

RECORDS
OF THE
SOUTH AUSTRALIAN MUSEUM

Vol. XIII, No. I

Published by The Museum Board, and edited by the Museum Director

ADELAIDE, APRIL 30, 1957

PRINTED BY PUBLISHERS LTD., FRANKLIN STREET, ADELAIDE

Registered in Australia for transmission by post as a periodical.

CULTURE SUCCESSION IN SOUTH EASTERN AUSTRALIA FROM LATE PLEISTOCENE TO THE PRESENT

BY NORMAN B. TINDALE, SOUTH AUSTRALIAN MUSEUM

Summary

This paper summarises work in Adelaide since 1928 to establish the archaeological culture succession. It gives newly available time data for the Kartan culture of Late Pleistocene, traces changes through Tartangan, Pirrian and Mudukian industries to the latest or Murundian Culture phase.

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Text Fig. 1-9

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A healthy science is one in which there is continuous re-evaluation of problems in the light of present evidence . . . As humans we think in terms of labels we put on things. But if the labelling system does not keep up with thought it is demonstrably a short time before thought ceases. . . . Putting the label on is only half the game; taking it off again is the other half.

HALLAM L. MOVIOUS, JUNIOR.

SUMMARY.

This paper summarises work in Adelaide since 1928 to establish the archaeological culture succession. It gives newly available time data for the Kartan culture of Late Pleistocene, traces changes through Tartangan, Pirrian and Mudukian industries to the latest or Murundian Culture phase.

Geological evidence and Carbon 14 data are compared and coordinated with the succession, the whole sequence being summarised in a table (fig. 1).

The survival of *pirri* implements as stone spear tips on the *karu* spear in Western Australia is reported, as is also the use of a Tartangan

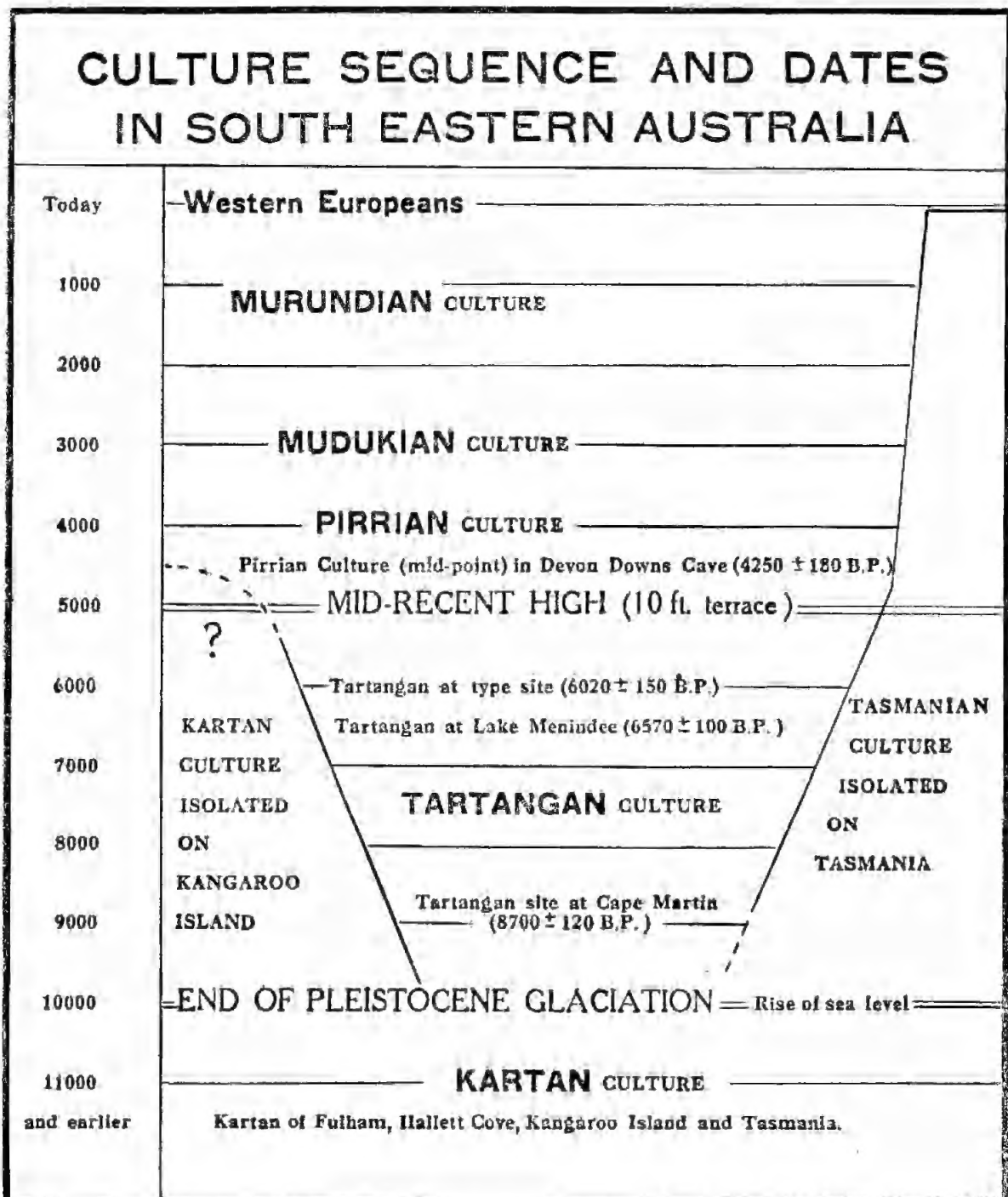


Fig. 1. Diagram summarising the succession of cultures in South Eastern Australia from the Last Glaciation to the present time.

type of knife called *jimari* among living people in the North of Western Australia, and of a hafted chipped-back knife called *juan*, from Queensland.

There is a brief discussion on the types of human beings who may have devised, developed, transported and used these implements in Australia and Tasmania.

The earliest date based on geological data is indicated to be Late Glacial, prior to 10000 B.P. (Before the Present), for the Kartan Culture of Hallett Cove and Fulham, South Australia. This culture is indicated as a widespread one, extending out from Indonesia and South Eastern Asia to Australia. The succeeding Tartangan culture, at a minimum, embraced the period between 8700 B.P., based on a C^{14} date at Cape Martin and 6020 B.P. at the type site at Tartanga. A C^{14} date of 4250 B.P. is available for a specific horizon (Layer IX) at the type site of the Pirrian Culture, in Devon Downs Rock Shelter, South Australia.

There is some discussion on climates and the conclusion is reached that there is no foundation for the existence of a major arid cycle in the Mid-Holocene Period but that the Mediterranean climate of Southern Australia in modern times represents the virtual maximum of an arid cycle which has been developing over the past two thousand years or more.

CULTURE SUCCESSION IN SOUTH EASTERN AUSTRALIA.

INTRODUCTION.

The idea of a succession behind the array of archaeological implements discovered in Australia is probably old but little tangible evidence was available until a relatively short time ago.

Definite cultural stratification in Australia perhaps was first demonstrated in 1929, with the spade, by Hale and Tindale (1930) at Tartanga, and at Devon Downs Rock Shelter, on the River Murray, in South Australia. This work began as the result of a chance find by a local collector of fossils, W. P. Roy, who showed a mineralised human part cranium to Edgar R. Waite, Director of the South Australian Museum, in January 1928, a few days before his death at the Australian Association for the Advancement of Science Congress of that month in Hobart.

Three culture horizons were found to be present in the 6 metre (21 ft.) depth of deposit in the rock shelter at Devon Downs and a still earlier culture horizon was in a river bank site on Tartanga Island a few miles away. The strata, in descending order, were named as Murundian (the present day culture), Mudukian, Pirrian and Tartangan.

Shortly afterwards Tindale and Macgraith (1931) identified another, and separate industry, on Kangaroo Island. This island was uninhabited when visited by European explorers in 1802. Some archaeological

implements had been reported previous to 1931 by W. Howchin but no details had been given. This Kangaroo Island culture (later to be named the Kartan) was recognised by Tindale (1937) also to be present on the mainland of Australia and in Tasmania, where it was an earlier stratum in a Tasmanian culture sequence. It was then demonstrated, on stratigraphic evidence, that implements at Fulham near Adelaide were older than the Pirrian and, by inference were older than the Tartangan; they occurred on an ancient land surface, now below sea level, which subsequently had been covered by marine deposits, and then by lacustrine beds above which were the Pirrian camps.

Tindale (1941) called this very old suite of implements the Kartan Culture, typically from Kangaroo Island, but present also on the mainland of Australia and in Tasmania. The industries specifically at Fulham and at Hallett Cove, South Australia, were thought at the time to be sufficiently different from the true Kartan Culture to be called the Fulham Industry simply because they supposedly lacked one specific implement type, the sumatralith. However it is now clear, at least at Hallett Cove, that this was due to insufficient collecting, for typical sumatraliths are known from the site, and the supposed differences can be considered less important.

The only other culture phase terms proposed for implement suites in South Eastern Australia are ones by McCarthy (1939) who has referred to the "Gambierian" in the South East of South Australia and the "Bondaian" and "Eloueran" on the coast of New South Wales. The status of the "Bondaian" was discussed by Tindale (1955) and all three are referred to in a later section of the paper.

The significance of the detailed sections and cultural sequences revealed by excavation at Devon Downs and Tartanga did not immediately attract attention in Australia. Thus Shellshear (1937) spoke of the "lack of accurate and detailed excavation work in Australia". A useful summary of work and opinions on man in Australia up to 1942 was given by Mahony (1943).

The next phase of study was geological exploration. Keble (1947, published 1948) had a paper which appeared just after one by Tindale (1947). These papers independently covered much the same ground in exploring the geological background of man's sojourn in Australia. The approach to the problem of dating Pleistocene and Recent time in Australia by establishing links with the world-wide phenomena of eustatic shore lines, foreshadowed by Tindale (1933) was amplified in 1947. The 1933 paper was not noticed by Keble, so that some of his conclusions had been long anticipated.

KARTAN CULTURE.

The Kartan Culture is characterised on Kangaroo Island by the presence of sumatraliths, hammer stones, horse-hoof implements, some discoidal implements of a type which have come to be known as *karta*, and some poorly worked flakes. Most of the implements are relatively large and coarsely made. Tindale and Maegraith (1931), Tindale (1937) and Cooper (1943) have described and figured many examples, and Tindale (1950, 1951) has reported the discovery of *karta*-like implements surviving in use as the cutting blades of the palaeolithic *kodj* axe of the people of South Western Australia.

At the archaeological site of Hallett Cove (Section 562, Hundred of Noarlunga) further field work has been done by Mr. H. M. Cooper. This site was originally found by him and recorded by Tindale (1937). Ploughing of the land for agricultural purposes has lately brought to the surface many more implements, including some very typical sumatraliths.

Cooper has observed that the Kartan implements of Hallett Cove are all made from pebbles derived from the fluvio-glacial deposits and associated chocolate shales of the Marinoan Series, which occur in nearby gullies, whence they have been carried up on to the plateau campsite. There are no implements made from stones derived from the present pebble beach, which lies at the base of the cliffs some two hundred feet below the site, although these pebbles were, at Moana and at other adjoining sites, very much used in a different fashion as raw material for implements by men of the Firriian and later cultures..

From this fact an inference is made by the present author that at the time of occupation of the Kartan site on the crest of the hills, sea level was lower than at present and hence did not lap the cliffs. The present pebble beach at Hallett Cove would then have been buried under a talus slope, and a foreshore plain, such as occurs further to the north as the Adelaide Plains would have extended out beyond the hills at Hallett Cove. It is evident that during the low sea levels of the Last Glaciation the shoreline was many miles away.

This is consistent with the presence of similar implements on the land surface below present sea level, at Fulham, a few miles further north (Tindale 1937, fig. 11).

The occurrence of a relatively large number of sumatraliths, at Hallett Cove on the mainland, narrows down the supposed differences between the Fulham Industry of the South Australian mainland and the Kartan Industry from Kangaroo Island. The ratios of sumatraliths to horsehoof implements approached 90 per cent on Kangaroo Island whereas at Hallett Cove sumatraliths are present only to the extent of about 40

per cent. On Kangaroo Island sites no fewer than 1,221 sumatralith implements have been recovered; the Hallett Cove site has to date yielded some 40 examples. Two possible explanations are offered to account for the different proportions of sumatraliths met with on mainland sites.

If Kartan men were present in Australia at the end of the Pleistocene Period they witnessed the rise of sea level from the low eustatic terrace condition which it held during the rigours of the last phase of the Last Ice Age. At first Kangaroo Island would have been connected with the mainland, hence from the point of view of any people then living in Australia this "island" was merely one of a number of cold, south-facing coastal areas. With the coming of early Recent Time, about 10000 B.P. Kangaroo Land began to be cut off from the mainland, as it is today. Any people living there would have become isolated, and protected from mainland contacts. It might be safe then to assume that, in their sheltered territory it would be possible to have a far lesser call to make combat weapons, hence horsehoof implements, perhaps chiefly used as unhafted adzes or choppers in working wood for weapon making, might become fewer in proportion to the *sumatra* implements used evidently in food gathering. It will be recalled that among some living aborigines of coastal South Queensland, sumatralith-like implements were used in digging out bracken fern rhizomes for food.

Another possible explanation of the differences should be considered. Aborigines of all periods were prone to retrieve the materials left on old campsites by earlier men, converting them to new uses according to their own ideals of implement making. On the mainland *sumatras* being large and of selected stone were doubtless good sources of quartzite for micro-liths and flakes throughout Recent Time. On the island where the Kartan Culture persisted unchanged till it became extinct, little such scavenging of surface sites would occur, hence the proportions of discarded implements present might not have been altered in this manner on the island. Mr. H. M. Cooper is at present studying a few implements of later cultures which hint at sporadic later casual visits to the island.

New sites for the Kartan Culture are constantly being discovered. At Moana, South Australia, H. Burrows and the writer found a typical *sumatra* on the surface of eroded kunkar limestone at the southern end of the sand plain. It was coated with lime (specimen A.48749). Mr. J. E. Johnson found several excellent sumatraliths at Terrapinna Rockhole on Moolawatanna Station in the Flinders Ranges, South Australia (specimens A.48785).

In August, 1955, on the official excursion to Keilor, Victoria, during the Science Congress, Mr. H. R. Hammet picked up and kindly presented

to the author a large, coarse, flaked implement which he found on the surface of a ridge in the valley above the left bank of the "Dry Creek", at Keilor, within 100 yards of the fossil skull site. This implement seems undoubtedly to belong with ones of the Kartan Culture. Whatever the age of Keilor man himself, Kartan implement users were probably once in this area. The specimen is now A.48061 in the South Australian Museum.

Dr. A. Gallus more recently has submitted for identification other large implement flakes found at several places in the Maribyrnong Valley, Victoria. Four of them prove also to be artefacts of types characteristic of the Kartan Culture phase. A typical quartzite flaked hand chopper was of a weight (22 oz.) and general form which might be expected to occur where tubular pieces of stone replace waterworn oval pebbles as raw material in the making of sumatraliths. Others of his specimens were found to be directly comparable with some implements described by Tindale (1937, p. 50) from the older or Kartan-like Culture phase at St. Helens, Tasmania. Tindale (1941) reported similar examples from Flinders and Cape Barren Islands in Bass Strait, where the Newer Tasmanian Industry is unknown.

Kartan types of implements are now known from many places on the Australian mainland, notably at Calligillup, six miles east of Mt. Barker in South Western Australia, at Roebourne in the north of Western Australia; and at Yarrie Station on the De Grey River, North Western Australia, where they were found by J. B. Birdsell and the present author, the first named locality in 1939, and the others in 1953.

Messrs. B. Main and G. W. A. Bartholomew found a single large flake which may belong to this culture on a sandhill between Roebourne and Cossack, in Western Australia. Dr. J. B. Birdsell and the writer found a horsehoof implement, similar to those of this culture, made from heavy ironstone, at a place 16 miles East of Flora Valley, in North Western Australia (Specimen A.45415 in S.A. Museum).

Mr. Lindsay Black has in his collection a typical sumatralith (his no. 1729) from Bootra, about 100 miles north of Yancannia near the border between New South Wales and Queensland; it is made on a rather rough-textured pebble of red-stained quartzite.

Mr. Brian Daily, now Palaeontologist in this Museum, several years ago found a rolled sumatralith (specimen A.46986 in the S.A. Museum) with the working edge extending along one side and the end of a rather elongate ovate pebble; it is not quite typical of Kangaroo Island sumatraliths. It was on a ledge of mottled red, white and yellow argillaceous sand of uncertain age between Late Tertiary and Sub-Recent time, about two

miles west of Lubra Point on the south coast of Bathurst Island in the Northern Territory. This ledge protruded from a sand dune about 70 feet above high tide mark. He noted that no other implement of this type, and no further sample of the rock of which it is manufactured was to be found either on this island or on the adjoining Melville Island, where he also worked. The specimen is figured by Tindale (1956 (2) p. 119). Daily found similar types of pebbles in Cretaceous Beds further east on Bathurst Island.

The occurrence is useful in indicating the possible extension of the Kartan Culture to what was part of the mainland of Australia in Pleistocene time.

It is of interest in another way. The present day inhabitants of Melville and Bathurst Island are of negritic type only slightly modified by some possible hybridisation with Australoid stock. This may help to confirm indications from other quarters that some former link may have existed between the negritos of Australia and Kartan Culture.

Implements of the same forms as those of the Kartan Culture are characteristic of many sites in South East Asia and Indonesia. They are reported as far to the north as in the Bac-son Mountains of Tongking, being found there and in Malaya, often in the lowest stratified occupational layers present in caves and rock shelters. Heine-Geldern (1932 pl. 1, fig. 4-5) figures examples from Bac-son.

Examples from caves called Gua Kerbau in Perak, and Gua Badak in Lenggong, collected by the late P. D. R. Williams-Hunt are in the South Australian Museum (specimens A.43256-43286).

Saurin (1953) suggests that Hoabinhien Culture sites in Indo-China are mostly, if not wholly Post-Pleistocene in date. One of the characteristic implements is the sumatralith.

The late date suggested for the Hoabinhien of Indo-China contrasts with the increasing evidence that in the Australian corridor and in Australia the Kartan Culture, which has similar implements, was at latest of Late Pleistocene times in its main period of dominance. By about 9000 B.P. it had already been supplanted by the Tartangan in South Eastern Australia, there being local survivals until more recent times only in peripheral areas, and on islands such as Kangaroo Island. However, if the Kartan Culture was, in the main, that brought to Australia by people of negritic stock, then it is probable that it persisted for a long time in the rain-forested areas along the eastern coast of Australia where negritos survived. In areas near Brisbane, for example sumatralith-like implements remained locally in use until modern times as digging stones in the gathering of bracken fern roots, for food (Jackson, 1939). McCarthy (1947) has reported *sumatra*-like implements from sites he identifies as

modern on the North Coast of New South Wales; the one figured is not very typical of the Kartian Culture ones of Kangaroo Island.

The late date suggested for this type of culture in a part of Asia may also reflect the similar fact that negritic populations proved able to maintain themselves until modern times in many areas of jungle. At some places their primitive implements probably remained in use for a long time, until they established sufficiently cordial contacts with more advanced peoples to enter into barter with them. It is noteworthy that in Malaya sumatraliths and archaeological pottery have been reported together, and that the Semang negritos today trade forest products with Malays for their requirements of metal tools, etc.

TARTANGAN CULTURE

This culture was originally reported from Tartanga Island in the Murray River, where there is a series of beds identified as of Pre-10 foot Terrace Age, with *Unio protovittatus* as the principal food shell, and a suite of piscine, reptilian and mammalian fossils, only one of which, a *Macropus*, may have been of an extinct species. Layer C, an upper horizon in the Tartangan series, is now dated by Carbon 14 to 6020 ± 150 B.P. Areas of Tartangan campsite are known also to be on the plateau near Swan Reach, a few miles away. At Lake Menindee, Tindale (1955) reported a Tartangan Culture as contemporary with beds containing a large assemblage of fossil mammals (Tedford 1955). A hearth in this Tartangan horizon has now been dated to 6570 ± 100 B.P.

At Cape Martin in the South East of South Australia Tindale (1956 (4) and paper in press) reports a still earlier Tartangan horizon, dated to 8700 ± 120 B.P. This is a *terra rossa* soil on a land surface demonstrably of Early Recent date. Tartangan sites found at Cape Northumberland, Kongorong, Symon, and inland from Blackfellow Cave in the South East of South Australia, as also at Cape Bridgewater, in Western Victoria are also being discussed in the same paper.

The known distribution of the Tartangan Culture is constantly being extended. Latest reports of possible sites is by two correspondents, Messrs. J. E. Johnson and S. B. Warne who, writing from the Western Desert near the Western border of South Australia state:—"At Giles Tank in Western Australia we have found what seems to be a Tartangan Culture and an undoubted culture of the Tartangan or pre-Tartangan has turned up on a small site 6 miles South of Mt. Harriet, South Australia, where large, coarsely but sharply percussion-trimmed, deeply patinated tools of micro-diorite are found. They are made on blocks and large insolation flakes and prepared cores, and comprise horsehoofs, block choppers and large flakes."

The area of distribution of the Tartangan as an archaeological culture thus possibly extends at least from the eastern borders of Western Australia to Cape Bridgewater in Victoria and from Lake Menindee in the Western part of New South Wales to the South Coast of Australia.

The Tartangan as revealed at these places resembles so closely the implement culture of the Tasmanian aborigines of modern times that there is every reason to suspect a link.

The Tasmanian implement types figured and described by Tylor (1895) for example can all be matched among the general run of implements of Tartangan facies to be taken in the coastal regions of the South East of South Australia. The work of the Tartangan peoples plus the nature of the flint there has yielded flakes identical in style, though naturally widely differing in manner of patination, etc.

Campbell and Noone (1943, p. 384), during their studies of the implements of the Woakwine Range in the South East of South Australia, sensed the resemblances between their Tartangan finds and those from Tasmania, even though they were puzzled by the absence of any implements of the types now known to belong to the Kartan Culture. It would seem they had not appreciated that two culture periods were involved. They did not use the culture names proposed by Hale and Tindale (1930).

The newly gained knowledge, that Tartangan folk were at Cape Martin no more than about one thousand years after the probable time of the severing of Tasmania from the Australian mainland at the end of the Last Glaciation, clearly supports the conclusion that there was a direct relationship and the fact that the Tartangan and Kartan people were not everywhere contemporaneous explains the seeming inconsistency of the absence of the Kartan types. One would expect that many of the Kartan campsites along the coast were obliterated by the rise of sea level which was one of the primary markers of the end of the Pleistocene.

The Kartan Culture, being earlier than the Tartangan had already spread to both the Tasmanian and Kangaroo Island areas before the Tartangans arrived.

We are led to see that most probably the Tartangan Culture also was moving into and had already taken over the occupation of parts of the Murray Valley and vicinity and of much of the area of Victoria near the entrance to Tasmania, by the end of the Pleistocene. Both cultures were shut off in Tasmania by the rise of sea level and we can postulate perhaps a period of culture clash in Tasmania about the end of Pleistocene time, leaving the Tasmanian Culture in command until modern times.

Although the Tartangan Culture seemingly thus occupied a good part of South-Eastern Australia by the end of the Pleistocene it probably had not yet had time to penetrate as far westward as the Mt. Lofty Ranges. Hence when the Kangaroo Island area was severed from the mainland by the same rise of sea level as cut off Tasmania, the older Kartan Culture was the only one represented in the area. It was cut off and persisted unchanged on this large island until it became extinct, perhaps by the time of the Mid-Recent High sea level. Despite active search no Kartan implements have been found on any Post-Mid-Recent coastal area on the island. In Tasmania, on the contrary, the newer Tartangan implement culture flourished, either replacing the older Kartan one or absorbing it (we cannot yet tell which) to become the Newer Tasmanian Culture of yester year. Certain it is that the Kartan on Kangaroo Island did not show any signs of change before it became extinct, whereas over much of the mainland of South Eastern Australia, in the archaeological succession, Kartan was superseded by Tartangan, and then by the Pirrian and the still later cultures which followed.

Sufficient indications now exist to enable us to visualize probable Early, Middle, and Late phases of the Tartangan Culture, the whole ranging in time from about the last cold phase of the Pleistocene down to about 5000 B.P.

Early Tartangan was a large blade culture which possibly spread to Australia from Asia, but it is not clearly recognised there; isolated blades have been found in New Guinea which show resemblances, but not much is known about them; they will be described when more information is to hand.

The Tartangan of Cape Martin, at 8700 B.P., can be regarded tentatively as the beginning of Middle Tartangan times. There is a wealth of cultural material, in flint, from Hoods Drift, Symon and elsewhere on the Woakwine Range which in part belongs here although much of it may, when C¹⁴ tests are made, prove to belong to the earlier phase and so be better placed with Early Tartangan.

Late Tartangan times, on the mainland, may have commenced before 6500 B.P. on the Darling River. It typically is the Tartangan of the type site at Tartanga, on the River Murray. The last named series comprise a late suite of implements, in an area short of good stone for their manufacture.

The solitary large crescentic implement of dull grey chert, figured by Hale and Tindale (1930 fig. 229) from Layer IX in Devon Downs Rock Shelter is like a Tartangan implement, and is either a very late survival or is an archaeological specimen picked up and carried there by a Pirrian man.

In its time of development the Tartangan of South Eastern Australia may have covered that critical period which saw the decline and ultimate disappearance of most of the population of large mammals and giant birds of the Australian Pleistocene.

Gill (1955) has discussed various theories to account for the crash of the giant mammal assemblages of the Australian Pleistocene but does not produce any clear cut evidence indicating man as a primary factor in their extinction.

Although climatic changes are generally blamed for their extinction, men doubtless had much to do with the final disappearance of these creatures.

Mr. H. M. Cooper in April 1955 found a hearth on the crest of red sand dunes at Port Augusta West, at the head of Spencer Gulf, South Australia, with burnt bones and teeth of *Diprotodon* and large flake tools. These perhaps belonged to an early phase of the Tartangan Culture or late Kartan period. He proposes to publish an account of this site.

From the data in the Lake Menindee area (Tindale 1955), the above mentioned observation made by Cooper, and also a hint given by the carvings of tracks of a giant bird (perhaps *Genyornis*) described by Hall, McGowan, and Guleksen (1951), at Pimba, South Australia it seems likely that man hunted and ate the principal Pleistocene species, and that in the Murray Basin, during the period between about 6500 B.P. and 6000 B.P., he succeeded in virtually eliminating all but a large kangaroo, *Macropus*, like the modern species, *Procoptodon*, and the Devil (*Sarcophilus*), which managed to survive in some numbers until Pirrian times, (Hale and Tindale, 1930, pp. 211 and 215).

It is not yet certain when Tartangan folk disappeared from the Murray Valley scene. They were definitely absent by 4250 B.P. when Pirrian folk already were living there. No Tartangan implements have been found on top of the blanket of ash spread by the eruption of Mt. Gambier, which has been dated to 4710 ± 70 B.P., although ones attributable to the Pirrian and Mudukian cultures are present.

We are indebted to Mr. T. A. Rafter for this C¹⁴ date, furnished in a letter addressed to Dr. C. Stephens of the C.S.I.R.O., Adelaide, on 29 June 1955.

There are some links between the Tartangan Culture and some people of the present time. During a visit of the Board for Anthropological Research Expedition to Yuendumu, Central Australia, in August 1951 (made possible by a grant from the Wenner-Gren Fund) there was an opportunity for this author to see and film a number of Ngalia men making stone knives at a factory site near the Government Station. The

members of this tribe have continued to use the mine because of a demand for knives to sell to European visitors to the Station. The Ngalia men whose techniques were studied on this occasion, were the same as those met by the author on a previous expedition to Cockatoo Creek in August 1932, when they were still nomadic savages, just being brought under control, after the murder near Coniston Station of a white man, during the initial phases of contact.

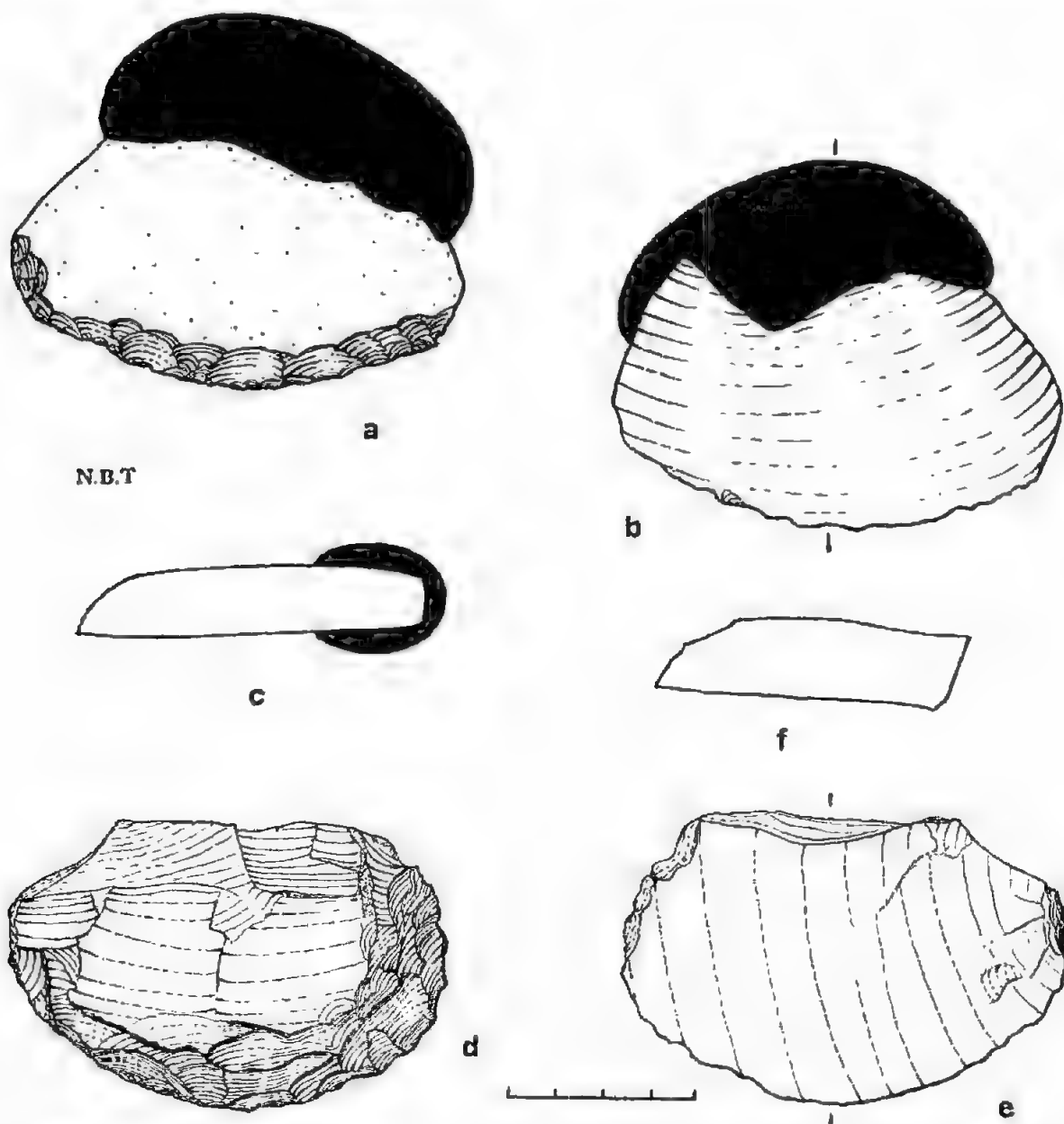


Fig. 2, a-c. Gum-bafted general purpose knife, of type used by Mangala tribe in desert east of La Grange Bay, Western Australia, native name [jimari]; specimen was No. 1964 in collection of Lindsay Black, width 5.5m., specimen now A.49903 in S.A. Museum; d f knife of *jinuri* type made by Pintubi tribesmen at a factory site near Yuendumu while demonstrating stone knapping methods (specimen A.42899 in South Australian Museum).

The Ngalia type of knife has not changed in the intervening years. Details of their technique of making knives, of rather typical Central Australian type, are reserved for a separate paper.

A man of the Pintubi tribe was present. He was a lately arrived visitor from the still nomadic Pintubi folk of the country along the Western Australian border, south east of Lake Macdonald. His knives were entirely different from those of the other workers. Pintubi ones were made from large flakes struck off from a core, sometimes as a long oval blade, and at others to make a wide squat one. All his trimming was done with the aid of a moderate-sized stone, used as a hammer, and the finished result showed primary, secondary and tertiary trimming. Whichever flake was obtained initially the secondary work fashioned it into an oval knife, trimmed on one long margin of the stone. In cross section the finished knife had the same rounded silhouette as is familiar in the large knife blade of the Tartangan Culture of Southern Australia. Fig. 2, d-f give two views and a diagrammatic section of one made by this Pintubi man. It was on a rather brittle flake of sugary-textured quartzite containing numerous flaws. The man indicated that the stone was poor, and claimed that in his own country much better material was available for use. Despite the apparent disability imposed by the poor stone his finished knife flakes were symmetrically and neatly fashioned. In use they were hafted in *Triodia* gum but at times could be used without. No attempt was made to trim that part of the butt which in normal use would be concealed beneath the gum of the handle.

Just afterwards a similar knife from North Western Australia was seen in the collection of Mr. Lindsay Black of Leeton, New South Wales, and a period of six months of field work in North Western Australia in 1953 enabled the data it provided to be followed up among the people from whom it had come.

Fig. 2, a-c shows two views and a diagrammatic section of this general purpose knife, made from a grey opaline silica, on a flake showing white cortex on the outer face. It is hafted with gum from one of the porcupine grasses (*Triodia*). In this specimen the nature of the striking platform is concealed by the gum haft but other known Mangala tribe examples show the remains of a striking platform set at about 110° angle from the inner face of the flake. The example came from east of La Grange Bay, in the dry sandy desert area behind the Eighty Mile Beach, in North Western Australia. The coastal region here is occupied by the Karadjeri, inland is the tribal territory of the Mangala people among whom this form of knife is used and known as [*j̄mari*]. The figured specimen is the one collected by Mr. Lindsay Black and it is listed in his collection under the

number 1964; through his courtesy it has now come to the Museum collection (A.49903). Similar knives, now restricted to special uses, are known and treasured at least as far south as the Fortescue River, among the Njangamarda, Njamal, Bailgu, Wanman, and Indjibandi folk. The people of these tribes have for some years been in contact with civilisation and have dropped the general use of stone implements; however they still need a form of this knife for their initiatory rite of circumcision. Hence every man who has the prospect, at some time or another, of being able to circumcise a future son-in-law, has in his possession one or more specimens, of several sizes, cached away in some safe place against that day. During the 1953 visit to North Western Australia it was possible to

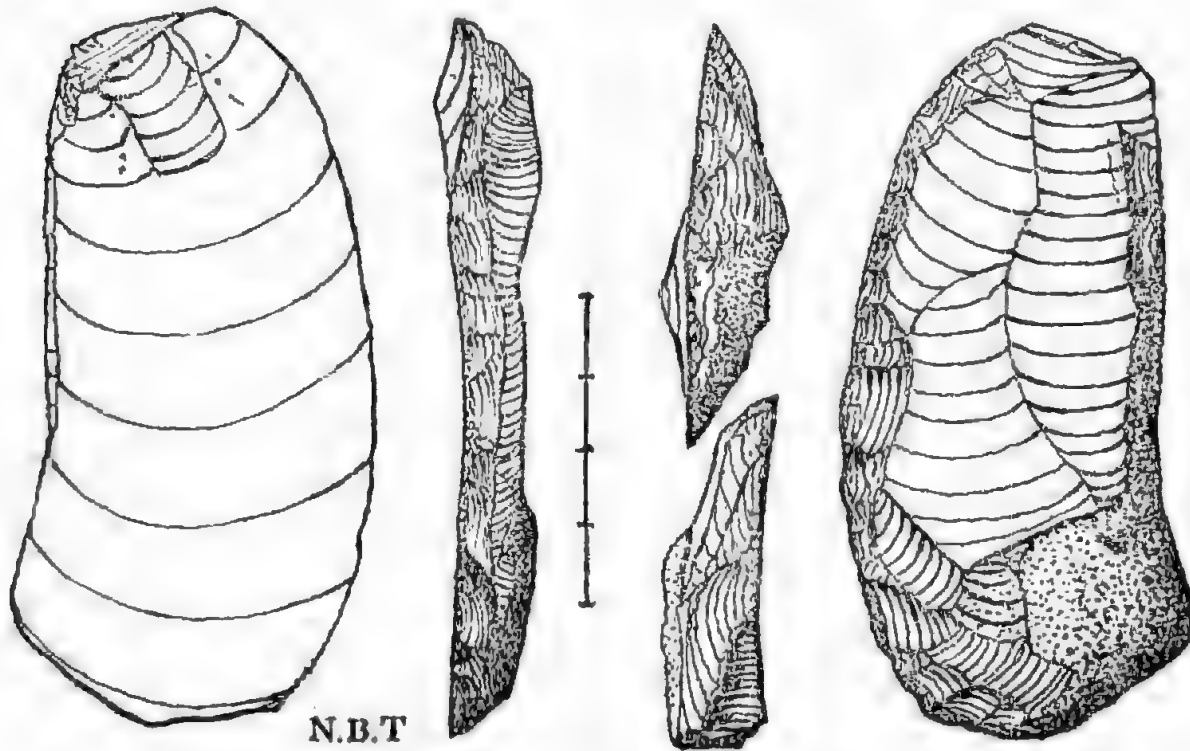


Fig. 3. Five views of archaeological quartz knife from the Tartangan horizon at Hoods Drift Section 541, Hundred of Kongorong (specimen A.30560 in S.A. Museum).

see numbers of them which were produced for inspection, sometimes from hiding places in cliff faces; to have a demonstration of the mode of manufacture, and to receive several as gifts. One of the noted mining places for the stone is at Pilbara Hill and specimens A.45156 and A.45157 in the S.A. Museum are ones from this factory area. Their specialised use as instruments during initiation has preserved knowledge of them for at least two generations more than otherwise might have been expected. For the same reason they are not now seen openly in camps where women folk might discover them. They were often depicted however when

native drawings were being made by men. They seem, only a short time ago, to have been the normal form of everyday knife in the Pilbara area of Australia, as they still are among the less sophisticated Mangala. The last named people, like the Wanman, who live east of Lake Waukarlykarly, are a folk so specialised for life in the dry sandy deserts south of the Fitzroy River that they seldom carry any other implement or weapons than a knife and a throwing club, and for much of the year live on lizards, on the heaps of grass grains gathered by ants about their nests, on small rat kangaroos, and occasionally on other small animals such as the blind marsupial mole.

The particular significance of this type of general purpose knife, for the present paper, is the close similarity, amounting to identity, of its form, mode and degree of trimming, and perhaps also the nature of its handle, with the archaeological Tartangan ones in South Eastern Australia. Fig. 3 gives several views of an example from the Tartangan layer at Hoods Drift for comparison with the modern examples.

The contrast between the untrimmed and unmarred back of the Mangala knife, which in use is concealed beneath the gum of the handle, and the superlatively well worked knife edge, with its rounded profile and curved cutting edge, is very characteristic.

Tartangan implements very generally show this same contrast, suggesting that they probably also were hafted in a similar manner, perhaps using one or other of the generally available gums and resins known to later aborigines. These include native pine (*Callitris*) gum, resin of the grass tree (*Xanthorrhoea*), gum from phyllodes of *Acacia aneura*, the exudate from the roots of *Leschenaultia divaricata*, sandalwood (*Santalum*) gum, and porcupine grass gum (*Triodia*), as well as beeswax from stingless native bees.

The Mangala name [*jimari*] for this knife is proposed as a general term for the type. It may be convenient in future to refer to Tartangan examples as archaeological *jimari*, defining the typical form as based on the Mangala version in current use, just in case it is later on proved that the resemblances between them are somewhat less real than seems apparent at present. The term *tronata* in Tasmania, while usually used in a more general sense, embraces specimens which are similar.

Tindale and Noone (1941) have described flakes from a hoard of 74 newly prepared blades near Eucla on the borders of South and Western Australia in present day sand dunes. This hoard includes some pieces closely similar in size and form to *jimari* and may hint that Tartangan-like culture survivals extended also to the Eucla district.

PIRRIAN CULTURE

A specific horizon in the Pirrian Culture, Layer IX in the type section at Devon Downs Rock Shelter, has been dated to 4250 ± 180 B.P. by a C^{14} test of *Unio* shells picked from a mass sample of the debris of the layer.

The same horizon possibly represents the high point in this culture. At least it chanced to produce a *pirri* implement (Hale and Tindale, 1930, fig. 177, and 179) technically so outstanding that it has scarcely been matched by any from hundreds of other sites and probably is the equal of any among thousands of *pirri* implements that have been collected. This culture was widespread and its users were prolific in the production of implements, from a great variety of stones. A collector in the Woomera area of South Australia possesses over two thousand examples picked up on surface sites in one area alone.

The Pirrian culture probably appeared in the Murray Valley about or just after the period of the Mid-Recent High Terrace. The earliest implements discarded on the top of the blanket of ash from the Mt. Gambier eruption of 4710 ± 80 B.P. are identified as most probably Pirrian and no earlier Tartangan ones have been found there.

The Pirrian Culture has now been reported from almost all parts of Australia excepting only Cape York Peninsula, coastal Queensland and parts of Eastern New South Wales; in these three places insufficient collecting has been done to regard their entire absence as established beyond doubt.

The most characteristic implement, the *pirri* implement itself, as indicated in a later paragraph in this paper, was a spear point. It survived until modern times in a part of Western Australia. There is evidence, to be elaborated in a later paper, which shows that the pressure-flaked biface blade culture of North Western Australia is likely to have been a direct development from the Pirrian. Study of the techniques of pressure-flaking has shown that in one tribe at least a rather large-sized, *pirri*-like, uniface hammer-dressed blade is made during a preliminary stage of preparation of the stone for pressure flaked blades.

Indications of the modern survival of the *pirri* are of particular interest. In the South Australian Museum is a spear (A.21356) from the collection of the late A. Zietz labelled "? Interior of Western Australia". It was probably collected during the last century. It has a well formed *pirri* trimmed on both lateral margins and set in gum, as the spear tip. The shaft is of the so-called composite type, the foreshaft being of hardwood, 118 cm. in length, with the junction of gum and hardwood shaft bound with kangaroo sinew. The length of the *pirri* and gum support is

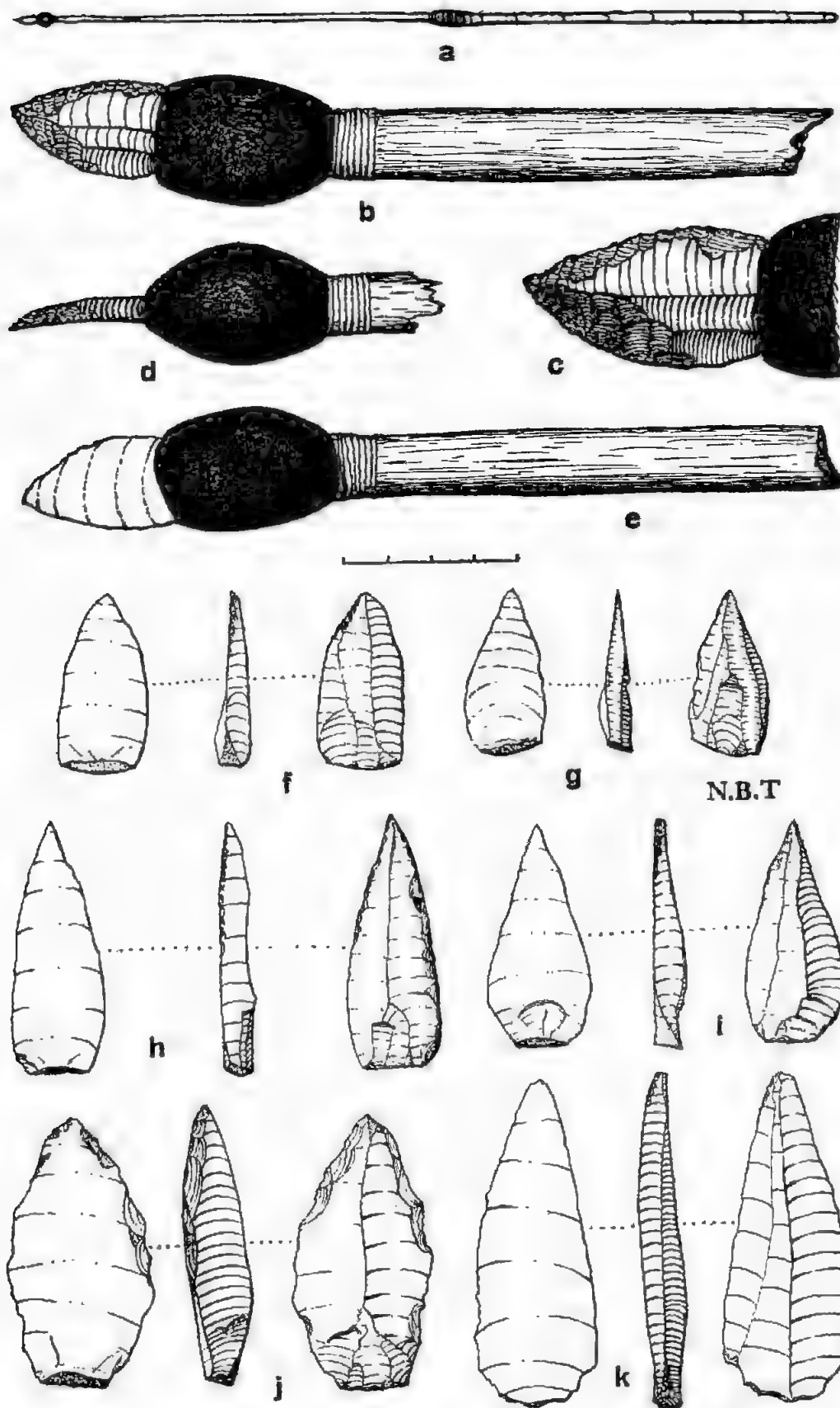


Fig. 4: Stone-headed composite spear from Western Australia and archaeological *pirri* projectile points from various places. a. Spear of type known as *karu* by Wanman people, example A.21856 in South Australian Museum from collection of A. Zieta, labelled "Interior of W.A."; total length 252 cm., of hardwood shaft 118 cm., of reed butt 127 cm. b-e Four views of head; d, is somewhat enlarged. f, 3 views of *pirri* from Coorong (Section 2, Hundred of Santo, South Australia, A.43956); g, Eucla, Western Australia, A.41879; h-i Claypan site south of Mt. Davenport, South Australia, A.21590; j-k Boolka Lake, New South Wales, A.21378 (scale, in centimetres, applies to all figures except a and c).

7 cm. The lower end of the hardwood shaft is inserted into a reed shaft 127 cm. long, and of a diameter of 1.5 cm. the union between them being lashed with sinews; the butt end of the spear shaft has received no particular preparation but is severed immediately below a knot in the cane, hence it appears as if prepared for use with a spearthrower. The spear shows the polish of much use. It is an important piece of evidence demonstrating one of the primary functions of the *pirri*. Fig. 4 (a-e) illustrates the specimen from several aspects. A secondary function for archaeological *pirri* was noticed by Hale and Tindale (1930 p. 205).

In the Bernice Pauahi Bishop Museum, Honolulu, is a similar example of hafted spear (their B702) from Western Australia (fig. 5). It originated with the Helms Collection. The specimen was examined at Honolulu by the writer in 1936. Richard Helms was the anthropologist of the Elder

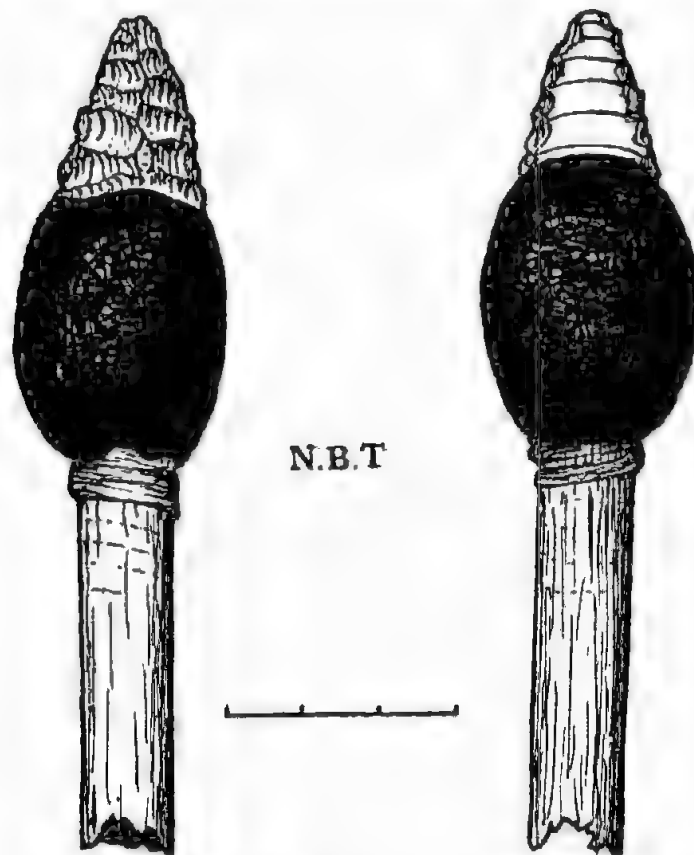


Fig. 5. Two views of head of composite shafted spear of modified *karu* type, Western Australia, R. Helms (specimen B702 in B. P. Bishop Museum, Honolulu).

Exploring Expedition in 1891-1892, but in his published account, although he described several spears, he made no mention of this specimen as having been obtained on the journey. He could of course have got it from elsewhere than in the area traversed by this Expedition. The stone shows

evidence of possible pressure flaking on both faces, thus resembling the pseudo-biface *pirri* implements which have been found archaeologically on the lower parts of the Eyre Peninsula in South Australia with traces of flaking on both faces. The general style of spear making is that of the Pilbara natives.

During my 1953 visit to the Pilbara area it was noticed that the aborigines of the Wanman Tribe, who live in the Desert east of Lake Waukarlykarly, when depicting spears, made drawings of a stone-headed type which they called *karu*. Njangamarda drawings showed a similar spear, called *karo*. Both of these were differentiated from the *tjinal* or *tjinali* a pressure-flaked spearhead of the Kimberleys, which occasionally comes as far south as the Mangala territory in trade in this area and by a more eastern route reaches to the Warburton Ranges as a rare traded object, there to be used as a circumcision knife. It is unfortunate for anthropologists that the making of spears has been suppressed in the Pilbara area and no actual specimens of *karu* could be obtained.

The existence of drawings of *karu* spears, the descriptions of the spears given by informants, plus the knowledge that spears with *pirri* points have been collected somewhere in this general area all tend to confirm the conclusion that in parts of the Pilbara and Upper Ashburton areas *pirri* tipped spears survived until modern times. It is proposed that the spear type be known by the Wanman tribe name *karu*; the Zietz specimen may be regarded as typical.

It is an interesting point to consider whether the survival of the *pirri*-pointed-spear among the people of this part of Western Australia is an indication that some of the peoples of this area are actual modern descendants of the peoples of the Pirrian Culture or whether we have here merely the local survival of one element of a Pirrian tradition which elsewhere has been swamped under a flood of later cultural elements.

Noone (1943) records a few examples of microliths of probable Mudukian facies from Millstream Station on the Fortescue River in territory now occupied by the blond-haired Indjibandi.

The real test may come when it is possible to ascertain whether or not a Mudukian industry dominated all this portion of Western Australia. No microlith implements were found by us in several months of search during the spare time between our anthropometric study sessions in the Marble Bar and Pilgangoora areas. In this connection it is of interest to note that, implement-wise, a culture reasonably similar to the Mudukian seems to have existed until modern times among the people of South Western Australia and extended at least as far north as the Lower Murchison.

Dr. H. Petri (in a letter) recently mentioned his finding of an archaeological campsite with *pirri* implements near Perth. From his discovery, which confirms a find made near Newman Rocks, we can perhaps infer that in South Western Australia a Pirrian culture phase once existed and may have been superseded by the present day Mudukian-like Culture.

The present day aborigines at Moolabulla, in North Western Australia, of the Djaru and Kitja tribes, say *pirri* points are *kanbira* or the "claws" of the "Eagle people", who existed before they themselves came into the country from the east. *Pirri* are commonly found in the sand around the originally palm-tree-girt spring at the Head Station, a few miles west of Hall Creek. Their own spear points are pressure-flaked biface blades with serrated edges which pass through a stage during manufacture when they are almost indistinguishable from large *pirri*.

Pirrian implements were found at several other sites in the valley of the Fitzroy River during the visit to North Western Australia; particular mention may be made of a site 19 miles west-south west of Louisa Downs, and another 9 miles south west of that Homestead.

At Wave Hill Police Station on the Upper Victoria River in the west of the Northern Territory, *pirri* implements occur on an eroded site near the Station itself whereas on the present camp of the aborigines attached to the Station, a few hundred yards further away, the dominant blade implements are all bifaced pressure-flaked ones as they are among the living Wandjira people of Inverway Station, who still make them. In Central Australia, at Teyon Station Homestead and at Macdonald Downs Homestead near Lilatara, *pirri* are found. Other localities worthy of mention are Lincoln Gap, west of Port Augusta, and Pimba, Louth Bay and Sleaford Mere on the West Coast of South Australia; some from the two last-named areas show incipient biface trimming. At Tower Hill, near South Gap, Nuriootpa, Fulham, Ooldea, and Miller Creek, all in South Australia, many are found. There is an extensive site 25 miles north of the Cooper Creek Crossing on the track between Marree and Birdsville. Specimens referable to the Pirrian Culture were found on sites examined by the present writer in 1955 around the southern shores of Lake Eyre, others are known from the Durham Downs, Queensland.

Worms (1950) reported *pirri* implements found archaeologically in the territory of the still active Bard tribe at Cape Leveque, North Western Australia, associated with worn adze stones.

Two rather aberrant examples of *pirri*-like implements have come from Victoria, one from Lake Lonsdale and the other from Altona. A rather short squat example which may really be an atypical engraver,

only resembling a *pirri* by chance, has come from Port Kembla, New South Wales.

It should perhaps be mentioned here in passing that the present author interprets the term *pirri* in its originally proposed sense as including both the developed *pirri* with secondary trimming and the so-called butted blades, which however they may be separated by the implement classifier still represent together with the *pirri* the whole range of form of a single type of spear head. Graphed they would yield a curve of the type characteristic of a continuous random series. They range from forms with margins entirely free of secondary working, to the most perfectly bilaterally trimmed examples. This is not to say that as more detailed time sequence studies can be made there will not be found higher and lower degrees of striving for perfect symmetry, by trimming, in the work of different periods and among the Pirrian peoples of different areas.

There have been many discussions on the status of the Keilor fossil skull in the Maribyrnong Valley, Victoria and much work has been done on the physiographic data of the area in attempting a solution of the problem of its position in time. Little attention has been paid to the quartzite implement flake found near the skull. This specimen, labelled as No. 45769 in the National Museum, Melbourne, was shown to the present author in February, 1949. This flake was labelled "Keilor" and "Dry Creek skull layer, few inches from skull, found by Dr. E. S. Hills". With the Director's permission freehand sketches were made of it. These are shown here as retraced in india ink (fig. 6, a-d).

The specimen is a thin blade some 3.9 cm. in length, 2.0 cm. wide and 0.7 cm. in general thickness. There is a small triangular striking platform with a diffused bulb showing an angle below 100° with respect to the main axis of the flake. Four flakes had been removed from the core in preparation for the striking off of this blade.

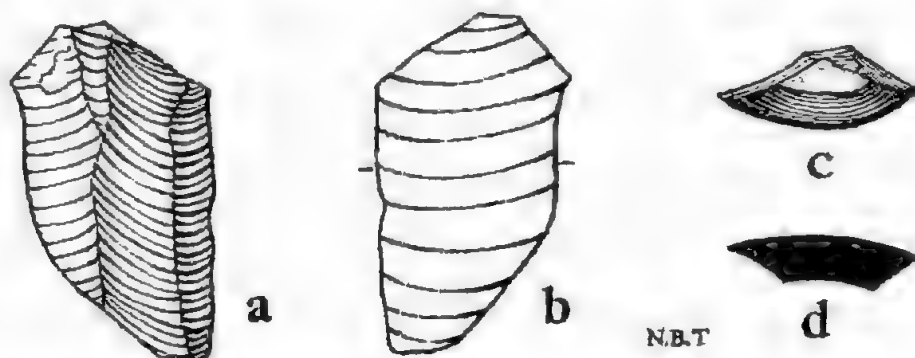


Fig. 6. Retracings of freehand sketches of the small blade found by Dr. E. S. Hills in the Dry Creek skull layer, a few inches from the Keilor skull. a. showing four flake scars on outer face; b. view of inner face; c. view in plane normal to striking platform; d. cross section at marked position (specimen 45769 in National Museum, Melbourne; natural size).

By itself this specimen is insufficient to mark positively the culture period to which it may have belonged but there are strong indications that the flake was made during one or the other of the two culture periods with small blade industries, Pirrian or the Mudukian, rather than in a Tartangan culture phase, in which it would seem very much out of place. The small, prepared, relatively acute angled striking platform, checked flake scars at butt, and long thin blade, appear first in the Pirrian Culture. By Mudukian times there is a high degree of skill displayed in preparing the final implement, on the core, before detaching it by a blow struck on this small face.

It can only be said that a man, probably at earliest of the Pirrian Culture, lived on the soil of the Dry Creek at Keilor on a horizon "a few inches from" the place where Keilor skull came to rest and he was possibly attempting to make a *pirri* when he struck off this flake.

MUDUKIAN CULTURE

The studies of Campbell and Noone (1943) and of Mitchell (1949) have made the principal microlith industry of Southern Australia well known since it was first observed in the section in Devon Downs Rock Shelter between the limits of 10 feet and 15 feet down, and named the Mudukian Culture (Hale and Tindale 1930).

This Mudukian horizon yielded examples of most of the microliths now known to be typical, but at the time the shelter was being studied relatively little was known about microlith industries in Australia, and it probably was only by chance that these tiny implements were picked out in sufficient numbers to make it clear that this was the period of dominance of microliths. More emphasis was laid by the writers on the presence of *muduk* bones in defining the culture. It is now known that these bones were fishing toggles similar to those still used in Western Europe when "snigging" for eels. In the later Murundian Culture of the Murray River they have been replaced by a similar toggle, cut in wood and known to living informants, a type abandoned as soon as the superior qualities of European metal hooks were known.

Relics of the Mudukian microlith culture are to be found over vast areas of Australia, in many places forming an upper stratum on long occupied sites, and at other places occurring as "pure" series without association with relics of any other period of occupation.

On 5 January 1934 a microlith crescent and five other small flints were found on the Mudukian site at Wimpinmerit, 100 yards west of the homestead (Specimens A.21157 in S.A. Museum). A month later Dr. H. K. Fry and the writer escorted Milerum, last old man of the Tangane-

kald, over the country from Lake Alexandrina to Kingston and were shown the sites and given the native names of many of the present day Murundian camps, and found other microlith sites in places which Milerum considered useless as camps.

Some further work was done in the area during February 1939, with J. B. Birdsell, and signs of stratification were observed in several places. After an intermission during the War the area was visited in 1947, and again in 1948, the superimposition of the Mudukian and Murundian Cultures being observed, as well as Mudukian above Tartangan, in company with E. C. Black, T. D. Campbell, D. Casey, J. B. Cleland, P. S. Hossfeld, S. Mitchell and G. Walsh. For the present paper it is convenient to draw particular attention only to the site at Section 541 Hundred of Kongorong, known to Mitchell (1949, p. 173) as Hoods Drift.

Study of a section (fig. 7) at this place shows that there is a thin sterile surface layer of wind-blown sand, a fixed dune surface until after Post-European times, containing roots of sedges. Beneath it there is a layer of pale red sand, without laterite nodules. Usually it forms a sheet less than a metre (2-3 ft.) in thickness containing some charcoal, very sparse signs of hearths, no preserved bone, but has a rich Mudukian microlith culture of fresh-looking flints including *bondi* points, *woakwine*

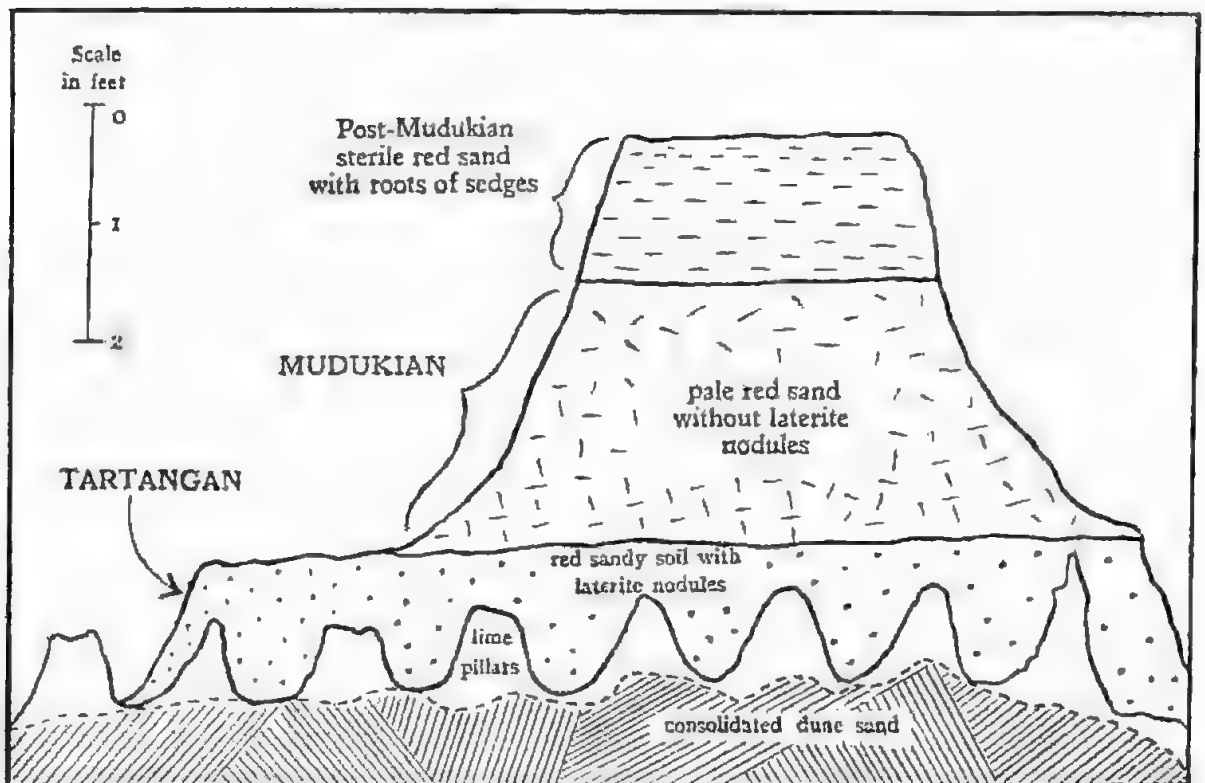


Fig. 7. Section of Hoods Drift, Section 541, Hundred of Kongorong, South Australia.

points, microlith discoidal adze stones, segments, triangular microliths and other characteristic Mudukian implements. Where erosion has not proceeded down below this layer only a Mudukian suite appears.

The red sand without nodules lies disconformably above a red sandy soil containing laterite nodules.

The A layer of this lower red soil contains abundantly a Tartangan industry in red-stained flint with large and characteristic blade implements. The B horizon of this soil, at a general depth of 0.3 metre has numerous lime pillars and further down is a variable thickness of sheet limestone forming a duricrust. The C layer below is of the rather compact dune of lime-sand of the Woakwine Range. Where erosion has proceeded to the level of the duricrust sheet both Tartangan and Mudukian implements are found, dropped together in profusion on to the surface; in places where the red sandy soil is still intact Tartangan knives and other flakes are *in situ* from the top of the red soil down to levels well below the summits of the limestone pillars. Mitchell (1949 p. 179) to whom this section was demonstrated commented on the differences in patination between the two suites then pointed out, accepted the proposition that two separate industries existed and were of different ages, but did not link them with the two industries named by Hale and Tindale (1930). He correctly deduced that the microlith suite was "Post-Mid-Recent Optimum" (i.e. after the Mid-Recent High or 10 ft. Terrace of this author), and that the earlier ones came before the Mid-Recent, as had been already deduced for Tarianga, and as is in this paper clearly confirmed by C¹⁴ dates at several places.

During a visit to the Coorong, South Australia, with Messrs. Anthony Sturt and H. A. Lindsay in March 1951 a site near Policeman Point, on Section 2, Hundred of Santo, was found to have microliths of the Mudukian type, with numerous crescents, small blades and microlith cores. The flints were fresh and were being eroded from a layer of light red soil overlaid by a sterile layer of about a foot of newer sand. The site itself was on and in the A horizon of a red earthy dune with a calcareous B horizon. The underlying shell lime dune sands form the seaward face of the same dune range as is called the Woakwine Range in the South East of South Australia.

The site has been visited since on several occasions and has yielded a rich microlith suite of implements including a fine stone drill-point, and the smallest perfectly formed crescent implement yet found; it measured only 6 mm. along the cutting edge. The food shells of this site are *Plebidonax deltoides* and one specimen of the shell was found which had been used as a spoke-shave scraper by having a circular hole punched through the centre of the valve, as used in recent years by Milerum,

the last survivor of the Tanganekald tribe. The site seems to have been concentrated on a point overlooking a little former embayment of the Coorong waters. Today this is silted up and dry land, situated over one hundred yards from the Coorong waters. It seems likely that when it was occupied the waters of the Coorong may have stood a few feet (perhaps no more than 3-4) higher than they do at present.

The particular significance of this site is that an occupational hearth may have a purely microlithic Mudukian Culture, including hut circles and workshops, without signs of any other implement suites, and if small changes in local physiography cause later inhabitants to prefer some other dwelling area the place will remain undisturbed. The implications are important for the historical study of implements since it reiterates what has been indicated before that the people of at least one interval in late Recent time used only the microlithic suite of implements we call Mudukian.

The following table compiled after a visit to the site on 17 November 1955 is useful as indicating the stone materials used at the site.

Material	Flint	Quartz	Red jasper	Other
<i>On surface</i>	268	4	1	4
<i>in situ</i>	36	1	—	1

The flint is that from the South East of South Australia, the quartz was of the clear type with glassy fracture from the direction of the Mt. Lofty Range, while the jasper is of the same type as occurs in the Mudukian of Devon Downs Rock Shelter. It probably came down river from the general direction of Broken Hill. It is clear that the trade connections of the Mudukian people of Policeman Point were with the Mt. Gambier district and that they had considerably less to do with people from the north than did those who were living at Devon Downs Rock Shelter at the same general time.

The red sandy soil is without enlarged laterite nodules, has a calcareous B horizon, and shows evidence of the presence of limey pillars, all overlying calcareous dune sands. The Policeman Point site seems to suggest, by its profile, that it was a soil being derived from the dune sands by leaching and was still forming during the period of occupation of the site by these Mudukian people, no more than say 3000 years ago.

Tindale (1955 p. 292) reported *bondi* points of the Mudukian Culture as occurring on sites in the interior of Western Australia, and used the

evidence to throw doubt on an idea put forward by McCarthy (1938) that these implements were confined to coastal areas and that they were in some manner connected with marine food-getting. The presence of such along the coast line of New South Wales had been thought by him to warrant the separation of the undoubtedly well developed Mudukian Industry of that area, under a different name, as the Bondaian Culture. Bondaian would appear to be synonymous with the Mudukian Culture.

Messrs. J. E. Johnson and S. B. Warne now report similar Mudukian implements from two further places in the Interior. They write under dateline of 24 May 1956 "We have found Muduk[ian] culture sites, with *bondi* points at Mount Crombie [in the North West interior of South Australia] . . . and in the Cavanagh Range, Western Australia. *Woakwine* points are found on both sites, oblique trimmed blades, crescents, trapezes and triangles". Receipt of these specimens, as this paper goes to press, confirms their observations. Several implements were made from meteorite glass, extending the areas in which this material was used for implements.

This new report should help to remove all doubts that the Mudukian Culture horizon is very generally distributed over Australia. McCarthy (1952) perhaps did not appreciate the effects of the local absence of suitable mines of implement stone, on the somewhat impoverished Mudukian at the Devon Downs type site. From the study of the many dozens of other known Mudukian sites around it, including the several discussed in this paper, it is clear that this was a local and casual deficiency no more significant than differences of wealth, in our modern culture, as between one community and another.

The suggestion was made by Tindale (1955) that *bondi* points could have been triangular needle points used in piercing skins, when sewing them together with sinews to make rugs and skin cloaks. Since then it has been noticed that Basedow (1925 p. 365) refers to stone points as being used for this very purpose, using the following words:—"In former days the River Murray and south-eastern tribes used pointed splinters of stone for making holes through the skins of animals they made up into rugs."

This apt description of the *bondi* point may give added weight to a conclusion reached before, that modern Mudukian Culture survivals were still present at the time of European occupation, particularly in peripheral places in South Australia where the people had not been driven out by the late-coming Murundian adze culture folk of the Centre, who, in recent centuries seem to have been pressing southward and eastward out of the Desert areas into South Eastern Australia.

From Esperance on the south coast of South Western Australia at least to Geraldton along the west coast, including the country of all the people of the *-up* areas, (those characterised by place names such as Wonnerup, Tamberup, Nampup etc.) and some of the territory of the *-ing* people further inland (whose place names have the form Tamberling, Nyabing etc.) aborigines were still using stone implements of Mudukian facies when first encountered by men of the Western world.

Not all the implements of the Mudukian Culture are small. Larger implements similar to the type described as *elouera*, which first appear in the Pirrian Culture lately have been found on more than one Mudukian site. Also in Queensland a knife, made on the same principle as the *elouera* but with a knife point is still in use. This type of knife, hafted with

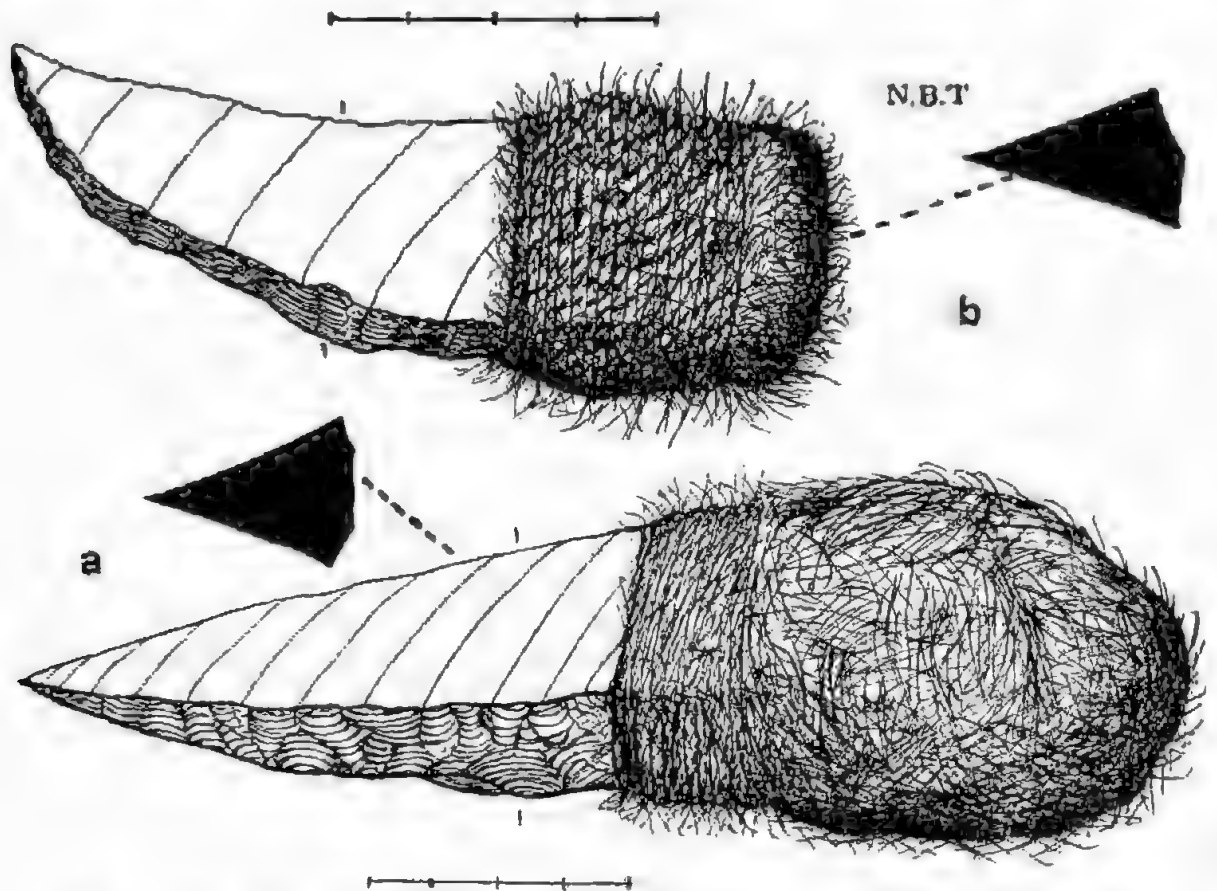


Fig. 8. Present day skin hafted knives of *juan* type, from coastal Queensland. a. Example from Bowen, Queensland, collected by Godeffroy, specimen Au261a in Grassi Museum, Leipzig, hafted with maternal skin and human hair string. b. Similar knife from Queensland, specimen E14 in Museum f. Völkerkunde, Hamburg. (Scales indicated centimetres.)

animal skin bound on while green with the fur side outward, survives along the eastern coast of Australia, and was known further inland in Queensland with a gum haft. It possibly also occurred in parts of New

South Wales. Fig. 8 gives views of two typical examples. It is proposed to report full details of available specimens in a separate paper. Contrary to the belief of Towle (1930) the "chipped" back is not the cutting edge. Most of the known examples are to be met with in overseas Museums; they were collected before the days when anthropological collections were being preserved in Australia, and when it was still possible to acquire examples of the material culture of the living aborigines of South Eastern Australia. Among the Ngaun and kindred tribes west of Charters Towers this knife is known as [juan] and [joan]. It is proposed to call the type by name of *juan*, used by the Ngaun tribe.

Microlith sites are found in Victoria and many have been described. If we are right in assuming that the assemblage of implements at Koroit, Victoria, for example, represents a developed Mudukian Culture, then the C¹⁴ date of 538 ± 200 B.P. reported by Gill (1955) may help to confirm a conclusion reached, before this date was available, that the living culture of the coastal Victorian natives at the time of first contact with Europeans may have been still transitional from the late Mudukian one, a Mudukian culture modified principally by the incoming of the edge-ground-stone-axe-making trait but not materially affected by the spearthrower-with-adze-stone-using Murundian people who had so much earlier appeared at Devon Downs and whose campsites became widely spread in parts of New South Wales, in the Murray Basin and over much of Northern South Australia, Central Australia and eastern parts of the Western Desert in Western Australia.

It is unfortunate that so far no assessment of the culture phase represented by the Goose Lagoon Midden date of 1177 ± 175 B.P. has been possible.

MURUNDIAN CULTURE

The change from the Mudukian to the Murundian Culture in the deposits of the type section in Devon Downs Rock Shelter is abrupt. Microliths and special bone implements disappear, and only adzestones, of several modes of manufacture, and usually very worn, persisted. From the very tentative time scale suggested elsewhere in this paper the change over might have taken place there as early as 2000 or 2500 years ago, but the only available time scale is based on an uncertain premise, namely that the rate of accumulation of ash, etc., in Devon Downs Rock Shelter was regular (fig. 9). No allowance could be made for possible compaction of the deposits by water seepage, and the compression of lower layers by weight of overlying beds so that a much later date might be indicated. Further it is unlikely that this date was the same everywhere in South Eastern Australia, for as pointed out earlier there is some evidence to

support the idea that Mudukian microlith people in some areas continued to live relatively unchanged until modern times.

The change over to the Murundian Culture may have been an expression of an increasing tempo of nomadic life, forced progressively on people of less favoured parts of Southern Australia by gradually increasing aridity such as is seemingly suggested by the diagram given elsewhere in this paper (fig. 9).

Assuming this late phase of desiccation was a Southern Australia-wide phenomenon, leading to the Mediterranean type of climate enjoyed here today, the Mudukian aborigines perhaps were under increasing pressure to give up a rather sedentary life of only seasonal migration from summer to winter camps in favour of moving more continuously about their territories, as do today the people of the sixty or more tribes of the Western Desert and its environs.

Only in a few more favoured areas such as along the Coorong and around Lake Alexandrina in South Australia, and in parts of coastal Victoria and New South Wales, etc., could the semi-sedentary way of life persist in a modified form, until modern times. There must have been population pressure also from people forced out of the Desert, leading to displacements even in favoured spots far from the Desert.

Study of the life of the Desert tribes shows that with enforced nomadism would come problems of transport. One of the solutions was the abandonment of unessential non-portable properties. From the mythology of the Ngalea, of the southern part of the Western Desert, who live today in a belt of maximum aridity we learn for example that their ancestors used skin rugs, as did the people of more favoured climes in South and South Western Australia until modern times. The Ngalea could no longer use them in everyday life, although they have preserved memory of them in their traditions.

In the archaeological record the change from Mudukian to Murundian was reflected *inter alia* by the trend towards the disappearance of skin-piercing stone points, a possible decline in fishing toggles (or in some areas, if data from living Murray River natives is confirmed, the replacement of bone ones by wooden ones) and by the increasing use of the readily portable adze-stone, set in gum on the end of the spearthrower, as a well nigh universal tool, a combination meat cutter, scraper, adze, chisel, gouge, borer and spear burnisher.

Superimposed on this was the progressive development, in the eastern half of Australia of edge-ground stone axes. These were most advanced in type in the north (hammer-dressed-edge-ground ones) and less advanced in the South (flake-trimmed and edge-ground types). The State of South

Australia being on the western periphery of the areas of axe distribution, the few edge-ground axes found, as far west as Yorke Peninsula, and in the vicinity of Adelaide, are ones traded, some from axe factory sites on Berrimah Station near Chatsworth on the Hopkins River (these are usually of a mottled gray igneous rock) and from Mt. William in Central Victoria (a dark, almost black, fine textured diabase). Other axes which have penetrated as far south west as the Southern Flinders Ranges by trade are all from the axe factory site near Cloncurry, Queensland. An earlier phase of this trade carried flaked, edge-ground axes, now only found archaeologically in the south, while late traded examples, including the hafted ones of the present day, are of the hammer-dressed type. Mr. J. E. Johnson has just found the battered remnant of a chipped and edge-ground fine-grained green diabase axe head at Mt. Moore, in the eastern part of Western Australia.

McCarthy (1947) described an important excavation at a rock shelter on Lapstone Creek, in Eastern New South Wales which shows the junction between an earlier Mudukian Industry (for which he uses the term Bondaian) and the later Murundian Culture, with an industry directly comparable with that in the type shelter at Devon Downs, as amplified by later studies in Southern Australia.

It is unfortunate that he has seen fit to propose a term "Eloueran" for this upper industry, which seems merely to add another synonym to the terminology of the subject and to mask identity with the Murundian of other places.

The Murundian of northern South Australia is characterised by well trimmed adze blades made at factory sites and traded over large areas. In the South East of South Australia it is characterised also by occupation mounds of the type called *myrniong* [marniong], which show high concentrations of shell food remains, ash, and stones of cooking hearths, with freshly worked flints. Similar sites are met with in parts of Victoria. A mound of this type at Cape Northumberland is being described in a separate paper, Tindale (in press). Concentration of camp debris in such mounds seems to imply the local persistence of the semi-sedentary mode of living.

In November 1955 several Murundian rock shelters at Section 562 Hundred of Caroline were studied. The sites are on the northern rim of a circular sink hole or collapsed cave, in Tertiary limestone, 75 ft. deep and 185 ft. in diameter. The sheltered areas, of which there are several, are small and possess only 0.5-0.9 m. of ash and camp debris yielding only bones of animals of living species of the district, and fresh Murundian flints. A track passing through the main rock shelter leads

down to a pool of water covering the southern half of the floor of the collapsed cavern. Implements recovered confirm the general picture of the Murundian developed in Devcn Downs Rock Shelter and elsewhere in Southern Australia.

GEOLOGICAL EVIDENCE FOR THE ANTIQUITY OF THE AUSTRALIAN CULTURE SEQUENCE.

The geological evidence used in the following summary is that presented before the Melbourne meeting of the A.N.Z.A.A.S. in August 1955, before the C¹⁴ dates were available. The two types of evidence thus were independently derived. The reasonably close degree of correlation between them may serve as an encouragement to those using either system of dating.

