. The small gibber stones on these plains vary in colour from dark brown to black, and it is difficult to pick out the tektites among them. I practised looking at tektites after they had been sighted by the blacks, but it was weeks before I first spotted a specimen, which thrilled me as much as if I had found a nugget of gold, and then I improved and at the end of a five-year term at Charlotte Waters I was as keen in the eye-sight as the aborigines. One of the hints the aborigines gave me was this: 'Supposem you find more big fella stone, alright, you look about properly fella and you findem mob little fella.' This theory I consider to be correct. When one located such a patch it would probably involve another quarter of a mile's walk before another stone would be found. After heavy rain had fallen on the gibber plains, stones became more plentiful and easy to detect. I feel assured that stones keep coming to the surface after every heavy rain and, in spite of the thousands that have been found around the old Police Station, thousands still remain to be found there. My collection, which was made over a period of five years was within a radius of several miles of Charlotte Waters—22 miles north, 30 miles west, 60 miles south, and 75 miles east—but by no means was the whole of that area intensively searched. The stones near Mount Dare are somewhat larger than those around Charlotte, and ovals and dumb-bells were more common there. Around Blood's Creek stones seemed to be of a smaller type, and very plentiful. At Eringa Station they were larger. At Eringa a friend of mine reported he had discovered the largest stone ever found in the country, reputedly as large as an apple. It had, unfortunately, been pressed into the ground by a wagon wheel, and cracked beyond value. The next largest stone I saw was found by a lubra and sold for a minty to Mrs. Child, of Crow Point Station. When it was shown to me I did my best to procure it, even offering two minties for it. This specimen, I believe, ultimately came into the hands of Professor Cleland and is in the Adelaide Museum. The stones in the sandhills are much cleaner and less chipped, readily collected after a heavy wind. It is very rare to find a perfect, flanged button specimen, and most of those in my collection I found around Charlotte Waters itself."

The general classification followed in this paper is that adopted in the Shaw Collection, itself a development from the general practice of those who have attacked this problem in earlier papers. Following upon the theory of genesis of these forms put forward in No. III of this series of papers, it was thought desirable to bridge over the passage from the round forms (buttons and lenses) to the long forms (boats, canoes, and dumbbells) by separating the "ovals" into two series, narrow ovals and broad ovals.

The following table shows the comparison in numbers of forms and average weights of the Shaw and Kennett Collections:

A *Complete Specimens*—

Class		SHAW No. of Specs.	SHAW Av. wt. in grms.	SHAW %	KENNETT No. of Specs.	KENNETT Av. wt. in grms.	KENNETT %
A1	Buttons - -	275	1·31	14	686	2·20	13·3
A2	Lenses - -	1094	·80	55	3249	6·93	63·2
A3x	Narrow Ovals -	168	·94	8	375	7·64	7·3
A3y	Broad Ovals -	—	—	—	365	9·17	7·1

Class		No. of Specs. (SHAW)	Av. wt. in grms. (SHAW)	% (SHAW)	No. of Specs. (KENNETT)	Av. wt. in grms. (KENNETT)	% (KENNETT)
A4	Boats - - -	171	1·12	8	323	5·79	6·2
A5	Canoes - -	81	1·10	4	10	1·27	0·2
A6	Dumbbells - -	70	1·22	4	67	8·61	1·3
A7	Teardrops - -	134	·90	7	62	8·93	1·2
	Total -	1993	av. ·93	100%	5137	av. 6·47	100%
B	*Broken Pieces—*						
B1	Round fragments -	980		51	284	—	16
B2	Elongate fragments	603	—	31	484	—	24
B3	Unclassified fragments - -	344	—	18	1175	—	60
	Total -	1927		100%	1943		100%
C	*Aberrant Forms—*						
C1	Aberrant forms -	(not separately classified)			104	—	100%
		3920			7184		100%

The outstanding difference is the larger average size of the Kennett Collection specimens. Piece for piece they are almost seven times as large as the Shaw specimens. Although the weights of the broken pieces are not given in this table, they also averaged about seven times as large as the Shaw specimens. There were some aberrant forms in the Shaw Collection, which were described and figured, but these were not so great in number as the "aberrants" of the Kennett Collection, where there are 104 specimens.

Both Shaw and Kennett utilised the aborigines in their collecting. It cannot be doubted that these collectors thus secured a fair average of the material that fell in each of the two vast areas over which they collected. These areas were some hundreds of miles apart. The conclusion is acceptable that though the whole of the australite fall was one vast "shower," there were distinct differences, at least in size, from place to place.

In the foregoing tables the numbers given for the Shaw Collection are those published in the paper already cited. In the following tables there are some differences, due to adjustments made in the light of further knowledge, particularly in the relation of "cores" to lens types and button types. The millimeter figures refer to the major diameters of the specimens in each group.

CLASS A1—BUTTONS

			SHAW	KENNETT
A1a with complete flanges	(i) unchipped		7	7
	(ii) slightly chipped		0	6
A1b with imperfect flanges	(i) ½ or more left		22	22
	(ii) ¼ to ½ left		17	23
	(iii) less than ¼—			
		(a) 14 mm.	27	126
		(b) 10-14 mm.	43	354
		(c) < 10 mm.	17	66
A1c	(i) large interior bubbles		0	0
	(ii) burst, centre back		15	0
	(iii) burst, various		36	3
A1d with saw cuts			7	—
A1e (pine seed forms)	(i) with flat tops > 14 mm.		—	10
	< 14 mm.		67	39
	(ii) with high tops		—	30
		Total	258	686

The proportion of flanged buttons was about the same in both collections, about one-seventh of the total complete specimens. Those with burst bubbles were commoner in the Shaw collection, perhaps an unimportant point. It is curious that so few of the "saw-cuts" were found in the Kennett Collection, none among the buttons; if these are contraction cracks it would suggest that the physical conditions of the fall at Charlotte Waters were different from those at Nullarbor Plains.

CLASS A2—LENSES

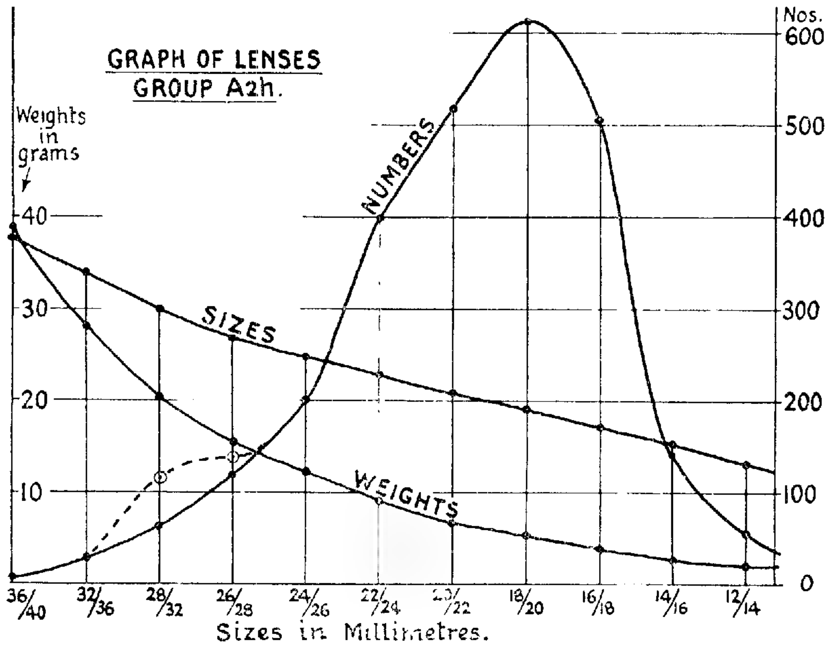
			SHAW	KENNETT
A2a	(i) 16-18 mm.		0	15
	(ii) 14-16 mm.		69	77
A2b	12-14 mm.		177	169
A2c	10-12 mm.		350	96
A2d	8-10 mm.		341	25
A2e	6-8 mm.	(i) larger	77	0
		(ii) int.	12	0
		(iii) smaller	6	1
A2f	Pitted discs	(i) larger	6	0
		(ii) int.	44	0
		(iii) smaller	6	0
A2g	Crinkly tops		6	9

			SHAW	KENNETT
A2h	(i)	36-40 mm.	1	8
	(ii)	32-36 mm.	0	30
	(iii)	28-32 mm.	0	118
	(iv)	26-28 mm.	0	138
	(v)	24-26 mm.	0	200
	(vi)	22-24 mm.	0	401
	(vii)	20-22 mm.	0	518
	(viii)	18-20 mm.	16	613
	(ix)	16-18 mm.		594
	(x)	14-16 mm.	0	140
	(xi)	12-14 mm.	0	54
	(xii)	heavily flaked (a) larger	152	40
		(b) smaller		87
	(xiii)	balls	0	6
A2i		Baker's special pitted disc	0	0
		Totals	1263	3249

Just as lenses formed the greater part, more than half, of the complete specimens of the Shaw Collection, so is this true of the Kennett Collection. But the 55% of the Shaw Collection is to be compared with 63½% in the Kennett Collection. It may be that the author's experience in handling many thousands of these objects, and considering their forms from the genetic point of view, has enabled him to more truly classify specimens as lenses when he might otherwise have been doubtful owing to their chipped equatorial areas. That factor would not materially affect the final percentages. The outstanding fact is that whereas the 1,263 lenses of the Shaw Collection averaged less than one gram in weight, the 3,249 lenses of the Kennett Collection were giants by comparison, 6·93 grams. The foregoing table shows the enormous preponderance of large lenses in the Kennett Collection. The original Shaw classification showed only 1,094 lenses; the addition of specimens there classified as cores, etc., brought the total lenses up to 1,263, the figure quoted in the foregoing table.

The group A2h xiii, called "balls," consisted of six heavily abraded and almost spherical specimens of large size. The possibility that they contained large bubbles, similar to the unique specimen in the Melbourne National Museum, led to their specific gravities being determined. They proved to be quite solid glass, the figures being: 1–2·48; 2–2·43; 3–2·51; 4–2·45; 5–2·47; 6–2·45. These figures were determined by W. G. Fenner; the determinations are above the average for australites, but they serve the purpose of proving that the spherical forms contained no large bubble.

This graph is published in support of the theory of the genesis of australite forms as put forward in my previous papers. From the point of view of size and abundance the group of lenses called A2h in this paper is the most important in the Kennett Collection. The graph shows sizes and weights of the specimens in the group. The important fact is that these correspond with a natural distribution curve, rising from a minimum of 8 at the greatest weight (39 grams), to a maximum number of specimens of 5·3 grams weight (613), and then decreasing to a minimum of 54 specimens at the lowest weight of 2 grams.



Class A3x—Narrow Ovals

			Shaw	Kennett
A3xa	with perfect flange		0	0
A3xb	with imperfect or	(i) 40-52 mm.	0	19
	no flange or rim	(ii) 34-40 mm.	0	39
		(iii) 28-34 mm.	0	94
		(iv) 22-28 mm.	0	115
		(v) 18-22 mm.	0	75
A3xc	with imperfect or no flange or rim	14-18 mm.	0	27
A3xd	,, ,,	10-14 mm.	0	6
A3xe	,, ,,	8-10 mm.	0	0
			0	375

Class A3y—Broad Ovals

			Shaw	Kennett
A3ya	with perfect flange		2	0
A3yb	with imperfect or no flange or rim	(i) 40-52 mm.	0	10
		(ii) 34-40 mm.	0	30
		(iii) 28-34 mm.	0	65
		(iv) 22-28 mm.	0	101
		(v) 18-22 mm.	18	73
A3yc	with imperfect or no flange or rim	14-18 mm.	50	58
A3yd	,, ,,	10-14 mm.	81	24
A3ye	,, ,,	8-10 mm.	17	4
			168	365

For reasons already given the ovals were separated into two groups: (a) broad, having a short diameter equal to three-quarters or more of the long diameter; (b) narrow, having a short diameter half to three-quarters of the long diameter. The proportion of ovals in the two collections is somewhat similar: Kennett, 14% (740); Shaw, 8% (168). The characters were quite similar except that, as the table shows, the Kennett specimens were larger, again more than seven times as large. No distinction was made between broad and narrow ovals in the Shaw Collection, and they are all included here as broad ovals.

Class A4—Boats

		Shaw	Kennett
A4a long axis	(i) 48-56 mm.	0	5
	(ii) 40-48 mm.	0	24
	(iii) 34-40 mm.	0	53
	(iv) 28-34 mm.	0	90
	(v) 22-28 mm.	15	117
A4b long axis	18-22 mm.	75	19
A4c long axis	14-18 mm.	52	4
A4d long axis	12-14 mm.	14	3
A4e thin, flat, translucent		8	0
A4f elongate crinkly tops		7	8
		171	323

"Boats" are ovals in which the short diameter is less than half the long diameter. These constituted 8% of the Shaw and 6% of the Kennett Collection. A few had the "crinkly tops," figured in previous papers, suggesting a flow of material to the rear side of the specimen during flight, in place of the formation of a flange.

CLASS A5—CANOES

		SHAW	KENNETT
A5a long axis	22-30 mm.	22	4
A5b long axis	18-22 mm.	18	3
A5c long axis	14-18 mm.	28	3
A5d long axis	12-14 mm.	7	0
A5e aberrant elongates		2	0
		77	10

There was a very small number of canoes (boats with pointed ends) in the Kennett Collection. Their absence, with the other differences noted, suggests that the fall at Charlotte Waters was more viscous or fell under different conditions. The average weights of canoes were about the same in both cases.

CLASS A6—DUMBBELLS

		SHAW	KENNETT
A6a long axis	(i) 65 mm. plus	0	1
	(ii) 55-65 mm.	0	1
	(iii) 45-55 mm.	0	10
	(iv) 35-45 mm.	0	22
	(v) 30-35 mm.	5	14
A6b long axis	25 30 mm.	23	5
A6c long axis	20-25 mm.	25	4
A6d long axis	15-20 mm.	7	0
A6e long axis, ladles		5	0
A6f long axis, beans or kidneys		5	0
		70	57

CLASS A7—TEARDROPS

		SHAW	KENNETT
A7a long axis, 12-15 mm.	(i) 35 mm. plus	0	8
	(ii) 25 35 mm.	0	18
	(iii) 15 25 mm.	0	31
	(iv) 12-15 mm.	6	2
A7b long axis	10 12 mm.	21	1
A7c long axis	8 10 mm.	45	1
A7d long axis	6-8 mm.	39	0
A7e air bombs, etc.		23	0
		134	61

Dumbbells and their ultimate separate halves (teardrops) were fewer in the Kennett Collection, but bigger. Here, again, the size ratio was about 7:1 (see Table 1). The comparative rarity of dumbbells, canoes, and teardrops was one of the peculiarities of the Kennett Collection, compared with the Shaw Collection. Those who personally examine the Kennett Collection will find little difference to the eye between some boats and some dumbbells. In cases of doubt, reliance was placed almost wholly on the sense of touch. If a constriction or "waist" could be detected by the fingers the specimens were classified as dumbbells.

CLASS B—FRAGMENTS

CLASS B1—ROUND FORMS—FRAGMENTS

		SHAW	KENNETT
B1a	buttons (with saw cuts), fragments greater than half	18	0
B1b	buttons (with saw cuts), fragments less than half	66	0
B1c	buttons with concentric fractures, large	32	2
B1d	buttons with concentric fractures, small	187	10
B1e	central conical portions of buttons	87	0
B1f	button cores, larger (now lens cores, A2h xii (a))	20	0
B1g	button cores, smaller (now lens cores, A2h xii (b))	106	0
B1h	"lumps", weathered and abraded (i) large	—	72
	(ii) medium	26	107
	(iii) small	—	43
B1i	fragments with bubble cavities	28	11
B1j	button fragments, with flanges, larger ($\frac{1}{2}$ or more)	23	14
B1k	button fragments with flanges, smaller (less than $\frac{1}{2}$)	181	25
B1l	button fragments without flanges, possibly lenses	206	0
		980	284

CLASS B2—ELONGATE FORMS—FRAGMENTS

		SHAW	KENNETT
B2a	(i) elongates with saw cuts	39	0
	(ii) elongates with saw cuts (trilobites)	20	0
B2b	varied elongates with concentric fractures	51	0
B2c	elongate fragments, with unusual flow ridges, etc.	10	0
B2d	elongate forms, with bubble cavities	42	20
B2e	elongate forms, mostly cores, some very irregular	36	0
B2f	(i) fragments, larger	130	102
	(ii) fragments, smaller	172	231
B2g	(i) dumbbell fragments, larger	27	43
	(ii) dumbbell fragments, smaller	52	72
B2h	teardrop fragments	24	16
		603	484

Class B3—Unclassified Fragments

		SHAW	KENNETT
B3a Nondescript fragments	(i) very large	0	96
	(ii) large	0	155
	(iii) medium	340	332
	(iv) small	0	490
B3b Flakes, accidental or aboriginal		4	102
B3c Foreign bodies		(10)	(17)
		344	1175

There is little need for comment on the figures concerning fragments. Round forms are more common, as already shown, than elongate forms, but round fragments are in a smaller ratio to elongate fragments than might be expected, unless we accept the idea that the elongate forms are more readily broken. Possibly the very great proportion of unclassified fragments (B3) in the Kennett Collection was due to more thorough collecting. The greater number of these fragments showed relatively fresh fractures.

Class C—"Indicators", Aberrants, and other Curious Specimens

(included in aberrant elongates, etc., in Shaw Collection)

Class C1, Round "Indicators"		30
Class C2, Elongate "Indicators"		22
Class C3, Curious Specimens—		
	(i) unusual flow ridges, etc.	18
	(ii) curious buttons	4
	(iii) helmet forms	2
	(iv) flat trays	10
	(v) "spoon" forms	2
	(vi) with bubble about to burst	1
	(vii) teardrop becoming button?	1
	(viii) specimen (?) touched in flight	1
	(ix) red inclusions	1
	(x) unusual colour and structure	2
	(xi) an inexplicable fragment	1
	(xii) detached two-thirds flange	1
	(xiii) parts of "aerial bombs"	4
	(xiv) (?) pine-seed forms	4
		104

It is necessary that some notes should be added concerning the aberrant or "irregular" forms which are set out in the foregoing table. When these are adequately described and figured, they should throw some light on the problem of the formation of australites. These notes give the simplest facts concerning them.

(a) "Indicators". These are forms in which most of the important equatorial portion has been chipped or flaked off, in the manner characteristic of thousands of specimens, with the exception that the flaking process has not been complete. There is thus a portion of the margin left, and this remaining margin "indicates", in almost every case, that the original form was of lens shape without flanges ("flanges" are characteristic of those types called buttons). This fact has already been published, with figures (Trans. Roy. Soc. S. Aust., lix, 1935, p. 131), but the Kennett Collection contains a number of corroborative examples, 52 in number. Baker (Min. Mag., London, xxv, No. 168, p. 493) refers to the flaking off of these unstable equatorial portions "during atmospheric flight". The writer believes this flaking to have slowly taken place in the years since the australites fell to the surface (*vide* Trans. Roy. Soc. S. Aust., 62 (2), 1938). The point stressed here is that these particular specimens tell us something of the original shape of the flaked specimens. In a very few "indicators" there is evidence of an original flange. The writer agrees with Baker's definition of a "core" *(loc. cit.)* except that he finds it difficult to imagine the flaking to have taken place to any extent, if at all, during flight (see pl. xix, Nos. 11, 12, 13).

(b) Specimens with unusual flow ridges. "Flow ridges" are external formations, usually on the front portion of the partly molten moving australite, and although they show remarkable uniformity in the majority of specimens, where preserved, there is in some specimens a very interesting series of irregularities. These call for physical and mathematical enquiry (see pl. xix, Nos. 14, 15, 17).

(c) Curious Buttons. Buttons are, as a rule, more than usually uniform, though no two are alike; they are between $1\frac{1}{2}$ and $2\frac{1}{2}$ cm. in diameter, and from 1 to 1·75 cm. deep. Among the curious forms of the Kennett Collection is a large button that is most irregular in form and outline, yet having a perfectly good flange, almost complete (see pl. xix, No. 16). Another is the smallest button I have seen, flange incomplete (pl. xix, No. 19); another is like a Cornish pasty, with a flange on one side only (see pl. xix, No. 15).

(d) Helmet Forms. These appear to be blobs of glass that once were buttons, but which have advanced far beyond the usual button form owing to melting and flowage during flight.[2] "Flat trays" are small objects, of varied type, approaching helmet forms at one extreme and flat discs at the other (see pl. xix, Nos. 22 to 27). "Spoon forms" are large, and are chiefly interesting because they are so unlike the usual australites (except in composition and colour), and so like the characteristic spoon forms of the moldavites.

[2] These forms, although somewhat deeper in the "crown", appear to be similar to those described by George Baker in the Proc. Roy. Soc. Vict., **52**, n.s., pt. ii 1940, p. 312.

(e) Other unusual forms include one teardrop that appears to have been flattening out to form a button, but there is no flange. There are many better examples in museum collections of this tendency for the flying teardrop to develop a flange. Another shows on its posterior surface a bubble that was just about to burst—not a very interesting specimen. Another suggests what the writer has looked for during the handling of many thousands of specimens —evidence of a specimen being touched during flight. Another specimen shows reddish surface inclusions; there are many such in the Melbourne University Collection, but apart from this dubious one, none in the Kennett Collection; Darwin's Australite, now in the Geological Museum, London, has a considerable amount of this red material in it; it has never been analysed.

(f) There are two fragments with unusual colour and structure, but not important, and one "inexplicable" fragment, which does not appear to be a part of any known australite form. There is a piece that is two-thirds of a button flange, separated from its parent button; four that are parts of some relatively large aerial bombs, broken, and with remarkably complex flow ridges, and four that I have called "pine-seed" forms, for lack of a better place to classify them.

Foreign Bodies. The group B3c includes 17 "foreign bodies". It is remarkable that the aborigines, with their exceptional acuity of vision, and their equally remarkable powers of observation, should have collected many specimens that are not australites. The writer's training in mineralogical and petrological observation, together with the experience of handling critically many thousands of australite and other tektite specimens, has not made him immune from error. Of the 17 mistakes in the Kennett Collection some are limonite, sand-blasted, and with good patina; others and more deceptive ones are waterworn cherts and other fine-grained homogeneous rocks. There are at least three definite aboriginal artefacts of chert, etc., and there are also two oval waterworn pebbles. Dr. Keith Ward, who collected from the aborigines in the tektite-sprinkled area of Kalgoorlie, Western Australia, many years ago, told me that if the native collector had any doubts of his specimen, he deftly struck a chip from the dull surface to reveal the reassuring glassy material within.

The Kennett Collection. The general facts of the John Kennett Collection support the knowledge already in our possession, and at the same time bring forward definite evidence of a feature long suspected but not substantiated. All the forms were lying on the surface, in the Central Australian desert and semi-desert areas; this supports the idea of their geological recency ("geologically recent but historically remote"). The forms are the same as those found elsewhere, and the relative abundance of the various types of forms is closely similar to what has been found in other areas. The number of aberrant forms, though not large, may be due to the assiduity with which Sergeant Kennett, aided by his aboriginal friends, so closely combed this area.

There is one minor point about collecting that might be recorded here. As one who has sought for australites among the abundant black and purple fragments with which the desert areas are strewn, I know the difficulty of discovery; Sergeant Kennett has learnt that one should search with his back to the sun, and look well ahead; thus the eye becomes "tuned in" to the glassy objects and they are more readily found.

The important evidence given us by the Kennett Collection is that, not only were the falls more numerous in some places than in others, but also that in the more densely sprinkled areas (*e.g.*, Charlotte Waters and Nullarbor areas) there were some general and striking differences between the characteristics of the australites themselves; those at Charlotte Waters were on the average seven times as large as those on the more southern field. The John Kennett Australite Collection is a unique and fascinating one, and in the interests of scientific enquiry it is to be hoped that it may be acquired intact by some institution, for there is still much desirable research to be done on this collection.

IV NOTES ON DARWIN GLASS

Darwin Glass (Queenstownite), found in north-western Tasmania, is generally considered one of the more doubtful tektites. In published tables and graphs of chemical composition and physical characters it stands somewhat apart from the accepted tektite groups. A careful comparison of external and internal characters, as revealed by the microscope, shows that in these features also the Darwin Glass specimens are distinct from such tektites as moldavites, australites, rizalites, billitonites, indo-chinites, or the more recently found bediasites.

Published accounts speak of "thousands of tons" of this material, but it is not easy to get specimens at present. I found there was none available at Queenstown itself, nor in the Museum at Hobart. Three pieces were kindly made available to me from the Launceston (Tasmania) Museum. Professor Cotton, of the University of Sydney, and Professor Richards, of the University of Queensland, generously lent me for inspection the whole of their material, and this is listed in the following pages; the total weight of the material was about 257 grams. In a subsequent paper the results of comparative examination will be made available detailing the external sculpture and internal flowlines, etc., of the various tektites, including Darwin Glass. In this section we shall deal only with numbers, forms, and weights.

Loftus Hills stresses the "twists, the tubercles, and the slaggy appearance." Suess noted the predominance of "stretched and distorted forms." David mentioned that they were rarely unbroken, many stalactitic with spiral twist, disc-shaped, and "striated, like pulled-out and twisted toffee."

These descriptions are excellent, but they do not give account of size and weight. The striking point of the specimens is their slightness and their "frothiness". Each specimen contains a mass of bubbles, and each bubble has the usual internal "hot polish" common to silica-glass bubbles, as I have investigated them experimentally in a glass-work furnace, by courtesy of the management of Australian Glass Manufactures, Ltd., Kilkenny, South Australia. The colour of Darwin Glass varies from almost clear, through a pale-green translucence similar to that of Libyan-glass, to green-grey, white, and black. There are no "perfect forms", with the exception of one boot-shaped piece, a tiny double-dumbbell, bent at right angles.

The striated or fasciated appearance is common. Tubercles are abundant. "Straight-cut" broken ends are not uncommon. Some of the pieces have a tendency towards the teardrop or spoon type; the smallest pieces are as shapeless as cinders, and not unlike them.

Whatever their origin, it is clear that at the time of their appearance, and just prior to their consolidation, they were "flung" in an irregular way, and under conditions that involved the incorporation of much gas. There is no evidence that any piece was soft when it reached the ground. The shapes of the bubbles give a suggestion of such rapid cooling that one may speculate whether they fell on the one-time glacial cap of their parent mountain.

The collection made by Sir Edgeworth David, lent by Professor Cotton, was collected at 13 localities. The accompanying particles of sand, etc., were the white and pink quartzite of that area. The following classification is the best that can be done to systematize the forms of this irregular group, and it is hoped that the terms may convey some meaning in the absence of plates:

(a) large elongated lumps;
(b) boot (the one complete form in the collection);
(c) phallic pieces, broken;
(d) teardrop forms;
(e) volcanic bomb type;
(f) fasciated pieces;
(g) lacework pieces;
(h) straight cuts (short pieces with sharp breaks at right angles to the axis, common in moldavites and called "partitions" in Czech collections).
(i) twisted and tubercled pieces;
(j) formless fragments; more than two-thirds of the total are in this group.

The localities mentioned in the lists are those written on the various envelopes by Professor David.

Locality	No. of Specimens	*a*	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*
Mount Darwin - - -	16	1	—	—	1	—	4	—	3	2	5
Darwin Glass - - -	76	—	—	—	1	1	—	1	10	—	63
Darwin Glass - - -	19	—	—	5	1	—	3	1	5	2	2
Crotty - - - - -	3	1	—	—	—	—	—	—	—	1	1
Ten-mile Railway Station -	77	—	—	—	2	—	4	1	7	4	59

Locality	No. of Specimens	*a*	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*
Darwin Glass - - -	8	1	—	—	—	—	2	—	—	1	4
West of Mount Sorrell -	19	—	—	—	—	1	—	—	3	4	11
10-mile Special - - -	15	5	—	—	—	—	1	1	2	2	4
Darwin Glass - - -	72	—	—	—	2	—	2	—	8	2	58
Darwin Glass (important) -	2	—	1	—	—	—	—	—	—	1	—
Gap at 10-mile - - -	15	—		—	1	—	1	—	1	4	8
E. Side N. Lyell Railway -	2	—	—	—	—	—	—	—	—	—	2
10-mile - - - - -	7	—		—	—	—	—	—	—	—	7
	331	8	1	5	8	2	17	4	39	23	224

The total weight of these 331 specimens was 191·05 grams, an average weight of ·57 grams. The three largest averaged 8·40 grams, and the three smallest ·06 grams.

The collection from the University of Queensland had a larger average size. It consisted of 41 specimens, classed as 2 broken phallics, 3 fasciated pieces, 3 lacework pieces, 1 stem-like specimen, 8 straight-cuts, 10 twisted and tubercled pieces, and 14 formless fragments. The total weight of these pieces was 66·1 grams, giving an average weight of 1·61 grams. These descriptive records are set down with no comment beyond an expression of opinion that quite different conditions prevailed at the time of origin of the various forms of Darwin Glass from those that prevailed when other accepted tektites were developed.

V STRAW SILICA GLASS

Not the least interesting of naturally occurring silica glasses are those found from time to time in the country, usually fairly scoriaceous but sometimes massive. This material varies from green to black and smoky-grey, and at times is found in large lumps up to 20-30 pounds in weight. Enquiry usually shows that the material has been found on or near the site where a straw-stack has been burnt. With the exercise of imagination one could have believed that this mode of formation might have entered into the story of the more obscure silica glasses, such as Libyan Glass and Darwin Glass.

Some pains were therefore taken to secure some of this material from various parts of South Australia. By the courtesy of the late Mr. L. J. Winton, acting head of the Mines Department, two analyses were made by Mr. F. L. Dalwood, and these are here placed on record. Mr. Dalwood records that owing to the presence of carbonaceous matter the ferrous iron could not be satisfactorily determined, and the whole of the iron is therefore set down as ferric oxide. The very high percentages of potash and soda put these glasses out of any possibility of relationship to tektite glasses, but they are, nevertheless, worthy of record:

Sample No. 1 No. 19189, Silica Glass from O.B. Flat, South Australia.
Sample No. 2 No. 19190, Silica Glass from Compton Downs, South Australia.

	19189	19190
Silica (SiO_2) - - -	66·04	57·40
Alumina (Al_2O_3) - - -	1·55	1·81
Ferric Oxide (Fe_2O_3) - -	0·59	0·59
Lime (Cao) - - - -	6·00	8·56
Magnesia (MgO) - - -	3·80	5·56
Potash (K_2O) - - -	11·98	13·58
Soda (Na_2O) - - -	6·88	8·98
Carbonaceous matter - -	2·69	3·16
	99·53	99·64

VI MISCELLANEOUS NOTES

Smoke Bombs and Sea-borne Bombs. From time to time descriptions have been given of the slag-bombs or smoke-bombs of impure silica-glass that are shot forth from the funnels of railway engines. These forms, in many ways, resemble the forms of australites, and contain many gas bubbles.

Following up this idea, Mr. W. Baragwanath, Government Geologist of Victoria, drew under my notice the fact that seekers of foraminifera in sea sands frequently found tiny siliceous spherules. Mr. W. J. Parr, an expert in foraminifera collecting, has kindly sent me a number of these spherules, tiny things, some of them much smaller than a pin-head, and exactly comparable with the spherules of silica-glass cast out from railway engines. Doubtless these come from the funnels of coal-burning steam-boats, and doubtless also they are to be found for the seeking where they have floated ashore on sea-coasts all over the world.

VII TEXAS TEKTITES

Tektites have been found in the United States of America in such goodly numbers as to suggest a fairly extensive shower, spread over an elliptical area east of the Brazos River, Texas. The discoverer, Professor Virgil E. Barnes, of the University of Texas, has sent me samples of this material, which I have compared microscopically with the other known tektites. A section of one of these specimens was kindly cut for me by Sir Douglas Mawson. These inspections and comparisons of external and internal structures show such definite similarities as to leave no doubt of the character of the material; the chemical analyses supplied by Professor Barnes confirm this.

The two analyses of Texan tektites, of which details were kindly forwarded to me by Professor Barnes, are as follows (F. A. Gonyer, analyst). It will be noted that the refractive indices and the specific gravities of the same specimens have also been determined. The results are as follows: *Specimen A*—SiO_2 73·52, Al_2O_3 15·88, Fe_2O_3 0·45, FeO 4·64, CaO 0·06, MgO 1·38, TiO_2 0·87, MnO 0·01, Na_20 1·30, K_2O, 1·73, H_2O 0·08. Total, 99·92. Nd. 1·052, S.G. 2·397. *Specimen B*—SiO_2 77·76, Al_2O_3 13·30, Fe_2O_3 0·37, FeO 3·36, CaO 0·04, MgO 1·19, TiO_2 0·76, MnO 0·01, Na_2O 1·41, K_2O 1·97, H_2O 0·02. Total, 100·19. Nd. 1·492, S.G. 2·357.

A full description of the Texas tektites has now been published by the University of Texas in their Contributions to Geology, 1939. The article is entitled "North American Tektites" and runs from page 477 to page 582, with five plates, a very complete bibliography, and many text figures. It is fortunate indeed that the first tektites to be found on the continent of North America should have come into the hands of one so interested and so able as Professor Virgil E. Barnes. The account he gives of the whole tektite question, with analyses, physical characters, distribution, etc., is the most comprehensive yet published in English. He calls the North American tektites "Bediasites," from the locality named after the Bedias tribe of Indians. One of his most interesting discoveries is the occurrence in tektites of remarkable lechatelierite inclusions.

The long history of the theories of the origins of tektites, as set out by Barnes, is a remarkably interesting comment upon the cautious resistance of the minds of men towards new theories regarding natural phenomena. Barnes's conclusion is that the tektites are fused shales or other sedimentary rocks. As the Bediasite area is an ellipse of not more than ten miles by five, it is possible to conceive of this explanation as being a reasonable one in that case.

The question of the australite distribution is, however, completely against the possibility of accepting such a theory. Australites, with their characteristic type forms, chemical composition, and physical characters, are spread over an area two thousand miles long by one thousand miles wide, and are found also on the off-shore islands, so that the actual strewnfield must have been far greater.

Within the past few years numerous cases have come under my notice of men in various Australian localities becoming interested in australites, finding first one, then half-a-dozen, and ultimately scores or hundreds. Australites are scattered over the southern two-thirds of Australia, in the densely-wooded and well-watered mountain areas, in the wide grasslands and in the vast desert areas. They are distributed over gneisses, schists, basalts, limestones, sands, clays, and every other variety of bed-rock which occurs throughout the southern two-thirds of Australia, including Tasmania. There must have been several million pieces in the original fall.

In the writer's opinion these facts of distribution, combined with the unique and regular form-types of australites, compel us to include them as extra-terrestrial objects without waiting for the more convincing evidence of an actual shower. The meteorite craters of Henbury, though within the australite area, are relatively trivial and quite unrelated to the occurrence or distribution of australites. Fulgurite tubes are occasionally found in Australia, but without relation to the occurrence and distribution of australites.

Barnes's concluding paragraph opens: "If, as practically all the evidence now indicates, tektites actually are proven to be fulgurites . . . ." This statement ignores the facts of form and distribution of the various tektite groups. It is difficult to imagine that lightning, which has no known regional characteristics, should produce only one kind of tektite over Australia, with its many scores of rock types, and quite other but equally distinct forms over Indo-China or Moldavia, with their relatively similar variety of rock types.