The earliest geological evidence available implied a late Pleistocene date, prior to the reinvasion by the sea of the coastal lands of Australia which was caused by the eustatic rising of sea level at the termination of the Last cold phase of the Last Glaciation (Tindale, 1933, and 1947). It has been estimated by several authors that at the cold maximum, a minimum of 250 feet, and at most 300 feet of water had been abstracted from the sea as ice and perched on land masses around the North and South Poles.

The original access to Kangaroo Island by the Kartan people probably was prior to this rise of sea level. The Fulham occurrence of Kartan implements on a land surface below present sea level also had suggested a late Glacial time and the indications and deductions at Hallett Cove described earlier in this paper had supported a similar date.

The latest relics of the Kartan Culture occurred on Kangaroo Island in silts at Rainy Creek. These were laid down when the 10 ft. Terrace was the shoreline (Tindale 1937, p. 42). No Kartan implements had been found seaward from this terrace on areas vacated by the seas of 10 ft. Terrace times, nor were they present on sand dunes which had been built up after the 10 ft. Terrace was vacated. A few isolated finds had hinted at sporadic later visits to the island but no continuing occupation after 10 ft. Terrace times.

Tartangan deposits along the Murray River were deposited on a series of silts forming successively higher layers on a bend of the river at Tartanga. The deposits afterwards were "drowned", consolidated, and the bones in them mineralised under water, then re-exposed. The river is at present base-levelled, hence the ten or more feet of rise necessary completely to drown the deposits could only have taken place during the 10 ft. Terrace times of the Mid-Recent. Their deposition thus was a pre-

Mid-Recent event and the successively higher layering of the successive Tartangan Beds, A-E, probably indicated a period immediately prior to that episode, when sea level was rising. In terms of the C^{14} dates available overseas for the Mid-Recent High this was prior to about 5000 B.P. Tartangan implements had not been found at any sites on the coast between the 10 ft. Terrace level and the present shore. They occurred on places which were close to the sea but always above the 10 ft. mark in relation to present sea level. An inference was that any ones nearer sea level had been either "rolled" in the sea or destroyed by the erosional effects of 10 ft. Terrace seas. Some evidence at Cape Martin in the South East of South Australia had indicated however that Tartangan implements might occur at places now below the 10 ft. level but only where the beds were inland and at the relevant time had been sufficiently buried under later sands as to be protected from erosion during the Mid-Recent High.

At Cape Martin the food shell fauna of a *terra rossa* soil horizon identified as Tartangan (Tindale, in press) indicated that both sandy beach—and lacustrine—shell faunas were being used as food, whereas a much later occupational horizon, with a distinct stratigraphic disconformity, identified as Murundian, showed rock shells, such as *Turbo*, indicating that when the second site was in occupation, consolidated sand dune cliffs, like those being eroded away at present faced the nearby sea. Here again the evidence indicated a pre-10 ft. Terrace period, before the present rocky shoreline was being attacked by the sea, for the Tartangan, and a Post-Mid-Recent date for the Murundian.

Pirrian occupational deposits at the Devon Downs type site had been laid down without violent disturbance by flood waters, at a nodal point of the Murray River where it was turning from a sweep against the left bank to one against the right bank. The rock shelter evidently had been formed or scoured clear of any earlier debris during 10 ft. Terrace Time. No signs of scouring were present after the bottom layer was put down 1.5 metres above present normal water level, although in the partial mineralisation of the bones in the lowest levels there was evidence of intermittent drowning, probably by percolation through the water table at times of high flood in the river itself. Indications were that the first Pirrian occupation had come after the retreat of river level (and sea level) from the 10 ft. Terrace. This on overseas data, signified a date after about 5000 B.P. At Fulham the Pirrian camp studied was on a small bank of sand within the area of swamp land which lay behind the present dunes, in a situation indicating a date after 10 ft. Terrace times. It was only a few feet above present sea level, but probably was formed before the large bulk of the present coastal dune system, of white

sand, was fully built up along the foreshore of today. Pirrian sites in general did not occur anywhere in these coastal dunes of the present shoreline, indicating that they were not being occupied during the latest period of shoreline development. They occurred at Moana near the sea but on an older suite of foreshore dunes behind the present ones. Evidence did not exist to prove the earliest appearance of the Pirrian people and it was not then possible to say from purely geological evidence whether they were present or not at any time prior to Mid-Recent times.

The Mudukian Culture phase, when the microlith industries flourished, had followed directly on the Pirrian Period without more than a minor break indicated by a hard line of separation in Devon Downs shelter. The implement suites were highly characteristic. At some places where Mudukian implements had been identified they had included ones made from australite glass. No meteorite glass implements were known from Pirrian or other horizon earlier, but it was, and still is not clear, whether this was because the australite shower had not yet fallen or whether the small sizes of these widely spread glassy meteorites did not suit the implement making habits of earlier men.

Some climatic data was available for the interval between the beginning of the Pirrian Period and the present. The indications were furnished by small Molluscan forms present in the shelter deposits at Devon Downs. They suggested that the climate had undergone a rather steady deterioration from a wetter climate towards a Mediterranean one. The signs were a diminution in the numbers of a fresh water species of *Bulinus* and a correspondingly slow and lately accelerated increase in a brackish-water shell (*Melania*). This had been inferred to indicate local climatic deterioration over the whole interval represented by the three successive periods, Pirrian, Mudukian and Murundian (Hale and Tindale 1930, fig. 249).

Sites of Murundian Culture had been found with freshly made implements and fresh bone in the present day dunes, as at Somerton, South Australia and in such places as on the tops of cliff paths leading up from present day beaches, as at Cape Northumberland, (Tindale in press) which had suggested their late development.

CARBON 14 EVIDENCE

To substantiate this general picture of culture succession some useful C^{14} dates are now available for the time since the end of the Pleistocene. In round figures 10000 B.P. may be taken as the time of the ending of the Last phase of the Last Glaciation.

Rise of sea level and flooding of the Pleistocene glacial shorelines may be presumed to have happened, according to C^{14} data, after 9861 ± 500

B.P. (Late Glacial of Cornwall) and before 9483 ± 350 B.P., the date indicated for a Post-Glacial site at Lake Pickering, Yorkshire (Libby 1954; Clark 1954).

Applying this information to South Australia in the light of the geological evidence set out earlier it can be inferred that the Fulham site on the land surface below marine deposits is to be referred to a time before 10000 B.P. The Hallett Cove Kartan site, which yields the suggestion that it was occupied when sea level was not at the present cliff line would also belong to a time prior to the year 10000 B.P. when part, and possibly the whole of the Gulf of St. Vincent was an alluvial plain with a river system threading its way across it towards the Southern Ocean.

The C^{14} tests for the Tartangan of Tartanga were made by Dr. W. Broecker of the Lamont Geological Observatory at Columbia University, using shells of the subfossil freshwater shell *Unio protovittatus*, which is a very thick-shelled form of the thin-shelled *Unio evansi*. Like *U. evansi* of the present day it once lived in the shallow waters of Tartanga Lagoon. Among the shells included in the sample were also a few broken pieces of *Unio ambiguus*, a species found principally in the deeper and faster flowing waters of the main river. *U. ambiguus* shells of Tartangan times do not show much difference in shell thickness or form when compared with modern shells of the same species.

The Tartangan subfossil shell sample was broken out by Dr. J. B. Birdsell and the writer from the eroding top surface layer of the considerable pavement of consolidated shell in Layer C of the Tartangan beds at the type site on Tartanga Island (Hale and Tindale 1930, fig. 10). Specifically it may be considered to date that surface. It was from this horizon that the body of the youthful individual known as Tartanga iii was buried.

When the sample was being gathered the Murray River was in partial flood so that lower beds, A and B, which have occupational debris to a depth of at least 1.75 metres below the top layer B, were inaccessible. The occupation of the site must have commenced some considerable time before the date 6020 ± 150 B.P. marking the virtual top of Layer C.

As control several pounds weight of *Unio evansi* shells were collected. These shells died on the margins of a lagoon, about two miles upstream from Tartanga, as the flood waters of 1953 subsided. One-half of this control sample was sent to Columbia University and one-half of the balance went later on to the Dominion Laboratory in New Zealand for parallel tests. Concerning this modern control sample (their no. 271F) Dr. Broecker reported that it was "found to be 1% greater than our

modern wood standard". Dr. G. J. Fergusson's comment on his portion of the test sample was:—"Enrichment of C^{14} w.r.t. our modern wood standard = $+ 1.70 \pm 0.4\%$ ".

It would appear a fortunate circumstance for archaeological work in Australia that freshwater *Unio* shells are likely to provide data so closely comparable with that derived from wood samples.

The test sample from Layer IX of Pirrian times in Devon Downs Rock Shelter was made up of shell fragments from a mass of the layer taken when the rock shelter was being excavated in 1930. When further opportunities for C^{14} tests occur, similar samples from the original excavation can be made available for each of the twelve layers in this shelter. No record is available to indicate at what horizon within the 30 cm. thickness of Layer IX this sample was collected. It has to be assumed that the date of 4250 ± 180 B.P. is indicative of an indefinite point within this bed in the Pirrian Culture.

The data sent to Dr. H. L. Movius for the Lamont Laboratory gave the following prior assessment of possible dates. For the Tartangan Layer C horizon "the evidence we have at present suggests that the Tartangan occupational horizons were probably laid down prior to the 10 foot Terrace and hence could be as early as Mid-Recent; a suggestion to that effect has been published."

For the Pirrian horizon IX the assessment given in this letter was "this material should date the mid-point of the Pirrian Culture. . . . We have no means of dating this layer but have concluded that it was laid down after 10 foot Terrace times. It is the oldest of the three culture horizons which we recognised in the shelter and seems to have been laid down at a time when the climate was moister than at present: at a guess it might be two to three thousand years old".

The expected dates were very satisfactorily confirmed.

The three tested Lake Menindee samples were the shells of a freshwater *Unio* kindly collected for us by Mr. L. F. Marcus, of the University of California. They were identified for us by Mr. B. C. Cotton, Curator of Shells at the South Australian Museum, as *Alathyria profuga* Gould 1851.

Two of the samples (L.F.M. no. 186 and 189) were from surface hearths lying on and above the Mudukian horizon. Both proved to be modern. The third (L.F.M. 188), which was a food hearth in the top part of Horizon B gave the C^{14} date of 6570 ± 100 B.P. This date indicates a horizon very close to the end of the period of deposition of the bed from on and within which both fossil mammals and implements of the Tartangan Culture were recovered.

The data sent to the Dominion Laboratory with the Lake Menindee specimens was as follows:—

LFM No. 188. Blowout I horizon B. *Unio* shells from Layer B in area I at Lake Menindee. The field notes of L. F. Marcus state "There were one or two shells in place in the B horizon and collected matrix labelled LFM 188—IB with this; and 1½ lb. (approx.) of shells separately in pieces—all that we could get. They were along about 10 yards in an E-W direction. There was not sufficient concentration to warrant digging, though we did a little without luck." Our statement about this was:— "The faunal association with Layer B comprises a long list of extinct genera of late Pleistocene or Early Recent mammals. Aboriginal implements of this horizon appear to be of the Tartangan Culture which has been dated as Early Recent (prior to the Mid-Recent Thermal Maximum). At Tartanga a middle horizon of the culture bears a Carbon 14 date of 6020 ± 150 B.P. A few implements found on the site suggest the Kartan Culture which is probably late Pleistocene, at least at its beginning."

LFM No. 186. Blowout II horizon B. *Unio* shells from Layer B in area II at Lake Menindee. L. Marcus' field notes state "Again on the surface at [the marked spot in Blowout II] in an area E-W 15 yds. and 5 yds. N.S. One or two in place as collected. These later broke up and were separated from the matrix. Four rat kangaroo mandibles and a maxillary fragment were found on the surface amongst the *Unio* fragments of Sample II-B".

LFM No. 189. Blowout IV horizon O. *Unio* shells from Layer O in area IV. L. F. Marcus' field notes read "Collected a 2 lb. (approx.) sample of these shells and the matrix below".

Our statement about the lastnamed sample was:—

"The fauna of Layer O at Lake Menindee comprised only living species of mammals. The aboriginal implements were all from the Mudukian Culture. This microlith culture has been shown to be Post-Thermal Maximum and later than the Pirrian Culture. For Layer IX at Devon Downs which represents a mid point in the Pirrian Culture we have a Carbon 14 date of 4250 ± 180 B.P. The date of this sample might well fall between 3000 and 1500 B.P".

Dr. Fergusson's reply was:—"Sample No. LFM 189, *Unio* shells Lake Menindee, Blowout IV, Horizon O, Age—Modern—w.r.t. modern *Unio* shells.

Sample No. LFM 186, *Unio* shells, Lake Menindee, Blowout II, Horizon B, Age—modern—w.r.t. modern *Unio* shells.

Sample No. LFM 188, *Unio* shells, Lake Menindee, Blowout I, Horizon B, age w.r.t. modern *unio* shells = 6,570 ± 100 years."

The dates were very acceptable, although the late date for the surface sites was unexpected. From the notes by L. F. Marcus it seems clear that the two samples which gave a modern date came from the loose sand layer forming the modern surface of the dune; rat kangaroo mandibles are quite common on these late surfaces.

CLIMATIC CHANGES

Fig. 9 is a redrawing of a diagram, first given by Hale and Tindale (1930). As now set out it uses a tentative time scale based on the supposed rate of deposition of ash, etc., in Devon Downs Rock Shelter. It emphasises again an interesting point, first drawn attention to in that paper, that since the time of the first appearance of the aborigines in this rock shelter the relative abundance of some microscopic shells of the fauna of Devon Downs has been changing. Expressed as a percentage *Bulinus*,

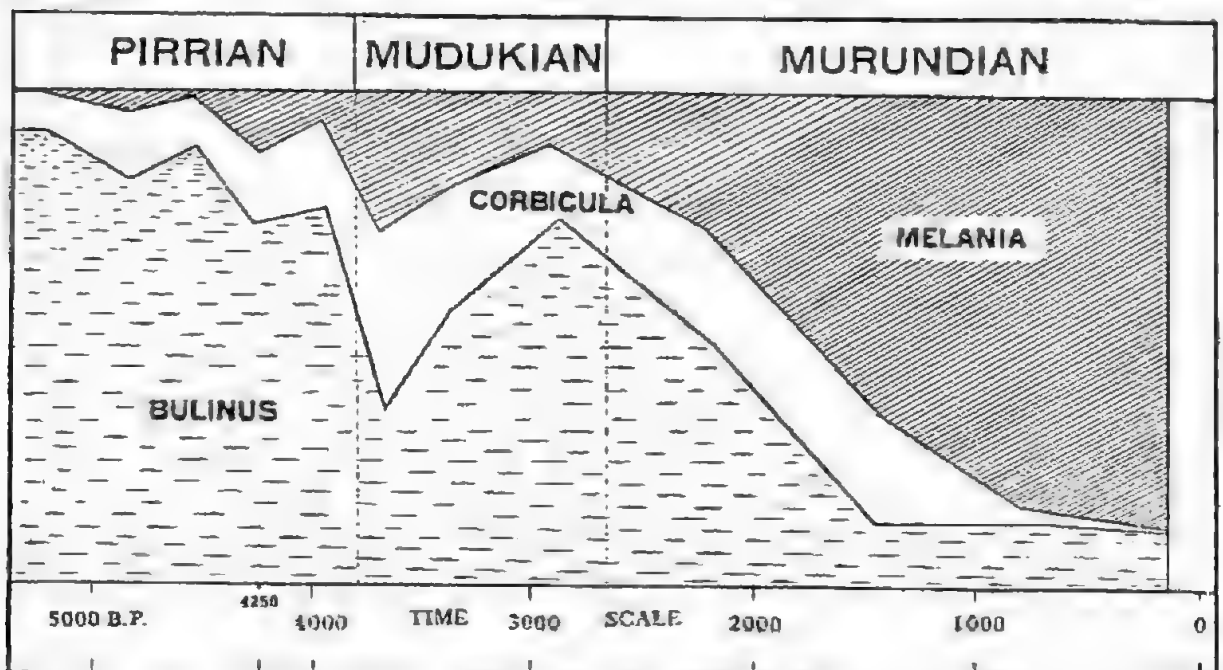


Fig. 9. Ratios of three small shells in Devon Rock Shelter, indicating change from *Bulinus* (a freshwater species) to dominance of *Melania*, a brackish-water form; *Corbicula*, a tolerant species.

a fresh water form has been gradually yielding place to *Melania*, a brackish-water-loving form, while *Corbicula* a more tolerant species, has remained relatively constant.

On the basis of the occurrence of this change Hale and Tindale had indicated a probable slow trend of change towards the Mediterranean semi-arid climate enjoyed in the Murray Valley at present. The diagram seemed to suggest that conditions at no time were appreciably drier than those being experienced at the present day.

The diagram in its original form, without positive indications of time scale, was ignored by Crocker and Wood (1947) when they postulated their "Great Arid" Hypothesis and linked it with the supposed climatic condition of Mid-Recent Time. With the C^{14} date of 4250 ± 180 B.P. to control the general scale it can now be read, in combination with data furnished by the 8700 B.P. terminal date for the *terra rossa* soils of Cape Martin in the South East of South Australia, as removing two of the main arguments for a supposedly great arid period in Mid-Recent times as postulated by these authors.

SUCCESSION OF INDUSTRIES

Drawing all the facts of the previous sections of the paper together and taking into consideration the time data available from Tartanga, Devon Downs, Lake Menindee and Cape Martin we are in a position to suggest the outline of culture sequence in South Eastern Australia, since Late Pleistocene times, as shown in fig. 1, which speaks for itself.

On this diagram we are not yet in a position to define in detail the times of transition from Pirrian to Mudukian and from Mudukian to Murundian in the area under consideration. Since probably we are dealing with culture shifts in terms of tribal displacement as well as in part changing implement fashions and cultural acquisitions it will perhaps be correct to assume that the times will prove to vary from place to place. As mentioned above we can secure some general indications of the times from data at Devon Downs Rock Shelter, if we use the convenient, but possibly specious assumption outlined in an earlier paragraph, that the rate of accumulation of ashy deposit and debris in the shelter was relatively constant. For the purposes of the diagram, using these indications, the Pirrian to Mudukian transition had been drawn as if it had occurred shortly after 3800 B.P. and the Mudukian to Murundian culture shift is shown as at about 2700 B.P. in Devon Downs Rock Shelter; both could be much later and the Mudukian to Murundian shift, in particular, may have been long delayed in some areas.

ROCK CARVINGS AND CULTURE SEQUENCE

The C^{14} dates described in the present paper enable some preliminary indications to be given of the possible cultural associations of the styles of rock carvings met with in Southern Australia.

The late Murundian style is found on the walls at Devon Downs and examples were figured by Sheard (1927) and by Hale and Tindale (1930 fig. 212). Thin linear marks predominate. The same style of drawing occurs on present day weapons from the Murray River, and

others like them were traced on the ground with a stick by an old aboriginal of the Maraura Tribe, when telling a story to Tindale (1939 fig. 256).

The Mudukian style, which may have extended up into the Early Murundian, shows designs with much heavier lines, wide curves, and forms representing animals and objects (Hale and Tindale 1930, fig. 246). The heavily scored rock carvings of Sydney district possibly belong to this same Mudukian culture phase.

Tugby (1953) indicates some Victorian rock shelter painting sites have associated occupational debris indicating a microlith culture. This perhaps is Mudukian.

Either the Mudukian or the Pirrian people made many "tally" marks as if keeping count, or "utilitarian" marks, comprising groups of "sharpening" marks as if bone points were being fashioned by rubbing on rocks. Such marks are reported from more than one place in Southern Australia and may be indicative of this period as in Devon Downs Shelter (Tindale and Mountford 1926; Hale and Tindale 1930).

A style of rock carvings, with probable tracks of giant birds, described by Hall and his colleagues (1951) are possibly ones from the Tartangan period. Egg shells of these birds have been found, believed to be food remains, in the horizon identified at Lake Menindee as of Tartangan times. It must be remembered however that there is some suggestion of the survival of knowledge of these birds in present-day traditions of the aborigines so the rock carvings may be later in time than Tartangan.

However, if these indications are valid the rock carvings found in South Eastern Australia range at least over the greater part of the past 6,500 years, and several changes of style are manifest.

PHYSICAL TYPES

The brief discussion of Australian physical types of man in this material culture paper is not to be considered an admission that there is any necessary link between the physical forms of men and the cultures they enjoy.

Both physical form and culture seem to have had similar broad histories of translation from Asia out towards the Australian continent, with modifications on the one hand due to possible local genetic changes and hybridisation, and on the other hand due to possible local inventions tacked on to what was a considerable legacy from older and widespread cultural influences from the mother of continents.

So far no evidence has come to light directly linking the Kartan Culture with any physical relics of man. Potential candidates would

probably have had to resist decay since late Pleistocene times. The Aitape frontal bone (Fenner 1941; Hossfeld 1949) might qualify in point of time but no implements were found with the fossil.

Indirect evidence has linked the Kartan Culture with the Barrinean negrito on the grounds that both are probably the oldest respective types in Australia. However Fenner (1941) has considered the Aitape skull fragment might be equated with his "Southern" Australoid type, the same as that named by Birdsell (1949) from study of the living, as the Murrayian type. The widespread practice reported among present day negritic peoples of cremations rather than burials, if it is an old custom, may have removed the greater part of any evidence for the existence of the negrito. Certain it is that on such places as Kangaroo Island where over 200 sites of occupation are now known and many thousands of stone implements have been recovered, no osseous relics of man ever have turned up. The best series of crania of Australian negritic aborigines is in the Australian Museum, Sydney. They are from the bodies of Barrinean natives killed by Native Police in the Cairns area, Queensland, in the 1890's.

Our specific knowledge of the physical form of Tartangan people is at present confined to the cranial pieces and part skeleton, including one tolerably complete, though once fragmented cranium from Tartanga, described by Hale and Tindale (1930). Tindale (1941) considered that the cranium of the best preserved youthful individual possessed some Tasmanoid characteristics, notably in the shape of the cranial vault and in the presence of small third molars, unusual in Southern Australoids, and usual in Tasmanoids. It is possible that the Tartangan youth shows closest relationship with the rather large Tasmanian crania found in Western Tasmania, which Wunderly (1938) has considered to be separate from the more truly negritic Tasmanians of the rest of Tasmania. Further work should be done before too much reliance is placed on these preliminary views. Since the Tartangan youth was buried from a horizon in bed C, the layer which provided the C¹⁴ date of 6020 B.P. this may be considered to give a reasonable indication of the date when he lived.

Mahony (1943) in writing of the Keilor find dismissed the Tartangan remains in one line. "There is no evidence of the age of the Tartanga bones", an explanation for his omission to compare them with his own find. The C¹⁴ date now available cannot be so readily ignored since it applies to a site from which several burials and many implement specimens have been recovered.

Gill (1955) has suggested a C¹⁴ date of 8500 B.P. for the Keilor cranium. Unfortunately the date is not based on material specifically

associated with the fossil and the implement associated with it gives only an inconclusive lead. He has attempted to show by a wide physiographic survey that the Keilor skull horizon may be linked with a diastem in terrace deposits dated to 8500 ± 250 B.P. This may well be so since man was probably an inhabitant of Victoria at all times from the Late Pleistocene on, but the presence of an implement has to be accounted for. Could this date refer to the horizon into which the skull was put by those who buried it, rather than the date of the living man? Aborigines today in places as far apart as Arnhem Land and the coastal areas of North Queensland use skulls separately from the rest of the body in ceremonies connected with mourning for the dead. The skull as found showed no signs of "rolling" and it is not weathered as if having laid on or near the surface after natural burial during some freshet. If it were not buried by such a flow of water, the odds are high that this or any other given skull would be one that had been given burial, and the chance that one with so perfectly preserved a molar dentition could have been "rolled" into position is possibly rather improbable. Absence of the front teeth could be accounted for by a period of use as a ritual object. The painted skulls of Eastern Arnhem Land, for example, in use, shed the same loose teeth as are missing in the Keilor skull.

If the general indications of a possible Pirrian date afforded by the implement flake are valid then Keilor man might have belonged to a period just after Mid-Recent High Terrace time. If the implement flake must be ignored, the place of Keilor man in the culture succession will have to be ascertained by indirect means, which can only come after further collecting is done in the area. However Gill (1953) has shown by fluorine tests that the Keilor skull belongs to the campsite from which the implement came so that it seems that a Post-Mid-Recent High date must be accepted. His first C^{14} date of 3000 B.P. is possibly nearer the mark than the revised one of 8500 B.P. (Gill, 1955 p. 52).

Keble (1946) has substantiated that the skull was related to the campsite, evidence for which was found in the terrace in the form of a layer of burnt bone, ash and red ochre.

Gill (1955) has reported other C^{14} dates for aboriginal hearths but as no human remains or identifiable implement cultures have been described in association, his reports lack significance for the purpose of the present paper, indicating as they do only that man lived in Victoria at the specific dates named.

Best preserved of adult crania which seem to be referable to the Pirrian period is probably the very robust "Southern" or Murrayian skull and jaw numbered as A.15555 in the South Australian Museum which

was excavated at Fulham in January 1931 from a grave 3 feet deep in red sand covered by three feet of gray sand.

This skull awaits detailed study. The body was lying in a flexed position in a pit dug from the surface of the red sand. It lay on its right side with the head to the west. With it were Pirrian implements including two *pirri*.

A probable Pirrian child bundle burial in the flexed position is the one found by H. L. Sheard and others (1927) in a rock fissure at Fromm Landing (specimen A.20616 in S.A. Museum). The preservation is such that some details of the skin and hands have been recovered also much of the fish network and wallaby skin wrappings in which the child was parcelled up. Its Pirrian date is presumed on the evidence of the presence in the wrappings of a single *pirri* spear point (A.20517), which unfortunately was only found after the first publication of the find, when the specimen was being prepared for display in the Museum galleries. This child seems to be of the present day Murrayian type and much like the infants from the Murundian Layers II and III in Devon Downs Rock Shelter.

There is thus some evidence to support the view that by Pirrian times the people were probably not other than of the Murrayian type of the present day.

There were two flexed burials at Lake Menindee from horizons within the Mudukian microlith culture layer. At present these are being studied at the University of California. They seem to furnish the suggestion that Mudukian folk were predominantly also of the same Murrayian type as the Pirrians who had preceded them by about a thousand years. Most of the flexed burials so common in Southern Australia are of this general type.

The Murrayian is represented by some 500 crania and part skeletons in the South Australian Museum collection. These are found wherever Murundian and Mudukian campsites have become exposed by erosion and all appear to represent people of the same general type. It was from measurements of living people of the South that Tindale and Birdsell (1941) recognised and Birdsell (1949) came to define as the Murrayian type the people of South Eastern Australia, while Fenner (1941) working entirely independently, on crania, recognised the existence of the same "Southern" type of aboriginal from his cranial remains.

The present day Carpentarian aborigines of North Australia may have been the original possessors of the Murundian Culture. In any case they seem to be responsible for the diffusion of the latest elements which it contains. The spread of the material culture elements evidently has been

far more rapid and widespread than has been the southward flow of Carpentarian genes.

Apropos of this difference between gene flow and culture drift, McCarthy (1939) expressed the opinion that "the hammer dressing technique which was employed on artefacts throughout north-central and eastern Australia is an early Neolithic trait in Malaya, and is therefore a comparatively late introduction to Australia".

GENERAL DISCUSSION

In addition to the points made in previous sections of this paper brief reference should be made to several other matters.

For many years various biface trimmed implements and cores have been turning up in various places in Australia.

McCarthy (1938) grouped them together under the term Gambierian, based on the many examples found in the South East of South Australia, and presumed them to represent a discrete culture. Tindale (1949) reported the occurrence of a *coup-de-poing* like example near Scaddan, Western Australia and described the use of crude examples like it on Mornington Island, in the living culture isolated there, as oyster picks.

The evidence for these being all relics of a specific culture phase has always been unsatisfactory and it still seems desirable to suspend judgment. It is likely that those found in the Mt. Gambier area belong to several different culture strata. Some are true flaked axes without edge grinding, similar in form to ones still made in entirely different material on Melville Island at the opposite end of the continent and elsewhere between, others are merely tabular pieces from which exploratory flakes have been removed to test the flint inside. The aborigines of the Kitja and Djaru tribes today explore white cherty rock in this manner and carry away from their mines, for later working into biface spear blades, blocks indistinguishable in general form from some Gambierian bifaces. Stapleton (1945) gives a good account with figures of some of these biface implements from the South East of South Australia.

The present writer has no pretensions to knowledge of soils, but some queries may be raised for soil men to answer. Is the formation of reddish sandy soil on dunes of predominantly limeshell sand, evidence for arid conditions, as has been stated, or is it an effect of relatively pluvial times, possibly with an alternation between winter wet and summer dry season? If the former idea is correct it must have been arid before and during the period around 8,700 years ago, at Cape Martin, and again during and after Mudukian times probably less than 3,000 years ago, for at both sites limestone pillars have grown up into the A horizon of

red earths, to levels higher than the occupation levels in which implements have come to rest.

Would it not be better to assume that immediately new shell-limesand is brought ashore from the sea, whether by wind or by exposures of new areas by retreat of the sea, leaching by percolation of rain water commences, the lime is carried downward, where it helps to consolidate deeper layers? What is left, the non-calcareous elements in the sand seem to become the red soil; it is composed for the most part of quartz sand grains and red earth. If there is a summer dry period this process seems to be interrupted, moisture moves upwards for this part of the year, to the extent that limestone pillars are formed. Presence of such pillars, projecting upwards into the reddish residual soils might be, not a mark of arid periods, but on the contrary a happening wherever rainfall is intermittent and heavy. The longer the process has continued the thicker will be the mantle of residual reddish soil with included quartz sand and the larger will be any lateritic ironstone pebble-like inclusions in this soil. The Mukudian horizon at Policeman Point is not old and the red residual soil contains no conspicuous laterite pebbles; the Tartangan horizon at Hoods Drift is older and it has many lateritic concretions in it.

The implements of the Tasmanian culture were never observed in use. So far as is known most of those in collections are ones found on abandoned campsites. Some of the types found, for example the high-backed scrapers, could well have, once, been hafted, as are the present day Australian adzes. The *tronata* (*tronatta*) blades of the Tasmanian (Noetling 1909) some of which seem to be the parallel of the *jimari* of the Mangala folk in Australia, might well have had a gum haft, since the back of these, like *jimari* knives, seldom are worked, and often show no signs of being battered. A chance discovery may some day solve this problem.

It is worthy of comment, in passing, that the Mousterians and Aurignacians of Europe may well also have used such hafts of gum or beeswax. It is known that much later in time some of the Epi-palaeolithic sites of the Swiss lakes show gum, used, with wood, as part of the handles of hafted knives. For example there is in the Peabody Museum at Harvard, a flint knife, about four inches long, from Bienne Lake Village in Switzerland, with its blade set into a grooved wooden handle and still held in place with traces of a resinous substance.

In Australia there are marked and fundamental differences in mode of treatment of the butts of knives depending on whether gum hafting or raw hide hafting is employed. A study of these might be of considerable interest to the European archaeologist in the interpretation of functions of old European implement types.

ACKNOWLEDGEMENTS

Many of the observations on which this paper is based were made on journeys over a period of years made possible by special grants from the South Australian Government, the Carnegie Corporation of New York, the Wenner-Gren Fund for Anthropological Research, the University of Adelaide and the Board of the South Australian Museum.

To Dr. Wallace Broecker of the Lamont Geological Observatory of Columbia University we are indebted for the C^{14} determinations for the Devon Downs and Tartanga sites. These tests were arranged through Dr. Hallam L. Movius of Harvard University.

Dr. G. T. Fergusson of the Dominion Laboratories, Lower Hutt, New Zealand, kindly provided C^{14} dates for the Lake Menindee site as also for an early Tartangan site at Cape Martin which is being described in a separate paper (Tindale, in press).

From a wide circle of colleagues and field workers have come many thousands of specimens from more than 2,000 Australian campsites. The implement collections at the Museum which have thus been developed provide the foundations for the observations here recorded. These specimens have been for many years, under the care of my associate Mr. H. M. Cooper. His careful observations in the field and his collating in the cabinets have been of inestimable help, here gratefully acknowledged. It would be impossible to name all contributors to the collections but particular thanks are due to Henry Balfour, G. W. A. Bartholomew, H. K. Bartlett, J. B. Birdsell, E. Couper Black, Lindsay Black, T. D. Campbell, J. B. Cleland, H. K. Fry, F. J. Hall, P. Hossfeld, J. E. Johnson, W. C. Johnstone, E. L. Lundelius, W. B. MacDougall, P. Stapleton, C. G. Stephens, R. A. Stirton, R. Tedford, G. Walsh and S. B. Warne for the making of systematic field records. Thanks are due also to all members of the Museum staff who have been on field work, and have added material to the collections.

Some 150 sites in all States were examined, and specimens also obtained by the present author from living aborigines on several expeditions in company with J. B. Birdsell, as well as during the numerous visits to Central and Western Australia, and the Northern Territory on expeditions conducted by the Board for Anthropological Research at the University of Adelaide.

Mr. L. F. Marcus of the University of California made a special trip to Lake Menindee to fetch samples for C^{14} analysis, and the recovery of the early date of 8700 B.P. for a hearth there is due to his work.

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**AUSTRALIAN FOSSIL PENGUINS,
WITH REMARKS ON PENGUIN EVOLUTION AND DISTRIBUTION**

BY GEORGE GAYLORD SIMPSON,
AMERICAN MUSEUM OF NATURAL HISTORY

Fig. 1-6

INTRODUCTION

A fossil penguin bone from Australia was first described by Finlayson in 1938. Since then three other specimens have been found. Glaessner (1955) has discussed the stratigraphy and biostratonomy of all four occurrences and has figured two of the more recently discovered bones. The four specimens were then referred to me for morphological and systematic study, which is the subject of the present paper. The specimens are the property of the South Australian Museum, and I am much indebted to the authorities of that Museum and to Dr. M. F. Glaessner of the University of Adelaide for the opportunity to study them.

The four Australian specimens come from two horizons, late Eocene and Oligocene. None is surely identifiable to species, but they represent at least three species. One Eocene specimen is identifiable to genus, *Palaeudyptes*. The other Eocene specimen may be of the same genus and species. The two Oligocene specimens are certainly of different species and probably genera, one a palaeudyptine and the other not placeable as to subfamily.

Since I reviewed the whole subject in 1946, additional discoveries of fossil penguins have been made not only in Australia but also in New Zealand and Antarctica. Several further studies on penguin paleontology and evolution have been published, notably the outstanding work of B. J. Marples (1952, 1953). Another full review is not now called for, but this occasion is taken to append an up-to-date summary of fossil penguin distribution and two brief notes on a morphological point and on a criticism of a theory of penguin origins.

In tables of measurements (Tables 1-3), I have numbered the dimensions as in Marples (1952, 1953) to facilitate comparisons. All measurements are in millimeters.

The accompanying drawings are by Chester Tarka.

DESCRIPTIONS OF SPECIMENS

Palaeudyptes cf. antarcticus

THE EOCENE HUMERUS

(Fig. 1.)

Specimen. S. A. M. No. P7158, left humerus, nearly complete but with salient parts of both ends eroded. Collected by W. Burdett.

Locality. Witton Bluff, at the southern end of Christie's Beach, about 16 miles south of Adelaide.

Horizon and Age. "Transitional Marl" member, which forms the base of the Blanche Point Marls, late Eocene (Glaessner, 1955).

Previous Publication. This is the specimen summarily described and figured in external and postaxial aspects by Finlayson (1938). Marples (1952) compared a cast with New Zealand specimens, but made only a generalized statement of similarity, without description or figure. Simpson (1946) discussed the specimen briefly on the basis of Finlayson's figures, and Glaessner (1955) has discussed its occurrence and age.

Description. This is a large, but not maximal, fossil penguin humerus. Size and proportions are near those of the seven New Zealand humeri referred to *Palaeudyptes antarcticus* by Marples (1952), but most dimensions are at or slightly below the smallest measurements on Marples' specimens. The proximal part of the shaft is, however, relatively thick (dorso-ventrally). The shaft tapers from proximal to distal, very slightly but still somewhat more than is usual in the New Zealand specimens. See Table 1. There is no preaxial angle or tubercle.

The distal end is somewhat eroded and crushed or cracked, but seems to have been about as in *Palaeudyptes antarcticus* (Marples, 1952, Fig. 2, No. 3). The angle between the midline of the shaft and a tangent to the ulnar and radial condyles was probably between 25° and 30°. This is a difficult measurement to make consistently, even on perfect bones, and is consequently open to considerable error here, but the angle is certainly unusually low. 40° is the smallest angle noted for *Palaeudyptes* by Marples, but on some of his illustrations I obtain values as low as 30° or slightly less, which suggests that our technique differs. In any case both this bone and New Zealand *Palaeudyptes* have low angles and there is insufficient evidence of significant difference between them.

The head is characteristically palaeudyptine, without apparently distinctive characters within that group. The same is true of the tricipital fossa, which is completely undivided and is small relative to the bulk of the whole bone (a point separately discussed later in this paper). There is no angle or prominence on the preaxial border, a feature

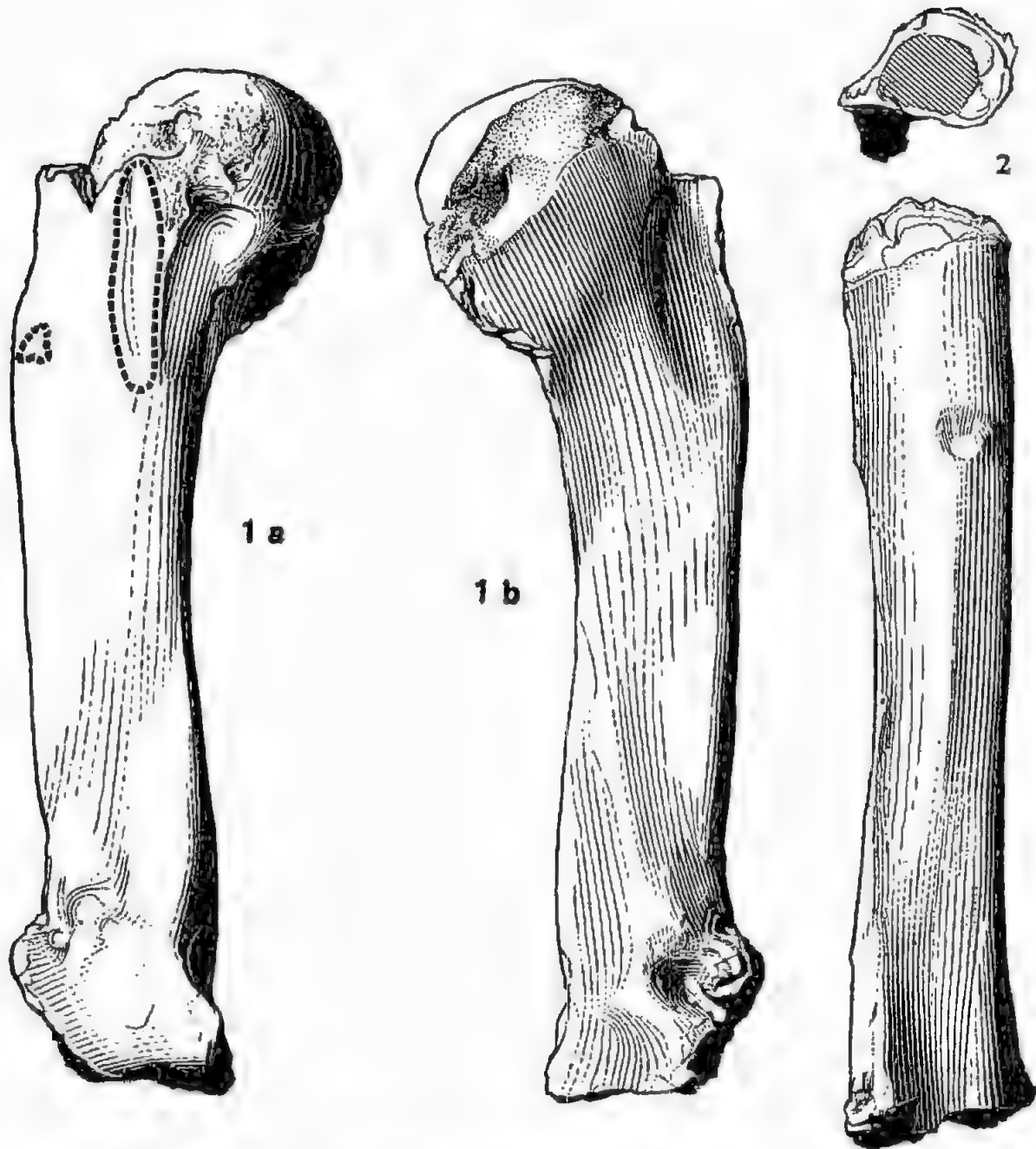


Fig. 1. *Palaeudyptes* cf. *antarcticus*, S.A.M. No. P7158, left humerus. a, ventral aspect. b, dorsal aspect. Insertions of *pectoralis secundus* and *latissimus dorsi* are marked by heavy broken lines. Cracks in shaft have been omitted and small missing fragments restored, but eroded parts of proximal and distal ends have not been restored ($\times 3$).

Fig. 2. *Palaeudyptes* cf. *antarcticus*? S.A.M. No. 10862, shaft of right tibio-tarsus. Proximal view, showing cross section at break, and posterior view. Cracks have been omitted and small fragments missing from shaft have been restored ($\times 2$).

constant in recent penguins, absent or slight in New Zealand *Palaeudyptes*, but present in some other palaeudyptines.

The insertion of the *pectoralis secundus* is not well defined, but it is evidently nearly parallel with the shaft and it is well separated from

the small *latissimus dorsi* insertion—characters typical of the early penguins and specifically of *Palaeudyptes antarcticus* although somewhat variable in the latter. There is a marked depression or small fossa between the proximal end of the *pectoralis secundus* insertion and the lip of the tricipital fossa (near and proximal to the insertion of the *pectoralis tertius*).

The capsular groove is not perfectly preserved or completely freed from matrix. It may, doubtfully, be a little less sharply defined or continuous than in New Zealand *Palaeudyptes* and to that extent more like recent penguins.

Classification. Finlayson (1938) pointed out the close resemblance of this bone to *Palaeudyptes antarcticus* of New Zealand but did not make a definite identification. Marples (1952) compared a cast with the New Zealand specimens and confirmed the resemblance except for the slightly smaller ("more slender") size of the Australian humerus. He referred to it as *Palaeudyptes* sp., as I (Simpson, 1946) had previously done from Finlayson's published data, alone. The bone obviously belongs to the Palaeudyptinae (Simpson, 1946, usefully redefined by Marples, 1952 and 1953). It cannot be distinguished generically from *Palaeudyptes*. It has slight and somewhat dubious apparent differences from New Zealand specimens of *P. antarcticus*, as noted above. These are no greater than variations that commonly occur within a single species, and they do not warrant designation of a new species. Nevertheless the possible slight morphological differences and the markedly different provenience prevent a fully positive assignment to *P. antarcticus*. The most reasonable identification at present is *Palaeudyptes* cf. *antarcticus*.

Table 1.

COMPARATIVE MEASUREMENTS OF HUMERI

	P7158	P10863	<i>P. antarcticus</i> (Marples)
1. Extreme length	154	—	159-172(2)**
2. Head to angle at base of dorsal sesamoid groove	152	—	153-166(4)
3. Distal end of insertion of <i>pectoralis secundus</i> to angle of 2	ca. 100	—	104-117(6)
4. Head, greatest diameter	ca. 45	ca. 53*	46-49 (5)

5. Pre-postaxial diameter of shaft $\frac{1}{3}$ distance from head	28 $\frac{1}{2}$	29	28-35 (7)
6. Same, $\frac{2}{3}$ distance from head	25 $\frac{1}{2}$	ca. 29	28-35 (6)
7. Dorsoventral diameter of shaft $\frac{1}{3}$ distance from head	13	14	11 $\frac{1}{2}$ -13 (6)
8. Same, $\frac{2}{3}$ distance from head	11 $\frac{1}{2}$	ca. 14	12-14 (6)
10. Preaxial side of radial condyle to longest distal process	ca. 40	—	45-50 (4)
11. Transverse diameter of distal end across ulnar condyle	ca. 18	—	18-21 (5)

*47.3 as preserved, about 5 $\frac{1}{2}$ mm. believed to be eroded.

**Figures in parentheses are numbers of specimens measured by Marples.

Palaeudyptes cf. antarcticus ?

THE EOCENE TIBIOTARSUS

(Fig. 2)

Specimen. S. A. M. No. P10862, right tibiotarsus, lacking both ends and with shaft somewhat broken. Collected by M. F. Glaessner.

Locality. North of Port Noarlunga jetty, at the base of the cliff extending southward from Witton Bluff, at high water level.

Horizon and Age. Just below the top of the Banded Marl member of the Blanche Point marls, about 20-25 feet above the transitional marl (in which P7158 was found), late Eocene (Glaessner, 1955).

Previous Publication. Listed but not described or figured by Glaessner (1955).

Description. This tibiotarsus is slightly smaller than that referred to *Palaeudyptes antarcticus* by Marples (1952), and hence is from an animal of the same size as the humerus described above. Few distinctive characters are preserved. The shaft is flattened dorsoventrally and is rounded, with a sharp crest only at and below the region of contact with the fibula. To the extent that they differ from recent penguins, these characters are common in the older fossil penguins and especially in the *Palaeudyptinae*.

Classification. Positive identification is hardly possible, but as far as it goes the bone is entirely consistent with reference to *Palaeodyptes*. Difference in age from the humerus of *Palaeodyptes* cf. *antarcticus* is not likely to be significant, and the fact that the two animals were of almost exactly the same size establishes a certain presumption that they were of the same species.

Table 2.

COMPARATIVE MEASUREMENTS OF TIBIOTARSI		P10862	<i>Palaeodyptes</i> <i>antarcticus</i> (Marples)
2. Pre - postaxial diameter $\frac{1}{3}$ length from proximal end	.....	ca. 24	28
3. Same, $\frac{2}{3}$ length	.....	ca. 19	23
4. Dorsoventral diameter $\frac{1}{3}$ length from proximal end	.....	ca. 16	16
5. Same, $\frac{2}{3}$ length	.....	ca. 14 $\frac{1}{2}$	16

Gen. et sp. indet., A

THE OLIGOCENE HUMERUS

(Fig. 3)

Specimen. S. A. M. P10863, right humerus without distal end and with proximal end heavily eroded. Collected by M. Pritchard.

Locality. Pritchard Brothers' building-stone quarry about 7 $\frac{1}{2}$ miles west-northwest of the town of Mt. Gambier.

Horizon and Age. Gambier limestone, Oligocene (Glaessner, 1955).

Previous Publication. Figured and tooth marks discussed by Glaessner (1955).

Description. The humerus when complete was at least as large as *Palaeodyptes antarcticus*, but of somewhat different proportions. The badly eroded head nevertheless indicates that this part was larger than in *P. antarcticus* both absolutely and in proportion to the transverse diameters of the shaft. The *pectoralis secundus* insertion is only very slightly oblique, well separated from the *latissimus dorsi* attachment, and the fossa between it and the lip of the tricripital fossa is shallow. There is a distinct preaxial tubercle or angle, and the contour of the shaft proximal to this is concave, making this slightly the narrowest part of the shaft, which nevertheless has nearly parallel sides and does not seem

to have been notably sigmoid. The tricripital fossa is narrow and undivided. Measurements are included in Table 1.

Classification. This specimen is quite surely palaeodyptine, but it cannot be referred with assurance to any named genus in which the humerus is known. The size of the species is probably in the range of

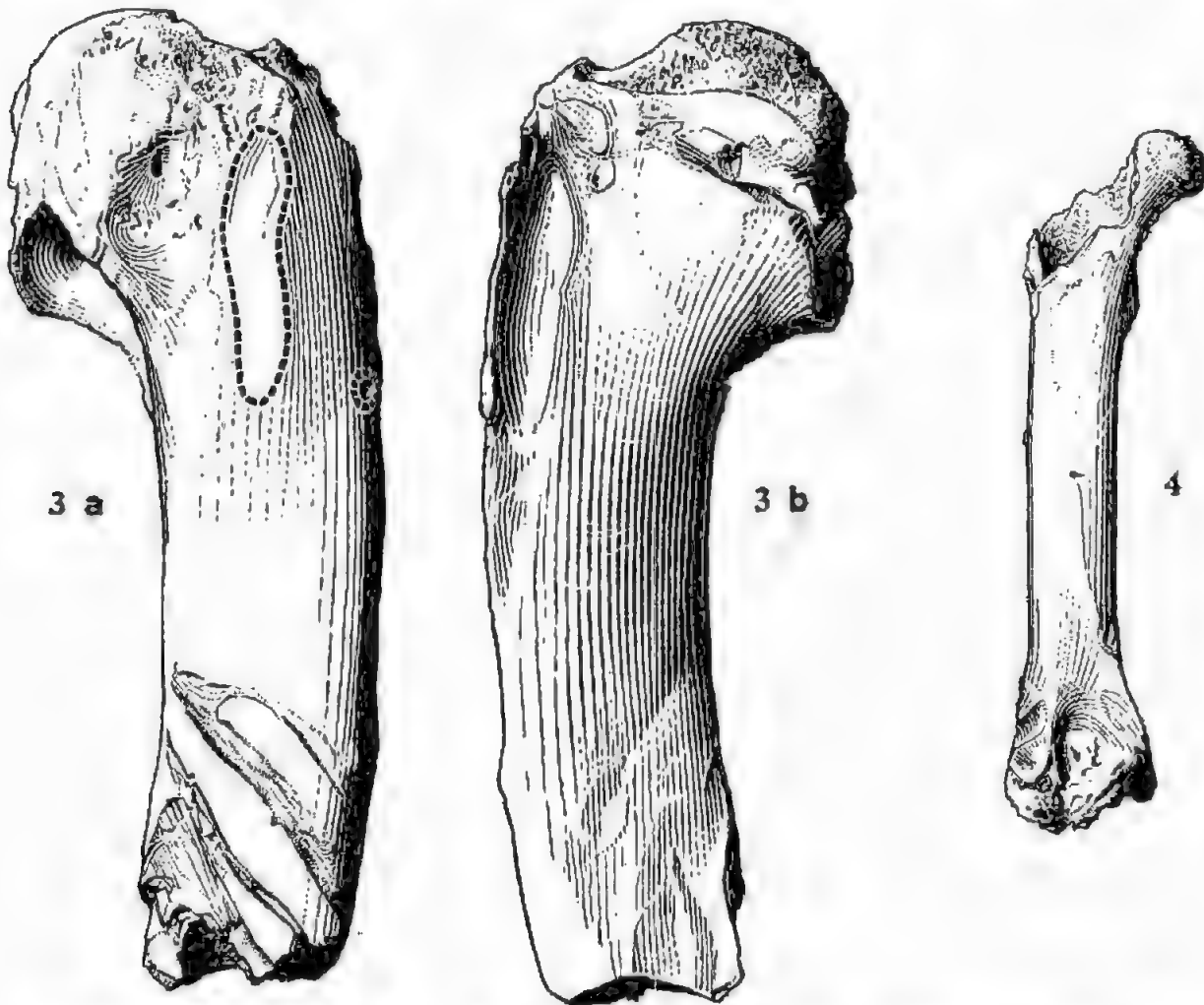


Fig. 3. Gen. et sp. indet., A. S.A.M. No. P10863, part of right humerus. a, ventral aspect. b, dorsal aspect. Insertions of *pectoralis secundus* and *latissimus dorsi* are marked by heavy broken lines. Cracks in shaft have been omitted and small missing fragments restored, but imperfections of proximal and distal ends are as shown. Apparent tooth marks on disto-ventral part are shown ($\times 8$).

Fig. 4. Gen. et sp. indet., B. S.A.M. No. P10870, imperfect left femur. Posterior (or ventral) aspect. No restoration ($\times 8$).

Palaeodyptes antarcticus, but it differs from *Palaeodyptes* especially in the relatively larger head and the prominent preaxial tubercle. *Pachydyptes* has a much stouter, stockier humerus and a smaller tubercle with the contour convex above it. *Platydyptes* and *Archaeospheniscus* have the *pectoralis secundus* insertion more oblique, and the latter genus also has a smaller tubercle and less concave contour above it. The Seymour Island *Anthropornis* is generally rather similar but has a relatively

smaller head and stouter shaft and a smaller preaxial tubercle. *Eosphae-niscus*, also from Seymour Island, has a heavily accented fossa between the *pectoralis secundus* and the tricipital fossa, quite different from the present specimen.

Few and slight as these differences are, they are just such as to distinguish the humeri of defined genera of palaeodyptines. It is therefore improbable that this specimen belongs to the same genus as any previously described humerus. Nevertheless it seems inadvisable to base a new generic or specific name on this inadequate type, which might make difficult or impossible the exact identification of future finds, especially because the length of the shaft and the important characters of the distal end are unknown. There are, furthermore, several named palaeodyptine genera in which the humerus is unknown and to which, therefore, this bone might conceivably belong. It is designated only as *gen. et sp. indet.*, with the comment that it is not the same as the late Eocene form described above, and that it is also of a different species, and doubtless genus, from the contemporaneous femur next described.

Gen. et sp. indet., B

THE OLIGOCENE FEMUR

(Fig. 4)

Specimen. S. A. M. No. P10870, left femur, lacking the trochanter and the distal end and with the head badly eroded. Found by D. J. Leonard.

Locality. Found in a block of building stone, from the vicinity of Mt. Gambier.

Horizon and Age. Gambier limestone, Oligocene, (Glaessner, 1955).

Previous Publication. Figured, without description, by Glaessner, 1955.

Description. The femur in penguins is not a very distinctive bone, and this specimen has lost just those parts that might have been most characteristic. The shaft is rather stout, although probably no more so than would be expected in average penguins of this size. Although the trochanter is lacking, the contour of the shaft below it suggests that it was less compressed laterally, or displaced medially, than in recent penguins—a feature common in the Miocene and older penguins. The shaft is nearly smooth except for a prominent rugosity just below the head and the usual, not especially prominent, ventral ridges above the condyles. The animal was slightly below the mean size of the living *Aptenodytes patagonicus*. (See Table 3.) Glaessner suggested that the trochanter had been bitten off, but there are no clear tooth marks.

Classification. This bone is unidentifiable, even as to subfamily, both because it lacks characteristic parts and because most genera and species of fossil penguins are known from and defined by the tarsometatarsus and the humerus and not the femur. This femur is much too small to be conspecific with any of the three specimens described above, and indeed the discrepancy suggests that it is not congeneric with any of them. All one can say now is that at least two quite distinct penguins, one a palaeudyptine and the other of unknown subfamily, are present in the Gambier limestone.

Table 3.

MEASUREMENTS OF FEMUR

P10870

1. Notch between head and trochanter to notch between condyles	ca. 90-95 (very rough approximation).
2. Greatest proximal width	ca. 22
5. Pre-postaxial diameter at middle of shaft	11½
6. Dorsoventral diameter at middle of shaft	11½

NOTE ON RELATIVE SIZES OF THE TRICIPITAL FOSSA

Wiman (1905), Finlayson (1938), and Lowe (1939) stated, on the basis of New Zealand, Australian, and Seymour Island fossils, that their tricipital fossae are smaller, relative to the size of the whole humerus, than in living penguins. I (Simpson, 1946) agreed that this is probably true of some, at least, of the larger fossil species, but pointed out that it is not true of smaller Patagonian fossils, notably in the genus *Palaeospheniscus*.

Marples (1952) made measurements for five New Zealand fossils, referred to four genera and species, and for one specimen each of seven recent species in five genera. The volumes were compared by filling the fossa with fine sand, the weight (W) of which was taken as directly proportional to the volume. The size of the humerus was measured as diameter of the head (D) and length of the whole bone (L). The indices $100 (W/D)$ and $100 (W/L)$ were then calculated and compared. These figures suggest, and Marples concluded, that the larger humeri have not only absolutely but also relatively larger fossae, contrary to the previous conclusions cited above. The evident further implication is that the differences depend on size and have no independent taxonomic value, or no bearing on evolutionary change other than size. It may be noted

that Marples' own figures show that the only recent species included in the comparison that are comparable in size with any of the fossils do, indeed, have larger fossae than the latter (see last column of Table 4). He concluded, however, that the species in question, *Aptenodytes forsteri* and *A. patagonicus*, "are clearly not typical penguins in this respect".

A valid index of relative size requires that "size" have the same number of dimensions in both terms of the comparison. Although less precisely quantitative, the comparisons involved in the statements about the tricripital fossa by Wiman, Finlayson, Lowe, and me were valid in that linear (one-dimensional) measurements of fossa and humerus were compared. The indices 100 (W/D) and 100 (W/L) are invalid because W is (indirectly) three-dimensional but D and L are one-dimensional. An index three-dimensional in both terms can be obtained by using the ratios W/D^3 or W/L^3 .

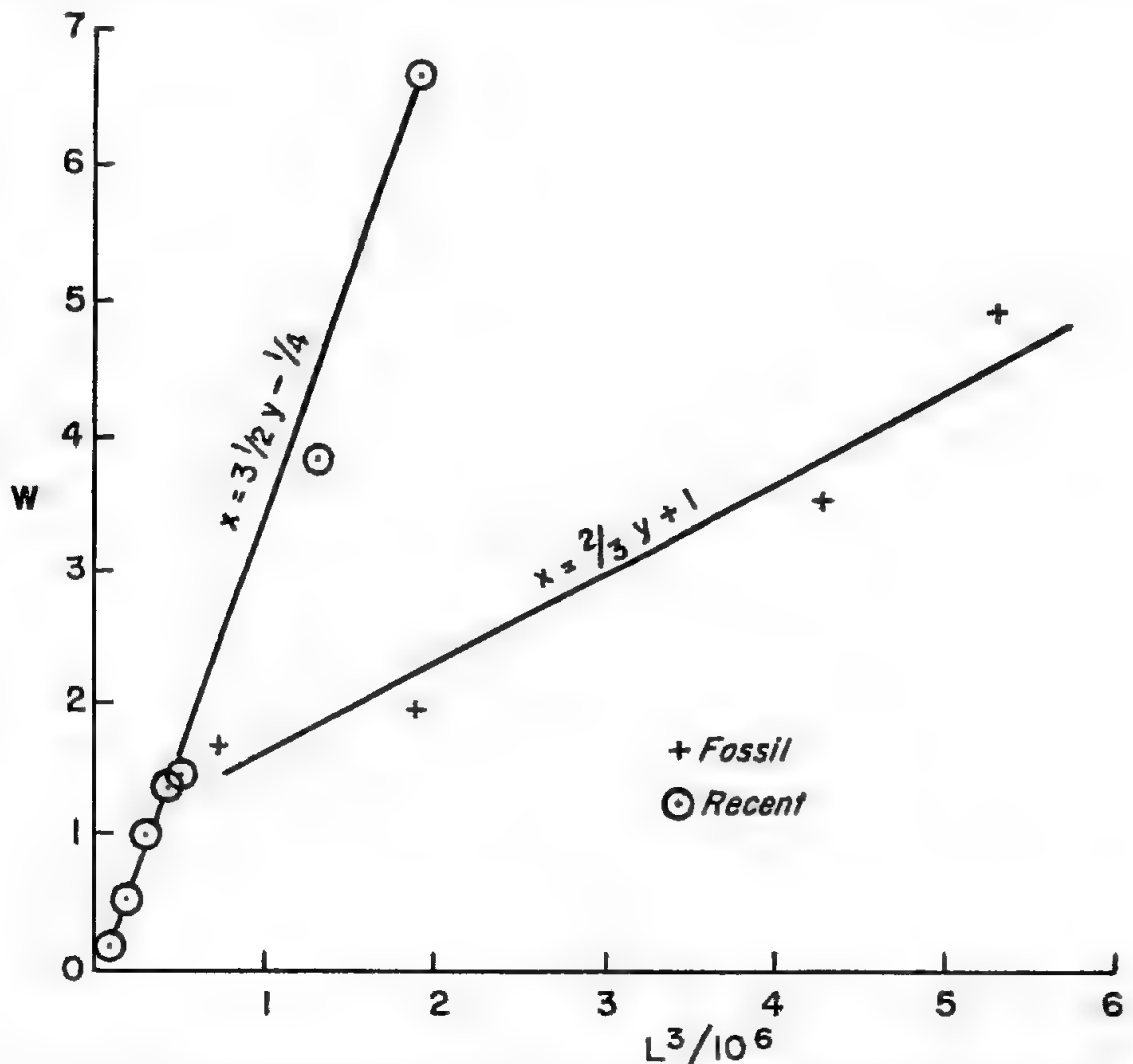


Fig. 5. Correlation of length of humerus and the index $10^6 (W/L^3)$ in some recent and fossil penguins. For fuller explanation see text. Raw data from Marples (1952).

Use of W to represent volume of the fossa depends on the relationship,

$$W = SV$$

where W is the weight of sand, V is the volume (three dimensional, of course) of the fossa, and S is the specific gravity of the sand-air aggregate. S depends in a complex way on the mineral composition and the size and shape distributions of the sand used. Its value is unknown in this case, but since it was kept constant in Marples' study his comparisons are valid in this respect. Use of L^3 (or of D^3) to represent volume of the bone depends on the relationship

$$L^3 = aV$$

in which a depends in a complex way on the shape of the bone. The value of a must vary somewhat from species to species and even from one individual to another, but in all penguins the shape of the humerus is sufficiently stereotyped to keep the variation of a within rather narrow limits. In other words, it is a reasonable premise that L^3 and V have a high, positive, rectilinear correlation. The correlation of L and V cannot be rectilinear.

In order to bring the index into a convenient order of magnitude the ratio W/L^3 may be multiplied, not by 10^2 as in Marples' index, but by 10^6 (i.e., 10^2 cubed). The results from Marples' raw data are given in the third column of Table 4, and compared with Marples' index in the fourth column. The indicated conclusions differ from those of Marples. Except for *Eudyptula minor*, the index for these recent penguins shows no evident trend with size and rather little variation. Since only single measurements are involved, the variation shown could be merely sampling variance around the same mean for the six species, although it is likely that some differences among species occur. It is *Eudyptula*, not *Aptenodytes*, that appears "clearly not typical . . . in this respect". The meaning of the apparent aberrancy of *Eudyptula* is not clear. Marples notes (without further data) that the volume of the fossa is highly variable in *Eudyptula* and the only specimen available to me seems to have a fossa relatively about as large as in other recent penguins.

In the four fossil penguins compared, the relative size of the fossa is decidedly smaller than in "normal" recent penguins (all the compared species except *E. minor*), confirming the earlier conclusion rejected by Marples. The discrepancy is most marked for the three largest fossil species, all of which have approximately the same index, 0.90-1.06 as against 2.83-3.59 for recent species other than *E. minor*. The fossil *Archaeospheniscus lowei* is of almost exactly the same size as the living *Aptenodytes forsteri*, but the indices are 1.06 and 3.50, respectively. The

smallest fossil species compared, *Platydyptes novaezealandiae*, happens to have a larger index (2.23) than the other fossils. This isolated observation is insufficient to establish a tendency for smaller fossil species to have relatively larger fossae, but it is noteworthy that still smaller species of *Palaeospheniscus* clearly have relatively large fossae (1). Note also, however, that if only three or four recent species had been included they might have suggested a trend that is evidently absent when the seven species are included. For instance, *E. pachyrhynchus*, *M. antipodes*, and *A. patagonicus* would have shown a regular decrease of the index with increasing size, and *E. minor*, *P. papua*, *A. patagonicus* and *A. forsteri* would have shown just the opposite, a regular increase of the index. (See Fig. 5.)

The data of Table 4 and the graph of Fig. 5 still do not strictly represent a valid regression or reveal a possible growth pattern, because the variate L appears (with different dimensions) in both terms of the comparison: L and $10^6 (W/L^3)$. The valid regression of W on $L^3/10^6$ (2) is shown in Fig. 6. The regressions for both the recent and the fossil penguins measured by Marples clearly tend to follow linear patterns, but the two regressions are decidedly different. The regression for the recent specimens does not suggest significant deviation from a straight line, and it is somewhere in the neighbourhood of $x = 3\frac{1}{2}y - \frac{1}{4}$. (That line is merely sketched in freehand and the approximate equation derived from it; the scanty data do not warrant more elaborate curve fitting.) It is noteworthy that *Eudyptula minor* also falls near this line, within the probable limits of sampling error, and that with this treatment no recent species seems to be "exceptional".

The fossil species do suggest that their regression is not straight, but there are only four individual sets of measurements, and departures from a straight line could be random. (Neither the fossil nor the recent regression is straighter on a log graph, and use of the allometric equation is not indicated.) The regression is somewhere in the general neighbourhood of the straight line $x = \frac{2}{3}y + 1$ (roughly sketched by eye, as for the recent data). Even with so few data, there can be no serious doubt that the regressions are very different for the recent and the fossil species being compared. It is also again clear that among the larger species the fossils have decided smaller tricipital fossae than the living forms.

(1) Because the specific gravity (S of preceding discussion) of sand-air aggregates must vary greatly and is unknown for the sand used by Marples, it is impossible for another worker to produce further data comparable with his. Direct, reproducible, and precise comparisons could be made from measurements of the volume of a liquid that can be held in the fossa and of the displacement of liquid by immersion of the whole bone, but such measurements have not been made.

(2) As in the index $10^6(W/L^3)$, the term 10^6 is introduced only to keep the variates compared in the same order of magnitude. The form of the regression would of course be the same if 10^6 were omitted.

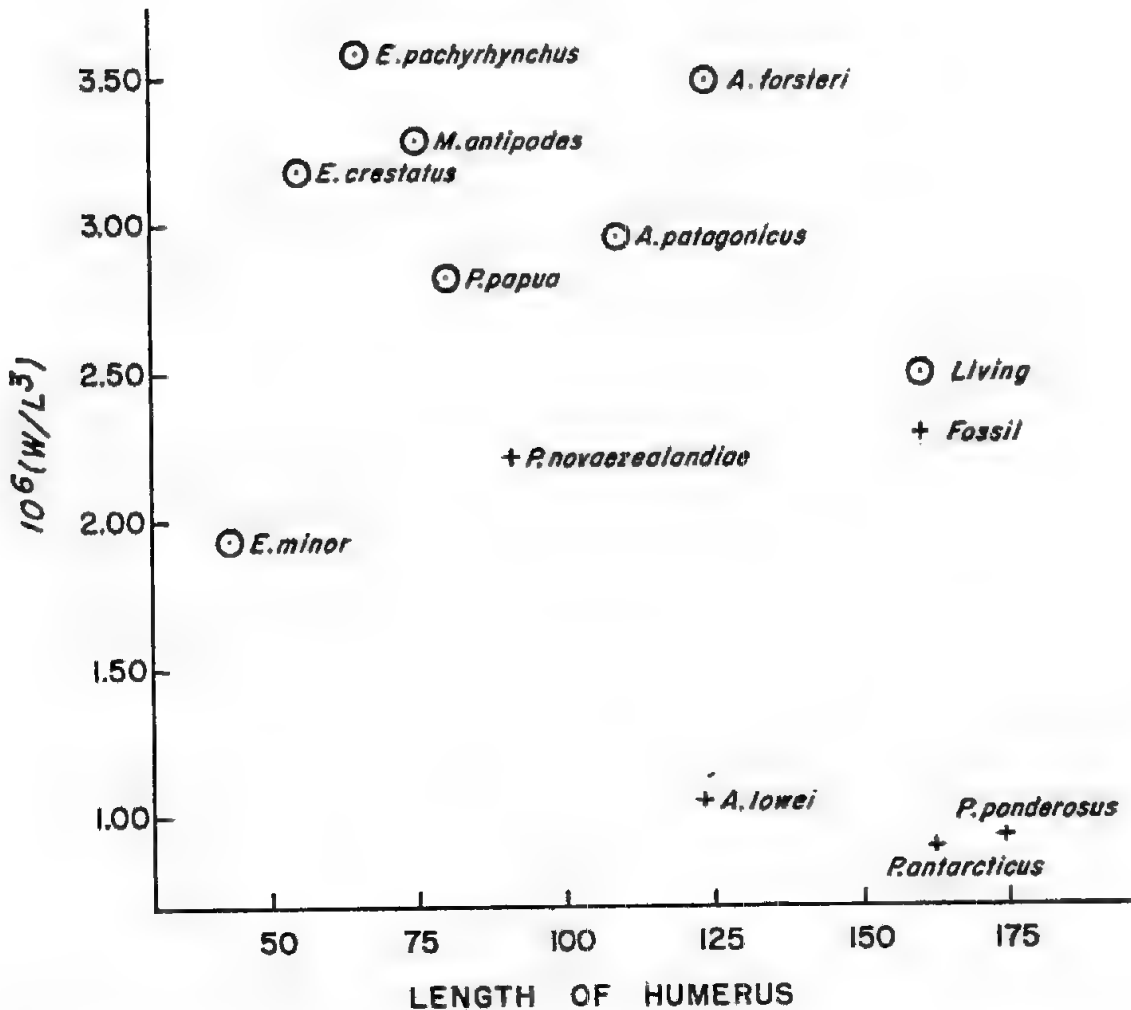


Fig. 6. Regression of W on $L^3/10^6$ for some recent and fossil penguins (species as in Fig. 5). For fuller explanation see text. Raw data from Marples (1952).

However, if an extrapolation of this regression should apply to other late Eocene to early Miocene penguins—an extrapolation not really warranted without further information—then the smallest of them would have tricipital fossae about equal to or even larger than those of recent penguins of the same size. It is suggestive, but no more than suggestive in the absence of precisely comparable measurements, that $L^3/10^6$ for the Patagonian fossil genus *Palaeospheniscus* (about 0.35-0.50 in various species) is in the region where the two regressions would intersect. As compared roughly by linear dimensions, that genus does indeed have tricipital fossae about as in recent penguins of comparable size.

Table 4.

RELATIVE SIZE OF TRICIPITAL FOSSA IN VARIOUS PENGUINS

(For explanation see text.)

Species:	Weight of sand (Marples) W	Length of humerus (Marples) L	Index $10^5(W/L^3)$	Index $10^2(W/L)$ (Marples)
Fossils:				
<i>Pachydyptes ponderosus</i>	4.91	174	0.93	2.8
<i>Palaeudyptes antarcticus</i>	3.81	162	0.90	2.3
<i>Archaeospheniscus lowei</i>	1.97	123	1.06	1.6
<i>Platydyptes novaezealandiae</i>	1.68	91	2.23	1.8
Living:				
<i>Aptenodytes forsteri</i>	6.68	124	3.50	5.3
<i>Aptenodytes patagonicus</i>	3.84	109	2.97	3.5
<i>Pygoscelis papua</i>	1.45	80	2.83	1.8
<i>Megadyptes antipodes</i>	1.39	75	3.29	1.8
<i>Eudyptes pachyrhynchus</i>	1.00	65.3	3.59	1.5
<i>Eudyptes crestatus</i>	0.53	55.0	3.19	0.9
<i>Eudyptula minor</i>	0.16	43.5	1.94	0.4

DISTRIBUTION OF FOSSIL PENGUINS

Fossil penguins are known from southern Argentina (Patagonia), Seymour Island ⁽³⁾, New Zealand, and South Australia. It was formerly believed that all occurrences were approximately contemporaneous, more or less early Miocene. Now Marples (1952) and Finlay (1952) have convincingly demonstrated that this is not true of the New Zealand specimens, and Glaessner (1955) has done the same for the Australian specimens. Although I have nothing new to contribute on this score, it will be convenient to review these newer data on penguin distribution, along with revised determinations which have not been gathered in any one publication.

New Zealand. Finlay (1952) identified and discussed microfossils associated with fossil penguins described by Marples (1952). The pertinent part of the provincial stage sequence and the ages assigned by Finlay are as follows:

⁽³⁾ This occurrence is commonly called "Antarctic", but Seymour Island is not part of Antarctica and it is well north of the Antarctic Circle, at about 64° 15' south latitude.

Middle Oligocene	Waitakian— <i>P</i>
	Duntroonian— <i>P</i>
Early Oligocene	Whaingaroan—? <i>P</i>
	Runangan— <i>P</i>
Late Eocene	Kaiatan— <i>P</i>
Middle Eocene	Bortonian
Early Eocene	Heretaungan—? <i>P</i>

Penguins are most abundant in the Duntroonian, but occur also in the other stages marked with *P*. The scraps thought to be from the Heretaungan, unfortunately unidentifiable, are probably the oldest known fossil penguins. Good identifiable specimens occur from Kaiatan to Waitakian, late Eocene to middle Oligocene by Finlay's dating. Although known occurrences of most of the described species are confined to one stage or another, there seems to be no evident evolutionary progression and the single, most abundant species *Palaeudyptes antarcticus* is identified by Marples, on the basis of good specimens, for the whole range Kaiatan-Waitakian. (See Table 5.) This is a remarkably long span for a single species. I know of no other species and rather few genera of vertebrates present in both late Eocene and middle Oligocene. It is possible that more abundant collections would permit specific separation, but Marples' specimens suffice to show that there is, at most, little difference between earliest and latest occurrences referred to this species. One must conclude that the rate of evolution for *Palaeudyptes* had become effectively *nil* by late Eocene, that the Kaiatan-Waitakian span was shorter than Finlay indicates, or that some of the specimens are incorrectly dated.

Australia. The two older penguin bones described above are from the Blanche Point marls, formerly but incorrectly considered Miocene (Finlayson, 1938), in horizons now placed in or near the late Eocene. The younger bones are from the Gambier limestone, now placed in the Oligocene without, as yet, closer correlation. The age determinations by Glaessner (1955) are based mainly on still unpublished studies of foraminiferal faunas. In themselves the fossil penguins as yet are of no help in correlation, but the penguins known from the two ages are quite different, as shown above.

Patagonia. The stratigraphic position of the Patagonian fossil penguins is exactly known. With three dubious and probably erroneous claimed exceptions, all are from the base of the Patagonian formation ("Juliense" member). They are associated with "the richest and best known of all South American Tertiary faunas" (Feruglio, 1949), with extraordinarily abundant invertebrates as well as numerous sharks and whales. Despite all this knowledge, the age has been and still is disputed. It has been placed everywhere from early Eocene through Miocene. Nevertheless there is now a clear consensus that the age is late Oligocene or early Miocene, i.e., deposition occurred at or around the Oligocene-Miocene transition. The subject has been fully reviewed by Feruglio (1949).

Seymour Island. The Seymour Island penguins are presumably associated with a rather poor marine invertebrate fauna. Association *in situ* was rarely or not observed, but no marked age difference between the penguins and the invertebrates seems to be indicated. The invertebrate fauna has at least one species in common with the Patagonian formation, and is otherwise composed of distinct but closely allied species (review and references in Feruglio, 1949). On this basis it is highly improbable that these penguins are older than late Oligocene or younger than early Miocene. Marples (1952) pointed out that the Seymour Island penguins resemble the late Eocene-middle Oligocene forms of New Zealand, while (most of) the Patagonian penguins seem to be less primitive. He concluded that the Seymour Island forms may be older, belonging somewhere in the Oligocene (assuming the Patagonian to be Miocene). It is, however, to be remembered that: (a) no genera, *a fortiori* species, are known to be common to Seymour Island and New Zealand; (b) the apparent evolutionary rate of zero for at least one penguin of this general type from late Eocene to middle Oligocene (if the New Zealand dating is correct) suggests that still later survival of related and not identical forms would be more likely than not; and (c) the Patagonian penguin *Archrodyles grandis* seems to be closely related to Seymour Island species. It seems probable that the marked difference between the Seymour Island and most of the Patagonian penguins is more a matter of facies than of age. (The localities are separated by some 20° of latitude and must both on this and on other accounts have had markedly different environmental conditions even in the Oligocene or Miocene.) On present evidence the Seymour Island penguins are not likely to have been appreciably older than the Patagonian, and might have been as late or even slightly later.

More recently Marples (1953) has revised the Seymour Island penguins, but without further discussion of their age.

Faunal lists. The known fossil penguins, according to the most recent revisions, are listed in Table 5.

Table 5.

KNOWN FOSSIL PENGUINS

A. New Zealand (data from Marples, 1952).

Indet.	Early	Late	Early	Middle
	Eocene	Eocene	Oligocene	Oligocene
	Heretaungan	Kaiatan	Whaingaroan	Waitakian
	x			
<i>Palaeudyptes</i>				
<i>antarcticus</i>	x	—	?	x
<i>Pachydyptes</i>				
<i>ponderosus</i>		x		
<i>Archaeospheniscus</i>				
<i>lowei</i>			x	
<i>A. lopdelli</i>			x	
<i>Dunroonornis</i>				
<i>parvus</i>			x	
<i>Platydyptes</i>				
<i>novaezealandiae</i>			x	?
<i>P. amiesi</i>			?	x
<i>Korora oliveri</i>				x

B. Australia (this paper).

	Age	
	Late Eocene	Oligocene
	Blanche Point marls	Gambier limestone
<i>Palaeudyptes</i> cf. <i>antarcticus</i>	x	
Gen. et sp. indet. A.		x
Gen. et sp. indet. B.		x

C. Seymour Island (Wiman, 1905, and Marples, 1953).

(All of same age as far as known, probably late Oligocene or early Miocene.)

Anthropornis nordenskjoldi
Eosphaeniscus gunnari
Notodyptes wimani
Delphinornis larsenii
Ichthyopteryx gracilis (validity doubtful)

D. Patagonia (Simpson, 1946; some highly dubious records and probable synonyms omitted).

(All of same age, basal Patagonian, "Juliense" member, latest Oligocene or early Miocene).

Palaeospheniscus gracilis
P. rothi
P. patagonicus
Paraspheniscus bergi
P. nereius
Perispheniscus wimani
Isolremornis nordenskjoldi
Paraptenodytes antarcticus
P. curtus
Arthrodytes grandis
Arthrodytes? andrewsi

NOTE ON THE ORIGIN OF PENGUINS

I have elsewhere (Simpson, 1946) supported the theory that penguins arose, not from flightless land birds or in a delimited land area, but from diving sea birds (ecologically similar to diving petrels) widely distributed around the South Temperate Zone. Recently de Meillon (1952) has opposed all aspects of that theory on the evidence of penguin fleas.

The only fleas known to occur on penguins are *Listronius robertsianus*, *Parapsyllus longicornis*, and *P. magellanicus*. Both genera belong to the subfamily Parapsyllinae, with six other genera. Except for those on penguins (and other sea birds) all members of the subfamily are confined to South America where most of them are rodent fleas. De Meillon therefore argues that the penguins must have acquired the fleas in South America and must themselves have originated there. This seems to be a *non sequitur*. There is no evident reason why the penguins may not have acquired these fleas after penguins had evolved as such and had spread to South America from any place or zone of origin. As to why they happen to have *only* South American fleas (as far as known), that is no harder to explain on either theory, hence no better evidence for or against either, than the fact that they have long been in Australia and New Zealand (since the Eocene) and probably also in Africa (fossils unknown) without, apparently, acquiring parasites there. It is also pertinent that the earliest known penguins antedate the appearance of rodents in South America.

Moreover all three species of penguin fleas are known to occur also on wide-ranging groups of flying birds: *L. robertsianus* on petrels, *P. longicornis* on shearwaters and an Antarctic thrush, and *P. magellanicus* on whale-birds, jaegers, sooty albatrosses, albatrosses, and Cape pigeons. There is no evident reason why the primary dispersal of the fleas may not have been partly or wholly by flying birds.

De Meillon also implies that the abundance of fossil penguins in the South American "Subantarctic" (most of them are from far up in the Temperate Zone) supports his view. But, as noted above, known fossil penguins occur *earlier* in Australia and New Zealand. In fact the fossil record is so spotty that it does not really suggest anything about the place of origin except to conform with the idea that penguins have always been southern and to show that they were very widespread in the southern Temperate Zone by the end of the Oligocene.

De Meillon further argues that penguins probably arose as non-flying land birds because land birds are most likely to come in contact with rodents and flying birds would avoid the rodents by taking to the trees or to islands. But penguins do regularly come ashore on rodent-infested coasts, and probably have long done so. (The Patagonian fossil occurrences, at least, are near or at what was then a continental shore.) So do flying sea birds that could have transmitted fleas to penguins. Moreover, ground-nesting flying birds are very common in South America and elsewhere where rodents, and their fleas, are abundant.

De Meillon further cites in the same connection the tick *Ornithodoros talaje*, which occurs on South American rodents and, as a distinct subspecies, in South African penguin nests. But the same species is also known on terns, and the other known penguin ticks have almost certainly been acquired from flying sea birds (Zumt, 1952). Moreover, however it occurred, the transfer of *O. talaje* from rodents to penguins probably took place relatively recently, millions of years after penguins first arose. Otherwise it is incredible that the ticks have moved to a new host and a new continent with only subspecific differentiation.

The evidence from parasites seems to me to have no special bearing one way or another on the origin of the penguins, and the theory earlier supported, although speculative, still seems most likely on other grounds.