Barnes's chief argument against meteoritic origin appears to be that tektites are so much more siliceous than even the most siliceous stony meteorite. When one recalls the stubborn antagonism of scientific men to the acceptance of siderites as having fallen from heaven, the opposition to glass meteorites loses some of its force. In considering the occurrence of glass meteorites we should not forget the Schonite of Hof Kalna, Sweden, nor the so-called "glass meteorites" recorded by Brezina as having fallen in Halle, Saxony, in 1904, and at Igast, Livonia, in 1855. The Igast and Halle specimens are frequently quoted in tektite bibliographies, and the evidence on record has never, so far as I know, been refuted.

Barnes says it is safe to predict that the analysis of any tektite yet analysed may be duplicated by an analysis of a sedimentary rock. It is easy to believe this interesting statement, but there is no evidence that the prediction would have any important significance upon the problem of tektite origins. Barnes raises the question of tektites of past geological ages. The known ones range from Miocene to Recent. Speculations as to their existence in past geological epochs led me to discuss the matter with Dr. L. J. Spencer, who mentioned the possibility of destruction by devitrification. Barnes speaks of the truncation of external flow structure as revealing the amount of material removed (? by terrestrial erosion), and therefore the "age" of the specimen. The known facts concerning australites show that the case is not so simple as this. There is evidence of two periods involving the loss of material in australites during flight, or in some other preterrestrial phase, with, in most cases, subsequent terrestrial erosion. The results of all three may be detected in thin sections by their truncating or bending effects on the internal flow lines.

In concluding this section it is urged that, once the chemical and physical characteristics of tektite groups have been determined by competent authorities, showing that for any one regional group they are uniform within fairly narrow limits, then we should direct our enquiries to the evidence presented by their forms, sizes, external sculptures, internal structures, and distribution. So far as forms are concerned, one is impressed by the recurrence of type-forms in the larger collections of Moldavites at Prague and of Indo-Chinites at Paris in a way that is not possible from seeing a few specimens only.

The present job before students, it seems to me, is tentatively to accept tektites on the evidence of form, distribution, uniformity of composition, etc., as being glass meteorites, and to devote attention to a study of the details of their possible derivation and fall, so far as these may be revealed by physical examination and facts of distribution. If, meantime, someone observes a tektite shower, so much the better, but it surely requires more than normal scientific inertia to assume that the only possible method of proof of meteoritic origin is to await the observation of a fall.

If, on the other hand, evidence is brought forward against the meteoric theory, it will be properly considered and evaluated. Of the multitude of theories put up during more than a century of enquiry, the meteoric one stands alone in the support it has received; the present evidence is, indeed, so much in favour of the extra-terrestrial origin of tektites that in the opinion of many workers it just falls short of proof.

DESCRIPTION OF PLATE XIX

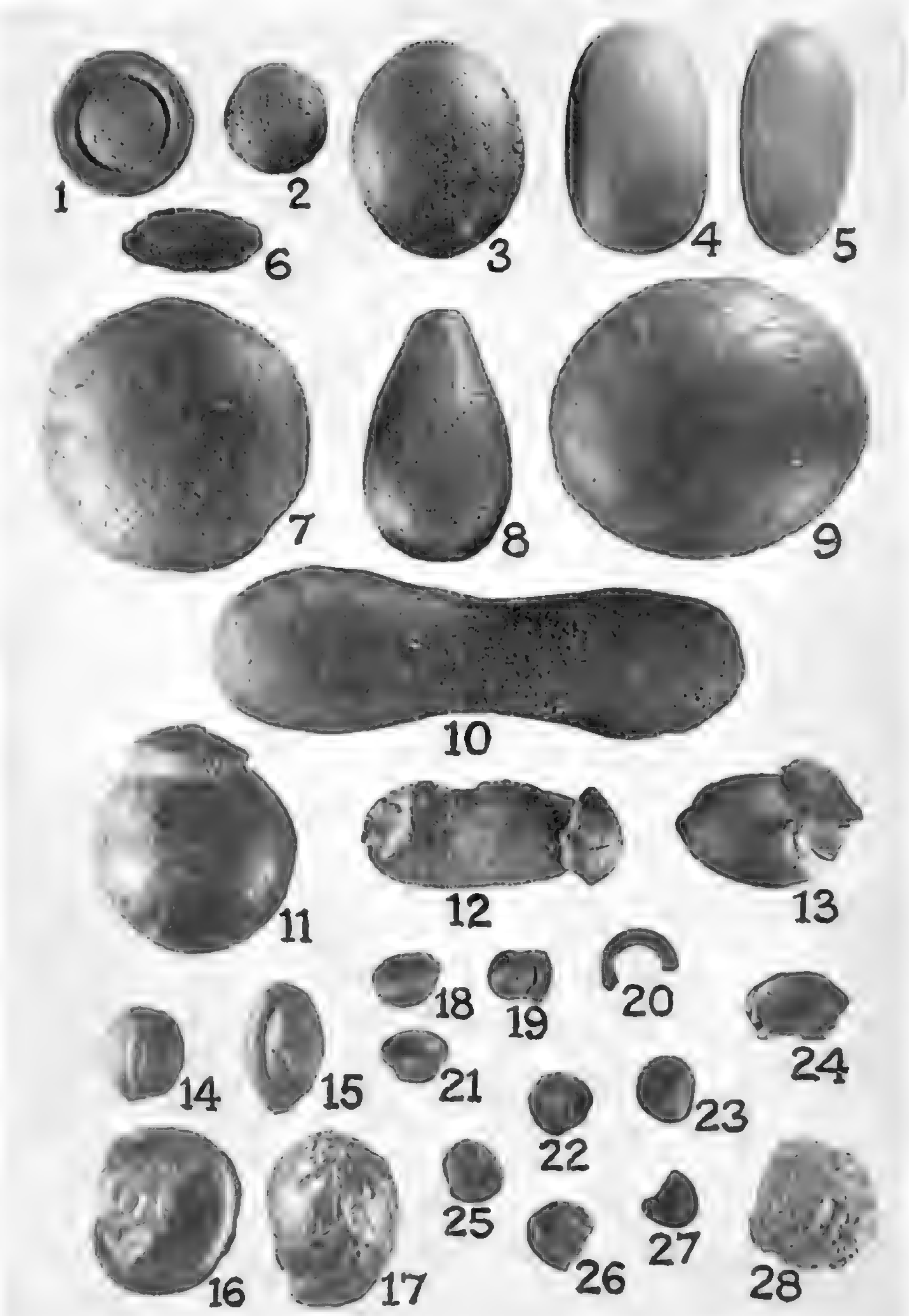
I am indebted for the photograph to the authorities of the South Australian Museum. In this plate the specimens are shown natural size. They consist of a selection of: (a) ten of the most typical specimens of the collection, (b) seventeen exceptional or aberrant specimens, and (c) one Texan tektite from Professor Barnes's collection. The numbering is as follows:

1, flanged button; 2, lens; 3, broad oval; 4, narrow oval; 5, boat; 6, canoe. (Numbers 1-6 are average-sized specimens.)

7, lens core; 8, teadrop; 9, broad oval core; 10, dumbbell. (7, 8, 9, and 10 are larger than the average specimens.)

11, round indicator; 12 and 13, elongate indicators. (The three foregoing specimens are cores in which portion of the original form remains, sufficient to indicate the original shape and size.)

14, seed type; 15, pasty type; 16, exceptional, irregular, flanged button; 17, the end of a curiously flow ridged teardrop; 18 and 21, helmet forms; 19, exceptional small flanged button, broken; 20, two-thirds of a button flange, detached; 22 and 27, small, scoop-like forms, unbroken; 23, 24, 25, and 26, flat, tray-like forms; 28, Bediasite from Virgil Barnes.



Typical Australite forms, Kennett Collection. Natural size.

THREE NEW SPECIES OF ISOCHAETOTHRIPS FROM AUSTRALIA

By H. VEVERS STEELE [1]

Summary

Family THRIPIDAE Uzel

Subfamily THRIPINAE Karny

Genus ISOCHAETOTHRIPS Moulton

This genus, *Isochactothrips*, was erected by Moulton in 1928. He separated it from *Taeniothrips* Uzel by the fully developed wings, in which both veins of the forewing have regularly spaced spines. *Physothrips seticollis* Bagnall, 1915, is the type of the genus.

THREE NEW SPECIES OF ISOCHAETOTHRIPS FROM AUSTRALIA

By H. Vevers Steele[1]

[Read 8 August 1940]

Family THRIPIDAE Uzel

Subfamily THRIPINAE Karny

Genus Isochaetothrips Moulton

This genus, *Isochaetothrips,* was erected by Moulton in 1928. He separated it from *Taeniothrips* Uzel by the fully developed wings, in which both veins of the forewing have regularly spaced spines. *Physothrips seticollis* Bagnall, 1915, is the type of the genus.

Isochaetothrips frankstoni sp. n.

♀ *Length,* 1160 μ; width of mesothorax, 265 μ. *Colour*—Yellow with slight reddish subcuticlar colouration. The end of the mouth-cone, two longitudinal bands on the mesoscutum, a spot on each side of abdominal segments III-VII are tinged faintly with grey-brown. Abdominal segment X also tinged with grey-brown. Spines on the head, pale yellow. Other spines and fringes, pale greyish-brown. Fore-wings, pale yellowish-grey. Hind-wings, clear. Antennal segments: I, pale yellow; II and III, pale yellowish-grey; IV-VIII, grey; III to VI, paler at the base. Ocellar crescents, red. Eyes, black. Legs, pale yellow with tinge of brown on tarsi. *Head*—Length, 90 μ; width, 150 μ. Dorsal surface (fig. 1 A): cuticle crossed by a few faint confluent transverse striae; eyes, 51 μ long and 44 μ wide, not projecting; interocellar bristles, 5 μ long, are between posterior ocelli; other bristles short and only visible under high power. Ventral surface: the distance from the most anterior part of head to tip of mouth cone, 206 μ; two bristles posterior to each antenna, inner 19 μ and outer 9 μ; a bristle on each side anterior to the mouth cone, 22 μ. Antennae (fig. 1 B) 8-segmented; respective lengths of antennal segments, 23, 31, 39, 34, 27, 36, 7, 12 μ. A forked sense cone is present on the dorsal surface of III and the ventral surface of IV. *Prothorax* (fig. 1 A)—Dorsal surface: 110 μ long and 197 μ wide; two bristles on each post-lateral angle of pronotum, outer 35 μ and inner 40 μ; the posterior margin bears four short, fine bristles between the post-lateral bristles and the median line, the median, 27 μ, is the stoutest; short, fine bristles scattered over pronotum as in fig. 1 B. *Pterothorax*—Three pairs of short, fine bristles on posterior margin of mesoscutum; two pairs on metascutum I (fig. 2 A) placed about 12 μ posterior to anterior margin, a fine outer pair 17 μ and a stout inner pair 39 μ. Legs with a few scattered fine bristles; distal half of hind tibiae with a row of short spines on their inner margins. Foretarsus without claw. *Wings* (fig. 2 B)—Fore-wing, 558 μ long; anterior margin bears 22-28 short spines 29 μ long interspersed with longer, finer bristles; anterior vein bears 15-19 bristles 27 μ long; posterior vein bears 14 bristles in all but one specimen, in this there are 11 bristles; alula bears six bristles. A long fringe, about 335 μ, on the posterior margin. *Abdomen* (fig. 1 C)—Dorsal surface: tergite VIII bears a comb containing about 16 teeth on posterior margin. Passing antero-posteriorly on segment IX, bristle I measures 26 μ, II 88 μ, III 80 μ, IV, 72 μ; segment X, bristle V 70 μ, VI 66 μ.

[1] Mrs. H. G. Andrewartha.

♂ (specimen damaged). *Length*, 920 μ; width of mesothorax, 118 μ. *Colour*—Paler than in female; antennal segments I and II pale yellow, III and IV pale grey-brown but paler at the base, V-VIII grey-brown. Mouth cone and tip of tarsi tinged with grey-brown. *Head*—90 μ long and 136 μ wide; respective

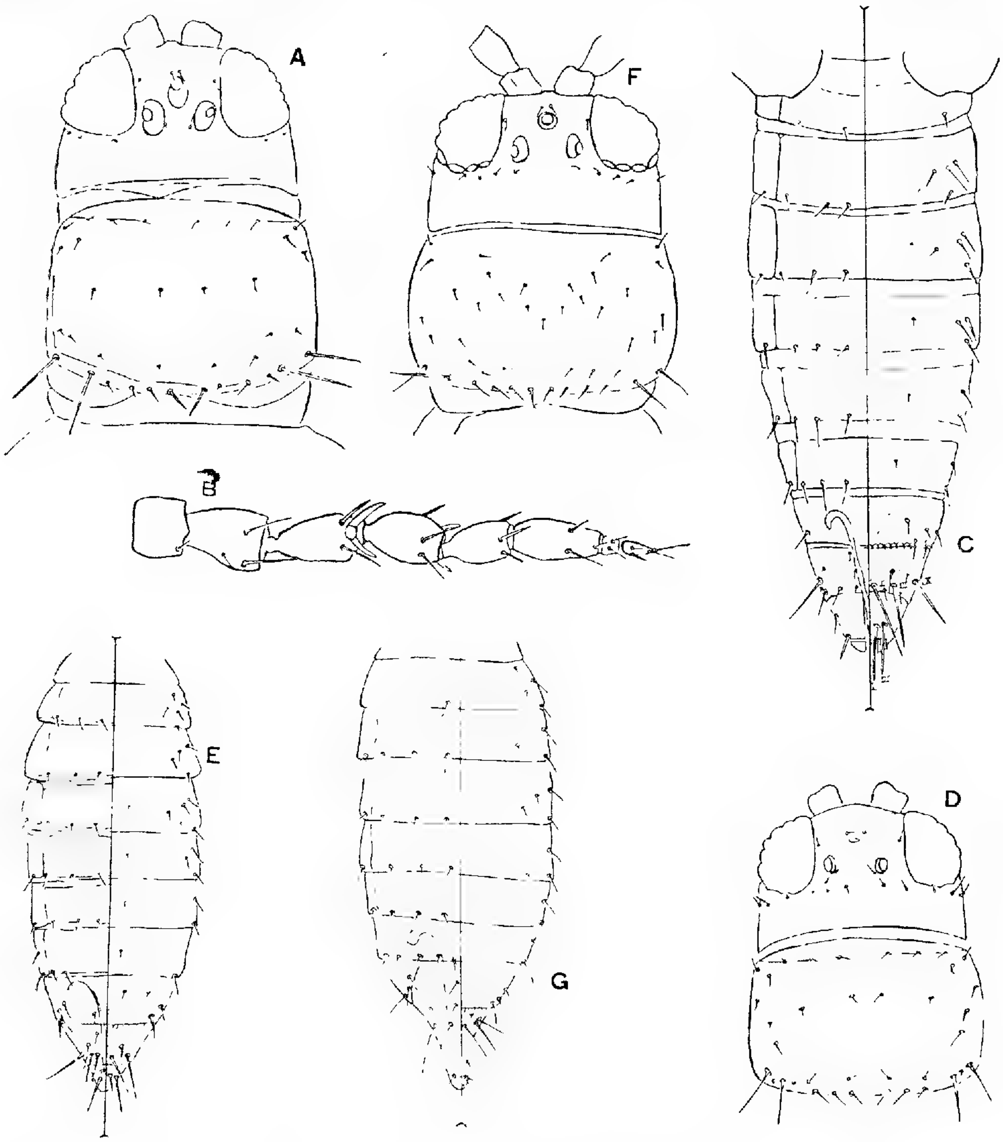


Fig. 1

A-C, **Isochaetothrips frankstoni** n. sp.—A, ♀, head and prothorax, dorsal; B, ♀, antenna, dorsal; C, ♀, abdomen, right dorsal and left ventral. D-E, **I. pallidus** n. sp.—D, ♀, head and prothorax, dorsal; E, ♀, abdomen, right dorsal and left ventral. F-G, **I. melanurus,** n. sp.—F, ♀, head and prothorax, dorsal; G, ♀, abdomen, right dorsal and left ventral.

lengths of antennal segments, 19, 31, 36, 31, 29, 34, 7, 7 μ. Eyes 53 μ long and 48 μ wide. *Prothorax*—122 μ long and 180 μ wide. *Wings*—Fore-wing, 500 μ long; anterior margin bears 24 short bristles 12 μ long interspersed with longer, finer bristles; anterior vein bears 16 bristles and posterior vein 13 bristles; alula

6 bristles. Hind-wing normal. *Pterothorax*—Spines on metascutum I placed about 36 μ posterior to anterior margin. *Abdomen*—Dorsal surface (fig. 2 D): tergite IX bears some fine bristles and three pairs of long, strong bristles, I is 49 μ long, II 19 μ long, and III 22 μ long. Tergite X bears one pair of long, strong curved bristles, VI 62 μ long, and some fine bristles. Ventral surface (fig. 2 C) has a faint transverse sole-shaped area on sternites III to VII; posterior margin of segment IX bears a strong curved bristle about 45 μ on each side of

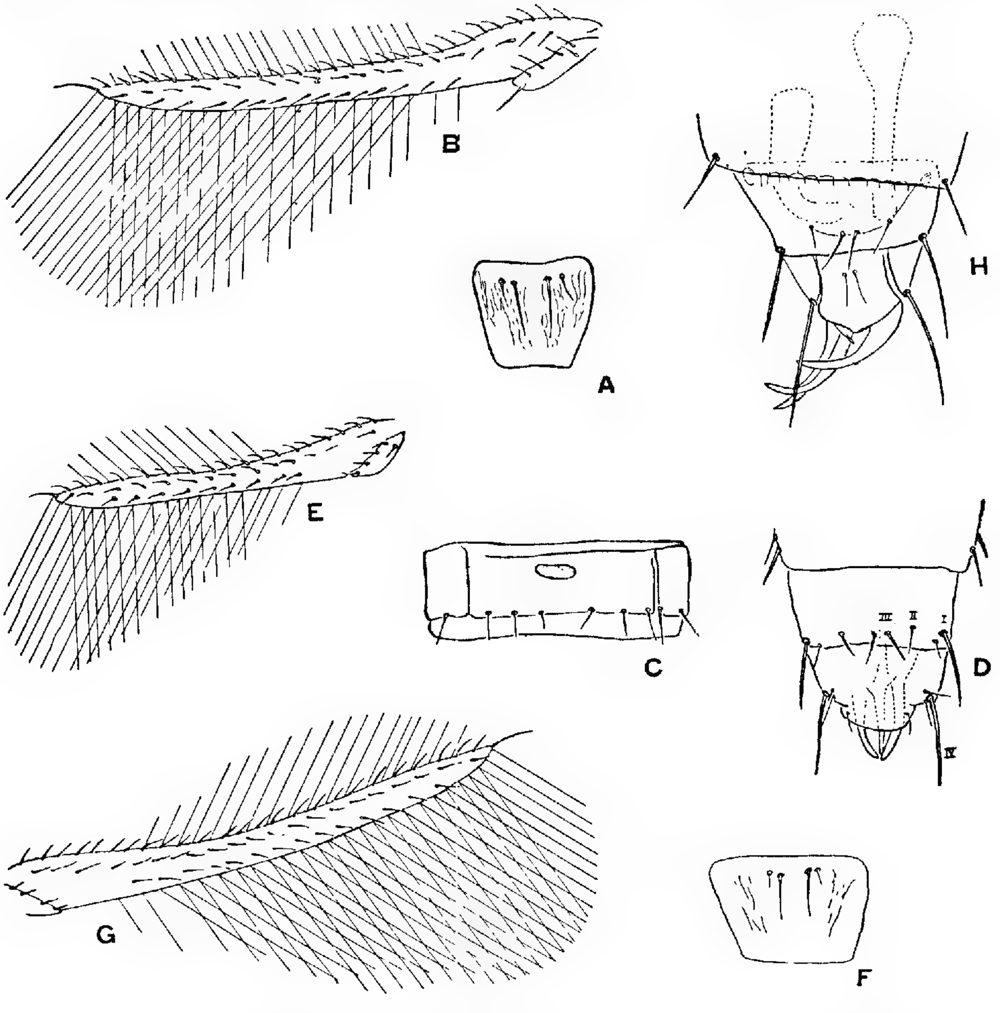


Fig. 2

A-D, **Isochaetothrips frankstoni** n. sp.—A, ♀, metascutum I; B, ♀, forewing; C, ♂, third abdominal segment, ventral; D, ♂, end of abdomen, dorsal. E-F, **I. pallidus**, n. sp. —E, ♀, forewing; F, ♀, metascutum. G H, **I. melanurus**, n. sp.—G, ♀, forewing; H, ♂, end of abdomen, dorsal.

median line and two near each lateral margin, outer 32 μ and inner 41 μ. Segment X bears a strong bristle, 62 μ long, on post-lateral angle.

Habitat—The specimens were collected from *Acacia* sp. at Frankston, Victoria, by Mr. H. G. Andrewartha on 16 May 1935.

The description was made from eight ♀ and one ♂, the latter damaged. The ♀ syntypes and the ♂ allotype have been deposited in the South Australian Museum.

Isochaetothrips pallidus sp. n.

♀ *Length*, 860 μ; width of mesothorax, 195 μ. *Colour*—Pale yellow. Head yellow, tinged with grey. Mouth cone tipped with brown. Antennal segments I and II almost colourless to pale greyish-yellow, II clouded with brownish-grey at distal end, III-VIII brownish-grey. Eyes reddish-black; ocellar crescents same colour as head and scarcely visible. Fore-wings pale yellow, hind-wings colourless, fringes yellow. Legs yellow, tarsi tinged with brown at distal end; spines greyish. *Head*—Length, 86 μ; width, 132 μ. Dorsal surface (fig. 1 D): cheeks straight; eyes 49 μ long and 44 μ wide, not projecting; cuticle crossed by faint confluent transverse striae; ocellar crescents scarcely visible; inter-ocellar bristles 9 μ at the posterior median border of each posterior ocellus; see fig. 1 D for placing of small bristles. Ventral surface: two pairs of bristles between the eyes, anterior median pair 19 μ and posterior lateral pair 13 μ, the latter placed about 39 μ posterior to anterior-median corner of eye. Two pairs of bristles posterior to the mouth cone. Length from anterior part of head to tip of mouth cone 170 μ. Antennae 8-segmented; respective lengths of antennal segments, 21, 29, 33, 25, 27, 37, 5, 9 μ. A curved sense cone is present on the dorsal surface of III and the ventral surface of IV. *Prothorax*—Dorsal surface (fig. 1 D): Length, 112 μ; width, 154 μ. Two strong bristles on each post-lateral angle. outer 26 μ and inner 31 μ. A small fine bristle between these two, three strong short bristles between post-lateral bristles and median line on posterior margin. *Pterothorax*—Four pairs of short fine bristles on posterior border of mesoscutum; two pairs on metascutum I (fig. 2 F) 12 μ from the anterior margin, fine outer bristle 17 μ, strong inner bristle 27 μ. Legs with scattered fine hairs. Lateral border of hind tarsi I bears a short spine at the base. Tarsi II bears a hook. *Wings* (fig. 2 E)—Fore-wing 430 μ long; anterior margin bears 16-20 bristles 27 μ long, interspersed with about 12 longer finer bristles; anterior vein bears 13-16 bristles; posterior vein bears 7-9 bristles, alula 5. Hind-wing normal. *Abdomen* (fig. 1 E, dorsal and ventral).—Dorsal; tergite VIII bears a sparse comb containing about 13 teeth 11 μ long. Tergite IX bears two strong bristles on posterior margin. Outer 74 μ long and inner 70 μ long. Segment X on each side bears two strong bristles, outer 45 μ and inner 54 μ.

Habitat—This description was made from three females collected from *Cassinia longifolia* by H. V. Steele at Kalorama, Victoria, 28 September 1932. The syntypes are deposited in the South Australian Museum.

Isochaetothrips melanurus sp. n.

♀ *Length*, 1039 μ; width of mesothorax, 242 μ. *Colour*—Head yellow, tinged with pink; thorax and abdomen bright yellow; posterior half of tenth abdominal segment brown. Legs yellow, tip of tarsi tinged with brown. Fore-wings pale greyish-yellow, and hind-wings yellowish. Eyes black; ocellar crescents red. Antennal segments: I pale greyish-yellow, II-VIII yellowish-brown, II-V pale at base, II sometimes darker than III and IV. Spines and fringes brownish-yellow. Spines on abdominal segment IX and X brown. *Head*—Length 95 μ, width 153 μ. Dorsal surface (fig. 1 F): cheeks straight; cuticle crossed by faint confluent transverse striae, a well marked ocellar area; eyes 54 μ long and 41 μ wide, not projecting, inner angle rounded. Minute inter-ocellar bristles on median edge of each posterior ocellar crescent. Small bristles as in fig. 1 F. Ventral surface: distance from anterior part of head to tip of mouth cone 179 μ. Two bristles posterior to base of each antenna, inner 27 μ and outer 27 μ. A long bristle at post-median corner of eye, 31 μ. There are two bristles on each side anterior to mouth cone. Antennae 8-segmented; respective lengths of antennal segments, 24, 34, 41, 36, 28, 36, 7, 10 μ. A forked sense cone is present on dorsal surface of III and ventral surface of IV. *Prothorax*—Length, 109 μ; width, 180 μ. Dorsal surface (fig. 1 F), two strong bristles on each post-lateral angle, inner 39 μ, outer 29 μ; four short bristles on the posterior margin on each side of median line, the median is the longest, 14 μ; short fine bristles scattered over the pronotum, as in figure. *Pterothorax*—Three pairs of fine bristles on mesoscutum; two pairs just posterior to the anterior margin on metascutum I, outer 22 μ and inner 39 μ. Legs with scattered short, fine hairs. Tarsi of hind leg bear spines stronger than in *Isochaetothrips frankstoni* and *pallidus*. Distal half of hind tibia with a row of short spines on its inner margin. Fore-tarsi without claws. *Wings* (fig. 2 G)—Fore-wing 640 μ long; anterior margin bears 26 short bristles interspersed with longer finer bristles, anterior vein with 20-22 bristles 24 μ long and posterior vein 13-14 bristles, alula 6 bristles. Hind-wing normal. *Abdomen* (dorsal and ventral surfaces, fig. 1 G)—Last segments of abdomen and the ovipositor elongated and, therefore, the posterior part of the abdomen is more pointed than in *Isochaetothrips frankstoni* and *pallidus*. Tergite VIII bears a sparse comb; two strong bristles on posterior border of tergite IX, outer 70 μ and inner 61 μ long; a strong bristle on tergite X, 56 μ long.

♂ *Length*—826 μ long, width of mesothorax 218 μ. *Colour*—Same as in the female, except that the posterior part of the abdomen is yellow and antennae paler in colour. *Head*—Length 87 μ, width 142 μ, respective lengths of antennal segments, 19, 32, 39, 34, 27, 36, 5, 10, μ. *Prothorax*—Length 107 μ, width 161 μ. length of posterior lateral bristles, outer 29 μ and inner 35μ, median 18 μ. *Wings*—Anterior border bears 24-27 short bristles interspersed by longer finer bristles; anterior vein bears 19-20 bristles and posterior vein 14 bristles, alula 6 bristles. Hind-wing normal. *Abdomen* (dorsal surface, fig. 2 H)—Tergite VIII bears a sparse comb; tergite IX bears two short, strong bristles near the median line, inner 24 μ and outer 12 μ, also a strong bristle on post-lateral angle 54 μ; tergite X bears short bristles near median line 17 μ, and long, strong bristles on post-lateral angles 73 μ. Ventral surface: sternite IX bears two long curved bristles on each side near posterior margin, one near median line 44 μ and one near lateral margin 39 μ; sternite X bears one strong bristle on post-lateral margin 63 μ long.

Habitat—This species was collected from *Acacia dealbata* by H. V. Steele 13 September 1933, at Kalorama Victoria.

The description was made from four ♀ and three ♂. The syntypes were deposited in the South Australian Museum.

Acknowledgments

The author desires to thank the Director and Mr. H. Womersley, of the South Australian Museum, for facilities to do this work, as well as advice throughout the work; also the Director of the Melbourne Museum for the loan of the Kelly collection.

A NEW TERMITOPHILOUS COLLEMBOLAN FROM SOUTH AUSTRALIA

By H. WOMERSLEY, South Australian Museum

Summary

In 1934 1 described a new genus and species of Collembola, *Isotobrya wheeleri* found in the nests of termites under tones at Mullewa, Western Australia. It has not since been seen, but recently my elder son has collected the following second species of the genus, again from the nests of termites, on Mount Sugarloaf at Burra, South Australia.

A NEW TERMITOPHILOUS COLLEMBOLAN FROM SOUTH AUSTRALIA

By H. Womersley, South Australian Museum

[Read 8 August 1940]

In 1934 I described a new genus and species of Collembola, *Isotobrya wheeleri* found in the nests of termites under stones at Mullewa, Western Australia. It has not since been seen, but recently my elder son has collected the following second species of the genus, again from the nests of termites, on Mount Sugarloaf at Burra, South Australia.

The genus seems, therefore, to be definitely associated with termites, but in both cases the specimens are rare. From Mullewa, although about four or five specimens were seen, only two were captured. At Burra, in spite of examining many hundreds of nests, about a dozen specimens only are available for study.

Isotobrya burraensis n. sp.

Description—Length, to 3mm. Colour entirely deep blue-black, antennae and eye-patches black, legs blue except tibiotarsi which are white, furca blue

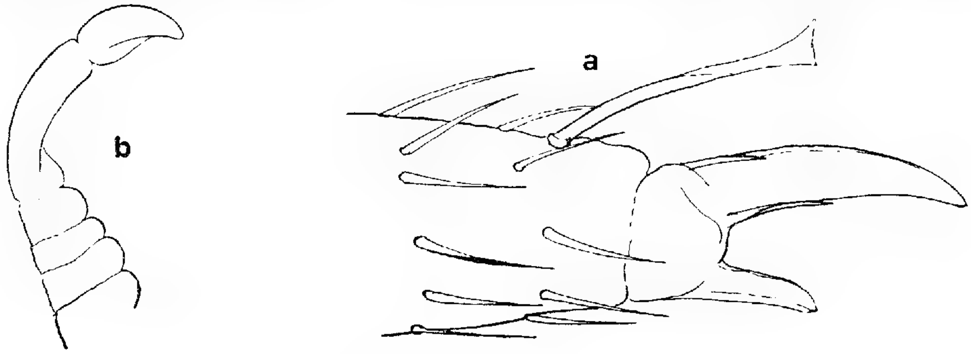


Fig. a-b

except mucrodens which are white. Ocelli, eight on each side. Antennae nearly four times as long as head diagonal; ratio of segments: 15 : 20 : 20 : 30, IV with apical exsertile knob. Ratio of dorsal lengths of thoracic and abdominal segments: th. II : III : abd I : II : III : IV : V : VI = 24 : 17 : 12 : 17 : 15 : 45 : 11 : 4. Legs normal, tibiotarsi (fig. a) with only a single very stout twisted spathulate tenent hair; claws with a pair of inner basal teeth to one-third and a pair of outer lateral basal teeth; empodium as figured, short, almost stump-like. Furca normal, reaching middle of abdomen II; mucro short (fig. b), falciform with inner basal lamella, without spine.

Clothing of short setae, with longer ciliated setae, somewhat clavate on the head and thoracic segments; these latter setae up to 300 μ long.

Habitat—Rare, in nests of termites, Mount Sugarloaf, Burra, South Australia, May to August 1940 (J. S. W.).

Remarks—This species is closely related to the genotype, *I. wheeleri*, the essential difference being in the dentition of the claws and in there being only a single thick spathulate tibiotarsal tenent hair, as compared with four slenderer ones in the genotype.

LARVAL TREMATODES FROM AUSTRALIAN FRESHWATER MOLLUSCS PART VII

By T. HARVEY JOHNSTON and L. MADELINE ANGEL, University of Adelaide.

Summary

Cercaria (Furcocercaria) trichofurcata n. sp.

Though several hundreds of the bivalve *Corbiculina angasi* (Prime) from the lower Murray River at Tailem Bend had been under observation prior to 7 February 1940, cercarial infection had not been detected. On that date, one specimen of the 243 collected was found to be giving off a large fork-tailed cercaria of a type quite new to us. It was seen subsequently in one of 840 on 26 February 1940, one of 289 on 8 March 1940, and in one of 70 on 1 May 1940. Even to the naked eye it appeared distinct from other furcocercariae observed by us. For a second or two the cercaria swims upwards rapidly, and then comes to rest with the body spherical and suspended by the furcae which form an angle of about 140° with each other, while the tail stem is vertical. In this resting state the spherical form of the body is more obvious than is usual with furcocercariae. From this position it sinks slowly until it is nearly at the bottom of the tube, when it swims upwards again. Examined under a cover-slip, the cercaria may draw up one of the furcae into a position more or less parallel with the main tail stem; both the furcae may become curved upwards and inwards so that the organism has somewhat the appearance of an anchor (fig. 5); or the body may be bent over to lie on the tail stem.

LARVAL TREMATODES FROM AUSTRALIAN FRESHWATER MOLLUSCS
PART VII

By T. Harvey Johnston and L. Madeline Angel, University of Adelaide

[Read 8 August 1940]

Cercaria (Furcocercaria) trichofurcata n. sp.

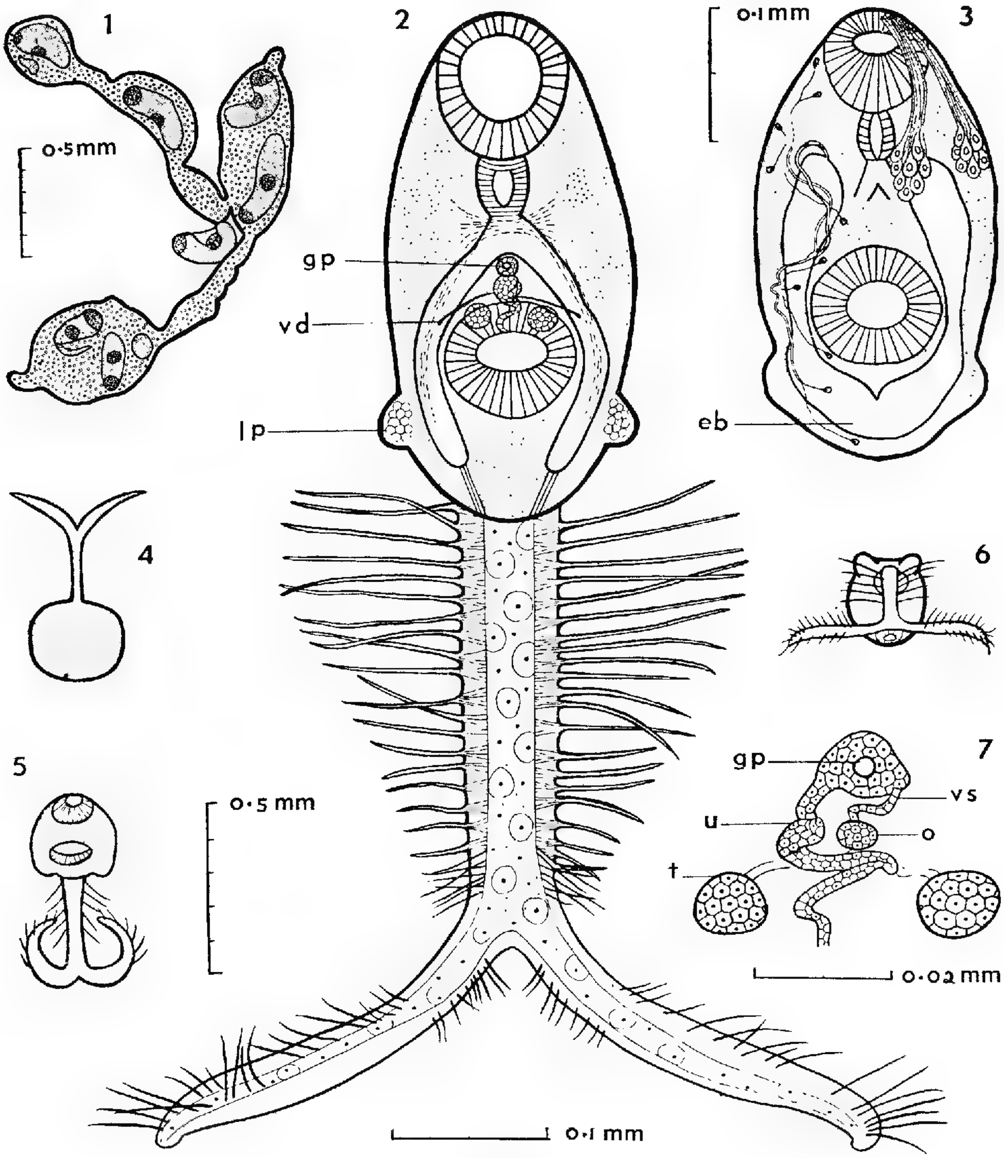
Though several hundreds of the bivalve *Corbiculina angasi* (Prime) from the lower Murray River at Tailem Bend had been under observation prior to 7 February 1940, cercarial infection had not been detected. On that date, one specimen of the 243 collected was found to be giving off a large fork-tailed cercaria of a type quite new to us. It was seen subsequently in one of 840 on 26 February 1940, one of 289 on 8 March 1940, and in one of 70 on 1 May 1940. Even to the naked eye it appeared distinct from other furcocercariae observed by us. For a second or two the cercaria swims upwards rapidly, and then comes to rest with the body spherical and suspended by the furcae which form an angle of about 140° with each other, while the tail stem is vertical. In this resting state the spherical form of the body is more obvious than is usual with furcocercariae. From this position it sinks slowly until it is nearly at the bottom of the tube, when it swims upwards again. Examined under a cover-slip, the cercaria may draw up one of the furcae into a position more or less parallel with the main tail stem; both the furcae may become curved upwards and inwards so that the organism has somewhat the appearance of an anchor (fig. 5); or the body may be bent over to lie on the tail stem.

In formalinised material the body was slightly curved, but was easily flattened with the slight pressure of a cover-slip. The measurements of such specimens are: body, 276-384 μ long by 175-192 μ wide (average, 314 by 184 μ); tail stem, 267-301 μ by 63-71 μ (average, 284 by 67 μ); furcae, 234-284 μ by 33-42 μ (average, 250 by 38 μ); sucker ratio, oral:ventral = 6:7.

Of the stains used intravitam, orange G was the best. Neutral red, and the use of nile blue sulphate after neutral red, were also satisfactory. For permanent preparations, alum carmine gave the best results.

The tail stem is long, with furcae of approximately the same length as the main stem. The most noticeable feature of the cercaria is the presence of many long stout hairs or bristles on the tail, arranged on either side of the main stem. These are longest near the body of the animal (where the greatest length was 125 μ), and gradually diminish in size as they approach the junction of the furcae. Towards the distal end of the tail stem, on either side of the midline on the dorsal surface, is a collection of nine or ten finer, shorter hairs. On the furcae themselves, the setae are finer, shorter, and more hair-like, and are arranged differently; there are two rows which, instead of being placed laterally, take a somewhat oblique course on the dorsal and ventral surfaces respectively, the rows terminating near the tip of the corresponding furca. The two rows ending together give the appearance of a bunch of longer setae arising from the tip of the furca—the other setae being necessarily less obvious because of their dorsal and ventral positions. A third row, shorter in length, and composed of still smaller setae, commences on the inner side near the junction of the two furcae; it is not quite lateral, and the hairs are directed slightly backwards. In mounted specimens the edges of the tail stem are nearly always folded over, dorsally and ventrally respectively, so that the setae appear at first sight to arise near the midline. This may indicate that, in swimming, the tail is twisted slightly. Longitudinal and transverse muscle fibres are present in the tail, and from the base of each "bristle" a small number of fibres radiate out to terminate around the main excretory canal (fig. 2). No caudal bodies were seen.

The body of the cercaria is beset with very small spines, regularly arranged. Near the posterior end of the body are two locomotor processes, situated dorsally



Figs. 1-7

Cercaria trichofurcata. Fig. 1, sporocyst with escaping cercaria; 2, 3, cercaria, anatomy; 4, cercaria, resting position; 5, 6, cercaria at rest, under coverslip; 7, genital system. Figs. 4, 5, 6, to same scale.

a, ventral sucker; act, anterior collecting tubule; b, brain; cg, cutaneous glands; eb, excretory bladder; ep, excretory pore; gp, genital pore; gr, genital rudiment; lp, locomotor process; o, ovary; pct, posterior collecting tubule; sdr, sex duct rudiment; t, testis; u, uterus; vd, vas deferens; vs, vesicula seminalis.

and projecting slightly. They have a definite cellular structure which stains deeply with neutral red, as well as with haematoxylin and other permanent stains. The surface is roughened.

There is a pronounced acetabulum which is slightly larger than the oral sucker, and is beset with tiny papilla-like elevations.

Eye-spots and prepharynx are absent. The pronounced muscular pharynx is succeeded by a very short oesophagus. The intestinal crura extend well back towards the posterior end of the body. Muscle fibres pass from the lower end of each crus to the base of the body, on either side of the origin of the tail.

The gland cells seem to be arranged in two groups on each side, and lie at the hinder level of the pharynx, the inner group reaching the point of bifurcation of the intestinal crura, while the outer group does not extend so far. The inner group is perhaps composed of an anterior dorsal and a posterior ventral group. The cells themselves are small, and number eight, or probably more, to each group. They stain with neutral red used intravitam, but in formalinised specimens do not take up chlorazol black, showing that they have no glycogen. The ducts of the cells pass laterally to the anterior border of the oral sucker.

The excretory bladder is relatively very large, the hinder part occupying the greater portion of the posterior end of the body. It is bifurcated, and the two arms narrow as they pass laterally to the acetabulum, and then broaden out again towards their termination near the posterior level of the pharynx. On each side there are five flame cells in the posterior, and five in the anterior, half of the body. At the junction of the posterior and anterior collecting tubules is a small dilatation. Ciliary patches were seen only where each main collecting tube joined the bladder. The bladder continues into the tail as a wide channel occupying about half the diameter, and terminating close to the tip of each furca. In mounted specimens the portion of the bladder in the tail may appear only as a narrow tube. There are no flame cells in the tail.

Staining with orange G, as well as with nile blue sulphate following neutral red, showed a band of nervous tissue just behind the pharynx and a nerve cord extending from it down each side of the body near the corresponding crus almost to the posterior end.

The reproductive rudiments of *C. trichofurcata* have attained considerable differentiation. Near the anterior border of the acetabulum are two small rounded masses of cells lying at approximately the same level. These apparently are the testes. Anterior to the acetabulum, and median, is a thickened mass of cells, the future cirrus sac, which communicates with the ventral surface by an obvious genital pore. From this region a thick cord of cells, the uterus, twists posteriorly and becomes no longer recognisable just behind the testes. The ovary is represented by one or more small compact masses lying near the coils of the uterus immediately posterior to the cirrus sac. From each testis a faintly discernible cord of cells passes across ventrally to the uterus, and the anlagen of the common duct can be seen, anterior to the ovary, passing to the cirrus sac. On each side a very fine structure, presumably the rudiment of the vitelline duct, has its origin in the region of the intestinal crus, then crosses just in front of the corresponding testis, and becomes unrecognisable in the ovarian region.

The numerous, branching, dark grey sporocysts are scattered throughout the body of the mollusc, occurring in the gills, liver and reproductive gland. They vary a good deal in size, fig. 1 being taken from one of medium size. Because of opacity due to abundance of tiny globules, the contained cercariae can be seen only when pressure is put on the cover-slip. Even then the suckers were the only feature seen clearly.

In the search for the secondary intermediate host of *C. trichofurcata*, negative results were obtained after subjecting the following animals to infection: tadpole, *Lymnodynastes* sp.; leech, *Glossiphonia* sp.; yabby, *Cherax destructor* Clark; freshwater amphipods, *Chiltonia subtenuis* (Sayce); mosquito larvae; chironomid larvae; larvae of the fly, *Eristalis tenax;* water bugs, *Agraptocorixa eurynome* (Kirkaldy); gastropods, *Plotiopsis tatei* and *Ameria pyramidata;* lamellibranchs, *Hyridella australis* and *Corbiculina angasi; Tubifex* sp.; as well as the fish, *Gambusia affinis* and *Carassius auratus.* We observed cercariae being eaten by *Gambusia* and *Cherax.* After a number of *Corbiculina* and some *Hyridella* had been left over-night in a dish containing one of the former infected with *C. trichofurcata,* five of the *Corbiculina* and one *Hyridella* appeared to be giving off cercariae. That is to say, when these molluscs were isolated in tubes containing fresh water, several cercariae appeared in each tube. Since these particular molluscs were subsequently found (by dissection) to be uninfected, it appears that they must have been harbouring the cercariae, probably in the mantle cavities. This also affords additional evidence that *Hyridella* and *Corbiculina* do not act as secondary intermediate hosts.

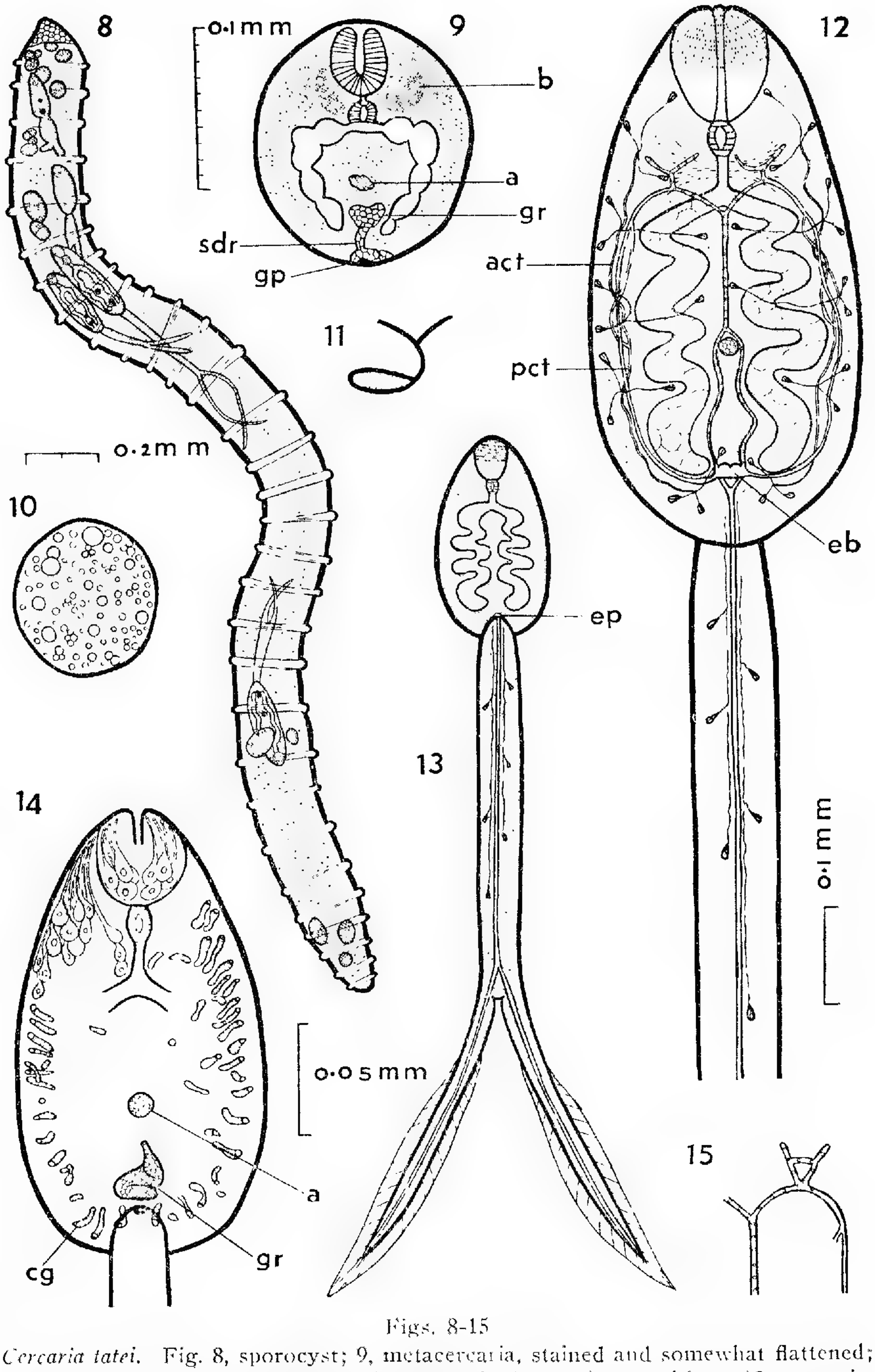
Cercaria trichofurcata does not belong to the Strigeoidea, as at present defined. It is not a Schistosome, because of the well-developed pharynx, and it is not a Strigeid because of the position of the genital pore anteriorly to the acetabulum. Miller (1926, 69) states that it is only the apharyngeal brevifurcata monostome group of furcocercariae in which flame cells are absent in the tail, but *C. trichofurcata,* which also has no flame cells in the tail, obviously does not belong to that group. A number of furcocercariae have been described as possessing "tactile hairs" or "scattered spines," or as having a "spiny tail," but none of them is suggestive of *C. trichofurcata* with its long, stout, densely placed tail spines. The possession of locomotor processes in this cercaria is also an outstanding character.

The general anatomy of *C. trichofurcata* resembles that of *Tandanicola bancrofti* Johnston, 1927, from the swim-bladder of the freshwater catfish *Tandanus tandanus* Mitchell, in the relative sizes of the suckers, the form of the excretory bladder, the absence of a prepharynx, the general form of the alimentary system, the bilateral arrangement of the testes with the ovary median and in advance of the former, the position of the testes in relation to the anterior border of the acetabulum, and in the position of the genital pore anteriorly to the acetabulum. The resemblance is so close that we think it likely that *Tandanicola* is the adult stage of the cercaria.

The fact that all endeavours to trace the secondary intermediate host of the cercaria have been unsuccessful, combined with the relatively advanced development of the reproductive system in the cercaria, may suggest that the cyst stage is omitted in the life cycle, and that infection of the fish occurs by direct penetration of the cercaria, possibly through the gills or even by the alimentary canal.

Cercaria (Furcocercaria) tatei n. sp.

Cercaria tatei, a parasite of *Plotiopsis tatei* (Brazier), at Tailem Bend, Lower Murray River, was first discovered in April 1939, when one of 287 specimens of the gastropod was infected with it. This molluscan species was not examined again until last February, when two of 535 specimens were observed to be infected. Of these, one continued to give off cercariae for a little more than two months. On 1 May 1940, one of 132 specimens collected was parasitised by it. This snail exhibited double infection, *C. plotiopsis* Johnston and Simpson 1939, a Heterophyid, also being present.



Figs. 8-15

Cercaria tatei. Fig. 8, sporocyst; 9, metacercaria, stained and somewhat flattened; 10, cyst, partly under pressure; 11, cercaria in resting position; 12, cercaria, living, compressed; 13, cercaria formalinised with boiling 10% formalin (note difference in size from fig. 12, which is of living cercaria); 14, gland cells of cercaria; 15, anterior portion of excretory system of cercaria showing modification seen in two specimens. Fig. 8, 10, to same scale; fig. 12, 13, 15.

The cercaria swims tail first for a few seconds and then hangs suspended by the furcae with the body bent to form an angle with the tail stem, and the furcae with an angle of less than 90° between them. The resting stage is long (up to 27 seconds, though often only from three to eight seconds), and during this period the cercaria gradually sinks towards the bottom. It swims upwardly, and at times laterally also. There was no evidence of either positive or negative reaction to light. Specimens were observed to remain alive for at least 72 hours. Looss recorded that *C. vivax* Sonsino lived more than two days (Wesenberg-Lund, 1934, 159).

For the measurements, an average of ten formalinised specimens was taken: body length, 200 μ (range, 184-242 μ); breadth, 117 μ (range, 108-125 μ); length of tail stem, 401 μ (range, 384-417 μ); breadth of tail stem, 50 μ (range, 46-54 μ); length of furcae, 301 μ (range, 284-317 μ); breadth of furcae, 27 μ (range, 25-33 μ). A great disparity of size was noticeable between extended living and formalinised specimens (fig. 12, 13). On the body are rather widely separated rows of extremely minute spinules, giving the surface, especially in the region around the base of the tail, a punctate appearance.

The tail does not arise from the posterior border of the body, but at some distance from it on the dorsal surface, in this respect differing from Miller's classification of longifurcate larvae (Miller, 1925, 63). The long tail stem is about twice the length of the body, and the ratio of stem to furca is 4:3. The stem is simple, but the furcae each bear a fin-fold arising below the junction of the two furcae and continuous around the tip to a corresponding level on the outer side. Fine striations traverse the fin-fold obliquely and directed towards the tip. The furcae arise separately from the main stem.

There are numerous small pale green cells in the tail—about twelve across the diameter—some of them being apparently stalked These cells stain deeply with methylene blue (intravitam), and are probably myoblasts. Several of these cells, situated near the central canal, were seen to be swinging like pendulums, each from a narrow transparent stalk. Wesenberg-Lund (1934, 132) states that in *Cercaria* No. 4 of Petersen "the excretory tube has an irregular coating of parenchymatous cells." and that he "often saw this string, the excretory tube with its coating of cells, lifted up towards the anterior part of the tail by means of the oblique longitudinal muscles, and again lowered to the posterior part."

The musculature of the tail is complex. There is a series of comparatively massive oblique fibrils arising from the lateral borders and apparently terminating around the central canal of the tail. The transverse fibres are very fine, and the longitudinal series can be seen only in the central part of the tail, though these fibres are probably present throughout.

The anterior organ measures about 42 μ x 31 μ. The anterior half is beset with about 14 rows of small spines. The mouth opens terminally through the anterior organ into the pharynx immediately below the latter, there being no prepharynx. The narrow oesophagus soon bifurcates into broad intestinal crura which have a somewhat spiral course, forming, typically, four more or less regular bends, and extending almost to the posterior end of the body. The intestine stains vividly with neutral red. Its walls are formed of large epithelial cells, as described by Faust (1922, 257) for *C. leptoderma,* but in *C. tatei* the outlines of the cells are distinct, and, in addition, the nuclei are large.

The ventral sucker is apparently represented by a small rounded parenchymatous mass of cells situated medially in the posterior half of the body.

The gland cells are not at all obvious, and can be seen only with careful study. Intravitam stains were used, but were not taken up by them. After treatment with neutral red, however, the cells became visible, although they were not coloured. The nuclei were not seen except in one or two of the cells of the most anterior group, and the shape of the cells could not be determined, since the margins were indefinite. In fact, the only indications of their presence were the finely granular nature of the protoplasm, and the ducts opening anteriorly. On either side of the midline and extending to the posterior border of the anterior organ is a group of four gland cells, the ducts of which pass laterally and terminate near the midline anteriorly. Behind the anterior organ is a mass of cells which appears to have no very regular arrangement. They extend down the sides of the pharynx and are then scattered across to the sides of the body, where they extend posteriorly as far as the level of the end of the oesophagus. They are too many, or too indefinite, to be counted. Intravitam staining also showed, distributed throughout the body, a number of cells in which there was a coarser granulation than in the gland cells. It was considered that they were probably not themselves gland cells.

Around the lateral borders of the body are a number of cutaneous glands, of comparatively uniform diameter throughout. These lie just below the ventral surface, and take a slightly curved course before they terminate on the latter by a narrow opening. There are 50 or 60 of these around the margin of the body, and a few throughout the ventral surface. These cutaneous glands can sometimes be seen in living specimens, but show up most clearly in those stained with chlorazol black, the glands appearing dark grey. Structures similar to these were recorded by Lutz (1933, 366-7) for *Dicranocercaria utriculata*. Wesenberg-Lund (1934, 132; pl. xxix, fig. 2) recorded for *Cercaria* No. 4 of Petersen "a series of 12-15 bright, clear bodies with a dark point along the borders of the body," and stated that he was "quite ignorant of their function."

In describing the encystment of *C. vivax* Sonsino, Azim (1933, 433) mentioned "cystogenic glands, previously described as cutaneous glands by Looss." We have not had access to this paper of Looss', but it seems probable that the structures mentioned by these four authors are similar to those which we have called cutaneous glands in *C. tatei*, and that these are, in reality, cystogenous glands.

The small body of the excretory bladder lies immediately anterior to the origin of the tail, the pore opening dorsally in this position. The comparatively narrow inner arms of the bladder pass upwards in the intercrural region. Just above the ventral sucker they unite into a single tube which passes forwards to a point immediately posterior to the origin of the intestinal caeca, where it bifurcates. Each tube so formed takes a wide swing laterally, and passes back along the outside of the crus to open into the bladder again. Where each tube lies above the corresponding crus, it gives off, anteriorly, an extremely short branch which soon divides into two short widely separated blindly ending arms. The intercrural parts of the excretory system, together with these arms, contain small refracting granules which are absent from the extracrural arms of the bladder. The main collecting tube joins the lateral arm at the level of the first intestinal bend, and passes back to the level of the mid-intestinal length where it bifurcates into an anterior and a posterior collecting tubule. There are 15 flame cells on each side of the body, nine to each anterior, and six to each posterior tubule. These are arranged in groups of three. A branch of the bladder extends into the tail, terminating near the tip of each furca. An island of Cort is present. Two collecting tubes in the tail extend far back into the main stem, and each receives the ducts of three flame cells. The connection of these tubes with the main system was not definitely determined, but it is thought that they connect with the posterior collecting tubes of the body, and, if this is the case, the flame cell formula would be 2 (9 + 9) rather than 2 (9 + 6 + 3).

Sporocysts occur in the mantle cavity of the mollusc. They are long and narrow, and at regular intervals there are pronounced muscle bands which give rise to projections on the surface, so that the structure has the general appearance of a tapeworm. Between the muscle bands the wall contains a number of finer circular muscular fibres and very minute fat globules. Each sporocyst contains cercariae as well as germ balls which may be oval or round, exhibiting early segmenting and later stages. All of these move freely in the sporocyst as it undergoes muscular contraction and expansion. At one end (? anterior) of the sporocyst is a pointed cap of cells, the nuclei of which are a prominent feature in stained preparations.

The genital rudiment lies just above the origin of the tail and near the posterior border of the body. It is more ventral anteriorly, and then curves posteriorly and dorsally to terminate near the excretory pore.

Negative results were obtained when experimental infections with the cercariae were attempted using the molluscs *Ameria pyramidata* and *pectorosa*, *Planorbis isingi*, *Plotiopsis tatei*, *Corbiculina angasi*, the tadpole, *Limnodynastes* sp., the leech, *Glossiphonia* sp., and the yabby, *Cherax destructor*. However, the cercariae were found to encyst in the muscles and body cavity of the fish *Gambusia affinis*. These cysts conformed to the descriptions given by other workers for related cercariae (Azim, 1933, for *C. vivax* Sonsino; Szidat, 1933, for *C. monostomi viviparae*) in that the enclosed metacercaria was an apparently structureless mass containing numerous small fatty globules with some larger ones (fig. 10). The fish had been subjected to infection for nearly six weeks (from March to May), and the cysts were consequently at different stages. Of these, the smallest were from 250 to 280 μ in diameter; the cyst wall was quite thin, and the cercaria occupied almost the whole of the cyst. The next group ranged from 300 to 330 μ, and in these the cyst wall was thicker, and the metacercaria occupied only about half the cyst. In what was apparently the most mature group the cyst wall was thick and the metacercaria very dark. Similar pigmentation was noted by Azim (1933, 433) who stated that in the metacercaria of *C. vivax* Sonsino black pigment began to be deposited about ten days after encystment, and that this continued until "a deep black figure" was formed inside the cyst. These mature cysts of *C. tatei* ranged from 384 to 418 μ. Some of the metacercariae were released from these cysts, but it was impossible to distinguish any structure in them until after staining, which showed that there was some differentiation. Another *Gambusia* subjected to infection for about 25 days yielded over 50 unpigmented cysts about 267 x 284 μ, the apparently structureless metacercaria occupying the whole or part of the cyst. Careful examination revealed the presence of an anterior organ, pharynx, and intestinal crura, and at least one flame cell was seen. When these metacercariae were stained a large depression on one surface was revealed. At the posterior end of this depression was a rounded structure with thick muscular edges; this is probably the developing tribocytic organ. A ventral sucker and genital rudiments were present but did not exhibit any advance on their state of development as seen in the cercaria. The oesophagus was rather long and narrow, and the crura wide.

A *Gambusia affinis* containing a number of cysts of *C. tatei* was fed to a rat on 23 May 1940. The faeces of the latter were examined several times, with negative results. It was killed on 19 June, but no trematodes were found.

The specific name is given as a tribute to Professor Ralph Tate.

Of the cercariae described by Sewell (1922), Wesenberg-Lund (1934), Szidat (1933), Tubangui (1928), Lutz (1933), Faust (1922, 1926, 1930), and others, as being related to *C. vivax*, *C. leptoderma* Faust (1922) is the only one possessing the same number of flame cells as *C. tatei*, but in other respects the two forms show marked differences. In *C. leptoderma* each group of three flame cells is described as having its own collecting tube, so that there are six pairs of secondary tubules, while in *C. tatei* the groups of three open (as far as we were able to observe) into the anterior or posterior collecting tubules as the case may be. The "secondary tubules" open into the "main collecting tubules" midway along the course of the latter in *C. leptoderma*, whereas in *C. tatei* the junction is more anterior. There is no X-shaped extension of the "main collecting tubules" anteriorly in *C. leptoderma*. The latter is brevifurcate, has gland cells differentiated into two kinds, has differently-shaped intestinal caeca, and is devoid of a ventral sucker, while the presence of a fin-fold is not mentioned. Its sporocysts occur in the liver; of *C. tatei* in the mantle cavity of the host.

C. tatei appears to be closely related to *C. vivax* (Looss, 1896), but unfortunately the number of flame cells in the body is not recorded for the latter. The two forms agree in the presence of a ventral sucker and of three pairs of flame cells in the tail. The cercariae are found in closely related gastropods (*C. vivax* in *Cleopatra bulimoides* Jick and *Melanopsis praemorsa* Linn., and *C. tatei* in *Plotiopsis tatei*), and the metacercariae occur in fish (*Gambusia affinis*).

Azim (1933, 433) has shown that *C. vivax* is the larval form of *Prohemistomum spinulosum* (= *P. vivax*) and other related cercariae have also been shown to belong to the Cyathocotylidae. The metacercaria of *C. tatei* appears to us to be closely related to the genera *Cyathocotyle* and *Cyathocotyloides*. We expect that the adult of *C. tatei* will be found in a fish-eating bird that frequents the River Murray region.

This series of investigations has been made possible by the Commonwealth Government's research grant to the Adelaide University; and by assistance, generously given, by Messrs. G. and F. Jaensch, of Tailem Bend.

Literature

Azim, M. A. 1933 Z. f. Parasitenk., **5**, 432-436
Dubois, G. 1938 Mem. Soc. Neuchat. Sci. Nat., **6**, 535 pp.
Faust, E. C. 1922 Parasitol., **14**, 255-257
Faust, E. C. 1926 Parasitol., **18**, 105
Faust, E. C. 1930 Parasitol., **22**, 152-3
Johnston, T. H. 1927 Trans. Roy. Soc. S. Aust., **51**, 133-136
Looss, A. 1896 Mem. Inst., Egypt, **3**, 1-252
Lutz, A. 1933 Mem. Insti., Osw. Cruz., **27**, 349-402
Miller, H. M. 1926 Ill. Biol. Monogr., **10**, 112 pp.
Sewell, R. B. S. 1922 Ind. Journ. Med. Res., **10**, Suppl., 370 pp.
Szidat, L. 1933 Z. f. Parasitenk., **5**, 443-459
Tubangui, M. A. 1928 Philipp. Journ. Sci., **36**, 37-54
Wesenberg-Lund, C. 1934 Mem. Acad. Roy. Sci. Litt., Danemark, ser. 9, **5** (3), 223 pp.

SOME NEMATODES PARASITIC IN AUSTRALIAN FRESHWATER FISH

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

Summary

The present investigation was undertaken as part of a study of the parasitology of the fauna of the lower River Murray swamps, especially at Tailem Bend, where we have been most generously assisted for several years past by Messrs. G and F. Jaensch. Some of our material has been obtained at Murray Bridge and Swan Reach; part of it was collected many years ago at Eidvold, Upper Burnett River, Queensland, by the late Dr. T. L. Bancroft and his daughter, Dr. M. J. Bancroft (Mrs Mackerras). We have also examined a small collection belonging to the Australian Museum, Sydney, and placed in our hand by its Director, Dr. C. Anderson, who collected some of it. We also acknowledge gratefully the assistance rendered through the Commonwealth Research Grant to the University of Adelaide

SOME NEMATODES PARASITIC IN AUSTRALIAN FRESHWATER FISH

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

[Read 12 September 1940]

The present investigation was undertaken as part of a study of the parasitology of the fauna of the Lower River Murray swamps, especially at Tailem Bend, where we have been most generously assisted for several years past by Messrs. G. and F. Jaensch. Some of our material has been obtained at Murray Bridge and Swan Reach; part of it was collected many years ago at Eidsvold, Upper Burnett River, Queensland, by the late Dr. T. L. Bancroft and his daughter, Dr. M. J. Bancroft (Mrs. Mackerras). We have also examined a small collection belonging to the Australian Museum, Sydney, and placed in our hands by its Director, Dr. C. Anderson, who collected some of it. We also acknowledge gratefully the assistance rendered through the Commonwealth Research Grant to the University of Adelaide.

Our work has included the examination of a large number of individual fish from the lower Murray, as well as parasites obtained elsewhere in Australia. Nematodes from 17 species of fish have been studied, most of them being food fishes, some of them very important, *e.g.*, Murray cod, callop, Murray perch and Murray bream.

Only three species of nematodes had been recorded previously from Australian freshwater fish. The first record was made by Baird in 1861 when he reported the occurrence of a brightly-coloured worm, regarded by him as *Filaria sanguinea* Rudolphi, in a minnow, *Galaxias scriba*, from the Murray River (but not further localised), the first member of the species to arrive in London in a living condition, though dying soon after. Linstow, in 1898, gave an account of *Amblyonema terdentatum* collected by Semon from *Ceratodus forsteri* from the Upper Burnett River. Next year Linstow (1899) described a brightly-coloured worm from *Galaxias attenuatus*, the parasite having been sent to Berlin Museum by Dr. Schomburck, of Adelaide. This nematode was regarded as identical with *Spiroptera bicolor*, which Linstow had described previously from European freshwater fish. *Galaxias scriba* is a synonym of *G. attenuatus*, and we indicate that the Australian worms identified as *Filaria sanguinea* by Baird and *Spiroptera bicolor* by Linstow may safely be considered as larval stages of a species of *Eustrongylides*, to which we have given the name *E. gadopsis*.

In this paper we deal with 18 species of nematodes, 17 of them being considered new, two of these being larval stages of *Eustrongylides*. A new genus, *Paraseuratum*, is proposed. A number of other larval forms also receive attention, and we hope to be able to associate some of them with adult stages later. Most of the genera to which species are allotted had not previously been recorded as occurring in Australia.

Types of all new species, unless stated otherwise, have been deposited in the South Australian Museum.

List of Parasites arranged under their Hosts

McCullochella macquariensis (C. & V.), Murray Cod:—*Capillaria murrayensis* n. sp.; *Contracaecum murrayense* n. sp.; *Contracaecum* sp. (larvae); *Goezia fluviatilis* n. sp.; *Spinitectus* sp. (larvae).

Plectroplites ambiguus Rich., callop, golden perch, yellow belly:—*Contracaecum murrayense* n. sp.; *Contracaecum* sp. (larvae); *Goezia fluviatilis* n. sp.; *Spinitectus plectroplites* n. sp.; *Procamallanus murrayensis* n. sp.; *Capillaria plectroplites* n. sp.; *Philometra plectroplites* n. sp.; *Eustrongylides gadopsis* n. sp.

Percalates colonorum Gnthr., Murray perch:—*Contracaecum murrayense* n. sp.; *Contracaecum* sp. (larvae); *Capillaria plectroplites* n. sp.; *Goezia fluviatilis* n. sp.; *Spinitectus percalates* n. sp.; *Spinitectus* sp. (encysted larvae); *Procamallanus murrayensis* n. sp.; *Philometra percalates* n. sp.; *Agamonema* sp.

Macquaria australasica C. & V., Macquarie perch:—*Contracaecum macquariae* n. sp.; *Spinitectus* sp.; *Philometra* sp.

Therapon bidyana Mitchell, Murray bream:—*Capillaria plectroplites* n. sp.; *Contracaecum* sp. (larvae).

Therapon sp., black bream from North Queensland rivers:—*Philometra* sp.

Pseudaphritis urvillei C. & V., congolli:—*Contracaecum* sp. (larvae); *Spinitectus* sp. (larvae); *Procamallanus murrayensis* n. sp.; *Rhabdochona jacnschi* n. sp.

Nannoperca australis Gnthr., pigmy perch:—*Contracaecum* sp. (larvae); *Goezia fluviatilis* n. sp. (larvae).

Mogurnda adspersus Castln., gudgeon (Burnett River):—*Contracaecum* sp. (larvae); *Goezia fluviatilis* n. sp. (larvae); *Spinitectus bancrofti* n. sp.

Carassiops klunzingeri Ogilby, carp gudgeon (Burnett River):—*Contracaecum* sp. (larvae).

Gadopsis marmoratus Rich., black fish, "slippery":—*Eustrongylides gadopsis* n. sp.

Nematalosa erebi Gnthr., bony bream:—*Contracaecum* sp. (larvae).

Galaxias attenuatus Jenyns, native trout, minnow:—*Eustrongylides gadopsis* n. sp.

Galaxias olidus Gnthr., minnow:—*Eustrongylides galaxias* n. sp.

Anguilla reinhardtii Strd., long-finned eel:—*Anguillicola australiensis* n. sp.

Tandanus tandanus Mitchell, catfish:—*Capillaria tandani* n. sp.; *Contracaecum* sp. (larvae); *Goezia fluviatilis* n. sp. (larvae); *Paraseuratum tandani* n. gen., n. sp.