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A NEW KOALA FROM THE PLIOCENE PALANKARINNA FAUNA OF SOUTH AUSTRALIA

By R. A. STIRTON, MUSEUM OF PALEONTOLOGY. UNIVERSITY OF
CALIFORNIA

Fig. 1-2

SUMMARY

A new genus and species of koala, *Perikoala palankarinnica* Stirton, is described on part of a left mandible from the Palankarinna fauna east of Lake Eyre in South Australia. The age of the fauna is thought to be early or, possibly, middle Pliocene. Detail features in the teeth have been emphasized. Other than in the koala, *Phascolarctos*, there are suggestions of affinities in the fossil with the bushtail possum, *Trichosurus*, with the giant gliders, *Schoinobates*, and with the ringtailed possums, *Pseudocheirus*. Comparative figures of P_3 , M_1 , and M_2 in these genera, including the fossil, have been made. Much more fossil evidence is needed to determine the phyletic relationships of the genera studied, and to understand the familial relationships of the koalas to the rather broad family Phalangeridae.

INTRODUCTION

Part of a mandible of a koalalike marsupial was discovered by Mr. Paul F. Lawson in the summer of 1954, when the South Australian members of the 1954 South Australian Museum-University of California expedition were returning from Birdsville to Adelaide. The specimen was found in place about 500 yards south of the Woodard locality where the bulk of the material was located in the escarpment along the west side of Lake Palankarinna. Fragmentary remains of other small vertebrates were found scattered through the matrix at this new site. This is the oldest known record of the Phascolarctinae and is the only one that has been recovered from the Tertiary. The paratype was picked up on the surface by Mr. Richard H. Tedford near this locality in 1953 (Stirton, 1955).

I am grateful to Mr. Herbert M. Hale, Director of the South Australian Museum, for the privilege of describing this interesting new genus. The illustrations were made by Mr. Owen J. Poe, staff artist, in the Museum of Paleontology at the University of California.

Genus *Perikoala* nov.

The characters of this genus are those of the type species until other species are described.

Perikoala palankarinnica sp. nov.

Holotype.—Part of left mandible with talonid of P_3 , M_1 and M_2 nearly complete. South Australian Mus. No. P 10893.

Paratype.—Fragment of right maxillary with posterior border of alveolus of P^3 , the roots of M^1 , M^2 in place but with much of the enamel surface and the inner edge broken away, part of the alveolus of M^3 and the base of the jugal arch. Univ. Calif. Mus. Paleo. No. 45343.

Type Locality.—Greenish-blue, fine grained, sandy gypsiferous clays; flood plain deposit on same level as channel sands of Woodard locality, but about 500 yards farther south; 35 feet above the basal conglomerate. U. C. locality V5375.

“The exposures are along the west side of Lake Palankarina, east of Lake Eyre; 18 miles S. 75° W. of Etadunna Station homestead. Military grid reference 656431, ordinance sheet Marree, South Australia, H54/1.2.5.6, zones 5 and 6, first edition 1942, scale 1:506880.” (Stirton, 1955).

Age.—Early or, possibly, middle Pliocene.

Diagnosis.—Lateral opening of dental canal not discernible on horizontal ramus below M_2 .

P_3 with lophid between hypoconid (1) and protoconid interrupted by tiny groove on slope of protoconid; protoconid and small entoconid connected by short high lophid, this continues downward and labial in wide curve to posterior base of hypoconid enclosing posterior talonid basin which opens posterolabially at that point; outline of talonid rounded, not triangular, without crest continuing from entoconid to posterolabial corner.

M_1 sharply angulate anteromedially; with prominent central basin; paraconid present, separated from much larger metaconid by rather deep lingual valley; metaconid without posterior spur into area of central basin; low irregular transverse crest extends lingually from hypoconid to midline of crown opposite similar crest descending from entoconid.

M_2 divided into anterior trigonid, central, and posterior trigonid basins; vestigial transverse crest between protoconid and metaconid more

(1) The premolar dental terminology is based on apparent analogous positions with those in the molar.

pronounced than one between hypoconid and entoconid; labial part of middle valley not deep transversely nor shelflike.

Anteorbital fossa of maxillary shallow; width of base of jugal arch opposite $M^2 = 6.7$; M^3 as wide as long (in paratype).

Description.—Horizontal ramus below M_2 deeper than in *Trichosurus* but shallower than in *Phascolarctos*, 16.5; thickness below $M_2 = 7.4$; small mental foramen 3.5 in front of anterior root P_3 , and below diastemal crest, 1.3 in diameter; surface of bone broken over anterior part of dental canal; lateral opening of dental canal not discernible on horizontal ramus below M_2 .

Molars with crenulated enamel surface in occlusal basins; no alveolus for P_2 .

Anteroposterior axis of P_3 in line with that of molars; anterior two-thirds of P_3 broken away; evidently bilobed; area back of protoconid preserved; protoconid not occupying anterocentral position; larger than hypoconid; lophid between hypoconid and protoconid interrupted by tiny groove on slope of protoconid; protoconid and small entoconid connected by short high lophid, this continues downward and labial in wide curve to posterior base of hypoconid enclosing posterior talonid basin that opens posterolabially at that point; outline of talonid rounded; not triangular, without crest continuing from entoconid to posterolingual corner; roots of P_3 larger than on molars, widely divergent.

M_1 partly destroyed on labial side; elongate, sharply angulate anteromedially; paraconid slightly lingual of median position, evidently separated from much larger metaconid by rather deep valley; metaconid with convex lingual surface; lophid extends posterolingually from metaconid to a much lower metastylid⁽²⁾ on lower median lingual edge of tooth; metaconid without posterior spur into area of central basin; slight crest leads down posteriorly (evidently from protoconid) to median valley where it terminates at transverse commissure adjacent to anterior wing of hypoconid, these wings or crests form labial margin of central basin; entoconid opposite hypoconid; low irregular (due to crenulated anterior and posterior slopes) crest extends lingually from hypoconid to midline of crown opposite similar crest descending from entoconid, this apparent vestigial transverse lophid separates posterior talonid basin from larger central basin; low crest runs from hypoconid posterolingually around to base of

(2) The median lingual stylid present in the molars of *Perikoala*, *Phascolarctos*, *Pseudoscheirus* and *Schoinodontes* is somewhat analogous in position to the *metastylid* in the Equidae (Osborn and Wortman 1892, Fig. 3). *Metastylid* in the Equidae is a misnomer since it did not arise from the cingulum nor is it a peripheral cusp. It seems to have arisen from the posterior half of the metaconid but is innervated from the posterior nerve plexus. On the other hand the median lingual stylid in *Perikoala* seems to be peripheral and indeed may have arisen from a cingulum in an ancestral form. I am sure no confusion can arise in referring to this cusp in the koala and related genera as the *metastylid*.

entoconid (³); no hypoconulid; low posterior *entostylid* posterolingual of entoconid on lingual surface; length of $M_1 = 6.4$; width across talonid = approximately 3.8 (part of labial surface of hypoconid broken away); roots parallel, more delicate than on P_3 , length = 9.5. M_2 nearly rectangular; transverse crests extend from protoconid and metaconid and separate anterior trigonid basin from anterior part of central basin; similar but much less apparent elevations extend from hypoconid and entoconid and divide talonid into shallow posterior talonid basin and posterior part of central basin; no paraconid; enamel surface broken away opposite both protoconid and metaconid; *metastylid* broken away; protoconid opposite metaconid; entoconid slightly anterior to hypoconid, sub-equal, crescentic cusps oriented anteroposteriorly, depth controlled by extensions and positions of anterolingual spur of hypoconid and posterolingual spur of protoconid (this character is intermediate between the features seen in *Trichosurus* and *Phascolarctos*); no anterolabial crest from hypoconid extending down to block mouth of median valley; labial part of median valley not deep transversely nor shelflike; large crenulated central basin; no hypoconulid; *entostylid* as on M_1 well developed on lingual surface below and posterolingual of entoconid; length of $M_2 = 11.5$; width across trigonid = 4.3; width across talonid = 4.6; width between hypoconid and entoconid = 2.6; roots as on M_1 , length = 8.5.

COMPARATIVE CHARACTERS ON RELATED GENERA

Phascolarctos

1. Mental foramen 2.0 in front of anterior root of P_1 , and 2.9 below diastemal crest, 1.7 mm. in diameter.
2. Prominent lateral opening of dental canal below M_2 .
3. Small masseteric foramen.
4. Cheekteeth with crenulated enamel surface in occlusal basins.
5. P_1 and P_2 absent.
6. P_3 with slight emargination on lingual and labial sides dividing tooth into anterior and posterior moieties; entoconid equal in size and opposite hypoconid, both connected to larger protoconid by lophids; median crest extends anteriorly from protoconid; connected to smaller

(³) Osborn and Wortman (1892, p. 89, Fig. 3) first described *entostylid* as a little reinforcing cusp that grew up behind the entoconid. This was labelled on a *Myxocynipus* tooth. A month later in another paper ("The history and homologies of the human molar cusps," *Anatomisches Anzeiger*, Jahrg. VII., No. 10, pp. 740-747.) Osborn referred to the same cuspid as "the distal or intermediate cusp" as "hypoconulid" and labeled it on a lower molar of *Homo*; furthermore he inferred its presence in *Maris* and *Anoplogomphus*. At first, evidently, Osborn did not recognize the homology of this cuspid in the Primates and in the Equidae but in 1918 he labelled the posterior cuspid on all equid lower molars and premolars as hypoconulid. Consequently, here, I am referring to the term *entostylid* to the "little reinforcing cusp that appears behind the entoconid."

protoconid by anteroposterior crest; lophid continues from entoconid to posterolingual corner; low concave posterior lophid forming posterior edge of talonid basin; slight posterolingual shelf; no paraconid; roots not widely divergent; position aligned with anteroposterior axis of molar series.

7. M_1 , nearly rectangular, not sharply angulate anteromedially; paraconid vestigial and not separated from metaconid by deep lingual valley; paralophid (⁴) curves around anterior border of tooth to vestigial paraconid; paraconid connected posteriorly to metaconid; protoconid smaller than metaconid; metaconid with nearly flat lingual surface; lophid extends posterolingually from metaconid to vestigial metastylid on median lingual edge of tooth; metaconid with posteromedian spur; protoconid with posterior spur terminating in median valley (homologous with part of labial border of central basin in *Perikoala*); low trenchant ridge connects protoconid with entoconid labially; trigonid and talonid basins instead of central basin; very low but distinct metalophid crosses middle of crenulated basin diagonally where it joins lophid that connects metaconid and metastylid; entoconid opposite hypoconid; no crest extends lingually from hypoconid into talonid valley towards entoconid; talonid valley anteroposterior in direction; low crest runs from hypoconid posterolingually around to entoconid; but no posterior talonid basin is formed; entostylid present; length of $M_1 = 8.0$; width across talonid = 5.0.
8. M_2-M_4 rectangular; trigonid and talonid basins widely open anteroposteriorly; no paraconids; protoconids opposite metaconids; hypoconids opposite entoconids, subequal, crescentic cusps oriented anteroposteriorly; labial shelflike median valleys deep, terminated lingually by anterolingual spurs of hypoconids (metalophids) and posterolingual wings of protoconids (protolophids), points of termination close to midlines of teeth; no indications of transverse crests directly connecting protoconids with metaconids or hypoconids with entoconids; small anterolabial crests of hypoconids that extend down to block mouths of median valleys become progressively stronger from M_1-M_4 . Metastylids and entostylids though somewhat inconspicuous become progressively weaker from M_2-M_4 .

Pseudocheirus

1. No mental foramen anterior to P_3 .
2. One small lateral opening of dental canal below M_1 .
3. Tiny masseteric foramen posterior to opening of opening of posterior dental canal.

(⁴) For lophid terminology see Stirton, 1941, p. 451, Fig. 4

4. Cheekteeth with smooth enamel surface.
5. P_1 and P_2 present; P_3 smaller than P_1 .
6. P_3 without lingual and labial emarginations, narrowly triangular; protoconid anterior to and higher than oblique hypoconid crest; hypoconid crest separated from entoconid by commissure; entoconid slightly lingual of hypoconid, in proximity of, but not connected to protoconid by crest; valley between protoconid and entoconid open across tooth; valley between paraconid and protoconid distinct; roots not widely divergent; position aligned with anteroposterior axis of molar series.
7. M_1 sharply angulate and narrower anteromedially; faint indication of paraconid; lingual surface between metaconid and anterior tip depressed as vestigial valley; paralophid descends from protoconid to anterolabial base of tooth; narrow trigonid valley opens anteriorly slightly labial of midline; protoconid much smaller than metaconid, rather flat shaped cusp; metaconid with flat lingual surface; lophid extends posteriorly from metaconid to vestigial metastylid on median lingual edge of tooth; protoconid with short posterior crest that extends down to edge of labial mouth of long narrow diagonal median valley; prominent metalophid runs diagonally across center of tooth and connects to vestigial metastylid; no central basin; anteroposterior trigonid trench instead of basin; talonid basin; entoconid anterior to hypoconid, not connected; no crest extends lingually from hypoconid into talonid basin toward entoconid; talonid lophids diagonal in direction; sharp diagonal hypolophid extends across to posterolingual corner of tooth to low but distinct hypoconulid; no entostylid; length of $M_1 = 4.1$; width across talonid = 2.2.
8. $M_2 - M_4$ narrow, elongate, angulate anteriorly; trigonid and talonid basins narrow, bounded posteriorly by protolophids and hypolophids with lingual openings between metaconids and metastylids and between entoconids and hypoconulids; on M_1 and M_2 , on M_3 and M_4 posterior openings of talonid basins between entoconids and hypoconulids because entostylids are missing; no paraconids; metaconids anterior to protoconids; entoconids anterior to hypoconids, metaconids and entoconids larger than protoconids and hypoconids, protoconids and hypoconids crescentic, metaconids and entoconids trenchant, all four cusps oriented obliquely; both labial and lingual median valleys short, directed anteriorly; no indications of transverse crests connecting protoconids and metaconids, or hypoconids and entoconids; no small crests leading directly anterior from hypoconids.

Schoinobates

1. No mental foramen anterior to P_3 .

2. Two and sometimes three lateral openings of dental canal may occur below P_3 , M_1 or anterior end of M_2 .
3. Small masseteric foramen present.
4. Cheekteeth with smooth enamel surface.
5. P_1 seldom present, greatly reduced; P_2 absent.
6. P_3 larger and with more complicated patterns than in *Pseudocheirus*, faint lingual and labial emarginations, narrow, nearly rectangular; protoconid anterior to and higher than obliquely curved hypoconid crest; hypoconid faintly discernible on crest; hypoconid crest connected to indistinct entoconid; entoconid connected to larger protoconid by curved crest; but posterolingual crest present; posterolingual sloping talonid basin with low ridge at its posterior margin; valley between protoconid and entoconid closed by high sharp crest lingually; distinct valley between paraconid and protoconid closed by crest lingually, position aligned with anteroposterior axis of molar tooth row.
7. M_1 not as sharply angulate and narrow anteromedially as in *Pseudocheirus*; paraconid small but distinct, connected posteriorly to metaconid by sharp lophid; lingual surface between paraconid and metaconid marked by distinct valley; paralophid descends from protoconid to anterolabial base of tooth; trigonid basin wider than in *Pseudocheirus* opens anteriorly slightly labial of midline; protoconid much smaller than metaconid, slightly less flattened than in *Pseudocheirus*; lophid extends posterolingually from metaconid to median lingual edge of tooth; faint metastylid; metaconid with posterolabial spur; protoconid without posterior crest extending down to edge of labial mouth of diagonal median valley; slight shelflike process at mouth of median valley; prominent metalophid runs diagonally across tooth and connects to spur back of metaconid to a small metastylid; no central basin; entoconid anterior to hypoconid not connected by lophid; no crest extends lingually from hypoconid into talonid valley toward entoconid; talonid basin diagonal in direction; hypolophid interrupted where talonid basin opens posteriorly; no hypoconulid; tiny entostylid posterolingually from entoconid; small conulid posterolabially and at base of entoconid in talonid basin, also present on M_2 but not on M_3 and M_4 ; length of $M_1 = 4.2$; width across talonid — 2.5.
8. M_2 -4 narrow, elongate, broadly angulate anteriorly; trigonid and talonid basins relatively narrow but wider than in *Pseudocheirus*; protolophids not continuous through to metastylids, and hypolophids not continuous to posterior lingual corners of teeth; no paraconids; metaconids anterior to protoconids, entoconids anterior to hypoconids, metaconids and entoconids larger than protoconids and hypoconids, protoconids and hypoconids crescentic, metaconids and entoconids trenchant, all

four cusps oriented obliquely; both lingual and labial median valleys short, directed anteriorly; no indications of transverse crests connecting protoconids and metaconids, or hypoconids and entoconids; no small crests leading directly anterior from hypoconids; stylids vestigial or absent and no hypoconulids on M_2 , M_3 and M_4 .

Trichosurus

1. Mental foramen 1.5 in front of anterior root of P_2 and 2.1 below diastemal crest.
2. Tiny lateral opening of dental canal present or absent below posterior end of M_1 .
3. No masseteric foramen.
4. Cheekteeth with smooth enamel surface.
5. P_1 present, P_2 absent.
6. P_3 without lingual and labial emargination, broadly triangular talonid with single median crest; no paraconid; roots not widely divergent; position oblique to anteroposterior axis of molars.
7. M_1 sharply angulate anteriorly; no paraconid; paralophid extends from protoconid straight forward to anterior tip; protoconid in antero-medial position, larger than metaconid; metaconid with convex lingual surface; no posteromedian spur from metaconid and no metastylid; protoconid with prominent lophid running posteriorly into center of tooth where it joins another coming forward from hypoconid blocking transverse central valley; area of central basin open as wide as lingual valley; entoconid opposite hypoconid, connected by transverse lophid; low crest runs from hypoconid posterolingually around to entoconid, forming shallow posterior talonid basin toward lingual side of talonid, no suggestion of hypoconulid on crest below and behind entoconid; length of $M_1 = 6.8$; width across talonid = 4.5.
8. M_2 with talonid slightly wider than trigonid, M_3 — M_4 with trigonids wider than talonids; trigonids and talonids traversed by high lophids between protoconids and metaconids, and hypoconids and entoconids; no trigonid, talonid nor central basins; no paraconids; protoconids and hypoconids opposite, crescentic cusps; metaconids and entoconids opposite, semi-crescentic, oriented anteroposteriorly, subequal; labial median valleys not shelflike, terminated lingually at a point labial to midline of tooth; no ridge leading directly forward from hypoconids down into median valleys; no lingual stylids.

CONCLUSION

Even with the limited evidence available *Perikoala palankarinnica* n. gen. and n. sp. is phascolarctine though the characters show it is

generically distinct from the living koala. If it is directly ancestral to *Phascolarctos* or even in a proximity to that position, considerable evolution has occurred in the group since late Miocene and early Pliocene time.

The patterns in the molars may indicate a distant relationship to a bilophodont marsupial. The koala patterns could have been derived from primitive bilophodont teeth somewhat like that possessed by the ancestors of *Trichosurus*. It is indeed unfortunate that no teeth were found with *Wynyardia* which otherwise shows trichosurine affinities.

Without some fossil evidence it is difficult to even guess where *Pseudocheirus* and *Schoinobates* fit into this phyletic picture. They are as specialized as *Phascolarctos* in their cheekteeth and in a somewhat different direction. Much more evidence is needed from fossils to determine the phyletic relationships of these genera, and to understand the familial relationships of the koalas to the rather broad family Phalangeridae.

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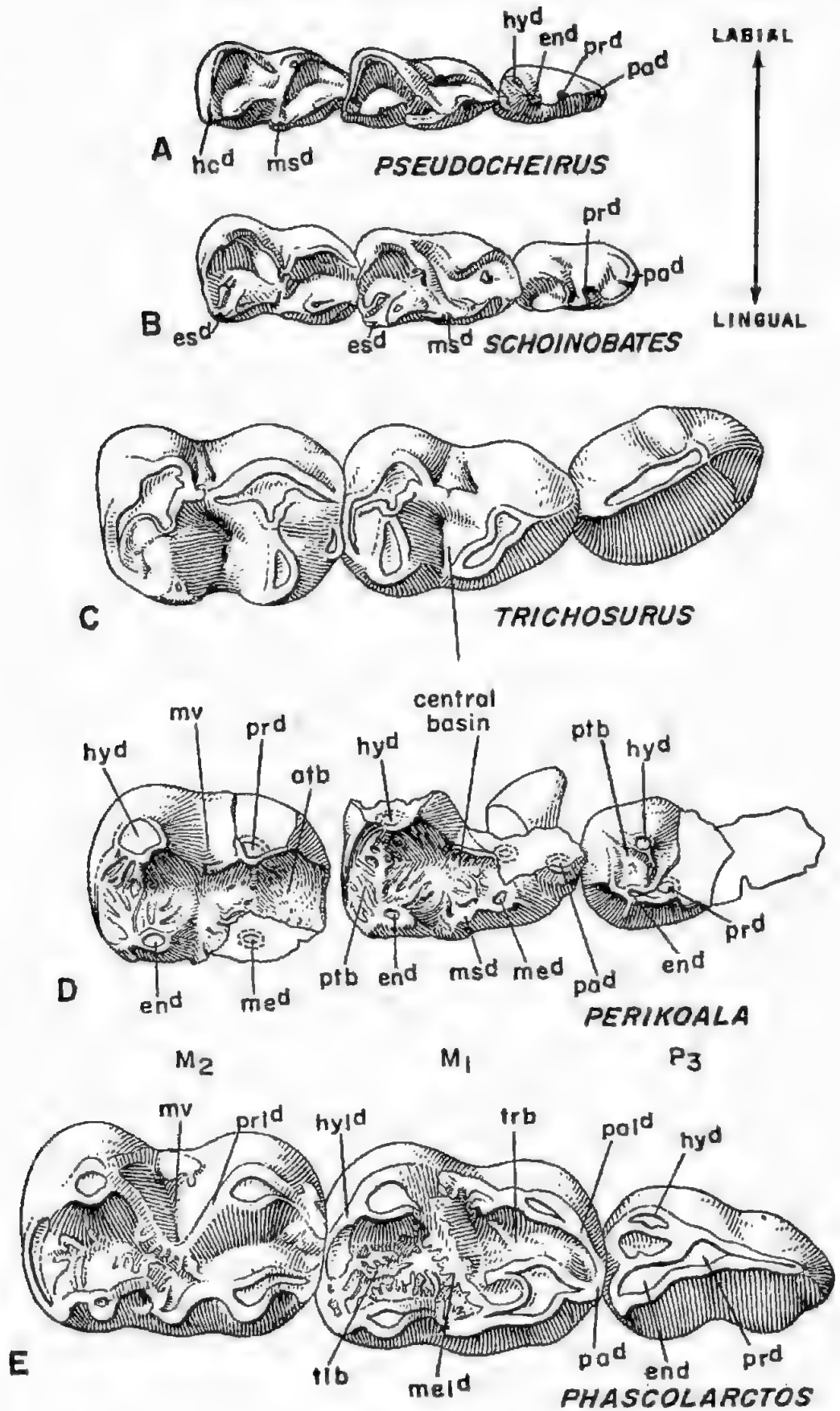


Fig. 1. Comparative occlusal views of left P, M, and M₂ in *Pseudocheirus laniginosus*, *Schoinobates volans*, *Trichosurus vulpecula*, *Perikoala pulankarinaica*, gen. et sp. nov. and *Phascolarctos cinereus* (X5). The anterior face of the trigonid is well worn in *Schoinobates*. *atb*, anterior trigonid basin; *en^d*, entoconid; *es^d*, entostylid; *hc^d*, hypoconulid; *hyd^d*, hypolophid; *hy^d*, hypoconid; *me^d*, metaconid; *mel^d*, metallophid; *ms^d*, metastylid; *mv*, median valley; *pa^d*, paraconid; *pal^d*, paralophid; *prd^d*, protoconid; *prl^d*, protolophid; *ptd*, posterior talonid basin; *tib*, talonid basin; *trb*, trigonid basin.

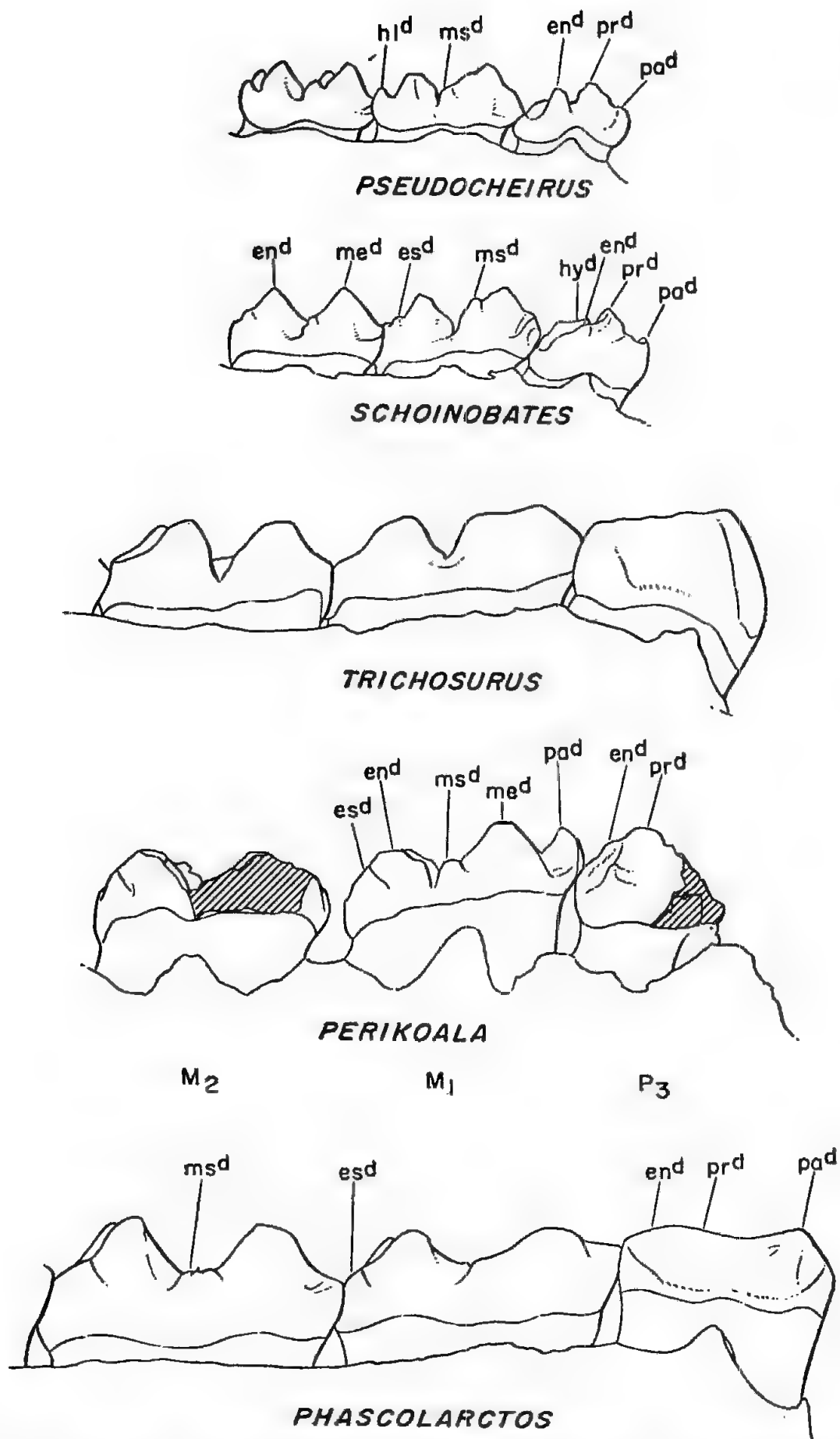


Fig. 2. Comparative lingual views of left P₃, M₁, and M₂ in *Pseudocheirus*, *Schoinobates*, *Trichosurus*, *Perikoala* n. gen., and *Phascolarctos* (X5).



KNEE MOULDED POTS FROM THE NEW HEBRIDES

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Plate i and text fig. 1

When engaged on geological investigations in the New Hebrides Islands in the year 1903, among other places I visited was Wuss on the west coast of Espiritu Santo, the largest island of the Group. The west coast is high and mountainous: in fact within a few miles of Wuss are located the highest peaks of the Island. It is a young coastline, determined by faulting and downthrow to the west of folded and faulted Tertiary and possibly late Mesozoic sediments, greatly intruded by andesite and basic igneous rocks.

Only at Wuss along the coast is there a comparatively large flat alluviated area. This is a few square miles in diameter, the result of copious outwash by streams from the mountainous hinterland. The sea front is a low beach line. A large native community exists there. The alluviated area which supports a considerable population at Wuss is set in a length of steep coast lacking protected harbours. Consequently the coast both to the north and to the south is unfavourable for the establishment of other native villages. The Wuss folk are therefore more isolated than is usual with other communities of the New Hebrides. This no doubt accounts in some measure for obvious differences which we noted in their way of life when compared with that of natives elsewhere in the New Hebrides. For instance we were struck with the extent of irrigation channels associated with the growing of taro, yams, sugar cane, etc. Also the people of Wuss were found to be remarkable for having developed on a notable scale an earthenware pottery industry. This latter may, however, be in large measure due to the fact that in that region there are available suitable clays derived from the older sediments and decomposed igneous rocks exposed in that locality. Elsewhere in the New Hebrides, in the coastal regions at least, coral, coral sands and volcanic sands are dominant while clay formations are scarce or absent.

The novelty of the pottery industry at Wuss was of so much interest that observations on the process of manufacture were recorded as outlined below. All operations were performed by women.

The raw material employed is a yellow clay. It was broken down to very small pieces, laid on a sheet of bark and sprinkled with water.

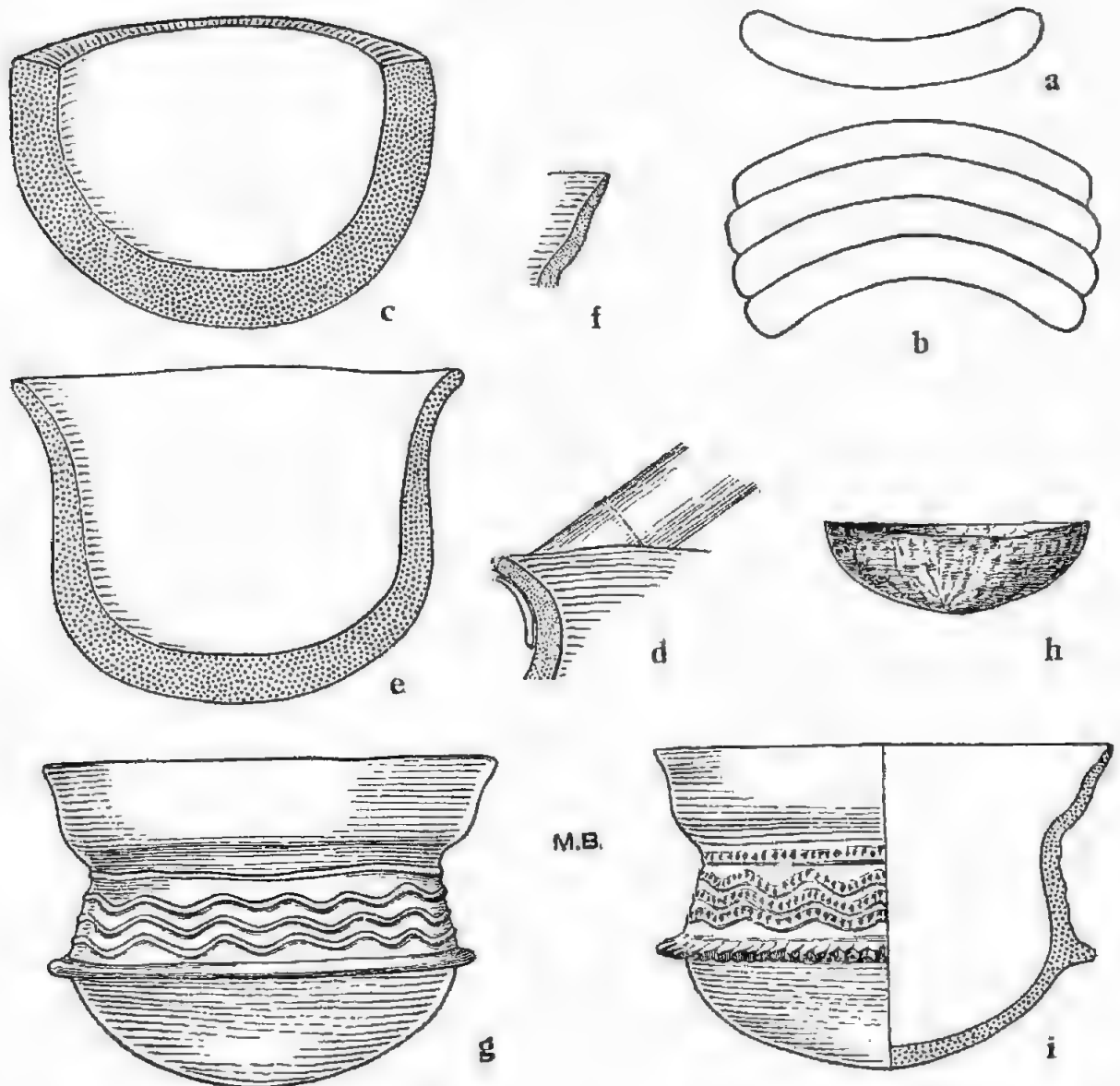


Fig. 1. Pottery making in Wuse Village: a, dished piece of kneaded clay; b, stack of dished pieces; c, raw pot as moulded on flexed knee; d, bamboo scraper being applied to lip of pot; e, section of pot after trimming of edge, but before scraping to proper thickness; f, section of lip after development of final form; g, pot after application of decorative rolls of clay; h, coconut shell scraper employed within the pot to reduce the wall to any desired thickness; i, finished pot.

Then followed a thorough kneading to a uniform doughlike consistency. When sufficiently mixed it was worked up into a ball-shaped mass.

Two other women then took a hand. Taking pieces of clay from the ball they worked on them with wet fingers, kneading them together to make smaller clay balls, each of which was then pressed out into shallow saucer-shaped forms (Fig. 1a). After making about six such dished pieces they were stacked on top of each other (Fig. 1b) and finally the pack was thoroughly kneaded and rolled up again to form a large ball.

From this stage on, the operation was performed by one person only. Kneeling on one knee and with the other sharply bent and wetted, the woman pressed the ball of plastic clay down onto the rounded end of the bent knee, while at the same time continuously rotating and patting it. In this way, in about three minutes the clay was moulded to a deeply concave form (Fig. 1c).

Then with a wetted piece of bamboo wood, its cutting end shaped as shown in Fig. 1d, she scraped and worked over the upper rim portion of the crude bowl, making it smooth, while at the same time thinning out the clay wall and tapering it off. In this operation one hand was held on the inside while the other manipulated the wooden tool. The uneven top edge was then pinched off and made smooth by running the wetted fingers over the surface (Fig. 1e).

The wooden tool was again employed to increase the curvature inside the mouth of the bowl. In this way a double curved lip was developed. Again with wetted fingers working around the lip it was smoothed and given its final form (Fig. 1f). The bamboo wood tool was also employed to even up the curvature of the exterior of the bowl, and use of this tool was again followed by the smoothing operation with wetted fingers.

Exterior ornamentation was then applied, effected as follows. Some of the well-worked clay was rolled between the hands to make elongated pencil-like sticks. These were worked in rib fashion on to the exterior of the bowl as shown (Fig. 1g) and the final impressed markings were done with a stick.

We did not personally observe the manufacturing process beyond this stage but were informed that the next step followed after a period of about five days. In that time the shaped clay bowl had partly dried and stiffened. Then operating on the interior of the vessel the overthick wall was reduced to the desired thickness, employing as a tool a segment of a coconut shell, usually smaller than that figured (Fig. 1h) and with sharpened edge.

Should cracks have developed in the clay walls of the pot during drying, repair is effected by cutting out the crack with a sharp-edged piece of bamboo wood followed by filling up the resulting groove with freshly prepared plastic pieces of damp worked clay.

A colour wash was then applied. This was a thin suspension of red ochreous clay in which the pot was dipped. After air drying for a few days inside one of the village houses the pots were ready to be fired. In this operation a number of the air-dried pots were assembled together and fire heaped around them. Fig. 1i gives an indication of the final form and the plate shows two examples collected in Wuss village.

The above account is of first hand observation made in 1903. The literature on the native pottery of the New Hebrides is mainly of this century and is scattered. Reference may be made to descriptions by MacLachlan (1939) who also quotes earlier sources.

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ABORIGINAL BARK PAINTINGS FROM FIELD ISLAND, NORTHERN TERRITORY

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Plate ii and text fig. 1

An examination of the early records suggests that, wherever the aborigines used sheets of bark to construct their wet-weather shelters, they decorated them with designs in coloured ochres.

Peron, (1807-16, pl. 18), in a sketch of a burial place on Maria Island, Tasmania, shows sheets of bark with painted designs; Bunce, (1857, pp. 49-50), refers to paintings on bark huts in central Tasmania; Smyth, (1878, p. 292), mentions their use on the Wonnangatta River, Gippsland, and Curr, (1886, p. 273), on the Parroo River of central New South Wales:

Worsnop, (1897, p. 37, pl. 18), illustrates two tracings made from a series of five bark paintings collected by Captain F. Carrington on Field Island, Northern Territory, in 1884, (Carrington, 1890, p. 73), (fig. 1).



Captain Carrington presented these paintings to the Royal Geographical Society of South Australia in 1887. They found their way later into the ethnological collection of the South Australian Museum, where they are still housed.

The Field Island series of bark paintings is of particular interest as they form a comparison with the art of Oenpelli, Western Arnhem Land, where Spencer, (1928, pls. 519-534), and Mountford, (1956, pp. 109-264, pl. 34-84, figs. 12-56), have recorded many bark and cave paintings. The paintings are also the only records of the art of the extinct Field Islanders.

Although the designs on the Field Island paintings have deteriorated during the past seventy years, it is still possible to clearly distinguish all but one of the original figures. To ensure a permanent record of this interesting group, I photographed them. Using the faint designs on the bark sheets as a guide, Miss Patricia Catcheside then retouched the prints illustrated on pl. ii.

On the upper edge of pl. ii_A is a conventionalised painting of a pied goose in flight. Below the goose are two beche-de-mer, and below them again a cat-fish. ⁽¹⁾ On the lower left is an excellent representation of a skip-jack.

Plate ii_B illustrates a decorative painting of an unidentified water-bird in flight. As far as I know this, and the pied goose on Plate ii_A, are the only examples of aboriginal art depicting flying birds in so realistic a manner.

On pl. ii_C is a further group of interesting figures. On the extreme left is an X-ray painting of a sweep; on the right is a pied goose which bears some resemblance to a bark painting recorded by Spencer, (1928, fig. 534), except that the Field Island example shows no trace of X-ray art. On the extreme right is an opossum, showing the prehensile tail, the whiskers and the two eyes on one side of the head ⁽²⁾.

In the middle of pl. ii_C is a woman with upturned legs, distorted arms and spines projecting from her face and vulva. This figure bears a close resemblance to cave paintings at Oenpelli of dangerous spirit-women called the *Nadubi*. Mountford, (1956, pl. 58B, page 203), records a myth and figures a cave painting of a *Nadubi* woman at Unbalanja Hill, Oenpelli. She, like the woman in the Field Island painting, has upturned legs, and spines projecting from her elbows, vulva and other parts of her body.

The aborigines believe that when a *Nadubi* spirit-woman sees an aboriginal travelling alone, she sneaks up behind him and shoots one of her spines into his body. Sometimes the medicine man is able to save the aboriginal's life by magically removing the spine, but more often the patient sickens and dies.

⁽¹⁾ Mountford, (1956, pl. 80B), figures an X-ray painting of a cat-fish, and on pl. 80B, one of a skip-jack.

⁽²⁾ This is not unusual in the art of the bark paintings. Spencer, (1928, fig. 535), figures a goose from Oenpelli, and Mountford, (1939, pl. XIV, fig. B), an echidna from Goulburn Island, in both of which the two eyes are shown on one side of the head.

There is an X-ray painting of a female sea-going turtle, (pl. iib), indicating lines of eggs and the alimentary canal, and on pl. iie are two sharks, the details of the one on the right having almost disappeared. In the upper left of the same sheet is an unidentified design, and on the upper right, an aboriginal holding an object in his hand.

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**THE GENUS MYRMIOTROMBIUM WOMERSLEY 1934 (ACARINA,
ERYTHRAEIDAE), WITH REMARKS ON THE SYSTEMATICS OF THE
ERYTHRAEOIDEA AND TROMBIDIOIDEA**

BY R. V. SOUTHCOTT, SOUTH AUSTRALIAN MUSEUM.

Text fig. 1-2

SUMMARY

The genus *Myrmicotrombium* Womersley 1934, with genotype (monotypic) *M. brevicristatum* Wom. 1934 is restudied, the holotype male being redescribed, as well as some details of the adult female and nymph. The mite, although having some features suggestive of the Smarididae, belongs to the Erythraeidae, and not to the Trombididae, in which it was placed by its author. The species is now recorded from Australian Capital Territory, as well as South Australia. On two occasions it has been captured in association with ants, but its relation to ants (if any) is at present conjectural.

A specimen from Burma is also referred to this genus.

The systematics of the Erythraeidae (Erythraeoidea) and of some of the Trombidioidea are referred to. Feider's (1955) subfamily Myrmicotrombiinae, erected within the Trombidioidea, cannot stand. The genus however merits a subfamily within the Erythraeidae, and hence the subfamily Myrmicotrombiinae n. sf. is erected within that family, and compared with the other subfamilies of the Erythraeidae, namely the Erythraeinae n. sf., Leptinae n. sf., Callidosominae n. sf. and Balaustiinae n. sf. (Balaustiidae Grandjean 1947), which are keyed.

INTRODUCTION

In 1934 Womersley described and figured as a new genus and species of mite *Myrmicotrombium brevicristatum*, placing it within the family Trombidiidae. This was described from "a single specimen collected with ants at Glen Osmond, South Australia, September 11, 1933", collected by himself. In 1937 Womersley, in revising the systematics of the Australian Trombidiidae, referred again to that genus and species, placing it within the subfamily Johnstonianinae Thor 1935. In 1947 Thor and Willman issued a monograph on the family Trombidiidae, and followed Womersley in the systematic placing of this mite, as have Baker and Wharton (1952). In a systematic account of the Trombidioidea (this term corresponding to the Trombidiidae of the previous authors mentioned)

Feider (1955) has erected a subfamily Myrmicotrombiinae to accommodate it, placing that subfamily in the family Stigmatrombidiidae⁽¹⁾ Feider 1955, *Seria Sagittotrombidiinae* Feider 1955, along with the subfamilies Tanaupodinae Thor 1935, Calothrombiinae Oudemans 1947 (in Thor and Willmann), Johnstonianinae Thor 1935 and Notothrombiinae Oudemans 1947 (in Thor and Willmann).

In extensive collecting of Acarina at Glen Osmond, South Australia, and surroundings, directed particularly towards the families Erythraeidae, Trombidiidae and Smarididae, from 1933 onward (see Southcott 1946b) the writer captured a species of mite corresponding to Womersley's description, on rare occasions. However this mite was found to belong to the Erythraeidae and not to the Trombidiidae. In life light pink plumose setation gives it a Trombidiid facies. Examination of the type specimen of *Myrmicotrombium brevicristatum* Wom. 1934 in the South Australian Museum collection, in 1945 showed that these specimens were of the same species. Mr. Womersley has agreed with the writer that the species should be placed in the Erythraeidae.

Redescription of *Myrmicotrombium brevicristatum* Wom. 1934

Fig. 1-2

Adult (Fig. 1 A-D; 2). Colour in life light pink.

The holotype (male) (mounted) with body ovoid, 950 μ long to tip of rostrum of chelicerae (mouth cone), 540 μ wide. Eyes present, one on each side, almost circular, 22-24 μ across, placed anteriorly on the propodosoma. In the midline, anteriorly on the dorsum, is a short crista, with two sensillary areas. The anterior sensillary area is placed shortly behind the eyes. It has a blunt indistinct "nasus", and is 30 μ long by 21 μ wide, and is provided with two very finely ciliated tapering sensillary setae, 30-32 μ long. Anterior sensillae bases 11 μ apart. In addition the anterior sensillary area carries 4 typical dorsal setae, 20-23 μ long. Posterior sensillary area pear-shaped, 24 μ long by 22 μ across, with two sensillary setae similar to the anterior, 42 μ long; sensillae bases 11 μ apart. Crista distinct, entirely behind the eyes (see Figs. 1A, 2). Distance between anterior and posterior sensillae bases (centres) 65 μ (intersensillary distance).

The dorsum of the body is provided with a bushy covering of heavily ciliated setae, of two distinct types and sizes. The larger setae are spatulate and heavily ciliated, 28-42 μ long and 11-15 μ wide where

(1) This family name proposed by Feider has no status as there is no genus with that Stigmatrombidi— on which it should be based. The same applies to the family Peritrematrombidiidae Feider 1955.

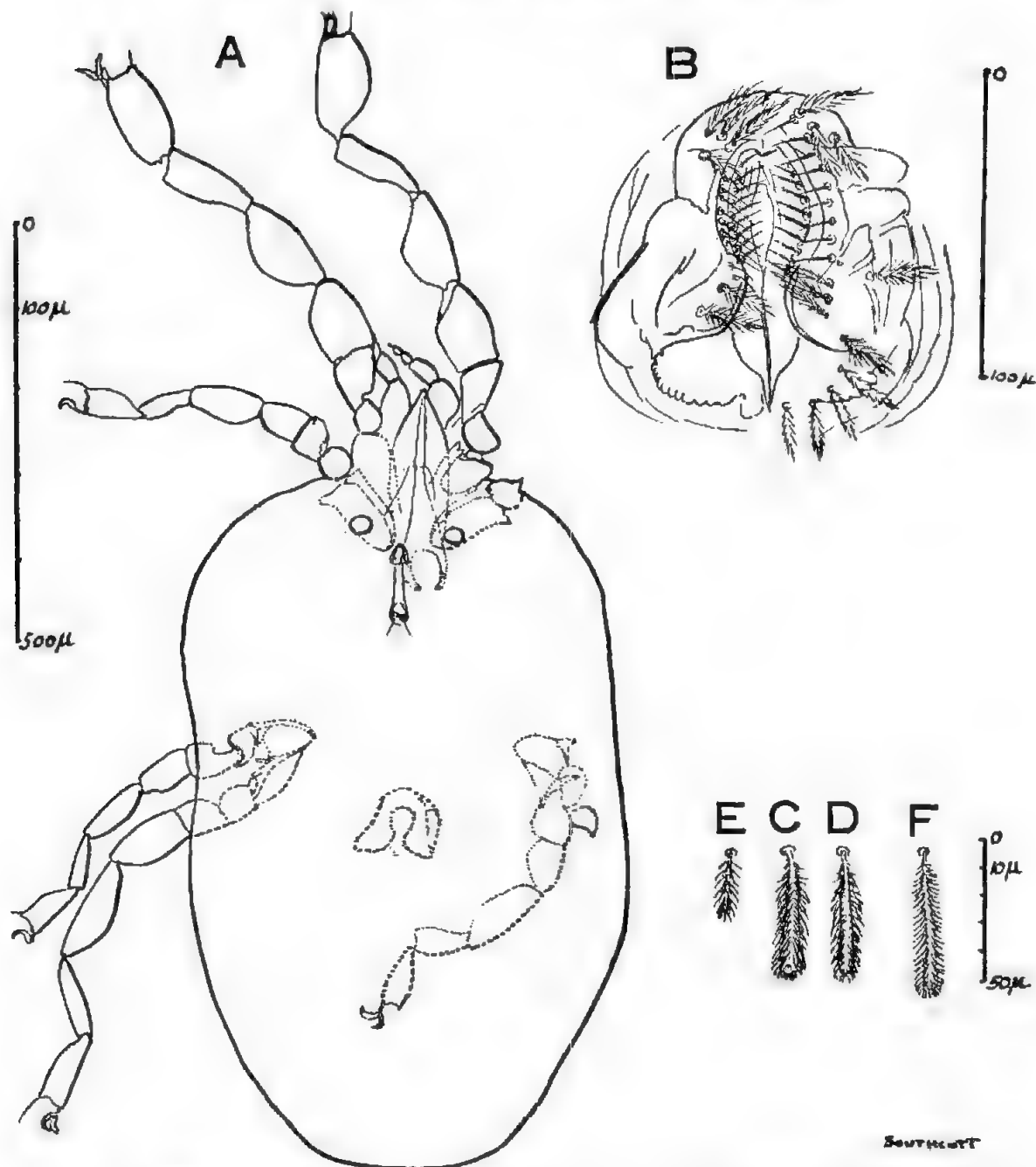


Fig. 1. *Myrmicotrombium brevicristatum* Womersley 1934; A-D adult male, holotype: A entire specimen, setae omitted (except supra-onychia papillae and setae). Legs II and III on the right hand side detached. Internal and ventral structures shown in stipple; B external genitalia and adjacent chitinous part of internal genitalia, male, showing labia majora and labia minora; C dorsal seta (spathulate type), from above; D same, below; E dorsal seta, shorter type; F nymph, dorsal seta, spatulate type (all setae to scale on right).

expanded. The ciliations are stiff, oblique and sharp-pointed, and change direction along the course of the seta, being more outstanding toward each end of the seta (Fig. 1 C). These setae show a slight inferior keel. The setae originate from a minute seta base, as is usual in the Erythraeidae; the seta base is 2.5μ wide. The smaller are more

numerous, and the larger spathulate setae are interspersed among them. The smaller setae are practically uniform in structure throughout their length, non-expanding, more slender, somewhat more flaccid, densely (and somewhat flaccidly) ciliated, setae 18-25 μ long (Fig. 1 E).

Venter with setae similar to the smaller dorsal setae, but these slightly larger and with more outstanding ciliations. The male genitalia are of typical Erythraeid type, with outer and inner lips as figured (Fig. 1 B) (*labia majora* and *labia minora*) respectively. There are no genital suckers.

Legs as figured. Leg I fairly stout, others somewhat more slender, however all the legs have a lumpy angular appearance, with the genua bellied (Fig. 1 A). Each tarsus carries above the claws, at its distal end, a projecting supra-onychial papilla and bristle, clearly tactile in function (two being present on each tarsus I). The tactile bristles curved and spiniform; on leg I 28 μ long, on II 30 μ , on III 28 μ , on IV 30 μ . Tarsus I 127 μ long by 64 μ high, II 70 μ x 36 μ , III 74 μ x 36 μ , IV 91 μ x 36 μ . Metatarsus (tibia) I 120 μ long, II 74 μ , III 77 μ , IV 107 μ . In their proximal parts the legs are provided with plumose setae similar to the body setae (Fig. 2); among these are short spiniform sensory setae usual for the Erythraeidae (some are shown in Fig. 2 on the (telo-) femur I and genu I. These sensory setae are more common on the more distal parts of the legs, and constitute terminally about 50% of the setae.

Chelicerae styliform, as figured, with the usual Erythraeid feature of the cheliceral stylets at the tip of the mouth cone. Posteriorly the gnathosomal endoskeleton ends within the body in the typical posterior cornua or "forceps" of the Erythraeidae (shown in Figs. 1 A, 2). There is no sign of any extrusile tube to the gnathosoma, as occurs in the Smarididae. The palpi are slender, with chaetotaxy as figured (Fig. 2). By the slender appearance the palpus suggests the Smarididae rather than the Erythraeidae. There are no specific features suggestive of the Trombidiidae.

The *adult female* is similar to the male, but the dorsal setae are longer, to 55 μ long with the larger type (spathulate) setae (allotype female from Morialta, South Australia, 9th October 1944, collected by H. Womersley, in the collection of the South Australian Museum); not figured.

Nymph (Fig. 1 F) (specimen from Black Mountain, Canberra, Australian Capital Territory, 19th October 1944, under stones, collected H. Womersley, in the collection of the South Australian Museum. Although

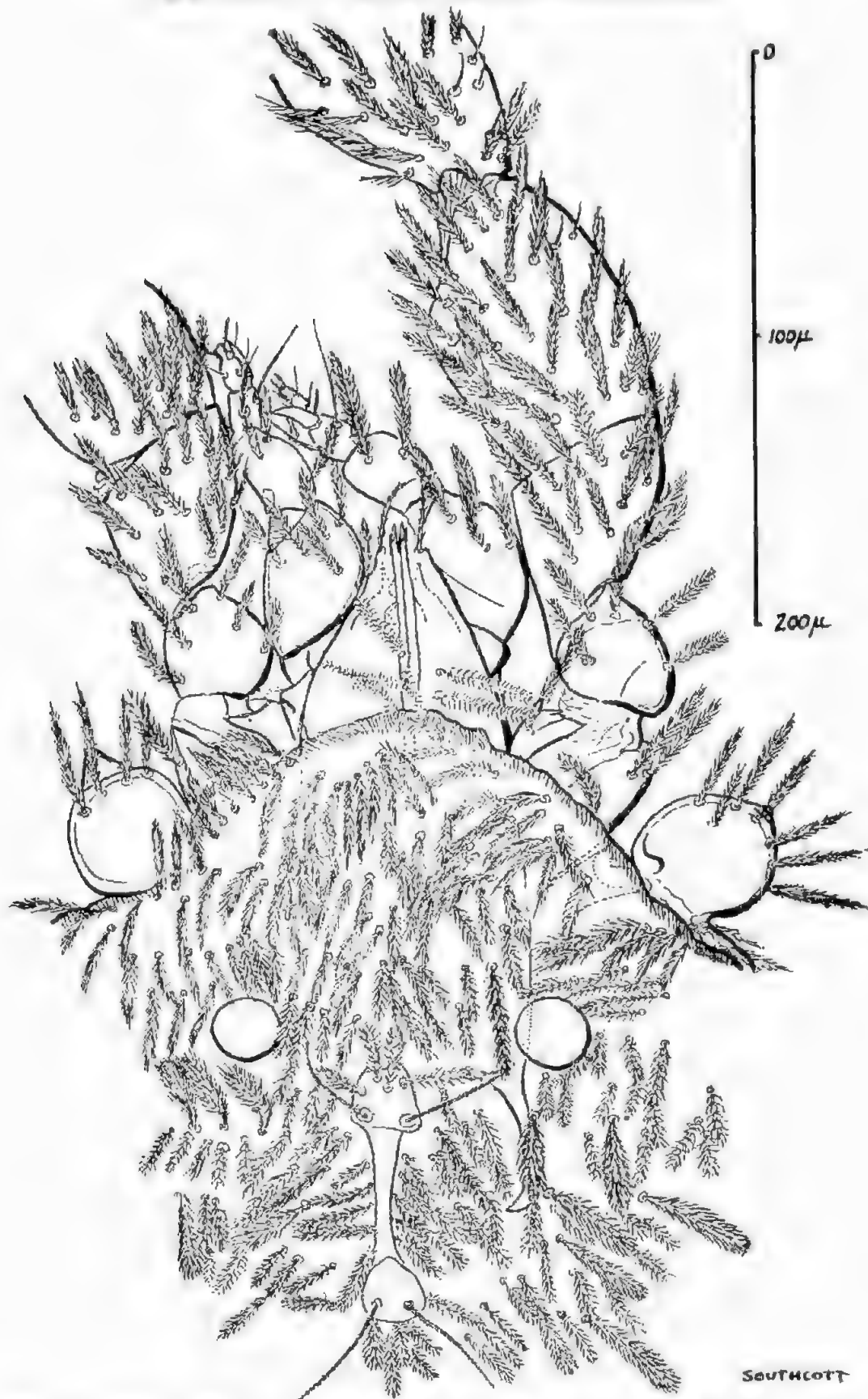


Fig. 3. *Myrmicotrombium brevicristatum* Womersley 1934; adult male, holotype, showing anterior part of dorsum of body, including crista and eyes, as well as the gnathosoma and palpi, and part of the anterior legs. To the right of the crista is shown the right posterior horn of the gnathosoma. (subcuticular).

rather damaged the following particulars may be given from the mounted specimen:)

Of the same general structure and setation as the adult, but the longer (spathulate) dorsal setae more slender, to 55μ long. The tarsi of the feet are proportionately higher than in the adult. Tarsus I 120μ long \times 70μ high, II 66μ \times 38μ , III 74μ \times 36μ , IV 85μ \times 34μ . Metatarsus I 135μ long, II 83μ , III 84μ , IV 108μ .

Localities. South Australia: Glen Osmond, 11 September 1933, with ants, male (holotype) (H. Womersley); Glen Osmond, in dead pine needles, March 1935, one specimen, male (R. V. S.); Glen Osmond, 7 May 1939, in soil at base of *Eucalyptus cladocalyx*, one specimen (R. V. S.); Brown Hill Creek, 19th June 1938, with ants, one specimen (J. S. Womersley); Morialta, 9th October 1944, one specimen, female, allotype (H. Womersley).

Australian Capital Territory: Black Mountain, Canberra, under stones, 19th October 1944, three specimens, including one nymph (H. Womersley).

Myrmicotrombium sp.

In the South Australian Museum collection is a slide of a specimen that can be referred to this genus, labelled "Nganyawa, 9 December 1946, in soil" (Burma: name of collector not given). No other information is recorded about it.

Unfortunately the specimen is in a very damaged condition, and is unsuitable for description. The spathulate dorsal setae are up to 38μ long, and the ciliations of these are possibly somewhat longer and stronger than in the *M. brevicristatum* specimens seen. Whether this is of any significance cannot be stated at present.

Biology of *Myrmicotrombium brevicristatum*.

On two occasions this species has been recorded in the company of ants (species of latter not stated). The original of these, as indicated above, is reflected in the generic name. Its life history is unknown. It has been observed only in superficial layers of soil or vegetable litter or under stones. Whether there is any association with ants, other than accidental, is not known.

The Affinities of the Genus *Myrmicotrombium*.

As is indicated in the description, from its styliform exsertile chelicerae, the genus belongs to the Erythraeidae and not to the Trombidiidae. Womersley was misled by its Trombidiid facies, and later writers had perforce to follow him, as none of them saw any specimens.

The genus is unique among the Erythraeidae in having the eyes placed entirely in front of the crista. In this character the genus resembles the genera *Smaris* Latreille 1796 (= *Sclerosmaris* Grandjean 1947) and *Fessonina* von Heyden 1826 (= *Æcosmaris* Grandjean 1947) of the Smarididae, but no previously described Erythraeidae. Another feature suggesting affinities with the Smarididae is the presence of the tactile bristle arising from a distinct papilla above the tarsal claws (supra-onychial papilla and seta). This is a highly developed feature in some of the Smarididae, e.g. the genera *Smaris* Latreille 1796 and in *Hirstiosoma* Womersley 1934 (= *Smaris* Grandjean 1947 non Latreille 1796) and to a lesser extent in *Fessonina* von Heyden 1826, where they are ciliated. Such setae are also present in some of the Erythraeidae.

Despite its affinities with the Smarididae, there is no trace of an extrusile collar by which the gnathosoma can be projected in front of the body, hence the genus belongs to the Erythraeidae.

Feider (1955) has erected a subfamily Myrmicotrombiinae in the family Trombidiidae (s.l.) monotypic for *Myrmicotrombium* Womersley 1934, which he grouped with the subfamilies Johnstonianinae and Notothrombidiinae, in his "Infraseria" Duplicitrombidiinae Feider 1955 (of his "Seria" Sagittotrombidiinae Feider 1955, family Stigmatrombidiidae Feider 1955). While it is not the purpose of the present article to deal with the systematics of the Trombidoidea, it is clear that the subfamily Myrmicotrombiinae Feider 1955, by definition cannot stand. It is however apparent that the characters of the genus *Myrmicotrombium* merit subfamily status within the Erythraeidae. The most important character is the placing of the eyes entirely in front of the crista, and on this character the writer proposes the subfamily Myrmicotrombiinae n. sf. (non Feider 1955). This subfamily possibly forms a connecting link between the Smarididae and the Erythraeidae⁽²⁾. It is not proposed to deal with the systematics of the Erythraeidae at any length in the present article (these will be considered in a separate paper), but it is thought desirable to indicate here the relations of the Myrmicotrombiinae to the other subfamilies of the Erythraeidae. These may be separated as in the following key to the adult forms:

1. Two eyes on each side Erythraeinae n. sf.
One eye on each side 2.
2. (1) Metatarsi (tibiae) of adults and nymphs with a pair of tubercles
at the distal end dorsally Callidosominae n. sf.
Metatarsi (tibiae) without tubercles 3.

⁽²⁾ These two families constitute the superfamily Erythraeoidea, a term introduced by Grandjean (1947a) to replace the "Suborders" Aphodostigmata Underwies 1909.

3. (2) Eyes entirely in front of the crista or cristal areas
Myrmicotrombiinae n. sf. non Feider 1955
 Eyes between levels of anterior and posterior sensillary areas of
 crista4.
4. (3) Eyes anterior to middle of crista.....Leptinae n. sf.
 Eyes behind middle of cristaBalaustiinae n. sf.

The subfamilies Erythraeinae, Callidosominae, Myrmicotrombiinae, Leptinae and Balaustiinae proposed above are based on the genera *Erythraeus* Latreille 1806, *Callidosoma* Womersley 1936, *Myrmicotrombium* Womersley 1934, *Leptus* Latreille 1796 and *Balaustium* von Heyden 1826 respectively. The genus *Balaustium* is used in the sense of Grandjean (1947b). The subfamily Balaustiinae nov. is proposed in place of Balaustiidae Grandjean 1947 (Grandjean 1947a).

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THE USE OF PLASTIC PANELS FOR ILLUSTRATING HEAVENLY BODIES

BY H. J. BOWSHALL, ARTIST, SOUTH AUSTRALIAN MUSEUM

Plates iii-iv

Some months ago, it was decided that illuminated panels showing some of the heavenly bodies would be welcome and interesting additions to the children's display gallery in the South Australian Museum. This exhibition, now ready for installation, depicts the Moon (pl. iii), *Halley's Comet*, the nebula in *Andromeda* (pl. iv), the chromosphere of the sun and the solar system itself.

When working on a glass sheet, internally illuminated by a light situated near the edge of the sheet, it was noticed that paint on the surface and small flaws in the glass, such as bubbles and scratches on the surface, become illuminated and glowed quite brightly. Our first models were constructed by painting the design on sheets of plate glass which were illuminated by passing light through one edge of the sheet. Results were not satisfactory, however, for light illuminated figures painted on the glass for a distance of only about two feet from the edge. Furthermore, most plate glass manufactured in Australia has a slight greenish tint, which alters colours painted on the glass, black becoming brown, for example.

Further experiments were carried out, using colourless sheets of plastic ("Perspex" acrylic) instead of glass, and the results were most encouraging. This plastic will transmit light from the edge to a distance of over five feet through the sheet, while colours applied to the surface of the sheet are not altered by the light.

Instead of painting the details on the plastic, it was decided to enter the field of light by engraving them into the surface of the sheets, and this proved to give far better results than the use of paint. The engravings stand out in high relief from the dark background, giving a realistic third dimensional effect. It was found that the deeper the engraving on the plastic, the more brilliantly illuminated that part became, and *vice versa*. If required, colours were applied to the engraved surfaces, a technique used for the solar system and chromosphere of the sun.

Several points concerning the use of plastic should be mentioned here. Most plastic sheets have a rather rough edge and this must be removed by polishing in order that the maximum amount of light may be transmitted through the sheet. As the upper edge of the sheet is the only source of light, it is important that this edge in particular be perfectly smooth. Moreover, as plastic is somewhat affected by heat, a light such as that provided by a cold fluorescent tube is preferable to ordinary filament lighting. The tube is arranged at the top of the sheet in such a manner that only light escaping from it passes down through the sheet itself. As the light enters the sheet, it is transmitted to the lower edge, and portion is reflected back through the sheet again.

When using this technique of "edge lighting" the plastic sheet, as in the case of glass used in preliminary experimentation, must be completely free of surface scratches. Unfortunately, plastic is very easily scratched, and even handling cannot prevent small scratches appearing on the surface. These must be removed by polishing with a fine cutting compound: the writer found tooth powders most effective. The sheet is then washed with a sponge cloth and water, and finally wiped dry with a soft cloth. However, harsh rubbing in the final drying of the sheet produces a considerable charge of static electricity on the surface, which readily attracts dust particles.

Experiments were conducted with several thicknesses of plastic. Sheets one-eighth of an inch thick were first employed, but light did not penetrate the required distance into the plastic; eventually it was found that sheets of a thickness of three-eighths of an inch gave optimum results.

The images were transferred to the plastic sheets as follows. Photographs of drawings of the required size were prepared from suitable illustrations and these were applied to the front, or viewing, surface of the sheet, with the backs of the photographs facing the front of the sheet. A powerful light was used to illuminate the viewing side of the plastic sheet; the figures, then clearly visible through the back of the sheet, were engraved on this surface. In the case of the moon it was necessary to prepare a composite picture, fitted together from sectional photographs. To complete the exhibit, and in order to ensure a dark background, a black velvet curtain was hung behind the plastic sheets.

It is hoped that, in the future, there will be further opportunity for the use of this technique of "edge lighting" for exhibition panels in the South Australian Museum.

ABORIGINAL CAVE PAINTINGS IN SOUTH AUSTRALIA

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SOUTH AUSTRALIAN MUSEUM

Plate v and text fig. 1-18

This paper records six localities of aboriginal cave paintings in South Australia, three of which are in the Mount Lofty Ranges, i.e. (i), Native Valley, Kanmantoo; (ii), Harrison Creek, Tungkillo; (iii), Cook Hill, about five and a half miles east of Mt. Pleasant. The other three groups are: Yappala Hills, south south-west of Hawker; Gilmore Well on Eyre's Peninsula about midway between Port Augusta and Whyalla, and a small group in a low cave near Wertaloon, on the eastern side of the Northern Flinders Ranges, (not shown on map, fig 1).

(i) NATIVE VALLEY, KANMANTOO

The Native Valley cave paintings are in a shallow cave on the eastern side of a creek on Section 393, Hundred of Monarto, a few miles in an easterly direction from the township of Kanmantoo.

These paintings have been known to the local residents for many years, but were first brought to my notice by Mr. H. M. Hale, Director of the South Australian Museum. Later, in company with other members of the Anthropological Society of South Australia, we visited the locality to record these fast disappearing examples of aboriginal art.

Most of the paintings, which were on the southern end of the cave, and on the roof were badly weathered, a few of them so badly that it was difficult to follow their outline. To ensure the greatest possible accuracy, the paintings were traced on transparent cellophane, from which fig 2 and 3 were prepared.

On fig 2, a and e, are simple human beings in positions suggestive of dancing; b, a pair of interlocked figures, one without a head, and c, a hollow-bodied man or woman that bears some resemblance to cave paintings recorded by Mountford (1937, fig. 12) from Napier Broome Bay, north-western Australia. At d, is a squatting individual with a tail and a boomerang-shaped object in front; f, and possibly the badly-eroded design h, are human representations, and the group at m, a curious meandering "rake" design, a human being, and a circle. On the bottom



Fig. 1. Localities of Cave Paintings in South Australia.

at n, are three designs which are almost certainly human, the figure on the right having been elaborated by a series of transverse lines. The design at k, could be a badly-drawn bird track but there is no reasonable

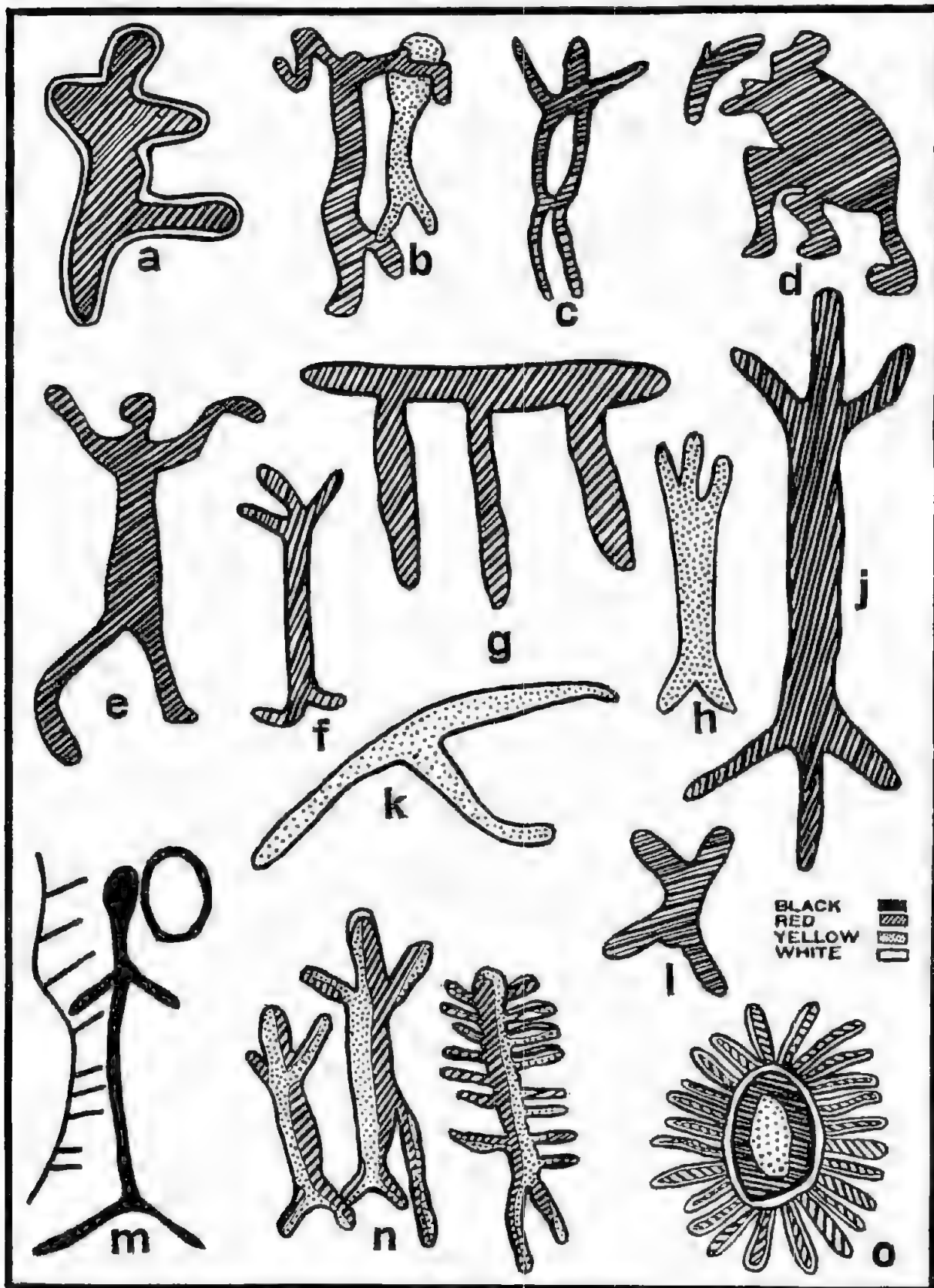


Fig. 2. Cave Paintings, Native Valley.

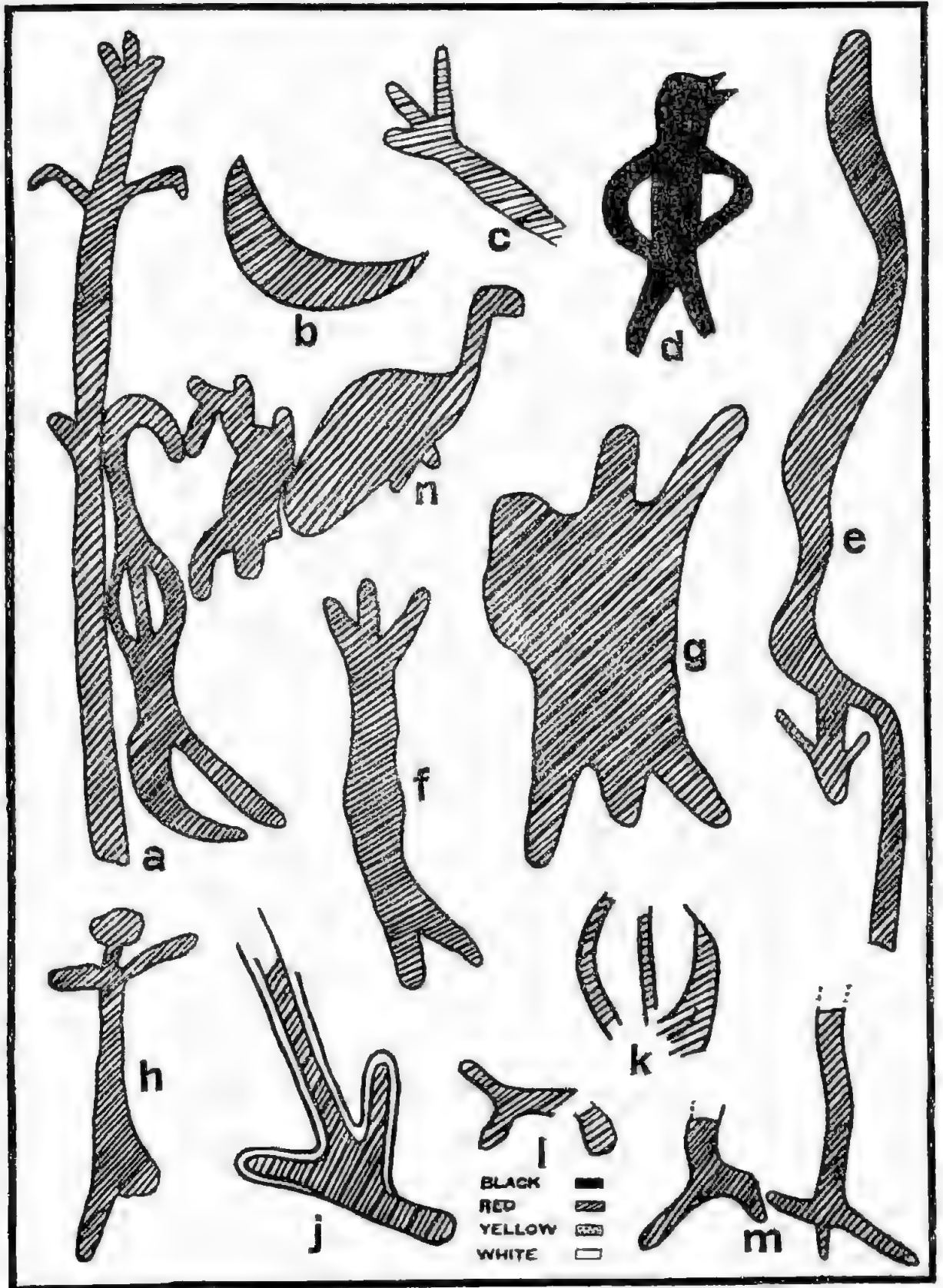


Fig. 3. Cave Paintings, Native Valley.

explanation of the "rake" design, g, or the ellipse with the radiating lines at o. There is a lizard design at j; l, is not decipherable.

The right-hand design of group a, fig. 3 suggests a human being, with arms akimbo, wearing a ceremonial head-dress. The figure to the left and the right are indecipherable. The design at b may represent a crescent moon ⁽¹⁾; c and j are exaggerated bird tracks. At n is an incomplete design of a bird similar to that recorded by Tindale and Sheard (1926, fig. 15), in the Yatalunga cave on the South Para River.

The figures e, k, l, and m are indecipherable; the remainder, d, f, h, and g, represent men and women.

(ii) HARRISON CREEK, TUNGKILLO

This group of cave paintings are situated on the roof walls of a low rock shelter (pl. V,A), on the southern edge of Harrison Creek, Section 481, Hundred of Tungkillo and about two miles south of a town by the same name. Members of the Anthropological Society assisted in the recording of this group.

On fig. 4, a, b, c, d, e, f, g, j, k, m and p, resemble lizards although it is possible that some of them may represent aboriginal men. On the left of c, is a barred circle, a common design in the rock engravings at Mt. Chambers Gorge, (Mountford, 1929, fig. 174-7).

The fern-leaf design at n resembles a cave painting in a rock shelter at Bimba, (Mawson and Hossfeld, 1926, fig. 2). This design is common in the art of the Central Australian deserts, (Mountford, 1937, fig. 5), and is present in the rock engravings of Panaramittee (Mountford, 1929, fig. 6). The figure to the left of n, as well as at o, and h, are indecipherable.

(iii) COOK HILL

Five and a half miles east of Mt. Pleasant and a quarter of a mile north of the Cook Hill Road is a large granite boulder about twenty feet long and six feet high. A deep overhang on the eastern side forms a low rock shelter, which was most probably a favourite camping place for the aborigines.

On the walls and ceilings of this shelter were a number of faded aboriginal paintings. Mr. N. B. Tindale, who first located these paintings and who kindly gave me the sketch from which fig. 5 was prepared, copied all the designs that were not too faint for definite recognition.

⁽¹⁾ There is a similar design in the Yappala Hills, fig. 97

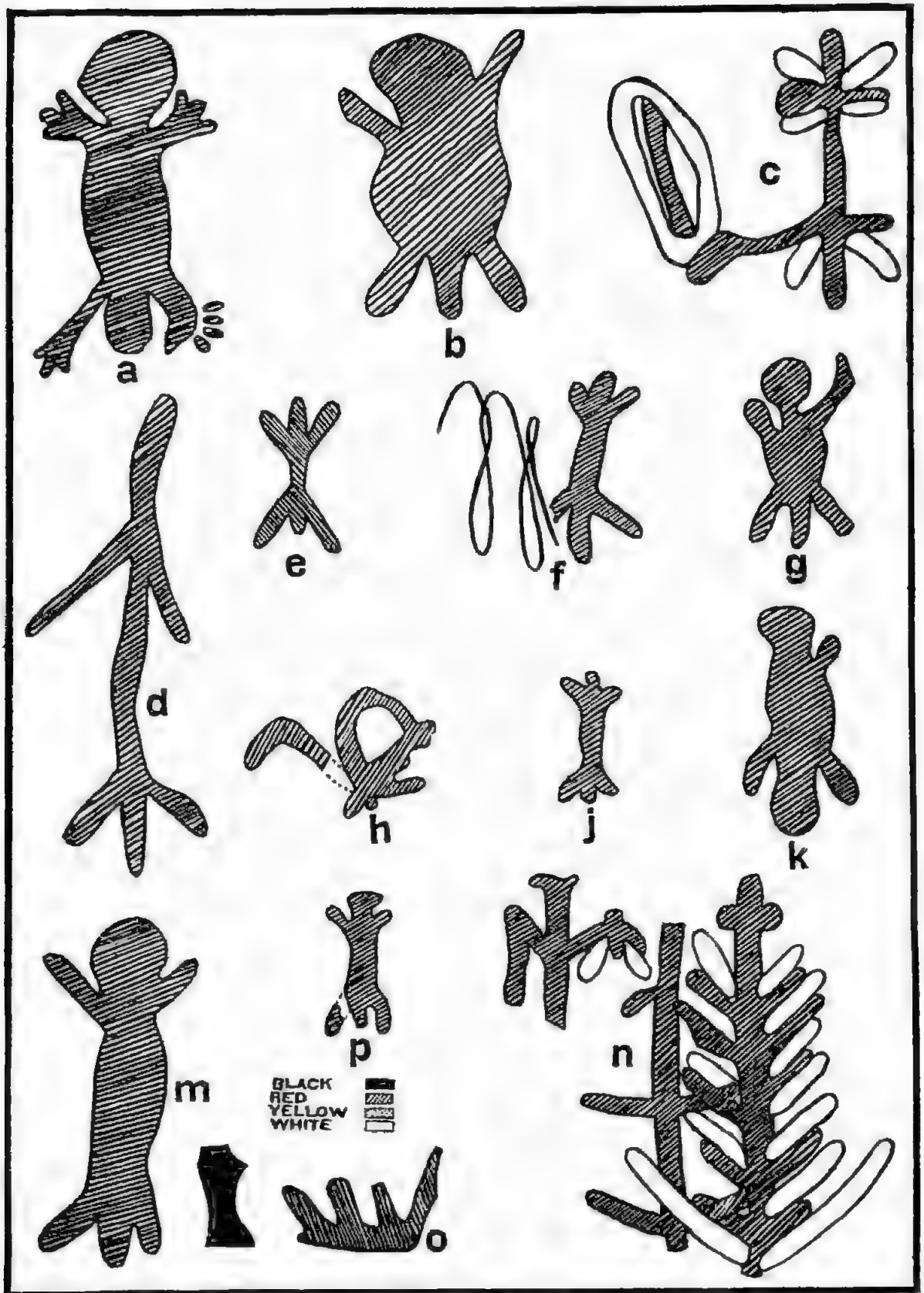


Fig. 4. Cave Paintings, Tungkillo.