Ceratodus forsteri Krefft, lungfish (Burnett River):—*Amblyonema terdentatum* Linstow.

Capillaria plectroplites n. sp.

Figs. 1-2

Numerous females from mucus on gills of a callop, *Plectroplites ambiguus;* and another from the Murray bream, *Therapon bidyana;* both hosts from Swan Reach. Length, 6·3-7·7 mm.; maximum breadth (near posterior end), 0·09 mm.; width at head ·01 mm., at base of oesophagus ·06 mm., and at anus ·015 mm.; ratio betwen oesophageal and intestinal regions of body, 4: 5. Vulva on projection just behind posterior end of oesophagus; anus subterminal; tail blunt; eggs, 50-53 μ by 23-25 μ.

Male worms from the Murray perch, *Percalates colonorum,* at Swan Reach, resemble the females in general appearance. Length, 3·9-4·5 mm.; width at head ·01 mm., at posterior end of oesophagus ·04 mm., at widest part of body ·05 mm., and just in front of bursa ·012 mm. End of oesophagus 2·26 mm. from head in specimen 4·49 mm. long. Spicule, ·24 mm.; sheath slightly longer; sheath or spicule with transverse striations; exact line between the two structures difficult to determine but striations continue somewhat in front of proximal part of spicule. At end of body two cuticular flaps opening ventrally and extending nearly to tip of tail. Greatest amount of extrusion of sheath observed was ·12 mm. Ratio of length of oesophageal region to posterior part of body about 1:1; but in female 4: 5, 3:4, 7: 9.

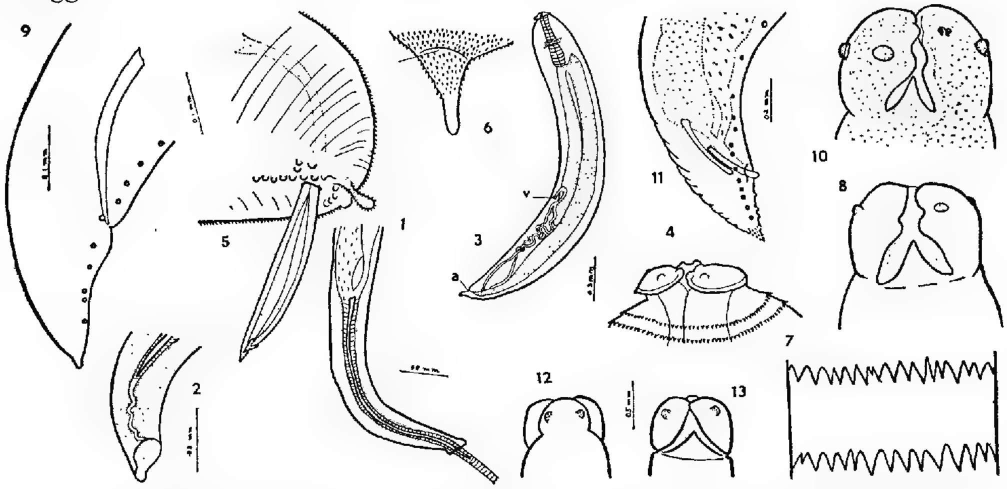
Capillaria murrayensis n. sp.

Single female specimen from intestine of Murray cod, *McCullochella macquariensis,* from Tailem Bend. Length, 12 mm.; width at head ·009, at vulva ·04, at widest part ·06, and at tail ·025 mm. Vulva at mid-length and just behind end of oesophagus. Eggs, 50-52 by 22 μ.

The species differs from *C. plectroplites* in its greater length, more attenuated form, and different ratio of the body regions (1:1).

Capillaria tandani n. sp.

Four females from intestine of catfish, *Tandanus tandanus,* Tailem Bend. Length, 7·1-8·6 mm. Anterior region of body shorter than posterior part, ratio 1:1·7-2·1. In specimen 8·6 mm. long, breadth at head ·01 mm., at end of oesophagus 0·06 mm., in widest region (near tip of tail) ·1 mm. Vulva just behind end of oesophagus, not salient. Eggs, 45 by 20 μ. Body apparently with numerous minute tubercles scarcely projecting through cuticle. The species differs from the two preceding in the ratio of its body regions and in the size of the eggs.



Figs. 1-2, *Capillaria pectroplites:* 1, posterior end of male; 2, bursa. Figs. 3-7, *Goezia fluviatilis:* 3, young female; 4, head of female; 5, tail of male; 6, tail of female; 7, part of cuticle in region of posterior oesophagus, showing spines. Figs. 8-9, *Contracaecum macquariae:* 8, head of young male; 9, tail of young male. Figs. 10-13, *Contracaecum murrayense:* 10, head of male; 11, posterior end of male; 12, dorsal, and 13, ventral views of head of very young female. Figs. 1, 4, and 6, to same scale; figs. 2 and 7. Figs. 8 and 9 to same scale; figs. 10, 12, and 13.

References to Lettering—a, anus; ep, excretory pore; g, gubernaculum; n, nerve ring; o, ovarian tube; u, uterus; v, vulva.

Goezia fluviatilis n. sp.

Figs. 3-7

Females from gill mucus, *Plectroplites ambiguus* and *McCullochella macquariensis;* males from *Percalates colonorum,* Tailem Bend.

Female adult 4·4-6 mm. long, young specimens 2-2·4 mm.; males 3-4·4 mm. long. Lips three, marked off from body by deep constriction, outer edge with cuticular expansion, inner border prolonged into two short rounded cuticular structures (possibly serving as teeth); dorsal lip with two papillae; ventral lips each with at least one papilla. Body widening rapidly behind head, then continuing at same breadth nearly to posterior end, then narrowing to tail, terminating in cylindrical tip. Rows of spines approximating towards posterior end of body, spines becoming smaller and more closely set; spines no longer arranged in definite rows in vicinity of anus; spines absent from distal half of cylindrical part of female tail.

In male 4·4 mm. long, width at head ·2 mm., at mid-length of body ·65 mm. Oesophagus ·6 mm. long, club-shaped; oesophageal appendix 1·4 mm. long; caecum conical, ·15 mm. long. Spicules ·65 mm. long, with wide alae extending beyond their tips like arrowheads. Tail ·14 mm. long, cylindrical part ·06 mm. Five pairs preanal and three pairs adanal papillae; also three papillae arranged on each side laterally from the adanals.

In a young female 2·4 mm. long, breadth at head ·16 mm., at mid-body ·4 mm.; oesophagus ·4 mm. long (·75 mm. in female 4·4 in length), ratio to body length 1:6; nerve ring surrounding oesophagus just before latter widens at ·2 mm. from head end; oesophageal appendix 1·1 mm. long; caecum ·08 mm. Tail ·11 mm. long. Uteri extending forward and uniting a short distance behind oesophagus to form median uterus which passes back to vulva; latter 1 mm. in front of anus in specimen 2·5 mm. long, dividing body length in ratio 3:2. Eggs, roughly globular, some with embryo. The position of the vulva and the equality of the spicules do not conform with the generic diagnosis for *Goezia,* but the differences are too slight to prevent the inclusion of the species in that genus.

Immature stages, probably belonging to *G. fluviatilis*, have been found in *Nannoperca australis* and *Tandanus tandanus* from Tailem Bend, and in *Mogurnda adspersa* from the Upper Burnett River, Queensland.

The specimen from *Tandanus* was an encysted larva, 1·35 mm. long, ·05 mm. in maximum breadth, contained in a cyst ·38 by ·4 mm. in the omentum. A larval tooth was present, and the rows of spines as well as the form of the anterior end were readily recognisable.

The immature worm from the intestine of *Mogurnda* measured 2·8 mm. long, with a maximum diameter ·2 mm. The truncated anterior end possessed a prominent larval tooth. The rows of minute spines extended from the head to the tip of the conical pointed tail. The latter was ·3 mm. long; the oesophagus ·36 mm., its appendix ·45 mm., and the intestinal caecum ·2 mm. in length. The specimen from *Nannoperca* was a moulted skin.

Contracaecum macquariae n. sp.

Figs. 8-9

From stomach of the Macquarie perch, *Macquaria australasica*, Goodradigbee River, New South Wales, collected by Dr. C. Anderson, Director, Australian Museum, Sydney. (Austr. Museum Coll., W. 2820.)

Male 15 mm. long; female 20-25 mm. long. Lips large, each with two pairs of narrow lateral flanges; interlabia conical, less than half length of lips; two papillae on dorsal lip, one on each subventral. No collar region, but head distinctly narrower than rest of body.

Male—Oesophagus 4·5 mm. long, straight, narrow, with club-shaped appendix 1·5 mm. long; caecum 3 mm. long. Nerve ring, cervical papillae and excretory pore not observed. Testis commencing just behind oesophagus. Tail conical 2·4 mm. long. Spicules 2·8 mm.; 8-10 pairs small preanal papillae in region extending 4·5 mm. in front of anus, five pairs postanal arranged laterally (fig. 9). *Female*—Tail ·6 mm. long, tapering, ending in papilla. Vulva not observed.

Type deposited in the Australian Museum, Sydney.

Contracaecum murrayense n. sp.

Figs. 10-12

Single male from *McCullochella macquariensis;* females from *Percalates colonorum,* both fish from Tailem Bend. Head about as wide (·15 mm. in male) as neck, without 'rolled collar" so commonly present in genus. Lips about ·16 mm. long, each with pair of lateral flanges; dorsal lip with two wide papillae; subventrals each a wide papilla ventrally and a pair of minute closely-set papillae on their anterior dorsal side; interlabia short, conical.

Male 12·8 mm. long, ·38 mm. maximum breadth. Oesophagus 3·5 mm. long, appendix about 1·3 mm.; caecum 2·6 mm. long. Nerve ring at ·5 mm. from head end and just in front of excretory pore. Tail ·3 mm. long, ·3 mm. wide at base, tapering to point, provided for the last ·08 mm. of length with short spines of varying sizes. Spicules equal, ·35 mm. long, of similar form, each with stout head followed by cylindrical shaft with rounded distal end. Nine pairs of lateral papillae, five postanal, four preanal; a more medianly-placed row of eight or nine pairs in front of the latter and spaced further apart to reach a point about 1·5 mm. in front of cloaca.

Females 16-18·3 mm. long; oesophagus about one-sixth body length; appendix ·45 mm., thin; caecum 2·1 mm. Nerve ring about ·5 mm. from head end. Tail pointed, ·53 mm. long, with tip ornamented as in male. Vulva ·7 mm. from head end (1:2·6 of body length); uteri backwardly directed. Eggs not present.

Though this species possesses many of the characters of the subgenus *Thynnascaris* Dollfus 1933—*e.g.,* the long oesophagus with a posterior bulb, short interlabia and equal spicules—it has been deemed preferable to place it under *Contracaecum.*

Young female worms obtained from *Plectroplites ambiguus,* at Tailem Bend, agreed with most of the specimens described above in most features except that they were much shorter, and in the case of very young specimens the interlabia were relatively shorter, with a broader base. The tails were provided with numerous spines.

Contracaecum spp. (larvae)

Larvae in various stages of development were found in *McCullochella macquariensis, Plectroplites ambiguus, Percalates colonorum, Tandanus tandanus, Therapon bidyana, Nematalosa erebi* and *Pseudaphritis urvillei,* all from the Lower Murray, as well as *Carassiops klunzingeri* and *Mogurnda adspersus* from the Upper Burnett River, Queensland. Some were encysted in the mesentery and omentum, and possessed small lips, distinct alimentary canal with appendix and caecum, as well as (usually) distinct genital primordia, the almost spherical cyst measuring about 1 mm. in diameter. Others occurred free in the intestine, some of them with a larval tooth, but otherwise resembling the encysted forms. It is possible that more than one species of *Contracaecum* was represented and the adult stage may be expected to be found in fish-eating water birds.

Measurements (in mm.) of specimens from the mesentery of the Murray perch (*Percalates*), from the lumen of the intestine of the callop (*Plectroplites*), and from cysts in the omentum of the catfish (*Tandanus*), are now tabulated.

Host	Murray	Perch	Callop	Catfish	
Length	3·25	3·35	3·34	2·3	3·3
Maximum diameter	·15	·16	·15	·1	·14
Oesophagus	·36	·45	·4	·3	·5
Oesoph. appendix	·3	·35	·35	·35	·5
Int. caecum	·2	·3	·2	—	—
Head to genit. anlage	?	1·1	1·3	—	—
Tail length	·1	·1	·1	·08	·12

Spinitectus plectroplites n. sp.

Fig. 14

Females from gill mucus of *Plectroplites ambiguus,* Tailem Bend. Length, 8-8·5 mm. First three rows with largest body spines, succeeding three rows with smaller spines, remaining rows with spines diminishing in size, becoming very small at level of posterior end of oesophagus and remaining so to end of body. Mouth with two lateral lips; vestibule 50 μ long, 15 μ wide. Oesophagus with anterior narrower part, ·18 mm. long, and posterior region ·55 mm. long. Nerve ring at ·12 mm. from head end and just behind third row of spines. Excretory pore ·15 mm. from head end and opening at base of spine in fourth row. Tail ·11 mm. long, tapering, pointed. Vulva near posterior end, ·3 mm. from tip of tail. Uteri uniting very near vulva, vagina very short. Eggs oval, smooth-shelled, 31-34 by 20-21 μ. The species differs from *S. gracilis* Ward and Magath 1916 in length, position of vulva, length of anterior region of oesophagus, and distribution of spines.

Spinitectus percalates n. sp

Figs. 15-16

From *Percalates colonorum,* Lower Murray River. The species differs from the preceding in the length of the buccal capsule, position of the nerve ring, and size of spines. The size of the female, the length of its tail and the position of the vulva are similar to those of *S. plectroplites.*

Male 6·6 mm. long; vestibule 40 μ long, 9 μ wide, not extending back as far as first row of spines. 20-22 spines in each row. Oesophagus, anterior region ·17 mm., posterior region ·5 mm. long. Nerve ring at level of fourth row of spines, ·13 mm. from head end. Tail ·14 mm. long, tapering to narrow tip. Spicules simple, tapering to a point, stouter spicule ·15 mm. long, the other ·09 mm. Papillae, 11 pairs arranged in two lateral rows each with four preanal, three postanal, and a group of four smaller caudal.

SPINITECTUS sp.

In *Percalates* and the Murray cod, as well as in the congolli, *Pseudaphritis urvillei,* Tailem Bend, immature encysting female worms of *Spinitectus* sp. were collected, but details regarding the structure of either end were not sufficiently recognisable to permit identification with the species described above.

Spinitectus bancrofti n. sp.

Figs. 17-18

A male and several indifferently preserved females from the intestine of *Mogurnda adspersa,* Upper Burnett River. Coll., Dr. M. J. Bancroft (Mrs. Mackerras).

Male, 7·1 mm. long, ·09 mm. maximum width. Female, 5·4-6·8 mm. Spines distinctly smaller than in the two preceding species, and commencing more posteriorly at ·09 mm. from the head end; each row with 26-28 spines, rows about 20 μ apart at anterior end, becoming closer and containing smaller spines behind level of mid-oesophageal length, but rows more separated near mid-body; spines extremely small and rows far apart and scarcely recognisable near tail. Vestibule bent, 40 μ long, 10 μ wide. Nerve ring at level of second row of spines, ·1 mm. from head end. Oesophagus, anterior region ·15 mm. long and ending at level of fifth or sixth row of spines, posterior part ·45 mm. long. Male, tail ·11 mm. long, spicules unequal, ·17 and ·055 mm. long; four pairs preanal and at least five pairs postanal papillae, all pedunculated and projecting into narrow caudal alae.

Females, all specimens young and without eggs; tail ·07 mm., constricted suddenly, then tapering behind anus to end in blunt point; vulva ·2 mm. from tip of tail.

The species is distinguished from the two preceding by the much greater distance from the head at which the rows of spines commence, the smaller size and greater number of the spines, the position of the nerve ring, and the spicular lengths.

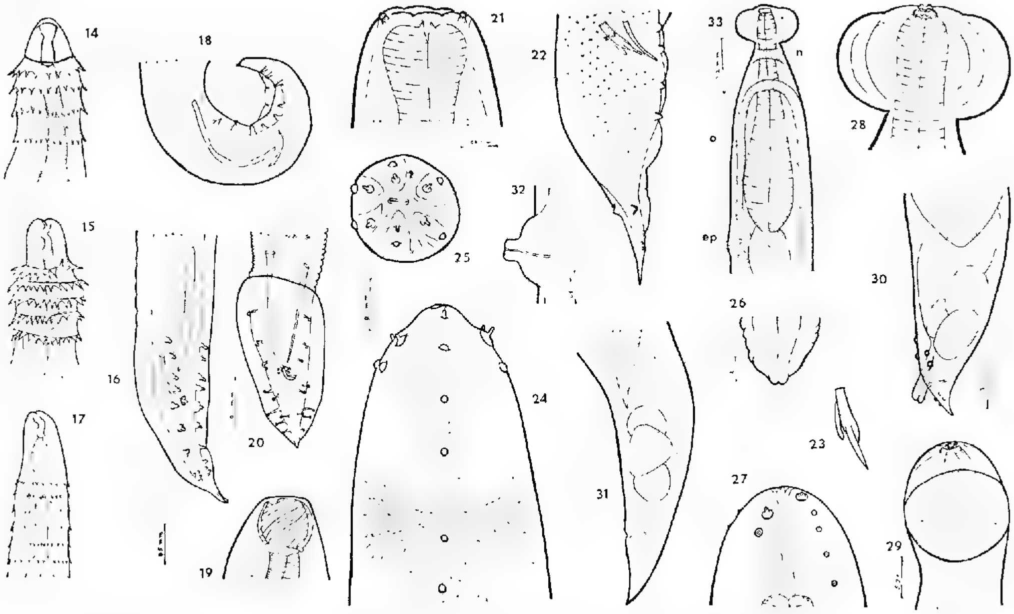


Fig. 14, *Spinitectus pectroplites:* head. Figs. 15-16, *Spinitectus percalates:* 15, head; 16, tail of male. Figs. 17-18, *Spinitectus bancrofti:* 17, head; 18, tail of male. Figs. 19-20, *Procamallanus murrayensis:* 19, head; 20, tail of male. Figs. 21-23, *Parascuratum tandani;* 21, head; 22, tail of male; 23, one spicule and gubernaculum. Figs. 24-26, *Eustrongylides gadopsis:* 24, head, lateral view; 25, head, anterior view; 26, posterior end of female. Fig. 27, *Eustrongylides galaxias:* head. Figs. 28-33, *Anguillicola australiensis:* 28, head, lateral view; 29, head, ventral view; 30, tail of male; 31, tail of female; 32, vulva; 33, anterior end. Figs. 14, 15, 16, 17, 18, and 19 to same scale. Figs. 22, 24, 25 and 27 to same scale; figs. 23, 28 and 29; figs. 30 and 31.

SPINITECTUS sp.

A damaged female from the stomach of *Macquaria australasica* from the Goodradigbee River, New South Wales, collected by Dr. C. Anderson. (Austr. Museum Coll., W. 2820.) The worm at first sight suggested a *Trichuris.* The thin incomplete anterior end measured 9 mm. long and the wider posterior region, containing abundant eggs, 7·4 mm. Anterior end with transverse rows of spines; latter becoming smaller posteriorly and at 2 mm. almost disappearing, but discernible again as very small structures on the tail. Oesophageal regions not distinguishable. Body width anteriorly ·06 mm., where the spines measure about 7 μ long; at 8 mm. from anterior end width is ·14 mm., at 9 mm. ·19 mm., at level of anus ·06 mm. Maximum breadth (near vulva) ·27 mm. Anus ·12 mm. from tip of tapering, bluntly pointed tail; vulva on prominence ·21 mm. in front of anus. Eggs, ·04 by ·02 mm., ovoid, thick-shelled, without polar plugs.

The characters of this incomplete, poorly preserved parasite suggest a new species of *Spinitectus,* but in view of its condition we abstain from naming it.

Procamallanus murrayensis n. sp.

Figs. 19-20

From *Pseudaphritis urvillei* from Swan Reach, *Percalates colonorum* from Murray Bridge, and *Plectroplites ambiguus* from Tailem Bend. Male 4-5 mm. long, ·13 mm. maximum breadth; female 8-10 mm. long, ·25-·3 mm. maximum breadth. Buccal capsule spirally striated, not markedly compressed laterally, 70 μ long, 70 μ diameter at its mid-length, base greatly thickened, anterior edge moulded into six lobes. Oesophagus in male with anterior muscular region terminating ·4 mm. from head, glandular portion ending at ·9 mm. from head, both parts with more or less pronounced curve in their most anterior portions. Nerve ring about ·2 mm. from head.

Male—Caudal alae membranous, joined ventrally as in *Physaloptera*, ·33 mm. long. Papillae, three pairs preanal, two pairs pedunculated postanal, two pairs sessile adanal. Cloaca ·15 mm. from tip of tail. Spicules ·29 and ·2 mm. long, simple, tapering, pointed.

Female—Tail ·1 mm. long, with narrow tip 30 μ long and 10 μ wide; two minute lateral papillae 50 μ from tip of tail; vulva a transverse slit just in front of mid-length of body; uteri opposed.

The species resembles *P. spiralis* Baylis 1923 in some features, but differs in the form of the buccal capsule, which is more spherical.

Paraseuratum tandani n. g., n. sp.

Figs. 21-23

A male and a few females, some poorly preserved, from *Tandanus tandanus* from Tailem Bend. Male 8·7 mm., female 5·5-8·5 mm. long. Anterior end truncated, tapering; six low lips, each with small papilla. Buccal capsule absent; vestibule very short. Oesophagus ·9 mm. long in male, commencing with dilatation followed by narrow tube widening at base; six short conical teeth projecting from anterior end into vestibule. Nerve ring at about mid-length of oesophagus. Excretory pore and cervical papillae not seen.

Male—Spicules equal, similar, ·11 mm. long; proximal half spoon-shaped; distal half simple, tapering to point. Gubernaculum 0·05 mm. long. Caudal alae arising about 2 mm. in front of cloaca and extending each as narrow wavy band to within ·05 mm. of tip of tail. Papillae; four pairs preanal (at ·55, ·2, ·06 and ·02 mm. respectively in front of cloaca); five pairs postanal, two pairs of these near anus, behind these the tail narrowing suddenly and bearing a pair of large dorso-lateral and two pairs of ventro-median papillae before ending in a fine spike. Cloaca ·45 mm. from tip of tail.

Female—Tail ·5 mm. long, tapering, ending in short spine curving somewhat ventrally. Vulva salient, 3·2 mm. from posterior end, in worm 8·5 mm. long, *i.e.*, 1:1·7 of body length from head end; vagina short; uteri opposite; eggs more or less globular, ·05-·06 mm. diameter.

This species does not fall into any previously described genus of Spiruroidea, so we propose a new genus, **Paraseuratum,** with the following characters:—*Seuratinae;* mouth surrounded by six low lips each with a small papilla. No longitudinal dark bands on cuticle. Buccal capsule absent; oesophagus long, with six short teeth projecting anteriorly into mouth cavity. Male with short narrow caudal alae, short spicules, and pointed tail. Female with tapering tail, vulva in second third of body length, and eggs subglobular. Type, *P. tandani* n. sp.

The appearance of the anterior end and the male tail is nearest to that of *Seuratum;* but from the latter our worms differ in having a longer oesophagus, six lips, and no longitudinal dark bands on the cuticle. Baylis (1923) placed *Seuratum* in the Cucullanidae. *Seuratum* and *Paraseuratum* differ from the other genera of the family in the absence of a vestibular enlargement of the oesophagus and in the absence of a preanal sucker in the male.

Rhabdochona jaenschi n. sp.

Figs. 37-38

Two specimens from a *Pseudaphritis urvillei* taken from the stomach of a Murray cod at Tailem Bend. Male, 2·55 mm.; female, 4·4 mm. long; of uniform diameter except at both ends, tapering at head end, narrowing suddenly at posterior end; maximum diameter of male 60 μ, of female 80 μ. Head rounded, with two small papillae. Mouth succeeded by elongate cylindrical pharynx, probably unarmed; ·1 mm. long in female. Oesophagus ·8 mm. long in female, about one-fifth body length, with narrower anterior part ·16 mm. long. Nerve ring at anterior end of oesophagus.

Male with caudal alae, about ·16 mm. long, each ·012 mm. wide; tail ·07 mm. long, alae meeting at its tip. About three pairs preanal and five or six pairs postanal papillae, all pedunculated but not all reaching edge of alae; exact number doubtful because of position of alae in the single specimen. Spicules dissimilar, unequal; one being 30 μ long, spatulate, with blunt tip; the other 95 μ long, cylindrical for proximal half, tapering in distal half. Gubernaculum about 10 μ long, shield-shaped.

Female with blunt tail about ·1 mm. long, ending in small round papilla. Vulva 2·1 mm. from posterior end and just behind mid-length of body. Eggs oval, 30 by 20 μ, with very thick shell.

The assignment of this species (named as an acknowledgment of the generous assistance rendered by Messrs. G. and F. Jaensch of Tailem Bend) to *Rhabdochona* is provisional, since it differs from members of the genus in possessing caudal alae. We were not able to observe any teeth at the anterior end of the pharynx.

Amblyonema terdentatum Linstow 1898

(Figs. 39-40)

Several specimens collected by the late Dr. T. L. Bancroft from *Ceratodus forsteri* from the Upper Burnett River, Linstow's type host and locality. Male, 10·1 to 12·8 mm. long; female, 12·1 to 15·4 mm. long. Head with six rather large papillae (not mentioned by Linstow); inside of buccal cavity indistinct, only outlines of part of teeth visible. Lips conical, shorter than in Linstow's figure. Oesophagus commencing at about 50 μ from anterior end.

Male with pointed tail; spicules (in specimen 10·1 mm. long) ·34 mm. in length (Linstow, ·137 mm.), gubernaculum ·09 mm. long (Linstow, ·11 mm.). Two pairs preanal and one pair postanal papillae (as stated by Linstow); in addition, three pairs more anteriorly situated than the preceding, a pair laterally near tip of tail, and a pair ventro-laterally (also near tip of tail), last pair on slight projection.

Philometra plectroplites n. sp.

Fig. 34

Two mature females from body cavity of *Plectroplites ambiguus* from Murray Bridge. Longer worm 10·5 cm.; cuticle with numerous minute, irregularly distributed bosses. Anterior end rounded, without lips and papillae. Oesophagus 1·05 mm. long, ·09 mm. broad; anterior end widened to contain small, nearly hemispherical, vestibule, 56 μ wide, 48 μ long. Nerve ring ·2 mm. from head end. Vulva and anus atrophied. Uterus voluminous, occupying most of body cavity; merging into an oviduct about ·5 mm. from head end. Larvae in uterus about ·022 mm. wide, ·47 mm. long; coiled in two complete spirals; anterior end rounded; tail tapering to fine point.

Philometra percalates n. sp.

Figs. 35-36

A male 2·6 mm. long from *Percalates colonorum*, Tailem Bend. Anterior end rounded, with eight small papillae; posterior end truncate. Oesophagus ·25 mm. long, with swollen anterior end succeeded by narrow region to nerve ring (·15 mm. from head end), then terminating in wider portion. Spicules ·105 mm. long, with narrow alae; gubernaculum ·04 mm. long, with barbed tip. Tail with four lobes, ventral pair longer, dorsal pair more pronounced.

This male may belong to the preceding species, but as the two sexes were not obtained at the same time, and the hosts belonged to different species, it has been deemed advisable to describe the worms separately.

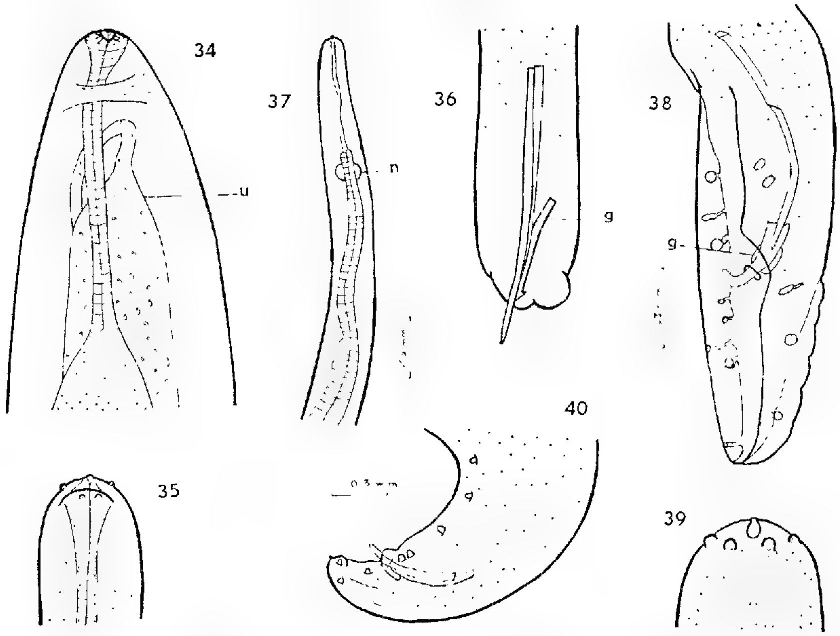


Fig. 34, *Philometra pectroplites:* anterior end. Figs. 35-36, *Philometra percalates:* 35, male, anterior end; 36, male, posterior end. Figs. 37-38, *Rhabdochona jaenschi:* 37, anterior end; 38, tail of male. Figs. 39-40, *Amblyonema terdentatum:* 39, head; 40, tail of male. Figs. 34 and 40 to same scale; figs. 35, 36 and 38; figs. 37 and 39.

Philometroides Ishii differs from *Philometra* in the absence of papillae, the presence of cuticular bosses, and the enlargement of parietal muscles in the former genus. Bosses have been noted in several species of *Philometra—nodulosa, parasiluri, sanguinea* and *senticosa*, the first two of which possess oral papillae (six and eight respectively), while the other two do not. The condition of the parietal muscles is not usually noted in the various species of *Philometra*. The male of *Philometroides* is unknown. The absence of essential literature has prevented us from reviewing adequately the species recorded under *Philometra*, but Furayama's paper (1932) relating to *P. fugimotoi* gives much useful information. We prefer to leave our two species under *Philometra* for the present.

PHILOMETRA spp.

A very long thin worm collected by Dr. C. Anderson from *Macquaria australasica*, Goodradigbee River, New South Wales (Austr. Museum Coll., W. 2820) belongs to the genus. It is broken, one fragment measuring 580 mm. and another 50 mm., each piece possessing a smoothly rounded end, but internal structure was not recognisable.

Another worm (Austr. Museum Coll., W. 1587), 45 mm. long, from a "black bream" (presumably *Therapon* sp.), collected by Dr. Hall in a tributary of the Mitchell River, North Queensland, probably belongs to *Philometra*, but its condition does not permit a study of its structure.

Eustrongylides gadopsis n. sp.

Figs. 24-26

Several long, thin, immature specimens from *Gadopsis marmoratus* from Orange, New South Wales (Austr. Museum. Coll.). Length, 70-80 mm. Anterior end domed; mouth elongated dorso-ventrally; four submedian and two somewhat elongate lateral papillae, laterals smaller and nearer mouth; row of long rounded papillae on each side anteriorly, becoming much smaller posterior to oesophagus and gradually diminishing till they disappear. Vestibule slightly cuticularized, ·35 mm. long; oesophagus very long, about 15 mm., one-fifth body length; nerve ring ·4 mm. from head end. Body narrowing suddenly near posterior end to terminate in small prominence bearing anus. Type deposited in Aust. Mus. (Reg. No. W. 3235).

A similar worm, 55 mm. long, was found in the freshwater perch, presumably *Plectroplites ambiguus*, by Dr. Hall in a tributary of the Mitchell River, North Queensland (Austr. Museum Coll., W. 1588).

Our species is the same as that described by Linstow (1899, 17) from *Galaxias attenuatus* from Adelaide, under the name ? *Spiroptera bicolor*. He had previously (1873, 298) described ? *Filaria bicolor* from European fish (*Esox*, *Silurus*), but in his later work (1899) he considered the parasite as ? *Spiroptera* and, though he mentioned *Silurus* as one host, he based his account on the Australian worm and gave several figures relating to it. The arrangement and form of the lips agree essentially with those of our specimens. We think it likely that his name was applied to larval stages of two distinct, but closely related, species of *Eustrongylides*. Since the name *Filaria bicolor* was already preoccupied by *F. bicolor* Creplin 1825 (also from European freshwater fish), Linstow's name was not valid. Chitwood (1933) renamed it *Eustrongylides linstowi*. The latter name must be attached to the parasite from *Esox* and *Silurus*, if distinct from the Australian parasite. Ciurea (1924) recognised Linstow's worm as a larval *Eustrongylides* and published figures of larvae belonging to the genus, some of his illustrations showing resemblance to our parasite. Cram (1927) listed *Spiroptera bicolor* Linst. as a synonym of *E. ignotus* Jägersk. Baird in 1861 referred to the presence of *Filaria sanguinea* Rud. (originally described as an adult worm from *Cyprinus* in Europe) in *Galaxias scriba* from the Murray River, and (1862 a, 207-8; 1861 b, 269-70) gave a brief account of it. Rudolph's species has been placed under *Philometra*, but Jägerskiöld (1909) mentioned that larvae from *Galaxias scriba* resembled *Eustrongylides ignotus* whose adult hosts are Ardeiform birds. *Galaxias scriba* is a synonym of *G. attenuatus* according to McCulloch (Mem. Austr. Museum, 5 (1), 1929, 47).

In view of the foregoing statements we apply the name *E. gadopsis* to the brightly-coloured larval parasite from *Gadopsis marmoratus* from New South Wales, *Plectroplites ambiguus* from Northern Queensland and *Galaxias attenuatus* from South Australia, its synonyms being ? *Spiroptera bicolor* Linstow from *Galaxias* and *Filaria sanguinea* Baird (nec Rudolphi), also from *Galaxias*. The name *Eustrongylides linstowi* should be restricted to the parasite first described from the European catfish, *Silurus glanis*, unless it be proved identical specifically with the worm from Australian freshwater fish. We may mention that we have studied a related species from *Galaxias olidus*, described below.

Eustrongylides galaxias n. sp.

Fig. 27

An immature worm from *Galaxias olidus* from the vicinity of Adelaide. closely resembling the preceding species. Length 120 mm., breadth ·74 mm. Papillae on head and lateral lines as in *E. gadopsis* but smaller. Vestibule ·2 mm. long, 25 μ external diameter, 9 μ internal diameter, anterior border appearing deeply serrated with six tooth-like projections. Oesophagus 23 mm. long. Posterior end rounded, anus terminal.

Anguillicola australiensis n. sp.