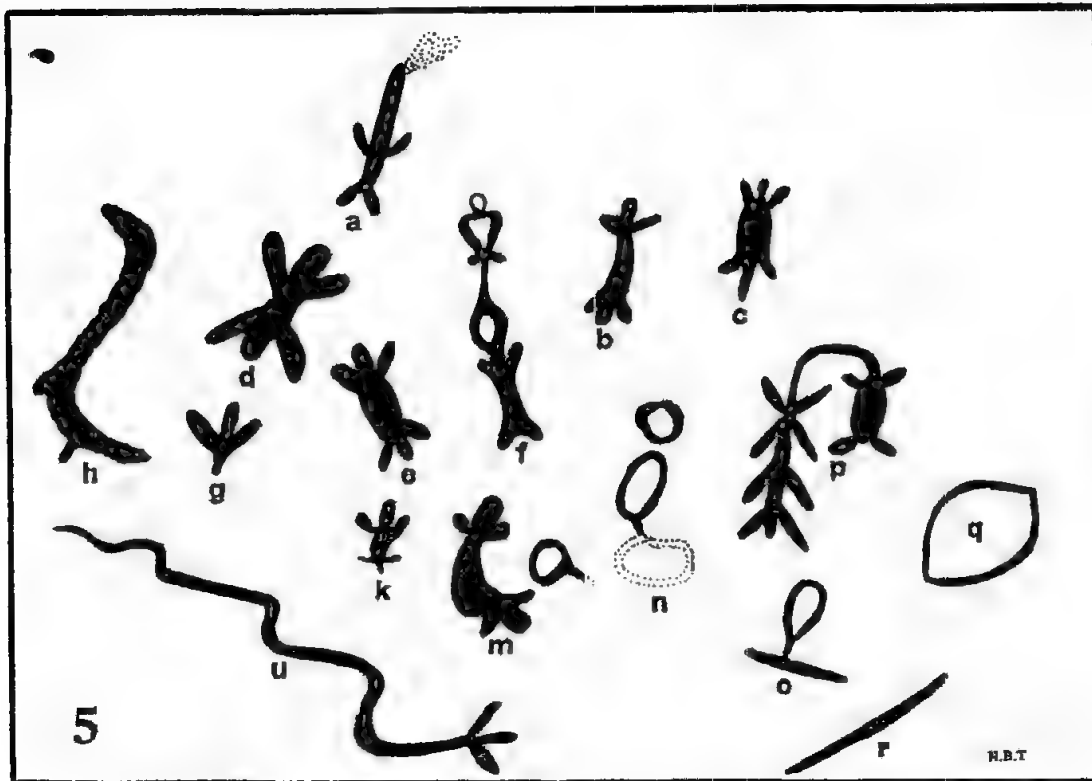


Fig. 5. Cave Paintings, Cook Hill.

The designs, a, b, c, d, e, f, k, and m represent either men or lizards. Similar designs are present in all the painted caves of the Adelaide Hills.

At f is a combination figure, the lower being either human or reptile, the upper, unidentifiable. There is a group of linked circles at n, and a single example at q.

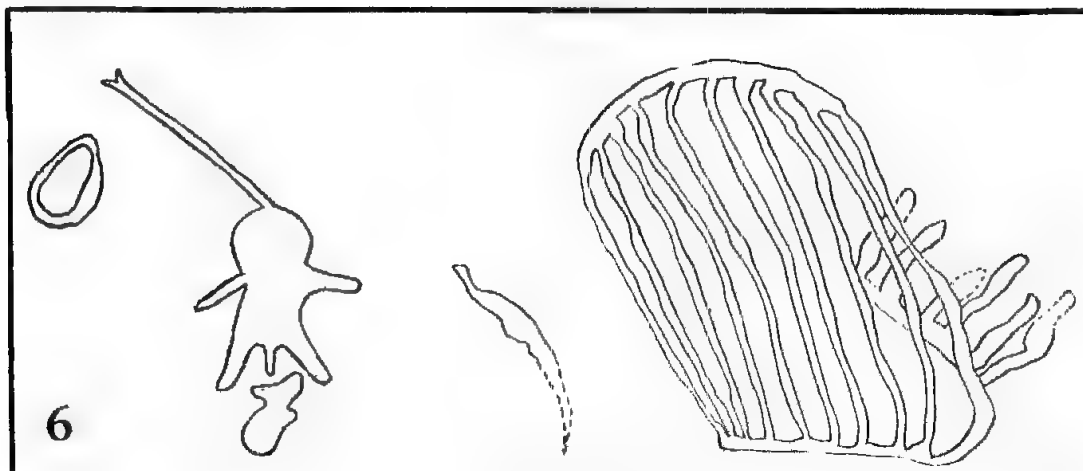


Fig. 6. Cave Paintings, Cook Hill.

A triple-headed snake at s, is similar to a cave painting on the River Marnie recorded by Hossfeld (1926, p. 290, fig. 2). There is no explanation for h, o, or the interesting figure at p, the right-hand side of which might represent the long-necked freshwater tortoise of the near-by River Murray.

(iv) THE YAPPALA HILLS

Three shelters in which there are a number of unusual cave paintings are situated at the southern end of the Yappala Hills, about six miles south south-west of Hawker, in the Hundred of Wonoka.

The larger shelter is half-way up the face of a steep cliff, on the western side of a ravine whose watercourse pours into Palmer Creek. Two smaller caves are situated on a conical hill to the east. For the sake of clarity, these shelters are designated, the western shelter (fig. 7); the upper eastern shelter, (fig. 8) and the lower eastern shelter (fig. 9).

During 1937, Mr. H. M. Cooper showed me photographs and sketches of some of the designs in the western shelter and Mr. Maurice Leask sent a description and photograph of the upper and lower eastern shelters.

It was not until 1955, in company with Mr. Ainslie Roberts, that I had an opportunity of personally investigating these caves. On that occasion we made a complete photo-mosaic of the western and upper eastern shelters, but did not locate the lower eastern group. I am indebted to Mr. H. M. Cooper for permission to use his sketches from which fig. 9 was prepared.

(a) The Western Shelter

This shelter is about thirty-five feet long and six feet or more in height. Fig. 7, traced with a photo-mosaic prepared, reveals a number of interesting designs which are not present in any other recorded group in South Australia. Another unusual feature is that all the designs, with the exception of the barred circles at j, have been painted in black.

At c, is the most striking and unusual design in the cave; a circle of radiating lines enclosing groups of curving crescents and U within U designs. At e, and f, are similar groups except that the radiating lines enclose a circular disc.

There are groups of parallel lines at a, b, f, g, l, and n, most of them associated with exaggerated paired kangaroo tracks, as at f. There are examples of the "rake" design, also present at Native Valley, (fig. 2). No reasonable explanation can be offered for the paintings at h, k and m.

The barred circle design at j resembles rock engravings in Mount Chambers Gorge of the Northern Flinders Ranges, (Mountford, 1929, figs. 174-7). These designs, which are seldom found in the cave painting or rock carving art of South Australia are particularly common in rock



Fig. 7. Cave Paintings, Yappala Hills, Western Shelter.

engravings of the upper Yule River of North Western Australia, (Worms, 1954, pl. 1b, 2d, 3a), where they represent a human vulva.

(b) The Upper Eastern Shelter

The paintings are in a low cave which had been eroded at the base of a large boulder. There were a few straight line markings on the low ceiling. The bulk of the designs, (fig. 8), extended along the back wall for about twenty feet.

The predominant painting was an incomplete oval, a, of short black lines. Although seldom present in cave paintings elsewhere in South Australia, these groups of short lines are particularly numerous in the cave paintings at Gilmore Well, (Pl. V, C). At b, are bird tracks, probably emus; c, paired boomerangs and what could represent a simple throwing stick; d, a group of parallel lines, a hand stencil with a finger

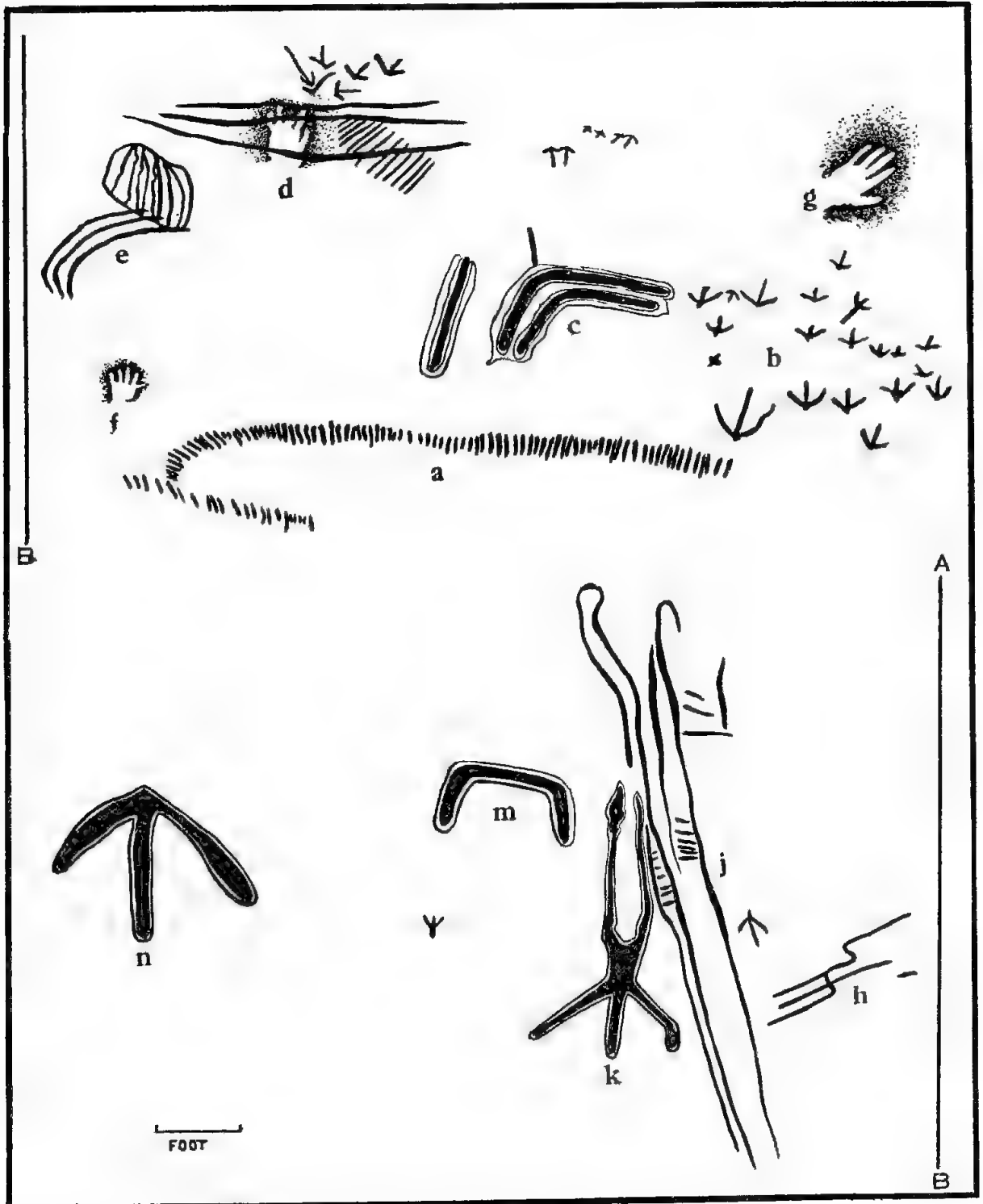


Fig. 8. Cave Paintings, Yappala Hills, Upper Eastern Shelter.

missing, and a number of bird tracks; e, grouped boomerangs and a multiple barred design; f and g, hand stencils, and h an unidentifiable design.

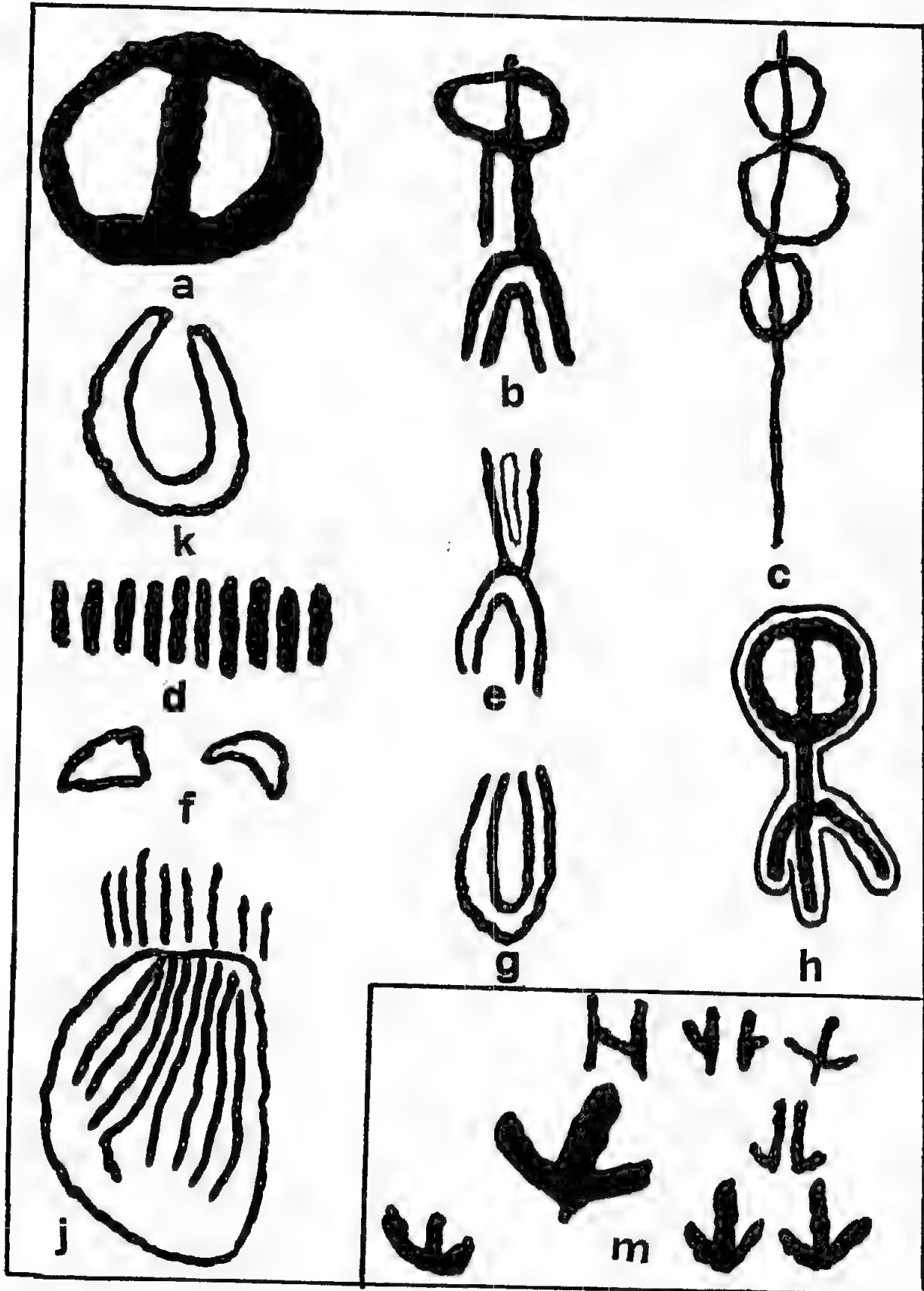


Fig. 9. Cave Paintings, A-J, Yappala Hills, Lower Eastern Shelter, M, Wertaloona.

At m is possibly a badly-drawn boomerang and n, an emu track. Design k, is interesting; it may consist of no more than a bird track attached either to a U-shaped symbol or an incomplete circle. I do not know of a parallel design in Australian primitive art.

(c) The Lower Eastern Shelter

As mentioned earlier, fig. 9, was prepared from sketches made by Mr. H. M. Cooper. The barred circle designs, a and c, resemble those at Mt. Chambers Gorge (Mountford, 1929, fig. 180-2); b, and h, are similar, but may have had a different meaning. There are U within U designs at k, g, and e, which are common in the art of central Australia (Spencer and Gillen, 1899, fig. d, p. 148; fig. f, p. 149; Mountford, 1937, fig. 3, 7, 9, 11). They are also present in the rock engravings at Mallett, (Basedow, 1914, pl. xvi, fig. B) and Yunta (Mountford, 1937, pl. x, fig. 5). Groups of parallel lines such as at d, were common at Yappala in both the upper and lower shelters. It is tempting to think of them as tally marks, but we have no evidence that this is so, nor that the aborigines ever kept tallies of events.

There is no reasonable explanation for the interesting figure at j, which is particularly common in the cave at Gilmore Well, fig. 17. Design b might be a combination of a barred circle and a U within U design; h is a barred circle and a bird track; e, combined U within U designs, and k, an incomplete circle.

(v) GILMORE WELL

Late in 1953, Mr. Hans Mincham of Whyalla wrote and told me of aboriginal paintings in two caves in the rough hills about three miles east of Gilmore Well, which, in turn, is about six and a half miles southwest of Blanche Harbour, Hundred of Jenkins (fig. 1).

During 1955, Mr. Ainslie Roberts and I visited these caves (Pl. V, B.), inspected the paintings and photographed a number of the paintings from which we prepared the illustrations. The lower cave was approximately sixty feet long and up to ten feet high, the upper cave being about a third the length of the lower.

Although there are hundreds of individual paintings in the two caves, the range of designs is particularly limited. On the right-hand side of the lower cave (Pl. V, C.) are a short number of parallel lines, in red and white, painted along the edge of more or less horizontal bands of rock. Between and above these bands are a number of bird tracks and paired footmarks of kangaroos.

On the walls and ceiling of both the smaller upper cave and the left-hand side of the lower cave (in addition to the painting of a man, lines

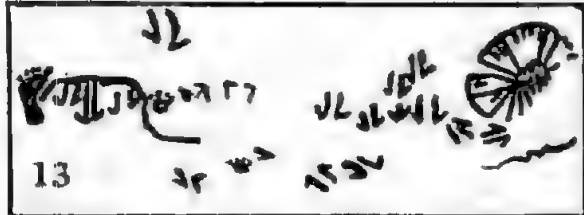
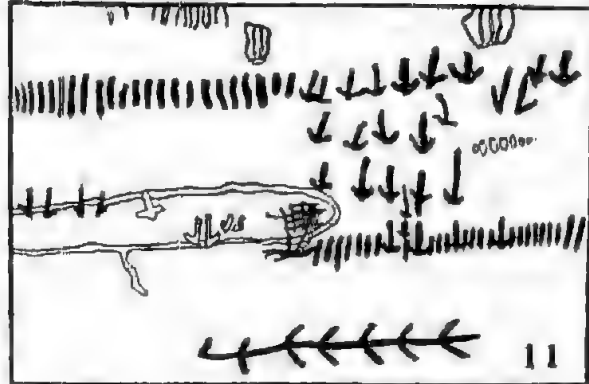
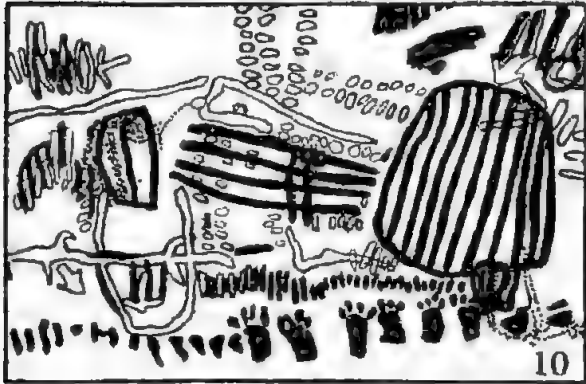


Fig. 10-14. Cave Paintings, Gilmore Well.

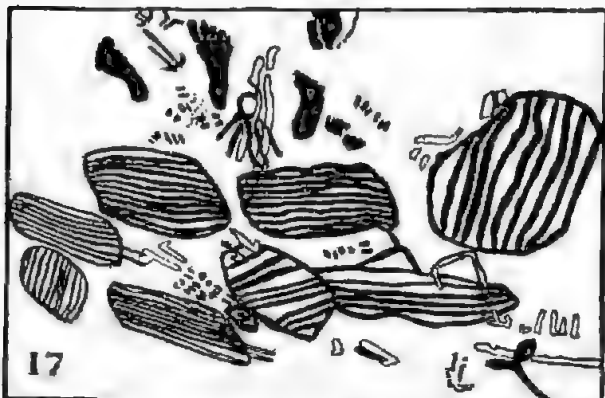
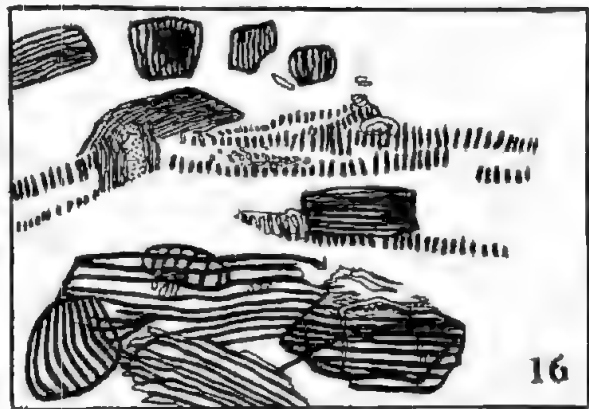


Fig. 15-18. Cave Paintings, Gilmore Well.

of short marks and multiple-barred designs), are a large number of human, animal and bird footmarks painted heterogeneously over the whole surface.

We did not make a complete photo-mosaic as at the Yappala Hills caves, but photographed a series of typical groups illustrated on fig. 6 and 10-18.

Along the lower edge of fig. 10 are a number of incomplete human footprints; on the right is a large multi-barred oval; in the centre a group of four long parallel lines intersected with transverse bars; and on the left, amid a number of heterogeneous figures, a single barred design.

The paintings illustrated on fig 11 are mostly tracks and groups of short parallel lines. At the bottom of the panel, some aboriginal artist has created an interesting pattern by joining a series of bird tracks together.

Fig. 12, (with the exception of the four multiple-barred designs on the lower left), is covered with the tracks of men, dogs, kangaroos and birds. One interesting series of tracks depicting a dingo chasing a kangaroo starts at a, in the centre of fig. 12, continuing up the wall, leaving it at b, then continuing across the ceiling as shown on fig. 14.

On fig. 13 are a number of kangaroo tracks, a human footprint on the left, and a fragment of a wheel-like design on the right. A similar design has been found among the rock engravings of Yunta Springs (Mountford, 1929, fig. 89), and in an elaborated form at Mount Chambers Gorge (Mountford, 1929), fig. 175).

On the left of fig. 6 is a crudely painted man in white, with a line (perhaps a spear), projecting from his head. There is no explanation for the patch of white below. On the right is a multiple-barred design.

On the left of fig. 15 are four grouped boomerangs; in the middle a multiple-barred figure, and on the right, a design of unknown meaning. Multiple-barred designs, with the exception of five groups of short marks and two of long parallel lines, occupy the most of fig. 16.

There are, on fig. 17, three well-drawn human footprints, two dog and five kangaroo tracks as well as eight multiple-barred designs.

On fig. 18, a "wheel" design, similar to than on fig. 13, is predominant. There is also a human footprint, group of short parallel lines, two emu tracks, and a number of indécipherable designs.

(vi) WERTALOONA

Mr. H. M. Cooper found a small group of cave paintings in a low cave on the eastern slopes of the Flinders Ranges, about five miles south of Wertaloona. These are shown at fig. 9, m.

DISCUSSION

A review of the paintings described in this paper suggest that, in the cave art of South Australia, certain types of designs tend to be used only in specific localities. Paintings of human figures are far more numerous than any other in the Adelaide Hills; the circular designs of short lines, fig. 7, c, e, and f, are only found in the Yappala Hills cave, and the multitude of short lines at Gilmore Well.

The same predominance of certain designs is also present in the art of the rock engravings; such as U within U designs at Mallett; (Basedow, 1914, pl. XVI, fig. B) and the barred circle designs at Mt. Chambers Gorge, (Mountford, 1929, pp. 351, 353).

This grouping suggests that some of the localities where paintings and rock engravings are now found were totemic places, although not necessarily forbidden to the women.

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RECORDS OF UNCOMMON SOUTHERN AUSTRALIAN MOLLUSCS

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Plates vi-vii

The following notes deal with records, localities and new information, gathered over the last few years, concerning some lesser known Southern Australian Molluscs. Two new genera are introduced.

Nautilus repertus Iredale

Plate vi (top)

Nautilus repertus Iredale, 1944; Australian Zoologist, 10, (3), 295-296, text fig.

A. R. Riddle 1920 published a paper entitled "An Adventitious Occurrence of *Nautilus pompilius* Linn, with a Short Bibliography on Ocean Currents affecting the Australian Coast." The *Nautilus* referred to was taken by James Scott of Yorketown at Foul Bay, Southern Yorke Peninsula, opposite what is locally known as the Old Mill. The animal was nearly intact, only small portions having been removed by sea-birds and it was not in an obvious state of decomposition.

This is the only record of *Nautilus* occurring in South Australia, not even a fragment of shell has been seen on our coast, previous to or since this record. Incidentally, no living *Nautilus* has been recorded from anywhere on the Australian Coast, though many shell fragments of *Nautilus alumnus* have been taken on the North Queensland Coast, and that species is presumed to be living in quantity nearby.

Nautilus pompilius Linne, type locality Amboina, is plentiful in certain places on the Indo-Pacific, such as the Philippines, the animals being used as bait and the shells as drinking vessels and as a source of Mother-of-Pearl ornaments by some Pacific Island natives. Quiggin mentions the use of this species by the natives of New Britain who make "lillie", a creamy-white string of *Nautilus pompilius* discs used as shell money.

Riddle, in his summing up, dismissed any possibility of the *Nautilus* having migrated from the West and concluded that "A migration, however, along the warm Notonectian current, which sweeps past the home

of the species and then down the Eastern Coast of Australia, seems more probable. . . . By this medium the migrating *Nautilus* could well arrive at a position East of Bass Strait and Tasmania. How it could then travel westward against the easterly current from the Great Australian Bight must be considered."

Iredale, p. 295 under his original description of *Nautilus alumnus* from Queensland, writes, "There is a record of a living specimen from Yorke's Peninsula, South Australia, A. R. Riddle 1920, which is not acceptable." The incorrect identification of the South Australian shell has thus, again, confused the issue concerning the authenticity of this specimen.

There are strong reasons why the conclusions of Iredale and Riddle are not correct. The shell concerned, which was accidentally broken and repaired years ago, was presented recently to the South Australian Museum by Mr. P. Scott. It is not the Indo-Pacific *Nautilus pompilius* Linne nor is it the still smaller, differently patterned Queensland and New South Wales species *Nautilus alumnus*.

The South Australian example is the large *Nautilus repertus* Iredale, described from South Western Australia. The specimen, D. 14518, is a big one measuring 22.7 cm. \times 17.6 major and minimum diameters as recorded by Riddle, approximating to the measurement of the Holotype from Rottnest, South Western Australia, examined by me in the Western Australian Museum in 1949. A shell of a similar size was mentioned in the Adelaide "Advertiser" on December 21st, following the present author's note about Riddle's specimen. This belongs to Mr. William Heslop of Glenelg, S.A. who received it from Cottesloe, Western Australia. One from Bunbury and one from Albany in the South Australian Museum, Verco collection, are typical. Verco 1935, p. 144 records a "*Nautilus pompilius* (*N. repertus*) in Captain Douglas' collection, taken on the beach at Esperance, in the Western Bight" approaching to within 900 miles of the South Australian locality and within the westerly drift. Whitley took a specimen at Pelsart Island, Abrolhos with muscle scar flesh attached. The South Australian record is the only *Nautilus* of any species with the complete animal, known to have been taken off the Australian coast.

From this known range of *N. repertus* it may now be safely presumed that a breeding ground exists off the Western Coast as suggested by Iredale 1944, p. 294, but it is situated probably off the South Western tip of the Continent.

This large species is characterized by the pale and reduced banding which becomes obsolete on the posterior half of the shell. There is no

perforation but a round brown colour patch covers the umbilical region.

All adventitious occurrences of strange species in Southern Australian waters have been definitely identified as of Western Australian origin. In other words the drift is from the West, and there is no drift from the east through Bass Strait.

The following evidence confirms this contention. Weeding 1942, p. 2, remarks, "It has been pointed out that a warm surface current from the Indian Ocean flows along the track of the Southern Ocean cold current and is about 400 miles wide and 250 fathoms deep. This is said to be on the surface at Cape Leeuwin but 150 fathoms below at Cape Northumberland", and the same author, speaking of varietal names applied to Western Australian Chitons, Weeding 1942, p. 1, states "This applies very definitely to those subspecific names introduced for Western Australian variants, for the variations found in these species are found, not only in Western Australia, but often in the bays of the Great Australian Bight and again, to a still greater degree, in Spencer Gulf, South Australia. The marine fauna of the Eastern Gulf Coast of that Gulf shows a definite Western influence."

Other examples of tropical types of Molluscs populating Western South Australia from South Western Australia, among many, not reaching Victoria, are the large Gastropods such as the Baler shell *Melo miltonis* Gray, *Dinassovica jourdani* Kiener and *Cellana laticostata*, all confined to the Flindersian Region, Cotton 1930, p. 219.

Argonauta nodosa Solander is common in South Australia but *Argonauta argo* Linne, the delicate, narrow Paper Nautilus of the Indian Ocean and South Western Australia is extremely rare here. Of 500 Argonauts taken by George Pattison at Troubridge Shoal, S.A., 490 were *A. nodosa* and only 10 were *A. argo* apparently drifted from South Western Australia.

In 1909, Verco, after exploring St. Francis Island, wrote in his manuscripts:—

"The following notes give evidence of Western drift in the Great Australian Bight. The circumstances were related to me by Lloyd and Arnold of St. Francis Island.

- a. On the west side of Dog Island, lying near St. Francis Island to the North of Petrel Bay, can be seen a large iron buoy which drifted from its moorings in Albany, W.A. Captain Weir of the "Governor Musgrave" tried to tow it off but it was too firmly embedded and heavy.
- b. A cargo boat belonging to the "Eclipse" in Esperance Bay, W.A., got adrift and was found by Lloyd beached in Smoky Bay.

- c. A teak log with the British Government brand on it, and supposed to have come from Burma was found by Lloyd stranded on the south side of Goat Island."

Verco concludes: "The current is said to flow eastward from the Leeuwin some distance south of St. Francis Island and to cause an eddy which comes up from the South East away to the East of St. Francis Island in the summer time. In winter the stray north westerly winds cause a current setting from the West in the Bight."

As Riddle 1920, p. 260 correctly remarks, in connection with the unique *Nautilus* "Its position on the Western side of the Bay, however, suggests a westerly drift."

***Charonia powelli* sp. nov.**

Plate vi (lower)

Shell large, fusiform, varices strongly formed and nodular, situated at about every one and a quarter turns and undulating the suture and giving a distorted appearance to the sculpture of spaced spiral heavily nodular ribs, about five between the centre of the body whorl and the angular shoulder formed by the most developed ridge. The heavy ridges have smooth, weak spiral riblets in the interstices. Colour bright yellowish to nut brown, maculated with dark brown and white on the nodules. Spire rather short and narrow. Aperture ovate, distinctly channelled above and below, the anterior canal somewhat recurved. Outer lip a little expanded, with teeth in groups of three, two, or single, light brown coloured. Columella concave, inflexed towards the canal, three plaits at the top, wrinkled anteriorly. Holotype. Height 167 mm., width 85 mm. S.W.A., Ellenbrook, D. 14517.

Remarks. This rather rare shell living in the Flindersian region of Southern Australia, has been recognised by collectors for many years as a species, distinct from *Charonia rubicunda* Perry 1811 (*Septa*) of New South Wales, though it has remained unnamed. *Charonia powelli* differs from the deeper water species *Charonia euclia* Hedley 1914 in being much more robust and having strong nodular sculpture, wider body whorl and shorter spire.

It can, however, attain to quite a large size, one cited by Cotton, 1945, p. 258 being 210 mm. in height. The present species is quite distinct from *Charonia rubicunda* Perry 1811, which inhabits the Eastern coast of Australia and *Charonia instructa* Iredale 1929 from deeper waters of the same area.

The genus *Charonia* Gistel 1848, type species *Murex tritonis* Linne 1758 has as synonyms *Tritonidea* Lamarck 1807 not Muller 1776, *Triton*

Montfort 1810 not Linne 1758 and *Eutrilon* Cossmann 1904. *Charonia powelli* is named after the well known New Zealand Conchologist, A. W. B. Powell, Assistant Director of the Auckland Museum.

Notovoluta kreuslerae Angas

Voluta kreuslerae Angas, 1865; Proc. Zool. Soc., Lond., 55.

This rare Volute has been taken from craypots in Encounter Bay and records from Investigator Strait, Middleton, Yankalilla, St. Francis Island, Port Elliott, Capé Borda, 55 fathoms. Tunk Head 16 fathoms, Backstairs Passage 22 fathoms, Newland Head 20 fathoms and Porpoise Head 12 fathoms were mentioned by Cotton 1946, p. 16, where a few details of the animal were given. Two from Newland Head in the collection of Peter Wearne each measure 102 mm. in length and a third one collected by him at Victor Harbour measures 83 mm. in length.

Cottonia dannevigii Verco

Scaphella dannevigii Verco, 1912; Trans. Roy. Soc., S. Austr., 36, 225, pl. 13, fig. 1-3.

The first specimen of this species taken in South Australia and the only one in the Museum collection is a dilapidated broken shell D. 816 lacking the whole of the last whorl, dredged by Verco, 1896, off Newland Head, 20 fathoms.

A large and good specimen is in the collection of Peter Wearne taken by Cain Rumbelow, 1953 Encounter Bay, in craypot, 12 fathoms. This second South Australian specimen is light yellowish-brown with the typical white band around the upper middle of the body whorl, and measures 160 mm. in length.

A young example, 89 mm. in height, taken in a craypot at Corny Point is in the J. Turnbull collection.

A further juvenile specimen measuring 89 mm. ($3\frac{1}{2}$ inches in length) with a portion of the protoconch present closely resembling that of *Mamillana mamilla* was taken by Robert Hall in March 1954 off Seal Rock, one mile South-East of Victor Harbour at 14 fathoms, from a craypot. The typical white band is again present. An exceptionally good example of *Voluta exoptanda* was taken in another craypot at the same time, place and depth.

The holotype of this species was dredged by the "Endeavour" in 77-105 fathoms, 90 miles west Eucla, Western Australia, together with eight further examples recorded by Verco (8) p. 226. Neither holotype of *Cypraea umbilicata armeniaca* Verco, nor *Scaphella dannevigii* Verco are in the South Australian Museum Collection. They were, according to Verco,

sent to the Australian Museum from his collection. On the back of a tablet bearing cuttings from the plate of *Nassaria torri* in this publication, Verco wrote, "The original of this shell is in the Federal Museum (in charge of the Australian Museum, Sydney) sent there by Dr. Verco after being described and figured in the Trans. Roy. Soc. S. Austr., 1912."

Mamilla mamilla Gray

Voluta mamilla Gray, 1844; Sowerby's Thes. Conch. 1, p. 207, pl. 50, fig. 57-58.

A juvenile dead shell in bad condition, taken at the Murray Mouth is the first record of this species from an exact locality in South Australia.

Umbilia hesitata armeniaca Verco

Cypraea umbilicata armeniaca Verco, 1912; Trans. Roy. Soc. S. Austr., 36, p. 211, pl. 10, fig. 1-3.

Mr. C. F. Kurtze of Portland has handled 2,000 shells of this once "rare" species, all trawled at 60-80 fathoms, Bass Strait near Cape Everard, Victoria during the last two years.

These specimens are a little darker than New South Wales examples. Some 6% approximated to the Flindersian variant *Umbilia hesitata armeniaca* in having the "apricot-yellow" base. About 5% are the miniature *Umbilia hesitata beddomei*—previously only recorded from New South Wales, but there are intermediate forms grading in size and shape into typical *Umbilia hesitata*.

Altivasum flindersi Verco

Latirus aurantiacum Verco, 1895; Trans. Roy. Soc., S. Austr., 19, 89-90, pl. 2, fig. 1, 1a, not Montfort 1810.

Altivasum flindersi Verco, 1914; Trans. Roy. Soc., S. Austr., 38, 484.

The holotype D. 13515, dredged in 18½ fathoms Backstairs Passage, is an immature living individual.

Later, two further specimens were dredged by Verco off Newland Head in 22 fathoms. The smaller living one measured 57 mm. in height and the larger dead one 86 mm. in height. Cotton 1945, p. 13, recorded a large specimen taken by W. Bowden at Cape Borda, 15 fathoms, September 2, 1946, and now finds that the specimen, housed in Mrs. E. R. Sims collection, measures 97 mm. in height. A still larger specimen taken by Bowden at Cape Borda and in the same collection measures 127 mm. in height. A shell in the collection of Mrs. L. A. Elliott, taken by her on Middleton beach, measures 50 mm. in height. The best and biggest specimen of all measuring 145 mm. in height, taken in a craypot at Corny Point, is in the J. Turnbull collection. In the same collection I identified

a perfect example of a rare volute *Iredalina aurantia* Powell dredged in New Zealand waters. There is only one living specimen recorded and all others are dilapidated examples.

***Xenophora flindersi* Cotton & Godfrey**

Onustus flindersi Cotton & Godfrey, 1938; Rec. S. Austr. Mus., 6 (2) 205.

The holotype specimen D. 13615 came from St. Francis Island, 15-20 fathoms and measures 18 mm. in diameter.

Three smaller specimens taken with the holotype are also in the Museum collection. Verco, 1909, p. 270, first recorded these specimens under the name of *Xenophora tatei* Harris 1897, a Miocene fossil from Muddy Creek, measuring 44 mm. in major diameter and *X. tatei* like many Tertiary fossils from Southern Australia, so closely resemble the recent forms as to suggest that many now living are Miocene persistent species.

Fortunately a series of six living specimens was dredged in January 1956 by David Howlett and Peter Wearne in the type locality. The largest individual measures 47 mm. across. The recent shell is more delicate and less strongly sculptured than the fossil which has, as Verco says, a wider umbilicus.

***Bothriembryon barretti* Iredale**

Bothriembryon barretti Iredale, 1930; Vict. Naturalist, 47, p. 119, fig. in text.

In the Malacological Society of Australia, Newsletter, Jan. 1957 gives a most interesting record of this species found between Madura and Balladonia on September 18th, 1956. The ground was strewn with white epibragms and some still adhered to the foot of the animal.

***Strangesta gawleri* Brazier**

Helix (Zonites) gawleri Brazier, 1872; Proc. Zool. Soc., 618.

This native snail originally described from the Mount Lofty Ranges was thought to be confined to the higher parts of that area. Mr. H. M. Cooper took many specimens alive at Stony Creek, Wilmington, 1,200 feet above sea level on August 21, 1955 following a very wet winter when water was accumulated in patches on the surface. He again took the species on August 28th, 1955 at Mount Remarkable. Specimens of this carnivorous snail placed in his garden at Glenelg are still alive a year later when a very wet winter was again experienced.

***Bothriembryon mastersi* Cox**

Bulimus mastersi Cox, 1867; Proc. Zool. Soc., 39.

The South Western Australian genus *Bothriembryon* extends across the Nullarbor plains represented by the species *B. barretti* Iredale.

At Port Lincoln *B. angasianus* Pfeiffer is found, a peculiar colour banded species and also *B. mastersi*. H. M. Cooper took *B. mastersi* in quantity alive at Streaky Bay and I took it alive at Moonta Bay, on the west coast of Yorke Peninsula and dead shells further south at Corny Point. *B. decreseensis* Cotton was described from Cape Cassini, Kangaroo Island and represents the South Eastern limit of the genus. It has not been recorded from the East coast of Yorke Peninsula.

Family Melanellidae

Melanella Bowdich 1882. Type species *Melanella dufresnii* Bowdich = *Melaniella* P. Fischer 1887 = *Eulima* Risso 1826.

The distinguishing feature separating the Melanellidae from the Styliferidae is the possession of an operculum by the former and the lack of it by the latter: Following Laseron's work a revised list of Flindersian species is given here with certain genera tentatively allotted to the family Styliferidae.

Euliamaustra Laseron 1955. *Eulima proxima* Sowerby.

augur Angas 1865. *Eulima*. S.W.A., S.A. (type), Tas., Vict.

orthopleura Tate 1898. *Eulima*. S.W.A., S.A., Holdfast Bay (type, D. 13463) Tas.

murrayae Cotton & Godfrey 1932. *Eulima*. S.W.A., S.A., Gulf St. Vincent, 10 fathoms (type, D. 10630).

planicineta Cotton & Godfrey 1932. *Eulima*. S.W.A., S.A., Gulf St. Vincent, 10 fathoms (type, D. 10635).

edwardsi Cotton & Godfrey 1932. *Eulima*. S.W.A., S.A., Cape Borda, 55 fathoms (type, D. 10634).

mayi Tate 1900. *Eulima*. S.W.A., S.A., Tas., Swansea (type, D. 13462), Vict.

tryoni Tate & May 1900. *Eulima*. S.W.A., S.A., Tas. (type), Vict.

inflata Tate & May 1900. *Eulima*. S.A., Tas. (type), Vict.

tenisoni Tryon 1886. *Eulima*. S.W.A., S.A., Tas. (type), Vict.

gradata Cotton & Godfrey 1932. *Eulima*. S.W.A., Ellenbrook (type, D. 10634), S.A.

immaculata Pritchard & Gatliff 1900. *Stylifer*. S.A., Vict. (type).

articulata Sowerby 1834. *Eulima*. S.A., Vict., N.S.W. (type).

roegerae Cotton & Godfrey 1932. *Eulima*. S.A., Cape Borda, 55 fathoms (type, D. 10629).

cunaeformis May 1915. *Eulima*. S.A., Tas. (type).

australiensis Thiele 1930. *Strombiformis*. N.W.A., S.W.A.

montebelloensis Iredale 1914. *Eulima*. N.W.A.

montageuana Iredale 1914. *Eulima*. N.W.A.

- modesta* Thiele 1930. *Melanella*. N.W.A., S.W.A.
helena Thiele 1930. *Melanella*. N.W.A., S.W.A.
elsa Thiele 1930. *Melanella*. N.W.A., S.W.A.
- Chryseulima* Laseron 1955 *Stylifer brazieri* Angas.
brazieri Angas 1877. *Stylifer*. S.W.A., S.A., Tas., Vict., N.S.W.
 (type).
expansilabra May 1911. S.W.A., S.A., Tas. (type), Vict.
 Laseron 1955, p. 87, in a valuable revision of these mostly parasitic species, mentions that the shell figured by May, 1923, pl. 45, fig. 11 from Tasmania is not *Eulima munita* Hedley 1903 (*Eulimoda*). He regarded it as possibly an undescribed species. It has been named, however, by May himself as *Eulima expansilabra* from Cape Pillar 100 fathoms. Cotypes of both species are in the South Australian Museum collection and the difference between them had been pointed out in 1932 by the present author when specimens were recorded from Cape Jaffa, Beachport, Neptune Islands, at 104 to 300 fathoms. Specimens have since been recognised from Hopetoun, King George Sound and Port Phillip, Victoria. There seems to be no authentic record of *Eulimoda munita* from the Flindersian region though it has been included in check lists.
- Curveulima* Laseron 1955. *Curveulima cornuta* Laseron.
commensalis Tate 1898. *Eulima*. S.W.A., S.A., Holdfast Bay (type, D. 13461), Vict., N.S.W.
indiscreta Tate 1898. *Eulima*. S.W.A., S.A., Holdfast Bay (type, D. 14196).
triggi Cotton & Godfrey 1932. *Melanella*. S.W.A., S.A., Cape Jaffa, 90 fathoms (type, D. 10633).
petterdi Beddome 1882. *Eulima*. S.W.A., S.A., Tas. (type), Vict., N.S.W., Q.
edwardsi Cotton & Godfrey 1932. *Melanella*. S.W.A., S.A., Cape Borda 55 fathoms (type, D. 10634).
- Cuspeulima* Laseron 1955. *Leiostraca acutissima*. Reeve.
acutissima Reeve 1886. *Leiostraca*. S.W.A., S.A., Vict., N.S.W. (type) = *Leiostraca lesbia* Angas 1871.
lodderae Hedley 1903. *Leiostraca*. S.A., Vict., Tas., N.S.W. (type) Q. = *Eulima vilrea* Adams.
williamsi Cotton & Godfrey 1932. *Strombiformis*. S.W.A., S.A., Cape Borda 55 fathoms (type, D. 1063).
broadbentae Cotton & Godfrey 1932. *Strombiformis*. S.W.A., S.A., Cape Borda 55 fathoms (type, D. 10636).
joshuana Gatliff & Gabriel 1910. *Leiostraca*. S.W.A., S.A., Tas., Vict. (type).

- bivittata* H. & A. Adams 1853. *Leiostraca*. S.W.A., S.A., Philippines, Soo Loo Sea (type)=*Eulima bilineata* Adams & Reeve.
- Fusceulima* Laseron 1955. *Fusceulima jacksonensis* Laseron 1955. *brunnea* Tate 1887. *Stylifer*. S.W.A., S.A., Vict. (type). Parasitic on the periproct. of *Stronglylocentrosus*, a sea urchin.
- Hebeulima* Laseron 1955. *Leiostraca inusta* Hedley 1906. *perexiguus* Tate & May 1900. *Rissoa*. S.A., Tas. (type), Vict. *fricata* Hedley 1907. *Eulima*. S.A., Vict., N.S.W. (type).

Family Styliferidae

- Stylimella* Laseron 1955. *Stylifer lodderae* Petterd 1884. *lodderae* Petterd 1884. *Stylifer*. S.A., Tas. (type), Vict., N.S.W. *petterdi* Tate & May 1900. *Stylifer*. S.W.A., Cottesloe, S.A., Tas. (type), Vict., N.S.W.
- Syntharella* Laseron 1955. *Eulima topaziaca* Hedley 1908. *topaziaca* Hedley 1908. *Eulima*. S.A., Tas., Vict., N.S.W. (type).
- Stylapex* Iredale 1925. *Stylapex lactarius* Iredale 1925. *laseroni* sp. nov. Laseron 1955, p. 100, pointed out that the Tasmanian species figured in May, *Illustr. Index Tasmanian Shells*, pl. 45, fig. 24, No. 999 as *Stylifer brazieri* Angas 1877 is not that species but an undescribed one. It is here named *Stylapex laseroni* sp. nov. and May's figure cited as Holotype.
- Hypermastus* Pilsbry 1899. *Hypermastus cori* Pilsbry 1899. *mucronatus* Reeve 1866. *Eulima*. S.W.A., S.A., Tas., Vict., N.S.W. (type). *georgiiregis* Cotton & Godfrey 1932. *Eulima*. S.W.A., King George Sound (type, D. 10631), S.A.

Genus *Granata* nov.

Shell ear-shaped, spire small, aperture oblong, oblique, nacreous; outer lip thin. Sculpture of close, equal, spiral, granular cords. Operculum horny, multispiral. Animal resembling that of *Trochus* but without lateral filaments. The general anatomy and radula is closely related to that of *Euchelus*, but the animal is large and not capable of being contained within the shell.

Type species: Stomatella imbricata Lamarck.

Remarks: It has been usual for authorities to take Gray's designation of *Stomatella imbricata* Lamarck as the type species of *Stomatella* Lamarck (Rafinesque) 1815, but Anton 1839 designated *Stomatella auricula* Lamarck 1818, from Southern Australia as type species of *Stomatella*. *S. auricula* is closely allied to *Stomatella planulata* Lamarck 1818, the type species of *Gena* Gray 1842, from the Indo-Pacific.

It therefore becomes necessary to introduce the new genus *Granata* for *Stomatella imbricata*. This genus is contained in the family Trochidae, subfamily Margaritinae though it seems that the *Granata*, *Herpetopoma*, *Euchelus*, *Danilia*, group is somewhat different from the typical *Margarites* group.

The genera *Stomatella*, *Gena*, *Stomatia*, *Pseudostomatella*, *Broderipia*, *Roya*, are quite distinct and belong to the Family Stomatiidae sometimes placed as a subfamily Stomatiinae of the Trochidae.

Genus *Notomella* nov.

Entomella Cotton, 1945; S. Austr. Naturalist, 23 (2), 14.

Type species: Emarginula candida Adams 1851.

The name *Entomella* is preoccupied by Cossmann 1888. This was pointed out to me by Myra Keen of Stanford University who asked that a substitute be supplied. The above name is to be incorporated in a revision of the Fissurellidae by Grace Johnson in the Treatise on Invertebrate Paleontology, edited by Raymond C. Moore, printed by the Geological Society of America, University of Kansas Press.

Equichlamys bifrons Lamarck

Chlamys bifrons Lamarck, 1819; An. S. Vert., 6, 164.

Reference was made, Cotton 1954, p. 168 to the presence of this edible "Queen Scallop" washed up on the beach, South of Outer Harbour. An acre of this species lives off the South Bank of the Outer Harbour, whence came examples recently donated to the Museum by Robert Hall. The shells are encrusted with sponges and usually have clusters of the Southern Slipper Limpet *Zeacrypta immersa* and an occasional *Capulus australis* attached to the valves. They are fixed to the sea bed debris at a depth of 10 to 20 feet below low tide and are immobile except in the young stage. Similar beds occur off Stansbury, Normanville, Yankalilla Bay, Backstairs Passage, Kangaroo Island at American River off Point Marsden and in Coffin Bay. Dredging off Point Marsden, Verco 1935, p. 64, wrote "Our dredge was thrown over in eighteen fathoms and brought up living and dead scallops, and in this country we worked until 4.30 p.m., passing over many miles of water. This revealed how immense must be the tracts thickly inhabited by these bivalves."

The three species *Notovola alba*, *Equichlamys bifrons* and *Mimachlamys asperimus* were taken in quantity and Verco continues "As for dead shells of these Scallops, they would have to be measured by the ton." Little investigation has so far been made as to the commercial possibilities of these Scallops though the Scallop industry of Tasmania is next in size to the Oyster industry.

Anadara trapezia Deshayes

Plate vii

Arca trapezia Deshayes, 1840; Mag. Zool., 21.

This dominant bivalve fossil of our Mid-Recent stranded beaches is found in numbers around Murat Bay, Port Wakefield, Outer Harbour, Yorke Peninsula near Ardrossan, inside the stranded beach dunes to the southwest of South Australia and at Port Augusta in quantity on the surface and from bores sunk to test foundations for the new power house.

Although many specimens are found joined, having died *in situ*, a quantity of valves also occur on the surface. A strange circumstance in connection with the odd valves is that at several places where they have been counted in a marked area, the percentage of left valves is about 60% and the right 40% of the total taken.

Mr. H. M. Cooper, who has collected many hundreds of these shells, meticulously counted those on an area at Port Augusta Power Station. Of 282 specimens picked up only 112 were right valves. A similar proportion of odd valves existed at Port Augusta West, Port Wakefield and Streaky Bay.

Valves have been picked up on native camp sites such as at Moana, Ardrossan, Port Wakefield and Port Augusta West, but their presence on these sites suggest that they have been transported by the aborigines for use as implements. One valve has been found near Lake Torrens.

The extreme western point at which specimens have been taken alive in Victoria is Port Phillip, according to paired shells with periostracum attached sent to the South Australian Museum by Gatliff some forty years ago. Another living series sent by Gabriel some time ago are from Western Port.

Mr. Richard Plant of Cowes, Phillip Island, recently reported four large colonies of *Anadara trapezia* living in shallow water in Western Port Bay, near Churchill Island, Reid's Bight (two) and Rhyll. While kindly forwarding specimens he mentioned that they were found living in mud in the vicinity of *Katelysia scalarina* the cockle which is so plentiful at the Outer Harbour, South Australia.

In the Malacological Club of Victoria, Newsletter, Vol. 4, No. 14, June 30th, 1956, it is mentioned that a member, Robert Burns, had taken eleven live specimens at Port Arlington, near Geelong. These localities are considerably further south than the Mid-Recent beds of South Australia and suggests that if the species were introduced to our State and placed in suitable localities it may repopulate our waters.

Incidentally, there is a single valve with ligament intact in the Museum collection taken many years ago by Walton and Matthews at Levens, Yorke Peninsula. This is undoubtedly a fortuitous occurrence.

***Ostrea sinuata* Lamarck**

Ostrea sinuata Lamarck, 1819; An. S. Vert., 6, 208.

Lamarck gave the locality "les mers de la Nouvelle Hollande". This is undoubtedly the South Australian Port Lincoln or so-called Mud Oyster and Port Lincoln has since been designated as type locality.

The species is identical with *Ostrea angasii* Sowerby 1871 from New South Wales where it is now extinct. During the last ten years there has been a noticeable increase in the size of natural beds and in the number of Port Lincoln oysters washed up on the local beaches. Off the artificially cut outlet from the Torrens River Swamps to the sea at Henley Beach South a considerable number of oysters may be picked up on the beach after heavy squalls which appear to have become more frequent during the last ten years. Heavy beach scouring, first recorded in 1949 off Broadway, Glenelg has again taken place this year during June, July and August. During August of this year quantities of oysters were taken attached to *Pinna dolabrata* and many such smooth attachment areas. A smooth worn motor tyre was covered with half-grown oysters and other smooth surfaced debris washed down through the outlet was similarly covered. The Sea Gull: (Silver Gull) are keen competitors with the human collectors.

Verco, in manuscripts, recorded many localities for this Oyster. S.A., Kangaroo Island, Eastern Cove, American River, Streaky Bay, Dredged Beachport 110 fathoms, Eastern Cove 11 fathoms, St. Francis Island 20 fathoms, Black Point, Yorke Peninsula 5 fathoms, Gulf St. Vincent 7 fathoms, Backstairs Passage 20 fathoms, Investigator Strait 20 fathoms, Ardrossan 8 fathoms, Cape Jaffa 130 fathoms, W.A. Albany, Hopetoun, King George Sound, dredged Great Australian Bight 30 miles west of Eucla 84-96 fathoms.

A large and old specimen measuring 170 mm. in diameter and 90 mm. in thickness across the two valves has a label attached, reading: "Mammoth Oyster, dredged in Dutton Bay, August 1912. Its age is estimated at 15 years. Presented by Mr. W. G. Randall, Chief Inspector of Oyster Fisheries." A still larger but younger example is 175 mm. (nearly 7 inches) in diameter and is labelled: "This oyster shell with the living fish was detached from a pile of the Port Victor Jetty. Mr. W. G. Randall who presented it estimated the age at about 10 years."

There are a number of further specimens in the collection closely approaching these in size.

***Saxostrea australis* Lamarck**

Ostrea australis Lamarck, 1819; An S. Vert., 6, 209.

This species, originally described from King George Sound, Western Australia was recorded by me living, from Coffins Bay and St. Francis Island. Further evidence of this Rock Oyster living in South Australia is now to hand. On August 11th, 1934 a well-known collector, Charles A. Anderson of Kingscote wrote "We have two kinds of oysters here, one is the Mud oyster and the other is a thin paper shelled one, in shape like the Sydney Rock."

Tate 1887 writes "The Sydney Rock Oyster (*O. glomerata* Gould) so largely imported as food is not indigenous in our waters (S.A.) but it has lately been introduced, so I have been informed, to the Port Lincoln district".

Verco, in his manuscripts, refers to odd occurrences of *O. glomerata*, *O. imbricata*, *O. mordax* in various places in South Australia.

It is possible that these accounts refer to *Saxostrea australis* in South Australia. The only authentic record of the introduction of the Sydney Rock Oyster *Ostrea commercialis* seems to be that relating to those brought in and cultivated for a few years at Osborne on the Port Adelaide River by the Adelaide Oyster Company Limited, in 1934. The project was abandoned.

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**A REVISION OF THE FLOWER BUGS (HETEROPTERA ANTHO-
CORIDAE) OF THE AUSTRALIAN AND ADJACENT PACIFIC REGIONS
—PART III**

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Fig. 1

Genus *Poronotellus* Kirkaldy, 1904

Poronotellus Kirkaldy, 1904: Entomologist, 37 (498), 280. Zimmermann, 1948: Insects of Hawaii 3, 179.

Poronotus Reuter, 1871: Ofv. Vet. Akad. Forh., 562. Champion, 1900. Biol. Centr. Amer. Rhynch., 2, 33.

Buchananiella Reuter, 1885: Act. Soc. Sci. Fenn., 14, 114 & 126. (668 & 680).

Cardiastethus (in part) White, 1879: Ent. Mon. Mag., 16, 142.

Body oblong, pubescent, head longer than the width between the eyes. Rostrum just reaching base of anterior coxae. Posterior margin of pronotum deeply sinuate, lateral margins almost straight. The channel of the scent gland reaching middle of pleurae, straight or directed posteriad apically. Can be easily distinguished from *Cardiastethus* on the shape of the scent canal and by the shorter rostrum.

This genus could not be included in Part II because at that stage it was not clear how many species were involved in these regions. The position is still not as clear as the author would like but it seems preferable to consider that there are only two very variable species concerned, *P. whitei* in Australia and New Zealand and *P. sodalis* in the Pacific Islands.

***Poronotellus sodalis* (White) 1878**

Fig 1A

Cardiastethus sodalis White, 1878: A.M.N.H., (5) 1, 372.

Buchananiella sodalis Reuter, 1885: Act. Soc. Sci. Fenn., 14, 127 (681).

Poronotellus sodalis Zimmerman, 1948: Insects of Hawaii, 3, 179.

'A reddish brown *Cardiastethus*, clothed with pale hairs; eyes and posterior lobe of the pronotum piceous; antennae, legs and elytra yellowish brown; the apex of the clavus and especially the cuneus apically, brownish fuscous; the apex of the second, the third and fourth segments of the antennae, the head between the eyes and the membrane fuscous.

Length about $2\frac{1}{2}$ mm.

(Translated from White's Latin description.)

'Oblong, piceous ferruginous, with a low pallid pubescence; rostrum, antennae, legs and the hemelytra yellowish testaceous, on the latter the clavus towards the apex and the cuneus fuscous membrane infuscated, veins fairly weak; rostrum only attaining the base of the anterior coxae; the sides of the pronotum strongly narrowed towards the apex, straight but very lightly curved just before the apex, the posterior part a little impressed in the middle, the rima orificiorum of the metastethium shortly curved backwards at the apex, the longitudinal lateral keel is almost straight and fairly remote from the apex of the rima. Length 2½ mm.'

'It is distinguishable from the following two species' (i.e. *corlinua* and *whitei*) 'in that the sides of the pronotum are less distinctly curved before the apex, the disc is obsolete impressed in the middle posteriorly, the rostrum is somewhat shorter and the different structure of the orifice of the metapleura. The body is oblong piceous ferruginous, with a very low pale pubescence. The head is piceous ferruginous, as long as wide (with the eyes), as long in front of the eyes as an eye, frons (male) a little wider than an eye. Rostrum pale yellowish testaceous reaching only to base of the anterior coxae, second segment hardly surpassing the head. Antennae yellowish testaceous, second segment apically a little more darkened, a little shorter than the width of the head with the eyes. Pronotum piceous ferruginous, about twice as wide basally as the median length, the apical annulus tenuous but distinct, sides straight but lightly curved a little in front of the apex, the lobe outside of the callus fairly narrow, the callus posteriorly and laterally demarcated by distinct impressions, the posterior disc in the middle a little or hardly impressed, flattish. Scutellum piceous ferruginous, medially impressed. Hemelytra testaceous, lightly shining, clavus towards the apex and the cuneus fuscous. The embolium apically about half the width of the apex of the corium, the inner suture becoming evanescent towards the apex but there is a strongly impressed longitudinal line going right to the apex, lateral margin straight; on the membrane the veins are very low. The mesopleurae are densely and lightly transversely striate. Legs yellowish testaceous, almost smooth.' (Translated from Reuter's Latin descriptions in his "Monographia".)

A series of specimens in the South Australian Museum collections from Fiji are referable to this species which seems to be fairly widely distributed in the Pacific. From them the following standard measurements have been obtained:—

Head. Length, 260-390; length in front of eyes, 90-140; length behind eyes, 50-100; length of eyes, 140-210; width across eyes, 310-400;

width of eyes, 90-210; interocular, 70-150; width of collum, 280-350.

Antennae. I, 70-110; II, 200-320; III, 140-200; IV, 160-260.

Rostrum. I, 70-110; II, 170-270; III, 160-220.

Pronotum. Anterior width, 310-390; posterior width, 670-830; median length, 220-330; lateral length, 350-480.

Scutellum. Anterior width, 410-540; median length, 290-430; lateral length, 330-410.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	170-260	400-400	300-400	30-40	40-50	50-90	30
II	150-220	310-410	320-430	30-40	30-50	70-90	30
III	170-220	400-500	520-620	30-50	50-90	70-120	30-40

Total length, 1770-2190; total width, 670-870; length abdomen, 870-1,070; length male genitalia, 190-340; length female genitalia, 120-140.

Loc. Distributed widely over the Pacific Islands, the species was first described from Hawaii. The specimens in the South Australian Museum are all from Fiji; Viti Levu (A. M. Lea).

Poronotellus whitei (Reuter), 1885.

Fig. 1B

Buchananiella whitei Reuter, 1885: Act. Soc. Sci. Fenn 14, 127 & 129 (681 & 683),

'Oblong, obscurely yellowish testaceous, with low yellowish pubescence, shining, hemelytra darker, cuneus infuscated, membrane smoky, the basal angle interiorly and the base of the veins sordid yellow, the latter all distinct, well elevated, antennae and legs pale yellowish, the second segment of the antennae fairly broadly infuscated; rostrum reaching the anterior coxae, the disc of the pronotum distinctly impressed in the middle. Length (male) 2 mm.

Habitat. Tasmania, D. Schayr. (Berlin Museum).

Very similar and closely allied to *B. continua* but differing somewhat in the slightly smaller size, and the more dilute colour. Body more darkly yellowish testaceous or almost ferruginous, shining. Head as long as the pronotum, length in front of eyes not much more than length of an eye. Rostrum just attaining the anterior coxae, pale yellowish, first segment blackish. Antennae pale yellow, first segment testaceous, the second as long as the head between the eyes and the apex, the apical 2/5 blackish (last missing in the example). Pronotum apically 2/3 narrower than at the base, apical annulus very distinct, callus fairly elevated, posterior disc more obsoletely punctate, basally deeply sinuate, lateral margins completely straight; all more obscurely yellowish testaceous or almost ferruginous. Scutellum almost ferruginous. Hemelytra

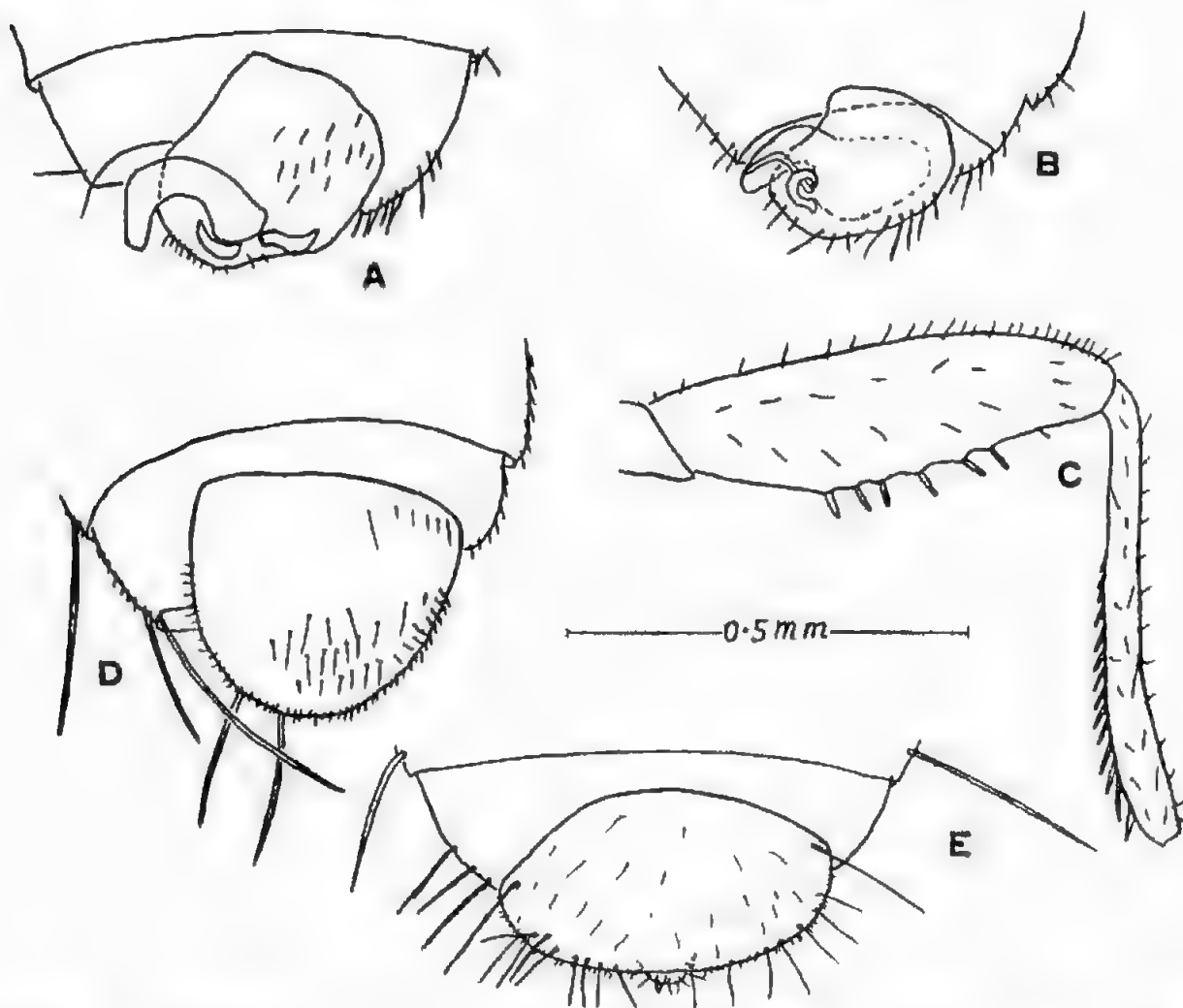


Fig. 1. A. *Poronotellus sodalis* (White); male genitalia. B. *Poronotellus whitei* (Reuter); male genitalia. C. *Ophobates woodwardi* sp. nov.; female, fore femur and tibia. D. *Lasiellidea glaberrima* Reuter; male genitalia. E. *Scoloposcelis parallelus* (Motsch); male genitalia.

darkish yellow, testaceous, almost flat with a fairly dense low pubescence, the exterior margin and the exterior puncture more deeply coloured to the apex of the corium; membrane smoky, veins basally and the inner angle paler, all the veins very distinct but more obsolete apically, the common areola of the two inner veins a little shorter than the basal space of the membranal suture between the base of the third vein and the internal angle of the membrane. Sternum and abdomen ferruginous, mesosternum laterally punctulate, ventrally and apical margin of the segments more or less blackish. Legs completely pale yellow, fairly smooth.'

(Translated from Reuter's Latin description in his "Monographia.")

All the Australian specimens of this genus and the two New Zealand ones available to me for study seem to belong to this species. From them the following standard measurements have been obtained.

Head. Length 380-500; length in front of eyes, 120-170; length behind eyes, 50-120; length of eyes, 170-220; width across eyes, 350-430; width of eyes, 120-170; interocular, 90-150; width of collum, 280-380.

Antennae. I, 80-120; II, 270-400; III, 160-210; IV, 190-260.

Rostrum. I, 70-140; II, 180-290; III, 160-210.

Pronotum. Anterior width, 290-400; posterior width, 710-930; median length, 260-350; lateral length, 410-530.

Scutellum. Anterior width, 380-620; median length, 360-500; lateral length, 360-510.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	190-300	380-500	350-480	30-70	30-70	90-120	30-50
II	170-240	360-480	400-500	34	50-70	90-120	30
III	170-260	480-570	580-590	30-70	70-100	100-170	30-50

Total length, 2,040-2,760; total width, 760-1,050; length abdomen, 900-1,550; length male genitalia, 190-290; length female genitalia, 90-210.

Loc. New South Wales: Bondi near Sydney (K. K. Spence, 1 specimen), Mittagong (A. M. Lea, 2 specimens), Hornsby (C. Gibbons, 2 specimens), Gosford (2 specimens); Queensland: Cairns district (A. M. Lea, 12 specimens, one of which was attracted to light), Somerset (C. T. McNamara, 1 specimen), Mt. Tambourine (A. M. Lea, 1 specimen), 15 mi. W. of Bowen (on *Casuarina cristata* = *lepidophloea*) 24th September, 1950, (E. F. Riek, 1 specimen); Victoria: Warringa (June 1936, 1 specimen), Grantville (6 specimens); Tasmania: Launceston (A. M. Lea, 1 specimen); Lord Howe Island (A. M. Lea, 12 specimens); New Zealand: Little Barrier Island, Hauraki Gulf (11 December, 1952, T. E. Woodward, 1 specimen); Otaki River south of Levin, Wellington Province (30 November 1951, T. E. Woodward).

The species is extremely variable both in the standard measurements where some very large ranges are recorded and in the colours noted. On the measurements no consistent group could be detailed, a specimen having a very high or low reading on one measurement would lie very near the average in most others, or a series of specimens all from the same restrictive locality (e.g. Lord Howe Island) often give the same extreme range as I have quoted for the whole species.

Because of this and the great variety of colour variants one is tempted to suggest that the species is in process of breaking up into a series of subspecies and that as yet definite groups have not appeared.

Another noteworthy feature about the species is that out of about 40 examples studied, only four were males.

Material belonging to genera and species dealt with in parts I and II of the present series but examined subsequently.

Subfamily ANTHOCORINAE

Orius australis (China), 1926

Orius australis (China), *synon.* Gross, 1954: Rec. S. Austr. Mus., 11 (2), 136-7.

A new series of females have been measured since this species was mentioned in Part I and the consequent extensions to the range of the standard data are:—

Head. Total length, 320-380; length in front of eyes, 80-140; length behind eyes, 50-70; length of eyes, 160-180; width of head across eyes, 380-410; width of eyes, 90-120; interocular, 140-190; width of collum, 310-400.

Antennae. I, 70-100; II, 200-220; III, 150-190; IV, 160-220.

Rostrum. I, 70-90; II, 240-270; III, 155-160.

Pronotum. Anterior width, 330-420; posterior width, 690-810; median length, 270-350; lateral length, 400-450.

Scutellum. Anterior width, 530-560; median length, 350-410; lateral length, 400-460.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	270	350-390	350-360	40	70	70-80	40-50
II	220-230	350-390	340-360	30-40	50-70	80-90	40
III	220-260	430-480	520-600	50	80-90	80-90	40

Total length, 1,980-2,250; total width, 690-380; length abdomen, 960-1,290; length ovipositor, 380-570.

Habitat. Queensland: the measured specimens are from a large series of specimens from Carnarvon Gorge, 29 May, 1954; St. Lucia, 30 May, 1951; Tibrogargan Creek, 4 September, 1953; Toorbul Point, 11 August, 1952; and Gratton (by sweeping), 4 March 1954, all collected by T. E. Woodward, University of Queensland.

Orius armatus Gross, 1954

Orius armatus Gross, 1954: Rec. S. Austr. Mus., 11 (2), 137-8.

One more specimen, unfortunately lacking the abdomen, has been measured and the alterations to the previously quoted ranges of the standard data are:—

Head. Length behind eyes, 50-90; length of eyes, 140-190; width of head across eyes, 360-400; interocular, 130-160; width of collum, 300-360.

Antennae. II, 200-230; III, 170-190.

Rostrum. II, 180-220; III, 150-170.

Pronotum. Anterior width, 330-400; median length, 270-290; lateral length, 360-400.

Scutellum. Anterior width, 480-530.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	120-210	330-380	310-360	40	70	70	30
II	170-180	330-360	320-360	40-50	60-90	70	30
III	200-210	420-470	480-520	40	50-90	90	30

The specimen is from Queensland: Carnarvon Gorge, 29 May, 1954, T. E. Woodward. Woodward Collection.

Anthocoris arctatus (Walker, 1872: Cat. Hem. Het., 5, 153) is actually an *Oxycarenus* (Lygaeidae) according to distant 1904 (A.M.N.H., (7) 14, 22).

Subfamily LYCTOCORINAE

Genus *Falda* Gross, 1954

Falda (Gross), 1954: Rec. S. Austr. Mus., 11 (2), 139) definitely is not an Anthocorid but belongs rather to the very closely allied Prostemmae, usually considered as a subfamily of the Nabidae. Carayon 1950 (Bull. Mus. Hist. Nat., (2) 22 (1), 95-101) has emphasised afresh the very close relationships of the Nabidae, particularly the Prostemmae, to the Cimicoid group of families. In appearance some of the smaller species are exceptionally like Anthocorids and it was this very close resemblance that led the author to first place this species as an Anthocorid. His attention was drawn to its true position by Dr. Carayon.

It is probably synonymous with *Alloeorhynchus* Fieber and *F. queenslandica* may in fact be *A. flavolimbatus* Kirkaldy, 1907 (Proc. Linn. Soc. N.S.W., 32, 781) although Kirkaldy's description is not sufficiently good to determine this.

Oplobates woodwardi sp. nov.

Fig. 1C

Elongate, shining, piceous. Rostrum would surpass somewhat the base of the head (if complete). Eyes fairly prominent with a long hair in front on each side. Collum well defined. Pronotum fairly rectangular but anterior angles not well marked, collar distinct but tenuous. Sides of pronotum with very fine ciliations and with a long hair at each posterior angle and one behind each apical angle. Fore and hind margins concave.

Hemelytra surpassing somewhat the apex of the abdomen which is equipped with some long hairs. A well developed ovipositor present. Fore femora slightly enlarged with six large teeth (30 u) fairly centrally placed on the inner margin. Fore tibiae slightly curved.

The standard measurements from the one female are:—

Head. Total length, 570; length in front of eyes, 210; length behind eyes, 90; length of eyes, 240-260; width across eyes, 480; width of eyes, 140; interocular, 220; width of collum, 360.

Antennae. I, 140; II, 500; rest missing.

Rostrum. I, 140; II, 400; last segment missing.

Pronotum. Anterior width, 380; posterior width, 770; median length, 330; lateral length, 500.

Scutellum. Anterior width, 600; median length, 470; lateral length, 380.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	410	550	550	—	—	—	—
II	—	520	520	30	70	120	—
III	—	620	810	—	—	—	—

Total length, 2,930; width across abdomen, 950; length abdomen, 1,030; length ovipositor, 550.

This species is easily distinguished from *O. femoralis* Reuther by its smaller size, more slender build, and longer more centrally situated teeth on the femora.

Loc. Queensland: Brisbane (T. E. Woodward, 1954, Holotype, Female, Reg. No. I 20,085) in the Department of Entomology, University of Queensland.

Lasiochilus derricki Gross, 1954

Lasiochilus derricki Gross, 1954: Rec. S. Austr. Mus., 11 (2), 143-5.

Two more specimens of these species have become available to the author for measurement since the original description. These measurements extend somewhat the ranges quoted for the standard data as derived from the holotype and the allotype. These new ranges are:—

Head. Total length, 430-500; length behind eyes, 70-120; interocular, 210-260.

Antennae. I, 120-170; II, 330-400; III, 350-380; IV, 400-430.

Rostrum. I, 220-260; II, 600-690; III, 350-400.

Pronotum. Anterior width, 430-460; median length, 360-400; lateral length, 480-520.

Scutellum. Anterior width, 500-520; median length, 380-430; lateral length, 420-470.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	310-330	520-580	550-640	30-50	90-100	140-150	50
II	220-280	520-620	550-590	50	90-100	140	60-70
III	240-260	690-760	790-830	50-70	90-120	140-170	70

Total length, 2,760-3,480; width, 1,090-1,330; length female genitalia, 720-800.

The two measured specimens are from "leaf mould in rain forest, Blackbut, South East Queensland, 10 September, 1954, T. E. Woodward." In the Department of Entomology, University of Queensland.

***Lasiochilus vitiensis* Gross, 1954**

Lasiochilus vitiensis Gross, 1954: Rec. S. Austr. Mus., 11 (2), 148.

Another female of this species is now available for measurement and the following extensions to the previously quoted ranges are now noted.

Head. Length in front of eyes, 140-170; width collum, 330-380.

Antennae. III, 260-280.

Rostrum. I, 90-100; III, 220-260.

Pronotum. Posterior width, 740-810; lateral length, 430-480.

Scutellum. Anterior width, 570-620; median length, 330-400; lateral length, 430-480.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	260-330	450-480	360-450		Same		
II	240-260	430-470	430-520		Same		
III	260-310	570-600	670-710		Same		

Total length, 2,410-2,690; width, 950-1,000; length ovipositor, 450-530.

Loc. The additional specimen is also from Fiji; Taveuni (May, A. M. Lea).

Subfamily DUFOURIELLINAE

***Lasiellidea glaberrima* Reuter, 1895**

Fig 1D

Lasiellidea glaberrima Reuter, 1895: Ent. Mon. Mag., 31, 172. Gross, 1954: Rec. S. Austr. Mus., 11 (2), 153.

A male specimen referable to this species is now available for study. From it the following standard measurements have been obtained.

Head. Total length, 590; length in front of eyes, 190; length behind eyes, 100; length of eyes, 240; width across eyes, 430; width of eyes, 120-140; interocular, 190; width of collum, 350.

Antennae. Missing.

Rostrum. I, 170; II, 350; III, 260.

Pronotum. Anterior width, 380; posterior width, 740; median length, 360; lateral length, 470.

Scutellum. Anterior width, 550; median length, 400; lateral length, 430-450.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I and II	Missing						
III	220-280	640-650	760-770	30	90	140	—

Total length, 2,950; total width, 770; length abdomen, 1,280; length male genitalia, 290.

Loc. Queensland; St. Lucia, Brisbane (30 June 1951, T. E. Woodward).

***Scoloposcelis parallelus* (Motsch.), 1863**

Fig. IE

Anthocoris parallelus Motschulsky, 1863: Bull. Soc. Mosc., 36 (3), 89.

Scoloposcelis parallelus auctt.: syn: Gross, 1954: Rec. S. Austr. Mus., 11 (2) 155.

Two more complete specimens are now in the South Australian Museum, both are from Rossel Island, Papua, H. K. Bartlett. One of these is a male and the genitalia are now figured for comparison with those of other genera.

***Cardiastethus aridimpressus* Gross, 1955**

Cardiastethus aridimpressus Gross, 1955: Rec. S. Austr. Mus., 11 (4), 412-413.

There is a misprint on page 412 in the standard data given for this species. The measurements for antennal segment I are of course 90-100, not as quoted 900-1,000.

***Cardiastethus lincolnensis* Gross, 1955**

Cardiastethus lincolnensis Gross, 1955: Rec. S. Austr. Mus., 11 (4), 413.

Another specimen collected by Lea from the holotype locality has since become available to the author and the measurements derived from this specimen extend somewhat several of the ranges quoted in the standard data for the species as derived from only four specimens. The new ranges are:—

Rostrum. I, 90-170.

Pronotum. Anterior width, 400-520.

Scutellum. Anterior width, 520-590.

Legs. Femur I, 480-520; femur III, 630-690; tibia III; 670-740; tarsus III, I, 30-50; tarsus III, II, 80-90; tarsus III, III, 100-120.

Total length, 2,070-3,190.

Measured specimen from Pt. Lincoln, South Australia. A. M. Lea (Reg. No. I. 20,084) in the South Australian Museum.

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PALAEOCRANGON, A PERMIAN ISOPOD CRUSTACEAN

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Fig. 1

Recent work on the Isopod suborder Phreatoicoidea (Nicholls 1943-44) which dates back to the lacustrine Triassic of Australia (Chilton 1918) has made it possible to review the position of a hitherto doubtful Permian fossil from England and Germany, *Palaeocrangon problematicus* (Schlotheim) (Fig. 1a). Bate considered it first as an Isopod (in Kirkby 1857, where the genus was re-named *Prosoponiscus*, without justification), and later as an Amphipod (Bate 1859), an interpretation in which von Ammon (1882) and others concurred. Geinitz (1863) questioned Bate's



Fig. 1. a—*Palaeocrangon problematicus* (Schlotheim). Reconstruction from figures given by Bate, 1859, pl. 6.

b—*Protamphisopus rotunamattensis* (Chilton). Reconstruction, from Nicholls, 1943, fig. 26A, with most of the appendages omitted and boundaries between abdominal segments 1-5 shown by dotted lines.

reconstruction and later van Straelen (1931) listed the fossil as "incertae sedis". *Palaeocrangon* has a head with a peculiarly curved frontal profile, projecting lateral lobes (eyes?), and strongly developed but incompletely preserved mandibles. There are seven thoracic segments, followed by an abdomen consisting of two very large segments. The terminal segment ends in a slightly upturned point. Uropods are visible on its sides. The body is laterally compressed, with a median ridge on the head and abdomen.