Figs. 28-33

Several worms from swim bladder of *Anguilla reinhardtii*, from Prospect Reservoir, near Sydney, New South Wales. Gravid females, 60-70 mm. long, 1·5 mm. wide; young females 25-30 mm. by ·5 mm.; males 40 mm. long, 1 mm. maximum breadth. Head end resembling the extruded bulbous proboscis of some echinorhynchs; marked neck constriction; body tapering at posterior end to a pointed tail. Anterior bulbous enlargement much wider dorso-ventrally than from side to side, hence different appearance when viewed laterally or dorso-ventrally; in female 25 mm. long this swollen region measured ·14 mm. long, ·22 mm. dorso-ventrally, and ·13 mm. from side to side. Mouth with six small lips or papillae; buccal cavity wider at base than anteriorly, with serrated anterior edge suggesting a leaf-crown with many elements; capsule 10 μ long, 28 μ wide at mid-length. Oesophagus ·82 mm. long, about 1:30 of body length; strongly muscular; widening regularly toward base; anterior end with six lobes projecting into buccal cavity. Nerve ring at ·18 mm. from head end, *i.e.*, just behind head swelling. Excretory pore on prominence in region of posterior end of oesophagus. Intestine very wide, filled with dark material. Actual position of anus in female not observed, but at ·4 mm. from tip of tail in worm 25 mm. long, and at a corresponding distance in larger worms, there is a slight indentation associated with a muscular band extending across the body; in front of indentation are four large glandular masses; anteriorly to the latter, at 1·1 mm. from tip of tail, the dark intestinal material is no longer evident; hence rectum probably a very narrow tube.

In two specimens which showed a similar disposition of pigment and glands, there appears to be a projection of the rectal wall through the anus, *i.e.*, at the point of attachment of the transverse musculature. These worms have a regular arrangement of papillae, two pairs preanal and two pairs postanal. We regard these specimens as males, although spicules were not seen. In a tube leading towards the anus numerous small spherical bodies, probably sperms, were noticed. Perhaps the projecting part of the rectal wall has replaced functionally the spicules.

In the female there is a rounded projection of the body wall, distant from the posterior end one-sixth of the body length, this prominence being surrounded by obvious lips, so that in the gravid worm the vulva is visible to the unaided eye. The ovarian tubes extend into the oesophageal and tail regions respectively. The thin-shelled eggs measure 12-15 μ by 25-26 μ.

Our species appears to be more closely related to *Anguillicola globiceps* (Anguillicolidae) described by Yamaguti (1935) from the swim-bladder of a Japanese eel, but differs mainly in the markedly swollen anterior end and in the form of the tail.

AGAMONEMA sp.

Very young nematodes, not further determinable, were taken from the eyes of *Percalates colonorum* from Tailem Bend. No organs, other than the alimentary canal, were recognisable. Length ·42 mm.; maximum breadth (at lower end of oesophagus) ·02 mm.; truncated head; head structures apparently absent; oesophagus ·15 mm. long; tail ·06 mm. long, tapering to a point.

REFERENCES

BAIRD, W. 1861 (a) Note on the occurrence of Filaria sanguinea in the body of the Galaxias scriba, a freshwater fish from Australia. P.Z.S., 1861, 207-8; (b) Same paper in A.M.N.H., (3), **8**, 1861, 269-270

BAYLIS, H. A. 1923. Report on a collection of Parasitic Nematodes, mainly from Egypt, etc. Parasitol., **15**, 1-38

BAYLIS, H. A. 1923 Note on Procamallanus spiralis. Parasitol., 15, 137-138

CIUREA, J. 1924 Die Eustrongylides-larven bei Donaufischen. Z. f. Fleisch. u. Milchhyg., **34**, 134-137 (not available).

CRAM, E. B. 1927 Bird Parasites of the Nematode suborders Strongylata, Ascaridata and Spirurata. U.S. Nat. Mus. Bull. 140

FURAYAMA, T. 1934 On the Morphology and Life History of Philometra fugimotoi Furayama, 1932. Keijo Jour. Med., **5**, 155-177

JÄGERSKIÖLD, L. A. 1909 Zur Kenntnis der Nematoden-Gattungen Eustrongylides und Hystrichis. Nova Acta reg. Soc. Sci. Upsaliensis, (4), 2, 48 pp. (not available)

LINSTOW, O. 1873 Einige neue Nematoden nebst Bemerkungen über bekannte Arten. Arch. f. Naturg., 1, 293-307

LINSTOW, O. 1898 Nemathelminthen von Herrn Richard Semon in Australien gesammelt. (Zoologische Forschungsreisen, etc. Jena.) Denk. Med.-Naturw. Ges., Jena, **8**, 469-472

LINSTOW, O. 1899 Nematoden aus der Berliner Zoologischen Sammlung. Mitt. Zool. Samml. Mus. Naturk. Berlin, 1 (2), 5-28

WARD, H. B., and MAGATH, T. B. 1916 Notes on some Nematodes from Freshwater Fishes. Jour. Parasit., **3**, 57-64

YAMAGUTI, S. 1935 Studies on the Helminth Fauna of Japan. Part 9. Nematodes of Fishes. Jap. Jour. Zool., **6**, 338-386

A REVISION OF THE GENUS DESMOTHRIPS HOOD (THYSANOPTERA) IN AUSTRALIA

By H. VEVERS STEELE [1]

Summary

This genus was erected by Hood in 1915 for the Australian species Orothrips austra1is Bagnall 1914. The following species have been described from this country. ♀ Desmothrips australis Bagnall 1914 (syn. ♂ Archaeolothrips fontis Bagnall 1924; Bagnall and Kelly 1928), ♀ tenuicornis Bagnall 1916, ♀ propinqus Bagnall 1916, ♀ bagnalli Karny 1920, ♀ obsolctus Bagnall 1924, ♂ comparabilis Priesner 1928, ♀ & ♂ davidsoni Morison 1930, ♀ elegans Morison 1930.

A REVISION OF THE GENUS DESMOTHRIPS HOOD (THYSANOPTERA) IN AUSTRALIA

By H. Vevers Steele [1]

[Read 12 September 1940]

This genus was erected by Hood in 1915 for the Australian species *Orothrips australis* Bagnall 1914. The following species have been described from this country. ♀ *Desmothrips australis* Bagnall 1914 (syn. ♂ *Archaeolothrips fontis* Bagnall 1924; Bagnall and Kelly 1928), ♀ *tenuicornis Bagnall* 1916, ♀ *propinquus* Bagnall 1916, ♀ *bagnalli* Karny 1920, ♀ *obsoletus* Bagnall 1924, ♂ *comparabilis* Priesner 1928, ♀ & ♂ *davidsoni* Morison 1930, ♀ *elegans* Morison 1930.

They have been differentiated mainly on: (a) the shading of the fore-wings; (b) the length of the third antennal segment; and (c) the colouration of the distal half of the same antennal segment.

In these and other characters *Desmothrips davidsoni* Morison differs from all the rest. From the description *D. tenuicornis* Bagnall seems to be a valid species.

In all the other species, however, the three characters given above tend to form a graded series (fig. A-F), but they are not always consistent within a particular specimen; for example, it is possible to find a specimen having the wing pattern of *D. australis* (in which the distal and middle fasciae are not confluent) and a yellowish third antennal segment shaded apically with light brown as in *D. elegans*. Consequently, I take *D. australis* Bagnall to be a very variable species embracing *propinquus* Bagnall, *bagnalli* Karny, *obsoletus* Bagnall, *comparabilis* Priesner, and *elegans* Morison.

Range of Variation in the above Characters

(a) Shading of fore-wing (fig. A-F). In nearly all specimens a small patch of brown at the base extends partly or wholly on to the alula. There are two transverse fasciae, one in the middle, the other at the distal end of the wing, varying in the extent to which they are confluent. The rest is clear.

In the original description of *D. australis* the transverse fasciae are not joined (fig. A). In one specimen examined they were united only by the darkening of the anterior and posterior veins. In the next stage (fig. B) the wing begins to darken just anterior to the posterior vein. Then, as in fig. C-D, the colour gradually extends forwards until the area between the posterior vein and the posterior marginal vein becomes completely brown (fig. E) as in *D. bagnalli, comparabilis, elegans,* and *obsoletus.* Finally, the brown extends partly into the area between the anterior and posterior veins (fig. F). Intermediates occur.

(b) In the specimens examined the length of the third antennal segment varied in the ♀ from 84 μ to 117 μ, and in the ♂ from 73 μ to 91 μ.

(c) The pale brownish-yellow third antennal segment varied from a slight brown area at the tip, to the distal half wholly dark brown.

Variations are also to be found in other characters, *e.g.*, in the number of segments in the maxillary and labial palpi. In some these varied from 6-8 and 3-4 respectively, and in one there were six segments to the maxillary palp on one side and seven on the other. The comparative length and width of the head also varied, but mostly it was wider than long, whether the wing fasciae were confluent or not.

[1] Mrs. H. G. Andrewartha.

The manner in which the above characters may be linked in different specimens may be illustrated as follows:

(a) by comparing the length of the third antennal segment in those in which the wing fasciae were joined along the posterior margin, with the length in those in which the fasciae are quite separated.

In 11 ♀♀ with the wing fasciae united, the lengths of the third antennal segments were 85, 85, 87, 88, 91, 97, 99, 100, 100, 102 and 110 μ respectively. In 12 ♀♀ with the fasciae free, the lengths were 84, 84, 86, 91, 92, 93, 93, 97, 100, 104, 108 and 117 μ. I have only one ♂ with confluent fasciae, and in this, the length of the third antennal segment was 73 μ. In those males with free fasciae the lengths were 74, 85, 87, 91 and 91 μ.

(b) by comparison of the lengths of the third antennal segment in those with the distal half of this segment brown, and those with only the apex brown. In the first case the lengths were 84, 84, 86, 91, and 102 μ in the ♀♀ and 73 μ in the ♂, in the second series they were 85, 85, 88, 91, 92, 93, 97, 97, 99, 100, 110 and 117 μ in the ♀♀ and 74, 87 and 91 μ in the ♂♂.

(c) by comparing the colouration of the third antennal segment with the variation in shading of the fore-wing, as follows:

1 Distal half of third antennal segment brown: wing fasciae confluent 2 ♀♀, 1 ♂; wing fasciae free, 3 ♀♀, 0 ♂.

2 Distal half not brown, only apex: wing fasciae confluent, 7 ♀♀, 0 ♂; wing fasciae free, 5 ♀♀, 3 ♂♂.

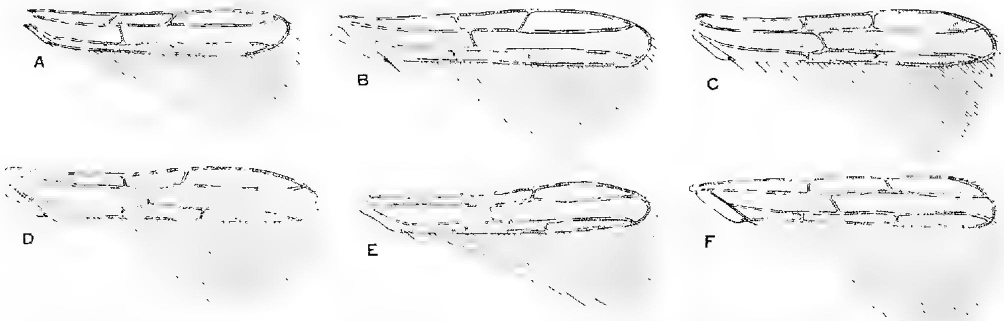


Fig. A-F Right fore-wing of specimens from: A, Kalorama, Vict.; B, Adelaide, S. Aust.; C, Warragul, Vict.; D-F, Adelaide, S. Aust.; F, Montville, Qld.

It appears that there are only three valid species of *Desmothrips* known from Australia, as follows: *davidsoni* Morison, *tenuicornis* Bagnall and *australis* Bagnall, the rest falling as synonyms of *D. australis*.

I again wish to extend my thanks to the authorities cited in my previous paper (Trans. Roy. Soc. S. Aust., 64 (2), 325), and, in addition, to Mr. N. E. H. Caldwell for the loan of Queensland material.

References

Bagnall, R. S. 1914 Ann. and Mag. Nat. Hist., (8) **13**, 287
Bagnall, R. S. 1916 *Ibid.*, (8) **17**, 397
Bagnall, R. S. 1924 *Ibid.*, (9) **14**, 626
Bagnall, R. S., and Kelly, R. 1928 Ent. Mon. Mag., Oxford, **64**, 204
Hood, J. D. 1915 Proc. Biol. Soc., Washington, **28**, 57
Karny, H. H. 1920 Acta Soc. Ent. Cech., **17**, 36
Morison, G. 1930 Bull. Ent. Res., **21**, 449-453
Priesner, H. 1928 Sitz. Ber. Akad. Wiss., Wien, Abt. I, Bd. 9

SOME FILARIAL PARASITES OF AUSTRALIAN BIRDS

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

Summary

Much of the material dealt with in this paper was, collected by Professor J. B. Cleland the late Dr. T. L. Bancroft and the late Dr. MacGillivray; most of the remainder by the senior author. Acknowledgment is made of assistance received through the Commonwealth Research Grant to the University of Adelaide. Types of new species have been deposited in the South Australian Museum.

SOME FILARIAL PARASITES OF AUSTRALIAN BIRDS

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

[Read 12 September 1940]

Much of the material dealt with in this paper was collected by Professor J. B. Cleland, the late Dr. T. L. Bancroft, and the late Dr. MacGillivray; most of the remainder by the senior author. Acknowledgment is made of assistance received through the Commonwealth Research Grant to the University of Adelaide. Types of new species have been deposited in the South Australian Museum.

List of parasites arranged under their hosts:

Passeriformes

Corvus coronoides Vig. and Horsf. (Eidsvold, Burnett River, Qld.), *Diplotriaena beta* n. sp.; (Musgrave Ranges, South Australia), *Aprocta corvicola* n. sp.

Strepera graculina White (Mount Irvine, South Australia), *Diplotriaena* n. sp.; (Scone, New South Wales) *Paralemdana clelandi* n. g., n. sp.

Graucalus melanops Latham (Fraser Island, Queensland), *Carinema graucalinum* n. sp.

Malurus lamberti Vig. and Horsf. (Ooldea, South Australia), *Diplotriaena delta* n. sp.

Cracticus destructor Temm. (Brisbane), *Diplotriaena epsilon* n. sp.

Myzantha flavigula Gould (Renmark, South Australia), *Pseudaprocta myzanthae* n. sp.

Acanthogenus rufigularis Gould (Monarto, South Australia); *Diplotriaena zeta* n. sp.; (Eidsvold, Queensland) *Filaria* (s.l.) sp.

Aphelocephala nigricincta North (Musgrave Ranges, South Australia), *Austrofilaria vestibulata* n. g., n. sp.

Spres superbus (Abyssinia, via Adelaide Zoological Gardens), *Diplotriaena gamma* n. sp.

Coraciiformes

Halcyon vagans Lesson (Lord Howe Island), *Hamatospiculum howense* n. sp.

Psittaciformes

Calopsittacus novae-hollandiae Gmelin (New South Wales), *Filaria* (s.l.) sp.

Pseudopsittacus mclennani MacGillivray (North Queensland), *Carinema dubia* n. sp.

Columbiformes

Columba livia Linn. (Adelaide), *Eulimdana clava* (Wedl) Founikoff.

Hamatospiculum howense n. sp

(Fig. 1-2)

From subcutaneous tissues of head and neck of *Halycon vagans*, Lord Howe Island.

Males up to 20 mm. in length, 0·4 mm. diameter; females to 35 mm. in length, 0·62 mm. diameter. Body cylindrical with rounded ends. Head with two short lateral cuticular projections on either side of small mouth, projections continuous with short root in hypodermis; externally from each is row of five papillae. Anterior part of oesophagus short, 0·2 mm. long in male, 0·3 mm. long in female; surrounded by nerve ring about mid-length; posterior part very long, reaching a third of body length.

Male—Tail rounded, cloaca 50 μ from tip; very slight alae in front of cloaca; one pair of large postanal and five pairs small preanal papillae, latter in alae. Spicules tapering to point, very unequal in size, 2·3 mm. and ·27 mm. in length.

Female—Anus atrophied, posterior gut not seen. Vulva salient, 1·2 mm. from head end. Eggs thick-shelled, 31 μ by 19 μ.

This species closely resembles *H. leticiae* Tubangui 1934, differing in the number of postanal papillae, the relative position of vulva, and the size of the eggs.

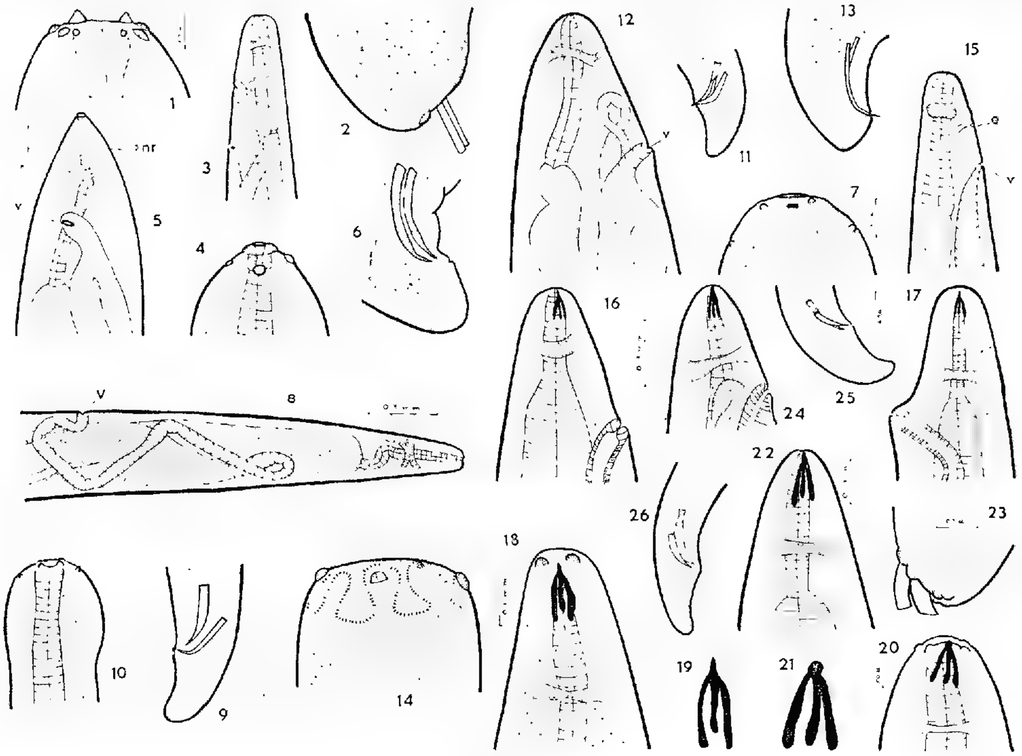


Fig. 1-26

Fig. 1-2, *Hamatospiculum howense:* 1, head; 2, tail of male. Fig. 3, *Paralemdana clelandi:* anterior end. Fig. 4-6, *Austrofilaria vestibulata:* 4, head; 5, anterior end; 6, tail of male. Fig. 7-9, *Carinema dubia:* 7, head; 8, anterior end; 9, male tail. Fig. 10-11, *Carinema graucalinum:* 10, head; 11, male tail. Fig. 12 13, *Aprocta corvicola:* 12, anterior end; 13, male tail. Fig. 14-15, *Pseudaprocta myzanthae:* 14, head, sub-lateral view; 15, anterior end. Fig. 16, *Diplotriaena alpha.* Fig. 17, *Diplotriaena beta.* Fig. 18 19, *Diplotriaena gamma:* 18, anterior end; 19, trident. Fig. 20-21, *Diplotriaena delta:* 20, anterior end; 21, trident. Fig. 22-23, *Diplotriaena epsilon:* 22, anterior end; 23 tail of male. Fig. 24, *Diplotriaena zeta.* Fig. 25, *Filaria* (s.l.) sp. from *Acanthogenys rufigularis*, male tail. Fig. 26, *Filaria* (s.l.) sp. from *Calopsittacus novae-hollandiae*, male tail.

Fig. 2. 4, 9, 10, 11, and 14 to same scale; fig. 3, 5, 8, 12, 13, 15, 16, 17 and 24; fig. 19, 21, 25, 26.

e, excretory pore; nr, nerve ring; v, vulva.

Paralemdana clelandi n. g., n. sp.

(Fig. 3)

From body cavity of *Strepera graculina* from Scone, New South Wales (Coll. Professor Cleland). A single female 13 mm. long, 0·55 mm. wide. Head truncated, posterior end rounded; mouth small, circular, leading through small ring of chitinous material to oesophagus; latter cylindrical, muscular, 0·5 mm.

long, surrounded by nerve ring at 0·11 mm. from head. At least four head papillae. Vulva about middle of oesophageal region; uteri uniting well behind this, passing posteriorly beyond mid-body; an ovary at either end of body; no ripe eggs present. Tail, 0·1 mm. long; anus distinct.

Not being assignable to any genus already erected, we suggest a new genus of Filariinae, **Paralemdana,** near Lemdana Seurat, characterised by a smooth anterior end; short wide oesophagus, not divided into two parts; vulva in oesophageal region; tail rounded and short; anus present. Type, *P. clelandi* n. sp.

Austrofilaria vestibulata n. g., n. sp.

(Fig. 4-6)

From *Aphelocephala nigricincta*, Musgrave Ranges, South Australia. Males 8·5 to 9·5 mm. long, 0·4 mm. wide; females 20 to 25 mm. long, 0·6 mm. wide. Head with four submedian papillae and possibly two lateral papillae; body cylindrical, conical anteriorly, rounded posteriorly. Stout chitinous cylindrical vestibule, anterior edge rolled outwards, forming thick ring around mouth, projecting beyond the body proper; in male, vestibule 25 μ long, 21 μ wide at base, inclusive of walls. Oesophagus 0·6 mm. long in male; 0·76 mm. in female; with an anterior thinner part 0·24 mm. long. Nerve ring difficult to distinguish; either at base of anterior part of oesophagus or around its mid-length.

Male—Caudal papillae absent; spicules equal, tapering, ·25 mm. long. No gubernaculum. Posterior end forming spiral of one and a half coils; tail 0·15 mm. long.

Female—Tail 0·1 mm. long; uteri uniting near vulva; latter 0·5 mm. from head. Eggs thick-shelled, 40 μ by 25 μ.

The characters of the head of this worm do not agree with those of any genus of the Filarioidea hitherto described, so far as we have been able to determine. The presence of a well-defined chitinous support in the buccal region indicates a member of the subfamily Setariinae. We suggest a new genus, **Austrofilaria,** with characters as follows:—*Setariinae;* cylindrical worms with rounded posterior ends and conical heads; relatively large and well developed vestibule with stout chitinous supporting walls; short oesophagus of two parts. Male without caudal alae or papillae; with short, equal, similar spicules. Female with vulva in region of second part of oesophagus. Type, *A. vestibulata*, n. sp.

Carinema dubia n. sp.

(Fig. 7-9)

From abdominal cavity of *Pseudopsittacus mclennani,* North Queensland, (coll. Dr. MacGillivray). Females about 25 mm. long, 0·32 mm. wide; male 15 mm. long, 0·184 mm. wide. Head rounded with four submedian and two lateral papillae, all very small. Mouth circular, leading by 3 μ long funnel-shaped vestibule to oesophagus; this tiny vestibule at its base surrounded by chitinous ring. Oesophagus very narrow, division into two parts more clearly indicated in some specimens than others, the distinction being that of cell structure, not of size. In male, oesophagus 0·38 mm. long, including anterior part 0·2 mm.; in female anterior portion 0·25 mm., the whole organ 0·45 mm. Nerve ring surrounding oesophagus at base of first part.

Male—Tail blunt, not coiled. Cloaca 0·7 mm. from posterior end. Perhaps a pair of papillae immediately anterior to, and a pair immediately posterior to, cloaca, but these (seen only in lateral view of the single male) may be the lips of the cloacal opening; latter on a prominence. Apart from these no caudal papillae have been observed. Spicules equal, tapering distally, 10 μ long.

Female—Tail rounded; anus not observed; vulva 1·7 mm. from head; uteri uniting at about this level, median uterus passing forward nearly to oesophagus; vagina coming back from this region to vulva. Uteri packed with larvae, on which no sheaths were detected. Larvae 4 μ in diameter, 360 to 370 μ long, with rounded anterior ends and elongate tails.

It is with some reserve that this species is assigned to *Carinema* because of the division of the oesophagus into two parts and the presence of six cephalic papillae and a buccal ring in our species.

Carinema graucalinum n. sp.

(Fig. 10-11)

From *Graucalus melanops*, Fraser Island, Queensland. One male and several females obtained. Male 8 mm. long, female 15-18 mm. long with maximum breadth of 0·15 and 0·32 mm. respectively. Anterior end somewhat club-shaped, with four submedian papillae around mouth. Oesophagus 0·4 mm. long in male, 0·55 mm. in female, cylindrical, surrounded anterior to its mid-length by nerve ring. Lateral lines marked by a double row of small refracting bodies under cuticle.

Male—Spicules subequal, about 60 μ long, spatulate, with rolled edges and terminating in narrow spine. Cloaca 50 μ from rounded tip of tail; caudal alae absent; and caudal papillae not seen.

Female—Vulva 0·95 mm. from head (*i.e.*, post-oesophageal). Anus probably absent; rectum not seen in any specimen, but in one there was an elevation resembling anal region at 0·2 mm. from the tip. Larvae in uteri 270 to 290 μ long, 5 to 6 μ in diameter, with rounded head and pointed tail; no sheath observed.

This species seems to be more closely related to *Carinema* than to any other genus. It differs from the only other known species, *C. carinii* Pereira and Vaz from a Brazilian bird and *C. dubia*, in the number of head papillae.

Aprocta corvicola n. sp.

(Fig. 12-13)

From behind the eye of *Corvus coronoides*, from the Musgrave Ranges. Males 12 to 20 mm. long, about 0·6 mm. in diameter; females 50 to 60 mm. long, 0·8 mm. diameter. Anterior end rounded; mouth circular; oral papillae not observed, small thistle-shaped vestibule leading to simple, narrow oesophagus; latter 0·65 mm. long in male, 0·7 mm. long in female, surrounded by nerve ring just behind its anterior end, 0·1 mm. from head in male, 0·15 mm. in female.

Male—Tail 0·2 mm. long, blunt, rounded. Neither papillae nor caudal alae present. Spicules equal, 0·28 to 0·32 mm. long.

Female—Uteri uniting very close to vulva, forming a short median uterus; vagina 0·1 mm. long; vulva 0·6 mm. behind head, about the middle of oesophageal region. Eggs thick-shelled, 45 to 50 μ by 30 μ, containing coiled larva.

The species differs in the position of the vulva from any other member of the genus the description of which we have been able to obtain.

Pseudaprocta myzanthae n. sp.

(Fig. 14-15)

From *Myzantha flavigula* (yellow-throated minah) (Coll. Dr. Cleland), 75 miles north of Renmark, South Australia. Only three females were taken, 23 to 24 mm. long.

Anterior end rounded, head with four submedian and two smaller lateral papillae. Dorsal and ventral papillae not seen. Cuticular ornamentation of anterior end characteristic of genus festooned above and between cephalic papillae. Buccal cavity 20 μ long, 23 to 25 μ wide. Oesophagus 0·6 to 0·65 mm. long; nerve ring at 0·15 mm. and excretory pore at 0·23 mm., from head end.

Tail rounded, 0·2 to 0·23 mm. long, ending in papilla-like tip, and bearing pair of large rounded papillae in lateral positions, 30 μ from tip. Anus well marked; rectum strongly cuticularised.

Vulva not salient, 0·3 to 0·4 mm. from head. Ripest eggs in vagina 50 to 55 μ by 30 μ, thick-shelled, containing larvae.

The differences between the two species of the genus previously described, *P. gubernacularia* by Shikhobalova and *P. decorata* by Li, depend (according to Li) on male characters. Since the present material consists only of females, it is impossible to continue the comparison on these lines; in our specimens, however, the cephalic festoons appear to be somewhat differently arranged in ventral and dorsal positions, and the eggs are much larger than in Li's species, while the female tail is longer than in that described by Shikhobalova. From these distinctions and the difference in distribution of the hosts, we assume it to be a new species.

DIPLOTRIAENA Railliet and Henry

The characters of this genus have been discussed by Li (1933, 193). As he points out, the features of most value systematically are the tridents and the spicules. In our material few males are present, and we have several species represented by female worms only, so that we have been compelled to rely on differences in lengths of body and trident and the relation of the latter to the position of nerve ring. In many of our specimens the posterior tips of the tridents were not clearly defined, so that it was often uncertain whether the middle prong was shorter than the lateral ones.

To facilitate comparison of our species the following table is appended, all measurements being in millimetres except where otherwise stated:

	alpha	beta	gamma	delta	epsilon		zeta
	♀	♀	♀	♂	♀	♂	♀
Length	70–90	56–69	58–68	34	to 45	to 20	36
Breadth	·95	·84		·45	·55	·45	·8
Antr. Oesoph.	·32	·47	not	·3	·4	·3	2·6
Postr. Oesoph.	5·7	5–6?	divided	2·8	?	2·0	
Tridents	·12	·17	·09	·08, ·095		·13	·15
Head—Nerve Ring	·25	·33	·22	·18		·22	·32
Head—Vulva	·7	·6	·4		·68		·5
Eggs, breadth	34 μ		14μ		25 μ		
,, length	50 μ		30μ		40–41 μ		
Tail	90 μ						
Spicule 1				Broken		·6–·7	
,, 2				Broken		1·2–1·4	

Diplotriaena alpha n. sp.

(Fig. 16)

From *Strepera graculia*, Mount Irvine, South Australia (Coll. Professor Cleland). Two females from the peritoneum, one 70 and the other 90 mm. long, both about 0·96 mm. wide. Anterior end rounded, with two small lateral and two smaller submedian papillae. Tridents 0·11 mm. long in longer worm and 0·13 mm. in shorter worm; in the latter the two tridents are not similar in shape, the median prong being the longest on one side, but the three of equal length on the other side. In the larger worm both tridents are alike and have three equal prongs. Anterior narrow part of oesophagus 0·3 to 0·35 mm. long, surrounded by nerve ring on its second half, 0·25 to 0·26 mm. from head; posterior part of oesophagus ending about 6 mm. from head. Vulva 0·7 mm. from head, *i.e.*, shortly after beginning of second part of oesophagus. Uteri uniting 1·8 mm. behind vulva; vagina straight. Eggs, 35 μ by 50 μ. Tail rounded, anus 90 μ from tip.

Diplotriaena beta n. sp.

(Fig. 17)

From *Corvus coronoides*, collected by the late Dr. T. L. Bancroft at Eidsvold. Two females present, 56 and 69 mm. long, 0·84 mm. wide. Anterior end rounded with four low papillae in submedian positions. Tridents 0·16 and 0·19 mm. long. Anterior part of oesophagus 0·43 to 0·5 mm. long; termination of second part not seen, owing to conditions of specimens. Nerve ring 0·32 to 0·34 mm. from head. Vulva on shoulder-like prominence of body 0·59 to 0·6 mm. from head end, *i.e.*, just posterior to beginning of second part of oesophagus. Eggs absent.

Diplotriaena gamma n. sp

(Fig. 18-19)

From *Spres superbus*, the Abyssinian starling, obtained from the Adelaide Zoological Gardens through the courtesy of the South Australian Museum. Two females present, 58 and 68 mm. long. Head rounded, with four large submedian and two smaller lateral papillae. Tridents 90 μ long, middle prong shortest, posterior tip of each prong somewhat enlarged. In specimen 58 mm. long nerve ring 0·22 mm. from head. Oesophagus apparently of the "undivided" type, its posterior end indistinguishable because of the twisted mass of uteri obscuring it. Vulva at 0·4 mm. from head end, lip salient. Uteri uniting about 1·2 mm. from vulva. Eggs, 30 μ by 40 μ.

Diplotriaena delta n. sp.

(Fig. 20-21)

From *Malurus lamberti* collected by Dr. J. B. Cleland at Ooldea. One male only present, 34 mm. long, 0·45 mm. wide. Anterior end with four large submedian papillae. Tridents bossed, of unequal length, 95 and 80 μ long, the three prongs being of almost equal lengths. Oesophagus of two parts, anterior 0·3 mm. long, posterior 2·5 mm.; nerve ring 0·18 mm. from head. Posterior end is broken off, one broken spicule showing.

Diplotriaena epsilon n. sp.

(Fig. 22-23)

From *Cracticus destructor*, collected at Brisbane by Dr. F. S. Roberts. Several males and females present, males up to 20 mm. and females up to 45 mm. in length, breadths respectively 0·45 and 0·55 mm.

Anterior end without apparent papillae. Tridents about 130 μ long in male; branches more or less equal length, with bosses. Oesophagus of two parts, anterior 0·3 mm. long in male, 0·4 in female, the termination of posterior obscured, in male probably 2 mm. from head end. Nerve ring in male 0·22 mm. from head end.

Tail of male rounded; two pairs of papillae before and two behind the subterminal cloaca, the two post-cloacal almost terminal in position. Spicules unequal; one 1·2 to 1·4 mm. long, tapering suddenly to end in a short spike; the other 0·6 to 0·7 mm., twisted, ending in a broad tip.

Vulva in region of beginning of second part of oesophagus, lips slightly salient. Eggs 40 to 41 μ by 25 μ, thick-shelled, with coiled larvae.

These appear to be much slighter worms than those from *Strepera* or *Corvus*; the eggs are relatively wider and there was no sign of submedian papillae.

Diplotriaena zeta n. sp.

(Fig. 24)

From the body cavity of *Acanthogenys rufigularis,* the spiny-cheeked honey-eater, from Monarto, South Australia (coll. Professor Cleland).

One female worm present, 36 mm. long, 0·8 mm. wide. Tridents 0·15 mm. long, with anterior tip prolonged to a point, not rounded as in *D. delta.* Nerve ring 0·32 mm. from head end; oesophagus of undivided type, 2·6 mm. long. Vulva ·5 mm. from head end.

Eulimdana clava (Wedl) Founikoff 1934

Several specimens of this species were found in the type host, *Columba livia,* from Adelaide. The females are up to 24 mm. in length, the measurements and structure agree exactly with Founikoff's description.

Filaria (s.l.) sp.

Fig. 25

From *Acanthogenys rufigularis,* from Burnett River District, collected by the late Dr. T. L. Bancroft. One male and parts of several females not including the posterior end, were present. Male 7·5 mm. long, 0·13 mm. wide; longest female part apparently more than a quarter of the body length, 10 mm. long, 0·32 mm. wide. Females so badly preserved that it is impossible to see internal organs. Male shows a rounded head, no head papillae, a small mouth leading to a 0·38 mm. long oesophagus surrounded just anterior to its mid-length by the nerve-ring. Tail rounded 0·7 mm. long, bearing no caudal alae or papillae. Spicules tapering, almost equal in length, 50 μ long. Because of the incomplete description it was considered unwise to assign the worm to any genus. Microfilariae were recorded from the blood of this host species in New South Wales by the senior author, in 1912.

Filaria (s.l.) sp.

(Fig. 26)

The posterior end of a male worm and the anterior end of a female were collected from *Calopsittacus novae-hollandiae* from New South Wales. Female fragment 2·9 mm. long, ·13 mm. wide; male 3·8 mm. long, ·13 mm. wide. Head smooth, rounded, showing no papillae. Vestibule supported by a narrow chitinous ring. Length of oesophagus and positions of anterior organs not ascertained. Male tail rounded at tip, 60 μ long, no papillae visible under oil immersion; spicules unequal, 60 μ and 45 μ in length, narrowing towards tips.