In Bate's reconstruction four abdominal somites and a telson are added which make the fossil appear like an Amphipod but Geinitz and in fact Bate himself figured what are obviously the basal portions of the

uropods on the sides of the second abdominal somite. This observation, in conjunction with the fact that only the two abdominal segments have been found, in identical relative position in all known specimens, makes it clear that the first segment represents the fused abdominal segments 1-5. A drawing of the only known fossil Phreatoicoid (fig. 1b) in which the sutures between these somites are omitted, demonstrates the striking resemblance between *Palaeocrangon* and the Phreatoicoids. Fusion of abdominal somites does not occur in recent Phreatoicoids but it is known in the suborders Flabellifera and Valvifera. It is not a primitive character and for this reason *Palaeocrangon* must be excluded from the Phreatoicoidea and placed between them and the higher suborders of the Isopods. According to Nicholls (1943-4) "the closest relationship (of the Phreatoicoidea) within the Isopods would appear to be with the Cirolanidae rather than with the Asellota. To non-Isopodan groups, the Amphisopidae seem nearest akin to the Apsseudidae (Tanaidacea), and since these latter are presumably representative of a more primitive stock of the Peracarida, with possible relationships to the Amphipoda, the resemblance of the Phreatoicoids to the Amphipodan type may be indicative of parallelism in evolution in forms derived from a common stock rather than, as Chilton has maintained, merely a superficial resemblance due to convergent evolution".

The occurrence of the primitive *Palaeocrangon* with pronounced Phreatoicoid affinities in the Permian is in good agreement with these views.

In a supplementary note to his paper, Nicholls (1944, p. 155-6) expresses the opinion that *Acanthotelson* forms a link between the Syncarida and the Phreatoicoidea and that the family Acanthotelsonidae might even be included in this suborder. This is particularly interesting in connection with Calman's statement (1933) on possible relations of the Syncarida, through the Acanthotelsonidae, with *Anthracoecaris* which has characters that could be expected to occur in the ancestors of the Tanaidacea.

It is likely that the Orders Tanaidacea, Isopoda (through *Palaeocrangon* and the early Phreatoicoidea) and possibly also Amphipoda (of which no definite pre-Tertiary fossil representatives are known) are related to early Anaspidae by way of the Acanthotelsonidae.

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G. Brown

RECORDS
OF THE
SOUTH AUSTRALIAN MUSEUM

Vol. XIII, No. 2

Published by The Museum Board, and edited by the Museum Director

Adelaide, 15th August, 1958

Printed in Australia by W. L. HAWES, Government Printer, Adelaide

Registered in Australia for transmission by post as a periodical

ABORIGINAL CAVE PAINTINGS AT SLEISBECK, NORTHERN AUSTRALIA

*BY CHARLES P. MOUNTFORD,
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Summary

This paper records aboriginal cave paintings adjacent to the Sleisbeck uranium mining field. This field is situated on the western edge of the Arnhem Land plateau near the headwaters of the Katherine River (text fig. 1).

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Plates viii to xv and text fig. 1

INTRODUCTION

This paper records aboriginal cave paintings adjacent to the Sleisbeck uranium mining field. This field is situated on the western edge of the Arnhem Land plateau near the headwaters of the Katherine River (text fig. 1).

The cave paintings of western Arnhem Land, particularly those at Oenpelli, early attracted the attention of investigators. Spencer, who saw those paintings in 1912, mentioned them briefly in his book (1914, p. 432). In his next book (Spencer, 1928), he illustrated several groups of the cave paintings at the same locality (fig. 538-40, pp. 823-4). Except for two photographs by W. R. Penniford, published by Tindale (1928 pl. i, pp. 35-6), no other illustrated records were made of these paintings until the publication of a survey of the cave paintings at Unbalanja Hill, Oenpelli and those of the adjacent localities of Cannon Hill, Inagurdurwil and Obiri (Mountford, 1956, pl. 34-48, fig. 11-55, pp. 109-181).

The Oenpelli art area is one of the most interesting in Arnhem Land, if not in Australia. Although there are a number of specialized forms in the area (Mountford, 1956, pp. 256-264), two forms predominate:—(a) a polychrome "X-ray art" in which the aboriginal not only paints what he sees of the external form of the creature, but also what he knows to be there, but cannot see, *i.e.*, the heart, lungs, intestines, and skeleton (Mountford, 1956, pl. 39F is typical); (b) a monochromatic art, which shows man in action—running, fighting or throwing spears. These latter paintings, always in red, and usually in single line, are supposed, by the aborigines, to be the work of a fairy-like people, called the *Mimi*, who still live in the rocky plateau (Mountford, 1956, fig. 14A, C, p. 112).

The writer has seen many thousands of paintings in and around Oenpelli, and knows of, but has not been able to investigate, other

groups north of Oenpelli, *i.e.*, at Coopers Creek, Tor Rock and Nimbawah (text fig. 1). It seemed reasonable to suppose, therefore, that there would be groups of cave paintings along the face of the Arnhem Land plateau to the south of Oenpelli.

Whilst the writer was in charge of the 1954 National Geographic expedition, at Melville Island, Dr. George Sleis, a geologist attached to the Northern Australian Uranium Company, sent a message informing me that he had found cave paintings near the Sleisbeck uranium field. Through the kindness of Mr. T. Becker, the field manager for

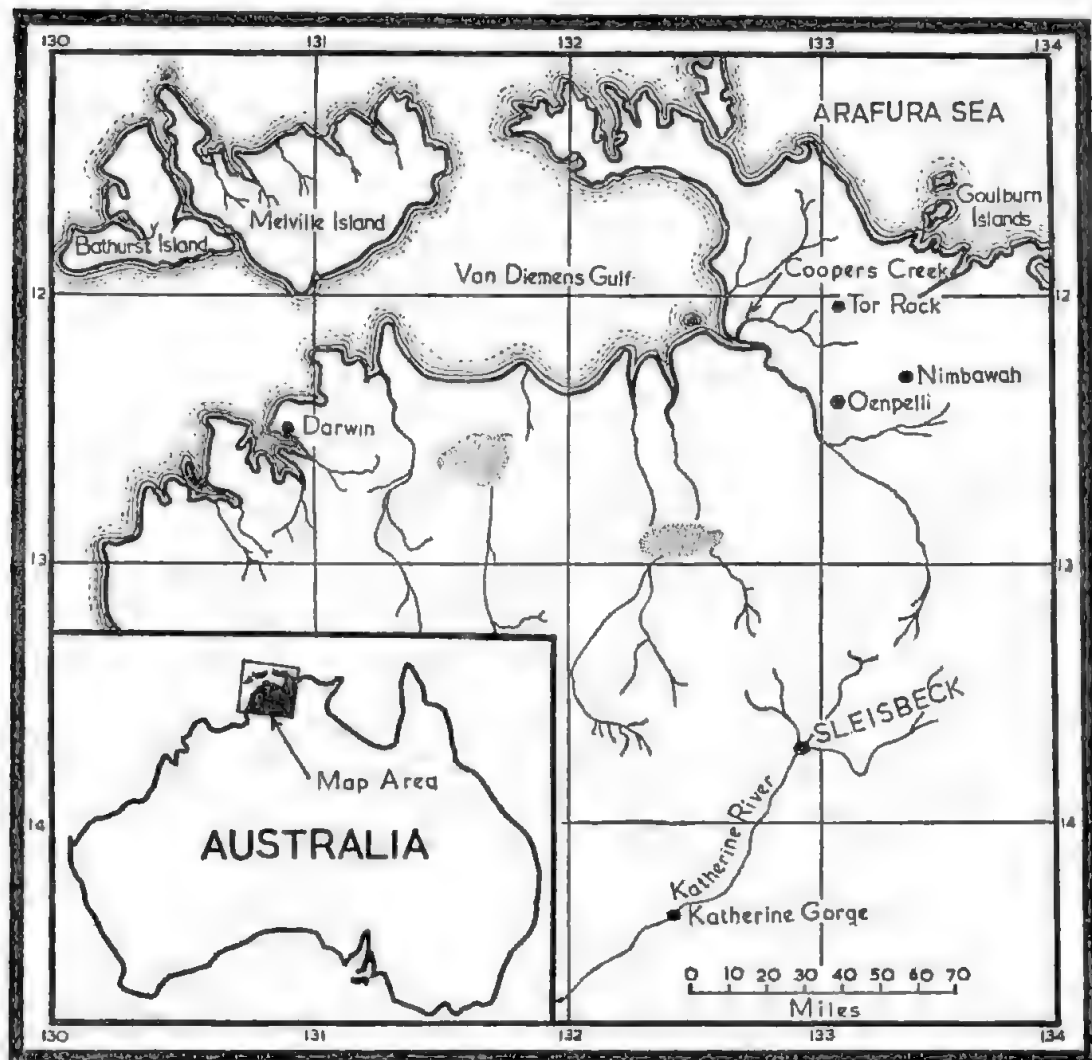


Fig. 1. Map showing location of Sleisbeck.

Sleisbeck, I was able, on my return to Darwin, to visit the locality and examine the paintings found by Dr. Sleis.

There were two groups; site 1, about five miles in an easterly direction and site 2, within a mile of the mining settlement. The paintings at the latter site are few and badly eroded.

At site 1 (pl. viii, A) in one of the residuals of the plateau, a deep horizontal cleft, *a*, provided an excellent camping place for the aborigines during the monsoon season. In their leisure time the aborigines had painted a large number of designs on both the ceiling and walls of that shelter. On some parts of the ceiling, as illustrated on pl. viii, B, much overpainting has made it difficult to differentiate some of the designs from others. In other places, where the paintings were more widely spaced, they tended to appear in groups.

The majority of the designs are painted in white, sometimes outlined in red, although there are a few in solid red; no designs in yellow or black were seen. This unequal distribution is due probably to a scarcity of the yellow and black pigments.

Unfortunately there were no aborigines in the locality at the time of the visit to the paintings. There is little doubt, however, that had some of the older aborigines been present they would not only have been able to explain the meanings of some of the paintings, but possibly to have related some of the associated myths.

Techniques of recording.—As at Oenpelli (Mountford, 1956, p. 178), the writer used the camera exclusively for recording, photographing in both monochrome and colour. On his return to the southern States, he first enlarged the photographs, then made tracings from them. From these tracings, Miss Patricia Catcheside prepared the accompanying illustrations.

DESCRIPTION OF THE PAINTINGS

Plate ix

A is a dancing figure which appears to be wearing a feather head-dress.

At C is a woman with a claw-like hand. The right side of her body is over-painted by an emu, outlined in white. There appears a goanna on the right and another emu on the lower left of the main figure.

D is a sea-going crocodile (white, outlined in red), painted in a simple form of "X-ray art." The tail is turned sideways to show the serrated crest.

A cat-fish at E is the best example of "X-ray art" in the Sleisbeck group. Underneath the main figure is a simple representation of another fish.

F, G, H and K are curious human figures in positions suggestive of dancing.

At J are two human figures. The one on the left, a male, has distended elbow joints which are similar to figures of men and women depicted on some of the cave and bark paintings at Oenpelli (Mountford, 1956, pl. 51, C and F). These curious "joint marks" have a wide distribution throughout Oceania (Schuster, 1951). On the right of the group is a painting of a woman whose limbs are dissociated from her body. In Australian primitive art, this characteristic is not unusual. Mountford (1937a, fig. 2), illustrates an aboriginal crayon drawing from eastern Western Australia in which parts of the body are dissociated. Boaz (1955, Part 3), also refers to many similar examples in the art of the Indians of the Pacific Coast of North America. The legs and arms at J are in the same position as the "hocker" figures in the Oenpelli area (Mountford, 1956, figs. 29 and 43).

H is an "X-ray" painting of a kangaroo in which the heart and lungs only are indicated. On the right and lower left are small human figures; on the lower right is a male "hocker" figure.

Plate x

A, an unidentified snake, partly covers a badly eroded human figure. The lower part of the snake is painted in simple "X-ray art."

B and C are paintings of the long-necked freshwater tortoise.

D is a goanna, a large reptile which the aborigines value as food.

E almost certainly represents a cat-fish, although the fleshy tentacles at the mouth are not indicated.

Group F consists of an unidentified fish and a headless kangaroo.

G is some kangaroo-like creature, while J is a bird; H and N are unidentified.

At K, the group consists of a squatting man, a fish and possibly a kangaroo.

L, a thick-tailed lizard, is probably one of the larger skinks, and at M is a line of nine fish, painted along a narrow ledge of rock.

Plate xi

On this plate are several groups of distorted figures whose positions are suggestive of dancing.

At A is depicted an attractive group of three human beings in white, outlined in red; two of them are women.

B, a dancing woman with an elongated body, has a bar across her face (perhaps some form of head-dress), and her breasts, pubes and knees decorated with lines and dots of red paint. C is a woman with long arms, short body and a curiously shaped head. D is another long-bodied woman of a type common at both Sleisbeck and at Oenpelli. Those previously recorded by Mountford (1956, fig. 18J and 32C), are typical of the Oenpelli area.

E is a curiously distorted human being with twisted arms and legs.

The hollow-bodied woman at F is similar to those recorded by Mountford (1938, fig. 36), from Napier-Broome Bay, Western Australia, and from the Oenpelli area (1956, fig. 21 and 28A).

G, K, L and N show male figures with much enlarged sex organs. The limbs of L are in the form of a "hocker" while those of M have swollen elbow joints, similar to the "joint marks" mentioned earlier.

The dancing woman at H, although somewhat eroded, indicates considerable movement.

J, a male figure, about ten feet in length, is wearing a head-dress. The figure has been painted on the lower edge of a projecting horizontal ledge of rock.

The painting at M is the only example observed at Sleisbeck that bears a slight resemblance to the running figures, either in the Oenpelli area (Mountford, 1956, fig. 12, 13, 31, 44, and 47), or those in the area of Napier-Broome Bay, in Western Australia (Mountford, 1937, fig. 2).

Plate xii

This plate illustrates an unusual group of human figures, most of which are painted in white and outlined in red. The man, whose head has disappeared through erosion, was several feet long. To the upper right of the man is a long-bodied woman and, at his feet, are two other well-executed long-bodied women and an unidentified bird. To the left, opposite the lower group of women is a design in white which probably represents a man wearing some form of head-dress; on the extreme left is an imperfect representation of some animal, perhaps an echidna.

Plate xiii

This plate illustrates some of the animals, birds and reptiles at site 1.

A is one of the larger wading birds. The artist has drawn the head inward so that the painting fits into the available space.

B, painted in red, and outlined with white, depicts one of the wallaby-like creatures. Above the wallaby are two drawings, in red, of human footprints.

A good example of a fish, painted in "X-ray art," is shown at C. This fish is, most probably, the freshwater skip-jack (see Oenpelli painting, Mountford, 1956, pl. 79A, for comparison). The fish covers the feet of a rare black wallaby (*Osphranter bernardus*), identified by the brush on its tail (Mountford, 1956, pl. 73B, p. 244).

D is a simple "X-ray" painting of a snake, and E, painted on an exposed vertical face of rock, illustrates an attractive, but somewhat eroded group of three kangaroo-like creatures. The smallest creature, on the right, has spines on its tail similar to the painting illustrated at F. This creature, with spines projecting from its mouth, legs, body and tail possibly illustrates one of the mythical beings, such as the *Nadubi* in the Oenpelli area. When one of the *Nadubi* observes an aboriginal travelling by himself, it kills the man by projecting into his body one of its many spines (see Mountford, 1956, pl. 58B, p. 203).

G, painted in red lines, and L and J, painted in white, are unidentified kangaroo-like creatures.

The group shown at K were the only paintings at site 2 that could be photographed successfully. They represent three long-necked freshwater tortoises.

Plate xiv

All the figures illustrated on this plate (except H, which is in red), were painted with white pigments.

At A is a distorted figure, a series of dots, and a small wallaby. The figures at B, a female and possibly a male, have their legs turned backwards towards the shoulders in the same manner as the much-feared *Mamandi* spirit people of the Oenpelli area (Mountford, pl. 58B, fig. 29, 45D, p. 197). The woman is holding a spear in her hand.

C is also a distorted man or woman similar to that shown on pl. xi, C. On the right is an eroded painting of a human figure.

A curious painting of a human figure without a body is shown at D. The legs and one arm originate at the shoulders; the other arm, with two hands, starts at the head of the figure. The elbow joints are enlarged in a similar manner to those of the painting depicted on pl. xi, N. The designs on either side cannot be identified.

At E are two men, or women, with hands upraised as if taking part in a dance. The figure on the right is wearing a head-dress.

The group at F can be seen on the lower left of plate xv. On the upper left of this group are two "hocker" figures; on the upper right, is a man with a much enlarged penis and, on the lower left, are two long-bodied figures with hands interlocked. There are also two unidentified birds on the lower left. G and J show two human figures in a squatting position, the lower left figure having an enlarged penis. The woman at K, with her limbs in the form of a "hocker," is wearing a head-dress.

Plate xv

This complex group, situated on the ceiling of the shelter, is somewhat separated from the majority of the paintings. Although at first sight the group appeared to illustrate some mythical story, a closer examination revealed that considerable overpainting had been carried out at different periods.

There are arm ornaments hanging from the elbows and upper right arm of the central figure, A, and decorations at its knees⁽¹⁾ and around its head.

At B, C and M are paintings of fish, C being most likely the skip-jack (see also pl. xiii, C).

D may be either a lizard or a badly drawn man, while on the right, at E, is a group of long-bodied men and women.

A man, F, partly obscured by the main figure, is holding in his hand an object, L, which resembles the goose-wing fan, called *norkun*, which the Oenpelli people often depict in their paintings (Mountford, 1956, fig. 47B, 52B, and 53).

At J is a long-bodied man in a sitting position; G and H, the figures on the lower left, have already been described in association with plate xiv.

(1) The aborigines of South Australia perform certain ceremonies with bundles of leaves tied to their knees (Angas, 1847, pl. 5, No. 4).

DISCUSSION

An examination of the cave paintings indicates that the art of Arnhem Land changes rapidly from north to south.

In the Oenpelli area, the "X-ray" paintings of creatures and men are particularly numerous, both in the caves and on the bark paintings. Although this "X-ray art" is common in the bark paintings of Goulburn Island, about sixty miles to the north of Oenpelli (Mountford, 1937), the designs are much simpler and not by any means as numerous at Sleisbeek, less than a hundred miles south of Oenpelli (text fig. 1). Further south, the representational art of Arnhem Land is soon absorbed by the abstract, conventionalized art of Central Australia. At Sleisbeek, with the possible exception of pl. xi, M, there is an absence of the single-line *Mimi* running figures, so characteristic of some phases of the cave art of Oenpelli.

On the other hand, the long-bodied and distorted figures, dominating the cave paintings of Sleisbeek, form but a small proportion of the designs in the caves at Oenpelli. The writer has examined photographs of similar long-bodied human forms painted on the walls of the Katherine gorge, about sixty miles south of Sleisbeek (text fig. 1).

Two other interesting figures with a wide distribution in Oceania, *i.e.*, the "hocker" figures and those with "joint marks" (distended joints), appear to be present in equal proportions at both Sleisbeek and Oenpelli.

SUMMARY

This paper records cave paintings on the headwaters of the Katherine River, and adjacent to the Sleisbeek uranium field in the Northern Territory of Australia. The paintings are illustrated and their resemblances to those at Oenpelli and other Australian localities are discussed.

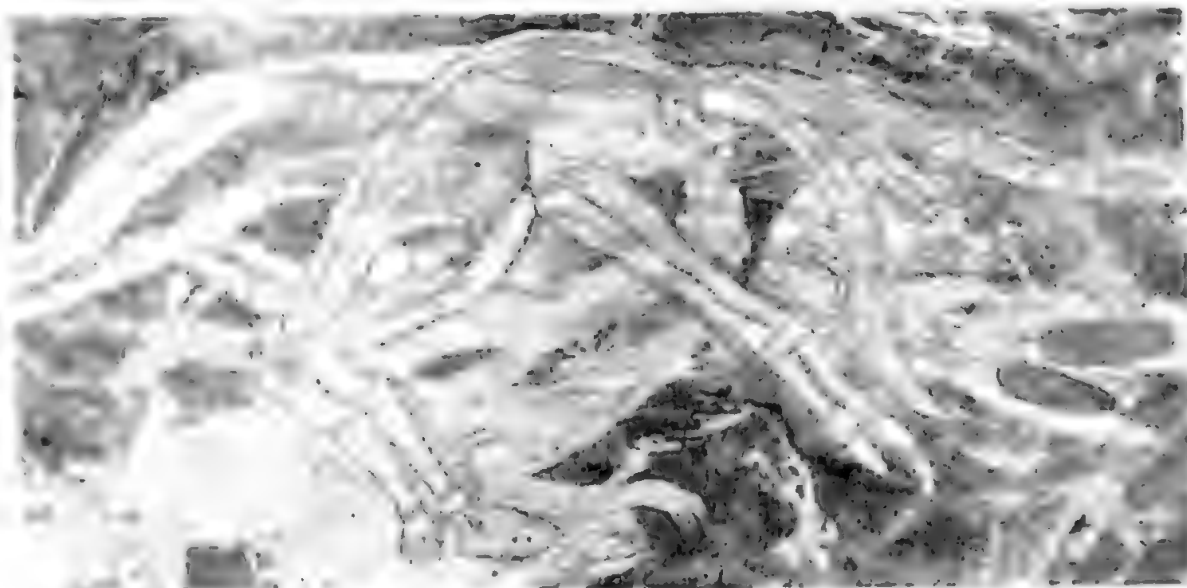
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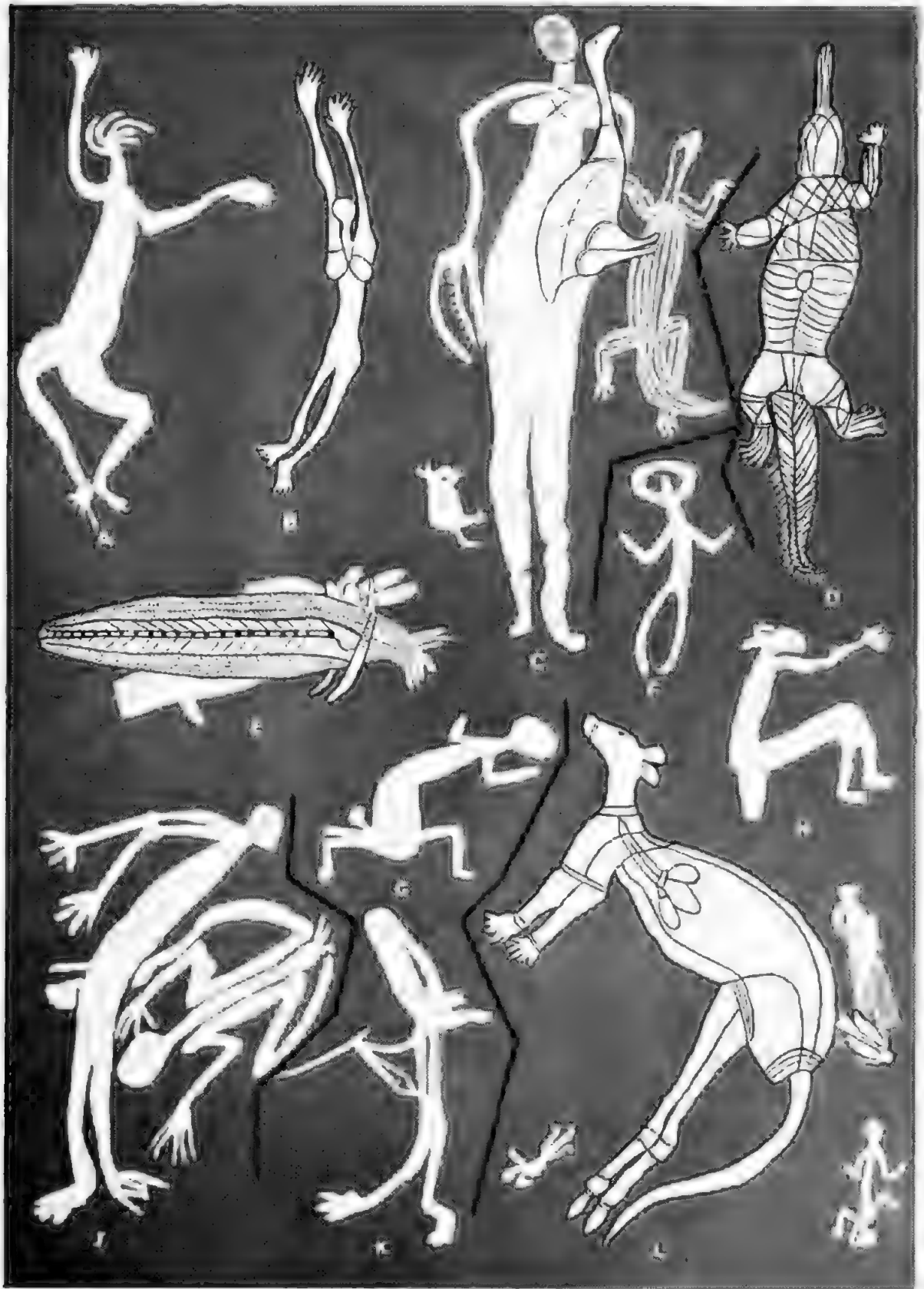


A

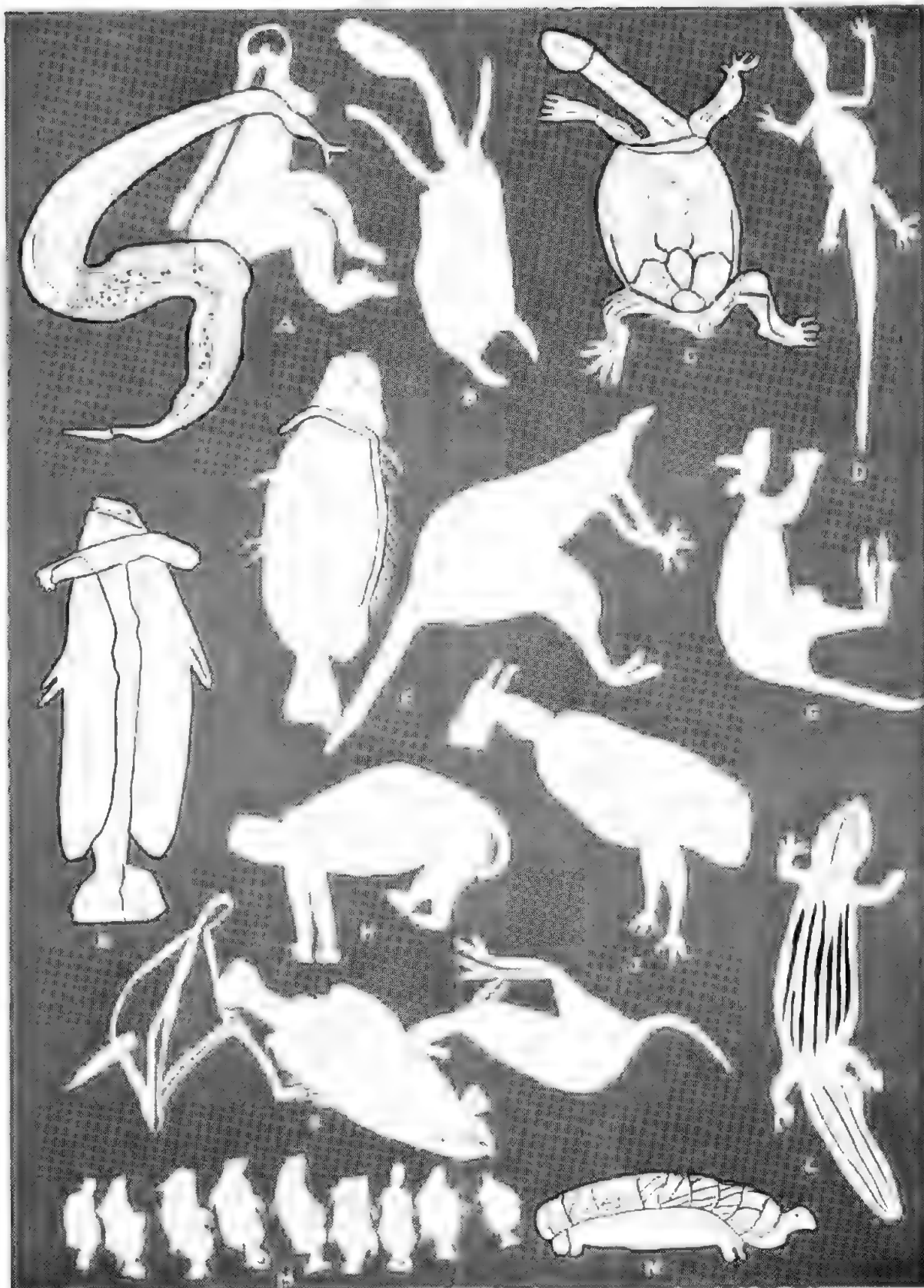


B

Cave Paintings at Shisheek. A, site; B, painted ceiling of above.



Cave Paintings at S.M. 1. Shaded



Cave Paintings at Site 1, Sleislock.

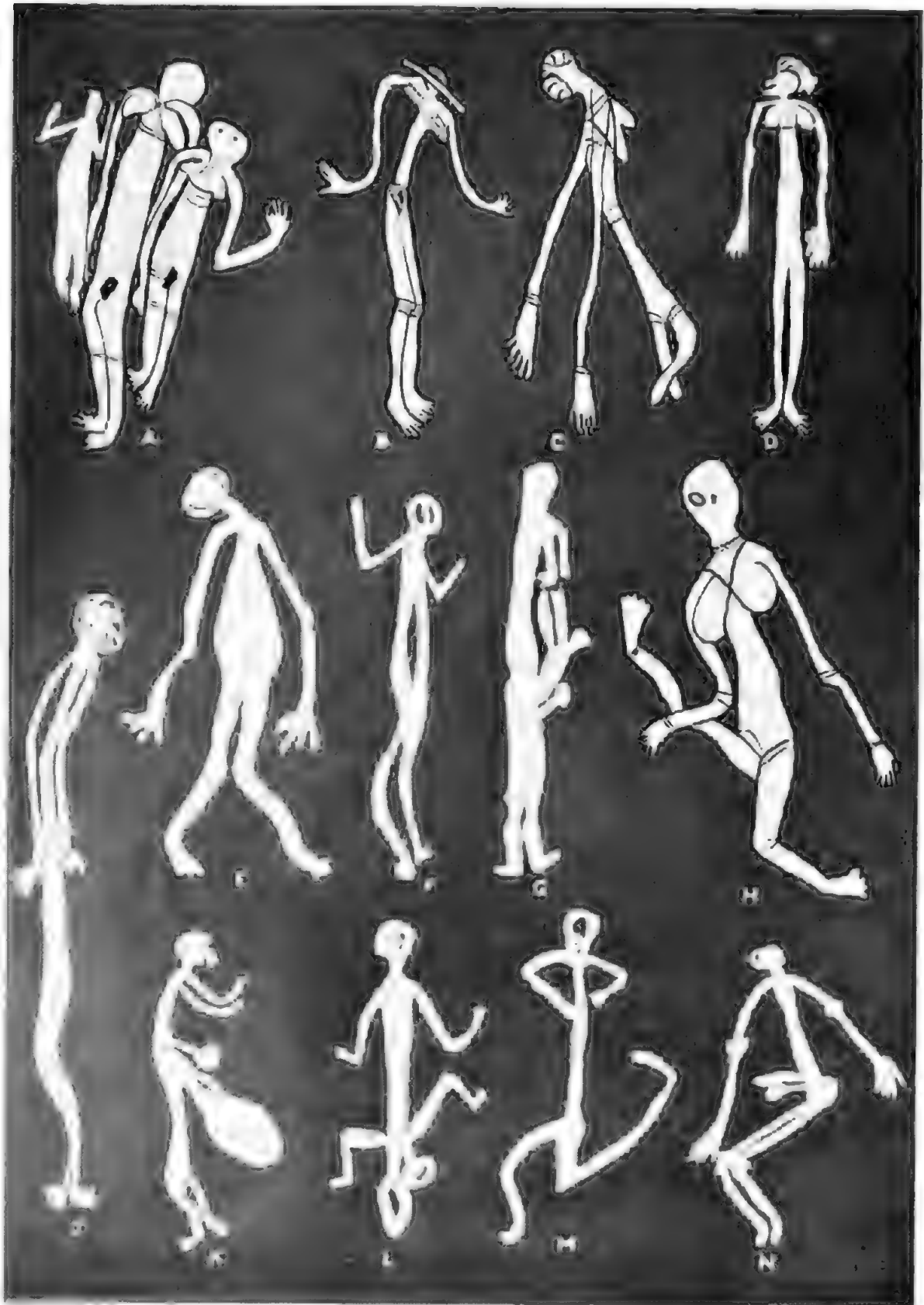
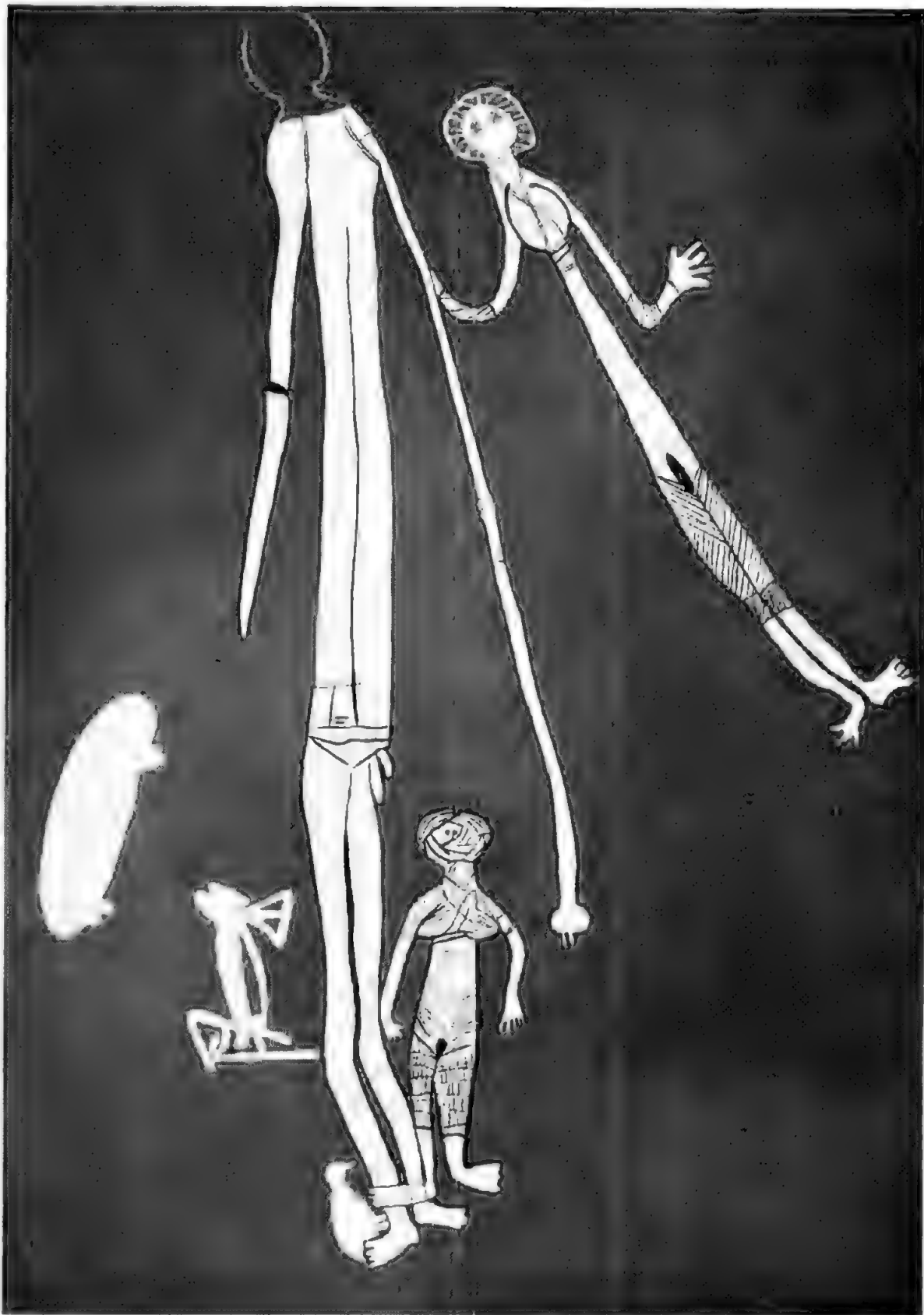


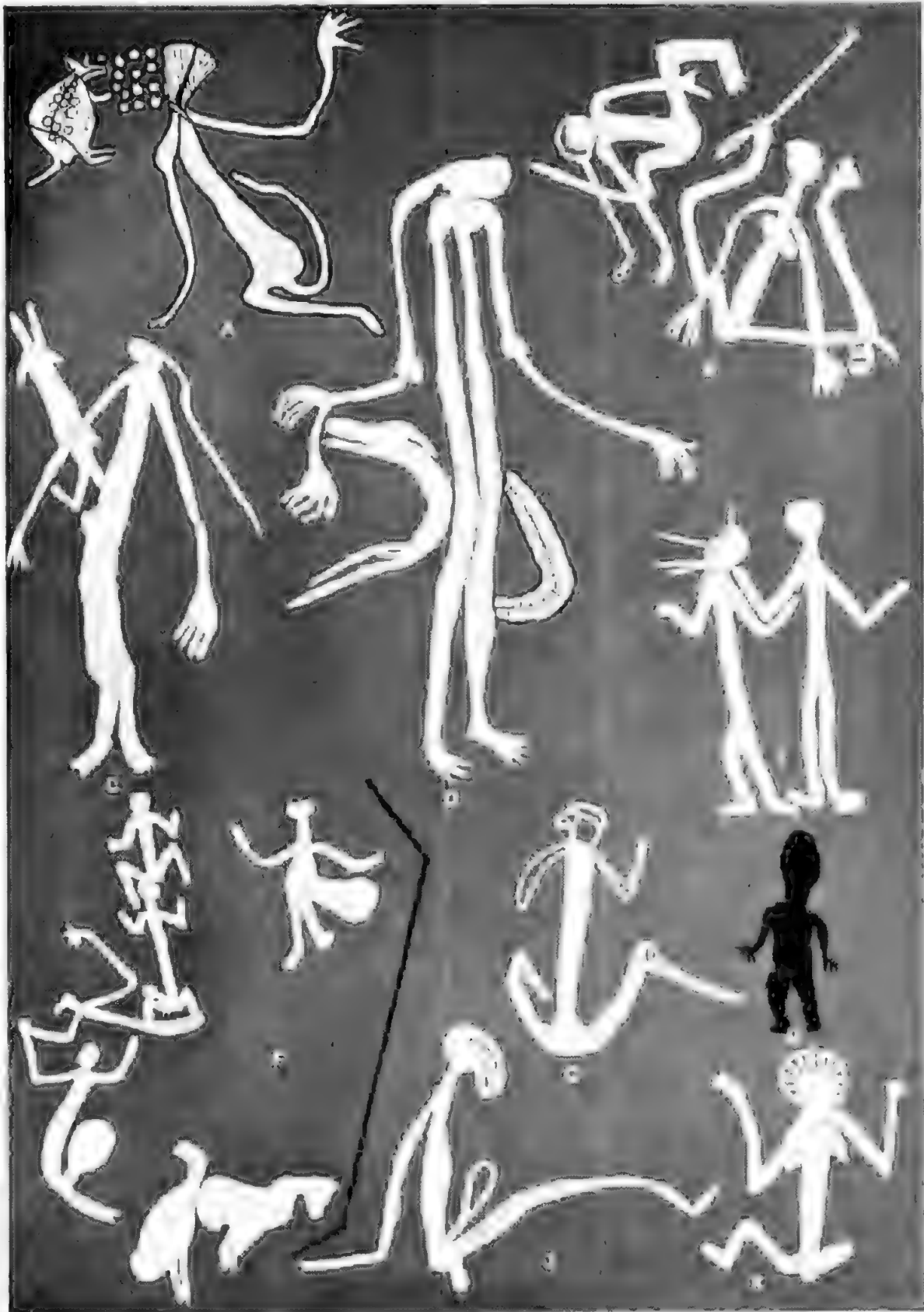
Fig. 1. Postures of the F. S. J. 1910.



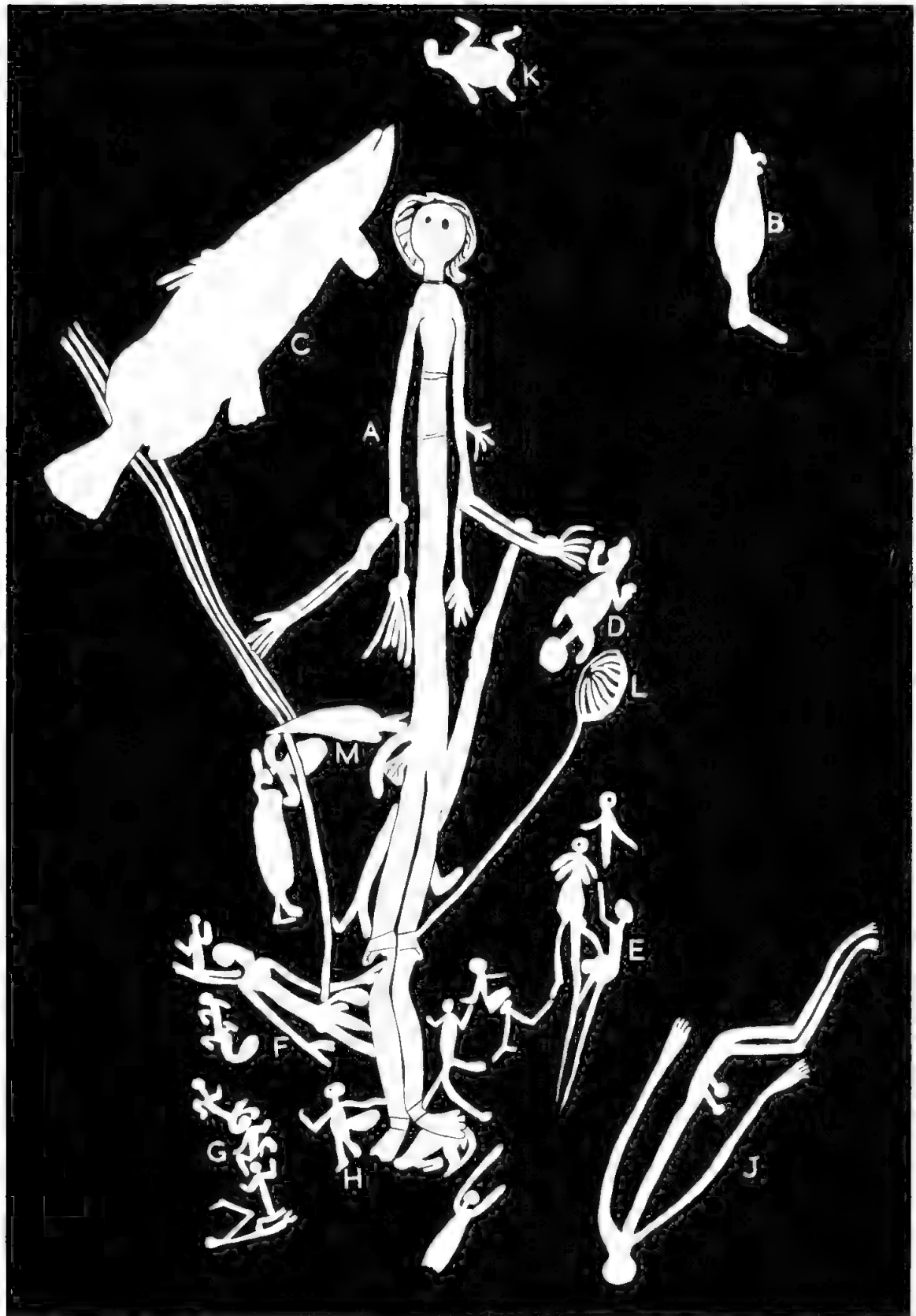
Cave Paintings of Site I, Gibraltar



Cave Paintings at Sites 1 and 2, Fleischlock



Cave Paintings at Site A, 1910-1911



Cave Paintings at Site 1, Sleisboek

**REVISION OF THE GHOST MOTHS
(LEPIDOPTERA HOMONEURA, FAMILY HEPIALIDAE)
PART VII**

BY NORMAN B. TINDALE, B.Sc., SOUTH AUSTRALIAN MUSEUM

Summary

Part VI of this revision was published in these Records, vol. XI, no. 4, 1955, pp. 307-344. The various genera of the family Hepialidae are being revised as opportunities offer; it is intended when the series is complete to discuss their mutual relationships.

**REVISION OF THE GHOST MOTHS (LEPIDOPTERA
HOMONEURA, FAMILY HEPIALIDAE)**

PART VII

By NORMAN B. TINDALE, B.Sc., SOUTH AUSTRALIAN MUSEUM

Plates xvi-xxiii and text fig. 1-35

INTRODUCTION

Part VI of this revision was published in these Records, vol. XI, no. 4, 1955, pp. 307-344. The various genera of the family Hepialidae are being revised as opportunities offer; it is intended when the series is complete to discuss their mutual relationships.

Genus *Endoclita*

In Part IV of this Revision (Tindale 1941, v. VII, pp. 18-39) the Indian members of this genus were discussed. To these are now added those species whose ranges extend to Indonesia, South-East Asia and the islands off the coast of East Asia as far north as Japan. Twenty-nine species are discussed, of which fifteen are described and figured as new.

It may be of interest to note that few members of the genus *Endoclita* seem to live east of Wallace's Line, where the genus *Oenetus* tends to replace it. *E. sibelae* Roepke 1935, the only reported species, which may be an exception, is from Batjan. It has not been examined. In general the species are relict ones and those of adjoining areas, though clearly related, have, from long isolation, become genetically so far sundered as to represent distinct species. Even forms seemingly very close in general appearance may be separated readily on examination of genital structures and wing venation, etc.

Little is known about their life histories. Of most of the species only a relatively few examples ever have been taken, and most of these have been captured only as a result of casual encounter, rather than after systematic search for them. Even the bringing together, on loan, of much of the available new material has yielded only meagre series upon which to base the study.

The status of the genus *Endoclita* has been discussed earlier and there is little to add. In some of the East Asian species the curious local expansion of the costa of fore-wing in the region of Sc_1 is at a maximum; elsewhere it has been suggested that this character cannot be used with any satisfaction to give separation of those possessing it, with full generic rank. The valid name *Hypophassus* is available for use by anyone who may see fit to employ it as a subgeneric tag.

Study of East Asian species suggests that some small variations occur in the positions of the cross veins. Thus in the fore-wings of *E. hosei* m vein appears just beyond the fork of M_1 and M_2 , instead of before it as in the genotype, while similar variations occur also in the hindwings of this and other species. There is also variation in the number of vannal veins in the hindwing, especially in females. In this sex there is a tendency for the development of two strong veins after Cu_2 with occasional traces of a short third one near base of wing. These veins are probably respectively PCu , $1V$ and $2V$. In other species only one such vein extends to the margin of the wing. In such species it seems generally to be that PCu is lost or developed only near the base of the wing and $1V$ is the strong vein extending to the margin while $2V$ may be reduced to a short stub near the base.

There is also some variation in the dimensions of the posterior legs, which in general tend to be reduced in size and to possess a specialized plume of hairs on the tibiae. In some species these hairs are found to be concealed in a fold of the integument of the thorax, in others the plume is large and in all available specimens is found fully displayed. Because of the poor condition of most of the specimens which are taken it is not always clear whether the difference between concealed and displayed male plumes is a real phenomenon or whether it is due merely to accidents of preservation. However the varying degree of reduction in the size of the posterior leg is of significance.

The genus is notable, in some species, for the enlarged eyes of the male and occasionally of the female. In this character they resemble members of the Australian and New Guinea genus *Oenetus* in which there also occurs every degree of enlargement of the male eyes. In that genus however it seems to reach a maximum.

The tendency to have enlarged eyes is not the only link between these two genera and it may be correct to say that *Oenetus* and *Endoclita* may be rather closely related with a tendency to replace each other east and west of Weber's or of Wallace's Line. Both genera

belong to that section of the family in which the larvae have a timber-boring habit and live principally in relatively wet, forested country, with a high, and year round rainfall. In general they are very vulnerable to periods of aridity. Some species extend to the temperate zone, as in Northern Japan and Tibet, but their true home seems to be in the wet tropics where their habitats appear to range from sea level near mountain ranges to altitudes of at least 6,500ft.

In the females of some species the anterior gonapophyses of the genitalia appear to be in some measure different on the two sides of the body. The condition is not unique in the family, for in some South American species the genitalia are so completely asymmetrical that it is hard to reconcile the two sides.

In this genus earlier authors were often confused by the similarities of wing marking in the species. They tended to pick out examples possessing the same general wing patterns, as species and later workers have tended to accept these wing pattern assemblages as species. Only through the study of characters of the genitalia has it been found that the several forms often found standing together in collections under one name label can be sorted out as discrete species. There sometimes has been uncertainty surrounding the identification of the one which should be linked with the original name and description, hence in the preparations for the present Revision most of the type specimens of the earlier described species have had to be sought out and re-examined. Only in the case of *E. annae* perhaps does some doubt remain as to the species intended to be described.

The Indian species of the genus were keyed in the earlier part of this revision. The following key, based almost entirely on the genitalia, gives only the East Asian forms dealt with in this paper. It is of necessity incomplete because the opposite sexes of some species are still unknown.

KEY TO THE EAST ASIAN AND INDONESIAN SPECIES
OF ENDOCLITA (based principally on the genitalia)

MALES

1. Tegumen of genitalia with a posterior, ventrally directed spine *marginotatus*
- Tegumen of genitalia without a posterior, ventrally directed spine 2

2. Tegumen in lateral view with ventral margin unarmed	3
Tegumen in lateral view with ventral margin armed	12
3. Margins of tegumen not widely apart at posterior extremity	4
Margins of tegumen widely apart at posterior extremity	5
4. Tegumen with more than two longitudinal keels	<i>paraja</i>
Tegumen with only two longitudinal keels . .	<i>javaensis</i>
5. Posterior margin of 8th sternite with distinctly angulate median notch	6
Posterior margin of 8th sternite without distinctly angulate median notch	7
6. Posterior margins of tegumen not touching posteriorly	<i>excrescens</i>
Posterior margins of tegumen touching posteriorly	<i>sinensis</i>
7. Teguminal margin curved	8
Teguminal margin straight	11
8. Teguminal margin forming an S curve	<i>camphorae</i>
Teguminal margin not forming an S curve . .	9
9. Sternite 8 strongly transverse	10
Sternite 8 nearly as long as wide	<i>aikasama</i>
10. Ventral lips of tegumen slenderly chitinized . .	<i>sericeus</i>
Ventral lips of tegumen stoutly chitinized	<i>aurifer</i>
11. Margins of tegumina parallel in posterior half (anterior half concealed)	<i>broma</i>
Margins of tegumina diverging from anterior to posterior extremity (anterior half not concealed)	<i>salvazi</i>
12. Spines on tegumen serially arranged	14
Spines on tegumen not serially arranged	13
13. Spines on tegumen in a double group	<i>aroura</i>
Spines on tegumen in a single group	<i>raapi</i>
14. Serial spines confined to anterior half of tegumen	<i>tosa</i>
Serial spines along most of margin	15

- | | |
|--|------------------|
| 10. Ventral eminence of 8th sternite much longer than wide | <i>warawita</i> |
| Ventral eminence of 8th sternite about as wide as long | 11 |
| 11. Posterior gonapophyses attenuated posteriorly | <i>williamsi</i> |
| Posterior gonapophyses broadened posteriorly | 12 |
| 12. Sides of 7th sternite parallel | <i>taranu</i> |
| Sides of 7th sternite converging towards anterior margin | <i>hosei</i> |
| 13. Anterior gonapophyses longer than wide . . . | <i>kara</i> |
| Anterior gonapophyses wider than long | <i>ijereja</i> |

Females either unknown or not keyed:—

marginotatus, paraja, javaensis, sinensis, aikasama, aurifer, bromia, salvazi, raapi, tosa, niger, crenilimbata, annae, sibelae, dirschi, niphonica.

Endoclita marginotatus (Leech)

This species was referred to and figured in the earlier part of my revision (1941, p. 22 and fig. 15); there is nothing fresh to add; it is keyed herein so that all the known Chinese species are mentioned.

Endoclita paraja sp. nov.

Plate xvi, fig. 1 and text fig. 1

Male: Antennae threadlike, short; head with eyes only moderately large, head, thorax, abdomen, except base, fuscous brown, legs and base of abdomen paler; posterior legs of moderate size, with large tibial plume of orange-yellow hairs. Forewing straight to Sc_1 , then strongly excavate before tip, apex falcate, termen and inner margin somewhat sinuate; im vein touching M forks at both ends, wing colour chocolate-brown with paler, somewhat iridescent transverse bands in anal and terminal areas and a triangular patch at about one-half length of cell; a cluster of three small black-rimmed silvery-white spots around junction of rm vein with M_1 and another set of three at basal M fork, two other tiny spots half way between rm vein and termen; a notable dark patch at point of obsolescence of Cu_2 , also traces of dark marks along costa. Hindwings with costal margin slightly concave, apex subfalcate, termen angled, im vein as in forewing; vannal region with PCu obsolete except at base, 1V and 2V both present, the latter a short

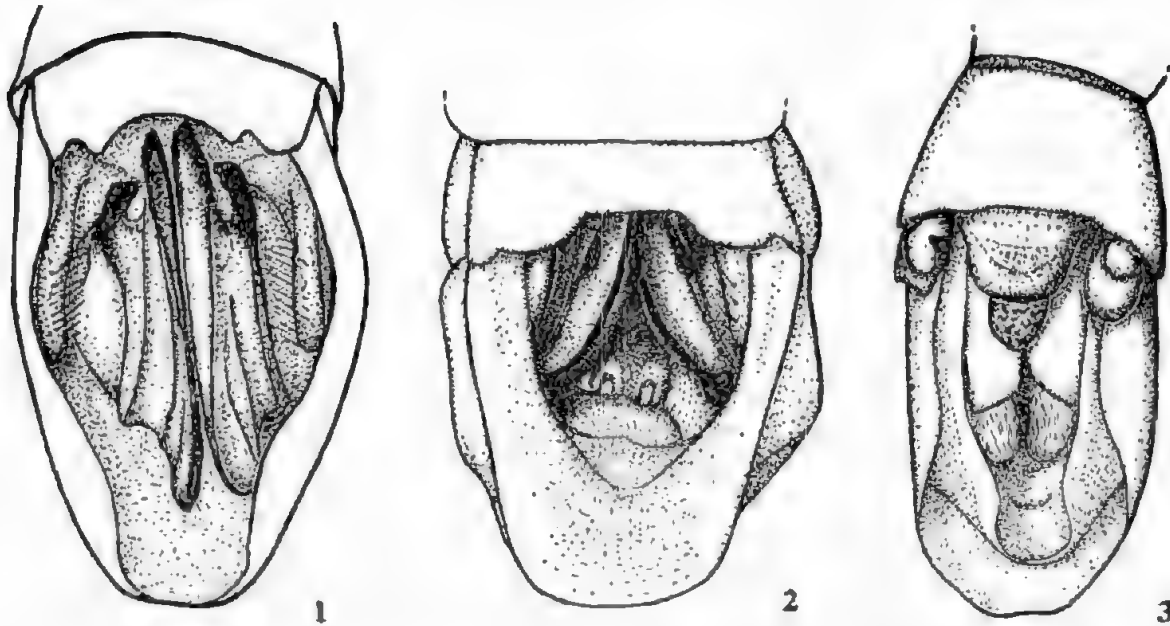


Fig. 1-3. 1. *Endoclyta paraja* Tindale, Borneo (?), male genitalia, ventral aspect. 2. *Endoclyta ezercacens* (Butler), Japan (Loomis), male genitalia, ventral aspect. 3. Female, Mt. Takao, genitalia, ventral aspect.

vein; tip of wing coloured as in forewing, with a single black-rimmed silvery spot just below R_2 near tip; rest of wing an iridescent purplish-blue in many angles of light, gray in others; the termen somewhat less iridescent, vannal region and base clothed in grayish-brown hairs. Wings beneath with traces of dark-brown spots along costa, otherwise dull iridescent purple, or grayish-brown, depending upon angle of view. Wing length 40 mm., expanse 85 mm.

Loc. Unknown (?Borneo) a male in Tring Collection at British Museum.

The only known example was found among Tring Museum duplicates with deficient locality data, but is believed to have come from Borneo.

The male genitalia (fig. 1) have the 8th sternite transverse with a median large notch and two smaller side notches on the posterior margin. The tegumen is large, in lateral view it shows rather an evenly curved silhouette with smooth margin; in ventral view the two teguminal plates are carried close together in the midline and show side ridges, one of which terminates anteriorly in a strong process; the harpes, so far as they may be seen, are simple, with a brush of forwardly directed hairs.

In the form of the genitalia this species bears some distant relationship to *E. javaensis* but that species has a far more delicately formed tegumen, without lateral keels and strong antero-lateral processes.

The species is characterized by the presence of the most brilliant purplish-blue, almost violet flush yet seen on the hindwings of any member of the genus. A similar example in the British Museum, which I have not been able to study in detail, may belong to the same species. It is labelled as from Borneo, and this may well confirm the place of origin of the specimen described above. It is similar to *E. tosa* of Java in its wing patterns but the genitalia show a double ridged tegumen instead of the simple one of that species; the hind margin of the 8th sternite shows three notches instead of one.

***Endoclita javaensis* Viette**

Endoclita javaensis Viette 1950, Bull. Inst. roy. des Sc. nat. de Belgique, 26 (41) p. 1; fig. 1 (genitalia).

Loc. East Java: Nongkodjadjar, Tengger, 1 Dec. 1933 4,000ft. (type, a male, unique, expanse 77 mm., in coll. Institute royal des Sciences naturelles de Belgique, I.G. 10.706).

This species has not been examined.

There is stated to be a costal swelling on the forewing; and the male genitalia, as figured, have the tegumen furnished with two anteriorly directed blunt processes and a ventral keel which presents a simple outline. So far as may be judged by the description and figure this species is nearest to *E. paraja*, which differs in having large antero-lateral processes on the tegumen and a very robust ventral keel.

***Endoclita excrescens* (Butler)**

Plate xvi, fig. 2 and text fig. 2-3

Hepialus excrescens Butler 1877, Ann. Mag. Nat. Hist. xx, p. 482 (female, not a male); Butler 1878, Ill. Lep. Het. B.M. ii, p. 20, pl. 27, f. 7.

Phassus aemulus Butler 1877, Ann. Mag. Nat. Hist. xx, p. 482 (male): Butler 1878, Ill. Lep. Het. B.M. ii, p. 20, pl. 27, f. 8.

Hepialus excrescens Leech, 1888, Proc. Zool. Soc. Lond., p. 645.

Hepialus excrescens Staudinger, 1892, Romanoff, Mem. Lep. (8), p. 289.

Phassus herzi Pfitzner, 1912, Seitz Macrolep. ii, p. 438, pl. 54a (*nec.* Fixsen).

Phassus excrescens Pfitzner and Gaede 1933, Seitz Macrolep. x, p. 842.

Male. Antennae thread-like, tapering, of about 22 segments, pale-brown; eyes normal; head rough-haired; head, thorax and abdomen above pale brown, bases of antennae, sides of thorax, and legs a richer orange-brown; posterior legs not reduced; a large tibial tuft of bright orange hairs present. Forewings with costal margin rather straight, a scarcely noticeable elevation in region of Sc_1 ; termen and inner margin forming a single even curve; im vein touching forks at both ends; wing colour warm brown with pale grayish-fawn marking and bands, many outlined narrowly in black. Hindwings with costa sinuate and narrowly bordered with colour and markings of forewing; rest of wing dull gray with only slight traces of a bronzy lustre when viewed from special angles; inner area with only Cu_2 and one vannal vein present, as in the genotype. Wing length 34 mm., expanse 74 mm.

Female. Similar to male in colour and markings. Posterior legs slightly reduced in size but without specialized plumes on tibiae. Forewings with im vein shortly before fork of M_1 and M_2 . Hindwing with Cu_2 , Pen , 1V and 2V veins all well developed and extending to margin. Wing length 42 mm., expanse 90 mm.

Loc. Japan: Yokohama (type, a female, collected by Jones, expanse 69mm., and a male, same details, expanse 76mm., described as type of *aemulus*, in British Museum). Yokohama, 25 Sept., 5 Oct. and 9 Oct. 1910; and Oiwake (Berlin Museum): Sugita, 11 Oct. 1889 and Kagoshima, Nov. 1898 (Tring Collection at British Museum), Ussuitoge near Mt. Asama, 2 Aug. 1916; Karnizawa, July 1914 (W. J. Holland) and Mitsukuri (United States National Museum) Tobetsu, Hokkaido, Sept.-Oct. 1903 (A. E. Wileman); Kyushu (J. H. Leech Collection in British Museum) Mt. Takao, 25 Sept. 1926 (Cornell University Collection) Ussuri; Chibarook, 2 Aug. 1911, a female (Tring Collection at British Museum).

The male example particularly described and figured in this paper is from Japan, probably Yokohama, and is from the Dr. H. Loomis Collection. It has been compared and agrees very exactly in size, colour and markings with type of *aemulus*, which is the opposite sex of the type of *E. excrescens*, which was wrongly considered also to be a male, but is a rather impoverished female. In the Berlin Museum there are two similar males, from Yokohama, presumably also taken by Dr. Loomis, although they are variously ascribed to "Laomis" and "Laom". The present author recalls with appreciation the encouragement he received from Dr. Loomis in his boyhood collecting efforts in Japan in 1914-1915.

A female from Mt. Takao is described, it also has been compared with the types, and differs from the type female only in its more normal size.

The male genitalia, as drawn without dissection (fig. 2) show the 8th sternite notched in subrectangular fashion along its posterior margin, in lateral view the tegumen is well chitinized with an evenly arcuate silhouette, not armed with spines, in ventral view the tegumina are seen to widely diverge towards the posterior extremity.

Despite marked differences in wing pattern and shape the male genitalia suggest a relationship with *E. crenilimbata*. This relationship is probably real, and may tend to support a view that the degree of expansion of the costa of forewing at Sc₁ is not a good character for generic separations in this genus.

The female genitalia of the Mt. Takao specimen (fig. 3) have the 7th sternite more than half as long as wide and the posterior margin somewhat concave. The 8th sternite has a rather wide and rounded ventral median prominence about as long as wide, its posterior margin is smooth and polished; above it and extending more posteriorly is a rather rugose projection about half as wide. The anterior gonapophyses are rugose, that on right side much wrinkled and with a pit, that on left side more rounded in outline. The posterior gonapophyses are wide and are embraced within a roll of the integument of the sternite, which forms a hood, open below, over the ovipore.

The resemblances of the female genitalia are with those of *E. camphorae*, but they are abundantly distinct in the dimensions of the anterior gonapophyses which are small irregular plates in this species, rather asymmetrical on the two sides, whereas in *E. camphorae* they are large smooth plate-like members.

Endoclita sinensis (Moore)

Plate xvi, fig. 3-4 and text fig. 4

Phassus sinensis Moore, 1877, Ann. Mag. Nat. Hist. (4) xx, p. 94.

Phassus herzi Fixsen, 1887, Romanoff, Mem. Lepid, iii, p. 335, pl. 15, fig. 3.

Male. Antennae short, filamentous, ochreous brown. Head, thorax and abdomen grayish-fawn, legs darker; posterior legs somewhat reduced, with a large tibial tuft of ochreous-yellow hairs. Forewing with costa slightly sinuate, no costal dilation at Sc₁, apex rounded, termen and inner margin rounded; wing colour grayish-fawn with a

smoky-brown patch near the base of the cell enclosing a white spot; there is a second elongate white spot, rimmed with black, lying in cell and at one end cut across by the junction of *rm* vein and M_1 ; three obscurely paired sets of black spots on costa, these have pale fawn borders; traces of one, occasionally two small, black-margined white spots in a localized brown patch just below apex. Hindwings dull grayish-fawn; vannal region with *Pcu* reduced to a vestige near base of wing; *2V* present as a short vein. Wing length 35 mm., expanse 76 mm.

Female similar to male; wings broader and more rounded, posterior legs without specialized hairs, costal spots of forewing tending to be in sets of three; subapical white spots present. Wing length 36 mm., expanse 79 mm.

Loc. China: Shanghai (type, a female, described as a male, expanse 60 mm., Moore Collection, 94-106 in British Museum); Chekiang (80-123 in British Museum, males, one described above, also a female same details, expanse 97 mm., described by Moore); Kiukiang, June 1887, A. E. Pratt, Tring Collection, in British Museum).

Korea: Gensan June 1887, J. H. Leech (female described above, in Leech Collection at British Museum, 1900-64). Pung Tang, 18 miles N.E. of Seoul, 29 June (the type of *herzi*, a female, expanse 80 mm., in British Museum).

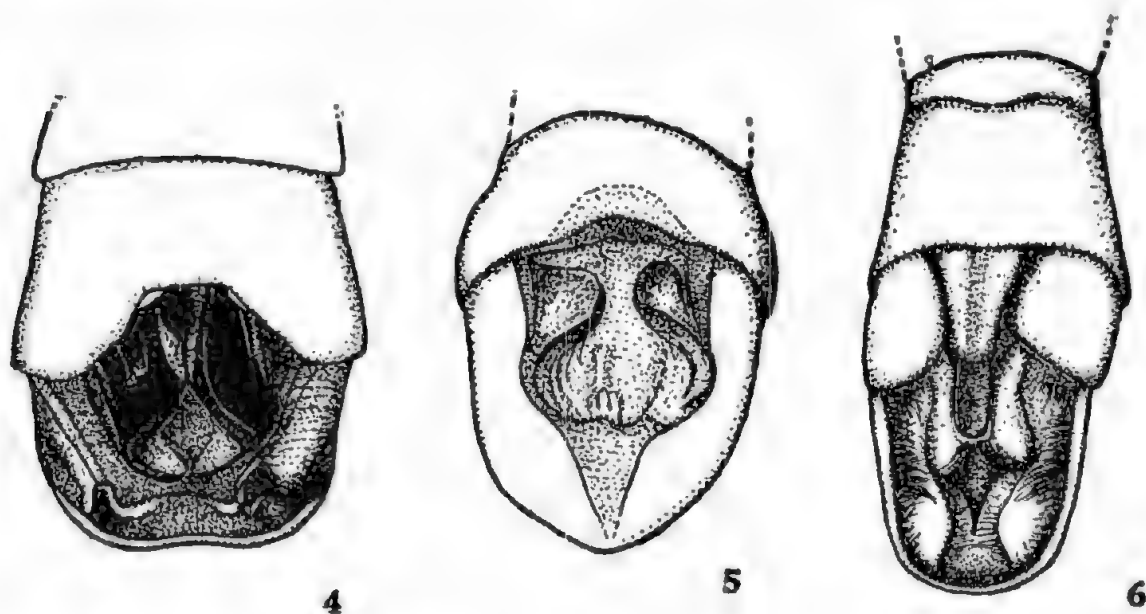


Fig. 4-6. 4. *Endoclyta sinensis* (Moore), Kiukiang, male genitalia, ventral aspect. 5. *Endoclyta camphorae* (Sasake), Tesio, male genitalia, ventral aspect. 6. Female, Yokohama, genitalia, ventral aspect.

The male of this species has not been previously described, since the type from Shanghai, although described as a male, is a female. I am indebted to Mr. W. H. T. Tams for sending for study, at very short notice, the pair figured here. A rather dilapidated male example from Kiukiang is in the Tring Collection; it has vein M_2 of forewing ending abruptly at about one-third the distance between the fork of M_1 and M_3 and margin. This is probably an individual variant.

It is difficult, on wing markings alone, to separate *E. sinensis* from *E. camphorae* of Japan; in both the sexes are similar and the colour and markings generally indistinguishable. Only when the genitalia are compared do valid differences appear. In the male at least these are quite of specific value, hence it is to be assumed that *E. sinensis* on the Asiatic mainland and *E. camphorae* in Japan are either old races or members of a superspecies which have remained so long apart, genetically, that they must be given the status of separate species. *E. kosemponis* also is clearly related, but is more distinctly separated by wing markings and colour differences as well as by characters of the genitalia. All three may be considered to form a species group in the sense of Zeuner (1943).

The male genitalia in this species (fig. 4) have the 8th sternite very robustly formed, with a broad and deep hind marginal notch and rather square cut outer angles. The tegumen is strongly chitinized and black, with the two side pieces rolled over towards the middle as if forming a longitudinal cylinder with a median ventral slit; the figure shows (rather inadequately) the general appearance. When viewed from the side that portion of the tegumen which most nearly meets the opposite side in the mid-line is seen to be smooth-margined and to form a rounded eminence. The female genitalia have not been examined.

In addition to the material studied in detail at Adelaide and at the British Museum, examples from the following localities have been seen and most probably belong to the species:—

Korea: Gensan (June and July). China: Ichang (June, Kuikiang (June) and Hongkong.

The type of *Phassus herzi* was briefly examined in the British Museum. It seems unquestionably to be a direct synonym of *E. sinensis*. The figure in Seitz Macrolepidoptera, ii, 1912, plate 54a, supposedly of this species, belongs to *E. excrescens*.

The expanse of the wings of the described "male" type example, was given by Moore as $2\frac{1}{2}$ inches (*i.e.*, 54 mm.) and of his female as $3\frac{1}{2}$ inches (89 mm.). It is difficult to reconcile these dimensions with

ones made by myself on the British Museum specimens, which gave a measure of 60 mm. and 78 mm. respectively ($2\frac{3}{8}$ and $3\frac{1}{8}$ inches). It should also be noticed that Moore speaks of the light coloured markings on the forewings of his species as bright yellow, whereas those of the examples seen seem to be silvery-white. It is not clear whether the present day appearance is due to the post-mortem changes of the past 70 odd years since they were captured, variation in several examples, differences in the quality of the light in which they were examined for the purposes of the original description, or a combination of all these.

***Endoclyta camphorae* (Sasake)**

Plate xvii, fig. 1 and text fig. 5-6

Phassus camphorae Sasake, 1908, Tokyo Nippon Konchu Kw. Ho., 2, p. 81.

Phassus camphorae Matsumura, 6000 Insects, p. 1024 fig. (female).

Phassus camphorae Pfitzner and Gaede, 1933 Seitz Macrolep. x, p. 843, pl. 78c.

Male. Antennae thread-like, with about 22 segments, bright ochreous yellow. Head with eyes moderate; head, thorax and abdomen grayish-fawn, legs slightly darker; posterior legs moderate in size, with a tibial tuft of dull ochreous-brown hairs. Forewings with costa straight, slight traces of an elevation at Sc_1 ; apex rounded, termen rather straight, inner angle and inner margin well rounded; venation as in genotype, wing colour grayish-fawn with paler bands and markings; three pairs of black spots along costa, each outlined in pale fawn; a white spot above basal M fork, enclosed in black; another white-centred black spot just above Cu_1 at one-half; also a group of three or more in outer part of cell near rm vein. Hindwings with venation as in genotype, colour grayish-fawn with apex well rounded, sub-hyaline; a few darker markings along costa; a faint purplish tinge on wing when viewed from certain angles. Wing length 34 mm., expanse 73 mm.

Female. Similar to male but colour a pale shade of grayish-fawn, long hairs at base of abdomen and on meso- and metathorax paler still; hindwings hyaline; vannal region with PCu developed only at base, 2V well developed, extending to one-half inner margin. Wing length 35 mm., expanse 76 mm.

Loc. Japan: Tesio, Hokkaido (June and July); Hakodate, Hokkaido (June and July); Junsai Numa, Hakodate (28 July); Yoshino, Yamato-ken (5 July); Yokohama; Shimonoseki (July); Ishizuchisan, Shikoku (26 June); Satsuma (May); Kagoshima, Kyushu (August).

So far as can be ascertained with material available at Adelaide *E. camphorae* is confined to Japan. It resembles closely in wing patterns *E. sinensis* but has markedly different male genitalia.

The male has the genitalia (fig. 5) with the posterior margin of the 8th sternite slightly and broadly excavated, with an arcuate area of rough surface forming a median lip. The tegumen when viewed laterally has the ventral margin smooth, and forming a conical eminence; in ventral view the tegumen is seen to be rolled inwards towards the centre line anteriorly, giving an S-shaped contour to the ventral margin.

The female genitalia (fig. 6) drawn from a rather small example expanding only 64 mm., from Yokohama, show a large 7th sternite with an anterior sinuate fold and slightly excavated posterior margin; the 8th sternite has two parts, a laterally compressed and longitudinally grooved ventral portion and a narrower, parallel-sided, ventrally grooved dorsal trough-like portion which is of considerable length. The anterior gonapophyses are angulate pieces with a rounded swelling at the posterior extremity; the integument of the sides of the ultimate segment form a hood over the ovipore.

The examples described are a male from Tesio (July, 1901) in the Tring Collection at the British Museum, and a female from Yokohama (Dr. H. Loomis). The type, from Southern Japan, has not been examined; the specimens under examination agree very well with the figure by Matsumura.

***Endoclista aikasama* sp. nov.**

Plate xvii, fig. 2 and text fig. 7

Male. Antennae (wanting in only available specimen). Eyes large and dilated but in lateral view not concealing whole of head. Head, thorax, legs and abdomen generally dark chocolate-brown, some lighter hair on the metathorax, posterior legs only slightly reduced, a large plume of specialized ochreous-yellow hairs on tibia. Forewings with costa sinuate, very slightly dilated at Sc., apex falcate, termen and inner margin in one continuous curve; im vein only shortly before fork of M₁ and M₂ and extending to fork of M₁ and M₂; wing colour chocolate-brown with slightly curved transverse darker lines between the veins, some incorporating tiny flecks of cream, margined with black; a group of three creamy-white spots at basal M fork and another group around the junction of rm vein and M₁; a somewhat more conspicuous brown patch where Cu₂ vein becomes obsolescent; in addition a

larger pattern of more shiny scales showing a purplish sheen in certain lights, and forming transverse bands along inner margin and across outer third of wing; also forming patches along costa. Hindwing with costa sinuate, termen and inner margin angulate; tip of wing brown with wing pattern of forewing; rest of wing dark gray with a strong purplish flush when viewed from many directions; basal fourth of wing clothed in dense fawn hairs. Wings beneath dull brown, with traces of wing pattern evident only along costa. Wing length 68 mm., expanse 144 mm.

Loc. Java: Vulkan Gede, 1894 (collected by Prilwitz, from Staudinger Coll., No. 759, in Museum f. Naturk., Berlin). Examples similar to this type specimen were in the Tring Museum, in 1936, as *niger* Eecke, which they are not. When compared directly with the type of

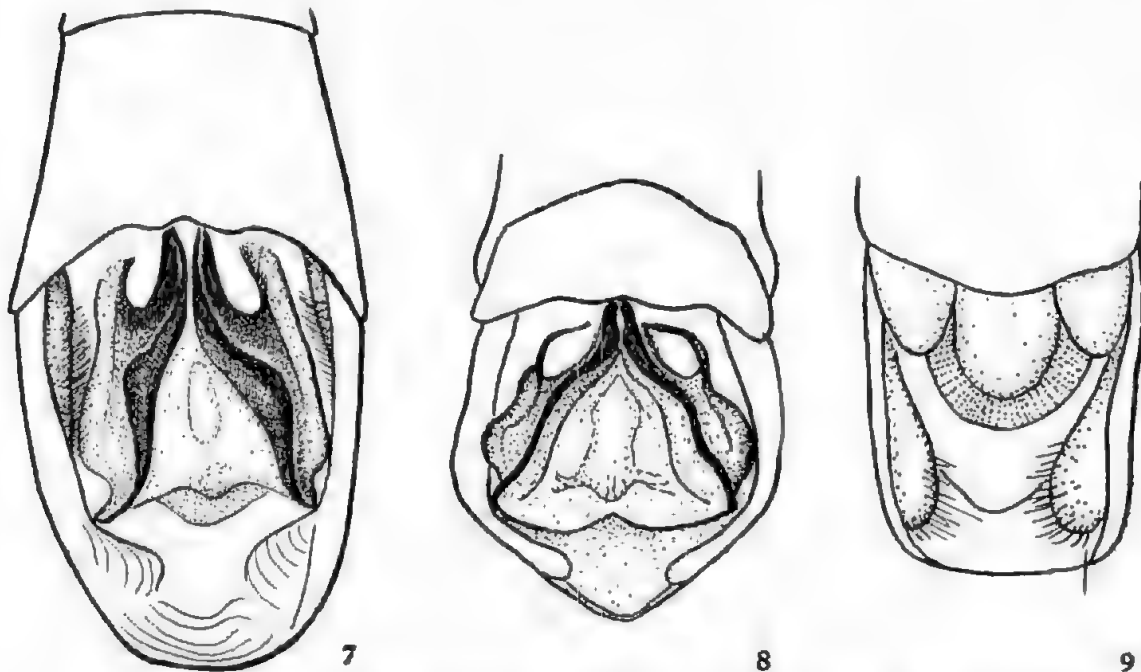


Fig. 7-9. 7. *Endoclyta aikasama* Tindale, Vulkan Gede, male genitalia, ventral aspect. 8. *Endoclyta sericeus* (Swinhoe), Java, male genitalia, ventral aspect. 9. Type, a female, Malang, freehand sketch of genitalia, ventral aspect.

pfitzneri which is a form of *E. niger*, the type of *E. aikasama* proved to be much larger and with different marking. At the time I formed the opinion that it might be only a giant form of *E. niger*, and conspecific, but closer examination and comparison with the example of *E. niger* described elsewhere in this paper has convinced me that they represent two species, not even closely related.

This is by far the most robust of the Indonesian species of the genus and the female, when taken, should be rather large. The rich brown colour, the falcate wings and the striking masses of golden yellow coloured plumes on the tibiae of the posterior legs are highly characteristic.

The genitalia have the hind margin of the 8th sternite broadly excavate and sinuate with a slight median notch (fig. 7). The tegumen, in ventral view, shows a slightly serrated margin which is reflexed outwards so that in lateral view the outline of the tegumen is smooth and apparently unarmed. It thus contrasts with *E. niger* in which the margin is not reflexed and consequently in lateral view the margin appears finely serrate.

Endoclita sericeus (Swinhoe)

Plate xvii, fig. 3 and text fig. 8-9

Phassus sericeus Swinhoe 1901 Ann. Mag. Nat. Hist. (7) vii, p. 469.

Male. Antennae threadlike, short, of twenty-two segments, bright ochreous brown. Head with eyes large, from the side concealing most of head except the frons, metallic gold in colour; head, thorax and legs dark brown; abdomen, and particularly the long hair at base of abdomen, much paler, posterior legs normal, a very large tibial plume, bright ochreous yellow. Forewings with costa somewhat sinuate, only a trace of an expansion at Sc_1 , apex falcate, termen and inner margin well rounded; wing colour dark chocolate-brown with obscurely defined paler fawn streaks and bands, particularly an irregular one from near costa at four-fifths to inner margin at two-thirds and traces of another parallel to termen; a semicircular pale fawn patch in cell at basal M fork, two black rimmed silvery-white spots with traces of a third, and a cluster of tiny similar spots at junction of rm vein and M_1 . Hindwings with costa slightly sinuate, termen well rounded, vannal area with PCu reduced. 1V and 2V present; wing colour grayish-fawn. Wings beneath with a series of brown spots along costa, elsewhere grayish-brown, in certain lights with a pale but strong bronzy lustre. Wing length 30 mm., expanse 66 mm.

Female. Similar to male; posterior legs not plumed. Wing length 30 mm., expanse 66 mm.

Loc. Java: Malang (Type, a female, 66 mm. in expanse, not a male as described, No. 1901-178 in British Museum); Soekaboemi; Nongkodjadar (4,000ft., Dec. 1930, A. M. K. Wagner); Java 1891 Fruhstorfer Coll. (allotype male in United States National Museum, *ex* Brooklyn Museum).

The male from the United States National Museum Collection described above may be regarded as the allotype, since the type is a female.

The male genitalia (fig. 8) have the 8th sternite wider than long, with the posterior margin waved. The tegumen has the ventral margin smooth; in ventral view it is sinuate, with the two halves diverging to the rear.

Fig. 9 gives a freehand sketch of so much of the female genitalia as may be seen on the type. The 8th sternite has a wide upper portion broadly rounded posteriorly and a broad ventral portion, also well rounded. The anterior gonapophyses are suboval in outline.

Although *E. javacensis* was taken at Nongkodjadjar in the same month as this species, it seems to be quite distinct.