This species differs from *Carinema dubia* from *Pseudopsittacus mclennani* in that the head bears no papillae and the spicules are unequal. It has many features in common with *Filaria* (s.l.) sp. from *Acanthogenys rufigularis,* but since in that form the spicules are equal and no peri-buccal chitinous ring was observed, and in view of the different hosts, it is considered wise not to identify the worms with one another.

Literature

Li, H. C. 1933 Report on a collection of parasitic worms, mainly from North China. Parasitol., **25**, 192-223

Founikoff, S. 1934 Situation de Filaria clava Wedl 1855 des pigeons dans la classification des nematodes. Ann. Parasit., **12**, 61-66

Johnston, T. H. 1912 Notes on some entozoa. Proc. Roy. Soc. Qld., **24**, 63-91

Shikhobalova, N. 1930 Sur une nouvelle filaire des oiseaux: Pseudaprocta gubernacularia n. g., n. sp. Ann. Parasit., **8**, 624-627

Tubangui, M. A. 1934 Nematodes in the collection of the Philippine Bureau of Science, ii, Filarioidea. Philippine Journal of Science, **55**, 115-123

NOTES AND EXHIBITS

TILLITE AND OTHER ROCKS FROM HALLETT COVE S.A.

Summary

Earlier this year, when Mr. Segnit presented to the Society his paper on the Geology of the Hallett Cove Area, it was not possible to adequately discuss his findings, for, in the case of papers read before this Society, we are not supplied with abstracts ; in any case, the paper was too long to be read, there being time only for a general summary to be communicated.

NOTES AND EXHIBITS

Tillite and other Rocks from Hallett Cove, S.A.

Earlier this year, when Mr. Segnit presented to the Society his paper on the Geology of the Hallett Cove Area, it was not possible to adequately discuss his findings, for, in the case of papers read before this Society, we are not supplied with abstracts; in any case, the paper was too long to be read, there being time only for a general summary to be communicated.

Now that the paper has been printed, fellow geologists will be able to consider and profitably discuss many novel points presented in that contribution.

It is not my purpose to enter upon any thorough discussion of the paper tonight, though I may state that my views differ in many respects from those of Mr. Segnit.

There is, however, one matter which is rather fundamental to any discussion upon glacial sediments, *i.e.*, what is tillite? In his map of Hallett Cove Area much that has been mapped as tillite by Mr. Segnit is not what the petrographic term "tillite" connotes. "Till" is defined as unconsolidated, unassorted morainic matter. "Tillite" is the same thing in the consolidated state.

In the map, the whole of the deposits connected with the younger glaciation are indicated as tillite. Actually only a very small part of such beds is tillite, by far the greater portion being of fluvio-glacial origin; much of it, too, is well-assorted fluvial sands and clays, no doubt derived from more or less distant morainic debris of the same age.

In the case of the older tillite, indicated on the map as occupying a considerable part of the northern end of the area, I have failed to find any tillite whatever in that locality. Where older tillite is shown, I found mainly sandstones and shales which are gritty and arkosic in their upper limits. In one or two places small fragments of rock, inhomogeneous with the main body, are embedded in it, but these can be well accounted for as of intraformational origin and, in other cases, as scattered spots in the rocks which have suffered subsequent chemical change, the original red colour of the rock having been bleached to yellow. I could find nothing in the nature of true tillite. Indeed, the pervading red colour of the rock is good evidence that this is not a glacial bed.

The real Sturtian tillite, with which this has been coupled in the paper under discussion, is developed only about three or four miles away in the Sturt Gorge. It is there an absolutely typical tillite, unassorted, grey in colour and packed with characteristically shaped erratics of a wide range of igneous, metamorphic and sedimentary rocks.

If Mr. Segnit wishes still to contend that the formation north-west of the Hallett Cove Railway Station is tillite, then it must be considered as not corresponding to that of the Sturt Gorge, but to be evidence of a second and later Proterozoic Ice Age.

D. Mawson

12 September 1940

A KEY TO THE NEMATODE PARASITES OF AUSTRALIAN MARSUPIALS AND MONOTREMES

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

Summary

The number in parenthesis after the name of the author of a genus or species refers to the reference (given at the end of this paper) to the original description of the parasite; where two or more reference numbers are given, the succeeding ones relate to additional descriptions. No attempt has been made to give all the literature referring to each species. The references are to such accounts as will make it possible to identify each species, as well as the genus, when the latter is peculiar to marsupials or monotremes. All distinctions, as far as possible, have been drawn from characters common to both sexes. Where this is impossible we have tried to find points of difference in both males and females. We have avoided as much as possible drawing distinctions from measurements of parts of the body, as we have found great variation in size in some species.

A KEY TO THE NEMATODE PARASITES OF AUSTRALIAN MARSUPIALS AND MONOTREMES

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

[Read 12 September 1940]

The number in parenthesis after the name of the author of a genus or species refers to the reference (given at the end of this paper) to the original description of the parasite; where two or more reference numbers are given, the succeeding ones relate to additional descriptions. No attempt has been made to give all the literature referring to each species. The references are to such accounts as will make it possible to identify each species, as well as the genus, when the latter is peculiar to marsupials or monotremes. All distinctions, as far as possible, have been drawn from characters common to both sexes. Where this is impossible we have tried to find points of difference in both males and females. We have avoided as much as possible drawing distinctions from measurements of parts of the body, as we have found great variation in size in some species.

To reduce the matter in the key, some abbreviations have been used; thus Y. & M. for Yorke and Maplestone, D. & W. for Davey and Wood, J. & M. for Johnston and Mawson. Since in all the species of Strongylidae from marsupials the dorsal ray divides into four branches (in nearly all species by two successive divisions), we have referred to "first branches" and "final branches," and to "first bifurcation" and "second bifurcation" of this ray without further explanation. The first branches are the two resulting from the first bifurcation of the ray, and the "final branches" are the four resulting from the bifurcation ("final bifurcation") of each of these two.

We have used the term "buccal ring" to indicate a chitinised ring around the buccal cavity; and the terms bipartite and tripartite to indicate a transverse division into two or three parts respectively.

KEY TO SUPER-FAMILIES

1	Oesophagus consisting of a narrow tube passing through the centre of a row of single cells.	Trichuroidea	
	Oesophagus not as above.		2
2	Males with a bursa copulatrix supported by rays.	Strongyloidea	
	Males without a bursa copulatrix.		3
3	Oesophagus dilated posteriorly to a bulb.	Oxyuroidea	
	Oesophagus not dilated posteriorly to a bulb.		4
4	Head with two lateral lips.	Spiruroidea	
	Head without lips.	Filarioidea	

KEYS TO FAMILIES AND SUB-FAMILIES

Trichuroidea Railliet 1916

	Male with spicule or copulatory sheath.	Trichuridae
	Anterior part of body longer than posterior.	Trichurinae

Strongyloidea Weinland 1858

1	Short filiform worms with buccal capsule usually small or absent.	Trichostrongylidae
	Female with double genitalia.	Trichostrongylinae
	Stout worms with buccal capsule well developed.	2
2	Mouth opening with teeth or cutting plates.	Ancylostomatidae
	Buccal capsule sub-globular with cutting plates.	Necatorinae
	Mouth opening without teeth or cutting plates.	Strongylidae
	Buccal capsule cylindrical or ring-shaped.	Trichoneminae
	Buccal capsule sub-globular.	Strongylinae

OXYUROIDEA Railliet and Henry 1916

Male with pre-cloacal sucker.	Subuluridae
Anterior part of oesophagus much longer than bulb.	Subulurinae
Male without pre-cloacal sucker.	Oxyuridae
Male with gubernaculum.	Syphaciinae
Male without gubernaculum.	Oxyurinae

SPIRUROIDEA Railliet and Henry 1915

Cuticle with chitinous spines anteriorly.	Rictulariidae (Rictulariinae)
Cuticle smooth, cephalic collarette present.	Physalopteridae (Physalopterinae)
Cuticle smooth, cephalic collarette absent.	Spiruridae
Lips large, trilobed.	Spiroxyinae

FILARIOIDAE Weinland 1858

Vulva atrophied in gravid female.	Filariidae
Mouth surrounded by chitinous ring.	Setariinae

KEYS TO GENERA AND SPECIES IN EACH SUB-FAMILY

TRICHURINAE Ransom 1911

With the characters of the subfamily — *Trichuris* Roederer
From Australian marsupials (bandicoots). — *Trichuris peramelis* Baylis (6, 21)

TRICHOSTRONGYLINAE Leiper 1908

1 With definite buccal capsule. — 2
Without definite buccal capsule. — 3

2 Buccal capsule containing one dorsal tooth only. — *Nicollina* Baylis (3, 4)
a Dorsal tooth about half length of buccal capsule. — *sarcophili* Cameron (11)
Dorsal tooth nearly as long as buccal capsule. — b
b Body with 10 to 12 longitudinal crests. — *tachyglossi* Baylis (3)
Body without longitudinal crests. — *echidnae* Baylis (3)
Buccal capsule containing one dorsal, and one or two ventral teeth. — *Austrostrongylus* Chandler (12)
a Dorsal ray dividing into three pairs of branches. — b
Dorsal ray dividing into two pairs of branches. — c
b First pair of branches arising before mid-length. — *thylogale* J. & M. (24)
All three pairs of branches arising together. — *aggregata* J. & M. (25)
c First pair branches of dorsal ray arising just proximal to final bifurcation. — *macropodis* Chandler (13)
First pair of branches coming off at about mid-length of dorsal ray. — d
d One ventral tooth; vulva one-sixth body-length from tip of tail. — *wallabiae* J. & M. (20)
Two ventral teeth; vulva one-ninth body-length from tip of tail. — *minutus* J. & M. (18)

3 Bursa asymmetrical. — *Asymmetricostrongylus* Nagaty (34, 35)
a Head with six lips. — *trichuris* J. & M. (20)
Head without lips. — b
b Dorsal ray dividing after half length. — *dissimilis* (Wood) (39)
Dorsal ray dividing about third length. — c
c Vulval flap present in female; spicules ·19 to ·21 mm. long. — *australis* (Wood) (39)
No vulval flap; spicules ·17 mm. long. — *asymmetricus* (Cameron) (10)
Bursa not asymmetrical. — *Filarinema* Mönnig (33)
Dorsal ray bifurcating at mid-point. — *flagrifer* Mönnig (33)
Dorsal ray bifurcating near tip; pair of lateral branches given off posterior to root of externo-dorsal ray. — *peramelis* J. &. M. (18)

The following unclassified Trichostrongyle worms have been recorded:
Trichostrongylus (s.l.) spp. J. &. M. (22), from *Dasyurus maculatus*.

NECATORINAE Lane 1917

Mouth opening antero-ventrally. — *Hypodontus* Mönnig (32)
Males 13-15 mm. long; females 17-20 mm.; vulva ·24 mm. from tip of tail. — *macropi* Mönnig *(macropodis)* (32)
Male 11 mm. long; female 14 mm.; vulva ·3 mm. from tip of tail. — *thetidis* J. & M. (20)

Strongylinae Railliet 1893

Buccal capsule cylindrical, without tooth. *Oesophagostomoides (O. giltneri)* Schwartz (36)

Buccal capsule subglobular, with large tooth. *Globocephaloides* Y. & M. (40)

a Tooth about quarter length of buccal capsule, latter 130 μ long. *affinis* J. & M. (19)

Tooth about third length of buccal capsule, latter 55-60 μ long. *macropodis* Y. & M. (40)

Tooth about half length of buccal capsule, latter 55-60 μ long. b

b Chitinous supports to buccal capsule arising just behind its base. *wallabiae* J. & M. (19)

Chitinous supports arising well behind base. *thetidis* J. & M. (20, 25)

Trichoneminae Railliet 1916

1 Buccal capsule followed by vestibule. *Pharyngostrongylus* Y. & M. (40)
(For key to species see later.)

Vestibule absent. 2

2 No lips or papillae around mouth. *Spirostrongylus* (*S. spirostrongylus*) Y. & M. (40)

Six or eight prominent lips. 3

Four elongate papillae around mouth, usually bi-partite. 4

No definite lips but with 6 or 8 papillae around mouth. 5

3 Thin cuticular frill around neck region. *Parazoniolaimus* (*P. collaris*) J. & M. (20)

No such frill. *Zoniolaimus* Cobb (14, 19)
(For key to species see later.)

4 Internal leaf crown of six elements. *Cloacina* Linstow (28, 17)
(For key to species see later.)

Internal leaf crown of eight elements. *Phascolostrongylus* (*P. turleyi*) Canavan (12)

5 Buccal capsule elongate, anterior edge forming leaf crown of four elements. *Buccostrongylus* J. & M. (19)

a Head without definite lips and bearing four long setae. b

Head with definite lips. c

b Buccal cavity narrower at top; 20-30 μ long. *buccalis* J. & M. (19)

Buccal cavity wider at top; 70-80 μ long. *setifer* J. & M. (20)

c Head with six lips. *australis* J. & M. (19)

Head with two circles of two lips each. *labiatus* J. & M. (20)

Buccal cavity of varying length, no leaf crown. 6

Buccal capsule shallow, around base of buccal cavity. 7

6 Worms over 3 cm. long; final branches of dorsal ray round and short. *Paramacropostrongylus* (*P. typicus*) J. & M. (24)

Worms shorter than 3 cm.; final branches of dorsal ray tapering. *Cyclostrongylus* J. & M. (20)

a Oral papillae rounded. *gallardi* J. & M. (20)

Oral papillae cylindrical. *clelandi* J. & M. (20)

Oral papillae conical. b

b Oesophagus pear-shaped; spicule : body length = 1 : 5·6. *dissimilis* J. & M. (20)

Oesophagus cylindrical, ending in bulb; spicule : body length = 1 : 1·2. *wallabiae* J. & M. (20)

7 Leaf crown present. 8

Leaf crown absent. 9

8 Lateral oral papillae longer than submedian. *Macropostrongylus* Y. & M. (40)
(For key to species see later.)

Lateral oral papillae equal to or shorter than submedian. *Coronostrongylus* (*C. coronatus*) J. & M. (19)

9 Eight oral papillae of different shapes. *Papillostrongylus* (*P. labiatus*) J. & M. (19)

Six rounded oral papillae. *Maplestonema* (*M. typicum*) J. & M. (20)

Key to Species of Pharyngostronglus Y. & M. 1926

1 Vestibule longer than ·06 mm. 2

Vestibule shorter than ·06 mm. 5

2 Vestibule wall without striations. *iota* J. & M. (20)

Vestibule wall striated diagonally. 3

Vestibule wall with transverse striations. 4

3 Bifid bristles on submedian oral papillae. *gamma* J. & M. (19)

No bristles on oral papillae. *ornatus* D. & W (15)

4 Vestibule about ·06 mm. long. *eta* J. & M. (19)

Vestibule about ·2-·23 mm. long. *macropodis* Y. & M. (40)

5 Vestibule with wall subdivided. 6

Vestibule wall not subdivided. 7

6 Vestibule wall bipartite. — *epsilon* J. & M. (19)
Vestibule wall tripartite. — 8
7 Vestibule short, thick-walled. — *parma* J. & M. (20)
Vestibule with straight thin walls. — 9
8 Dorsal ray very stout; branches short. — *delta* J. & M. (19)
Dorsal ray thin; branches long, arched. — *zeta* J. & M. (19)
9 Bursa not papillated, lateral lobes not separated from dorsal. — *theta* J. & M. (20)
Bursa usually papillated, all lobes partly separated. — 10
10 Dorsal ray divided to base, each branch bidigitate. — *woodwardi* Wood (39)
Dorsal ray divided about mid-length. — 11
11 Leaf crown present. — 12
Leaf crown absent. — 13
12 Leaf crown of ten elements. — *brevis* Canavan (12)
Leaf crown of forty elements. — *australis* (Mönnig) (37)
13 Bristles on each oral papilla; spicule : body length = 1 : 3. — *beta* J. & M. (17)
No bristles on oral papillae; spicule : body length = 1 : 5-6. — *alpha* J. & M. (17)

Key to Species of Zoniolaimus Cobb 1898

1 Spicules 1·5 mm. long. — *brevicaudatus* Cobb (14, 20)
Spicules at least 5 mm. long. — 2
2 With six lips. — 3
With eight lips. — 10
3 With pair of accessory structures at base of each submedian lip. — *eugenii* J. & M. (23)
Without such structures. — 4
4 Lateral branches of dorsal ray arising before bifurcation. — 5
Lateral branches of dorsal ray arising after bifurcation. — 8
5 Ratio of spicule to body length about 1:9. — 6
Ratio of spicule to body length 1:3·2. — 7
6 Lateral lips each with one median papilla. — *bancrofti* J. & M. (19)
Lateral lips each with two papillae, at anterior margins. — *bipapillosus* J. & M. (19)
7 Dorsal ray long and narrow; lateral lips long; bristles on submedian lips long. — *clelandi* J. & M. (20)
Inner branches of dorsal ray long; vagina short; submedian papillae half-way up lips. — *communis* J. & M. (19)
Inner branches of dorsal ray short; vagina long; submedian papillae below half-way on lips. — *longispicularis* (Wood) (39, 17)
8 Posterior half of oesophagus widened. — 9
Oesophagus cylindrical. — *petrogale* (J. & M.) (17)
9 Ratio of spicules : body length = 1 : 6-9. — *uncinatus* J. & M. (19)
Ratio of spicules : body length = 1 : 2·6. — *onychogale* J. & M. (19)
10 Very short worms; males 7·75 mm. — *setifer* Cobb (14, 20)
Longer worms; males over 10 mm. — 11
11 Submedian lips shorter than others. — *wallabiae* J. & M. (20)
Submedian lips not shorter than others. — 12
12 Spicules short (1:8-10 body length). — 13
Spicules long (1:2·5-3·5 body length). — 14
13 Externo-dorsal and externo-lateral rays very short. — *labiostrongylus* (Y. & M.) (40)
Externo-dorsal and externo lateral rays three-quarters length of laterals. — *insularis* J. & M. (19)
14 First pair of branches of dorsal ray dividing at mid-length into fairly long branches with rounded ends. — *grandis* (J. & M.) (17)
First pair of branches of dorsal ray dividing near tips into short rounded branches. — *macropodis* (J. & M.) (17)

Zoniolaimus spp. not identified either because of their condition or because of the absence of males have been recorded from the following hosts: *Macropus thetis*, *M. major*, *M. ualabatus* and *M. ruficollis*.

Key to Species of Cloacina Linst. 1898

1 Without oral papillae. — *dubia* J. & M. (17)
With oral papillae. — 2
2 Without lateral lips. — *wallabiae* J. & M. (20)
With six lips, or no lips. — 3
3 With definitely inflated cervical cuticle. — 4
Without definitely inflated cervical cuticle. — 7
4 Oesophagus with accessory bulb. — 5
Oesophagus without accessory bulb. — 6

5	Buccal capsule long, narrow, thin-walled.	*liebigi* J. & M. (17)	
	Buccal capsule short, wide.	*inflata* J. & M. (17)	
6	Cuticular inflation extending to posterior end of oesophagus.	*expansa* J. & M. (20)	
	Cuticular inflation extending to middle of oesophagus.	*longispiculata* J. & M. (19)	
7	Oesophagus club-shaped or straight.		8
	Oesophagus with terminal bulb.		15
8	Buccal ring wavy.		9
	Buccal ring straight.		10
9	Elements of leaf crown separate; no accessory lips.	*bancroftorum* J. & M. (19)	
	Each element of leaf crown joined to accessory lip.	*thetidis* J. & M. (20)	
10	Submedian oral papillae prominent.		11
	Submedian oral papillae small.		13
11	Tips of elements of leaf crown recurved.	*magnipapillata* J. &. M. (20)	
	Tips of elements of leaf crown simple.		12
12	Distance from top of lips to oesophagus short.	*cornutus* (D. & W.) (15)	
	Distance from top of lips to oesophagus long.	*robertsi* J. & M. (19)	
13	Lateral branches of dorsal ray given off just after first branches.	*burnettiana* J. & M. (19)	
	Two first branches of dorsal ray each dividing near tip into pair of equal branches.		14
14	Oesophagus club-shaped.	*minor* (D. & W.) (15)	
	Oesophagus of more or less even width.	*curta* J. & M. (17)	
15	Oesophagus with cardiac as well as terminal bulb.		16
	Oesophagus with terminal bulb only.		17
16	Plump oral papillae; nerve ring around cardiac bulb.	*australis* J. & M. (17)	
	Plump oral papillae; cardiac bulb just anterior to terminal bulb.	*ernabella* J. & M. (17)	
	Thin oral papillae; buccal ring with narrow shelf projecting into cavity.	*vestibulata* J. & M. (24)	
17	Submedian papillae appearing spindle-shaped (proximal segment insignificant).		18
	Submedian papillae obviously of two segments.		19
18	Buccal ring thin and deep.	*linstowi* J. & M. (25)	
	Buccal ring stout and shallow.	*dahli* Linst. (28)	
19	Upper segments of submedian papillae shorter.		29
	Two segments of more or less equal length.		20
20	Buccal ring shallow, walls thick.		21
	Buccal ring deep, walls thin.		26
21	Submedian oral papillae short.		22
	Submedian oral papillae stout, large.		25
22	Lips deep (measuring above constriction at "neck").		23
	Lips shallow.		24
23	Leaf crown present; anterior edge of buccal ring straight.	*parva* J. & M. (17)	
	Leaf crown absent; anterior edge of buccal ring wavy.	*longelabiata* J. & M. (21)	
24	Lips plump; tips of elements of leaf crown blunt.	*obtusa* J. & M. (20)	
	Lips small; tips of elements of leaf crown pointed.	*gallardi* J. & M. (25)	
25	Submedian oral papillae standing away from head.	*hydriformis* J. & M. (17)	
	Submedian oral papillae bent towards mouth.	*frequens* J. & M. (17)	
26	Female very long, with attenuate posterior end.		27
	Female not especially attenuate.		28
27	Excretory pore just behind nerve ring.	*magna* J. & M. (17)	
	Excretory pore near bulb of oesophagus.	*communis* J. & M. (17)	
28	Spicules less than 1:2·5 body length; vagina about 1·3 mm. long.	*petrogale* J. & M. (17)	
	Spicules more than 1:3·5 body length; vagina about 0·5 mm. long.	*similis* J. & M. (19)	
29	Submedian papillae short, conical.	*macropodis* J. & M. (17)	
	Submedian papillae long.		30
30	Lips absent; spicules 1:3 body length.	*elegans* J. & M. (17)	
	Six lips; spicules half body length .	*digitata* J. & M. (25)	

Cloacina spp. not identifiable either because of their condition or because of the absence of males, have been recorded from the following hosts: *Macropus apicalis*, *M. welsbyi*, *M. agilis* and *Isoodon obesulus* by J. & M. (19); and from *Macropus ualabatus* and *M. thetis* by J. & M. (20).

Key to Species of Macropostrongylus Y. & M. 1926

1	Externo-dorsal ray arising from base of dorsal.	*baylisi* Wood (39)	
	Externo-dorsal ray not arising as above.		2
2	Buccal cavity supported only by ring at its base.	*australis* Y. & M. (40)	
	Walls of buccal cavity more or less completely chitinised.		3

3 Buccal capsule more than twice as long as broad. *labiatus* D. & W. (15)
Buccal capsule less than twice as long as broad. 4
4 Lateral and submedian papillae conical; laterals much larger. *macropostrongylus* Y. & M. (40)
Lateral papillae rounded; submedian conical. 5
All oral papillae rounded. 6
Submedian papillae rounded with digitiform projections; laterals large, domed. *macrostoma* D. & W. (15)
5 Buccal cavity about as deep as broad. *yorkei* Baylis (2)
Buccal cavity half to a third as deep as broad. *dissimilis* J. & M. (20)
6 Lateral papillae lip-like; much longer than submedian. *lesouefi* J. & M. (20)
Lateral papillae not much longer than submedian. 7
7 Shelf projecting from buccal capsule into buccal cavity; bifid bristle on each submedian papilla. *pearsoni* J. & M. (24)
No such shelf present; no bristles on papillae. *wallabiae* J. & M. (20)

SUBULURINAE Travassos 1914

Male with two spicules and gubernaculum; preanal sucker simple. *Subulura* Molin 1860
With six lips and six interlabia. *peramelis* Baylis (5, 21)
With six lips and no interlabia. *peragale* J. & M. (25)

SYPHACIINAE Railliet 1916

Vestibule unarmed; tail of male ending in spike. *Syphacia*
To this has been referred the species (male unknown). *trichosuri* J. & M. (18)

OXYURINAE Hall 1916

Vestibule unarmed; tail of male ending in spike. *Austroxyuris* (*A. finlaysoni*) J. & M. (18)
Vestibule with three teeth, male tail ending in spike. *Passalurus* Duj. 1845
To this has been referred the species. *parvus* J. & M. (18)

Other oxyuroid worms recorded but not classified are: *Oxyuris* (s.l.) *acuticaudata* J. & M. (18) from *Petauroides volans; Oxyuris* (s.l.) *potoroo* J. & M. (22) from *Potorous tridactylus*.

RICTULARIINAE Hall 1913

Series of circles of spines on anterior part of body; spines of first three rows very large. *Echinonema* (*E. cinctum*) Linst. (40)

PHYSALOPTERINAE Railliet 1893

Cervical papillae simple, caudal alae meeting in front of cloaca; vulva in front of middle of body; without prepuce-like sheath over head. *Physaloptera*
a No trilobed inner tooth on each lip. *papuensis* J. & M. (25)
Outer tooth on each lip shorter than inner. *peramelis* J. & M. (21)
Outer tooth on each lip longer than inner. b
b Cervical collarette wide, loose; vulva one-third body length from head. *sarcophili* J. & M. (25)
Cervical collarette almost absent; vulva just in front of mid-body. *parvicollaris* J. & M. (25)
Cervical collar of medium size. c
c Vulva one-third body length from head. *peragale* J. & M. (24)
Vulva a quarter body length from head. *thalacomys* J. & M. (25)

The following species has been recorded but not fully classified: *Physaloptera sp.* J. & M. (23) from *Thylogale eugenii.*

SPIROXYINAE Baylis and Lane 1920

With two large trilobed lips bearing teeth. *Protospirura* Seurat
To this has been referred the species. *marsupialis* Baylis (2, 7A, 18)

SETARIINAE Y. & M. 1926

All fully described filarial worms from Australian marsupials fall in the genus *Dipetalonema* Diesing 1861.

Key to Australian Species of DIPETALONEMA

1 Head so small that papillae indistinguishable. *capilliforme* Baylis (7)
Head papillae in two rings around head. *robertsi* J. & M. (18)
Three pairs head papillae. 2
Two pairs head papillae. 6

2 Lateral papillae large. 3
Lateral papillae small. 4
3 Buccal capsule spherical. *dendrolagi* Solomon (37)
Buccal capsule tubular. *tenue* J. & M. (16)
4 Male 57 cm.; female 9·5 cm. long; male with caudal papillae in ring around cloaca. *annulipapillatum* J. & M.
Male 10-13 cm.; female 18-40 cm.; male with caudal papillae in two longitudinal rows. 5
5 Shorter spicule quarter length of longer. *spelaea* (Leidy) (26, 38, 8, 16)
Shorter spicule half length of longer. *trichosuri* (Breinl) (9, 1, 16)
6 Female relatively stout; vulva in oesophageal region; wide caudal alae in male. *roemeri* Linst. (30, 1, 16)
Female thin; vulva just post-oesophageal; male unknown. *rarum* J. & M. (16)
Female thin; vulva some distance behind oesophagus; no caudal alae in male. *dasyuri* J. & M. (16)

The following unclassified *Dipetalonema* spp. have been recorded: from *Perameles nasuta* (lung); J. & M. (21, 22); *Macropus ruficollis* (liver) J. & M. (21); *Petrogale penicillata* (coelome) J. & M. (21); *Dendrolagus lumholtzii* (coelome) J. & M. (16); Wallaby, probably *Wallabia bicolor* (liver) J. & M. (23); *Macropus thetis* (liver) J. & M. (25). *D.* sp. J. & M. (21) from *Perameles nasuta*, and "Nematode sp." Linst. 1898 (29) from *Dasyurus hallucatus*, possess heads similar to that of *D. robertsi*. Also *Filaria* (s.l.) spp. from *Dasyurus maculatus* (coelome); *Trichosurus caninus* (peritoneum); *Potorous tridactylus* (liver), recorded by J. & M. (16), and from *Dendrolagus bennettianus* (mesentery) by J. & M. (25). *Filaria dentifera* Linst. 1889 (29) from *Trichosurus vulpecula* is apparently a larval form with head surmounted by a large tooth.

References

1 Baylis, H. A. 1925 Notes on some Australian parasitic nematodes. A.M.N.H., (9), **15**, 112-115

2 Baylis, H. A. 1927 Some new parasitic worms from Australia. A.M.N.H., (9), **20**, 214-225

3 Baylis, H. A. 1930 Four new Trichostrongylid Nematodes from Queensland. A.M.N.H., (10), **6**, 1-18

4 Baylis, H. A. 1930 A nomenclatural correction. A.M.N.H., (10), **6**, 550

5 Baylis, H. A. 1930 Some Heterakidae and Oxyuridae (Nematoda) from Queensland. A.M.N.H., (10), **5**, 354-366

6 Baylis, H. A. 1932 A new species of the nematode genus Trichuris from Queensland. A.M.N.H., (10), **9**, 31-32

7 Baylis, H. A. 1934 On two filarial parasites of marsupials from Queensland. A.M.N.H., (10), **13**, 549-554

7A Baylis, H. A. 1934 Some spirurid nematodes from Queensland. A.M.N.H., (10), **14**, 142-154

8 Boulenger, C. L. 1928 Report on a collection of parasitic worms, mainly from Egypt. Pt. 5, Filarioidea. Parasitol., **20**, 32-55

9 Breinl, A. 1911 (1913) Nematodes observed in North Queensland. Aust. Inst. Trop. Med., Report for 1911, 39-46

10 Cameron, T. W. M. 1926 On a new species of Trichostrongyle worm from the Bennett's wallaby. Jour. Helminth., **4**, (1), 23-26

11 Cameron, T. W. M 1931 On a new species of Trichostrongyle worm from the Tasmanian Devil. Jour. Helminth., **9**, 153-156

12 Canavan, W. P. 1931 Nematode parasites of Vertebrates in the Philadelphia Zoological Gardens and vicinity, ii. Parasitol., **23**, 196-228

13 Chandler, A. 1924 A new genus of Trichostrongylid worm from a kangaroo. Parasitol., **16**, 160-163

14 Cobb, N. A. 1898 Extract from M.S. Report on Parasites of stock. Agr. Gaz. N.S. Wales, **9**, 296-321 and 419-454

15 Davey, D. G., and Wood, W. A. 1938 New species of Trichoneminae (Nematoda) from Australian kangaroos. Parasitol., **30**, 258-266

16 Johnston, T. H., and Mawson, P. M. 1938 An account of some filarial parasites of Australian marsupials. Tr. Roy. Soc. S. Aust., **62**, (1), 107-121

17 Johnston, T. H., and Mawson, P. M. 1938 Strongyle nematodes from Central Australian kangaroos and wallabies. Trans. Roy. Soc. S. Aust., **62**, (2), 263-286

18 Johnston, T. H., and Mawson, P. M. 1938 Some nematodes from Australian marsupials. Rec. S. Aust. Mus., **6**, (2), 187-198

19 Johnston, T. H., and Mawson, P. M. 1939 Strongyle nematodes from Queensland marsupials. Trans. Roy. Soc. S. Aust., **63**, (1), 121-148

20 Johnston, T. H., and Mawson, P. M. 1939 Strongyle nematodes from marsupials in New South Wales. Pr. Linn. Soc. N.S.W., **64**, 513-536

21 Johnston, T. H., and Mawson, P. M. 1939 Sundry nematodes from Eastern Australian marsupials. Tr. Roy. Soc. S. Aust., **63**, (2), 204-209

22 Johnston, T. H., and Mawson, P. M. 1939 Some nematodes from Victorian and Western Australian marsupials. Trans. Roy. Soc. S. Aust., **63**, (2), 307-310

23 Johnston, T. H., and Mawson, P. M. 1940 On a collection of nematodes from Australian marsupials. Rec. Aust. Mus., **20**, (5), 360-366

24 Johnston, T. H., and Mawson, P. M. 1940 Nematodes from South Australian marsupials. Trans. Roy. Soc. S. Aust., **64**, (1), 95-100

25 Johnston, T. H., and Mawson, P. M. 1940 New and known nematodes from Australian marsupials. Pr. Linn. Soc. N.S.W., **65** (in press)

26 Leidy, J. 1875 On some parasitic worms. Pr. Ac. N. Sci. Philad., 27, 17-18

27 Linstow, O. Zur Systematik der Nematoden nebst Beschreibung neuer Arten. Arch. f. Mikr. Anat., **49**, 608-622

28 Linstow O. 1898 Nemathelminthen gesammelt von Prof. Dr. F. Dahl in Bismarck Archipel. Arch. f. Naturg., **1**, 281

29 Linstow, O. 1898 Nemathelminthen von Herrn Richard Semon in Australien gesammelt. Semon's Forschungsreisen in Australien, 5. Denk. Med. Gaz., Jena, **8**, 469

30 Linstow, O. 1905 Helminthologische Beobachtungen. Arch. f. Mikr. Anat., **66**, 355-366

31 Mönnig, H. O. 1926 Three new helminths. Trans. Roy. Soc. S. Africa, **13**, (3), 291-298

32 Mönnig, H. O. 1929 Hypodontus macropi, n. g., n. sp., a hookworm of the kangaroo. Ann. Rep. Dir. Vet. Serv. Pretoria, **15**, 303-306

33 Mönnig, H. O. 1929 Filarinema flagrifer, n. g., n. sp., a new Trichostrongylid parasite of the kangaroo. *Ibid.*, 307-309

34 Nagaty, H. F. 1932 The Genus Trichostrongylus Looss, 1905. Ann. Trop. Med. Parasit., **26**, 457-518

35 Nagaty, H. F. 1938 The genera Asymetricostrongylus Nagaty 1932 and Libyostrongylus Lane 1923, etc. Livro Jub. Prof. L. Travassos, Inst. Osw. Cruz, 341-352

36 Schwartz, B. 1928 Two new nematodes of the family Strongylidae parasitic in the intestine of mammals. Proc. U.S. Nat. Mus., **73**, (2), 1-5

37 Solomon, S. G. 1933 Notes on a new species of Beinlia. Jour. Helminth., **11**, (2), 101-104

38 Walton, A. C. 1927 A revision of the nematodes of the Leidy collection. Proc. Acad. Nat. Sci. Philad., **79**, 49-163

39 Wood, W. A. 1929 Some parasitic nematodes from Western Australia. Rep. Dir. Inst. Anim. Path., Cambridge, (1929) 1930, 205-214

40 Yorke, W., and Maplestone, P. A. 1926 The nematode parasites of vertebrates. London

ADDITIONS TO THE FLORA OF SOUTH AUSTRALIA NO. 39

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

Summary

SCHEUCHZERIACEAE

Triglochin ovoidea n. sp. Herbula annua flaccida; folia fere capillaria plerumque quam scapi longiora; scapi gracillimi 4-7 cm. longi; racemus terminalis densus 8-13 mm. longus 10-35 florus; fructus ovoideus vel fere ellipticus 1-$1^1/_4$ mm. longus $^3/_4$ mm. crassus; carpidiis tribus fertilibus subcylindricis dorso rotundatis excalcaratis, tribus sterilibus carpophorum simulantibus.

ADDITIONS TO THE FLORA OF SOUTH AUSTRALIA
No. 39

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

[Read 10 October 1940]

Scheuchzeriaceae

Triglochin ovoidea n. sp. Herbula annua flaccida; folia fere capillaria plerumque quam scapi longiora; scapi gracillimi 4-7 cm. longi; racemus terminalis densus 8-13 mm. longus 10-35 florus; fructus ovoideus vel fere ellipticus 1-1¼ mm. longus ¾ mm. crassus; carpidiis tribus fertilibus subcylindricis dorso rotundatis excalcaratis, tribus sterilibus carpophorum simulantibus.

Beside Lake Bonney, River Murray, Dec. 1924, *C. D. Andrew.*

Resembles in habit *T. hexagona,* from which it scarcely differs except in the fruit. In Trans. Roy. Soc. S. Aust., **49,** 271 (1925) I erroneously called this species *T. Muelleri* Buch., not having at that time seen an authentic specimen of that plant.

Cyperaceae

Schoenus brachyphyllus F. v. M. Mr. S. T. Blake, after examining the type of the Western Australian *S. laevigatus* W. V. Fitzg., finds that the latter differs from our species in the lower glumes of the spikelet glabrous and the upper ones only minutely ciliate, the nut somewhat larger, darker and almost globular (not obovoid), and the hypogynous bristles better developed. *S. brachyphyllus* has only been collected along the Hindmarsh Valley, Myponga and Encounter Bay.

Schoenus foliatus (Hook. f.) S. T. Blake in Proc. Roy. Soc. Qld., 51, 48 (1940) instead *of axillaris* (R. Br.) Poir. Encycl. Suppl. 2, 251 (1811), non Lam. Illustr. 1:137 (1791). A change of name under the law of priority.—*Scirpus foliatus* Hook. f. in Lond. Journ. Bot., **3,** 414 (1844).

Inman Valley; Millicent, S.E.—Also Eastern States, Tasmania and New Zealand.

Schoenus deformis (R. Br.) Poir. Beachport, S.E., summer 1930-40, *R. L. Crocker.* A new locality. Small specimens, with leaves more or less curved.

Cyperus sanguinolentus Vahl, Enum. Pl., 2, 351 (1806) instead of *C. Eragrostis,* Vahl, *l.c.* 322. This change is necessary owing to *C. Eragrostis* Vahl being a later homonym of *C. Eragrostis* Lam. Illust. 1:196 (1791).—Mount Compass; marsh near Victor Harbour.—Also Eastern States and southern Asia.

Cyperus dactylotes Benth. instead of *C. Clelandii* J. M. Black in Proc. Roy. Soc. S. Aust., **48,** 253 (1924). An examination of my type by S. T. Blake proves that these species are identical.—Cordillo Downs.—Also in the Eastern States.

Juncaceae

**Juncus acutus* L. Ethelton, near Port Adelaide, "well established on tidal flats," June 1940, *J. B. Cleland.* Near *J. maritimus* Lamk., from which it differs in a denser panicle, the inner perianth-segments obtuse instead of acute and the reddish-brown capsule twice as long as the perianth.—Almost world-wide, but not hitherto found in Australia.

Chenopodiaceae

Salicornia Blackiana Ulbrich (1934) = *S. pachystachya* J. M. Black (1921) non Bunge ex Ungern-Sternberg (1866). Cliffs at mouth of South-West River, K.I.; Jan. 1940; *J. B. Cleland.* A new locality.

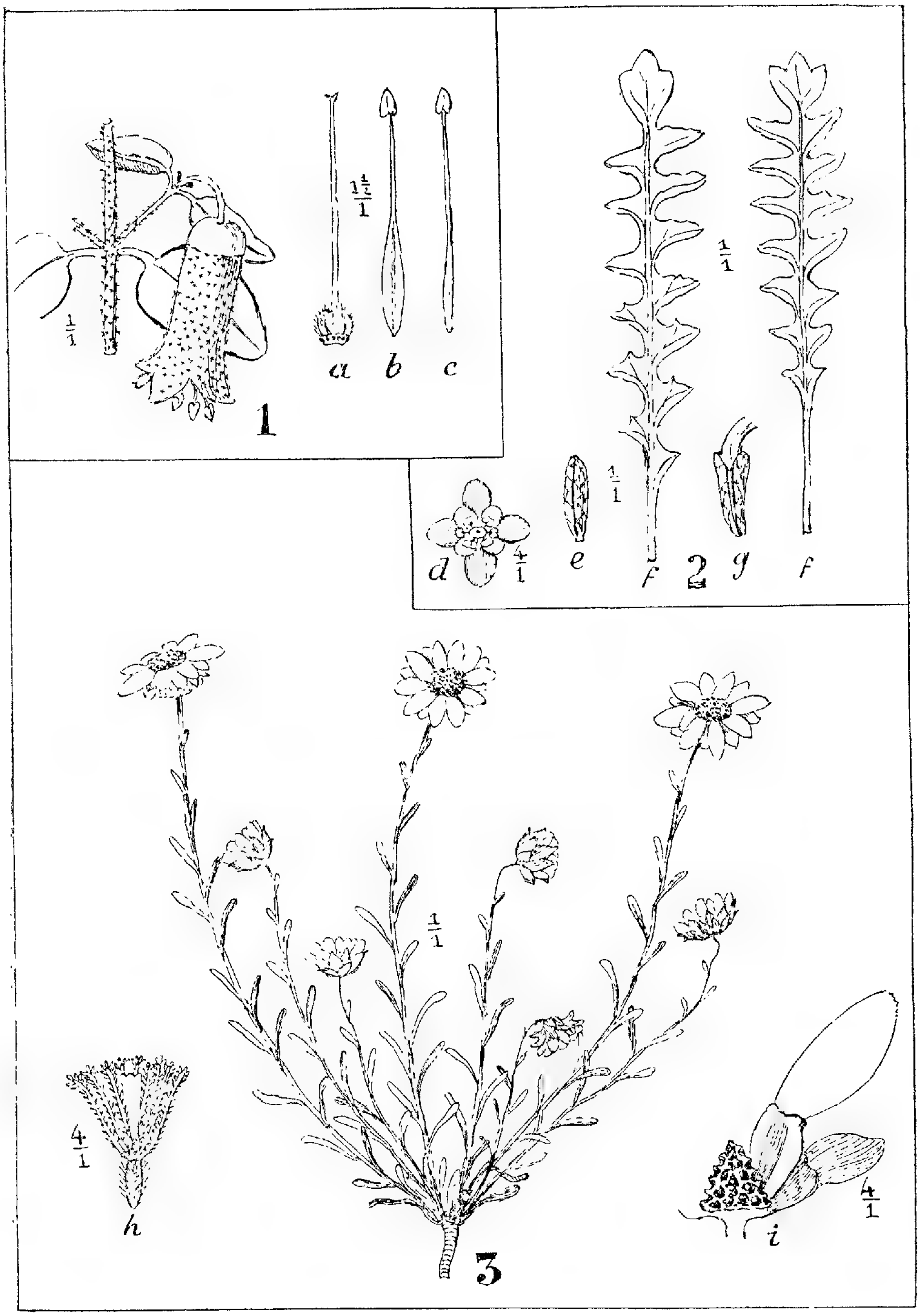


Fig 1 *Correa pulchella*—*a*, ovary and style; *b* and *c*, two stamens.
Fig. 2 *Geococcus Fiedleri*—*d*, flower; *e*, one valve of pod; *f*, *f*, two leaves; *g*, pod and part of peduncle.
Fig. 3 *Helipterum chlorocephalum* — *h*, fertile flower; *i*, conical receptacle and two involucral bracts.

Umbelliferae

Hydrocotyle rugulosa Turcz.—Kingston, S.E.; summer 1939-40; *R. L. Crocker.* A new locality.

Caryophyllaceae

**Tunica prolifera* (L.) Scop. (*Dianthus prolifer* L.). The Bluff (Rosetta Head), Encounter Bay. Nov. 1935, *J. B. Cleland.* "Abundant."—A new locality.

Ranunculaceae

**Adonis aestivalis* L. Between Blyth and Clare, Nov. 1917, *H. W. Andrew;* between Redhill and Snowtown, Oct. 1924, *J. D. Somerville;* Sutherlands, Sept. 1929, *E. F. Boehm;* Georgetown, Aug. 1939, *J. G. Wood.* This South-European plant, with showy bright-red flowers, is doubtless an escape from gardens. Professor Wood reports its occurrence in fields near Georgetown. Known to gardeners as Pheasant's Eye.

Cruciferae

Geococcus Fiedleri Scheuermann in Fedde Repert., **147**, 262 (1939). According to the author this plant differs from *G. pusillus* J. Drumm. in having 12-14 leaf-lobes instead of only 6-8, and the pod 1 cm. long, lanceolate, acute, reticulate, instead of 2½-5 mm. long and ovate-oblong. This is the only form collected in South Australia and has hitherto passed as a form of *G. pusillus.* The type of *G. Fiedleri* was found growing in a garden at Leipzig where refuse of Australian wool had been thrown. A specimen was sent by Scheuermann to the Kew botanists, who reported that they had no identical material. Our specimens have 10-14 triangular lobes (besides the large terminal one), opposite or alternate, and decreasing in size towards the base of the leaf. The pod is 5-12 mm. long, terete down to the base, where it becomes cordate-sagittate. A figure of the type of *G. pusillus,* which came from Western Australia, is given in Schulz's revision of *Cruciferae* in the second edition of the "Nat. Pflanzenfamilien," and agrees with Scheuermann's observations. The details of the new species given here (fig. 2) are drawn from South Australian specimens.

Leguminosae

Glycine tabacina (Labill.) Benth.—Banks of Willochra Creek near Melrose, Dec. 1938, *J. B. Cleland.* Recorded by Mueller for Crystal Brook and Rocky River, but has not been collected for many years past.

Pultenaea scabra R. Br.—Deep Creek, south of Second Valley Forest Reserve, flowering and fruiting, Dec. 1938, *J. B. Cleland;* Mount Gambier (no collector or date). First mainland records in South Australia.

Rosaceae

**Poterium Sanguisorba* L. Sheep's Burnet or Salad Burnet. Between Beaumont and Waterfall Gully, Nov. 1931; on railway line near Goolwa, Nov. 1935, *J. B. Cleland.* "Abundant." A new record.—Europe and temperate Asia. Naturalised in Victoria and New South Wales.

Rutaceae

Correa

Mr. Edwin Ashby has published in the Proceedings of the Linnean Society of London, session 151, 214-221 (1939), a revision of the South Australian species of *Correa,* with descriptions of three new species.

C. affinis Ashby, *l.c.* 215, is distinguished by the author from *C. aemula* (Lindl.) F. v. M. by thinner leaves, a more slender peduncle with the broad bracts at its base instead of at the summit, and the pedicel with two linear bracteoles. *C. affinis* is proposed as a new name for our South Australian specimens hitherto placed under *C. aemula*. The type of the latter was collected near the Grampian Range in Victoria. I regret that I am unable to recognise any specific differences. A specimen from the Grampians in the Tate Herbarium, and one kindly sent me by Mr. Ashby from his garden at Blackwood as *C. aemula*, agree with our local specimens in having two ovate bracts at the summit of the peduncle and two linear bracteoles attached to the slender pedicel at the spot where it is jointed. It is noteworthy that neither Bentham nor Mueller, with a large collection from both States before them, considered even a varietal distinction necessary. *C. aemula* is well illustrated on plate 7 of Mueller's "Plants Indigenous to Victoria."

Another new species is *C. neglecta* Ashby, *l.c.* 217, with its variety *minor*, *l.c.* 219, both of which the author was good enough to send me specimens grown in his garden. Var. *minor* is evidently the same as *C. pulchella* Sweet, Fl. Australasica t. 1 (1827-28). The description and figure are from a plant grown in England from seed collected on Kangaroo Island in 1823 by William Baxter. I think Sweet's name covers both *neglecta* and its variety, because the leaves of the Kangaroo Island specimens are, especially the lower ones, often as rigid and broad as those from Yorke Peninsula. I also think Ashby is right in considering this a valid South Australian species and not a form of *C. glabra* Lindl. (1939), which was found in western New South Wales and has a green corolla. The original description of *pulchella* states that the leaves are leathery, broadly ovate, obtuse, subcordate at base, stellate when young, becoming glabrous; flowers solitary, pendulous, of a bright salmon colour; calyx cup-shaped, truncate, not toothed. This graceful shrub evidently became a favourite in England, for it is also figured in Loddige's Botanical Cabinet, t. 1684. *C. pulchella* is known by its glabrous appearance, its leaves flat or slightly concave above owing to the upturned margins, 1-2 cm. long by 5-15 mm. broad, and by its slender curved pedicels 5-8 mm. long, with two short, linear or lanceolate caducous bracteoles at base, the peduncle short or almost obsolete, with two leafy bracts at base; calyx 4-5 mm. long; corolla red, 24-28 mm. long; filaments as long as corolla or slightly exserted, alternately broader in lower part; style usually stellate-hairy towards base; rhachis of branches and branchlets more or less stellate-hairy (fig. 1).

Localities for *C. pulchella:* Rocky River, Stokes Bay, Kingscote, Cape Borda (Kangaroo Island); Point Yorke, Cape Spencer, Corny Point, an island in Pondalowie Bay (Yorke Peninsula); Port Lincoln, Cape Donington, Streaky Bay (Eyre Peninsula, and there sometimes with narrower oblong leaves, channelled above). It is evidently a coastal species.

The third new species is *C. Turnbullii* Ashby *l.c.* 219, grown at Blackwood from seedlings obtained by the author on Chauncy's Line, Hundred of Freeling. Mr. Ashby, who does not keep dried specimens, was only able to send me a small branch with leaves and one calyx, but, judging from this sample and from the author's description, the new species is almost certainly the same as a specimen collected at Monarto South in 1921 by Professor Cleland. The leaves resemble those of *C. decumbens*, but the calyx (5 mm. long) is truncate and toothless and the reddish corolla is shorter (16-18 mm. long), the filaments alternately broader towards base, but not so much exserted, the style stellate-hairy in lower part. A specimen from Port Vincent, Yorke Peninsula, appears to be the same plant, the chief difference being that the hairs are denser and more persistent. It is satisfactory that this shrub, which is little known and seems to be rare, has received a name.

We have still, however, several specimens which do not fit into even that polymorphous species *C. rubra* Sm., and the genus remains in need of a Pan-Australian revision.

Thymelaeaceae

Pimelea flava R. Br. Between Millicent and Robe, S.E., October 1939, *E. C. Black*. Flowers yellow. A new locality.

Solanaceae

Solanum hoplopetalum, Bitter et Summerhayes.—Coombe railway siding, 90-Mile Desert, Feb. 1940. Specimen received per E. S. Alcock, Mount Gambier. There are thinly scattered short simple hairs on the leaves and branchlets, but the hairs are not so dense as on the typical Western Australian specimens of *S hoplopetalum*. The specimen from Coombe is therefore intermediate between *S. hystrix* R. Br. and *S. hoplopetalum*. Moreover, the typical specimens of the former from Murat Bay and Ooldea are not completely glabrous (apart from the stout bristles), but have often a few short hairs on the petioles and branches. The question therefore arises whether *S. hystrix* should not be considered as a species varying from almost glabrous to rather densely pubescent, and whether *S. hoplopetalum* should not be dropped altogether, or included as a slight variety.

Compositae

Toxanthus perpusillus, Turcz. Ooldea Soak, Aug. 1939, *J. B. Cleland*. A new locality.

**Matricaria multiflora* (Thunb.) Fenzl. This South African plant, reported in 1931 as established north of Mallala, has now been found near Port Lincoln, Nov. 1939, *H. D. Adams*.

Helipterum chlorocephalum (Turcz.) Benth., Ooldea.—*H. Troedelii*, F. v. M. var. *patens* Ewart in Trans. Roy. Soc. Vict., 22 (n. s.), pt. i, 15 (1909); *H. roseum* (Hook.) Benth. var. *patens* (Ewart) J. M. Black in Trans. Roy. Soc. S. Aust. **45**, 21 (1921). Has been found at Ooldea by several collectors since 1920 but not elsewhere in our State. The first specimens found in that locality were too young to show the conical receptacle. The spreading rays of the inner involucral bracts are pure white in our specimens, as well as in those from Western Australia, with which they have been compared by the courtesy of Mr. C. A. Gardner. The shorter outer bracts are sometimes greenish-brown. Under its correct name this is a new record for South Australia (fig. 3).

**Achillea tomentosa* L. Kingscote, K.I., Dec. 1934; Jan. 1940, *J. B. Cleland*. Flowers yellow.—Southern Europe.

THE MORPHOLOGY AND LIFE HISTORY OF THE TREMATODE, DOLICHOPERA MACALPINI NICOLL

By T. HARVEY JOHNSTON and L. MADELINE ANGEL, University of Adelaide.

Summary

Doliclhopera macalpini Nicoll is a common parasite of the venomous tiger snake, *Notechis scutatus* (Peters) , found in swampy regions in South-Eastern Australia and frequently seen in the Murray swamps in this State. The worm occurs in the trachea, the upper part of the lung and upper six inches of the oesophagus. It has been reported from the intestine and peritoneum, but these situations are not normal habitats for the adult, entry being due to injuries received by the snake during capture. In the lung many flukes are to be found embedded in the alveoli, appearing as very darkly pigmented bodies which can be squeezed out from the sacs.

THE MORPHOLOGY AND LIFE HISTORY OF THE TREMATODE, DOLICHOPERA MACALPINI NICOLL

By T. Harvey Johnston and L. Madeline Angel, University of Adelaide

[Read 10 October 1940]

Dolichopera macalpini Nicoll is a common parasite of the venomous tiger snake, *Notechis scutatus* (Peters), found in swampy regions in South-Eastern Australia and frequently seen in the Murray swamps in this State. The worm occurs in the trachea, the upper part of the lung and upper six inches of the oesophagus. It has been reported from the intestine and peritoneum, but these situations are not normal habitats for the adult, entry being due to injuries received by the snake during capture. In the lung many flukes are to be found embedded in the alveoli, appearing as very darkly pigmented bodies which can be squeezed out from the sacs.

The trematode was first described (though not named) by McAlpine (1891), whose material came from the copper head, *Hoplocephalus* (*i.e.*, *Denisonia*) *superbus* Gunther, from Victoria. Johnston (1910) reported it as *Apoblema* sp., a distomid fluke with a small, but well marked, caudal appendage, occurring in the oesophagus of *D. superba* in the Sydney district (N.S.W.). The same author, in 1911, recorded it as *Hemiurus* sp. (syn. *Apoblema* sp.) from the same host (p. 239) and from the black snake, *Pseudechis porphyriacus* (Shaw) (p. 238), both from the vicinity of Sydney. These generic determinations were obviously due to a mistaken view of the character of the caudal appendage which is quite unlike that of Hemiurids. In 1914 Nicoll described *Dolichopera parvula* (1914, 342) from *Python variegatus* from North Queensland, and attached the name *D. macalpini* to the parasite described by McAlpine. He placed both species in a new genus which he assigned doubtfully to the Lepodermatidae, but he pointed out that the position of the uterus was unique, other striking features being the almost symmetrical arrangement of the testes, the atypical position of the ovary, and the unusual disposition of the yolk glands. The location was stated to be the intestine and lungs (?) of snakes. An account of *D. macalpini* was given later by Nicoll (1918, 290), based on material from *Notechis scutatus* and *Denisonia superba* from Victoria (collected by Dr. G. Sweet) and from an unnamed snake from Flinders Island, Bass Strait (collected by Dr. J. B. Cleland). Nicoll then considered that the normal habitat of the parasite was the lung, trachea and oesophagus. In the same year (1918, 374) he published a figure of *D. macalpini* and mentioned that the worm was obtained from the two species of snakes just named, the localities being given as New South Wales and Victoria. In the same year Johnston (1918, 211-2) synonymised his *Apoblema* sp. and *Hemiurus* sp. with *D. macalpini* and stated that the snake from Flinders Island (referred to by Nicoll) was *Notechis scutatus*.

Fairley and Splatt (1929, 337, 348), in referring to ophidian diseases, mentioned that *D. macalpini* (identified by one of us) caused a most serious malady of Australian venomous snakes. In a letter to the senior author, dated 25 July 1928, Dr. Fairley stated that the parasite caused a high mortality amongst the collection of poisonous snakes at the Walter and Eliza Hall Institute of Medical Research, Melbourne, consequently depreciating the venom yields.

Bradley (1926, 577) described briefly a young fluke, under the name *Cercaria nigrocystica*, found in mixed bowel contents from "black snakes" in the Monaro district of New South Wales. These small parasites were regarded as having recently emerged from cysts. Johnston and Cleland (1937, 198) stated that

Bradley's trematodes represented the young stage of *D. macalpini* whose adult occurred in the tiger snake and copper head, specimens of the parasite having been obtained by them from New South Wales, Victoria and South Australia. *C. nigrocystica* was therefore placed by them as a synonym of *D. macalpini*.

We have examined material from *Notechis scutatus* from New South Wales (Sydney; Glenfield), Victoria and South Australia (South-East; Tailem Bend; Pearson Island); and from *Denisonia superba* from New South Wales (Sydney district), Victoria, and Flinders Island, Tasmania.

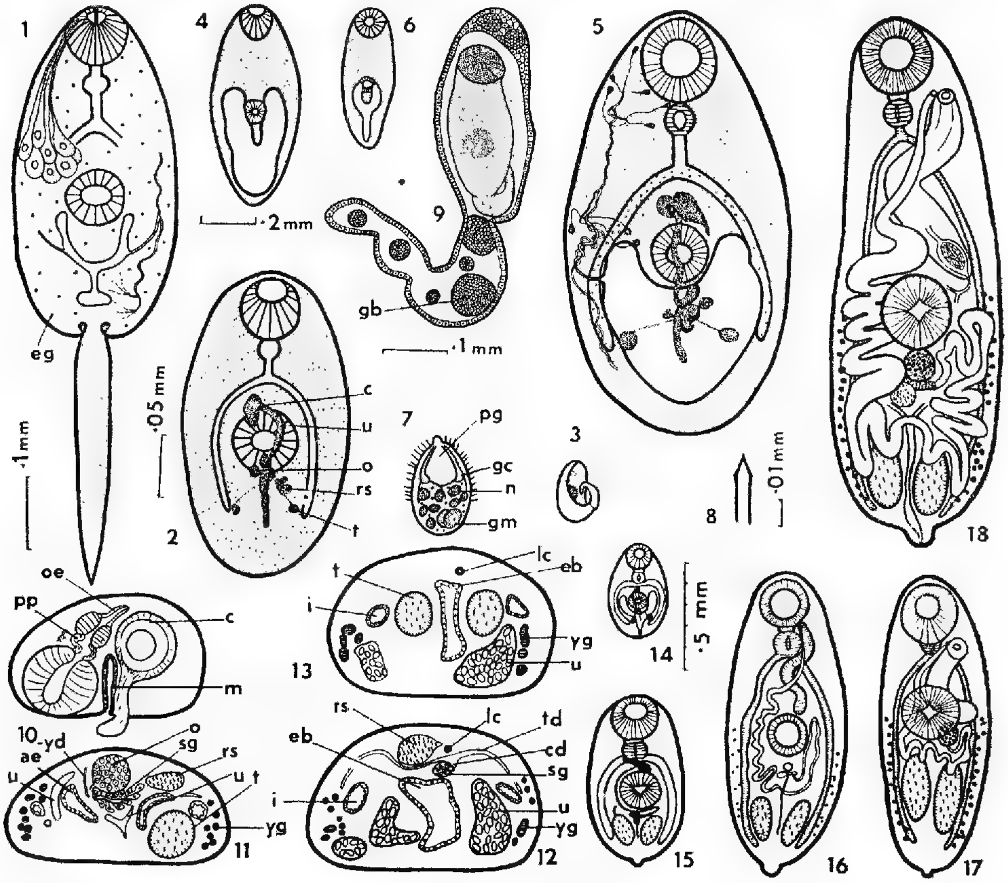


Fig. 1-18

Fig. 1, living cercaria (excretory system incomplete); 2, cercaria, formalinised, showing genital anlagen; 3, cercaria, normal position when killed with boiling formalin; 4, 6, metacercaria, living, showing form of excretory bladder; 5, metacercaria, anatomy; 7, miracidium; 8, stylet; 9, sporocyst; 10-13, transverse sections of adult; 10, through genital pore and pharynx (somewhat oblique); 11, through ovary and shell gland (somewhat oblique); 12, through transverse yolk ducts; 13, through testes; 14-18, various stages of development in the snake; 14, youngest stage (metacercaria), free in intestine; 15, stage from oesophagus (? lung); 16, largest specimen not yet mature (from lung); 17, smallest egg-bearing specimen; 18, young adult, showing disposition of uterine loops Fig. 1 and 5 to same scale; 3 and 4; 7 and 8; 6 a sketch; 10 to 18 to same scale (beside fig. 14).

Reference to lettering—ae, arm of excretory bladder; c, cirrus sac; cd, common yolk duct; eb, excretory bladder; eg, excretory granules; gb, germ ball; gc, gland cell; gm, germ mass; i, intestine; lc, Laurer's canal; m, metraterm; n, nuclei; o, ovary; oe, oesophagus; pg, primitive gut; pp, prepharynx; rs, receptaculum seminis; sg, shell gland; t, testis; td, transverse yolk duct; u, uterus; yd, yolk duct; yg, yolk gland.

The parasites are nearly black to the naked eye, with a colourless margin, the heavy pigmentation being due to the dense mass of dark brown eggs in the large looped uterus which occupies the greater part of the central area. The worms, when mature, are fairly thick, usually with both ends broadly rounded, but the posterior bears a short caudal projection arising slightly ventrally, this prominence sometimes being somewhat lobed. The form of the parasite is variable, occasionally rather pointed posteriorly, and sometimes constricted behind the acetabulum. There is a dense covering of spines, more closely set anteriorly. They occur on all parts excepting the suckers, but including the caudal appendage. Mature specimens vary from 2 to 4·8 mm., most of them being 3 to 4 mm. long, with a maximum breadth (at the acetabulum) of from 1·3 to 1·7 mm. The ratio of length to breadth is about 2·5 : 1. The oral sucker is subterminal, usually directed ventrally, and measures 0·3 to 0·45 mm. in diameter. The acetabulum is slightly behind the mid-body and measures 0·25 to ·45 mm. in breadth, its dimensions being usually very slightly smaller than those of the anterior sucker. The ratio of the two suckers is about 6 : 5.

A broad, short prepharynx is present but is usually not obvious, as it lies above the posterior part of the oral sucker. The pharynx measures about ·14 mm. in diameter and is followed by a short oesophagus. The caeca extend just beyond the testes and reach almost to the end of the worm where their tips are slightly inturned.

The excretory bladder is very extensive, with a long wide stem lying between the testes and passing forward to bifurcate just behind the shell gland, the wide arms extending forward to surround the acetabulum except anteriorly. These arms may reach some little distance in front of the ventral sucker. The main canal arises from the corresponding arm at about the level of the middle of the acetabulum and soon divides into its anterior and posterior branches extending almost to either end of the worm. The excretory pore is at the tip of the caudal appendage. The testes are usually elongate-elliptical, sometimes nearly circular in outline, and lie side by side in the posterior quarter or fifth of the body, the stem of the excretory bladder separating them. One testis is generally slightly in advance of the other. The organs measure ·33 to ·4 mm. long, ·15 to ·18 mm. wide, and about ·2 mm. in dorso-ventral diameter. Their distance from the tip of the body is usually about half their length. The very narrow vasa deferentia each arise from the anterior end of the testis, the two travelling forward near Laurer's canal and above the shell gland, uniting just before entering the cirrus sac in the vicinity of the anterior half of the acetabulum. The sac extends in a curved course from the latter to lie in the region between the two suckers, finally terminating toward one side, on a level with the posterior border or the mid-region of the oral sucker. The organ has an even diameter of about ·2-·25 mm., and a length of about 1·3 mm., thus being more than one-third of the body length. It has a large seminal vesicle succeeded by a pars prostatica and a long ejaculatory portion. The cirrus is unarmed. Amphitypy of the organ is common.

The spherical ovary, ·14 to ·2 mm. in diameter, lies immediately behind the acetabulum. The oviduct arises from it on the side remote from the receptaculum seminis and has a well-defined spherical or pyriform oocapt with thick walls and sphincter fibres. The duct curves downwards, close to the ovary for a very short distance, bending inwards to join with the common yolk duct and then entering the shell gland. The latter lies between the ovary, receptaculum and the two arms of the excretory bladder, and below the level of the ovary and receptaculum. The ootyp, after passing through the gland, curves downwards as the uterus which becomes thrown into a few coils below and behind the shell gland, and may enter the most anterior part of the intertesticular zone. The rounded or elliptical receptaculum seminis lies obliquely behind the ovary and is of about the same size. It is connected with Laurer's canal by a very short duct dorso-posterior to the shell gland. Laurer's canal passes back from the ootyp as a long, narrow, sinuous duct above the excretory bladder. It has a relatively thick wall and very narrow lumen, and terminates on the dorsal surface near the posterior end of the intertesticular zone.

The yolk glands are numerous, most of them being extra-caecal, lateral and ventro-lateral from the crura but some follicles are dorsal. The series extends from the level of the anterior border of the acetabulum to the vicinity of the ends of the caeca. There are many ducts on each side, these travelling inwards above the crura and converging to form the transverse duct of each side. The duct of one side travels just above the arm of the excretory bladder and immediately below the antero-ventral border of the receptaculum; that of the other side skirts the ovary and dips downwards just outside the oviduct to meet its fellow below the ovary but above the shell gland. A very short common yolk duct travels ventrally to join the oviduct.

The mature uterus is very extensive and becomes very wide in the mid-region of the worm. After leaving the shell gland it travels forwards on one side of the acetabulum, then backwards in a series of loops below the crus of the same side. In the posterior region it is thrown into three or usually, four extensive loops, two on either side below the crura and the testes, these loops sometimes reaching well behind the testes. In compressed specimens one of these loops may become displaced so as to lie in the intertesticular zone, giving an appearance like that seen in typical Reniferine flukes. The uterus now travels forward on the side opposite to its commencement, its folds lying below the crus and above part of the acetabulum; it then crosses in front of the latter and below the cirrus sac which may be largely obscured by its folds. The narrow, thick-walled metraterm accompanies the cirrus sac and terminates between the male pore and the oral sucker. Eggs are extremely abundant, brownish-yellow, dark brown in the mass, and measure ·028 to ·034 mm. by ·018 to ·019 mm.

Life History

The adult trematodes, on being placed in water, rapidly pour out large masses of eggs, just as Byrd (1935, 199) has recorded for *Renifer aniarum* and *Dasymetra conferta*. At different times prior to September 1939 we had tried without result to hatch these eggs in water, and had also tried experimental infections of various molluscs from the Tailem Bend region. On 5 September 1939 eggs were placed in large petri dishes, to which were added several of each of the following molluscs: *Plotiopsis tatei, Ameria pyramidata, A. pectorosa, Planorbis isingi, Corbiculina angasi,* and *Hyridella australis*, which were known to be uninfected. After some days the molluscs were removed to aquaria. For a month after exposure to infection they were tested for the presence of cercariae twice a week, and subsequently, daily. On 25 October, that is, six weeks after being subjected to infection, one *Ameria pyramidata* started giving off small xiphidiocercariae. In the following month four more *Ameria pyramidata* and *pectorosa* gave off cercariae. Subsequent dissection showed that none of the other molluscs had become infected.

In May 1939 a comprehensive experiment to ascertain the intermediate host produced only negative results. In February 1940 many *Ameria* were placed in contact with eggs of *Dolichopera*, but none of those snails which survived produced cercariae. These experiments seem to indicate that spring is the normal time of year for *Ameria* to become infected with *D. macalpini*. The cercaria of this trematode belongs to a type which had been found frequently throughout the summer when routine examinations of *Ameria* from Tailem Bend were made.

Miracidia

Though miracidia are present in the eggs when laid, we were unable to obtain any hatching in water even after some months of immersion. Increasing the temperature of the water also failed to bring about the result. Later a number of *Amnicola* were allowed to crawl over a dense mass of eggs. After one-and-a-half hours some of the snails were crushed in half-normal saline. Miracidia could be seen in the gut, attempting to pierce through its wall by means of the head-lobe. Other snails which had been placed in contact with the eggs for periods of one to four hours were killed, and serial sections were made. In those killed seventy minutes after contact, some of the miracidia had hatched in the gut, while others were beginning to escape from the egg shell. After three hours most of the shells were empty, and the miracidia were free in the gut or penetrating the walls. Our experience is thus similar to that recorded by Talbot (1933, 523) for eggs of *Lechriorchis,* and by Byrd (1935, 199) and Walker (1937) for those of *Renifer* and *Dasymetra.*

The chief features detected in the living miracidia were fairly long cilia, and a number of fatty globules of varying sizes. Staining showed a number of large nuclei in the posterior part of the miracidium; in most there were only eight of these nuclei, but others showed as many as 19, all of them much smaller. There are no eye spots. In the anterior part of the miracidium is a clear region, which is evidently the primitive gut. Along each side of this is a narrow duct, which appears to terminate in a large gland cell, the exact size of which could not be determined. In the nucleated region are two fairly large germ masses, which do not stain quite so deeply as the nuclei. From one to three yolk nuclei are present within the egg shell, and these remain after the miracidium has escaped.

Sporocyst

The comparatively small sporocysts develop in the liver, which is generally packed with them. There are a number of refractive granules which give the sporocyst an opaque appearance. There are rarely more than two or three cercariae, but a number of germ balls at various stages of development may also be present. The length of living sporocysts usually ranges from 184 by 100 μ to 470 by 167 μ, but some may be as large as 750 by 167 μ.

Cercaria

After their escape from the snail, cercariae swim for a second or two, the body appearing spherical, and then come to rest with the body curved and elongated and the tail hanging downwards. They are perhaps negatively phototropic. Measurements of 20 formalinised specimens ranged from 220 to 340 μ, the average length being 276 μ. The width of the body was not taken on account of inaccuracy due to the curved position assumed by the cercaria at death.

The body surface is covered with small spines which are more marked in the preacetabular region. Caudal pockets are present. Small refractive excretory granules are scattered throughout the body, but are not numerous. The stylet is 24·7 μ long, the anterior truncated section being 8·5 μ—that is, the ratio of the anterior to the posterior section is 1 to 2. At its widest point (at the junction of two sections) it is 3·8 μ wide. The oral and ventral suckers are almost equal in size. There is a well-marked prepharynx. A short oesophagus follows the latter, and the intestinal crura extend to about the mid-length of the post-acetabular region. There is a group of about eight gland cells on either side, in front of the ventral sucker.

The excretory bladder is roughly Y-shaped, the stem varying according to the state of expansion or contraction of the cercaria. It may be simple, or may consist of a posterior bulb-like portion and an anterior narrower tube from which the wide arms of the bladder arise. When the cercaria is contracted, the arms do not reach quite to the posterior border of the sucker, but they do so when the body is extended. The main collecting tubes arise from about midway along each arm, and the union of anterior and posterior collecting tubules is on a level with the posterior border of the acetabulum.