This species seems to fall closest to *E. gmelina* of Burma in the form of the genitalia, although the resemblances may be in part accidental; in wing form, notably the absence of a costal expansion on the forewing, it is distinct from *E. gmelina* and falls closer to *E. damor* from which it can be readily distinguished by the form of the 8th sternite of the male, which is not deeply notched as in that species.

***Endoclita aurifer* sp. nov.**

Plate xviii, fig. 1 and text fig. 10

Male. Antennae very short, threadlike, ochreous; eyes large, brown, thorax brown, darker on the sides, abdomen pale brown, posterior legs with a moderately large tibial plume of golden yellow hairs. Forewings relatively broad, falcate at tip and with costa moderately dilated about Sc_1 ; wing colour dull purplish-brown, markings in the form of linked circular ochreous patches forming spots between the veins, each spot contains several tiny ochreous-white-centred brown spots; the ochreous markings are most concentrated in a triangular patch enclosed between the area bounded by costa, from near base to just beyond Sc_1 , a line from there to near fork of M_4 and Cu_{1a} , and a line along vein Cu_1 to near base; another large ochreous patch at apex and several series of spots running parallel to termen; silvery-white spots much larger than the white ones on rest of wing occur just before middle of wing and again at end of cell; there are traces of several very dark orange spots along Cu_2 . Hindwings subfalcate, termen angled, dull purplish-brown, ochreous at tip. Wing length 37 mm., expanse 78 mm.

Loc. Java: type a male, unique, in British Museum (*ex* Tring).

This male is a very striking one. Its relationships are probably with the next species, *E. bromia* with which it shares an almost identical basic wing pattern, although the wings are somewhat longer in proportion and the colours are unlike.

The male genitalia so far as they may be seen from below without dissection (fig. 10) have a tegumen which has on its margin no armature of spines, the tegumen is drawn out anteriorly into a depressed projection which passes inside the posterior margin of the 8th sternite; the posterior part of the tegumen is laterally expanded.

In the form of its genitalia this species, like *E. sericeus*, shows relationship with *E. gmelina* of Burma, but the 8th sternite is quite

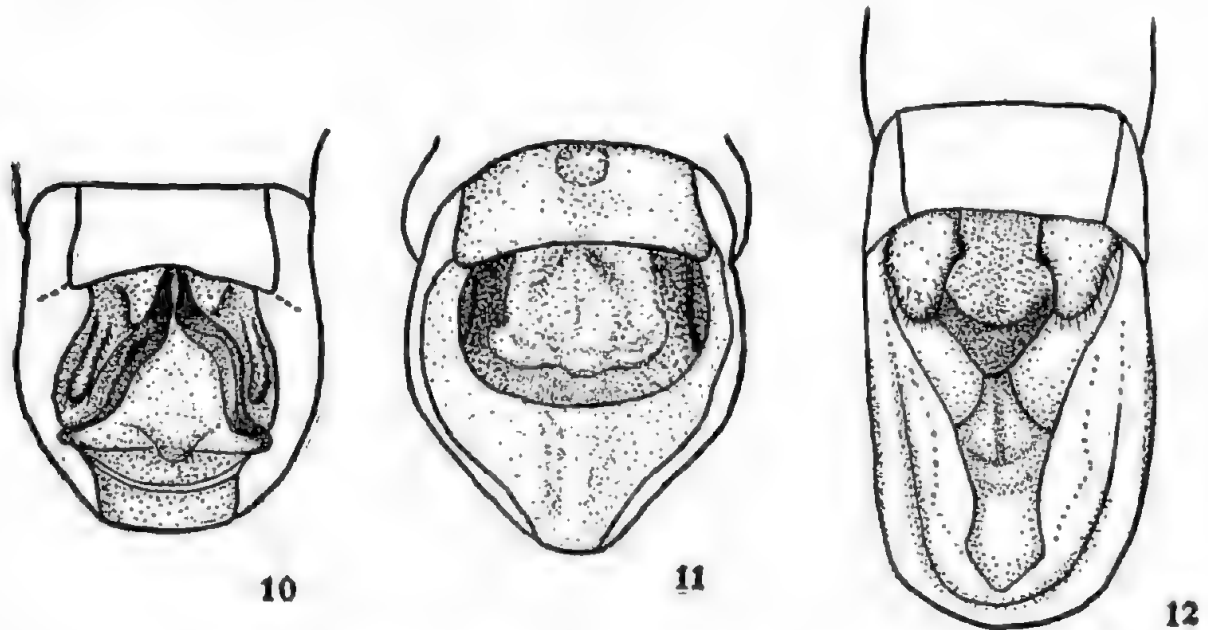


Fig. 10-12. 10. *Endoolita aurtifer* Tindale, Java, male genitalia, ventral aspect. 11-12. *Endoolita bromia* Tindale. 11. Male, Djember, genitalia, ventral aspect. 12. Female, Mt. Andjasmara, genitalia, ventral aspect.

different, having merely a slightly concave posterior margin instead of a highly complex outline as in that species.

This species may be close to *E. javuensis*, an East Javanese species taken at 4,000ft. at Nongkodjadjar in Tengger, but appears to be distinct by reason of the more widely separated posterior portions of the tegumen. The sinuate line of the keel of the tegumen, when viewed from the ventral side, also contrasts with the relatively straight margin figured by Viette for that species.

Endoclyta bromia sp. nov.

Plate xviii, fig. 2-3 and text fig. 11-12

Male. Antennae lacking in available specimen; eyes moderately dilated, head and thorax dull brown, abdomen pale grayish-fawn darker at tip; posterior legs slightly reduced, with deep orange tibial plume. Forewings relatively broad, falcate at tip, only slightly dilated on costa at Sc_1 , colour grayish-fawn with rich chocolate-brown markings, generally in the form of linked circular discs, in basal half of wing uniting to form a triangular patch, also two broad bands running parallel to termen in distal half of wing; the fawn areas and chocolate-brown spots are marked with numerous fine dark lines running between the veins. There are two small silvery-white spots, margined with black, below middle of cell and a group of much smaller ones near apex of cell. Hindwings grayish-fawn with costa near tip bearing three brown patches. Forewing length 35 mm., expanse 76 mm.

Female. Eyes moderately dilated, ochreous-brown. Head, thorax and abdomen dull brown; wings as in male, background colour pale fawn; circular markings as in male, but dark brown, with contained spots represented only by linear black marks; silvery-white spots present in cell, as in male, but smaller and black-edged; traces of four darker marks below Cu_1 . Hindwing dull grayish-brown with traces of a subterminal series of darker circular marks appearing like "water-marks." Wing length 38 mm., expanse 80 mm.

Loc. Java: Djember, Besoeki Residency 1,300-2,500 feet, Möllinger, 1892 (type, a male in British Museum, *ex* Tring); Mt. Andjasmara, Malang district, November and December 1828, G. Overdijkink (allotype female in Joicey Coll. 1930-75, at British Museum). The sexes are associated with some confidence.

The wing pattern of this species, from Eastern Java, is similar to *E. aurifer*, with which it shows relationship. It is possible that it is the dark extreme form of that species but in view of some seeming differences in the genitalia, so far as they may be compared, I prefer to regard it as a separate species.

In the only male available for study the genitalia are deeply retracted, the tegumen so far as it appears is unarmed, the two sides being placed widely apart; the 8th sternite is evenly concave on its posterior margin. When compared with *E. aurifer* the terminal segment of the body is very differently formed in this species (fig. 11).

In the female genitalia the 7th sternite has the posterior margin entire and transverse, the anterior gonapophyses are flat plates, rounded at the tips, but coming to a blunt point near the middle of the inner margin. The 8th sternite has its posterior margin triangular with a rounded point (fig. 12).

The female genitalia show resemblances with those of *E. gmelina* but the anterior gonapophyses are much broader and the shape of the 7th sternite shows little resemblance to its form in that species.

***Endoclista salvazi* sp. nov.**

Plate xviii, fig. 4 and text fig. 13

Male. Antennae short, threadlike, with about 29 segments, with incipient traces of pectination and a few fine hairs, eyes dilated; head, thorax except sides, which are brownish-black, and abdomen and legs brownish-fawn, posterior legs with a conspicuous plume of golden yellow hairs. Forewings with costa straight and a very conspicuous dilation at Sc_1 ; wing tips falcate, termen rounded, slightly concave at inner angle, colour pale grayish-fawn with markings slightly more brown; a series of generally paired small black spots along costa, a larger one near inner margin and two series of black-bordered silvery-white spots at middle and at end of cell, also a scattered group of small ones in apical fourth of wing, the intensified brown colour of cell outlines a triangular patch of grayish-fawn near the middle of the wing. Hindwing with costal margin sinuous and deeply concave at about three-fifths its length, apex slightly falcate, termen dilated in anterior half, slightly concave at hind angle; markings at wing tip as in forewing, rest of wing grayish-fawn with faintest traces of a purplish sheen from some angles of view. Wing length 43 mm., expanse 92 mm.

Loc. Laos: Thado, 6 June, 1915, R. Vitalis de Salvaza (type a male, unique, in Cornell University Collection, lot 841).

This species appears to be related to *E. paraja* and *E. tosa*, particularly in the form of the wings, and in the placing of the conspicuous black spot on the forewing, but the strong dilation of the costa and the far larger eyes, which from the side conceal most of the head save the palpi and the frons, are very evidently different. The male genitalia (fig. 13) in ventral view show what appears to be the 8th sternite as wider than long with a sinuously margined posterior lip. The tegumen has a straight ventral keel and the keels of the two sides diverge markedly toward the posterior extremity of the body.

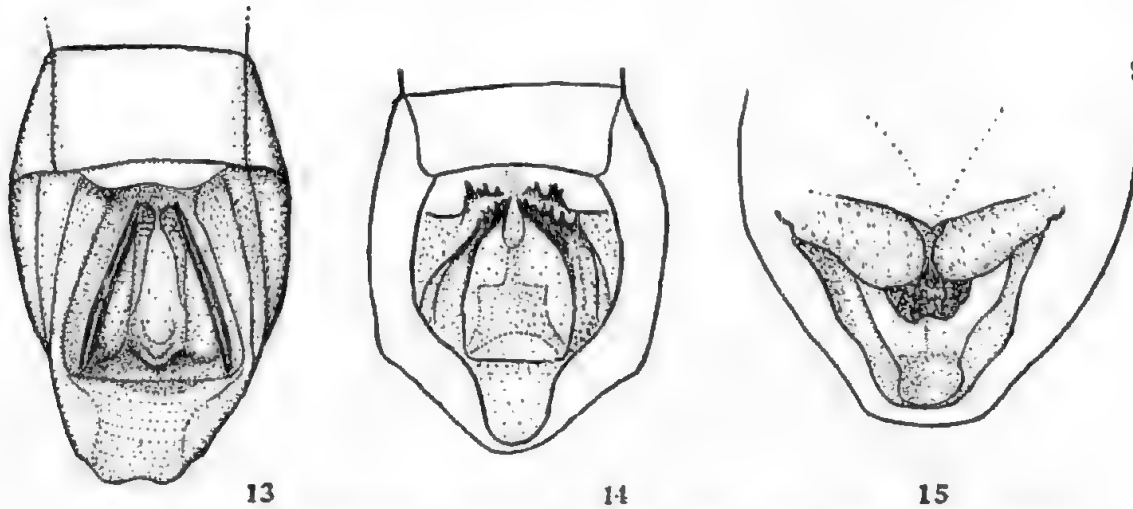


Fig. 13-15. 13. *Endoclitia salvazi* Tindale, Thado, male genitalia, ventral aspect. 14-15. *Endoclitia aroura* Tindale. 14. Male, Lebong Sandai, genitalia, ventral aspect. 15. Female, Lebong Sandai, genitalia, ventral aspect.

In the key the male genitalia of this species fall into a section entirely different from *E. tosa* and *E. paraja*. The former is distinctive because of the parallel arrangement of the teguminal margins and the conspicuous spines along the margins. *E. paraja* differs in the much larger tegmina meeting firmly in the midline instead of diverging, and is distinctive in the form of the posterior margin of the 8th sternite.

***Endoclitia aroura* sp. nov.**

Plate xix, fig. 1-2 and text fig. 14-15

Male. Antennae very short, threadlike, composed of about 22 subspherical segments; eyes moderate; head and thorax densely rough-haired, dark brown, abdomen and legs greyish-fawn; a plume of yellow hairs on posterior tibia. Forewing with costa straight, slightly concave beyond Sc_1 , apex round-pointed, termen well rounded, wing colour fawn with a faint purplish iridescence, markings in the form of tiny brown streaks, each tending to surround a patch composed of a few yellow scales; a large patch of yellow scales at end of cell. Hindwings with costa concave, apex blunt-pointed, wings broad, grayish-fawn with a dull purplish iridescence, except near apex, which has the pattern of the forewing. Wing length 25 mm., expanse 53 mm.

Female. Much larger than male, form of wings and markings similar, hindwings with purplish iridescence even less evident. Wing length 50 mm., expanse 105 mm.

Loc. Sumatra: Lebong Sandai, Benkoelen (male type and allotype female, Joicey Collection in British Museum 1929-122); another female, same details, but expanding 92 mm.

Lebong Sandai is in the south-west of the island of Sumatra. The circumstances of the taking of the specimens have not been recorded.

This species is reminiscent of Indian species such as *E. rustica* and its allies. The absence of costal dilation on the forewing, and the wing form itself strengthens the resemblance, but the male genitalia are of different form and it is clear that they are at best but distantly related species.

The male genitalia (fig. 14) have an 8th sternite much wider than long. The tegumen is armed with irregular teeth set in a double row at the anterior end; viewed from the ventral aspect the keels of the tegumina diverge widely towards the posterior extremity.

The female genitalia (fig. 15) so far as they may be seen without dissection in the allotype example, show the 7th sternite with a convex posterior margin coming to a blunt point in the midline. The anterior gonapophyses are broad digit-like plates, largely covering the heavily chitinized 8th sternite, whose posterior extremity appears as a rounded eminence, deeply incised on its ventral side.

Two dried eggs, presumably of the species, were found adhering to the hairs of the tip of the abdomen of the female. They suggest that, when newly laid, the eggs were smooth-shelled and almost spherical, with a diameter of 0.7 mm.

***Endoclita raapi* sp. nov.**

Plate xix, fig. 3 and text fig. 16

Male. Antennae simple, threadlike, eyes dilated; head, thorax and abdomen dark grayish-brown, posterior legs with a moderate sized ochreous tibial plume. Forewings with region of Sc₁ not noticeably dilated, but the margin excavated beyond; wing tips feebly falcate, chocolate-brown with traces of dark purplish-brown markings and patches, particularly a semicircular patch lying behind R vein at about middle of cell, below which are two brown margined angular silvery-white spots; at the end of the cell there is another group of three small silvery-white spots; in the terminal half of wing there are numerous obscure markings between the veins, a few of these take the form of

small light-centred brown spots; near the apex other of these markings are tinged with ochreous brown. Hindwings grayish-brown, a few traces of ochreous brown and darker brown mottlings at the wing tip. Wing length 35 mm., expanse 74 mm.

Loc. Nias (Raap) type, a male, in British Museum (ex Tring) and male paratype in South Australian Museum.

This species is rather inconspicuous. It shows no signs of iridescence even when the wings are moved in a bright light. The bright chocolate colour of the forewings with the obscure traces of ochreous rings each of which is dark margined and centred, are reminiscent of *E. aurifer* from Java, but in that species the tegumen of the male is not armed with spines along its antero-lateral margin.

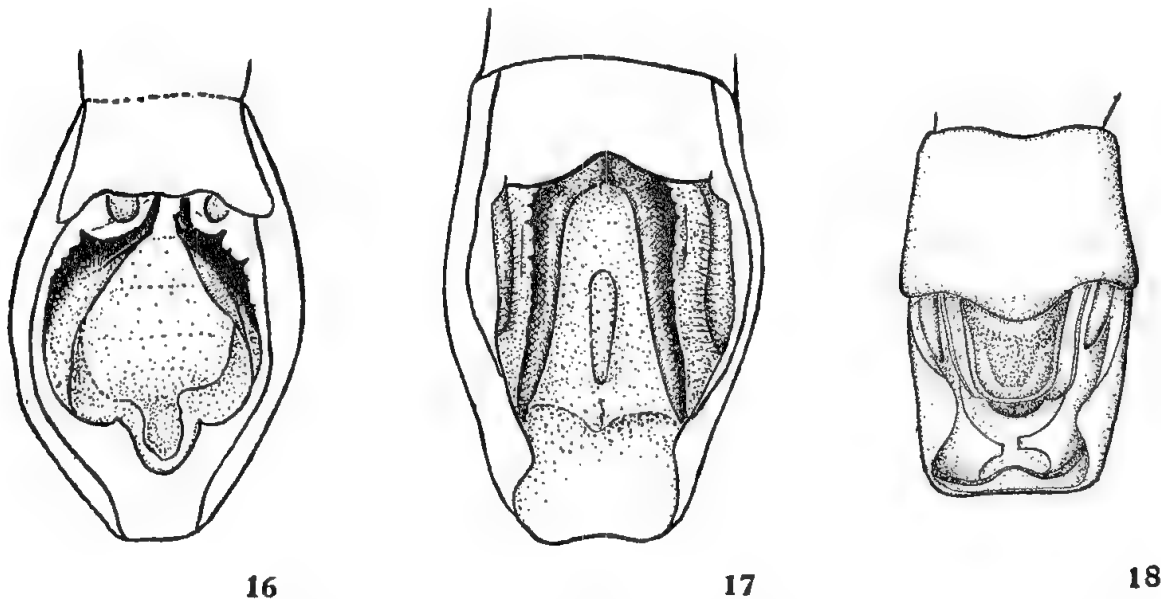


Fig. 16-18. 16. *Endoclita raapi* Tindale, Nias, male genitalia, ventral aspect. 17. *Endoclita tosa* Tindale, Tengger, male genitalia, ventral aspect. 18. *Endoclita aurata* (Hampson), Laos, female genitalia, ventral aspect.

The male genitalia of the figured specimen appear to have suffered injury to part of the tegumen of the right side. For critical detail chief reliance should be placed therefore on the tegumen of the left side (shown on right side of fig. 16). This shows a series of spines on the antero-lateral portion; what appear to be the harpes are small, inconspicuous swellings barely projecting beyond the posterior marginal limits of the 8th sternite.

Endoclita tosa sp. nov.

Plate xix, fig. 4 and text fig. 17

Male. Antennae simple, threadlike, very short, ochreous coloured and composed of about 22 segments. Head wide with prominent eyes, in lateral view almost concealing outline of head. Head, thorax above, abdomen and legs grayish-fawn, becoming more gray on abdomen; posterior legs reduced and with a yellow tibial plume. Forewing with costa straight, a slight dilation at Sc_1 , termen and inner margin well rounded in a single curve; apex pointed, slightly falcate; termen well rounded; wing colour pale grayish-fawn with dull brown markings and suffusions, notable a broad V-shaped area in middle of wing and a broad band composed of obscurely circular discs of brown each with a few yellow scales at their centre; this area extends along termen from apex to inner margin at three-fourths; two series of black-bordered white spots, one near notch of V-shaped brown patch and the other at r-m vein, a notable black spot inwards from two-fifths inner margin. Hindwings with costa rather straight, apex blunt-pointed, termen dilated and hind angle slightly excavated; traces of forewing pattern at tip of wing, rest dull gray, smooth-scaled, and showing a dull purplish iridescence in some angles of light. Wing length 37 mm., expanse 80 mm.

Loc. Java: Singolangoe, Tengger (5,000ft., April 1934, F. P. A. Kalis. Type a male, unique in British Museum, *ex* Tring).

This species is close to *E. paraja* which is believed to be a Bornean species, but it differs in the less intense purplish flush of the hindwings, in the different shape of the 8th sternite, and in the tegumen, which has, in ventral view, a series of lateral spines on its margin, instead of being unarmed when viewed from this aspect.

The male genitalia (fig. 17) have the 8th sternite wider than long, with the posterior margin somewhat excavated in the midline. The tegumen is strongly chitinized and the ventral keel rolled slightly outward and armed with a series of teeth. The harpes are long, and so far as may be seen without dissection, are digitiform and clothed with laterally directed hairs.

Endoclita aurata (Hampson)

Plate xx, fig. 1 and text fig. 18

Phassus auratus Hampson, 1892, Fauna Brit. Ind. Moths, i, p. 321 (male).

Endoclita aurata Tindale, 1941, Rec. S. Austr. Mus., 7, p. 37, pl. 7, f. 69 (male).

Female. Antennae filamentous, of about 20 segments, dark brown with paler annular rings. Eyes large, in lateral view concealing most of head, brilliantly reddish-gold in colour; head, thorax and legs yellowish-fawn, abdomen grayish-fawn, posterior legs slightly reduced; no tibial plume. Forewings with costa straight, apex, termen, and inner margin well rounded. Wing colour pale brown with paler fawn transverse bands obscurely margined with darker brown; a patch of scales just below apex and an area along costa from near base to two-thirds with golden yellow scales which show a brilliantly golden and metallic gloss from certain angles. Hindwings with costa sinuate, apex well rounded, termen and inner margin angled, colour pale grayish-fawn, showing a pale bronzy lustre from some angles. Wings beneath pale grayish-fawn without markings. Wing length 25 mm., expanse 53 mm.

Loc. Laos: Thadua. 8 Oct., 1915, R. Vitalis de Salvaza (allotype female, in Cornell University, lot 841, sub. 266). Burma: Bernardmyo, 5,500-7,000ft. (type, a male, in British Museum).

The male was redescribed in my 1941 paper. The female which is now confidently associated with it, extends the range of the species from Burma to Laos.

The female genitalia (fig. 18) have the 7th sternite almost as long as wide, with the posterior margin convex in the midline and showing slight lateral concavities; the 8th sternite is large, wide at the anterior end and evenly rounded posteriorly with a raised rim when seen in ventral view; the anterior gonapophyses are slender and spine-like, ending in a sharp point.

This species shows some relationship with *E. sericeus* of Java, and is superficially like *Nevina aboe* but is readily differentiated from the latter by the typical *Endoclita* venation.

***Endoclita niger* (van Eecke)**

Plate xx, fig. 2 and text fig. 19-21

Phassus niger van Eecke, 1915, Zool. Med. Leiden, i, p. 248.

Phassus pftzneri Gaede 1933, Seitz Macrolepidoptera, 10, p. 843, pl. 100a.

Male. Antennae threadlike short, ochreous. Head with eyes moderate; head, thorax, abdomen and legs pale fawn; posterior legs somewhat reduced, a specialized plume of hairs present but concealed in a fold of the metathorax. Forewings with costa sinuate; a moderate costal expansion at Sc_1 ; wing tip strongly falcate; im vein from close to fork of M_1 and M_2 ; ground colour several shades of pale brown arranged in circular patches between the veins with a tendency for each ring to have a small ochreous-white spot outlined with fuscous; more conspicuous creamy-white spots at basal M fork and at junction of rm vein with M_1 ; a slight infuscation runs along vein R_5 nearly to termen. Hindwings with im vein directly from fork of M_1 and M_2 , only one vannal vein (1V) to margin, PCu obsolete except at base, wing texture subhyaline, colour gray except at tip where the forewing pattern is present; the gray parts of the wing are perhaps brilliantly iridescent in life but only traces of a purplish sheen remain in the specimen described. Wing length 39 mm., expanse 83 mm.

Loc. Java: Vulkan Gede (Prilwitz, 1894).

The type of *E. niger* has not been examined, but there seems little doubt about the synonymy given above.

From the expanse given (140 mm.) it is possible that the type is a female, not a male, as described. A female of close to the given dimension, from Western Sumatra (*ex* Fruhstorfer Collection), is in the Tring Collection.

E. aikasama also from Vulkan Gede, and described in this paper was originally associated with this species. However it is much larger (146 mm. expanse), and is not the same species. The two differ in colour and in the form of the genitalia.

The type of *E. pfitzneri* from Western Java in the Berlin Museum has been examined. It is larger than the male example described above (expanding 121 mm.), but otherwise it agrees very well with it. It also agrees with the figure published in Seitz *Macrolepidoptera* 10 (plate 100a) save that its wing tips are little more falcate than shown there and, as in the described specimen, there are many fine yellow marks forming elongate ocellate centres to each disc-like marking on the forewing. The hindwing is more a dull purplish-gray than the colour indicated in the figure. The antennae are shown as far too long in the Seitz figure.

Fig. 20-21 show two views of as much of the male genitalia of the type example of *pfitzneri* as may be seen without dissection. The tegumen in lateral view (fig. 21) is evenly arched posteriorly, the

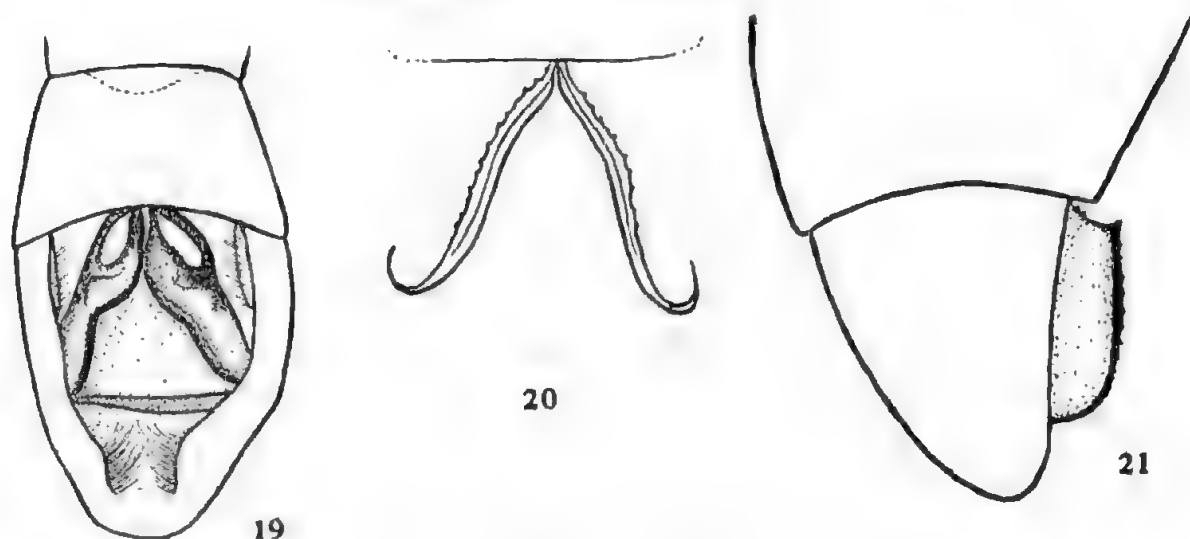


Fig. 19-21. 19, *Endoclista niger* (van Eecke), Vulkan Gede, male genitalia, ventral aspect. 20-21, Type male of *E. pfitzneri*, free hand sketches of male genitalia, ventral and lateral aspects.

margin has a slightly serrated appearance from spines which project laterally from the outwardly turned over lip of the tegumen, as may be seen in ventral view (fig. 20). The third figure (fig. 19) is a ventral view of the genitalia of the male example from Vulkan Gede described above. This shows more of the anterior portion of the tegumen than is evident in the type of *E. pfitzneri*. The contour of the tegumen from below is a trifle more angulate than in that example.

Endoclista crenilimbata (Le Cerf)

Plate xx, fig. 3 and text fig. 22-23

Hypophassus crenilimbata Le Cerf 1919, Bull. Mus. Nat. D'Hist. Nat. Paris, 25, p. 471.

Male. Antennae (wanting in example studied), head with eyes relatively small; head, thorax and legs pale fawn in colour with a narrow black line on side of thorax; posterior legs slightly reduced, with a very large tibial plume of ochreous-fawn hairs, abdomen gray, slightly paler near base. Forewings with costa strongly expanded at Sc_1 , apex with trace of falcation, postero-lateral angle of wing with crenulated indentations between the veins; im vein nearer to fork of M_1 and M_2 than in the genotype and touching M_3 after fork of M_3 and M_4 ; wing colour pale ochreous fawn tending to a grayish-fawn on terminal third; indistinct traces of black lines enclosing gray patches of scales along costa and notably in apical third of wing. Hindwings with im vein as in forewings, vannal region with two well

developed veins after Cu_2 ; these are probably 1V and 2V, with vestiges of a PCu at base, between Cu_2 and 1V; wing colour dark gray without any marked metallic sheen even when viewed from many different directions. Wing length 43 mm., expanse 93 mm.

Loc. China: Yao Gi, 4,000-5,000ft (male in United States National Museum); Pin-Fa, Kwaichau, R. P. Cavalerie, 1918 (type, probably a female, not a male, in Paris Museum).

The specimen described as the male is in the collection of the United States National Museum and has been kindly loaned to me for study, along with the other material not yet described.

This species is unmistakable because of the crenulated margin of the forewings in the region of the anal angle, and the dilation of the costa at Sc_1 , which in this species probably attains almost a maximum.

In the original description the type example was said to be a male but later on in the paper is indicated to be a female; since the posterior legs are indicated to be ochreous gray and no mention is made of the very large plume of ochreous hairs it is probable that it is a female.

The male genitalia (fig. 22-23), so far as visible without dissection, show the 8th sternite broadly excavated on its posterior margin. The tegumen has a strong ventral keel, finely serrated on its margin, the two sides diverge strongly towards the posterior extremity.

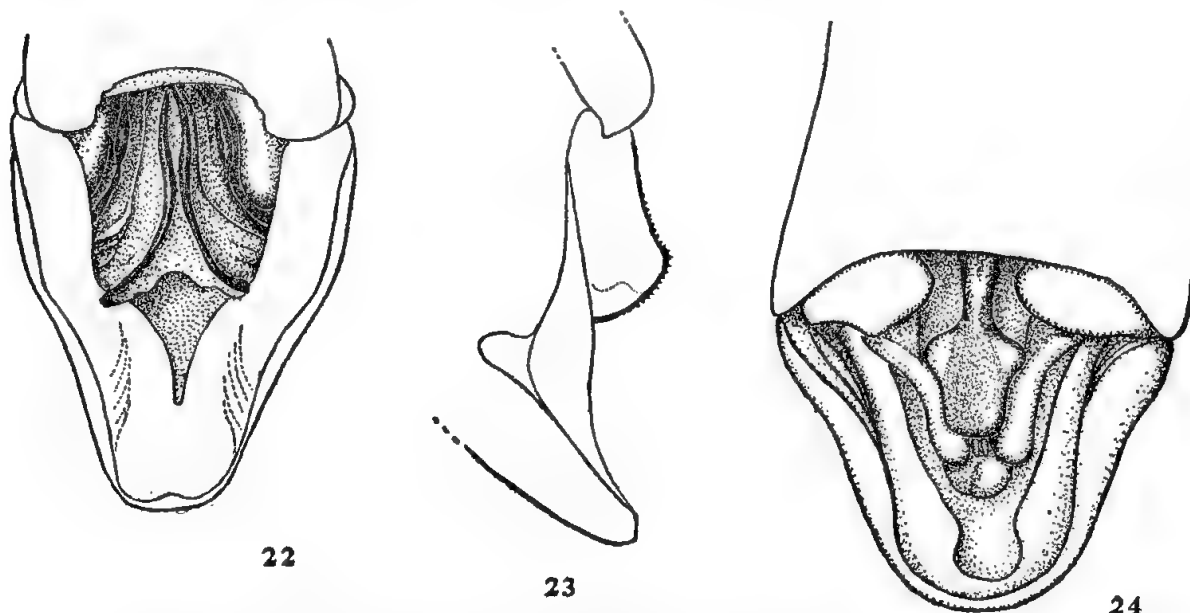


Fig. 22-24. 22-23. *Endoclita crenilimbata* (Le Cerf), Yao Gi, male genitalia, ventral and lateral aspects. 24. *Endoclita topeza* Tindale, Kiang Kong, female genitalia, ventral aspect.

In the form of its genitalia this species seems to fall into the same section of the genus as *E. excrescens* from which it differs greatly in the degree of expansion of the costa of forewing as well as in wing pattern.

***Endoclita annae* (Le Cerf)**

Hypophassus annae Le Cerf, 1933, Bull. Soc. ent. France, 38, p. 131.

Loc. South China: vicinity of Tatsienlu, 1910. Type described as a male, expanse 96 mm. (*ex* collection of Charles Oberthur in collection of R. Biedermann). This species has not been examined.

From the description it would seem to fall near *E. crenilimbata* since the inner margin of the forewing has three crenulations between M_2 and 1V. No costal dilation of the forewing is mentioned and the hindlegs are not indicated as armed with a tuft. On the other hand there is mention of some crenulation on the margin of the hindwing and the presence of silver spots on the forewings. The expanse of the wings is given as 96 mm. If the sex determination is correct this must be a very distinct species; if however it should prove to be a female it is just possible it could be the same species as *E. crenilimbata*.

***Endoclita topeza* sp. nov.**

Plate xx, fig. 4 and text fig. 24

Female. Antennae (wanting in available specimen). Head with eyes moderately large, but in lateral view not concealing whole of head; head, thorax, abdomen and legs dull ochreous fawn. Forewings with costa straight, traces only of a costal dilation at Sc_1 , apex well rounded, termen rather straight, inner margin well rounded, wing colour fawn with grayish-fawn suffusions and pale brown markings between the veins enclosing paired oval areas of ground colour; five black spots on costa, each with a diffused fawn-coloured centre and three groups of black-bordered creamy-white spots, small ones near apex, a group of two or three with one larger spot at r-m vein and two smaller spots in cell at about one-third its length. Hindwings with costa concave in middle, apex well rounded, termen straight and hind margin well rounded, small traces of the forewing pattern at apex, rest of wing ochreous fawn, somewhat brighter than forewing. Wing length 51 mm., expanse 109 mm.

Loc. Laos: Kiang Kong (Xiang Khong) 14 April, 1920, R. Vitalis de Salvaza (type, a female) unique, in Cornell University Collection, lot 841, sub. 267).

This specimen stood in the Cornell University collection under the name *Phassus signifer* but it is not that species. I am indebted to Dr. W. T. M. Forbes for the opportunity of studying it. Through his kindness I have held it for some years. Its closest relationship is with *E. chalybeata*, both in wing markings and in the form of the female genitalia. The last named organs differ in the more robust character of the table-leg-shaped 8th sternite, which contrasts with the more truly spatulate form met with in *E. chalybeata*. It may be regarded as the eastern representative of a small species group embracing *E. chalybeata* and the present form.

The female genitalia have the 7th sternite about as long as wide, its posterior margin broadly concave; the 8th sternite is narrow at the anterior extremity and even narrower towards the middle of its length before it swells into a large spade-like portion with strongly dilated sides. The anterior gonapophyses are somewhat irregularly shaped plates and the posterior gonapophyses are well chitinized members; a narrow disc-like portion near the midline is separated by a deep constriction; the integument of the sternite forms an incomplete hood over the ovipore.

***Endoclita davidi* (Poujade)**

Plate xxi, fig. 1 and text fig. 25-26

Hepialus davidi Poujade 1886, Bull. Soc. Ent. France, 6 (vi) p. xcii (male and female).

Hypophassus exerescens Viette, 1948, Musée Heude, xii (8) p. 84 (*nec* Butler).

Female. Antennae (wanting in example described), eyes normal, moderate; head, thorax, apical half of abdomen above, and underside, also legs, bright orange-brown; basal half of abdomen above, dark brownish-fawn; posterior legs small, without notable tibial plume. Forewing with costa straight save for a rounded eminence at Sc_1 , termen gently rounded in a curve continuous with inner margin; im from just before fork of M_1 and M_2 and touching fork of M_3 and M_4 ; wing colour orange-brown with traces of darker orange-brown spots along costa and in a triangular patch in middle third of wing, traces of ochreous-yellow marks outlining some brown spots, also two areas flushed with yellow, one in cell and the other along inner margin below Cu_m ; there is another yellowish band, broken into rectangular patches, running slightly obliquely to the termen; internally from this is a row of raised brown spots, some margined with darker ochreous-brown.

Hindwings with costa straight, termen evenly rounded, anal area with veins Cu_2 , 1V and 2V to margin, Pcu represented only near base; wing colour dark gray, the scales being long and hair-like except along the termen, where they are orange-brown, and near apex, where the colour and markings are like those of forewing. Wing length 48 mm., expanse 103 mm.

Loc. Tibet: Moupin (type a male, and allotype female in Mus. Soc. Ent. de France; not examined). China: Chia Kou Ho (two males, one female, in British Museum). Formosa: Suishako, 1907; Oryusan, Ipinchiku 6,500ft., A. E. Wileman, 24 Nov., 1908.

The female example from Suishako, described above and figured, resembles very closely ones from Chia Kou Ho standing in the British Museum under this name. Some doubts may remain as to the probability that specimens from Formosa and ones from Moupin are likely to belong to the one species, but the descriptions fit very well. The ochreous forewings and dark hairy-scaled hindwings with ochreous margins are highly distinctive. I do not follow Viette in regarding this species as synonymous with *E. excrescens*.

Pfizer, in Seitz Macrolepidoptera, ii, p. 434, regarded the species as a form of *Hepialus nebulosus* Alpheraky but the three males and the female example standing in the British Museum are certainly members of the genus *Endocrita* and possess a distinct costal expansion at Sc_1 of forewing so that they cannot fall in the genus *Hepialus*. The male genitalia show relationship with those of *E. crenilimbata* from which the species differs markedly in wing form. Fig. 25 is based on a sketch of the tegumen of one of the British Museum male examples of *E. davidi* from Chia Kou Ho, as viewed from the side. It shows a long, gently arcuate and finely serrated margin to the tegumen, in contrast with the shorter, slightly excavate margin found in the related *E. crenilimbata* (fig. 23).

The Chia Kou Ho examples were taken by A. E. Pratt at 1,700ft. in July, 1889. The female closely resembles the one described above from Formosa; its abdomen had been detached and remounted ventral side uppermost, but is unlikely to be incorrectly associated. An example from Canton, China in the United States National Museum has the costal expansion very conspicuously developed and another from Suifu in the same collection shows an even more extreme development of this feature. Since these specimens were not critically studied it is possible they do not represent the one species.

The genitalia of the Formosan female (fig. 26) show the 7th segment semicircularly excavate on posterior margin; the ventral portion of the 8th sternite is produced posteriorly into a long digitiform process, this is narrower than the dorsal portion of the same segment, which, from a wide root extends backwards to a similar process, whose ventral surface shows indications of grooving. The anterior

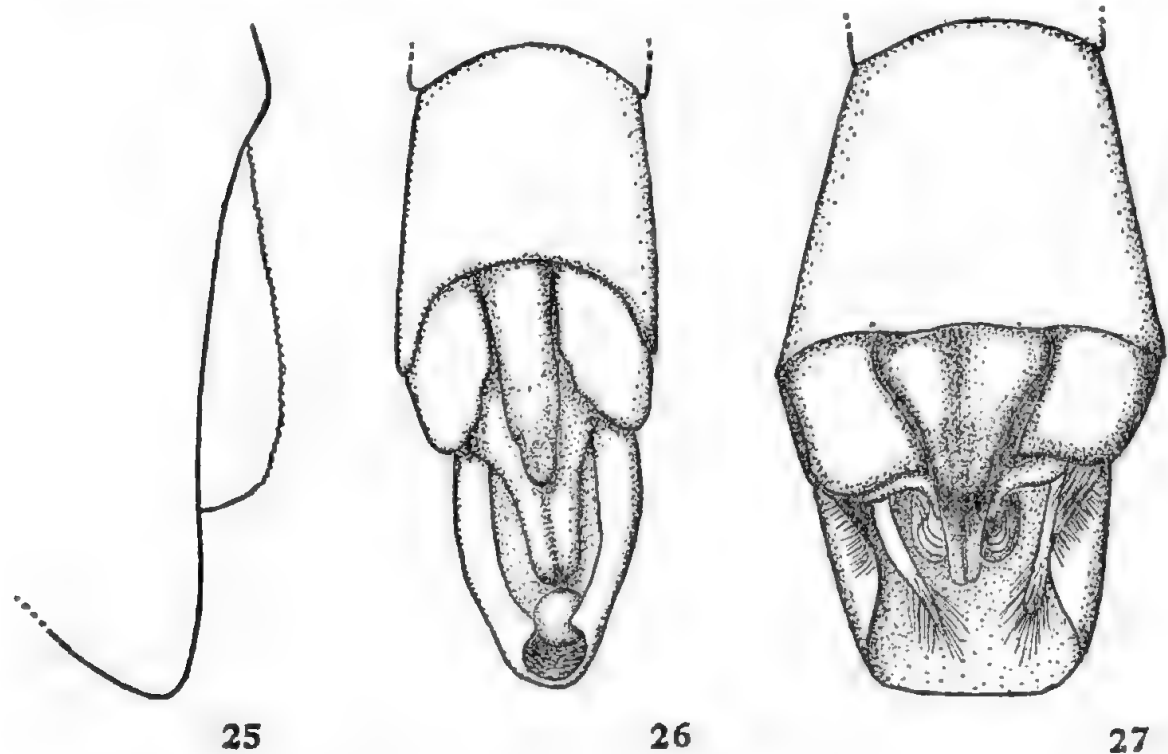


Fig. 25-27. 25-26. *Endoclita davidi* (Poujade). 25. Freehand sketch of genitalia of male from Chia Kou Ho, in British Museum, lateral aspect. 26. Female, Suishako, genitalia, ventral aspect. 27. *Endoclita kosemponis* (Strand), Rokki, female genitalia, ventral aspect.

gonapophyses are large oval plates with the inner margins slightly crenulated. In the example under examination there is a newly laid egg in the channel formed by the folding over of the terminal segment. This egg is 0.55 mm. in diameter, spherical with a small micropyle at the end directed anteriorly; it is cream coloured.

Endoclita kosemponis (Strand)

Plate xxi, fig. 2-3 and text fig. 27

Phassus signifer var *kosemponis* Strand 19 , Arch. Naturg. 81, Abt. A. 12, p. 150.

Female. Antennae short, threadlike; eyes moderate, in lateral view not concealing outline of head; head, thorax, abdomen and legs grayish-fawn. Forewings with costa straight, apex not acute, termen rounded; wing colour light grayish-fawn with dark grayish-brown markings, principally a large triangular patch in centre of forewing embracing a black bordered creamy-white spot near end of cell; a series of grayish-brown spots along costa and delicate semi-lunate light fawn areas, margined by grayish-brown, principally along inner marginal and terminal portions of wing. Hindwings with costa concave, apex well rounded, termen rounded, a slight concavity at hinder angle, pale grayish-fawn without markings save for traces of two darker spots along costa near apex. Wing length 44 mm., expanse 94 mm.

Loc. Formosa: Kosempo (H. Santer 1911, type, a male and allotype female, same details but captured June 1907, in Deutsches Entom. Mus., Dahlem): Rokki (L. Gressitt) 13 May 1934, a female, described above, in Cornell University Collection, and another, same details, but taken 17 May 1934, in South Australian Museum.

I am indebted to the authorities of the Deutsches Entom. Museum, at Dahlem for the photographs of the type and allotype reproduced in this paper. I examined the examples briefly in 1936 but failed to note the dimensions and Strand's original description is not available to me.

The female described is in the Cornell University collection. Through the courtesy of Dr. W. T. M. Forbes I was able to compare it directly with the type female in Berlin.

The male is similar to the female described above, grayish-brown in colour; in neither sex are there any indications of a costal swelling on forewing. The head is slightly wider in the male than in the female but in both the eyes are of normal size.

This species is abundantly distinct from *E. signifer* of Assam with which it has little in common. Its principal relationships are seemingly with *E. damor* and *E. chalybeata* which possess the same basic wing patterns and equally are without costal expansion on the forewing.

The male genitalia could not be examined in detail during my visit to Berlin, but inspection of the type showed that the hind margin of the 8th sternite was widely and deeply notched in a sweeping curve while the teguminal margins of the two sides, in ventral view, appeared to diverge widely from the anterior end to the middle of their length and then to converge again, leaving a subrectangular median space.

Female genitalia (fig. 27) based on the example from Rokki, have the 7th sternite transverse, the eighth modified into a ventral heart-shaped median plate with a shallow central groove and a more dorsal, posteriorly produced flat projection narrowly grooved along its midline; the anterior gonapophyses are large and plate-like with a spine or distal projection on the postero-median extremity. There is a pair of slender, distally hair-covered processes which may be the posterior gonapophyses. In some details the female genitalia are reminiscent of *Endoclita damor* but in that species the anterior gonapophyses are irregular in shape, the postero-median projection of the 8th sternite is not grooved for its whole length, and what appear to be the posterior gonapophyses are broad plates.

***Endoclita warawita* sp. nov.**

Plate xxi, fig. 4 and text fig. 28

Female. Antennae wanting in only example available, eyes moderate, head, thorax, except a lateral brown line, and base of abdomen above, pale creamy-brown with scales of fine velvety texture, abdomen somewhat darker (much abraded in the type example). Forewings short and wide, costa with a marked dilation at Sc₁, wing tip strongly falcate; *rm* vein directly from fork of M₁ and M₂; wing colour warm brown. Wing pattern of usual *Endoclita* type; eight rich brown patches on costa, each in part outlined with black and white lines; three groups of silvery-white spots one at junction of *rm* vein and M₁ and three-fifths the distance between *rm* vein and M₁, a second around fork of M₂ and M₃, and the third between R₁ and M₁ at three-fifths the distance between *rm* vein and wing margin; the pattern on the inner margin and the transverse lighter bands are marked with scattered silvery-white scales which give the wing a slightly glistening appearance. Hindwings strongly angled, slightly falcate at tips; veins with Pcu and IV both well developed, also basal traces of 2V; apex of wing narrowly brown within a darker spot, texture of rest of wing sub-hyaline, with dusky-brown scales, strongly opalescent, and violet or purplish-brown when viewed from most angles. Forewing length 36 mm., expanse 76 mm.

Loc. North Borneo: Mt. Kina Balu, 1,200 to 1,500 metres (Waterstradt) 1894. Type, a female, unique, in Museum f. Naturk., Berlin, marked as part of Staudinger Collection, No. K739.

This species is readily distinguishable from *P. ijereja* which occurs in the same locality, because of the marked costal expansion of the forewing. The origin of im vein on M_1 and M_2 is also different. It is much smaller than that species and has ochreous-brown wings rather than grayish-brown ones. In both species the hindwing shows a purple sheen in certain lights, particularly marked in the present species, being evident also on the underside of both wings. Although the only

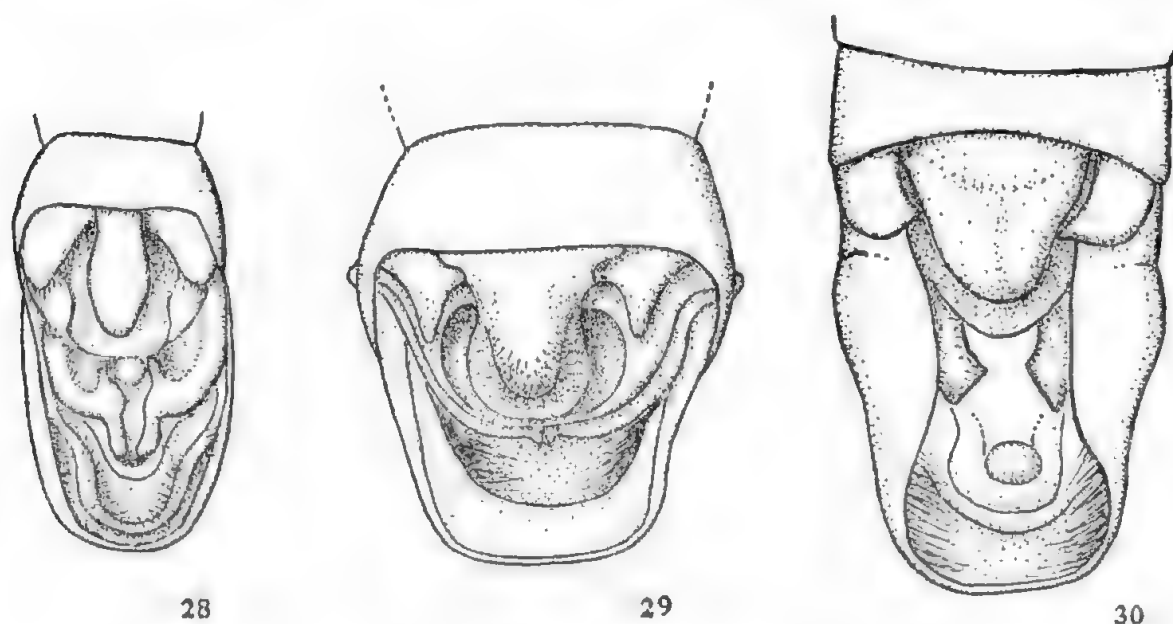


Fig. 28-30. 28. *Endoclita marawita* Tindale, Mt. Kina Balu, female genitalia, ventral aspect. 29. *Endoclita williamsi* Tindale, Los Banos, female genitalia, ventral aspect. 30. *Endoclita taranu* Tindale, Lebong Sandai, female genitalia, ventral aspect, with egg appearing in orifice of ovipore.

available specimen is much worn there should be no difficulty in recognizing it again with the aid of the figure.

The female genitalia (fig. 28) have the 7th sternite transverse, and with an entire hind margin much drawn backwards at the sides; the 8th sternite has a digitiform median process and rolled lateral margin; the anterior gonapophyses are rounded and plate-like; the posterior gonapophyses have strongly chitinized and dilated terminal processes.

***Endoclita williamsi* sp. nov.**

Plate xxii, fig. 1 and text fig. 29.

Female. Antennae (wanting in available specimen); eyes large, in lateral view masking whole of head; head, thorax, abdomen and legs

pale fawn, hind legs small, without specialized plume of hairs. Forewing with costa straight, slightly falcate at tip, dull brown with unobtrusive paler bands following general pattern characteristic of the genus; some ill-defined black spots along costa, a group of three small silvery-white spots around junction of rm vein and M_1 , another white spot at fork of M_2 and M_3 ; traces of minute, generally paired, ochreous spots outlined in dark brown, on apical third of wing. Hindwing with both Pcu and $1V$ veins present; smoky-brown except very narrowly at wing tip; an obscure opalescent blue sheen on wing in certain lights. Wings beneath dull brown without well defined markings. Forewing length 44 mm., expanse 93 mm.

Loc. Philippine Islands: Los Banos, at light (F. X. Williams) type a female, unique, in United States National Museum.

This species is named for Mr. F. X. Williams to whom I have been indebted for many observations on Hepialidae. At first glance this species might be thought to be the *E. ijereja* of Mt. Kina Balu, but the eyes are much larger and there are significant differences in the sex organs.

The female genitalia (fig. 29) show a seventh sternite with hind margin entire and straight, with claw-like anterior gonapophyses. The 8th sternite has a large medial ventral elevation and internally a broad plate with the lateral margins curled down. The semi-circular hind margin of the median elevation is clothed in dense hairs on small papillae. The terminal part of the abdomen is widely flanged.

In the form of the genitalia this species probably falls closest to *E. hosei* of Sarawak, also described in this paper but differs in the shape of the anterior gonapophyses and the form of the 8th sternite.

***Endoclita taranu* sp. nov.**

Plate xxii, fig. 2 and text fig. 30

Female. Antennae short, threadlike, purplish-brown, of about 22 segments. Head with eyes large but not covering silhouette of head; head, thorax above, abdomen and legs pale fawn, sides of thorax brownish-black, posterior legs of normal size, without specialized plume on tibia. Forewings long, slender, costa sinuous with a marked costal expansion at Sc_1 ; apex strongly falcate, termen and inner margin well rounded in a single curve; colour grayish-brown with dull brown suffusions, notably in the middle of the wing, and enclosing a triangular patch of light gray scales in middle of cell; a pair of black-bordered

silver spots at one-third length of cell and a group of three around junction of rm vein with M_1 ; faint traces of other spots along costa and in a line of brownish suffusion extending from near apex to inner margin at three-quarters; a white and black bordered brown spot inwards from inner margin at one-half. Hindwings with costal margin slightly concave, tip of wing markedly falcate, termen well rounded with a slight concavity at hind angle, colour dull grayish-brown with a bright purple suffusion evident from some angles of view, tip of wing with rudiments of wing pattern of forewing. Wing length 56 mm., expanse 119 mm.

Loc. Sumatra: Lebong Sandai, Benkoelen (type a female, unique, in Joicey Collection at British Museum, 1925-122.).

From the similarity in size one might consider this species to be the female of the large *E. aikasama* of Java, but there is apparently no instance of a species with the costal dilation of forewing developed in the female and absent in the male. The wing patterns are similar and both have falcate wing tips. On close inspection the similarities in the two species become less apparent and it is with some confidence that they are kept apart.

The female genitalia show a broadly transverse 7th sternite with parallel sides, and a broad vertical projection to 8th sternite, about as wide as long; the posterior gonapophyses are slightly dilated at their posterior extremities. In the available specimen (fig. 30), an egg is held in the opening of the ovipositor, it is nearly spherical, smooth and pale cream coloured.

***Endoclita hosei* sp. nov.**

Plate xxii, fig. 3 and text fig. 31

Female. Antennae short, filiform, of 22 segments. Eyes large, dilated, but in lateral view not quite concealing rest of head. Head, thorax, legs, and probably abdomen (much abraded in the type specimen) pale fawny-brown, posterior legs of normal size without specialized plume. Forewings with costa straight, except for a moderate expansion at Sc_1 , apex slightly falcate, termen and inner margin in a single swept curve; m vein just beyond fork of M_1 and M_2 ; wing colour pale brown with richer brown areas in centre of wing and in a series of circular patches running parallel to termen; a double patch of brown towards costa, and of black below it at the point of obsolescence of Cu_2 ; a series of dark brown and black spots along costa; there are

traces of a series of tiny black-ringed creamy-white spots just below each vein along termen; a group of three larger ones at junction of r-m vein and M_1 , two others at the basal M fork and trace of others. Hindwing with costa straight, termen and inner margin angulate, im vein before fork of M_1 and M_2 but after branching of M_2 and M_4 ; P_{cu} and IV both extending to margin; wing tip brown, with pattern of forewing; rest of wing dull gray, in certain lights with a dull purplish suffusion. Wing length 46 mm., expanse 97 mm.

Loc. Sarawak: Baram district (Charles Hose). Type a female, unique, in Tring Collection at the British Museum.

A first impression is that this species is close to *E. warawita* from nearby Mt. Kina Balu, because of the almost identical wing patterns, but the wings are relatively longer and the costal eminence on forewing less conspicuous; the form of the 8th sternite and of the genital processes show it to be quite a different species.

The female genitalia have the 7th sternite transverse, with the side margins converging towards the anterior end. The 8th sternite is a broad plate with semicircular posterior margin, the posterior gonapophyses have the distal extremities dilated.

In the type specimen unhatched eggs are visible through a break in the wall of the abdomen. They are spherical, matt surfaced, 0.5 mm. in diameter, and show traces of a micropyle on one side.

***Endoclita kara* sp. nov.**

Plate xxii, fig. 4 and text fig. 32

Female. Antennae (wanting in described specimen); head with eyes moderately large, in lateral view not covering silhouette of head; thorax, abdomen and legs ochreous-fawn. Forewing with costa sinuous, slightly dilated at Sc_1 , apex blunt-pointed, termen and inner margin well rounded, wing colour pale grayish-fawn with brownish-fawn suffusions; particularly a V-shaped area in middle of wing marking off an area of pale ground colour in cell; groups of black-bordered white spots at two-fifths cell and near r-m vein, a series of brown margined circular patches between veins, principally in terminal third of wing, each circle with traces of a tiny central brown-ringed cream-coloured spot, a figure eight shaped black spot obscurely margined with cream-coloured scales inwards from inner margin at one-half, and traces of others. Hindwings with costa nearly straight, apex blunt, termen rounded but slightly straightened near inner angle; grayish-fawn with

a brassy lustre from some angles of view; traces of forewing pattern only at tip of wing. Wing length 27 mm., expanse 57 mm.

Loc. Java: Vulkan Gede, Preanger district (1896, Prilwitz, type, a female, unique, in Mus. f. Naturk., Berlin).

Related to *E. sericeus* from which it appears to differ in the narrower dorsal part of the 8th sternite, the form of the posterior margin of the 7th sternite, and in the longer, apically acutely pointed anterior gonapophyses.

The female genitalia (fig. 32) have the 7th sternite transverse with the lateral margins converging towards the anterior extremity.

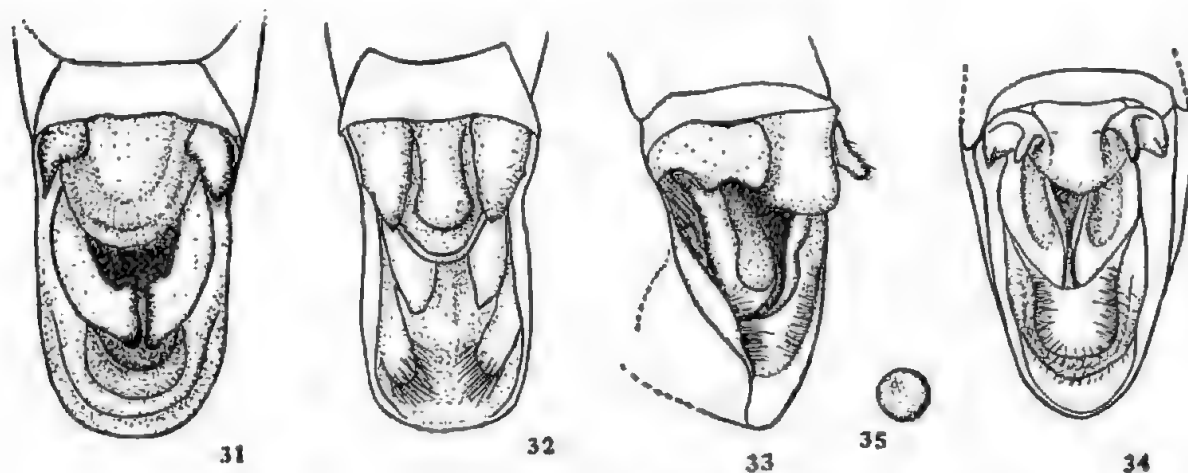


Fig. 31-35. 31. *Endoclita hosri* Tindale, Sarawak, female, genitalia, ventral aspect. 32. *Endoclita kara* Tindale, Vulkan Gede, female genitalia, ventral aspect. 33-35. *Endoclita ijereja* Tindale, Mt. Kina Balu. 33-34. Female genitalia, oblique and ventral aspects. 35. Egg diameter 0.60 mm.

The 8th sternite has a nose-like ventral process and a well rounded posterior margin; the anterior gonapophyses are large and triangular in shape, terminating posteriorly in blunt points.

Endoclita ijereja sp. nov.

Plate xxiii, fig. 1 and text fig. 33-35

Female. Antennae (wanting in the described specimen); head with eyes moderate, in lateral view not masking whole of head; head, thorax and base of abdomen pale fawn, abdomen possibly darker (much stained on type specimen); hind legs small, without specialized hairs. Forewings with Sc_1 present but without appreciable costal swelling, im vein separated from fork of M_1 and M_2 by a stalk shorter than in

the type of the genus; wing colour smoky-brown with numerous paler smoky-fawn markings, including a broad band across forewing from costa at four-fifths to inner margin at three-quarters; a line of black-centred pale-fawn-margined spots along costal vein, others on costal margin and a larger brownish-black spot where Cu_2 becomes obsolete; a cluster of three white spots at junction of r-m vein and M_1 , and another two (or three) at fork of M_2 and M_3 , other flecks of creamy-white scattered on outer third of wing. Hindwings with veins Pcu and $1V$ both present; apical fifth of costa marked as in forewing, rest of wing smoky-brown; in certain lights all but the anal margin and the apical fifth of wing glows with a purplish-brown sheen. Forewing length 54 mm., expanse 114 mm.

Loc. Borneo: Mt. Kina Balu, 1,200-1,500 metres, 1893 (Waterstradt) type, a female, unique, in Mus. f. Naturk., Berlin.

This example bears a Staudinger collection No. K. 739. At first glance it is like *E. signifer* in the pattern of wing markings but the wing tip is slightly more falcate, the costal markings are more numerous and there are many points of difference in the details of the markings.

The female genitalia (fig. 33-34) have the 8th sternite with its posterior margin spade-shaped and the 7th with posterior margin straight, the anterior gonapophysial elements, in view from below, show a rounded spine-like process overlying a blunter projection; in oblique lateral view it appears more like a plate with two rounded projections; the posterior gonapophyses are large with a median keel and deep medio-lateral fold. In the form of the genitalia this species bears no relationship to *E. signifer*.

Eggs dissected from the abdomen are available as are also others still adhering to the apex of abdomen. They are 0.6 mm. in diameter, spherical, smooth, with a small circular area of different texture around the micropyle. Colour of dried eggs, dark brown (fig. 35).

***Endoclita sibelae* (Roepke)**

Phassus sibelae Roepke 1935, Trop. Natuur. 24, p. 102, fig.

This species, described from Batjan Island, has not been examined.

***Endoclita signifer* (Walker)**

Phassus signifer Walker 1856, Cat. Lep. Het. Brit. Mus., vii, p. 1568.

Endoclita signifer Tindale 1941, Rec. S. Austr. Mus., 7, p. 30.

Hypophassus signifer Viette 1948, Musee Heude, xii (8), p. 83.

Viette reports this species from Tonkin at Hoa Binh. It is not clear whether he has critically examined and compared the genitalia of his specimens. Previous identifications of the species in Eastern Asia all have proved to be based on other species, for example the female example described in this paper as *E. topeza* long stood under this name in the Cornell University Collection.

UNIDENTIFIED SPECIES OF ENDOCLITA

Other species thought to belong to *Endoclita* but not critically considered for this revision are *Phassus dirschi* Bang Haas 1939 from Kansu, and *Gorgopis nipponica* Butler 1879.

REFERENCES CITED

- Bang-Haas, O. 1939: *Iris*. p. 59, fig.
Butler, A. G. 1879: *Ann. Mag. Nat. Hist.*, (5), iv, p. 357.
Zeuner, F. E. 1943: *Trans. Zool. Soc. London*, 25, p. 110.

ADDITION TO PREVIOUS PART

Sahyadrassus magnus Tindale

Plate xxiii, fig. 2

In a previous part of this revision, Tindale (1942, p. 154), this species was described, but not figured. The paper had been rather rapidly completed during a brief leave from military duties. The deficiency is now made good. The only known example, in the British Museum, is a rather dilapidated looking male which was much injured in the post when being sent to me in Australia. In the original description it was ascribed in error to the South Australian Museum collection.

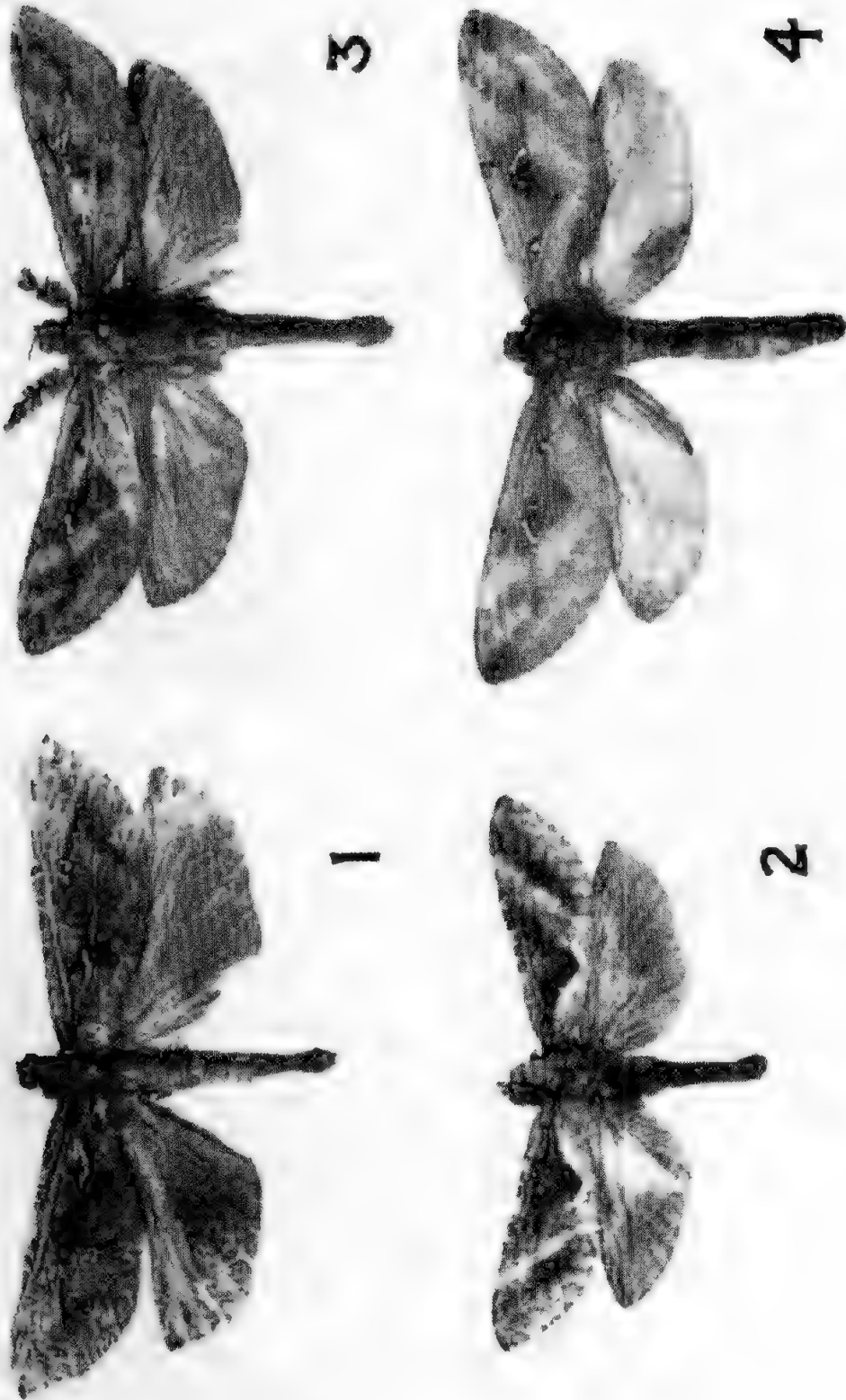


Fig. 1. *Endocheila parvata* Tindale, male, Borneo (1), 85 mm.
Fig. 2. *Endocheila cretensis* (Butler) - male, Yokohama, 74 mm.
Fig. 3. *Endocheila sinensis* (Moore), male, Chekiang, 76 mm.
Fig. 4. *Endocheila sinensis* (Moore), female, Gensan, 79 mm.

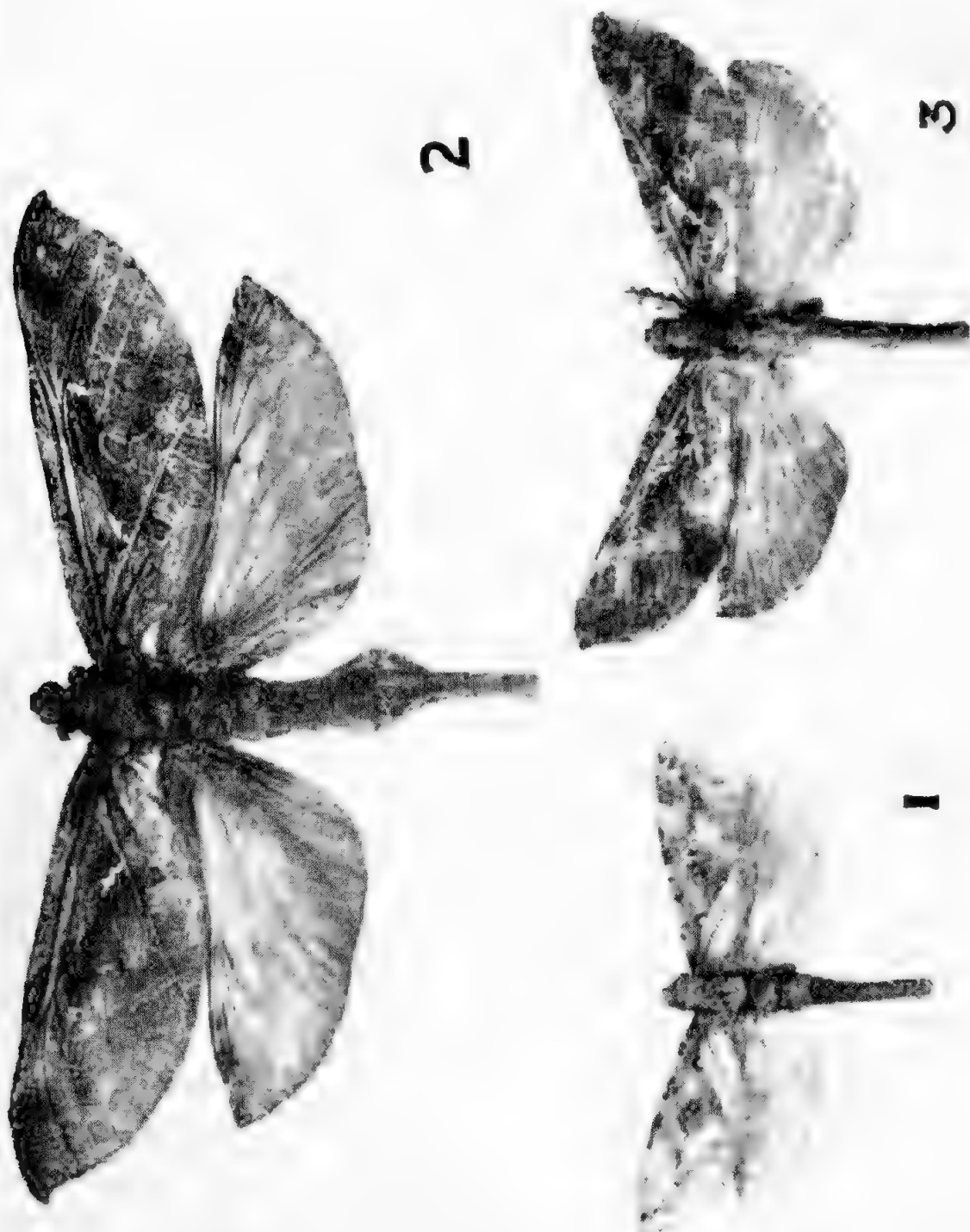


Fig. 1. *Eudachta camphorae*, Sasako, male, Togo, 73 mm.
Fig. 2. *Eudachta akasana* Tinkale, male, Vulkan Gede, 144 mm.
Fig. 3. *Eudachta saccus* (Swinhoe), male, Java, 66 mm.

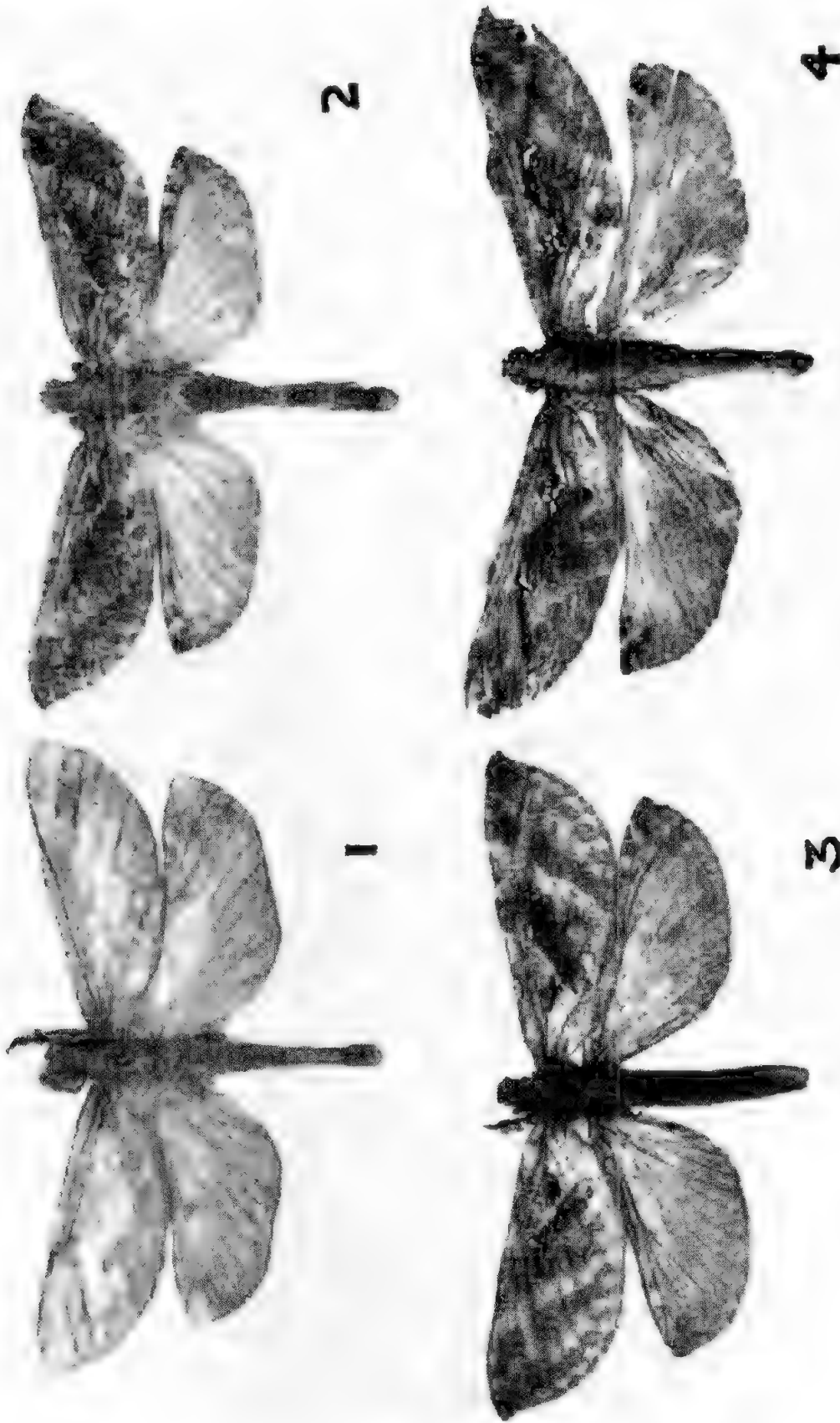


Fig. 1. *Eudocilia aurifer* Tindale, male, Java, 78 mm.
Fig. 2. *Eudocilia booma* Tindale, male, December, 76 mm.
Fig. 3. *Eudocilia booma* Tindale, female, Mt. Ancljasmara, 80 mm.
Fig. 4. *Eudocilia sabrazi* Tindale, male, Thabo, 92 mm.

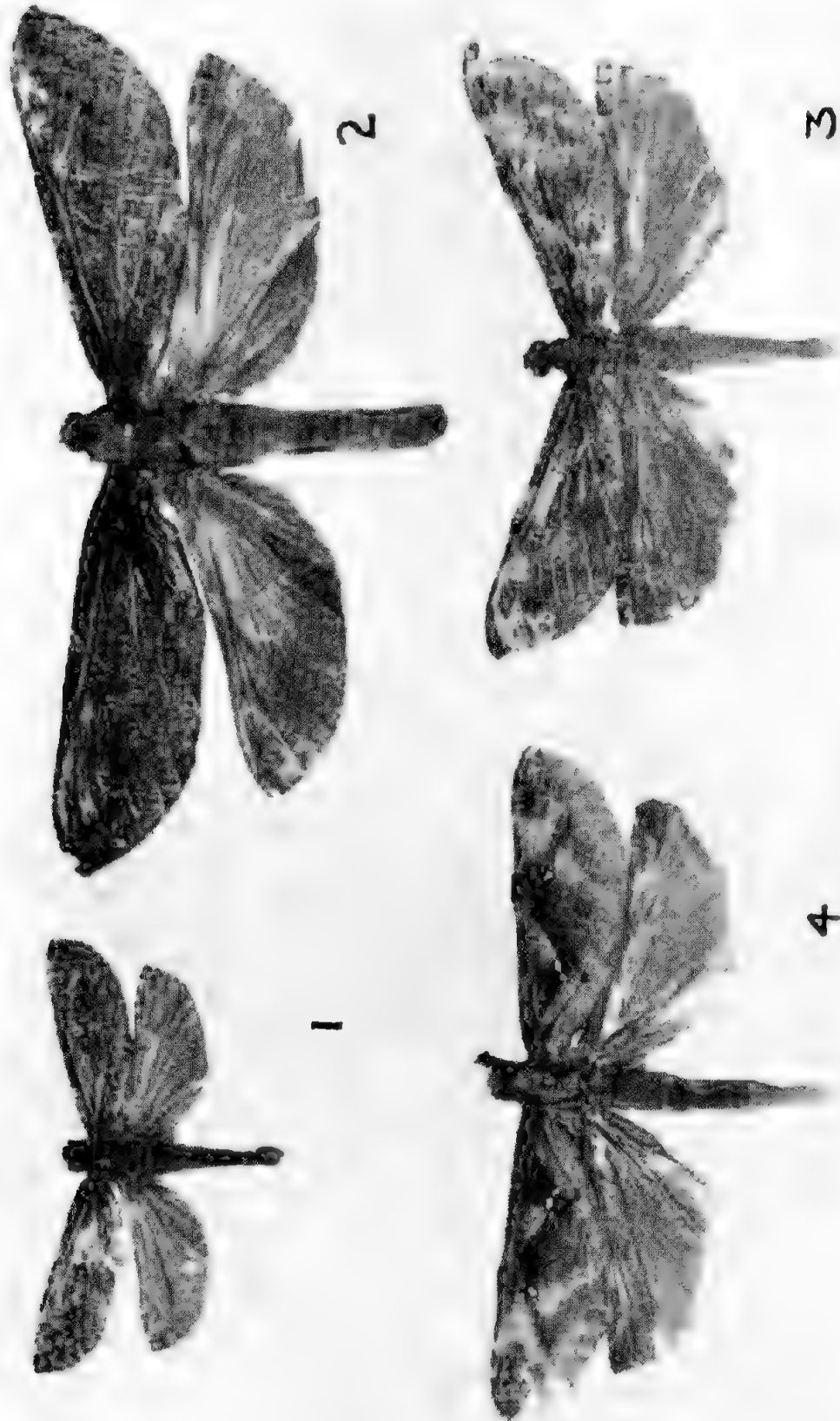


FIG. 1. *Eudochila oona* Tindale, male, Leihong Sandak, 53 mm.
FIG. 2. *Eudochila oona* Tindale, female, Leihong Sandak, 105 mm.
FIG. 3. *Eudochila caepi* Tindale, male, Nipis, 74 mm.
FIG. 4. *Eudochila tosa* Tindale, male, Tenggor, 80 mm.



Fig. 1. *Eudocheta aurata* (Hampson), female, Laos, 53 mm.
Fig. 2. *Eudocheta nipa* (van Eecke), male, Vulkan Gede, 83 mm.
Fig. 3. *Eudocheta crinitimbata* (Le Cerf), male, Yao Gi, 93 mm.
Fig. 4. *Eudocheta topozia* Tindale, female, Laos, 109 mm.



Fig. 1. *Eudachista darwin* (Pavajede), female, Suishako, 16.5 mm.
Fig. 2. *Eudachista kosoniponis* (Strand), male, Kosompo.
Fig. 3. *Eudachista kosoniponis* (Strand), female, Kosompo.
Fig. 4. *Eudachista adarata* (Fernald), female, Kina Bala, 7.6 mm.



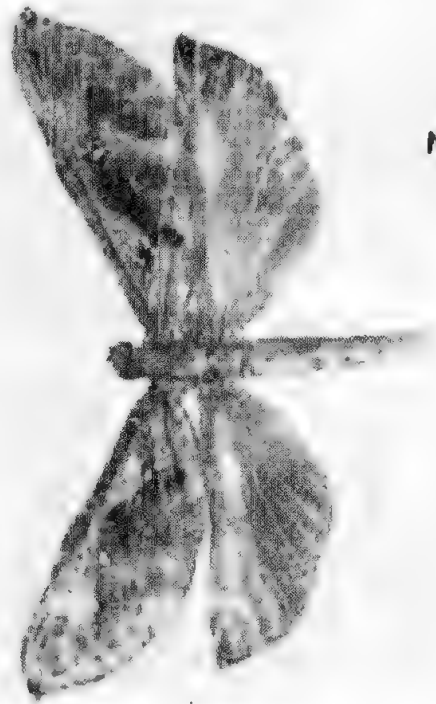
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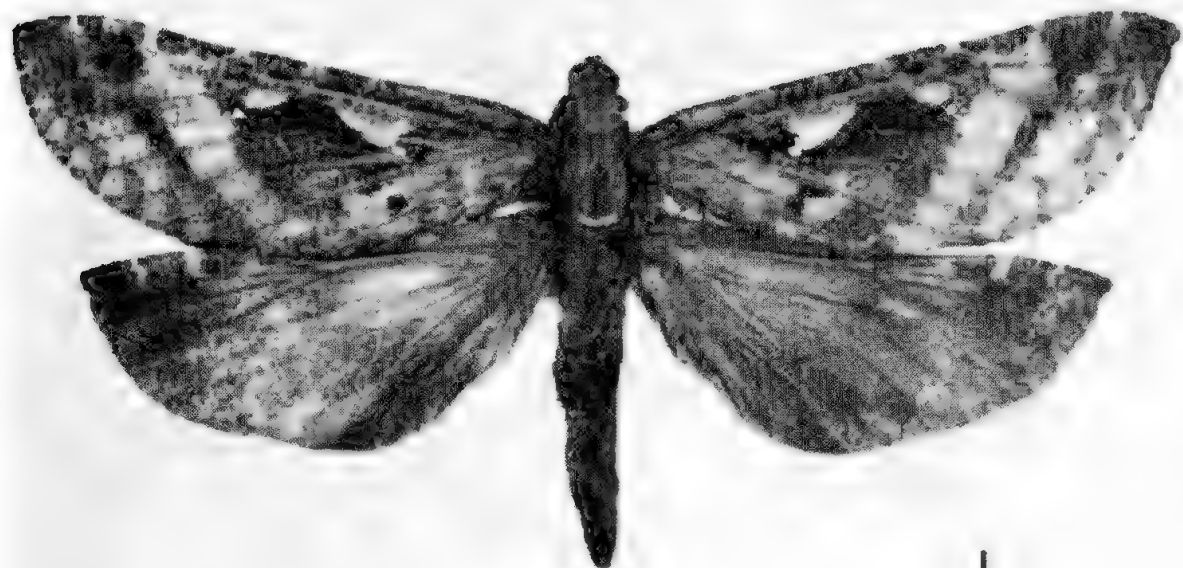


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Fig. 1. *Euboechla williamsi* Tindale, female, Los Baños, 93 mm.
 Fig. 2. *Euboechla tacana* Tindale, female, La'ong Sandan, 119 mm.
 Fig. 3. *Euboechla hasei* Tindale, female, Sogavak, 97 mm.
 Fig. 4. *Euboechla lata* Tindale, female, Vulkan Gedeh, 57 mm.



1



2

Fig. 1. *Endoetila tjersja* Tindale, Fumulo, Mt. Kinu Bulu, 114 mm.
Fig. 2. *Sahyadrassus magnus* Tindale, nudo, Palni Hills, S. India, 110 mm.

NEW CRETACEOUS FOSSILS FROM NEW GUINEA

BY MARTIN F. GLAESSNER, UNIVERSITY OF ADELAIDE

WITH A CONTRIBUTION ON A NEW AMMONITE GENUS

BY R. CASEY, GEOLOGICAL SURVEY OF GREAT BRITAIN

Summary

Mollusca including the ammonite, *Chimbuites sinuosocostatus* gen. et sp. nov., *Pleuromya cuneata* sp. nov. and several species previously known from Australia are described from the Albian of Papua and New Guinea. Two new *Trigonias*, a dimitobelid belemnite and a new species of tubicolous worm *Rotularia* are described from the Cenomanian. An introduction summarizes new data on the Cretaceous of New Guinea which have become known during the last decade.

NEW CRETACEOUS FOSSILS FROM NEW GUINEA

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With a Contribution on a New Ammonite Genus

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Plates xxiv-xxvi and text fig. 1-5

ABSTRACT

Mollusca including the ammonite *Chimbuites sinuosocostatus* gen. et sp. nov., *Pleuromya cuneata* sp. nov. and several species previously known from Australia are described from the Albian of Papua and New Guinea. Two new Trigonias, a dimitobelid belemnite and a new species of tubicolous worm *Rotularia* are described from the Cenomanian. An introduction summarizes new data on the Cretaceous of New Guinea which have become known during the last decade.

INTRODUCTION

Much progress has been made in the study of Cretaceous sediments and fossils in the Australian part of New Guinea since they were last reviewed (Glaessner 1943, David 1950). The main results of the new discoveries can be summarized as follows: (1) greater extent and completeness of the Cretaceous record, (2) confirmation and extension of Australian relations of the faunas, and (3) zoning of facies according to tectonic environment. Any approach to detailed biostratigraphy of this large and little-known area can only be gradual and detailed zonal correlation of Cretaceous strata is not yet possible. It should be based on detailed zonal collecting from continuous fossiliferous sequences which could not be carried out because of difficulties of terrain and tectonics. Nevertheless, the identification of a number of fossils has led to age determinations which though necessarily somewhat vague and provisional, have added to the record of Cretaceous geological history of the area.

The Cretaceous commences in New Guinea with basal Lower Cretaceous (*Infravalanginian*) shales, with a fauna corresponding to that of the Lochambel beds at the top of the Spiti shales in the Himalaya. It includes *Haplophylloceras strigile* (Blanford), a distinctive species which is also well known from the Sulu Islands and from Western New Guinea. It was found recently in Papua, in the vicinity of the Kereru Range. The Infravalanginian Zone ammonite *Subthurmannia boissieri* (Pictet) has been recorded by Spath (1952, p. 23) from this locality.

The presence of higher *Neocomian* cannot be as clearly demonstrated. The absence of well-dated faunas of this age is, however, less likely to be due to regional non-deposition than to lack of suitable facies or to local erosion prior to a transgression of the Aptian or Albian. Evidence of such a transgression was found in the headwaters of the Fly River (Osborne 1945).

The *Aptian* is not represented by distinctive molluscan faunas. The genera *Muccoyella* and *Peratobelus* which are abundant in the Aptian of Australia have not been found in New Guinea and the ammonite tentatively identified as *Deshayesites* is shown by Casey to represent a new genus of Albian affinities. Assemblages of smaller foraminifera suggesting Aptian age occur but are not yet sufficiently well known to permit definite correlations.

The *Albian* is well represented but has not yet been zoned. Australian affinities are now well established though other elements are also present in the Albian fauna of New Guinea. Among them are *Ptychomya* and *Nerinea* (Glaessner 1945), and *Puzosia*.

The foraminiferal fauna of the Albian of New Guinea contains a number of well-known European and North American species, in addition to some from the Great Artesian Basin and others from the Carnarvon Basin (Western Australia).

In the *Cenomanian*, affinities can be established only with the northern and western fringes of the Australian continent (Melville and Bathurst Islands, Carnarvon Basin), as the Great Artesian Basin does not contain marine deposits of this age. Such affinities have been found among the foraminifera and mollusca but further discussion has to be deferred until the Australian Cenomanian faunas are described.

The following Table summarizes the known faunal relations:

	New Guinea	Australia
<i>Pseudavicula papyracea</i> ⁽¹⁾	Alb.	Alb.
<i>Aucellina gryphaeoides</i>	Alb.	(2)
<i>Pleuromyu cuneata</i>	Alb?	—
<i>Linotrigonia (Oistotrigonia) lima</i>	Cen.	(2)
" <i>Trigonia</i> " <i>papuana</i>	Cen.	(2)
<i>Cymatoceras hendersoni</i>	Alb.	Alb.
<i>Cymatoceras</i> sp.	Cen.	—
<i>Chimbuites sinuosocostatus</i>	Alb.	—
<i>Puzosia</i> cf. <i>planulata</i>	Alb.	—
<i>Myloceras davidi</i>	Alb.	Alb.
<i>Myloceras</i> cf. <i>flindersi</i>	Alb.	Alb.
<i>Laboceras trifidum</i>	Alb.	Alb.
<i>Parahibolites blanfordi</i> ⁽¹⁾	Alb.	—
<i>Dimitobelus (Tetrabelus) macgregori</i>	Alb.-Cen.	(2)
<i>Rotularia spirulaeoides</i>	Cen.	—

The Chimbu Cretaceous sequence on the north flank of the Kubor Anticline⁽³⁾ is characteristic of a distinctive tectonic zone which Edwards and Glaessner (1953, p. 111) recognised as geosynclinal. They referred to it as miogeosynclinal while Rickwood (1955, p. 81) considers it as "more nearly eugeosynclinal than miogeosynclinal". There is agreement on the necessity of assuming more mobile belts to the north and east of the area, with volcanic islands as a source of the abundant volcanic component, while a relatively stable area was situated to the south and west. In this area the Albian and Cenomanian fossils here described were collected from greensands and calcareous shales. These

(1) See Glaessner 1945. (2) Similar species or subspecies in the Albian of the Great Artesian Basin.

(3) This section is included in the area studied by Rickwood (1955) who found further fossils and revised the stratigraphy. He mapped the *Kondaku Tuffs* (Lower Cretaceous) and the overlying *Chim Group* (*Maril Shales* and *Chimbu Tuffs* of Edwards and Glaessner), pointing out that its subdivisions are recognizable only in the Chim Valley and that it is "probably not wholly Upper Cretaceous" as ammonites found by natives in this vicinity and described below as Albian came from its base. There is of course no reason why the rock-stratigraphic Kondaku/Chim boundary used in mapping should coincide with the chronological Albian/Cenomanian boundary. The top of the Chim Group is probably not younger than Cenomanian (or Turonian) rather than "a record of uninterrupted sedimentation from the uppermost Cretaceous . . . to Eocene" as Edwards and Glaessner had thought possible. Rickwood has found that not only one but all limestone "lenses" with Eocene foraminifera included in the upper part of Noakes's section below the main Eocene scarp are slump blocks and that Cretaceous fossils, including *Dimitobelus macgregori* (Glaessner) occur only 1,500 feet below the top of the Chim Group.

sediments are probably an eastward extension of the Albian-Cenomanian Feing Group (Osborne 1945, Glaessner 1945) of the Upper Fly River area 200 miles to the west-north-west, which they resemble.

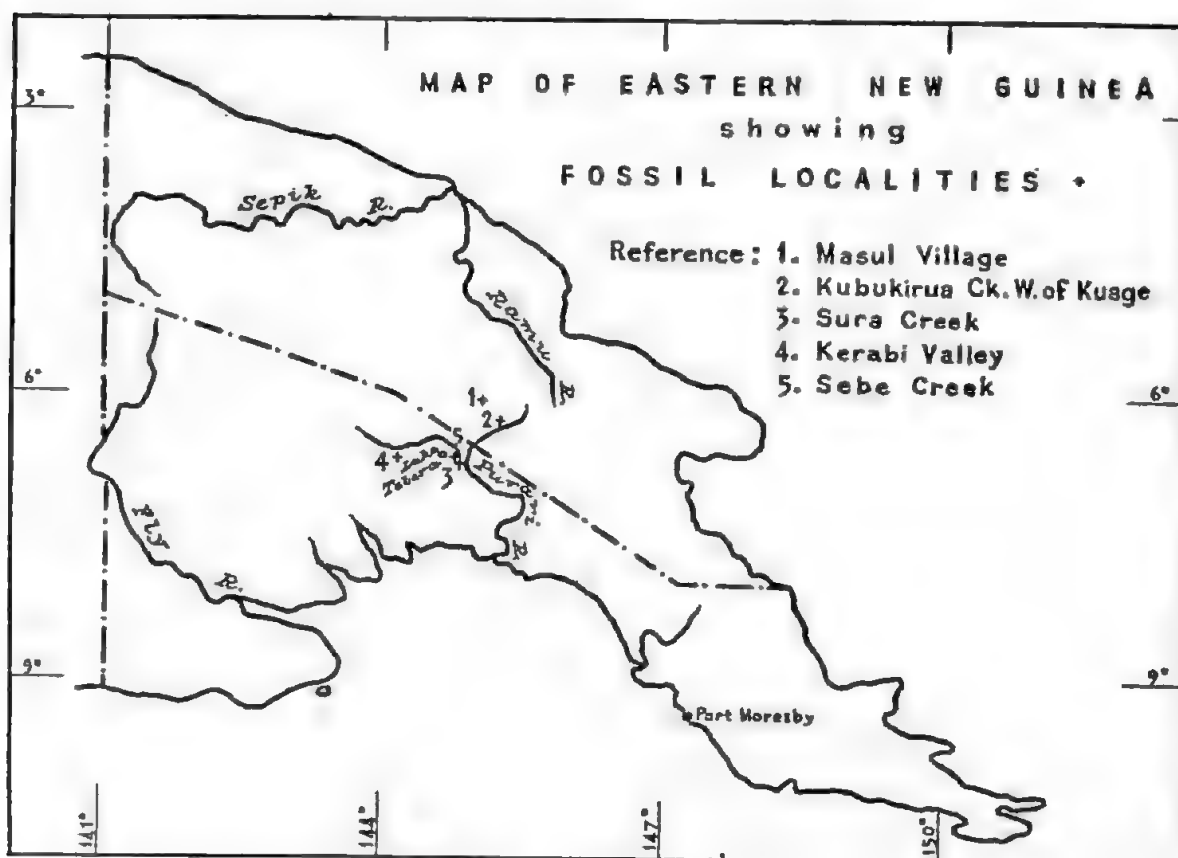


Fig. 1 Locality map.

It is probable that the fossils described from a less altered portion of a phyllitic greywacke series (Kaindi Schists) near Wau in New Guinea (Glaessner 1949) are also of Albian or Cenomanian age. The genera *Cliona*, *Cucullaea*, *Glycymeris*, "*Trigonia*", *Cardium*, *Vulsella*, *Inoceramus* and *Tibia*? have been recognised. These rocks represent a regionally metamorphosed zone of the mid-Cretaceous geosyncline of New Guinea.

The localities of most of the described species are shown on the accompanying map (fig. 1) which was kindly made available by the Australasian Petroleum Company.

Holotypes of the new species are in the palaeontological collection of the University of Adelaide. Paratypes are in the South Australian Museum. Other examined specimens have been returned to the private collection of the Australasian Petroleum Company.

ACKNOWLEDGEMENTS

The author is indebted to the Australasian Petroleum Company for permission to describe these fossils and to publish this paper; to Dr. P. E. Kent, Mr. W. D. Mott, Mr. F. K. Rickwood and Mr. G. A. V. Stanley, who collected or obtained the fossils and supplied information, and to the Departments of Geology of the Universities of Melbourne and Queensland, and the Australian Museum (Sydney) for the loan of specimens. The Australasian Petroleum Company provided the drawing of text fig. 1; Miss A. M. C. Swan assisted in the drafting of the other text figures, and Miss M. J. Wade (University of Adelaide) photographed most of the specimens.

DESCRIPTIONS

***Aucellina gryphaeoides* (Sowerby)**

Plate xxiv, fig. 1a-b and text fig. 2

Avicula gryphaeoides J. de C. Sowerby, Trans. Geol. Soc., ser. 2, vol. 4, 1836, pp. 156, 335, pl. 11, fig. 3.

Aucellina gryphaeoides Pompeckj, N. Jahrb. Min. etc., Beil.-Bd. 14, 1901, pp. 354, 365, pl. 16, fig. 6-8.

Aucellina gryphaeoides H. Woods, Mon. Cretac. Lamellibr. England vol. 2, pt. 2, Palaeontogr. Soc. 1905, p. 72, pl. 10, fig. 6-13.

Aucellina gryphaeoides hughendenensis (*non* Etheridge), Edwards and Glaessner, Proc. Roy. Soc. Vict., vol. 64, 1953, p. 98.

Material and occurrence: Two left valves and one right valve from Kubukirua Creek, west of Knage Village, Eastern Highlands of New Guinea, about 5 miles northeast of Wahgi-Purari junction (Coll. G. A. V. Stanley). One left valve from Sura Creek, east-south-east of Lake Tebera, Papua (Coll. F. K. Rickwood).

Remarks: The specimens from New Guinea agree remarkably well in shape, curvature, and ornamentation with the English species, two specimens of which from the Cambridge Greensand were kindly forwarded for comparison by Dr. L. R. Cox, of the British Museum (Natural History). In the right valve the height is slightly less than the length and the radial ribs are more pronounced on the surface of the internal mould. In the left valve the proportions and curvature of the umbo are identical with those of the English form.

A comparison was made with specimens from the Tambo Formation of Queensland (Granada and Ilfracombe) of the species described by Etheridge as *Avicula hughendenensis*. R. Etheridge Jr. in Jack and Etheridge. 1892, p. 461), remarks that *A. gryphaeoides* differs from the Australian form in having a much larger umbo in the left valve, "and the general characters of the right valve are quite different." The first of these statements can be confirmed, the second is of questionable value. Pompeckj noted the longer auricle of the left valve and the radial sculpture. These distinguishing characters are of minor importance compared with differences between other species of the genus and may therefore be considered as subspecific. Only the somewhat more pronounced radial sculpture is seen in the New Guinea specimens which are thus closer to the English form. On examination of further material from with the very wide geographic range of the species,

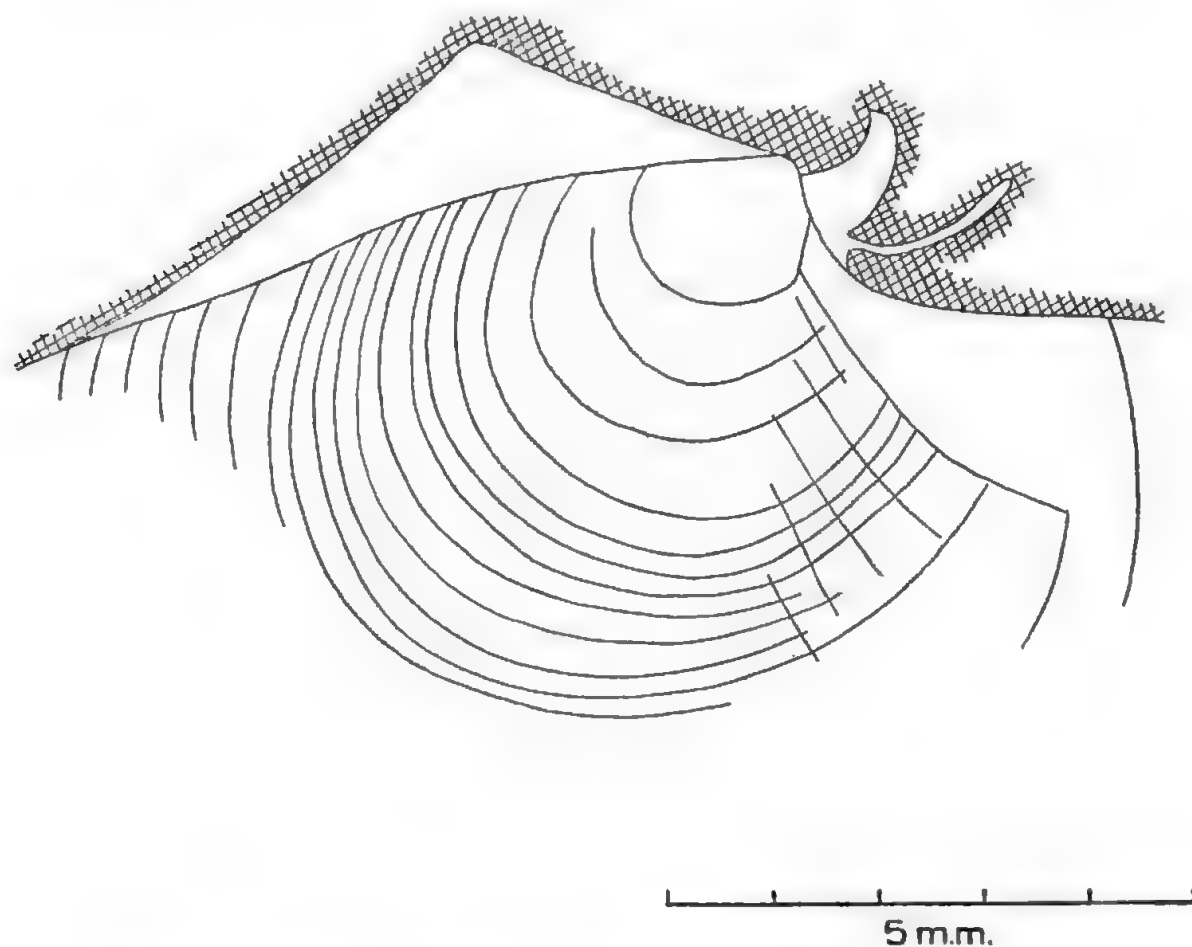


Fig. 2. *Aucellina gryphaeoides* (Sowerby). Enlarged view of the proximal portion of right valve (pl. 1 fig. 1b), camera lucida drawing showing outline of complete posterior and fragmentary anterior auricle.

they may be found to constitute another subspecies. The characters of the umbo and auricles are, however, definitely as in the English form to which the present specimens are therefore referred.

A. incurva Etheridge from the Albian of Darwin, *A. euglypha* Woods from the Albian of New Zealand, *A. parva* (Stoliczka) from the Cenomanian of Southern India and *A. radiatostriata* (Bonarelli and Nagera) from the Upper Aptian of South Georgia are clearly specifically different, the last-named differing in the much stronger radial sculpture, the less projecting umbo and the less strongly developed posterior part of the left valve (see Wilckens 1947).

Age: It is difficult to reach a definite conclusion about the stratigraphic range of this species and allied forms. Woods (1905) listed it from the Upper Gault, the Cambridge Greensand, and the Cenomanian up to the zone of *Holaster subglobosus*. Gillet (1924) also includes in this species d'Orbigny's *Inoceramus coquandi* (Upper Aptian). Pompeckj (1901) considers the identity of this species with *A. gryphaeoides* as "very probable" but points out that it has not been properly described. D'Orbigny's type figure does not show the characteristic shape of the umbo of the English form. An Aptian age of any typical *gryphaeoides* does not seem to be well established. Neither has it been figured from the Upper Cenomanian. In the Caucasus it was listed by Renngarten from the Upper Albian where it occurs stratigraphically above the Lower Albian *A. caucasica* Abich. *A. gryphaeoides* is therefore to be considered as mainly an Upper Albian form, possibly extending into the Lower Cenomanian (Woods, Pompeckj). Earlier and later references require confirmation. *A. g. hughendenensis* is according to Whitehouse restricted to the Middle and Upper Albian Tambo Formation of Queensland and its equivalents in South Australia. H. O. Fletcher collected many fine specimens of this subspecies at Onepah Station, about 30 miles N.N.E. of Tibooburra, New South Wales (Australian Museum, Nrs. F: 42149, 42155-7, 42169-70, 42179, 42208, 42215, 42219).

***Linotrignonia (Oistotrignonia) lima* sp. nov.**

Plate xxv, fig. 7a-b and 8-9

Material: Holotype (Adelaide University Geol. Dept. No. F15324) showing both valves in apposition, partly concealed by hard sandy matrix. Paratype, a left valve, carinal portion and umbo broken but surface well exposed by weathering. Also about 10 external and internal moulds and fragments (Coll. F. K. Rickwood).

Diagnosis: Flank ribs mostly gently curved, bearing long, stout, close-set spines; area very wide, covered with numerous small blunt tubercles which are arranged to form oblique curved costae diverging from the flank ribs at an angle of about 60-70° in the young and about 40° on the adult shell.

Description: Shell thick, broadly elliptical in outline, but with a straight, relatively short postero-dorsal margin. Umbo small, very slightly projecting. Area wide, almost flat; marginal carina obtuse, straight. In young specimens the area is covered with numerous crenulated costae which are straight near the carina and bend upward near the dorsal margin. In the adult the areal costae break up into numerous small blunt tubercles giving the area a distinctive rasp-like surface. Flank ribs reaching the ventral margin at an angle of about 70-80°; they are very gently curved, separated by wider spaces, about 10 with a few short antero-ventral intercalations. There are 7-8 additional anterior flank ribs, diverging sharply from the main ribs towards the anterior margin which they reach at right angles. The main and some of the anterior costae are at first covered with and later in ontogeny break up into long stout close-set spines. The chevron-like divergence of areal and flank ribs on the marginal carina is well marked, particularly in young stages (pl. xxv, fig. 9), but in the adult the areal costae are much weaker than the flank ribs and growth lines become increasingly well marked. The costae are seen on the internal surface of the valves as broad depressions. The interior margin is crenulated. Teeth and buttress well developed, with fine dental crenulations, but not well preserved.

Measurements: Length 41 mm., height 31.3 mm., length of carina about 40 mm. (holotype), maximum thickness 28.5 mm. Length of paratype about 37 mm.

Comparison: This species resembles closely the form described as *Trigonia (Acanthotrigonia) phyllitica* Glaessner (1949), from the sheared and partly contact-metamorphic greywacke-phyllite complex of the Kaindi Group in the Morobe District of New Guinea. Since then Cox (1952) has revised the taxonomy of the Trigoniidae and has removed the "spinose scabrae", to which both this and the new species belong, from *Acanthotrigonia* (now placed in the synonymy of *Pterotrigonia*), to form a new subgenus *Oistotrigonia*. This is a far more satisfactory grouping. *Linotrigonia (Oistotrigonia) phyllitica* (Glaessner) differs from the new species in the ornamentation of the area which is covered with fine but distinct ribs becoming obsolescent near the

lateral edge. The flank ribs appear to have been sharper and are covered with "small protuberances". While these observed differences make it impossible to place the present material in *L. (O.) phyllitica*, the discovery of better preserved material of this species must be awaited before their significance can be fully evaluated. In other species of the subgenus the flank ribs swing forward much more strongly, the spines are less distinct, and the area is not as closely papillate.

Occurrence: East of Lake Tebera, Papua; common in dark green glauconitic sandstone, with *Dimitobelus macgregori*, *Dentalium* sp., gastropods, and other lamellibranchs.

Age: While the subgenus *Oistotrigonia* occurs throughout the Cretaceous and is therefore unsuitable for detailed age determination, the association of the new species with other mollusca unlike those from the Lower Cretaceous of New Guinea point to a probable Cenomanian age. This does not conflict with local stratigraphic observations.

Remarks: Another species of *Trigonia* (*sensu lato*) occurs in the Purari Greywackes. It has a small area and numerous flank ribs which are vertical in the median part. The available material does not permit detailed description and identification.

"Trigonia" papuana sp. nov.

Plate xxvi, fig. 1a-b

Material: (1) Holotype: Right valve, almost complete but with the umbonal portion worn smooth (Queensland University Geol. Dept. No. F17914, coll. W. D. Mott, loose in stream gravel in outcrop area of Cretaceous sandstones); (2) Fragment of calcareous matrix (Queensland Univ. Geol. Dept. No. F17915) containing two almost complete left valves and numerous fragments. Worn. Coll. W. D. Mott; (3) Fragmentary right valve. Coll. R. A. Woodward; (4) Rock fragment measuring about 1½ x 2 x 3 inches containing remains of at least twelve valves forming a shell breccia (lumachelle). Coll. R. A. Woodward.

Description: Shell thick, triangular to pentagonal in outline, length equalling height, almost equilateral, moderately convex. Anterior margin straight, ventral margin convex, postero-ventral angle obtuse, posterior and postero-dorsal margins straight and subequal in length. Umbo broadly rounded, worn in all available specimens.

Area wide, moderately convex, with a very faint median furrow and weak concentric growth lines. Marginal carina well developed in the holotype, rounded, with a shallow furrow between it and the area and a wider and deeper sulcus along its anterior side. Both sulcus and carina appear to be variable, the sulcus being better developed in the paratype specimens in which the carina is not as clearly visible as in the holotype.

Umbonal portion of the valve smooth, showing only faint growth lines, the beginning of the median ridge, and the sulcus. Anterior and ventral part of the valve ornamented with concentric ridges (8 in the holotype). They take an arcuate course from the anterior margin of the valve to the anterior border of the sulcus where they end abruptly, or to the ventral margin. The surfaces of the first two ridges are smooth to undulating, the later ones are covered with close-set rounded knobs becoming more distinct and numerous on the younger costae and varying in size.

Hinge teeth of right valve long and strong, finely crenulated.

Comparison: This species belongs to a rather obscure and uncommon group of Trigoniidae. Some of its distinctive characters occur in a somewhat vague manner in some of the specimens described by Woods (1917) as *T. hanetiana* d'Orbigny from the Senonian of Amuri Bluff, New Zealand. Among them are the subtriangular outline, the carina and sulcus, and the oblique arcuate trend of the costae (see particularly pl. 9, fig. 4). In the new species there is no indication of the divergent short anterior ribs which form an angle with the main ribs in most of the specimens figured by Woods. The valves are not elongate in outline, the tubercles on the ribs are different in shape and size, and the sculpture of the area is much weaker in the New Guinea species. The New Zealand form does not agree entirely with the typical South American *T. hanetiana* which is even less like the new species. *T. obtusa* Hupé was included by Woods in the synonymy of *T. hanetiana* as "a short form". I was unable to see figures or descriptions of this form in the literature at my disposal.

Taxonomic position: Marwick (1932) erected a new genus *Pacitrigonia* in which he placed *T. hanetiana* d'Orbigny, *T. explecta* Wilckens, and his new species *P. sylvesteri*. In these Upper Senonian species the oblique sculpture is weak while in the new species it is dominant. Other differences are the oblong, inequilateral shape and the obscure carina in *Pacitrigonia*. Among the new genera and subgenera described by Cox (1952), *Buchotrigonia* (*Syrotrigonia*) shows

the closest resemblance but according to the generic diagnosis the costae are non-tuberculate. The correct generic and subgeneric position of this species must therefore remain undecided until more material becomes available and publications which are at present inaccessible to the writer can be consulted.

Occurrence: Kerabi Valley, north-west of Mt. Murray, Papua.

Age: Cenomanian, greensands with *Mantelliceras* and other Acanthoceratids.

***Pleuromya cuneata* sp. nov.**

Plate xxiv, fig. 2a-c

Pleuromya n. sp., Edwards and Glaessner, Proc. Roy. Soc. Vict., vol. 64, 1953, p. 64.

Holotype: Adelaide University Geol. Dept. No. F15300.

Material: 19 specimens, with both valves in apposition.

Diagnosis: Shell thin, ornamented with conspicuous concentric folds varying in strength, with occasional irregular fusion of adjoining folds in the central part of the shell. Folds bluntly triangular in cross section, with a gentler ventral slope. Fine growth lines on and between folds. Umbones situated between one-third and a half of the shell length from the anterior end, incurved, not prominent. Anterior end short, broadly and evenly rounded, posterior end narrowed. Greatest height either in front of or at the umbo. Posterior sulcus weak in some specimens, absent in others. Posterior gape moderate.

Measurements:

Spec.	Length	Height	Max. thickness	Ant. distance of umbo
a	69	46	36	30.5
b (Holotype)	67	47.5	33.5	24
c	64+	46	30.5	35
d	52	36	27	21.2
e	50.5	35	25	20.5
No. 194 (Erni)	56.5	40.5	28.5	22

Description: In all specimens both valves are preserved, with some of the thin shell adhering to the cast. Some are partly enclosed in hard calcareous nodules. The hinge is not exposed but after cutting a specimen sagittally a small tooth-like projection was found under the umbo of the left valve. The external ligament and strong nymphs are clearly visible. One or two specimens show faint traces of the deep

pallial sinus which appears to end below the umbo. In eight specimens the right valve is slightly larger or at least higher at the umbo and hinge than the left valve. In three specimens the valves and their heights are equal. The valves taper strongly and evenly towards the narrowly rounded posterior margin and the thickness of the shell decreases along an almost straight line from its maximum which is anterior to the umbo. This gives the shell a pronounced wedge shape in both lateral and dorsal views. There is a slight variation in the position of the umbo, in the strength of the folds, and in the posterior sulcus which is faintly visible in only five of the specimens. There is no anterior ridge or other radial sculpture.

Remarks: The new species shows all features recently enumerated in the diagnosis of *Pleuromya* (Arkell 1934), with the exception of details of the hinge structure which are not clearly visible in closed shells. *P. cuneata* differs from *P. alduini*, the type species, in its much straighter ventral margin bringing the greatest height almost below the umbo. It resembles closely and appears to be congeneric with *P. borealis* Warren from the Albian of the Mackenzie River Valley, Canada (Warren 1947). Specific differences are seen in the narrow umbo and in the anterior end being more evenly rounded and sharply angular in dorsal view. The posterior gape is wider.

Occurrence: The exact localities at which this species occurs are not known. The present specimens were collected by natives near Masul Village, on a tributary of the Chimbu River, about three miles east-south-east of Chimbu, Eastern Highlands of New Guinea, together with specimens of *Chimbuites sinuosocostatus* and a few other species. Two further specimens were obtained by a missionary from natives living in the north-eastern slopes of the Bismarck Mountains, about 25 miles north-west of Chimbu. These were used by members of the Gende tribe as magic stones in connection with their gardening. It is probable that the specimens from the Chimbu area were collected by the natives for similar purpose but it is unlikely that all the specimens came from the same source as there is little intercourse between the tribes in this area, and similar rocks are known to occur at both localities. The specimens from the Gende tribal area were briefly described by Erni (1944, p. 474) as "*Pleuromya* or *Panopaea*" and their sculpture was compared with *Panopaea gurgitis* (Brongniart). The posterior end of one specimen and the posterior dorsal side of the other are damaged. Plaster casts of the two fossils presented by the late Dr. Bernoulli of the Basel Museum show that they are specifically

identical with the Chimbu material which is well enough preserved to show all features required for generic identification.

***Cymatoceras hendersoni* (R. Etheridge Jr.)**

Text fig. 3a-c

Nautilus hendersoni R. Etheridge Jr. (MS.) in Jack and Etheridge, Geol. Pal. Queensland and New Guinea, 1892, p. 502.

Nautilus (Cymatoceras?) hendersoni R. Etheridge Jr. Queensland Geol. Survey Bull., 13, 1901, p. 34, pl. 1, fig. 1-2, pl. 2, fig. 1-3.

Nautilus (Cymatoceras?) hendersoni R. Etheridge Jr., Contr. Pal. South Aust., No. 14, 1905, p. 16, pl. 1, fig. 6-9, pl. 3, fig. 9-12.

Eutrephoceras hendersoni (Etheridge), Teichert, J. Paleont., vol. 26, p. 737.

Cymatoceras sp. Edwards and Glaessner, Proc. Roy. Soc. Viet., vol. 64, 1953, p. 98.

Material: Three incomplete casts, one with some of the outer shell well preserved.

Description: The best preserved specimen, about 150 mm. in diameter and 100 mm. wide, shows the distal half of the outer whorl enclosing the complete inner whorls. It is septate throughout. Only a small portion of the surface of the shell is visible. There are eight to nine septa in each of the preserved half whorls. The suture line consists of a wide ventral saddle, a shallow rounded lateral lobe, a high and undulating umbilical saddle. There is a small annular lobe, the whorl section is regularly rounded, the height being about three-fifths of the width. The venter is gently arched. The umbilicus is deep and narrow. The siphuncle is centrodorsal where the height is about 63 mm.

Another specimen which must have reached a diameter of over 200 mm. is poorly preserved but shows surface sculpture consisting of fine wavy ridges with a wide lateral forward sweep. They are unequal in strength and spacing, giving on the whole the impression of being somewhat accentuated at intervals of about 5 mm. These ridges are seen only on the outer surface of the shell which is thick. Very fine longitudinal striae can be seen only with a hand lens.

The third specimen is smaller, 87 mm. in diameter, and much worn. It shows clearly 16 septa in the last whorl.

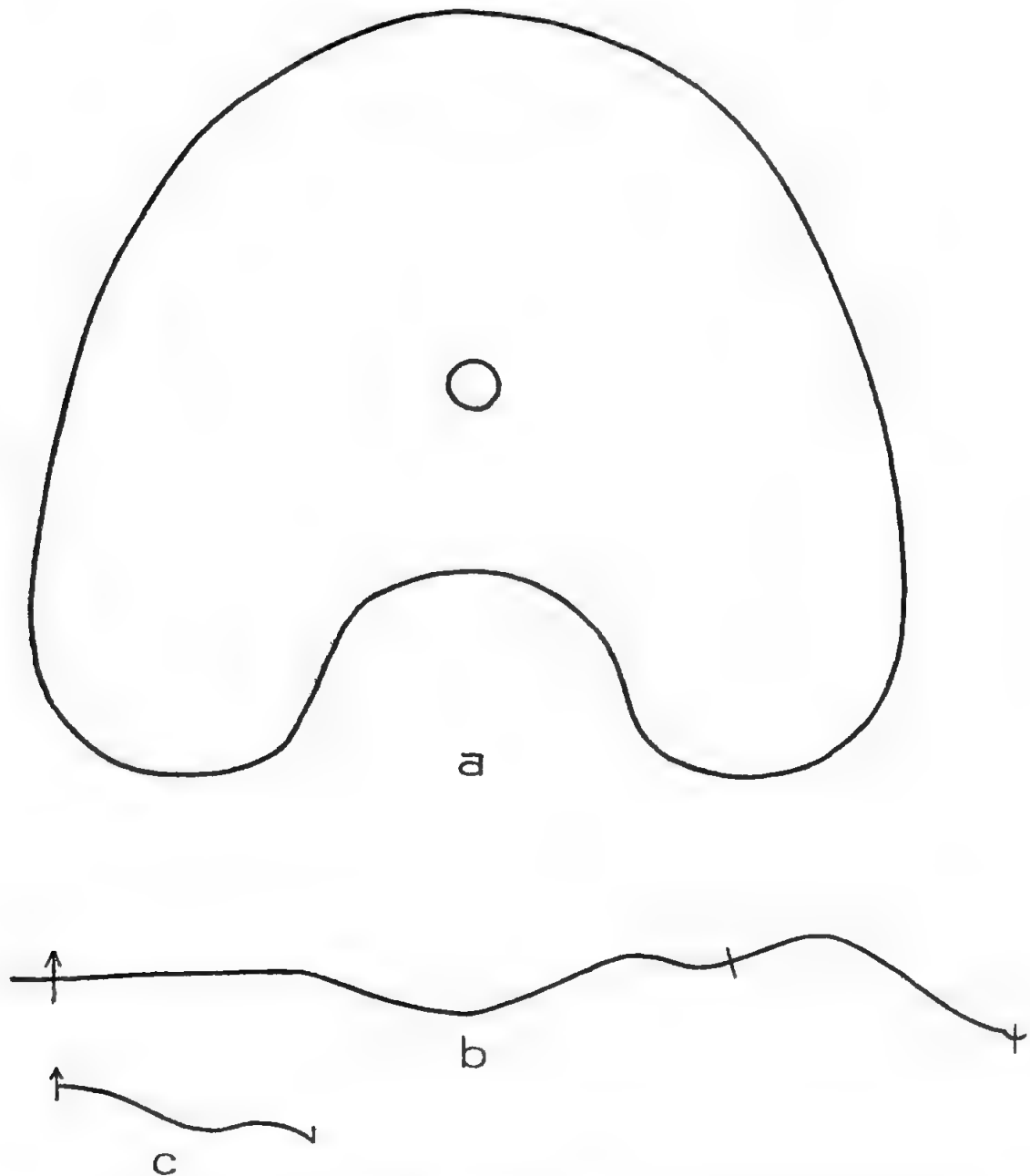


Fig. 3. *Cymatoceras hendersoni* R. Etheridge jun. a. Septal view, b. mature suture, c. Juvenile suture.

These specimens agree well with Etheridge's description of the Queensland species, particularly in the general shape and the delicate sculpture. The umbilical lobe seems to be more strongly expressed in the present specimens but as Etheridge did not draw the suture line and only figured it on a cast in which the edges of the chambers were damaged, the significance of this possible difference is uncertain.

Occurrence: The figures represent characters of a specimen found in a concretion in shale, outcropping in Kubukirua Creek, west of Knage Village, 5 miles northeast of the Waligi-Purari Junction, Eastern Highlands, New Guinea (Coll. G. A. V. Stanley). Other specimens were found by natives near Masul Village, 3 miles east-south-east of Chimbu airstrip, Central Highlands of New Guinea.

Age: The age of the specimen from near Knage is Albian. It was found together with *Aucellina gryphaeoides*, and a foraminiferal fauna of Albian age occurs in close proximity. The specimens from near Masul were received together with *Chimbuites* but other fossils indicating younger (Cenomanian) age (*Mantelliceras* and *Turrilites*) were also obtained from natives in this vicinity.

Remarks: Another species of *Cymatoceras* occurs in the Cenomanian greensands with *Acanthoceras* in the Kerabi Valley. It can be distinguished by its much more sinuous costae which are separated by narrow sharp furrows. There are also very fine longitudinal ventral furrows spreading out laterally. The only known specimen measures 47 mm. in diameter.

Chimbuites Casey and Glaessner gen. nov⁽⁴⁾

Type species: *C. sinuosocostatus* Casey and Glaessner nov. sp.

Diagnosis: More or less involute. Whorls subrectangular in section, with flattened sides, rounded ventro-lateral shoulders and feebly convex venter. Umbilical wall steep, smooth, but with rounded rim. Costation of flexuous primary ribs, thickened on the lower half of the flanks and terminating at the umbilical margin, alternating with groups of secondary ribs. Secondary ribs end mostly at mid-flank; others make low-angle bi- or tri-furcation from the primaries. Ribs traverse the venter with a forwards sinuosity, their regularity interrupted by periodic, shallow, vestigial constrictions, confined to the venter and the outer half of the flanks. Suture line with narrow, sub-symmetrically trifid lateral lobes, and numerous auxiliaries declining with gentle obliquity to the umbilicus.

This new genus is to be placed in the Family Hoplitidae *sensu lato* and is allied to the genera *Uhligella* Jacob, *Lemuroceras* Spath, *Cymahoplites* Spath, *Puzosigella* Casey and *Pachydesmoceras* Spath.

(4) The description and discussion of this new genus was contributed by R. Casey who also reviewed the description of its type species. I wish to thank Mr. Casey for his valuable contribution (M.F.G.).

These are all heavily ribbed derivatives of the Desmocerataceae which connect that superfamily with the Hoplitaceae. *Uhligella* has much blunter ribbing and the ribs are raised into bullae at the umbilical margin on the inner whorls. *Lemuroceras* and *Cymahoplites* are more compressed, the umbilical wall is oblique and the costation different. *Puzosigella* has a more distinct rim to the umbilicus, which on the early whorls is surmounted by obtuse bullae, the inner half of the flank tends to become smooth at the size of the New Guinea specimen, and the suture line has the reduced number of auxiliaries and umbilical retraction of *Puzosia*. *Pachydesmoceras* has more numerous, finer, secondary costae on the inner whorls which rarely branch from the primaries; on the outer whorls the costation simplifies by reduction in the proportion of secondaries to primaries and bifurcation is there more frequent.

Uhligella ranges from Upper Aptian to Middle Albian and is typically European (though the generic name has been used uncritically for ribbed desmoceratids from all parts of the world). *Lemuroceras* is top Lower to basal Middle Albian and is at present known only from India and Madagascar. *Cymahoplites* and *Puzosigella* are of about the same age; the former occurs in Central Russia, the latter in California. *Pachydesmoceras* is known mainly from occurrences in the uppermost Albian of Eurasia, but has been reported from the Lower Turonian of Japan and Cameroons.

***Chimbuites sinuosocostatus* Casey and Glaessner sp. nov.**

Plate xxiv, fig. 3a-b; plate xxv, fig. 1a-b and 2, and text fig. 4

1953 *Deshayesites* n. sp. Edwards and Glaessner, Proc. Roy. Soc. Vict. vol. 64, p. 98.

Holotype: Adelaide University Geol. Dept. No. F15308.

Material: Eight specimens in varying states of preservation.

Description: Whorls thick, with slightly rounded flanks, and arched but flattened venter; umbilicus narrow. Greatest whorl thickness half-way between the mid-flank and the umbilical rim. Ribs gently sigmoidal on the flanks and continuous across the venter with a pronounced forward sinus. There are only 12-13 primaries which bifurcate somewhat irregularly about the middle of the whorl height, with intercalation of three to four rounded but distinct secondaries. There is little if any difference between primaries and secondaries across the venter. Fine growth lines appear on the surface of the shell. On the

last whorl of the largest specimen and on the body chamber of the holotype the ribs become flatter and less distinct. The suture is as described for the genus.

Measurements:

Specimen:	Holotype											
	a		b		c		d		e		f	
	mm.	%	mm.	%	mm.	%	mm.	%	mm.	%	mm.	%
diameter	130	100	87	100	94.5	100	84	100	62	100	40.5	100
whorl height . .	60	46	43	49	44	46	40	47	32	51	20	49
whorl thickness	46	35	36.5	41	39	41	35	41	26.5	42	17	41
umbilicus	23	17	17.5	20	21	22	19	22	12.5	20	8.4	20

Remarks: All specimens are septate throughout but the largest shows the spiral suture extending another quarter whorl, apparently without septation. The holotype, which is intermediate in size, shows the body chamber over one-third of the last whorl. There is little



Fig. 4. *Chimbutes sinuosocostatus* Casey and Glaessner n. g., n. sp. Whorl section, A.U.G.D. No. 15311.

variation in ribbing, inflation, or width of umbilicus over this size range but the sculpture becomes weaker and smoother on the body chamber of the larger specimens. The venter is more broadly rounded in smaller specimens and the inflation of the whorls near the umbilical margin is more pronounced in the largest specimen which is, however, somewhat deformed and abraded. The forward inclination of the primaries seems to increase with age. There is a slight variation in the depth of the ventral forward sinus but in all specimens in the present collection, except one, it is well formed. This exceptional specimen is preserved as a septate fragment of two whorls with a maximum height of about 30 mm., equal to that of the smallest measured specimen of *C. sinuosocostatus*. The ribs divide here closer to the venter. The external and lateral lobes are wider and the external saddle is more elaborate. This may represent another species.

Locality: Near Masul Village, about 3 miles east-south-east of Chimbu airstrip, Eastern Highlands, New Guinea, collected by natives probably from pebbles in a small local stream, and presented to a party led by Mr. G. A. V. Stanley in 1949.

Age: Probably Albian. The matrix of the holotype contains another fragmentary specimen and also abundant small gastropods.

***Puzosia cf. planulata* (Sowerby)**

Plate xxv, fig. 3

cf. Ammonites planulatus Sowerby, Sharpe, Cret. Ammonites, Palaeontogr. Soc., 1855, pt. 2, p. 29, pl. 12, fig. 3 (non fig. 4).

Description: Two specimens of *Puzosia* have been found close together, one over 300 mm. in diameter and the other less than 35 mm. The smaller specimen is complete but the shell is only partly preserved and the distal umbilical portion of the body chamber is damaged. There are six constrictions. On the surface of the shell they form a rounded tongue-like ventral forward sinus which is marked proximally by a ventrally much widened and projecting smoothly rounded rib. On the internal cast the ribs are extremely faint and hardly noticeable. The distal edges of the constrictions are more strongly marked than the proximal edges. The ventral sinus is angular and almost interrupted. Spath (1923, p. 48) described *P. planulata* (Sowerby) as compressed, having a larger umbilicus than *P. communis* Spath, acute chevrons on the periphery, and more distinct costation. In these respects the small specimen agrees with *P. planulata* but in the absence of material for direct comparison and of sufficient literature on other species the identification must be left in doubt.

In the large specimen of *Puzosia* the outer whorl is septate throughout. One third of this whorl was lost and in the gap one third of the penultimate whorl is seen. At a diameter of about 300 mm. the height and width of the whorl are about 160 mm., at its proximal fracture they are about 112 mm. The diameter of the umbilicus is about 100 mm. The venter is more arched and the flanks are more rounded than in the small specimen. The ornamentation is similar but obsolescent and the ventral sinus is more rounded though not less pronounced.

Locality: Kubukirua Creek, west of Kuage Village, 5 miles north-east of the Wahgi-Purari Junction, Eastern Highlands of New Guinea.

Age: Albian.

Myloceras davidi Whitehouse

Plate xxvi, fig. 2-3

Crioceras sp. R. Etheridge Jr., Rec. Aust. Mus., vol. 7, 1909, p. 144, pl. 38, fig. 1-2.

Myloceras davidi Whitehouse, Mem. Queensland Mus., vol. 8, 1926, p. 235, pl. 37, fig. 2.

Material: Two incomplete specimens (coll. F. K. Rickwood).

Description: "Coiling crioceratid, whorls compressed; first whorls more loosely coiled than later; costae thin, numerous, with small papillate ventro-lateral tubercles; septal suture with rectangular saddles and deep very numerous L_1 " (Whitehouse). This species is distinguished from others, according to its author, by the compressed shape of its shell and by the deep narrow lateral lobe of the septal suture. Both characters are well shown in the present specimens in which the costae are slightly flexed as in the holotype.

Locality: Vicinity of Sura Creek, south-east of Lake Tebera, Papua.

Age and distributions: This species is known from the Upper Albian Tambo Formation of Queensland. Its occurrence provides a further valuable link between the Albian faunas of Queensland and New Guinea.

Myloceras cf. flindersi (McCoy)

cf. *Ancyloceras flindersi* McCoy, Ann. Mag. Nat. Hist., ser. 4, vol. 20, 1867, p. 356.

cf. *Crioceras flindersi* (McCoy) (*partim*) R. Etheridge Jr., Rec. Aust. Mus., vol. 7, 1909, pl. 39, fig. 1-3.

cf. *Flindersites flindersi* (McCoy), Whitehouse, Mem. Queensland Mus., vol. 8, 1926, p. 237.

Material: Two fragments of the distal part of the shell, mostly preserved as casts (Coll. F. K. Rickwood: No. 226KH, with *Pseudovicula?* sp.; 245KH, with *Inoceramus* sp.).

Description: The fragments, both from the straight part of the shell, agree in size and development of ribs and nodes with Etheridge's figures. There is considerable irregularity in the height of insertion of secondary ribs. The tubercles are markedly elongate. The venter is

preserved in one specimen but it is too badly crushed for an exact description of its ornamentation. It was apparently much narrower than in Etheridge's specimens.

Measurements: Dorso-ventral diameter 60-65 mm., transverse diameter about 25 mm. (deformed by compression). Length of larger fragment about 80 mm.

Occurrence: Vicinity of Sura Creek, east-south-east of Lake Tebera, Papua.

Age: Albian.

Remarks: Spath (1938, p. 601) has placed the genus *Flindersites* Whitehouse in the synonymy of *Myloceras* Whitehouse.

Labeceras trifidum Whitehouse

Plate xxvi, fig. 4a-c

Crioceras sp. R. Etheridge Jr. in: Jack and Etheridge, Geol. Pal. Queensland and New Guinea, 1892, p. 502, pl. 33, fig. 4.

Crioceras laqueus R. Etheridge jun., Rec. Aust. Mus. vol. 7, 1907, pl. 49, fig. 7, 9 (*non* fig. 8).

Labeceras trifidum Whitehouse, Mem. Queensland Mus. vol. 8, 1926, p. 228.

Material and preservation: Three specimens showing the terminal "hook". In one of them the collapsed straight portion and the aperture can be seen, in another the entire body chamber from the last septum to the apertural margin is preserved. Both are from a greenish grey-wacke. The third specimen, from a grey shale, is distorted.

Description: The species was based on incomplete specimens showing the "body chamber with prominent dorso-lateral tubercles from which very fine but prominent ribs trifurcate" (Whitehouse 1926, p. 228). This description of the ornamentation, as well as the reference to subcircular whorl section with flattened venter, fits the specimens from New Guinea well. It is noted that the trifurcation is common but not regular; bifurcating ribs with and without tubercles occur also, as in the specimens figured by Etheridge. Some of the tubercles are very prominent, particularly in the area of strongest curvature. The apertural lappets are arcuate and directed slightly inward. They project 6 mm. beyond the straight ventral margin of the peristome in a specimen in which they are 12 mm. apart and in which the greatest width of the chamber is 17 mm.

Measurements: The distance between the aperture and an external tangent to the back is 32.5 mm. in a specimen in which the dorso-ventral and transverse diameter of the last septum are 13.2 mm. The other specimens are about the same size.

Occurrence: From the area north of the Middle Purari River, Papua. One specimen was found 5 miles north of a point on the river 6 miles below Hathor Gorge, the others are from the same area.

Age and distribution: This species is known from the Upper Albian of Queensland and South Australia. The genus is restricted to the Upper Albian.

***Dimitobelus (Tetrabelus) macgregori* (Glaessner)**

Plate xxvi, fig. 5a-b and 6, text fig. 5

Tetrabelus macgregori Glaessner, Proc. Roy. Soc. Vict., vol. 56, pt. 2, 1945, p. 160, pl. 6, fig. 12.

Dimitobelus n. sp., Rickwood, J. Geol. Soc. Aust., vol. 2, 1955, p. 73.

Material: Holotype (Melbourne University Geol. Dept. No. 1876); two fragmentary rostra (Queensland University Geol. Dept. No. F14501-2, coll. W. D. Mott); one well-preserved small and seven larger fragmentary rostra. Of these, four represent the apical portion and three shows the phragmocone, two of them are partly embedded in the matrix, and one is free and very large (coll. F. K. Rickwood).

General remarks: The study of the new material has made it necessary not only to amend the description of the species but also that of the genus. The large new specimen (F15294) shows the phragmocone to a length of about 70 mm. (25 mm. maximum width), with the rostrum broken between the two main longitudinal grooves (see pl. xxvi fig. 5) so that the siphuncle is exposed between them. This proves that the main grooves are ventro-lateral, not dorso-lateral as I had stated in the original description of the species. This description was based on a comparison with an unnamed species of *Tetrabelus* from New South Wales (Etheridge 1902, p. 46, pl. 9, figs. 3-5, Whitehouse 1924, p. 415). A careful study of other species of *Tetrabelus* shows, however, that in *T. seclusus* and *kleini*, Blanford, Gürich, Spengler and in fact Whitehouse had considered that two deeply incised furrows correctly as ventro-lateral. This is clearly seen to be the position in relation to the siphuncle in a specimen from Mountain Well, Onepah Station, 30 miles north-north-west of Tibooburra, New South Wales (Coll. H. O. Fletcher,

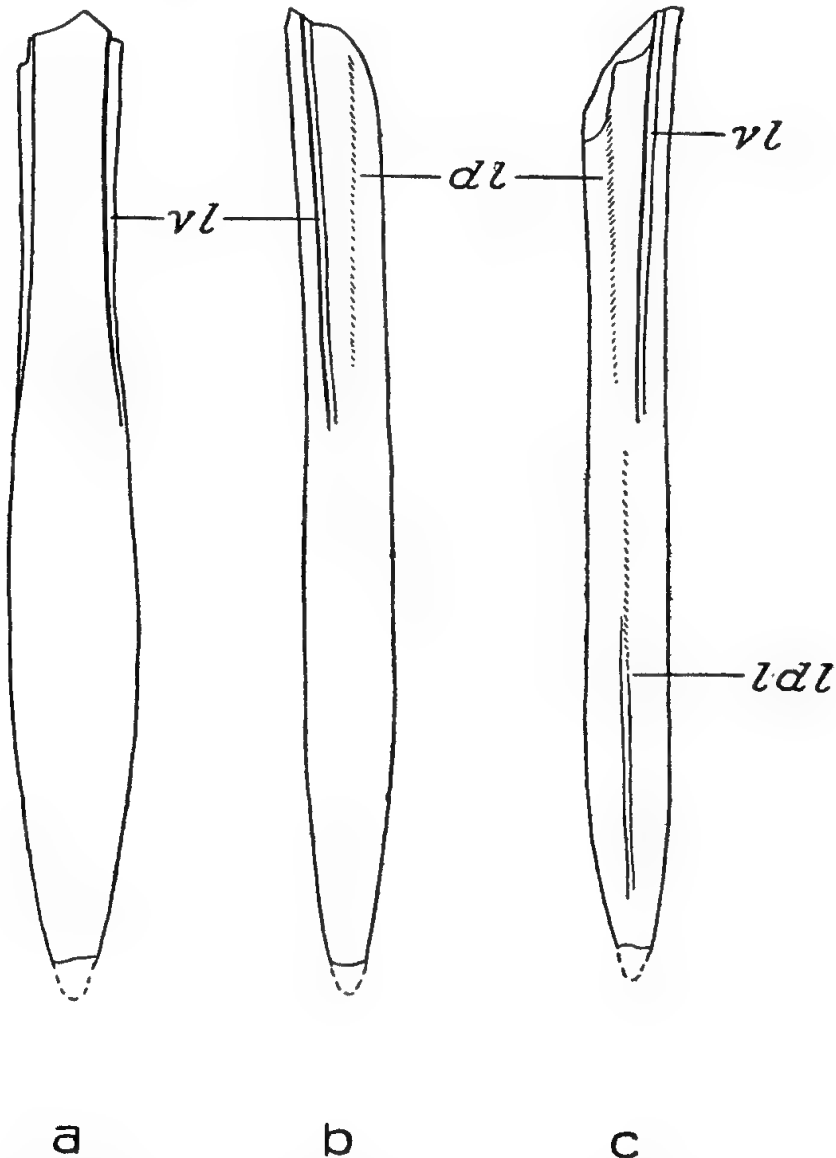


Fig. 5. *Dimitobelus* (*Tetrabelus*) *macgregori* (Glaessner). Holotype. a. Ventral view. b. Left lateral view. c. Right lateral view. vl. Ventro-lateral grooves. dl. Dorso-lateral lines. ldl. Lateral double lines (left side covered with matrix).

Aust. Mus. No. F42263) which probably represents the form which was described but not named by Etheridge from the same area. Moreover, this relation of the same grooves to the siphuncle can also be seen in the specimen figured by Etheridge (1902a) as *Belemnites eremos* Tate from South Australia, though Tate, Etheridge and Whitehouse had described them as dorso-lateral in this and other forms which are now placed in *Dimitobelus*. I have stated elsewhere (Glaessner 1957) that there is no evidence for this interpretation which must be abandoned.

Generic position: Although originally distinguished mainly on the assumed presence of dorso-lateral grooves the genus *Dimitobelus* should not be merged with *Peratobelus* in which only ventro-lateral grooves but no lateral double lines are present. *Tetrabelus* was believed by Whitehouse to be "a direct descendant of *Dimitobelus*, the line of division occurring at the stage when the ventro-lateral groove ceases to be dependent on the dorso-lateral, but has an independent existence (now disconnected from the lateral lines" (Whitehouse 1924, p. 414). His definition of the *Tetrabelus* is: "Clavate belemnites with dorso-lateral grooves and lateral lines, but having, in addition, independent ventro-lateral grooves". In *Dimitobelus* the ventro- (not dorso-) lateral grooves merge (after a swing towards the dorsal side) with the lateral lines, and a dorso (not ventro-) lateral anterior extension of these lines may also be present. This makes the separation ("independence") of the ventro-lateral grooves from the lateral lines the main distinguishing feature, not the two pairs of lines (see Whitehouse's fig. 3). Etheridge's species, however, and the new specimen from New South Wales do not show this separation although in other characters they resemble *T. kleini* and *T. seclusus*. It is therefore preferable to consider *Tetrabelus* a subgenus of *Dimitobelus*.

Description: Rostrum clavate, strongly constricted in the alveolar region, dorso-ventrally compressed, particularly where it expands to its greatest width. Ventro-lateral grooves deeply incised and sharply defined, extending well below the protoconch, straight but directed towards a lateral position at their posterior end where they approach the fine lateral double lines. Dorso-lateral lines weakly impressed in the alveolar region. Apex tapering gradually. The compression of the rostrum seems to increase during growth. The alveolar angle is about 15° , increasing slightly anteriorly. The bulbous protoconch is about 0.55 mm. wide and 0.4 mm. long, the following chamber of the phragmocone is 0.25 mm. long. The ratio of maximum transverse to maximum dorso-ventral diameter of the clavate portion of the rostrum is 1.3 in five specimens, 1.4 in one, and 1.2 in the smallest individual.

Comparison: This species resembles closely *D. diptychus* (McCoy) (= *B. canhami* Tate) but differs in the less clavate shape of the rostrum and in the less intense dorso-ventral flattening, the mean ratio of the maximum transverse to the maximum dorso-ventral diameter being 1.3 (range 1.2—1.4), as compared with 1.4—1.5 in *D. diptychus*. It appears from a study of type specimens in the collections of the University of Adelaide that the forms described by Etheridge from South

Australia as *Belemnites eremos* (R. Etheridge Jun., 1902, p. 51, pl. 7, fig. 18-21) should be included in *D. diptychus*.

Occurrence: Middle Purari River, Paw Creek and about 8 miles north-west; vicinity of Sebe Creek, east of Lake Tebera, Papua; Chim Valley, 2 miles north-west of Chimbu, Western Highlands of New Guinea (coll. F. K. Rickwood); Kerabi Valley, north-west of Mt. Murray, Papua (coll. W. D. Mott).

Age: Upper Albian and Cenomanian. The specimen (pl. xxvi, fig. 5) which was found about 8 miles north-west of the locality of the holotype was associated with *Myloceras* and *Labeceras trifidum*. Both these occurrences are in the Upper Albian. The specimens from the Kerabi Valley are associated with large *Mantelliceras* and other Acanthoceratids in greensands. The specimens from near Lake Tebera were found in similar greensands, together with the *Linotrigonia* described above, stratigraphically above the fossiliferous Albian. The material from the Chim Valley came from a very hard shelly impure glauconitic limestone 1,500 feet below the top of the Chim Group, several thousand feet above the horizon of the fossiliferous Cenomanian "Maram" Shales which contain foraminifera in the Chimbu section and *Euomphaloceras* at Mingende about 7 miles west.

***Rotularia spirulaeoides* sp. nov.**

Plate xxv, fig. 4a-b and 5-6

Material: Six specimens (Queensland University Geol. Dept. No. 1833, coll. R. A. Woodward), 5 specimens collected by W. D. Mott, including the holotype, Adelaide University, Geol. Dept. No. F15320.

Description: Shell small, discoidal, umbilicate on both sides. Whorls inflated, apico-basal diameter increasing rapidly up to the last whorl, radial diameter of the whorl increasing slowly. The earliest portion seen consists of two flatly trochospiral whorls followed by one or two planispiral adult whorls expanding above the blunt apex of the initial coil incompletely and somewhat irregularly involute on both sides, at first to about half the whorl height but finally becoming evolute and ending in a short tangentially projecting constricted tube. Peripheral margin with a single broadly rounded keel, externally separated from the body of the whorl by shallow but clearly marked grooves which are about equidistant from the umbilical and peripheral margins. Surface showing arcuate growth lines concave towards the aperture above and below the lateral groove in which the direction of curvature is reserved. Irregularities of growth tend to produce alternating

umbilical constrictions and ribs. The coiling is sinistral (in the sense of Cox 1953, not of Wrigley 1951). In transverse section the inner tubular space is circular, with a dense inner and a layered outer wall which is very thick along the umbilical edge, and with a thin brownish "epidermal" covering.

Measurements: Diameter up to 21 mm., greatest thickness of last whorl in largest specimen 7 mm. diameter of tube 2.7 mm.

Comparison: The species differs from "*Tubulostium*" *discoideum* Stoliczka (Cenomanian of Southern India) in the rounded peripheral keel, the periphery in the Indian species being truncated. The new form resembles "*Rotularia*" *spirulaca* (Lamarek) very closely in shape and surface sculpture but differs in the lower and more rounded keel and the depressed early whorls which according to Rutsch (1940) often project above the adult coils in that common European Eocene species. In the new form the early whorls are lower than in "*Rotularia*" *clymenioides* (Guppy) from the Eocene of the Antillean Region. Other differences are the gradual transition to the planispirally coiled part of the shell and the greater thickness of the flanks at the level of the periphery of the preceding whorls in the new species. The forms described by Gardner (1939) from the Eocene of the Gulf Province of North America differ in surface sculpture and the development of the peripheral keels.

The new form differs from "*Spirulaca*" *gregaria* R. Etheridge Jr., in that the latter is concavo-sub-convex, and the periphery is not ridged or angled. In "*Tubulostium*" *ornatum* Wilckens from New Zealand the peripheral keel is separated from the lateral bulging zones by two much more pronounced furrows. "*T.*" *jullax* Wilckens from the Senonian of the Antarctic has a triple peripheral keel. *R. australis* Cox is smaller than *R. spirulacoides*, being 14 mm. in diameter, and appears to be less involute and more discoidal, and the straight section of the tube is longer.

Taxonomic position: The taxonomy and nomenclature of the group to which the new species belongs has been discussed extensively in recent years (Gardner 1939, Rutsch 1939, Wrigley 1951, Cox 1953). While Rutsch has argued in favour of considering these fossils as gastropods and of applying to them the name *Tubulostium*, Wrigley has shown conclusively that the earliest stage of formation of the tube, which is rarely preserved, has the character of a worm tube. Wrigley's arguments in favour of the application of the generic name *Rotularia* DeFrance 1827 instead of *Tubulostium* Stoliczka 1867 (which may

replace it if the prior use of *Rotularia* by Lamouroux in 1822 is confirmed) were accepted by Cox (1953).

Locality: Kerabi Valley, north-west of Mt. Murray, Papua.

Age: The genus ranges from Albian to Lower Oligocene. The association of the new species with *Mantelliceras* and other Acanthoceratids places it in the Cenomanian.

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EXPLANATION OF PLATE FIGURES

PLATE XXIV

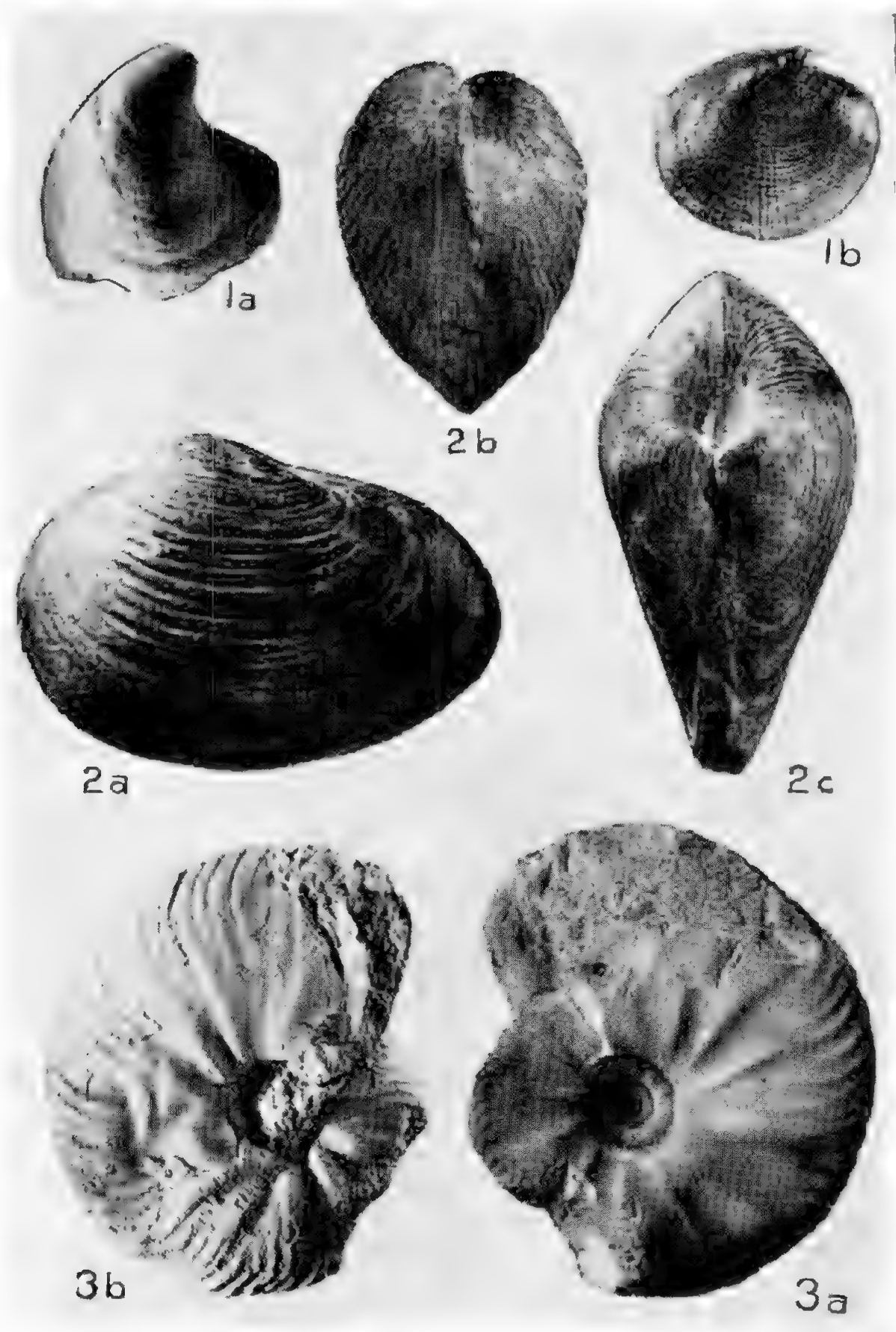
- Fig. 1a-b. *Aucellina gryphacoides* (Sowerby). 1a. Left valve, internal mould, A.U.G.D. No. 15312, x1.8. 1b. Right valve, internal mould, A.U.G.D. No. 15313, x1.4.
- Fig. 2a-c. *Pleuromya cuneata* n. sp. Holotype, A.U.G.D. No. F15300. Nat. size.
- Fig. 3a-b. *Chimbuites sinuosocostatus* Casey and Glaessner n.g., n. sp. Holotype, A.U.G.D. No. F15308. Note regeneration of damaged shell flank in Fig. 3b. x0.77.

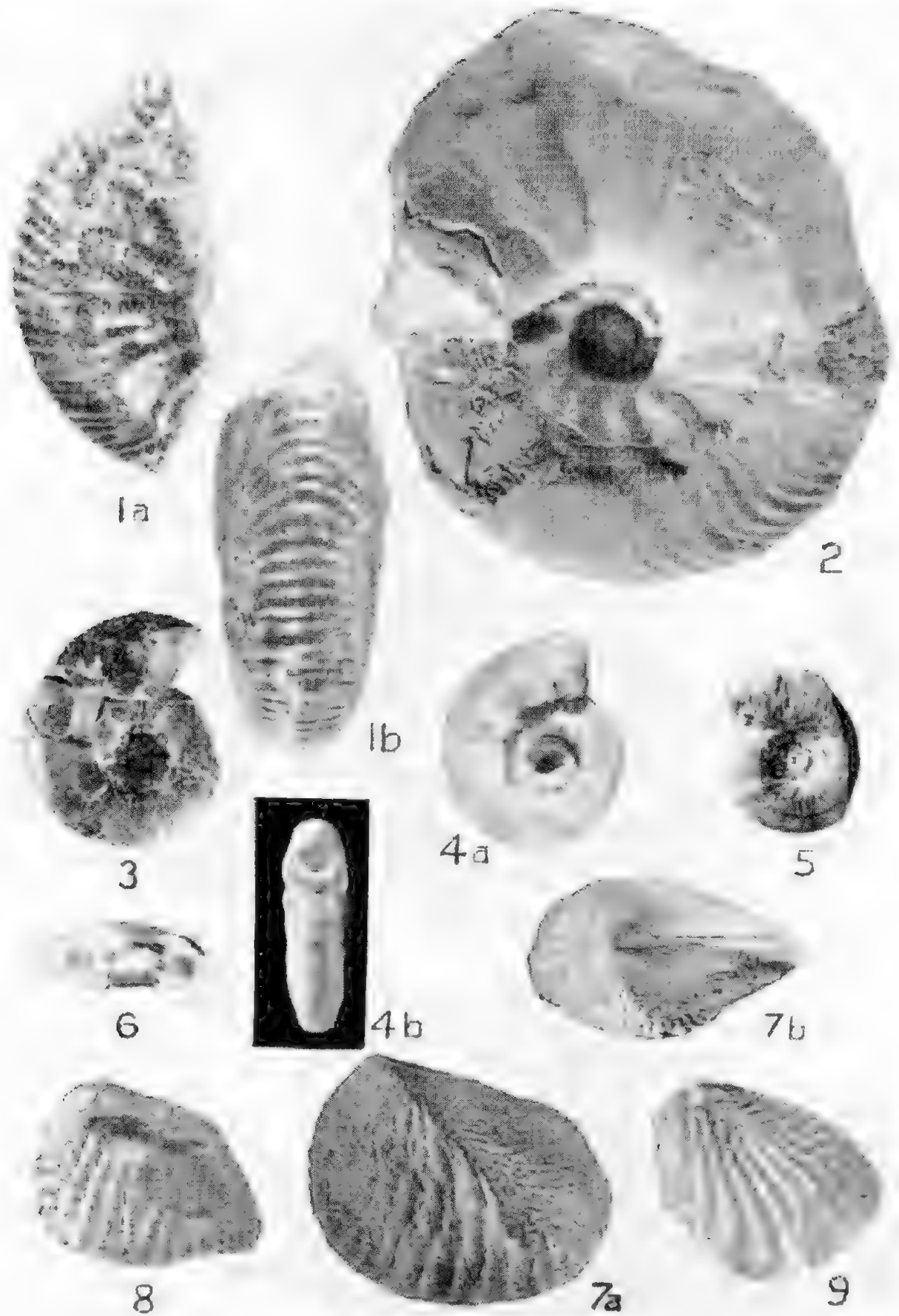
PLATE XXV

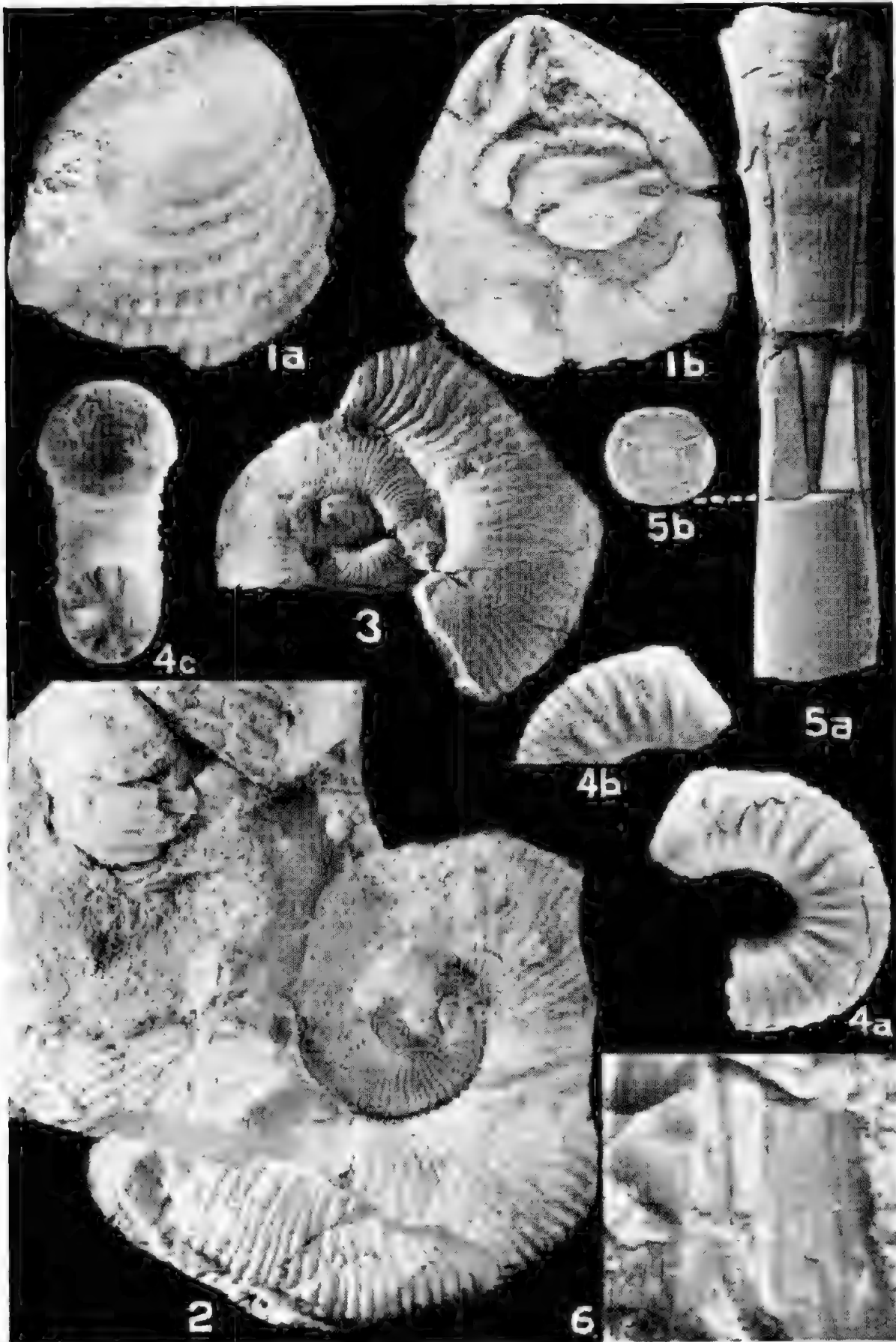
- Fig. 1a-b. *Chimbuites sinuosocostatus* Casey and Glaessner, n.g., n.sp. Paratype, A.U.G.D. No. F15311. Nat. size.
- Fig. 2. *Chimbuites sinuosocostatus* Casey and Glaessner, n.g., n.s. Paratype, A.U.G.D. No. 15310. x0.57.
- Fig. 3. *Puzosia* cf. *planulata* (Sowerby). A.U.G.D. No. 15315. Nat. size.
- Fig. 4a, 4b, 5, 6. *Rotularia spirulacoides* n. sp. Fig. 4a, b. Holotype, A.U.G.D. No. 15320, x1.4. Fig. 5. Paratype, A.U.G.D. No. 15321, x1.5. Fig. 6. A.U.G.D. No. 15322, x1.9.
- Fig. 7a, 7b, 8, 9. *Limotrigonia* (*Oistotrigonia*) *lima* n. sp. Papua. Fig. 7a, b. Holotype, A.U.G.D. No. F15324, nat. size. Fig. 8. Paratype, damaged left valve showing spinose sculpture, A.U.G.D. No. 15325, 0.9 nat. size. Fig. 9. Plastotype of external mould of young left valve, A.U.G.D. No. 15326, x1.4.

PLATE XXVI

- Fig. 1a, b. "*Trigonia*" *papuana* n. sp. Right valve, holotype, Q.U.G.D. No. 17914. Nat. size.
- Fig. 2, 3. *Myloceras davidi* Whitehouse. Fig. 2. A.U.G.D. No. F15317. 0.8 nat. size. Fig. 3. A.U.G.D. No. F15318. 0.7 nat. size.
- Fig. 4a-c. *Laboceras trifidum* Whitehouse. Complete body chamber, internal mould with shell remnants. A.U.G.D. No. F15293. Nat. size.
- Fig. 5a, b. *Dimitobelus* (*Tetrabelus*) *macgregori* (Glaessner). Fragmentary rostrum, A.U.G.D. No. F15294. Fig. 5a. Proximal portion of incomplete rostrum. The part covering the phragmocone has been removed to show the siphuncle and the smooth "splitting surfaces" between the ventro-lateral grooves and the phragmocone. Fig. 5b. Showing transverse section, upper half of periphery indented by ventro-lateral grooves. Nat. size.
- Fig. 6. *Dimitobelus* (*Tetrabelus*) *macgregori* (Glaessner). A.U.G.D. No. F15295. Split rostrum showing cast of protoconch and proximal portion of phragmocone in situ. x8.







**AUSTRALIAN BEETLE-MIMICKING BUGS OF THE FAMILY
LYGAEIDAE (SUBFAMILY RHYPAROCHROMINAE-TRIBE LETHAEINI)**

BY GORDON F. GROSS, SOUTH AUSTRALIAN MUSEUM

Summary

During sorting of the Museum collections of Lygaeidae Rhyparochrominae the writer came across the four very interesting species described in this paper. They belong to two new genera which must be placed in the tribe Lethaeini in respect of the three tricholbothria on sternum V, the last of which lies posterior to spiracle V (Scudder, 1957, p. 154).

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Fig. 1, A-D

INTRODUCTION

During sorting of the Museum collections of Lygaeidae Rhyparochrominae the writer came across the four very interesting species described in this paper. They belong to two new genera which must be placed in the tribe Lethaeini in respect of the three trichobothria on sternum V, the last of which lies posterior to spiracle V (Scudder, 1957, p. 154).

In both genera the hemelytra have lost all trace of a membrane and have become hardened so that there does not appear to be any distinction between clavus and corium. The condition does appear to be one of brachyptery for, although hardened, these "elytra" extend almost to the apex of the abdomen. This is also true of the brachypterous hemelytra of *Myocara* Bergroth. I would suggest that in the case of these two new genera the macropterous form is either absent or very rare.

At first glance both genera resemble small beetles and the resemblance of one of them (*Carabocoris nov.*) to some of the smaller members of the Carabidae is particularly striking.

The four species are extremely shining and without (*Coleocoris nov.*) or virtually without (*Carabocoris*) punctation above. This condition is also partly developed in some other members of this section of the Lethaeini (e.g., *Myocara* Bergroth). The types of all four species are lodged in the South Australian Museum.

SYSTEMATIC

The four species and the two genera may be distinguished by the following key.

1. Pronotum with lateral margins in anterior three quarters broadly curved, in posterior quarter straight and parallel thus making

pronotum of pronounced carabid shape. Hardened hemelytra with sparse punctations. Upper surface of insect chestnut brown except for four yellow patches, a pair on lateral margin of each "elytron" . . .
Carabocoris biplagiatus sp. nov.