The exact number and positions of the flame cells were not determined for the cercaria. This was partly due to the fact that the experimental snails lived only for a very short time after they commenced giving off cercariae, and partly to the presence of cystogenous cells throughout the body, which made the flame cells difficult to see. There appeared to be at least two groups of flame cells in the most posterior region—posteriorly and laterally respectively to the main stem of the excretory bladder. The arrangement in the anterior half of the body was ascertained in the metacercaria and will be mentioned later.

In the vicinity of the anterior border of the acetabulum is the anlage of the cirrus sac, and from this region the uterine strand of cells extends backwardly. Near the posterior border of the acetabulum is the ovarian rudiment, and a cord of cells (anlage of Laurer's canal) extends back from the latter almost to the posterior end of the body. The testes are placed postero-laterally and on the same level, and from each a fine vas deferens passes inwards and forwards.

Cyst Stage

In experiments to determine the secondary intermediate host of *D. macalpini*, infected *Ameria* were placed in aquaria with a number of different animals. The cercariae were found to encyst in tadpoles, *Lymnodynastes* sp.: but not in the fish, *Gambusia affinis;* the leech, *Glossiphonia* sp.; or in the gastropods, *Plotiopsis tatei* and *Ameria* spp. The round cysts measure from 250 to 325 μ in diameter, the most usual size being 300 μ. The cyst wall is brown, and recognition of the outline of the metacercaria is rendered more difficult by reason of the distended excretory bladder which is now packed full of refractive granules and appears as a large dark mass which may be bluntly Y-shaped, and forms a characteristic feature of the encysted stage.

The cysts, when dissected out from the muscles and other tissues of the tadpole, were kept in half-normal saline. After eight days some of the metacercariae were still active.

Metacercaria

The body spines of the metacercaria, though not very conspicuous, cover the whole surface. The sucker ratio (anterior : ventral), measured for ten specimens, is 4 : 3. The prepharynx is obvious. The intestinal crura bifurcate from the short oesophagus some distance anteriorly to the acetabulum. In the living metacercaria the crura appear to contain a number of granules, not so refractive and not quite so large as those in the bladder. Staining with neutral red following orange G shows a number of fusiform bodies in the caeca.

The excretory bladder is very large; it extends from the posterior border of the body to the posterior level of the acetabulum, and the broad arms extend laterally. In some specimens (depending on the state of expansion of the body) they reach beyond the anterior border of the acetabulum, while in others, with the body contracted, they appear to extend only half-way up the sides of that organ. The bladder is packed with highly refractive granules which render the body in this region quite opaque. The flame cells of the anterior half of the body could be traced, but those of the posterior end were obscured by the granules in the bladder. The main collecting tubes arise a short distance behind the anterior end of each arm, and their bifurcation into the anterior and posterior collecting tubes is on a level with the front border of the acetabulum. Three accessory tubules join the anterior collecting tubule, and each is formed by a group of three flame cells. As mentioned previously, there appeared to be at least two groups of three flame cells in the posterior half of the body of the cercaria, and the arrangement in the anterior end of the body suggests that there may be another group connected with the posterior collecting tube, making the flame cell formula $2 [(3 + 3 + 3) + (3 + 3 + 3)]$.

The genital system in the metacercaria has not reached very much greater differentiation than that shown by the cercaria.

Development in the Tiger Snake

The tiger snake feeds largely on frogs. We have recovered cysts of *D. macalpini* either in, or amongst, digesting material belonging to *Limnodynastes tasmaniensis* (*platycephalus*), *L. dorsalis* (*dumerili*) and *Hyla aurea raniformis*, at Tailem Bend. Cysts and escaping metacercariae have been found on several occasions in the intestine, and a complete series indicating growth and development have been obtained from the intestine and the lung. Very young stages have been found to be more or less abundant in the intestine of tiger snakes collected from mid-August to October, as well as from early February to early May. It seems likely that infection by metacercarial cysts may occur at any time from early spring until early autumn, *i.e.*, during the whole of the non-hibernating period of the reptiles.

In the smallest specimen studied, ·42 by ·28 mm., evidently an escaped metacercaria, the excretory arms reached the level of the anterior border of the acetabulum, the testes were very small, the two vasa deferentia were recognisable, and the cirrus sac was a rounded, nearly median, structure behind the intestinal bifurcations. The uterine cord was quite obvious, sinuous and extending from the front of the cirrus sac backwards above the acetabulum to become continuous with a thickened curved mass which showed some differentiation, indicating the future ovary. The rest of the female anlage extended back as a sinuous cord of cells representing Laurer's canal. The young fluke does not seem to advance much beyond the stage just described while in the intestine.

Washings from the lung and oesophagus showed stages measuring from ·5 mm. upwards in length. Many of these (even one ·5 mm. long) already had developed the caudal appendage. The testes were very much larger, ·15-·17 mm. long, and more or less symmetrical. The cirrus sac was elongate and extended forwards below one crus, reaching the level of the posterior border of the pharynx. The uterine cord showed a well-marked loop between the ovary, acetabulum and one testis, as well as one in front of the sucker. The ovary was more distinct and rounded than in the earlier stage.

With further growth the female complex becomes more completely differentiated. The largest worm which had not yet produced eggs measured 1·3 by ·5 mm. It had testes ·15-·17 mm. long by ·1 mm. wide, the uterus had a long loop laterally from the acetabulum, while the uterus on the opposite side of the latter was thrown into a number of short undulations. The cirrus sac had the adult form, was ·5 mm. long, ·05 mm. wide, and opened in the adult position. The yolk glands were extremely small but occupied the adult positions.

The smallest specimen seen with eggs measured 1·4 by ·5 mm. The testes were ·35-·4 mm. long; cirrus sac ·5 mm. long by ·1 mm. wide, and its posterior end was adjacent to the well-developed spherical ovary. The yolk glands had increased considerably in size, though still relatively smaller than in the adult. The uterus resembled that of the stage just described above except that three or four loops just indicated as appearing in the region between the testes and the acetabulum in that stage were more pronounced in this specimen. In still later stages these loops become much larger and may come to lie below the crura and part of the testes, but there is little or no extension into the intertesticular zone. With the increase in the number of eggs in the uterus the latter becomes more and more swollen, until it may obscure most of the other organs.

The relationships of *Dolichopera* are obscure. Nicoll (1914, 343) placed it in Lepodermatidae, but stated (p. 344) that its inclusion there was somewhat doubtful because of the arrangement of the testes and the position of the uterus. Baer (1924, 26) considered Reniferinae Pratt 1902 to be worthy of family rank, and in his Reniferidae he included *Renifer, Lechriorchis* and five other genera, four of these seven (including the two named) being placed in Reniferinae as restricted by him. The family Lepodermatidae was considered to be quite distinct from the Reniferidae, though the character of the uterus is similar in both. Because of lack of information regarding the excretory system, Baer was unable to assign *Dolichopera* to either of the families (p. 30), but stated that it was extremely doubtful whether Nicoll was correct in placing it in the Lepodermatidae. Baer listed it (p. 31) amongst the "genera incerta" of Reniferidae. Travassos (1928) included *Dolichopera* without comment in Reniferinae.

Perkins (1928), in a review of the Telorchiinae, placed *Dolichopera* under it, remarking that the genus possessed a diagonal arrangement of the testes, as well as a uterus which, though overlapping the testes, did not penetrate the intertesticular zone. Perkins stated that it differed from *Telorchis* Lühe only in the more transverse arrangement of the testes, the more asymmetrical position of the genital aperture, and the more extensive uterus; and that *Dolichopera* was the Australian equivalent of that genus. A key to the genus was given (1928, 353).

Mehra (1931) gave an emended diagnosis of Reniferinae (Lepodermatidae) and included *Dolichopera* under it (p. 173) as a very aberrant genus because of the following characters—position of the genital pore near the right margin of the body on a level with the oral sucker; more or less symmetrically placed testes; position of the ventral sucker behind the middle of the body; and the testes situated in the last quarter of the worm.

Though Mehra (1937, 462) still places *Dolichopera* in the Reniferinae, all other recent workers dealing with the group (Ingles, 1933; Talbot, 1934; McMullen, 1937; Byrd, 1935; Byrd and Denton, 1938) have restricted the subfamily and also the Reniferidae to include those species possessing certain characters (including the presence of a uterus passing between the testes and extending to the posterior end of the body) which prevent the inclusion of the Australian fluke.

The tendency recently is to regard the Reniferidae as a well-defined family allied to the Plagiorchidae and some others, all of them being placed under the Plagiorchioidea because of the general similarity in the adult and larval stages. The subfamily Reniferinae is now restricted by McMullen (1937) and by Byrd and Denton (1938) to a small group of allied genera (*Dolichopera* being definitely excluded by the latter authors [p. 381]), others being allotted to the Telorchiinae, whose close relationship with the Reniferinae was stressed by McMullen (1935; 1937). The latter author (1934; 1935), as a result of his study of the life history of *Cercorchis* concluded that Telorchids were related to Plagiorchids. The various genera now assigned to Reniferinae have been discussed by the authors mentioned above, as well as by Price (1935; 1936). Byrd and Denton (1938) have published generic diagnoses as well as keys for the genera and species.

From the foregoing it will be seen that the systematic position of *Dolichopera*, based on the study of the adult stage, has not been determined satisfactorily. We will now consider the relationships of its larval stage, comparing it with similar stages of several Reniferine species.

Cercaria brevicaeca Cort (1914, 83; 1915, 62) is a typical Reniferine larva. Amongs others there may be mentioned that of *Zeugorchis syntomentera* Sumwalt, described by Ingles (1933); *Caudorchis* and *Lechriorchis* by Talbot (1933); *Renifer, Dasymetra* and *Pneumatophilus* (as well as *Cercaria ramonae*) by McCoy (1928); *Renifer* and *Dasymetra* by Byrd (1935); while the larval stages of *Cercorchis* and *Telorchis* (Telorchiinae) have been studied by McMullen (1935) and Krull (1935) respectively; and of *Plagitura parva* by Stunkard (1936). An excellent attempt to correlate the various types of cercariae and adults amongst the Plagiorchioidea was made by McMullen (1937).

The cercaria of *Dolichopera macalpini* is essentially of the same type as those described above for Reniferines, and so also are the other early stages. All of them ultilize tadpoles as the second intermediate host.

C. Dolichoperae macalpini differs from *C. brevicaeca* in the greater length of caeca, shorter arms of the excretory bladder, larger stylet, fewer gland cells, and slightly different ratio of the diameters of the two suckers of the former; from *C. ramonae* in the size of the body and in the size and form of the stylet; from *Zeugorchis syntomentera* (cercaria) in the sizes of the caeca and excretory arms, and in the sucker ratio; from *Dasymetra conferta* (cercaria) in the form of the stylet, but most of the other features resemble those of the Australian species, and these remarks hold also for *Dasymetra villicaeca;* from *Renifer aniarum* in the size of the caeca, excretory arms, and stylet, as well as in the sucker ratio; from *Lechriorchis primus* in the size of the caeca, excretory arms and stylet, the number of gland cells and the sucker ratio; and from *Caudorchis eurinus* in the sucker ratio and the number of gland cells.

Some of the species whose life cycles have been referred to have recently been assigned to other genera by Byrd and Denton (1938), *e.g., Caudorchis eurinus* to *Zeugorchis, Renifer aniarum* to *Neorenifer;* and *Zeugorchis syntomentera* to *Paralechriorchis.*

The cercaria of *Dolichopera macalpini* differs from most Reniferine cercariae (except *Caudorchis* and *Dasymetra*) in possessing longer caeca, rather shorter arms of the bladder, i.e., they do not encircle the acetabulum to the same extent as in others; and in the sucker ratio, the anterior sucker being slightly larger than the posterior. All have the same excretory pattern. Corresponding differences also occur in the metacercariae of the forms mentioned. We may, then, state that *Dolichopera macalpini* has a Reniferine type of larva and life history and that its cercaria resembles that of *Dasymetra* more nearly than that of any other, but the adult stages are quite different.

As pointed out by certain authors mentioned above, *Dolichopera* differs from all genera included in the Reniferinae in the character of its female system, especially the relation between the uterus and testes. Perkins included it in the Telorchiinae but had to qualify its inclusion. If it were not for the characters just mentioned, *Dolichopera* would be very close to *Renifer*, and especially *Neorenifer* Byrd and Denton. It seems to us that our species shows a definite relationship with both subfamilies, but rather more closely with the Reniferinae.

Byrd and Denton (1938, 397) have attempted to indicate the derivation of the Telorchiinae, as well as the definitely Reniferine genera, from primitive Reniferidae. From the Reniferine ancestor they postulate a Dasymetrid-like stock from which arose *Natriodera* and *Zeugorchis* on the one hand and *Dasymetra* on the other. From the last-named the remaining genera have arisen. We have already noted that the cercaria of *Dolichopera* very closely resembles that of *Dasymetra* and *Caudorchis* (*i.e., Zeugorchis*), especially the former, rather than those of any other Reniferine genera. This seems to indicate some close ancestral relationship. If so, then *Dolichopera* must have arisen, in common with *Dasymetra,* from an ancestral Reniferine. Since the characters of the adults are so different, the two genera must have diverged long ago. *Dolichopera*, as already mentioned, possesses uterine characters somewhat similar to those of Telorchiinae. We therefore suggest that it arose from the Renifėrid stem near the point of origin of the Telorchiinae and that its position is best expressed by erecting a subfamily to receive it. Perkins (1928, 343) has given reasons for assuming that a form like *Lecithopyge* from European frogs is a primitive member of the Telorchiinae, more typical of the subfamily than is *Telorchis*.

The type species of *Dolichopera* is *D. parvula* Nicoll from an Australian python. *D. macalpini* occurs in certain of our Elapine snakes. Nicoll (1918, 293) referred to the differences between the two trematodes in regard to the position of the ventral sucker, testes and yolk glands, the relative sizes of the cirrus sac, and the distribution of the uterus. He went on to state that in some respects these differences appeared to be of much more than specific value, but that from various considerations it appeared inadvisable at the time to separate the two forms generically. Nicoll's figure of *D. parvula* indicates the uterus passing back between the testes to a point well behind them, whereas his account and his generic diagnosis state that it extends back between the testes only for a short distance. Since he mentioned that his specimens were compressed, it seems to us possible that the uterine loop may have become displaced by pressure from its normal position below the testis, just as we have seen in some specimens of *D. macapini*. His figure of the latter shows a uterine loop lying in the anterior part of the intertesticular region. In view of the similarity of the two species and their differences from other trematodes, we suggest that they be allocated to a new subfamily. Since the two do not appear to be congeneric, we propose a new genus, *Dolichoperoides*, for *D. macalpini*, this genus to be the type of the Dolichoperoidinae n. subfam. We have selected the latter genus because of the more complete knowledge of its anatomy and life cycle.

Dolichoperoidinae n. subfam.

Reniferidae: cuticle spiny; acetabulum in posterior half of body, smaller than anterior sucker; oesophagus short; caeca extending almost to end of body; genital pore nearly marginal, near oral sucker, on one or other side of body; cirrus sac elongate, sinuous; testes nearly symmetrical, lying in posterior part of body; ovary on one side just behind acetabulum; receptaculum seminis and Laurer's canal present; uterus extensive, occupying most of the region between the testes and the oral sucker, not extending between the testes into the posterior end of the body, but may underlie the testes; metraterm feebly developed; vitellaria numerous, follicular, mainly extracaecal, in posterior half of body; larval stage a xiphidiocercaria with long caeca and Y-shaped excretory bladder whose arms do not surround the acetabulum. Adult in lung, trachea and oesophagus of snakes; metacercaria in frogs. Includes *Dolichoperoides* and *Dolichopera*.

Dolichoperoides n. gen.

Dolichoperoidinae: acetabulum near midbody; testes near posterior end of body; cirrus sac very large; uterus with very numerous coils between the testes and acetabulum, as well as in front of the latter. Type *D. macalpini* (Nicoll 1914).

Dolichopera Nicoll 1914, emend. Johnston and Angel

Dolichoperoidinae: acetabulum well behind mid-body; testes just behind acetabulum; cirrus sac relatively small; uterus with coils mainly preacetabular. Type *D. parvula* Nicoll. Because of the similarity in regard to structures which are known, we assume that there will be found both receptaculum seminis and Laurer's canal, and that the life history will be similar to that of *D. macalpini.*

Summary

1 An account of the anatomy of *D. macalpini* from Australian venomous snakes is given.

2 A new genus (*Dolichoperoides*) and subfamily (Dolichoperoidinae, Reniferidae) have been erected to receive it.

3 The various stages in the life cycle are described. Miracidia hatch after eggs have been taken into the digestive tract of the pond snails, *Ameria pyramidata* and *A. pectorosa*, in which xiphidiocercariae are produced in from six to ten weeks.

4 The metacercaria stage occurs in frogs, *Hyla* and *Limnodynastes.*

5 *Cercaria nigrocystica* Bradley 1926 is an agamodistome (excysted metacercaria) stage of *Dolichoperoides macalpini.*

We desire to acknowledge our indebtedness to Messrs. G. and F. Jaensch and L. Ellis, of Tailem Bend, for unselfish assistance in regard to material. This research has been made possible by the Commonwealth Research Grant to the University of Adelaide.

References

Baer, J. G. 1924 Description of a new genus of Lepodermatidae (Trematoda) with a systematic essay on the family. Parasitol., **16**, 22 31

Bradley, B. 1926 Notes on larval trematodes from New South Wales. Med. Jour. Austr., 1926 (2), 573-578

Byrd, E. E. 1935 Life history studies in the Reniferinae (Trematoda Digenea) parasitic in Reptilia of the New Orleans area. Tr. Amer. Micr. Soc., **54**, 196-224

Byrd, E. E., and Denton, J. F. 1938 New trematodes of the subfamily Reniferinae, with a discussion of the systematics of the genera and species assigned to the subfamily group. Jour. Parasit., **24**, 379-401

Cort, W. W. 1914 Larval trematodes from North American freshwater snails. Jour. Parasit., **1**, 65-84

Cort, W. W. 1915 Some North American larval trematodes. Illinois Biol. Monogr., **1**, 447-532

Fairley, N. H., and Splatt, H. B. 1929 Venom yields in Australian venomous snakes. Med. Jour. Austr., 1929 (1), 336-348 (also fig. 11, 9th March, 1929)

Ingles, L. G. 1933 Studies on the structure and life-history of Zeugorchis syntomentera Sumwalt, etc. Univ. Calif. Publ. Zool., **39** (7), 163-178

Johnston, T. H. 1910 Exhibits of entozoa. Proc. Roy. Soc. N.S.W., **44**, xvii

Johnston, T. H. 1911 A census of Australian reptilian entozoa. Proc. Roy. Soc. Qld., **23**, 233-249

Johnston, T. H. 1918 Notes on miscellaneous endoparasites. Proc. Roy. Soc. Qld., **30**, 209-218

Johnston, T. H., and Cleland, E. R. 1937 Larval trematodes from Australian terrestrial and freshwater molluscs, Pt. I, A survey of literature. Trans. Roy. Soc. S. Aust., **61**, 191-201

KRULL, W. H. 1935 A note on the life cycle of Telorchis robustus Goldb. (Trematoda, Telorchiidae). Pr. Helm. Soc. Washington, **2**, 65

McALPINE, D. 1891 Remarks on a fluke parasitic in the copper-head snake. Proc. Roy. Soc. Vict., **3**, 40-43

McCOY, O. R. 1928 Life history studies of trematodes from Missouri. Jour. Parasit., **14**, 207-228

McMULLEN, D. B. 1935 A note on the relationship of the Telorchinae and Reniferinae. Jour. Parasit., **21**, 217-219

McMULLEN, D. B. 1937 A discussion of the taxonomy of the family Plagiorchiidae Lühe 1901 and related trematodes. Jour. Parasit., **23**, 244-258

MEHRA, H. R. 1931 A new genus (Spinometra) of the family Lepodermatidae Odhner from a tortoise, with a systematic discussion of the family. Parasitol., **23**, 157-178

MEHRA, H. R. 1937 Certain new and already known distomes of the family Lepodermatidae Odhner (Trematoda), with a discussion on the family. Z. f. Parasitenk., **9**, 429-469

NICOLL, W. 1914 The trematode parasites of North Queensland, I. Parasitol., **6** (4), 333-350

NICOLL, W. 1918 Dolichopera macalpini n. sp., a trematode parasite of Australian poisonous snakes. Parasitol., **10**, 290-293

NICOLL, W. 1918 The trematode parasites of North Queensland, IV. Parasites of reptiles and frogs. Parasitol., **10**, 368-374

PERKINS, M. 1928 A review of the Telorchiinae, a group of distomid trematodes. Parasitol., **20**, 336-356

PRICE, E. W. 1935 A re-study of Stafford's types of the trematode genera Lechriorchis and Zeugorchis. Jour. Parasit., **21**, 437

PRICE, E. W. 1936 Redescriptions of the type species of the trematode genera Lechriorchis Stafford and Zeugorchis Stafford (Plagiorchiidae). Pr. Helm. Soc. Washington, **3**, 32-34

STUNKARD, W. H. 1936 The morphology and life history of Plagitura parva Stunkard 1933. Jour. Parasit., **22**, 354-374

TALBOT, S. B. 1933 Life history studies on trematodes of the subfamily Reniferinae. Parasitol., **25**, 518-545

TALBOT, S. B. 1934 A description of four new trematodes of the subfamily Reniferinae, with a discussion of the systematics of the subfamily. Tr. Amer. Micr. Soc., **53**, 40-56

TRAVASSOS, L. 1928 Fauna helminthologica de Matto Grosso. Mem. Inst. Osw. Cruz, **21**, 309-341, 343-372

WALKER, J. H. 1937 Experimental studies on eggs and miracidia of Renifer aniarum (Leidy 1891) and Dasymetra villicaeca (Byrd 1935). Pr. Soc. Exp. Biol. Med., **37**, 246-248

ROYAL SOCIETY OF SOUTH AUSTRALIA (INCORPORATED).

Receipts and Payments for the Year ended September 30, 1940.

ROYAL SOCIETY OF SOUTH AUSTRALIA (INCORPORATED)

Receipts and Payments for the Year ended 30 September 1940

RECEIPTS	£	s.	d.	£	s.	d.
To Balance, 1 Oct., 1939				328	15	4
,, Subscriptions				147	0	0
,, Life Member Composition				15	15	0
,, Govt. Grant for Printing				281	4	4
,, Contribution to Cost of Printing Papers—						
University of Adelaide	41	0	0			
Dr. R. S. Rogers	1	10	0			
				42	10	0
,, Use of Room by other Societies	15	0	0			
,, Sale of Publications	6	17	10			
				21	17	10
,, Interest— Transferred from Endowment Fund				206	14	7
(In Suspense, Remittance from Enemy Occupied Country, 16/10.)						
				£1,043	17	1

PAYMENTS	£	s.	d.	£	s.	d.
By Transactions (Vol. 63, Pt. 2, and (Vol. 64, Pt. 1)—						
Printing	459	18	1			
Illustrating	141	18	1			
Publishing	17	6	7			
				619	2	9
,, Librarian				38	0	0
,, Library; Fittings, etc.				5	3	0
,, Sundries—						
Conversazione	8	15	0			
Cleaning and Lighting	7	0	2			
Printing, Post. & Stat.	16	19	3			
Petties	4	0	0			
Typing	2	18	6			
Insurances	6	18	4			
Bank Fee & Chq. Bks.	1	4	5			
				47	15	8
,, Research Fund				10	0	0
,, Endowment Fd. Life Subs.				15	15	0
,, Balances, 30 Sept. 1940—						
Savings Bank of S.A.	294	1	11			
Bk. of Aust. £332 17 6, *Less* Outstand. Chq. 318 18 9	13	18	9			
				308	0	8
				£1,043	17	1

ENDOWMENT FUND as at 30 September 1940

(Capital—Stocks at Cost Price £5,798 6s. 1d.)

1939—October 1	£	s.	d.	£	s.	d.
To Balance—						
Aust. Consolidated Stock	5,762	0	0			
Savings Bank of S.A.	20	11	1			
				5,782	11	1
,, Life Members' Subs.				15	15	0
,, Interest—						
Inscribed Stocks	198	16	6			
Savings Bank of S.A.	7	18	1			
				206	14	7
				£6,005	0	8

1940—September 30	£	s.	d.	£	s.	d.
By Revenue Account				206	14	7
,, Balance—						
Australian Consolidated Stock	5,762	0	0			
Savings Bank of S.A.	36	6	1			
				5,798	6	1
				£6,005	0	8

RESEARCH FUND as at 30 September 1940

1939—October 1	£	s.	d.
To Balance	16	0	0
,, General Fund	10	0	0
	£26	0	0

1940—September 30	£	s.	d.
By Grant C. P. Mountford	10	0	0
,, Balance—Savings Bank of S.A.	16	0	0
	£26	0	0

Audited and found correct. We have verified the Government Stocks at the Registries of Inscribed Stock, Adelaide, and the respective Bank Balances.

O. GLASTONBURY, F.A.I.S., A.F.I.A. }
F. M. ANGEL } Hon. Auditors

HERBERT M. HALE,
Hon. Treasurer

Adelaide, 10 October 1940

AWARDS OF THE SIR JOSEPH VERCO MEDAL

LIST OF FELLOWS, MEMBERS, ETC.
AS ON 30 SEPTEMBER 1940

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.
1938 Prof. James A. Prescott, D.Sc., A.I.C.

LIST OF FELLOWS, MEMBERS, ETC.

AS ON 30 SEPTEMBER 1940

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.

Date of Election

Honorary Fellows.

1910. *Bragg, Sir W. H., O.M., K.B.E., M.A., D.C.L., LL.D., F.R.S., Director of the Royal Institution, Albemarle Street, London (Fellow 1886).
1926. *Chapman, F., A.L.S., "Crohamhurst," Threadneedle Street, Balwyn, Vict.
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.
1925. Adey, W. J., M.A., C.M.G., 32 High Street, Burnside, S.A.
1927. *Alderman, A. R., Ph.D., M.Sc., F.G.S., University, Adelaide—**Council**, 1937-.
1931. Andrew, Rev. J. R., 5 York Street, Henley Beach.
1935. *Andrewartha, H. G., M.Agr.Sc., Waite Institute (Private Mail Bag), Adelaide.
1935. *Andrewartha, Mrs. H. V., B.Agr.Sc., M.Sc., 29 Claremont Av., Netherby, S.A.
1929. Angel, F. M., 34 Fullarton Road, Parkside, S.A.
1939. *Angel, Miss L. M., M.Sc., University, Adelaide.
1895. *†Ashby, E., F.L.S., M.B.O.U., Blackwood, S.A.—**Council**, 1900-19; **Vice-Pres.**, 1919-21.
1902. *Baker, W. H., Ningana Avenue, King's Park, S.A.
1936. Barrien, Miss B. S., M.Sc., University, Adelaide.
1932. Begg, P. R., D.D.Sc., L.D.S., 219 North Terrace, Adelaide.
1939. *Berndt, R. M., S.A. Museum, Adelaide.
1928. Best, R. J., M.Sc., F.A.C.I., 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.
1923. Burdon, R. S., D.Sc., University, Adelaide, S.A.
1922. *Campbell, T. D., D.D.Sc., D.Sc., Dental Dept., Adelaide Hospital, Adelaide—**Rep.-Governor**, 1932-33; **Council**, 1928-32, 1935; **Vice-President**, 1932-34; **President**, 1934-35.
1907. *Chapman, Sir R. W., Kt., C.M.G., M.A., B.C.E., F.R.A.S., 23 High Street, Burnside, S.A.—**Council**, 1914-22, 1939-.
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-; **Vice-President**, 1926-27.
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.
1907. *Cooke, W. T., D.Sc., A.A.C.I., University, Adelaide—**Council**, 1938-.
1938. *Condon, H. T., S.A. Museum, Adelaide.
1929. *Cotton, B. C., S.A. Museum, Adelaide.
1924. de Crespigny, C. T. C., D.S.O., M.D., F.R.C.P., 219 North Terrace, Adelaide.
1937. *Crocker, R. L., B.Sc., Waite Institute (Private Mail Bag), Adelaide.
1929. *Davidson, Prof. J., D.Sc., Waite Institute (Private Mail Bag), Adelaide—**Council**, 1932-35; **Vice-President**, 1935-37, 1938-39; **President**, 1937-38.
1928. Davies, J. G., B.Sc., Ph.D., Council Sci. and Ind. Research, Box 109, Canberra.
1927. *Davies, Prof. E. H., Mus.Doc., The University, Adelaide.
1930. Dix, E. V., Blackwood Park, Blackwood, S.A.

Date of Election.

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.
1933. *EARDLEY, MISS C. M., B.Sc., University, 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—**Rep. Governor**, 1929-31; **Council**, 1925-28; **President**, 1930-31; **Vice-President**, 1928-30; **Secretary**, 1924-25; **Treasurer**, 1932-33; **Editor**, 1934-7.
1935. *FENNER, F. J., M.B., B.S., 42 Alexandra Av., Rose Park, Adelaide.
1927. *FINLAYSON, H. H., University, Adelaide—**Council**, 1937-40.
1931. FREWIN, O. W., M.B., B.S., 68 Woodville Road, Woodville.
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., No. 1 Service Flying Sch., Pt. Cook, Vic.
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.
1925. †GOSSE, J. H., Gilbert House, Gilbert Place, Adelaide.
1910. *GRANT, PROF. KERR, M.Sc., F.I.P., University, Adelaide.
1933. GRAY, J. H., M.D., B.S., Orroroo, S.A.
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., Riverton, 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.
1930. *HOSKING, J. S., B.Sc., Waite Institute (Private Mail Bag), Adelaide.
1924. *HOSSFELD, P. S., M.Sc., Private Bag, Alice Springs.
1939. HUTTON, E. M., B.Agr.Sc., Roseworthy College, S.A.
1928. IFOULD, P., Kurralta, Burnside, S.A.
1918. *ISING, E. H., c/o Comptroller's Office, S.A. Railways, Adelaide—**Council**, 1934-39; **Vice-President**, 1939-40.
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.
1934. JOHNSTON, J., A.S.A.S.M., A.A.I.C., A.A.C.I., Sewage Treatment Works, Glenelg, S.A.
1921. *JOHNSTON, PROF. T. H., M.A., D.Sc., University, Adelaide—**Verco Medal**, 1935; **Rep. Governor**, 1927-29; **Council**, 1926-28, 1940; **Vice-President**, 1928-31; **President**, 1931-32; **Secretary**, 1938-40; **Rep. Fauna and Flora Board**, 1932-39.
1939. †KHAKHAR, M. H., Ph.D., M.B., Khakhar Buildings, C.P. Tank Road, Bombay, India.
1933. *KLEEMAN, A. W., M.Sc., 46 Byron Road, Black Forest, S.A.
1939. LEASK, J. C., A.M.I.E., 9 Buller Street, Prospect.
1922. LENDON, G. A., M.D., B.S., M.R.C.P., North Terrace, Adelaide.
1930. *LOUWYCK, REV. N. H., 85 First Avenue, St. Peters, Adelaide.
1938. *LOVE, REV. J. R. B., M.C., D.C.M., M.A., Kunmunya Mission, *via* Broome, W.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**, 1930-33; **Vice-President**, 1933-35, 1936-37; **President**, 1935-36.
1923. MARSHALL, J. C., Mageppa Station, Comaum, S.A.
1939. MARSHALL, T. J., M.Agr.Sc., Waite Institute (Private Mail Bag), Adelaide.
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.
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; **Rep. Governor**, 1933-40; **President**, 1924-25; **Vice-President**, 1923-24, 1925-26.
1938. *MAWSON, MISS P. M., M.Sc., University, Adelaide.
1920. MAYO, H., LL.B., K.C., 16 Pirie Street, Adelaide.
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., Beltana, 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.
1924. Morison, A. J., Town Clerk, Town Hall, Adelaide.
1936. *Mountford, C. P., 25 First Avenue, St. Peters, Adelaide.
1925. †Murray, Hon. Sir G., K.C.M.G., B.A., LL.M., Magill, S.A.
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 20C, 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., Waite Institute (Private Mail Bag), Adelaide.
1926. *Piper, C. S., M.Sc., Waite Institute (Private Mail Bag), Adelaide.
1936. Platt, Prof. A. E., M.D., B.S., D.T.M., D.T.H., Dip.Bact., F.R.A.C.P., Adelaide Hospital.
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., St. Mark's College, North Adelaide.
1937. *Rait, W. L., M.Sc., St. Peter's College, Adelaide.
1925. Richardson, A. E. V., C.M.G., M.A., D.Sc., 314 Albert Street, East Melbourne.
1905. *Rogers, R. S., M.A., M.D., D.Sc., F.L.S., 52 Hutt Street, Adelaide—**Council**, 1907-14, 1919-21; **President**, 1921-22; **Vice-President**, 1914-19, 1922-24.
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-; **President**, 1939-40.
1925. *Sheard, H., Nuriootpa, S.A.
1936. *Sheard, K., S.A. Museum, Adelaide.
1934. Shinkfield, R. C., Salisbury, S.A.
1938. *Simpson, Mrs. E. R., M.Sc., Warland Road, Burnside.
1924. Simpson, F. N., Pirie Street, Adelaide.
1925. †Smith, T. E. Barr, B.A., 25 Currie Street, Adelaide.
1936. Southwood, A. R., M.D., M.S. (Adel.), M.R.C.P., Wootoona Terr., Glen Osmond, S.A.
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-.
1934. Symons, I. G., Murray Street, Mitcham.
1929. *Taylor, J. K., B.A., M.Sc., Waite Institute (Private Mail Bag), Adelaide—**Council**, 1940-.
1940. Thomson, J. M., 302 The Terrace, Port Pirie, S.A.
1923. *Tindale, N. B., B.Sc., South Australian Museum, Adelaide—**Secretary**, 1935-36.
1937. *Trumble, 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., Waite Institute (Private Mail Bag), Adelaide.
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.
1939. Warhurst, Miss B. W., B.Sc., Commonwealth Munitions Lab., Maribyrnong, Vict.
1936. Waterhouse, Miss L. M., 35 King Street, Brighton, S.A.
1939. Weeding, Rev. B. J., Eudunda.
1931. Wilson, C. E. C., M.B., B.S., "Woodfield," Fisher Street, Fullarton, Adelaide.
1938. *Wilson, J. O., 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-.
1923. *Wood, Prof. J. G., D.Sc., Ph.D., University, Adelaide—**Council**, 1938-40; **Vice-President**, 1940-; **Rep. Fauna and Flora Board**, 1940-.

Associate

1940. Birch, L. C., B.Agr.Sc., Waite Institute (Private Mail Bag), Adelaide.
1936. Sprigg, R. C., Toddville Street, Seaton Park, Adelaide.

Deceased

Goyder, G. A. M., B.Sc., F.G.S.   Showell, H.

GENERAL INDEX.

[Generic and specific names in italics indicate that the forms described are new to science.]

GENERAL INDEX

[Generic and specific names in italics indicate that the forms described are new to science.]

CONTENTS

PART I

PART II