Pronotum trapezoidal, upper surface largely piceous (*Coleocoris* nov.) . . . 2.

2. With three lateral yellowish patches, one on humeral angles of pronotum the other two on lateral margins of "elytra" . . .
Coleocoris triplagiatus sp. nov.

Coloration not as above, but with at least some of the coloration as longitudinal or transverse lines . . . 3.

3. Lateral margins and base of pronotum yellow, so also lateral margins of "elytra" and also a longitudinal line on "elytra" about one-third out from inner margin and not reaching to base or apex . . .
Coleocoris lineatus sp. nov.

Base of pronotum only, and lateral margins of "elytra" as well as two patches very near the inner margin and about one-quarter way along length of inner margin from tip of scutellum yellow . . .
Coleocoris ocellatus sp. nov.

Genus *Coleocoris* nov.

Above shining, impunctate with scattered long hairs. Beneath with a few punctations for the most part arranged in rows on the thorax but otherwise impunctate with sparse long hairs and a short pilosity. Head strongly triangular, immersed almost to eyes which are moderately large, ocelli apparently absent. Tylus just surpassing jugae. Antennae about half length of body, first segment shortest but surpassing apex of head, second the longest, third a little shorter, subequal to or a little longer than fourth. Antennae with a short semi-adpressed pilosity and three or four spine like hairs on first segment and apical part of second. Rostrum of various lengths but always surpassing middle coxae.

Pronotum flattened trapeziform, almost square anteriorly, posterior and lateral margins straight, latter marginate, posterior angles almost a right angle, anterior ones shortly curved, no trace of a collar. Scutellum about as long as wide, flattened, with apex acuminate and lateral margins smoothly excavate in a sweeping curve.

Hemelytra feebly convex, thoroughly hardened like beetle elytra, reaching almost to base of last abdominal segment, apical margins curved and lateral margins broadly curved.

Fore femora incrassated with three or four spines beneath near the middle running towards apex and several near apex on upper side, hind and mid femora likewise with several spines on upper side near apex and hind femora also with several spines near apex below. All tibiae with about 15-20 strong spines scattered along their length. First segment of tarsi at least twice as long as remaining two segments together. Coxae with two or three spines. Sternum V with three trichobothria placed in line, anterior pair close together, posterior one placed behind spiracle and near hind margin.

Genotype: Coleocoris triplagiatus sp. nov.

I am unable to exactly place this genus amongst the described forms though it does seem to have some affinities with *Myocara* Bergroth. The head is longer in *Myocara* and the latter genus has ocelli but otherwise the head and pronotum are very similar in shape to those

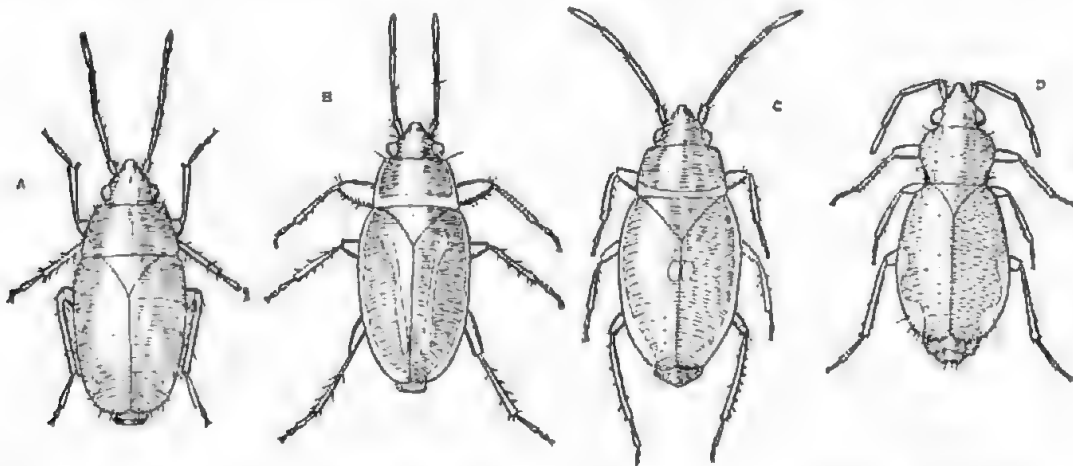


Fig. 1. A, *Coleocoris triplagiatus* gen. et sp. nov. B, *Coleocoris lineatus* sp. nov. C, *Coleocoris ocellatus* sp. nov. D, *Carabocoris biplagiatus* gen. et sp. nov. (All approximately x7.)

of *Coleocoris*. There are odd punctations on the pronotum and scutellum of *Myocara* and quite a lot on the hemelytra of *Myocara* but the underside of the two genera is very similar, even to the arming of the legs. In brachypterous *Myocara acuminata* Bergroth the hemelytra are likewise quite large but there is still a distinction between clavus and corium.

***Coleocoris triplagiatus* sp. nov.**

Fig. 1A

Above and below a shining dark brown with scattered long brown hairs and a very short and very sparse white pilosity, thicker and longer on the underside of the abdomen and the antennae. Above with three yellowish spots on either side, one in each posterior angle of the pronotum and two on the lateral margin of each "elytron," an oblique one about half way along and an oval one at about three quarters. Coxae, rostrum and three apical segments of antennae brown, first segment of antennae, apex of fourth and legs yellowish brown, a light yellow triangular patch on outer posterior margin of the propleuron confluent with yellow patch on upper side at humeral angle. Rostrum surpasses mid coxae, some long hairs on head and pronotum, length of antennal segments 0.30 mm., 0.70 mm., 0.70 mm., 0.70 mm., hind femora 1.0 mm., hind tibiae 1.1 mm. Total length 3.4-4.0 mm., width 1.7 mm., length pronotum 0.90 mm.

Locs. South Australia: Holotype male (Reg. No. 120,092) allotype female (Reg. No. 120,093) from Moolooloo Station, Flinders Ranges 2,000ft. (H. M. Hale, 1921) ten paratypes, two of which are larval (Reg. No. 120,094), from Leigh Creek (no collector or date) and one paratype (Reg. No. 20,095) from Mt. Remarkable (October, 1925, F. E. Wilson).

***Coleocoris lineatus* sp. nov.**

Fig. 1B

Body above and below a dark shining brown with above an extremely sparse and short pilosity, below, at least on abdomen, legs and antennae this pilosity somewhat thicker and longer. Above with lateral margins of thorax and elytra and upper apical quarter of third antennal segment bright yellow, hind margin of pronotum and a longitudinal stripe on each "elytron" about one-third way out from inner margin and commencing at about half length of scutellum from basal margin and not reaching apical margin by about half this distance dirty yellow. Femora, rostrum and antennae brown, tibiae and tarsi yellowish brown.

Head with a long hair on vertex on each side of the line joining middle inner margin of eye to base of tylus and another in each anterior corner of pronotum. Rostrum surpasses mid coxae, length of antennal

segments 0.30 mm., 0.65 mm., 0.63 mm., 0.50 mm., hind femora 1.1 mm., hind tibiae 1.3 mm. Total length 3.7 mm., width 1.7 mm., length pronotum 0.70 mm.

Loc. Thursday Island: Holotype female (Reg. No. 120,096) and two paratype females (Reg. No. 120,097). No other data.

***Coleocoris ocellatus* sp. nov.**

Fig. 1C

Body above and below piceous, with a very fine white pilosity beneath, thicker on the abdomen and antennae. Hind margin of pronotum continuing obliquely across hind angles, and a patch beneath contiguous with it on the outer posterior angle of the propleura, lateral margins of "elytra" (wider in the hindermost portion) and two rectangular patches near the inner margin a little behind apex of scutellum, and last antennal segment (except at base) white, the apical two-thirds of latter a dirty white. First three segments of antennae, rostrum, coxae, femora, dark brown, tibiae brown, tarsi yellowish brown.

Rostrum reaching almost to base of third ventral segment, length of antennal segments 0.30 mm., 0.66 mm., 0.57 mm., 0.60 mm., hind femora 1.1 mm., hind tibiae 1.4 mm. Total length 3.8 mm., total width 1.6 mm., length pronotum 0.77 mm.

Loc. Western Australia: Holotype female (Reg. No. 120,099) and paratype female (Reg. No. 120,098) both from Swan River (J. Clark, no other data).

Genus *Carabocoris* nov.

Above shining, with scattered punctations on elytra and scattered long hairs especially along edge of pronotum and "elytra." Beneath with strong punctations for the most part arranged in rows on the thorax, otherwise impunctate with sparse long hairs and a sparse short pilosity. Head strongly triangular, immersed almost to eyes which are moderately large, ocelli apparently absent. Tylus just surpassing jugae. Antennae about half length body, second segment the longest, third and fourth subequal and both shorter than second. Antennae with a short adpressed pilosity and a few strong hairs on first segment. Rostrum reaching hind coxae.

Pronotum flattened, anterior and posterior margins straight, lateral margins marginate, anterior three quarters a smooth convex curve, posterior quarter straight parallel sided, hind angles almost a right angle, no trace of collar. Whole pronotum in appearance remarkably like that of a typical carabid beetle. Scutellum about as long as wide, flattened with apex acuminate and lateral margins smoothly excavate in a sweeping curve, scutellum somewhat smaller than in *Coleocoris*.

Hemelytra feebly convex, thoroughly hardened like beetle elytra, reaching base of penultimate abdominal segment, apical and lateral margins broadly curved. Surface sparsely punctate.

Fore femora incrassated with three or four short spines beneath in the apical quarter, mid and hind femora with some very short spines near apex. All tibiae with about 8-12 strong but short spines scattered along their length. First segment of tarsi at least twice as long as remaining two segments together. Sternum V with three trichobothria placed in line, anterior pair close together, posterior one placed behind spiracle V and near hind margin.

Genotype: Carabocoris biplagiatus n. sp.

The affinities of this genus are undoubtedly with *Coleocoris*. It must rank as a separate genus as the three species of *Coleocoris* described above from widely separate localities are all remarkably close to one another structurally and *Carabocoris* falls considerably out of this range in features other than the distinctive shape of the pronotum (*e.g.*, punctation of "elytra," different position of anterior femoral spines, weaker arming of tibiae and antennae, etc.).

***Carabocoris biplagiatus* sp. nov.**

Fig. 1D

Body above and below dark brown, with legs antennae, rostrum and two lateral patches on "elytra," one about the middle and the other just before apical angle, yellow. A few sparse dark hairs near apex of head, along lateral margins of pronotum and lateral and apical margins of "elytra," and beneath; on upper surface of abdomen and on legs and antennae a very short close white pilosity. Length of antennal segments 0.30 mm., 0.60 mm., 0.57 mm., 0.57 mm., hind femora 0.9 mm., hind tibiae 1.6 mm. Total length 3.8 mm., total width 1.6 mm., length pronotum 0.69 mm.

Loc. Western Australia: Holotype female (Reg. No. I20,100) from Lake Austin (H. W. Brown, no other data) and two paratype females (Reg. No. I20,101) from Cue (H. W. Brown, also no other data.).

REFERENCE

Scudder, G. G. E., 1957: "The higher classification of the Rhyparochrominae (Hem. Lygaeidae)" *Ent. mon. Mag.*, 4 (18); 152-156.

**ON CENTRAL AUSTRALIAN MAMMALS
(WITH NOTICE OF RELATED SPECIES FROM ADJACENT TRACTS)
PART III – THE POTOROINAE**

BY H. H. FINLAYSON, HONORARY CURATOR OF MAMMALS, SOUTH AUSTRALIAN MUSEUM

Summary

Since the Horn Expedition of 1894 (Spencer, 1896) comparatively little has been published on the marsupials of Central Australia. This venture while rich in new discoveries, left many gaps in the detailed knowledge of eremian species. Much is still obscure regarding their general biology and local and regional distribution and status, and in particular, the level of subspecific differentiation attained by eremian marsupials in relation to corresponding forms in the peripheral areas of the continent, is almost unknown.

ON CENTRAL AUSTRALIAN MAMMALS
(With notice of related species from adjacent tracts)

PART III—THE POTOROINAE

BY H. H. FINLAYSON, HONORARY CURATOR OF MAMMALS, SOUTH
AUSTRALIAN MUSEUM

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INTRODUCTION

Since the Horn Expedition of 1894 (Spencer, 1896) comparatively little has been published on the marsupials of Central Australia. This venture while rich in new discoveries, left many gaps in the detailed knowledge of eremian species. Much is still obscure regarding their general biology and local and regional distribution and status, and in particular, the level of subspecific differentiation attained by eremian marsupials in relation to corresponding forms in the peripheral areas of the continent, is almost unknown.

Pastoral settlement in Central Australia since 1894 has had an adverse effect on the mammalian life of large areas, including that worked over by the Horn Expedition, but the creation of Aboriginal Reserves originally totalling 75,000 square miles on the adjoining borders of the States of South and Western Australia and Central Australia has incidentally provided a partial sanctuary for fauna. Here the introduction of domestic stock and most other European enterprise is banned, and nearly virgin conditions prevailed until the entry of the European fox in numbers within the last 25 years.

During the years 1931-35 the writer visited this area four times spending in all some 13 months in field observation and collecting, between $136^{\circ} 30'$ and $128^{\circ} 10'$ East and $23^{\circ} 30'$ and $28^{\circ} 0'$ South (approx.). The main collecting stations and routes covered during this portion of the work are indicated upon a detailed map which accompanies a general description of the country, published by the writer in 1936 and two preliminary papers upon muridae from the same source appeared in 1940 and 1941. The mammals of the Lake Eyre Basin had been dealt with earlier (1931-39). Since 1945 enquiry and further field work have been extended to areas of the Northern Territory to the north and east of the main reserve. In the present series of papers the term "Central" is used for the whole tract covered without reference to political boundaries, since conditions as they effect the ecology of mammals are not sensibly different in the three sections.

The summaries of distribution of most species are given in broad outline only and are subject to future modification. The sparse and fluctuating occurrence of many of the surviving mammals, the vast areas involved and the confusion caused by European occupation, make a more detailed treatment impossible. All that is attempted here is to quote localities for all material examined, to add the results

of personal observation and of enquiry among natives and correspondents, and to combine this with existing records, many of them little known and scattered through the literature of exploration and surveys. The body of data assembled in this way, provides a considerable advance both in scope and accuracy on the information previously available, but anything approaching a satisfactory survey, has long since ceased to be possible. Systematic interrogation of aborigines, with authentic specimens to stimulate interest and facilitate comparison, has long been practised by the writer and has proved a most fruitful source of information. When subject to checking and cross checking among the older people of widely separated and independent groups, such testimony can be refined to a high degree of utility, and it is keenly to be regretted that the chaos into which aboriginal life has sunk, has brought this source almost to an end.

The data and material obtained on these private expeditions has formed the nucleus on which the following reports are based, but in addition, much other relevant material in the South Australian Museum has been consulted. In reviewing the morphology of Central Australian species, one of the chief aims has been to provide a reliable description of an authentic series, which might serve as a basis for comparison with other populations when such are available, and so shed light on the degrees of subspecific differentiation mentioned above. In some cases also where fossil or subfossil material has been available in sufficient amount, such a comparison has given useful information on the Post Pleistocene history of the species. In this work metrical data in the form of ranges and approximate means of dimensions and indices has been freely used in arriving at tentative conclusions, but conventional statistical analysis is deferred. It has been necessary to distinguish a few well marked forms by nomenclature, but in general I have been chary of adding new names for such differences as have been demonstrated and taxonomic treatment along trinomial lines has not been consistently followed. In the present state of the development of the subject, such a course, even if desired, is a hazardous one owing to the frequent inaccessibility of type specimens and the impossibility of forming just estimates of the normal range of variation in the species they represent.

In this connection it may be noted, that within the Central Australian field itself, conditions as they apply to ground living mammals are especially ill adapted to the operation of the *Formenkreise* type of mechanism, which underlies the theory of the development of the

geographic subspecies. Over vast areas of the country, the ecological gradient is exceedingly low and physical barriers to the free movement, even of small forms are absent. On the other hand, climatic factors in the form of sparse and irregular rainfall, exert cataclysmic effects by periodic depopulation of whole districts during drought and repopulation of the same by the breaking of drought. These population movements are almost entirely capricious in direction, and in mammals of high mobility and dispersal capacity result in a constant mingling of communities over areas so wide that regional differentiation of a permanent character is largely suppressed.

***Bettongia lesueuri* Quoy and Gaimard 1824**

Originally described from Dirk Hartog Island in Shark Bay on the Western Australian coast in lat. 26° South, this rat kangaroo has since been shown to have had one of the most extensive continental ranges of any of the Australian marsupials, reaching from about 14° South lat. in the north-west down to the extremity of the south-east coast in lat. 37° 50' South, and from the west coast almost across to the eastern cordillera in New South Wales. The north-eastern sector embracing most of Queensland and part of New South Wales has yielded no published records of the species and thus forms an interesting hiatus in its distribution, but whether of fact or merely record, is somewhat doubtful (fig. 1).

The range has frequently been given as Western and South Australia and this has misled many writers, even in recent years, to overlook its former presence in Victoria and New South Wales. That it occurred in the Murray districts of these States in 1863 was plainly attested by Krefft in Lydekker (1894) and more doubtfully, in northern New South Wales in 1865 by Macgillivray (in Iredale 1937). Tate (1948) has also published evidence of its occurrence in Victoria.

The former habitat included a wide range of climates but wherever it occurred it seems to have followed a fossorial way of life on more or less open plains, and has shown itself, especially in arid districts, markedly intolerant of pastoral occupation, so that both its numbers and dispersion have been greatly reduced from what obtained primitively. Nevertheless, it still occupies large areas in the States of Western and South Australia and the Northern Territory.

Two races have been separated from the original insular form; *B. lesueuri grayi* Gould 1840 based on the Swan River in Western Australia and *B. lesueuri harveyi* Waterhouse 1842 from Eyre

Peninsula, South Australia. In addition, the insular form *B. lesueuri lesueuri* Quoy and Gaimard 1824, has now been accorded a representation on the adjoining mainland by Glanert (1950). While these names have been widely used, the morphological basis on which they have rested is of the flimsiest, and as Harper (1945) has pointed out, the lines of demarcation or intergradation between the forms are quite unknown.

The material in hand comprises series from both Central Australia and the lower districts of South Australia, and these will be considered separately.

THE CENTRAL AUSTRALIAN REPRESENTATIVE

DISTRIBUTION AND HABITS: The former distribution in the Centre was wide (fig. 1), but its limits can now be but vaguely indicated in all those areas which have been under pastoral occupation for long. Probably its greatest stronghold was along the east-west axis of the Macdonnell Range system and in the south-west sector in and about what are now the great Aboriginal Reserves on the borders of the three States. As late as 1940 it was still numerous here, particularly so in the Musgrave-Everard Range area from which it extended with increasing sparseness into the north-west districts of South Australia, to about lat. 30° South. Forty years before this, at about the turn of the century, its colonies were continuous over the western half of the latter State, as far down as the Adelaide-Wakefield plain.

Of its northern extension, there is little satisfactory evidence, but I place its limit provisionally at about 20° South lat. To the west of Stuart's line in this latitude it may extend somewhat further north, but to the east of it, the Barkly Tableland was apparently never occupied, and interrogation of Wombaia survivors there has given only negative results.

The eastern limits lie near the Queensland border. It is well known to the eastern Arunta and the Ilyowra, and remained within their territory between the Plenty and Sandover Rivers until the late 1920's. The Wonkanooroo have a name for it in the south-eastern extremity of the Arunta desert but it was not reported by either Colson in 1938 or Madigan in 1939 in their traverses of the central portion of this region. South of the Arunta Desert, Andrews (1876) collected it in 1874 in the Lake Eyre district probably on the Macumba at the north end, and Sanger (1882) recorded it from the lower Cooper on the east side. Sanger's account of it, however, is more

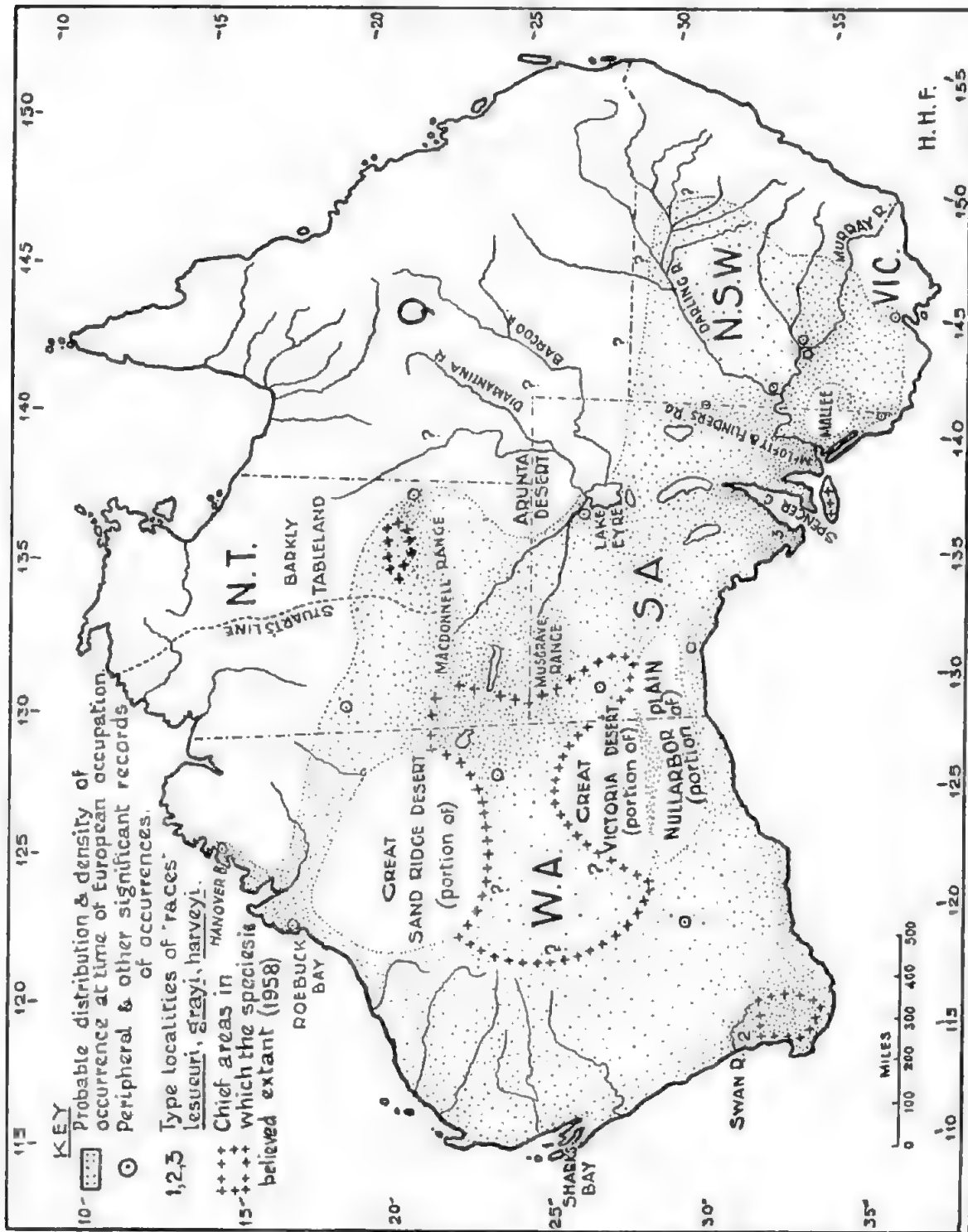


Fig. 1. Map of the distribution of *Bettongia lesueuri* Q & G.

suggestive of *Caloprymnus* than *B. lesueuri* and in 1931 I was unable to get any positive evidence of the latter in this part of the Lake Eyre Basin. Longman (1930) does not record it as a Queensland species.

To the west, the records are few and derived chiefly from journals of exploration in the Sandridge, Gibson, and the Victoria Deserts and their value is uncertain owing to frequent confusion in the accounts with *Lagorchestes* spp. and *Thalacomys*, and the absence of material in support. However, I accept Giles' citation (1889) at approximately 24° 42' South and 127° 44' East in Gibson Desert in 1874 as the mode of occurrence is characteristic and I have taken it personally north of Desolation Glen in the Rawlinson Range, only 50 miles south-east of his locality. Carnegie's (1898) record from Wilson Cliffs in the Sandridge Desert at lat. 22° 1' South and 126° 57' East may perhaps relate to *Thalacomys*. The Canning Stock Route Expedition of 1931, which crossed about 100 miles west of Wilson Cliffs, recorded neither the animal nor its warrens, nor is there any recognizable account of the animal in J. Forrest's journal of the 1874 traverse along the 26° parallel, though in the latter case as in most early exploration, such negative evidence is not likely to be significant. The question of the isolation of these Central and South Australian populations of *B. lesueuri* from those of Western Australia, which has an obvious bearing on the validity of the three races named is thus left undecided by the published records. The case for continuity of distribution in the recent past, based on the continuity of available habitats is, however, a very strong one; even if the central portions of the three western deserts are regarded as impassable barriers, there remain three avenues of feasible intercommunication along three routes, *viz.* the coast lands of the Bight, the 26° parallel, and the north and eastern margin of the Sandridge Desert. In connection with the latter it may be noted that the large "rabbit" warrens recorded by M. Terry in 1929 in the Tanami district in approximately 28° South and 129° 51' East, would almost certainly be warrens of *B. lesueuri* doubtfully parasitized by rabbits.

Its present status (1958) is everywhere a rapidly dwindling one. It survives in very small numbers in the territory of the northern moiety of the Ilyowra and of the Worgaia to the east and north of the Elkedra (Ilketera) River, which has only recently been brought under pastoral occupation; possibly also, as an extremely attenuated remnant at one or two points in the drainage of the Sandover and Plenty Rivers, and in the Reserves of the south-western sector. In the latter its persistence will depend in large part on the extent to

which the fox is able to increase its range to the north. The southern portions of the Reserve have been heavily infiltrated by this pest in recent years and it is doubtful if it exists today in the Musgrave Range area, where it was in large numbers only twenty years ago.

The species formerly occupied a prominent place in aboriginal life and lore, in practical venery and in legend. Its identity is easily traceable in their accounts, by its habit, unique in the Macropodidae, of excavating large warrens for community dwelling and by its truculence. To the Pitjanjarra of the Reserves it is known as metika or tchungoo, and the second of these terms has a very wide usage, ranging in the north beyond the Rawlinson Range into Pintubi territory, while in the south recognizable variants of it can be traced as far as Ooldea. The western Arunta call it tnunka, but their eastern moiety have largely adopted the Ilyowra word, alutta, which in recent times they have carried into the Pituri creek and Toko range area on the Queensland border in lat. 22° 30' South approx. The original Wonkamunna of this district are now reduced to a very few individuals who no longer occupy their home territory, and in a recent visit to it I was unable to learn their name for the animal from their supplanters, or to fix definitely whether the species ever occurred there. However, it certainly extended to a point about half way between the Tarlton and Toko ranges, and within 50 miles of the border. These two names also have considerable extension to the north and are used or understood, far beyond the boundaries of the Arunta and Ilyowra as drawn by Tindale (1940). The Wonkanooroo and Dieri call it kanunka, which suggests a recent derivation from the Arunta word.

In 1931-35, before the fox had become a serious factor, I found it one of the most plentiful mammals of the Reserves. However, its numbers fluctuate greatly and its occurrence is local and discontinuous and not uniform. Warrens housing a big population during one season may be found quite deserted the next, though conditions have not greatly changed in the meantime. It has often been described as an animal of the "sandhills" but this is only true in the vernacular sense in which all areas away from rocky ranges, are so described. With the exception of rocky hills and ranges and dense thickets, it colonizes most types of country; grassy and herbaceous loam flats within the major ranges, open mulga and ironwood parks skirting the ranges, and penetrates deep into the true sandridge areas as well. Here as elsewhere, however, its warrens are usually made in the firm loam at slight elevations on undulating swales and not in the sandridges

proper. On the northern margin of the Amadeus Basin the burrowing is often done into slight outcrops of friable limestone and gypseous rock and in 1950 I noted a similar occurrence over a small area between the western Macdonnells and Stuart Bluff Range, though the animal has long been extinct there. This is the type of warren noted by Giles (*supra*) and is affected also apparently by the coastal colonies at Roebuck and Shark Bay.

In general, Central Australian warrens are much less complicated than those described in Western Australia by Gilbert in Gould (1855) and Dahl (1897). One excavated on a loam flat at Yaringa, south-west of the George Gill Range, went to a total depth of no more than four feet, at which level lay the main gallery from which two *tehungoos* were taken. Above this were many short off-shoots which were occupied by rabbits only and this arrangement is a frequent one but whether it is universal here as Wood Jones (1923-1925) avers it is further south, is doubtful. The burrowing habit is more fundamental in *tehungoos* than in rabbits, a large proportion of which in these latitudes lead a surface existence or make use of shallow excavations only for shelter or breeding. When the rabbit invaded the centre, abandoned or incompletely utilized *tehungoo* warrens were plentiful as they are now, and it seems more likely that the rabbit parasitized the *tehungoo* than *vice versa*, as has been suggested, and this is also the native version. No doubt the rabbit has introduced an adverse factor into the ecology of *B. lesneuri* as with other small native herbivores, but in the 60 years they have been together in the south-western areas of Central Australia, it has not proved a fatal one, and but for the increase of the fox it might have continued to enjoy a somewhat reduced tenure, indefinitely. In areas of pastoral occupation still other factors are superimposed by the presence of stock, with which it cannot cope.

It is extremely shy and cautious, strictly nocturnal and in summer at least, leaves the warrens only long after dark and is a most difficult animal to observe under natural conditions, even when it is plentiful. In the accounts of the Horn Expedition and of some of the explorers it is confused with *Lagorchestes hirsutus* which is often seen in daylight in spinifex tracts. The *tehungoo*, however, is not normally found in such country but burrows in areas where the small plant cover tends to be rather varied with *salsolae* and succulents such as *Calandrinia* and *Portulaca* and when large warrens are occupied, its pads—*tehungoo* roads in local parlance—are often conspicuous,

radiating out to its feeding grounds. The track nearly always shows a distinct imprint of the tail between those of the feet, and these are wider apart than in *Lagorchestes*.

In addition to the green parts of a large number of plants, it excavates and eats quantities of bulbs and tubers, of which the roots of the very widely spread procumbent species, *Boerhaavia diffusa*, are the most important (Pitjanjarra, karrpilba; Iyowra, ayepa). The bulbs of the yelka or nut grass, *Cyperus bulbosus*, and of a lily called by the Iyowra ilelgunya (*Crinum* sp.) are also sought out, as well as an unidentified yamlike product known as poonba in the Musgrave Range area. In the south-west sector, where the quondong (*Eucarya acuminata*) is plentiful, its fruits (waianoo, mangada) are an important item of diet and are taken down into its burrows in quantity. Not only is the fleshy rind eaten but, like the local *Notomys*, it makes use of the oily kernel of the nut as well, which necessitates gnawing away a large part of the flinty hard casing; a task for which the stout rodentlike first incisors are well adapted (Pl. xxvii, fig. II; Pl. xxviii, fig. A).

Under present day conditions it is not easy to get undamaged specimens. It is wary of traps especially on warrens and when caught in the ordinary types of small steel trap is difficult to hold owing to its fragile limbs. A good many are taken accidentally by doggers in the much larger dog trap which often takes the animal by the middle and prevents struggling. Practically the only way of getting it undamaged is by digging it out which is extremely laborious. It is powerful for its size and when taken from a burrow struggles violently and scratches and bites severely, making the while a harsh aspirant sound with occasional grunts. The latter I presume is the call which it has often been stated to make at night when abroad, though I have never heard it thus in the Centre.

On moonlight nights the blacks occasionally take them when feeding away from the warrens, either by the spear or with dogs, and if pressed for food, the women will sometimes dig out the smaller burrows, though nowadays the labour involved is out of all proportion to the probable results. In the heyday of the species on the Sandover River, where for a time it was in very large numbers, the Iyowra practised some ingenious methods of shortening this labour. Having selected a large and well populated warren, a party of men working in the middle hours of the night, when the animals were away feeding, securely blocked up the entrances to all the deep burrows, but left

open a number of shallow experimental drives which were always present on the outskirts of the larger warrens. The aluttas, returning before dawn, were thrown into confusion by this denial of their accustomed refuge, and after frantic but unavailing efforts to clear the entrances, were forced by the rising sun to take shelter in the shallow drives. Here they were promptly stupefied with smoke to prevent them digging deeper (which they otherwise do very expeditiously) and were then dug out in numbers with little trouble. They were much relished as meat. Thirty-five years ago, towards the end of their major tenure of the Ilyowra country, their way of life became considerably disorganized and a portion of the remnant forsook the warrens and lived in holes in creek banks.

From most nonhuman predators it was well protected by its strictly nocturnal feeding and deep burrowing habit, but the largest of the local lizards (*Varanus giganteus*), a voracious creature, attacked it in the warrens, and took considerable toll.

The specimens personally examined have been free from the larger ectoparasites. The animal has no characteristic smell. Reproduction appears to extend over the greater part of the year and pouch embryos and young, up to 170 mm. long, have been obtained both in mid-summer and mid-winter.

EXTERNAL CHARACTERS: The material examined represents 32 individuals, obtained from the following localities, all in the south-western sector: (*a*) Chundrinna, N.W. of the Everard Range at lat. 26° 51' S. and 132° 13' E.; (*b*) several other points between Chundrinna and the southern front of the Musgrave Range; (*c*) Allarinna, on the northern front of the Musgrave Range; (*d*) near Murrachurra Spring, 20 miles east of Mount Conner in lat. 25° 26' S. and 132° 13' E.; (*e*) Yaringa, 12 miles S.W. of King's Creek in the George Gill Range; (*f*) north of Desolation Glen in the Rawlinson Range at about 24° 53' S. and 128° 16' E. That portion of the series which is sexed comprises 12 ♂, 13 ♀.

Wood Jones (1923-1925) has given an extended account of the external characters of a series from the Lake Phillipson area and as the present material is in substantial agreement with his, a full description is dispensed with and the following supplementary notes substituted.

His illustration of the *head* gives a much better impression of the appearance of the living animal than earlier figures; the deep abruptly truncated muzzle is especially characteristic and in this point it differs

from its congeners while somewhat resembling *Caloprymnus*. In life the rhinarium is bluish pink and its upper margin is evenly convex and not spurred upwards in the centre. The facial vibrissae are well developed though slender; the genals and supraorbitals are unusually large and exceed the mysticals. The ear backs are evenly convex and without indentation as in *Caloprymnus*.

In the *manus* the palm is yellowish white and coarsely granular; the palmar pad being less developed than in *Caloprymnus*. The digital formula based on the distal extension of the digits is $3 > 2 > 4 > 5 > 1$ as given by Wood Jones, but the disproportion in general development of the three central digits is slight and the formula for size is $3 > 4 > \text{or} = 2 > 5 > 1$; the claws are white and translucent. In the *pes*, the plantar surface where exposed is yellowish white, and coarsely granular over its whole extent whether covered or exposed; at about the mid point of the metatarsus the granules are hexagonal and average 15 per cm. but elsewhere they vary much in shape and are often irregular. The encroaching of the hairs from the dorsum of the foot over the plantar surface is a constant feature in all young and young-adult animals and the condition is usually much as figured by Wood Jones (*op. cit.*, fig. 155). The hairs at this stage are not felted down into a mat but are arranged in two overlapping layers taking origin in opposite margins of the dorsal surface and remaining quite separate; the development of hair is profuse and the insulation of the less calloused portions of the sole and digits, very effective. In old animals, however, the hairs are thinned out by abrasion and the entire plantar surface of *pes* and digits is not infrequently quite naked. The apical segment of the fourth digit is much less expanded than in *Caloprymnus* or *Aepyprymnus*, and the elements of the main interdigital pad are sometimes incompletely fused as in *Potorous*, a shallow sulcus dividing it into two longitudinal moieties. The nails of the digits are yellowish white and translucent.

The *tail* is nearly circular in section and tapers slowly to its apex; calloused areas are not developed upon it. The pouch opening is posterior to the mid point of the ventral length and the space intervening between its lower margin and the cloaca is often nearly nude, and sharply defined by laterally diverging hair tracts. The *clouca* has no enlarged bristles, but a short fleshy process is developed on its posterior margin, similar to but smaller, than that which I have recorded for *Caloprymnus* (1932). No sternal gland has been observed.

Secondary sexual differences are slight; the male is not superior to the female in linear dimensions, but is more massive, with a thicker blunter head, and deeper muzzle, and heavier feet.

PELAGE: The general colouration viewed from a distance of a few feet varies in different individuals from grizzled buff grey to grey brown with lighter ventrum and the head and appendages distinctly contrasted in warmer buff and tan. At its best the pelage is dense and soft; mid dorsally the main pile reaches 22 mm. with guard hairs to 30 mm., lengthening on sides to 25 mm. and 33 mm. respectively. The basal half of the main pile is about Ridgway's slate grey, the succeeding third forms a sharply contrasted band varying in different individuals from light buff, to tilled buff, and the extreme tip clove brown. The guard hairs are slate grey in the shaft, with a narrow brown band separating it from the flattened blade which varies from ivory yellow to near white and the extreme tip shades off from sepia to black; a small proportion of guard hairs are dark throughout. The composition of the pelage is thus similar to that of *Caloprymnus* but the overlay of ivory and white is much less profuse and has less effect on the general ground colour, which ranges from deep olive buff to light brownish olive.

The sides are similar to the dorsum, but paler and less grizzled and are sometimes separated from the ventrum by a lateral line of rich buff. The ventral fur averages 17 mm. with a sparse overlay reaching 30 mm.; it is mostly bicolor, with a basal zone of slate grey almost obscured by the terminal colour which is creamy white variably washed and dappled with warm buff. The scrotum, small areas on the throat, and mid belly are creamy white to the base. The head is more warmly coloured than the body, the ground colour varying from tawny olive to cinnamon buff; on the muzzle it is closely grizzled with brown and buff but the crown and genal surfaces are more uniform. The inner surfaces of the ear are nearly nude except distally where they are sparsely covered with short adpressed cinnamon buff hairs. Externally the ear backs are well covered with loose fluffy fur, slate at base, rich tawny olive terminally and conspicuously bordered at the anterior margin with clove brown.

The forelimb is externally long haired, buff dulled by the basal slate colour; internally somewhat lighter; the manus densely clothed with adpressed hairs of clear cinnamon buff lengthening over the base of digits but not obscuring the claws. The hind limb is externally like the sides or rather darker and sometimes has a poorly developed

lighter hip stripe. The pes also is cinnamon buff or slightly richer and has a tendency to darken on the outer metatarsal surface and the fifth digit. Its hairing is close, short and dense dorsally, but is greatly lengthened on the sides so as to overlap and obscure large areas on the plantar aspect of the digits. In most examples the digits of both manus and pes are stained a bright orange tan by clay dust; this can be completely removed by mild detergents leaving the colour the prevailing buff. The immediate tail base is clad with dorsal body fur which gives place suddenly to short coarse hairs, which are closely adpressed except on the terminal third of its dorsum, where a progressive lengthening begins. Laterally and ventrally the colour is uniform cinnamon buff, but dorsally this is darkened by a pencilling of brown, increasing distally until it completely replaces the buff ground colour of the subterminal fifth or more by rich prout's brown to clove brown. The apex of the tail for distances averaging 35 mm., is pure white on all surfaces when unstained and dorsally its hairs are lengthened to 20 mm. and frequently form, especially in subadults, a distinct erect crest. The tail is everywhere densely clad and its scutation completely obscured.

Variation of the pelage in density, texture, degree of grizzling and ground colour is considerable, but in the present series cannot be satisfactorily linked with local, seasonal, or sex factors. The shabbiest coats with the darkest ground colour are found in winter months, when rump abrasion is often marked; but dense, even, richly coloured coats and their opposites occur at all times of the year and there is little evidence of a seasonal moult affecting members of a colony, simultaneously. The coat in subadults as late as the P³M² stage, is often looser, with a greater exposure of ground colour than in adults.

Wood Jones (*op. cit.*) comments on the fugitive nature of the "yellow" colouration in this species. I find that field skins in my own collection, personally made in 1932 and 1933, and which have had no contact with liquid preservatives and have been stored in the dark, still show the original colouration as noted on the freshly killed animals at the time. Others in the South Australian Museum of the same provenance which were treated there by immersion in alum and salt pickle, show a more or less marked change of olivaceous ground colour to warmer browns, which are not normal to the living animal, and there is a variable degree of bleaching of the cinnamon buff of the appendages.

Under the name "*Bettongia lesueur graii*" Gould, Boardman (1949) has described the hair tracts in an advanced pouch young from

Bernier Island, which however, would more conventionally be regarded as representing the typical race *B. lesueuri lesueuri* of Quoy and Gaimard. In the present series, examples suitable for checking the primary tracts are lacking, but in adults, except for small suprarrhinal and preorbital divergences, the external pelage over the entire dorsal surface is directed uniformly caudad, and on the limbs distad, the postaxial trends of the latter being largely obscured. In undisturbed material the ventral inclination of the lateral fur is slight and there is no median opposition ridge on the ventrum, as is frequent in *Caloprymnus*. A reversed gular tract, directed forward and outward is constant, and radial tracts diverging from the pouch margins and precloacal areas of females, and the scrotal area of males, can usually be made out. In general, interruptions to the primitive caudad flow in the adult pelage, are much less in evidence on both dorsum and ventrum, than in most Macropodinae.

DIMENSIONS: The range and mean values in mm. of conventional measurements for a bisexual series of eight fully adult individuals at the P⁴M¹ stage, is given in tabular form on p. 267. Even when age changes are thus drastically restricted, the variation in all items is high, reaching 26% in the head and body length. Sexual differentiation is inappreciable, the adult female being as large as the male. Maximum dimensions for ear and pes are often attained as early as the P³M² stage. The tail is always shorter than the head and body in adults, but may be subequal in younger animals.

The following figures give the detailed measurements of a subadult ♀ (P³M³) from Yaringa Creek, at the western end of the George Gill Range, in Central Australia: head and body, 285; tail, 285; chest, 150; length of manus, 24; nail of third digit, 9; pes, 101; 4th toe, 42; nail of 4th toe, 17; ear, 36 x 22; rhinarium to eye, 31; eye to ear, 25; eye (intercanthal), 11; weight in grammes, 910.

Weights of adults are not available, but would probably reach 2,000 grammes.

CRANIAL CHARACTERS (Pl. xxvii, fig. A-II): Both skull and dentition of *B. lesueuri* present notable features which have been imperfectly described and some of these separate it decidedly from its congeners, by making an approach (especially in dentition), to the more advanced condition of *Aepyprymnus* and *Caloprymnus*.

Since existing descriptions give little information on the variation which occurs, and are based for the most part on mixed series from several localities, the whole question of subspecific variation on these

important heads, remains quite vague. In the present work, 72 skulls, (the majority of them not sexed), from South, Central and Western Australia have been used in examining the cranial and dental characters of the species as a whole; fifteen of these, taken from individuals of known external characters, represent the Central Australian population, and these alone form the basis of the following description. Differences shown by material from other localities, are dealt with in the sequel, using this homogeneous series, as a standard of comparison.

Intrinsic variation within the series, is high, both in non-metrical morphology and dimensions; in a series of 23 cranial and mandibular measurements the percentage variation in adults ranges from 7.5-40%, with a mean of 15%. Many of the most salient features of the skull observed singly, such as the development of the rostrum, size and shape of nasals, width of zygomatic arch and interorbital region (which are very apt to give premature impressions of sub-specific difference) are subject to marked individual variation.

The skull is densely ossified, with strong muscle ridging, and with the mandible, attains a maximum weight of 19 grammes; it is the shortest and widest in the genus and in this respect is equalled by *Caloprymnus* alone amongst the Potoroinae, the length \div breadth ratio falling as low as 1.5. The maximum zygomatic width is usually posterior, but wide variations occur in the overall zygomatic outline, which is sometimes similar to *Trichosurus vulpecula*.

The muzzle region is short deep and less conical than usual, and the mean facial index of 181 is one of the lowest for the subfamily. The nasal bones reach or slightly exceed the level of the anterior margins of the orbits; their length \div breadth ratio is variable as is also their overall shape and the combined posterior margin may be almost transverse, sharply angulate or invaginate in the mid line; there is always a distinct and sometimes a sudden, constriction of their width just anterior to the maxillo-premaxillary suture. The interorbital area of the frontals is of medium width averaging 25% of the basal length; but is parallel sided until late in life when the free margins converge slightly to form a moderate intertemporal constriction. The supraorbital ridges are sharp and overhanging and occasionally develop rudimentary postorbital processes. The variability of the coronal portion of the frontoparietal suture mentioned by Wood Jones (*op. cit.*, p. 209) is well illustrated but the transverse condition is the commoner. The development of the temporal ridges

reaches a maximum for the subfamily in *B. lesueuri*, but their confluence on the parietals is very posterior and a sagittal crest as in *Potorous tridactylus* is not formed. At a lower level on the vault, the squamosal suture is often strongly ridged. A crescentic interparietal is long persistent and overlaps in part the supraoccipital on the lambdoid crest, which is but moderately developed.

The occipital plane is nearly vertical and deeply indented and its arch is low and broad; the paraoccipital process is well developed and distinct posteriorly though its anterior surface is closely applied to the bulla and it has little free projection.

On the lateral aspect, the premaxilla is reduced, though less so than in *Aepyprymus*, and still makes an important contribution to the wall of the nasal cavity; its suture with the nasal is about equal in length to that of the maxilla. The facial plate of the lacrymal has from $\frac{1}{2}$ to $\frac{1}{3}$ the area of the orbital plate; the lower foramen in adults is usually larger than the upper, but they may be subequal and are occasionally confluent. The zygomata, especially the malar contribution, are relatively much the most powerful in the Potoroinae, and the infrazygomatic process of the maxilla, though it falls far below the standard of *Caloprymnus* and the Macropodinae, is distinctly indicated. The area of the temporal pterion is rugose and deeply impressed and the series inspected affords no exception to, nor important variant of, the frontal-squamosal contact, which, following Owen's original observation (1866) now proves to be constant for the subfamily (Finlayson 1932, 162, and Pearson 1950, 213-221). The diastema, with that of *Aepyprymus*, is relatively the shortest in the subfamily, and the posterior palate is one of the narrowest; its posterior vacuities are also long and narrow and occupy almost the whole of the intermolar space, the medium septum and posterior bar being reduced to fragile remnants often lost by damage; their anterior extension varies from the middle of M^1 to its anterior margin, and a pair of small foramina sometimes lie beyond this. The anterior palatal foramina are exceedingly variable, the length fluctuating over a 40% range.

The enormous expansion of the alisphenoid bulla is perhaps the most conspicuous specialization of the skull, though it comes as a culmination of a well marked tendency in the Potoroinae, and is less remarkable in the Macropodidae as a whole since the discovery of *Lagorchestes asomatus* which approaches it in this character. Nevertheless the bulla in *B. lesueuri* is probably the largest in relative volume in the Marsupialia and has comparatively few rivals in the

whole of the Mammals. In the prepared skull, owing to the incomplete condition of the upper rim of the tympanic annulus, the bulla communicates freely with accessory cavities in the posterior root of the zygoma and adjoining parts of the squamosal; the condition in varying degree is general throughout the Potoroinae but is especially developed in *B. lesueuri*. While the habits of *L. asomatus* are unknown, *B. lesueuri* remains unique in the Macropodidae as a fossorial adept and in seeking some functional correlation of the enlarged bulla, this fact inevitably comes to mind, and receives some support from the fossorial and strongly bullate *Thalacomys* of the same region. However, the conflicting evidence of the fossorial and non bullate wombats amongst marsupials, and bullate and non bullate rodents of burrowing habits must leave the matter an open one.

Tate (1948, p. 241) has noted a condition in the mastoid squamosal region in which the Phalangeridae and Macropodidae differ. I find that the same area has differential value both at sub-family and species rank, within the latter. In the Macropodinae with few and partial exceptions, the mastoid margin of the squamosal and the root of the zygomatic process are separated by a deep fissure above the tympanic annulus. In all genera of Potoroinae persistent attempts are made to bridge this gap, by the outgrowth of a delicate flange-like process from the mastoid margin of the squamosal, which narrows the fissure to a channel. In *B. lesueuri* alone, this channel is in old age sometimes converted into a closed canal by a separately ossified plate joining the flange to the zygoma root (Pl. xxvii, fig. F).

The mandible is distinguished by the stoutness and convexity of the lower border of the horizontal body below the molar rows, the width and relative erectness of the ascending process, and the extension of the angular process into a slender style conforming to the contours of the bulla. The confluence of the pterygoid and masseteric fossae, is wide as noted by Tate, but very variable, and the masseteric canal is very large. Abbie has suggested that the latter is a functional correlation in the Potoroinae to the presence of a large premolar, but the relative development of the canal seems to bear no simple relation to the size of the premolar or the length of the jaw in the different species, as one would expect if this were so. *Potorous tridactylus* with a long slender jaw, and comparatively small P⁴ has the canal as strongly developed as *B. lesueuri*, where these proportions are reversed. Moreover the long slender jaw of *Dorcopsis luctuosa* which supports an enormous premolar (both absolutely and relatively larger

than anything shown by the Potoroinae), makes no departure from the meagre development of the canal general in the Macropodinae.

The evidence of sexual differentiation is unsatisfactory, being supported on the female side by two adult skulls only, but so far as it may be accepted indicates that cranial differences are slight. The female skull tends to be slightly smaller, with shorter nasals, wider interorbital space, longer anterior palatal foramina and a higher facial index. Muscular impressions tend to be less in aged females than in aged males. Age changes are not marked and their recognition is complicated by irregularities in dental succession and individual variation. This leads to a wide overlap in dimensions and structural detail between different dental groups; thus skulls as early dentally as P³M² may be as large in overall size as aged skulls of the same sex at P⁴M⁴.

DIMENSIONS: As the sexual factor cannot be accurately assessed in any of the three recent populations and scarcely at all in the sub-fossil one, but is known to be slight, comparisons have been made for the most part with bisexual series. The following figures give the range and approx. mean of skull measurements of (1) a bisexual series of 8 at P⁴M⁴ and (2) 3 females at P³M³: greatest length, 64.3-73.3 (69.2), 62.3-65.3 (63.4); basal length, 54.2-60.2 (57.2), 52.3-52.6 (52.5); zygomatic breadth, 40.5-45.6 (43.0), 38.7-40.6 (39.9); nasals length, 22.8-28.6 (26.3), 22.5-24.9 (23.6); do. greatest breadth, 11.1-13.4 (12.4), 10.7-12.1 (11.6); do. least breadth, 4.9-6.8 (5.9), 5.2-5.5 (5.3); depth rostrum, 12.0-13.6 (13.0), 11.3-12.9 (11.8); interorbital constriction, 13.2-16.3 (14.5), 14.0-15.4 (14.5); palate length, 34.8-38.0 (36.4), 31.4-34.9 (32.8); do. breadth inside M², 9.8-12.2 (11.3), 9.5-11.1 (10.4); ant. palatal foramina, 2.2-3.8 (2.8), 2.0-2.8 (2.5); diastema, 7.3-9.0 (7.6), 6.0-8.4 (6.8); bulla length, 15.1-17.0 (15.9), 14.3-16.6 (15.0); bulla breadth, 11.0-13.3 (12.2), 11.2-12.1 (11.6); facial index, 171-191 (181), 166-197 (179); mandible, maximum breadth, 40.2-44.0 (41.7), 36.5-38.8 (37.9), maximum depth below M₂, 8.1-10.0 (8.8), 6.6-8.6 (7.6); breadth ascending process, 13.7-16.3 (14.8), 12.5-13.5 (13.0).

DENTITION (Pl. xxviii, fig. A-M): Variation in linear dimensions of teeth not rapidly altered by wear, such as the premolars and molars, ranges from 5-34% with a mean of 15%.

The incisors, as a group are relatively large and functionally important teeth, by the standards of the genus, and they sustain heavy wear. As a result the 1st and 2nd are subject during life to marked changes of size and shape. I¹ when unworn has a broad alveolar base

tapering to a pointed apex; growth is persistent however over a large part of the life span and as the tooth is extruded the apex is worn back to a chisel edge which steadily widens until it yields the maximum diameter of the tooth. Its size dominance over I^2 and I^3 is greater than in *B. cuniculus* or *B. penicillata* and tends to increase with age, and from $\frac{1}{2}$ to $\frac{3}{4}$ of its height projects beyond their working level. The dorsoventral height ranges in the present series from 4.9-7.9 mm. and its antero-posterior diameter from 2.2-3.0 mm. Both Thomas and Waterhouse claimed that a broader and flatter I^1 was diagnostic of *B. lesueuri*, but the material in hand does not support this. There is however a noticeable rotation of the tooth with advancing age, so that its labial wall becomes more and more anterior in aspect and less lateral.

I^2 is relatively constant, reaching a maximum antero-posterior length of 3.0 mm. in young skulls and a transverse breadth of 2.1. I^3 when unworn is comparatively narrow and upright with a vertical height of 3.1-3.6 mm. and antero-posterior length of 2.0-2.6; with age, it is thrust forward more and more and obliquity of wear may increase the latter value to 3.3 mm. The transverse broadening of I^2 and the inturning of the cutting edge of I^3 are both more marked than in other bettongs and foreshadow the extreme condition of *Aepyprymus*.

The lower incisor is comparatively stout for the genus but shows all the differential characters separating the Potoroinae from the Macropodinae in this feature; *i.e.*, its great absolute length and relative narrowness, maximum width at alveolus with evenly tapering outline to the apex, absence of median expansion of the blade, and of abrupt incurving of the upper margins. In adults of moderate wear, the anteroposterior length from alveolus is 10.6-11.4, and this is maintained or even increased in very old animals, where the shaft of the tooth may be completely denuded of enamel. The maximum transverse breadth of enamel ranges from 2.7-3.1 and shows considerable resistance to age changes until late in adult life, though its site moves steadily distad. On the other hand the maximum breadth of the tooth as a whole, including dentine, increases markedly with age and is always proximal; in eight adults it varies from 3.2-4.3.

The canine is well developed but variable in size, shape and inclination. In the young fully enamelled condition it is flattened and incisiform, with the labial face nearly as large as that of I^3 , and with a vertical height of 3 mm. *ca.* and anteroposterior breadth of 2.2 mm.

As wear advances the apex becomes more pointed, the recurvature is accentuated and both height of the tooth and width of root exposure in alveolus may increase to 3.7 mm. The premaxillary suture bisects its alveolus and the tooth is always much nearer to the 3rd incisor than to either of the premolars. Although clearly a functionally important tooth its apex never descends much below the middle of I³.

In the permanent premolars, *B. lesueuri* illustrates in an extreme degree the general trend of the Potoroinae towards enlargement, suppression of cusps and vertical corrugation. P⁴ is a narrow and usually almost parallel and straight sided blade and in relation to skull size is by far the largest tooth in the subfamily. Wear is heavy, but is chiefly seen in removal of the surface grooves, and reduction of the height of the blade; the latter may fall from 3.8 mm. to 1.7 mm. while length and breadth are almost unchanged. In taloned forms of the tooth, the maximum breadth is always posterior, otherwise at about the anterior third. Both the crest of the blade and the enamelled wall of the crown are of nearly even height throughout its length, the main posterior cusp alone being sometimes slightly raised; in 10-grooved examples the anterior cusp is scarcely differentiated. The number of grooves on the external wall varies from 8 to 10; 9 being present in 50% of examples and 8 and 10 occurring with equal frequency in the remainder. The grooves may form an even series of shallow crescents with the convexity anterior or they may have a more or less radial arrangement converging postero ventrally to a common centre below the posterior angle of the crest. The normal inclination of the long axis of the tooth is evenly anterointernal towards the midline of the palate; rarely it may be parallel but never extraverted as in *penicillata*.

A point of some general significance with P⁴ is the variability of the postero-internal talon and its cusp and the internal ledge—structures which in the Macropodinae are regarded as of great specific integrity. In *B. lesueuri* of this series, both may be completely absent or strongly developed in premolars of the same degree of wear (Pl. xxviii, fig. F and G), and the talon is sometimes accompanied by a posterior fossette. Anteroposterior length of unworn or slightly worn examples ranges from 7.6-8.7 mm. with a mean of (8.2), transverse breadth 2.5-3.3 (3.0) and vertical height of enamel 3.2-3.8 (3.5).

The lower secator P₁ is a simplified and somewhat reduced version of the upper, with length and breadth about 15% less but with the height of the blade retained. The maximum breadth may be

either posterior or anterior or at both, but never median. External grooves vary from 8 to 10 and generally conform to those of its opponent; where the number differs, the lower tooth generally has the fewer. The talon and internal ledge are almost completely suppressed. Antero-posterior length 6.5-7.3 (7.0); transverse breadth 2.5-2.8 (2.7); vertical height of enamel crown 3.2-3.8 (3.5).

The 3rd upper premolar P^3 is a much shorter and broader tooth than the secator; its maximum width is always median and its outline oval in superior view. The talon is absent, but the internal ledge variably developed, and either 5 or 6 grooves are present on the external wall with equal frequency; the grooves are commonly almost intact when the tooth is shed. The 3rd lower premolar P_3 is similar to the upper and is reduced in about the same proportion as the lower secator. Its outline is slightly reniform, the lingual wall being concave with the crest of the blade conforming to this curvature; grooves 5 or 6. Seven examples of upper and lower 3rd premolars, derived from skulls showing a rather wide range of development, have the following dimensions, respectively:—antero posterior length, 4.7-5.4 (5.0), 4.0-4.9 (4.5); transverse breadth, 2.7-3.1 (2.9), 2.3-2.8 (2.5); height of enamel crown, 2.7-3.2 (2.9); 2.9-3.3 (3.1).

The upper deciduous premolar MP^3 , is of the usual quadrate molariform type and is frequently as large as the third true molar. Its chief interest lies in the sectorial modification of the antero external cusp, augmenting the blade of the contiguous P^3 . I first drew attention to this feature in *Acypyrhymus* (1931) where it is very strongly developed and Tate (1948, 249) has since discussed it in other genera. In *B. lesueuri*, it is well, though variably developed in both upper and lower series. The mandibular tooth MP_4 is trigonid the anterior lobe being almost monopolized by the secant antero-internal cusp; it remains however four rooted. In size MP_4 is much inferior to M_3 . The following are the dimensions of MP^4 and MP_4 respectively in the 7 subadult skulls: antero-posterior length, 3.3-3.8 (3.5), 3.3-3.5 (3.3); breadth anterior lobe, 2.8-3.2 (3.0), 1.8-2.5 (2.2); breadth posterior lobe, 3.3-3.7 (3.5), 2.7-3.0 (2.9).

The upper molar rows, in distinction from *B. cuniculus* and *B. penicillata* are decidedly arched, with the greater convergence posterior. The effect is accentuated by the rapid diminution, in overall size and especially of transverse breadth, of the 2 posterior molars, which is a marked though not exclusive characteristic in *B. lesueuri*. Tate (1948, 269) has recently redirected attention to the

difference between the Potoroinae and Macropodinae in molar formulae and has published some dimensions of the molars of 3 examples of *B. lesueurii*. As noted earlier by Wood Jones, however, there is much individual variation in this regard, and in the present series the range in dimensions is wider than given by Tate. I find also, that in expressing the general size relations of the molars as functional units, an approximation to the *sectional crown area* is a more convenient and more adequate criterion than linear dimensions alone, and the formulae which follow are based on the values of $l \left(\frac{ab}{2} + \frac{pb}{2} \right)$, where l is the anteroposterior length, and ab and pb are the transverse breadths of the anterior and posterior lobes, respectively.

In the upper molars the sequence $M^2 > M^1 > M^3 > M^4$ occurs in 5 of the 7 completed dentitions measured, the other 2 showing the alternatives $M^1 > M^2 > M^3 > M^4$ and $M^1 = M^2 > M^3 > M^4$ the position of M^3 and M^1 being constant throughout. In the remaining 8 skulls, $M^2 > M^1$ holds in all, and $M^1 > M^3$ in the 3 examples in which the latter tooth has erupted. Clearly therefore there is a high degree of probability, that on completion of the molar series in the subadult examples, 13 of the 15 examples (87% ca.) would show the dominant 2.1.3.4. sequence. The frequencies quoted later in comparing populations have been deduced in this way from mixed series of adult and subadult dentitions, rather than on adults alone, which sometimes form less than half the available material and would certainly yield less accurate estimates. The range and mean of the molar crown areas expressed as a percentage of that of the corresponding first molars are: M^1 (100); M^2 97-114 (106); M^3 63-95 (78); M^4 20-49 (31). In the mandibular series, the declension in size is less rapid. The sequence $M_2 > M_3 > M_1 > M_4$ holds for approx. 62%, $M_1 > M_3$ in 31% and $M_1 = M_3$ in the remainder; M_2 and M_4 are constant in the sequence. The variation in crown area of the lower molars and their mean values, expressed as a percentage of that of M_1 is: M_1 (100); M_2 113-134 (124); M_3 90-121 (104), and M_4 40-60 (49).

With regard to size relation between the upper and lower series there is also much overlapping, but in general the upper 1st and 2nd molars are larger in crown area and relatively wider than the lower and the lower 3rd and 4th molars are larger in area and wider than the upper. Length $>$ breadth is the commoner condition in most of the molars of both series, but breadth $>$ length has the higher frequency in M^1 , M^2 and M_3 . In M^1 the posterior lobe is generally

wider than the anterior, and in M_1 invariably so; in all other molars both upper and lower, narrowing of the posterior lobe is by far the commoner condition. M^4 is excessively variable and sometimes almost vestigial and is not always strictly bilobed in form, so that its quantitative relations are less accurately expressed than in the anterior teeth.

The crown pattern of the molars is essentially similar to that of *Caloprymnus* and *Acypyprymnus* and represents an advance on the lophodont element of the bunio-lophodont system of cusps which prevails in the rest of the sub family. In the upper molars, however, the main transverse ridges are still confined to the buccal cusps. There is a general increase in height and saliency of all cusps and ridges and in particular a precursor of the anterior basal ledge of the Macropodinae is strongly developed. In unworn upper molars, the occlusal surface is narrow, occupying only about $\frac{1}{2}$ the available width of the crown, and the exposed lingual wall is frequently twice the height of the buccal. Corresponding features in the lower teeth are similar but less marked. Crown wear on the molars is comparatively slow and at the P^4 M^4 stage dentine exposures are generally confined to the lingual cusps of M^4 ; in very aged examples it does, however, proceed to complete obliteration of crown pattern. Interproximal wear is also negligible except in very aged examples. In the three dimensions studied there is no significant difference between corresponding molars of adult and subadult dentitions.

The range and mean (in brackets) for—(1) the antero-posterior length; (2) breadth of anterior lobe; and (3) breadth of posterior lobe, of the molars in a bisexual series of 15 skulls, follows:— M^1 . 4.0-4.4 (4.2); 3.9-4.5 (4.2); 3.9-4.6 (4.3). M^2 . 4.0-4.5 (4.2); 4.1-4.7 (4.5); 4.0-4.6 (4.2). M^3 . 3.6-4.0 (3.8); 3.6-4.2 (3.8); 3.0-3.5 (3.2). M^4 . 2.0-3.0 (2.3); 2.1-2.8 (2.3); 1.5-2.2 (1.8). M_{11} . 3.7-4.2 (4.0); 3.0-3.6 (3.4); 3.6-4.2 (3.8). M_{12} . 4.0-4.9 (4.4); 3.9-4.5 (4.1); 3.8-4.5 (4.0). M_{13} . 3.6-4.1 (3.9); 3.7-4.2 (4.0); 3.0-3.8 (3.5). M_{14} . 2.4-3.1 (2.8); 2.6-3.0 (2.8); 1.6-2.2 (2.0). The values for M_{13} in situ are: Upper 11.4-13.0 (12.1). Lower 11.3-12.8 (12.2).

The tooth change in *B. lesneuri* is subject to considerable variation; the commonest condition is that P^4 erupts after M^3 or with M^4 , when the skull has attained to 90% of its metrical development and somatic development is equally advanced. The premolar condition in *B. lesneuri* is a more reliable guide to maturity than the molar; M^4 is erratic in coming into place, sometimes delayed until the skull is

aged, at others appearing precociously in very early life. The functioning dental condition P³M³ appears to be long persistent and tides the animal over a considerable range of developmental stages.

Sexual differentiation in the teeth is chiefly shown by the 1st upper incisor which in both adult and subadult groups is distinctly larger in males than in females and of more persistent growth. In this it usurps the usual sex linkage of the canine, which is not appreciably different in the sexes.

THE LOWER SOUTH AUSTRALIAN REPRESENTATIVE.

DISTRIBUTION AND HABITS: There is abundant evidence to show that *Bellongia lesueuri* was formerly one of the most numerous and universally distributed mammals of South Australia, finding and colonizing suitable habitat zones in all the districts of the State with the possible exception of the deeper Mallee and the flooded portion of the lower South-East and the inner portions of the Nullabor Plain. It was well established on the Adelaide Plain, where its remains are sometimes brought to light today from long forgotten warrens, by suburban building operations.

To the early settlers it was a familiar animal and traditional knowledge of it persists in many country districts, but written accounts are rare, the early press commentators on the South Australian fauna nearly always quoting the existing accounts of Waterhouse and Gould, which relate almost entirely to Western Australia. A valuable exception was provided by A. Molineux who published some interesting details of its abundance in 1855-6 in the farming districts of the Lower North between the Light and Gilbert Rivers, 50 miles north of Adelaide, where it did some damage at harvest time, both to standing crops and hay stooks. He mentions having shot 149 in four nights, and 50 in one night in this locality, and confirms much that had been observed by Gilbert in Western Australia; particularly in the enormous size of the warrens, the call, and the strictly nocturnal habit. He considered that they were grass and grain eaters in the main, and referred to the European prejudice against the flesh, which he had personally found baseless. J. H. Browne (1897) also gave a valuable account of it in the same district, describing its burrows and the natives' method of procuring it therefrom which included a fumigating technique as in the Centre.

G. W. Francis records that in 1862 it was one of the first zoological items in the collection maintained in the Botanic Gardens,

as an early precursor of the Adelaide Zoological Gardens, and two years later M. Symons Clarke gave details of two specimens taken near the suburb of Walkerville, and again in 1889 near Two Wells, 30 miles north of the town. From 1900 to 1904 the greater number of the specimens in the South Australian Museum were received, chiefly from the Gawler River district, which at this time, was one of its last strongholds on the Adelaide-Wakefield Plain. A small group from this locality was maintained in captivity in the Museum grounds, and formed the basis of the mounted group now exhibited there. The last specimen from Eyre Peninsula was obtained at Worunda, near Port Lincoln—the locality of Waterhouse's type of *harveyi*—in 1909.

With regard to aboriginal names for the species in lower South Australia, the only terms which can be assigned to *lesueuri* with much certainty, are *yelki* of the Narranga of Yorke Peninsula, and *bukurra* or *bokra* of the Ngadjeri of the Lower North district.

The chief causes of its remarkably sudden decline have been discussed by Wood Jones (*op. cit.*), but these are not adequate for a complete explanation in all districts. The late Mrs. Daisy Bates while at Ooldea collected considerable evidence from the aborigines to show that its numbers had diminished markedly in the coastal areas at the Head of the Bight before European influence had become appreciable there, and this at a time when it was still very plentiful in the drier tracts north of Ooldea to the Musgraves. However, by 1910 from one cause or another, it appears to have been virtually extinct in the Southern Division of the State, below the parallel of 32° South, which includes all the agricultural areas. In the pastoral country to the north of this line, the succeeding 40 years have, as far as can be ascertained, seen its disappearance from all except the far north-western district, where both its populations and its prospects of survival are identical with those of the Centre, already reviewed.

We owe to the energetic intervention of the late Professor Wood Jones the possibility of the survival of the species in the south. In 1920 he obtained living specimens from the Lake Phillipson area in the north-west division, and successfully maintained them as a breeding colony at the University of Adelaide for some years. Some of the progeny of this group were transferred in 1924 to the sanctuary of Flinders Chase at the western end of Kangaroo Island at the mouth of St. Vincent Gulf. The site is for the most part densely bushed and not very well suited to its habits, but recent reports from the Ranger indicate that it is still extant though its increase is slow.

Reports of the recurrence of "kangaroo rats" in the southern mainland of South Australia, are made almost yearly, but all which have been investigated prove to be due to confusion with the bandicoot, *Isodon obesulus*.

Remains of the species are plentiful in alluvium and cave deposits throughout the State and are a common constituent of aboriginal kitchen middens.

The series examined below represents approximately 36 individuals, of which the bulk is unsexed skeletal material. It is much more restricted in geographic range than the Central Australian collection, coming for the most part from the coastal Adelaide-Wakefield Plain, with outlying specimens from the nearer foothills of the Mt. Lofty Range and from Yorke and Eyre Peninsulas. The locus of its most northerly specimens is 700 miles south-west of that of the most southerly of the Central series. Some examples bred in captivity by Wood Jones from stock from Lake Phillipson, an intermediate site, are anomalous in respect to pelage and cranial characters and have been deleted from both accounts.

EXTERNAL CHARACTERS AND PELAGE can be tested only on four individuals; a skin from southern Eyre Peninsula and three mounted specimens from the Adelaide district, which have been on exhibition in the South Australian Museum for thirty years. Soft parts, so far as they can be checked in this dried material are in close agreement with the Central animal. The Eyre Peninsula skin is in good preservation, unfaded and indistinguishable from winter skins from the Centre. The mounted specimens are too faded for colour comparisons, but are in close agreement with Central skins in all points of composition and colour distribution; the subadult specimen has a white apical crest strongly developed. The pelage is not richer in the south.

FLESH DIMENSIONS are quoted in the table on p. 267 for a bisexual series of 9 examples at P⁴M⁴. The variation is still wider than in the Centre, reaching 26% in the head and body length, and there is a wide overlap with that series in each item; the slight increase in the mean length of pes in the south may be significant, but the other differences are doubtfully so.

CRANIAL CHARACTERS (Pl. xxvii, fig. C): Twenty skulls from Lower South Australia have been examined and measured; four only are subadult, the remainder are at P⁴M⁴ and for the most part are much more aged than skulls of the same dental stage from Central Australia.

In structural features there is close agreement with the Central series but the southern skull tends to be slightly larger. In a series of 21 cranial and mandibular measurements of the 16 at P⁴M⁴, the increase in the mean value varies from 1 to 15% with an average increase of 5%; the greatest being the length of the anterior palatal foramina (15%), depth of mandible (13%) and diastema (11%). Two other measurements are lower; the least width of nasals (2%) and the facial index (4%). The increase is greater in longitudinal dimensions than in transverse, so that the skull is frequently proportionately narrower in zygomatic width (8%) and in the width of the mandible and its condyle (9%).

The differences between the two geographic series have no doubt been accentuated by the greater average age of the lower South Australian skull, but are not primarily due to this cause, since the sub-adult skulls at P³M³ show similar differences from their Central counterparts. The mean variation in the dimensions of the southern series is even greater than in the Central one, in the proportion of 22-15, and in nearly $\frac{2}{3}$ of the measurements the range completely overlaps both maxima and minima of the latter. As in the Central series dwarf fully adult skulls occur, smaller in most dimensions than average subadults.

DIMENSIONS: The following figures give the range and mean of skull measurements of bisexual groups of (1) 16 at P⁴M⁴ and (2) 4 at P³M³. Greatest length, 63.2-76.2 (72.9), 68.0-70.0 (69.3); basal length, 54.0-66.5 (63.1), 57.1-60.0 (58.9); zygomatic breadth, 39.5-46.2 (43.9), 41.8-43.2 (42.4); nasals length, 23.3-30.0 (27.8), 24.7-25.7 (25.3); nasals greatest breadth, 11.5-15.3 (13.2), 10.0-11.9 (11.1); nasals least breadth, 5.0-7.0 (5.8), 4.6-5.5 (5.1); depth rostrum, 11.5-14.1 (13.3), 11.7-13.6 (12.7); interorbital constriction, 14.0-17.0 (15.5), 14.6-15.2 (14.9); palate length, 33.3-41.2 (38.7), 34.0-37.5 (35.9); palate, breadth inside M², 10.3-13.3 (12.5), 10.8-11.8 (11.3); ant. palatal foramina, 2.5-4.4 (3.3), 2.7-3.2 (3.0); diastema, 6.7-10.2 (8.7), 7.7-9.0 (8.2); bulla length, 14.6-18.7 (17.1), 16.0-18.0 (16.7); bulla breadth, 10.5-14.8 (12.6), 12.4-13.5 (13.0); facial index, 162-195 (174), 171-181 (174); mandible, maximum breadth, 38.0-45.0 (42.4), 40.5-40.5 (40.5); mandible, depth below M₂, 9.0-11.8 (10.3), 8.1-9.2 (8.7); mandible, breadth ascending process, 13.4-17.0 (15.0), 14.0-14.4 (14.2).

DENTITION: Here also the range of variation in dimensions is greater than in Central Australia, and in all items there is a generous overlap between the two series. The mean dimensions of teeth which

are substantially free from age and wear changes, such as the length and breadth of premolars and molars tend to be slightly higher than in Central Australia, the chief increases being P^4 3.5%, P^3 6%, Ms^{1-3} 3%, M_{1-3} 4%, M^3 15%, M_1 10%. In many other dimensions, however, there is a virtual identity of mean values and P_3 is 2% and M_1 4% lower. The prediastemal teeth are difficult to compare accurately owing to age changes, but in subadults are also slightly larger, the canine probably as much as 10%.

Structurally the teeth in the two series are in close agreement. The crown of the canine is obscurely bicuspid in two examples. P^4 is somewhat more constant in talon development than in the Central series and its anterior expansion is more frequent and more marked; one 7-grooved example occurs, but otherwise 8, 9 and 10 grooves appear with about the same frequency as before. In the lower P_4 a taloned variant with sigmoid outline (Pl. xxviii, fig. J) not seen in the Central series, occurs in 2 examples.

The chief change in the absolute dimensions of the molars as compared with their Central Australian counterparts, is the mean increase in the 3rd and 4th of both jaws, and of the 2nd in the upper, and a decrease in M_1 of the lower jaw. The molars also tend to be slightly narrower.

The gradation in molar size as interpreted by the sectional crown area yields the same prevailing sequences as in the Central material. The enlargement of the posterior teeth with respect to the first however (especially marked in the lower jaw), leads to the occasional appearance of such conditions as $M^3=M^1$ and $M_3=M_2$, which have not been noted in the Centre, while $M^1>M^2$, $M_1=M_3$, and $M_1>M_3$ do not occur. In the upper molars $M^2>M^1>M^3>M^4$ accounts for approx. 90% of the cases, $M^2>M^1=M^3>M^4$ for 5% and $M^2=M^1>M^3>M^4$ for 5%. In the lower series $M_2>M_3>M_1>M_4$ occurs in approx. 79% of cases and $M_2=M_3>M_1>M_4$ in the remainder. The range and mean of the sectional crown areas expressed as percentages of those of the first molars, are as follows: M^1 . (100); M^2 . 100-125 (112); M^3 . 68-100 (83); M^4 . 27-59 (36) and M_1 . (100); M_2 . 117-142 (130); M_3 . 104-132 (119); M_4 . 53-82 (62).

The tooth change is not illustrated. There are no supernumary molars, but a vestigial P^1 occurs in one example. The following figures give the range and mean of the linear dimensions of the cheek teeth; the values for the third and the deciduous premolars are derived from 4 subadults and the remainder from 16 at the P^4M^4

stage. P¹ length, 7.7-9.3 (8.5); P¹ breadth, 2.6-3.6 (3.1); P² length, 5.0-5.6 (5.3); P² breadth, 2.6-3.0 (2.8); MP¹ length, 3.4-3.7 (3.5); MP² breadth ant. lobe, 2.8-3.1 (2.9); Ms¹⁻³ *in situ*, 11.3-14.0 (12.5); and in the mandible P₁ length, 6.0-7.5 (6.9); P₁ breadth, 2.5-3.3 (2.7); P₂ length, 4.3-4.6 (4.4); P₂ breadth, 2.3-2.7 (2.5); MP₁ length, 3.2-3.5 (3.4); MP₂ breadth, 2.0-2.3 (2.2); Ms₁₋₃ *in situ*, 11.1-13.0 (12.7); M¹ anteroposterior length, 3.9-4.6 (4.2); breadth anterior lobe, 3.7-4.5 (4.2); breadth posterior lobe, 3.6-4.5 (4.2). M². 4.2-5.2 (4.5); 4.0-5.0 (4.4); 3.6-4.8 (4.2); M³. 3.5-4.5 (4.0); 3.5-4.2 (4.0); 3.7-4.0 (3.4); M⁴. 1.9-3.6 (2.7); 2.1-3.3 (2.8); 1.7-2.5 (2.1); M₁. 3.5-4.2 (3.8); 3.1-3.5 (3.3); 3.4-4.0 (3.7); M₂. 4.0-4.9 (4.4); 3.6-4.3 (4.1); 3.7-4.5 (4.0); M₃. 3.6-4.7 (4.3); 3.6-4.3 (4.1); 3.4-4.1 (3.7); M₄. 3.0-3.4 (3.1); 2.7-3.4 (3.0); 1.9-2.8 (2.3).

SUBSPECIFIC DIFFERENTIATION IN *Betlongia lesueuri*.

The relationship of the Central Australian and lower South Australian Populations: While it is possible by the close examination of series to detect and define divergent trends in these two populations, it must be emphasized that the differences noted are not only slight in themselves but are of an average character and leave many individuals of both groups virtually inseparable by an appeal to the minutiae of morphology, and certainly quite inseparable by the facile and subjective methods which have been rife in differentiating geographical "forms" of Australian mammals. It is noteworthy that the range of variation in the geographically restricted sample from lower South Australia is greater in most items than in the more widely dispersed one from the Centre: a fact which appears to conflict with the belief, for which there seems much justification in other cases, that aridity with its concomitant of instability in ecological conditions, is a potent factor in promoting variability in eremian forms.

Under these circumstances the use of another trinomial to distinguish the Central Australian animal is clearly superfluous and for practical purposes the two groups are here regarded as forming a taxonomic unit.

The wider question of the validity of *B.l. harveyi* as a South and Central Australian subspecies, in relation to the typical *B. l. lesueuri* of Shark Bay and *B. l. grayi* of the Swan River district, is beyond the practical scope of the present work. Although large collections of both the latter are in existence and both have been stated to be variable, no detailed analysis of characters has been published, and

without such the material locally available is inadequate for a decision. Tate (1948, 269) the latest commentator, on a basis of existing accounts, opines *grayi* doubtfully distinct from *lesueuri*, *harveyi* probably more so. Cabrera (1919) held the opposite view.

The following comments, suggested by the results of the foregoing examination, are made as an interim contribution on this head. Recent belief in the distinctness of *grayi* from *harveyi*, seems to be based chiefly on the statement of Wood Jones (*op. cit.* 210) that the Western Australian animal was larger bodied and shorter eared. The comparison from which this conclusion arose, appears to have been made between South Australian animals measured in the flesh and the dimensions of the type as given by Thomas (1888) for the stuffed skin, in which the ear would have been much contracted and the body very probably stretched. The more recent measurements of Shortridge in Thomas (1907) made on animals in the flesh from the Avon district of Western Australia give values for the head and body and tail which are much closer to those of South, Central and north-west Australian specimens, while both ear and pes are actually the longest recorded.

The skull characters of the south-western animal have not hitherto been known with certainty; the specimen O measured by Thomas (1888) is doubtfully localized and gives values which merge almost entirely with those of lower South Australia. The provenance of Waterhouse's specimens is also uncertain. Three skulls from south-west Western Australia which have been examined during the present work, differ from the lower South Australian population in much the same way as the latter do, from that of Central Australia, i.e., there is an average 6% increase in the mean of all dimensions except 3; the greatest being in the rostrum which is noticeably deeper and wider and in the least breadth of nasals. The diastema, inter-orbital constriction and breadth of bulla are slightly lower by 2-3%. Again, however, as in the South-Central Australian comparison there is a very wide overlap in the range of dimensions, which involves 20 of the 23 items studied.

Similar size increases occur in most elements of the dentition and there is a slight increase in hypsodontism especially of P⁴ (Pl. xxviii, fig. K) which is a stouter as well as a higher tooth when unworn; its grooves are 10 in the 2 examples which can be counted—Thomas records up to 14 for the species. The mean for the length of molar rows is not increased but the individual teeth are slightly broader than in South Australian skulls. In matters of proportional development

which can be tested by mensuration, the south-western skull and dentition are closer on the whole to those of lower South Australia than to those of the Centre, but in a small residue of characters an intermediate condition obtains. In the crown area ratios of the molars for example, the upper teeth repeat and accentuate the trend in the lower South Australian series, towards enlargement of the posterior teeth at the expense of the first. But in the lower jaw there is a return to the Central Australian condition. The size sequence formula however, for both upper and lower teeth is the dominant one as it occurs in both South and Central Australia.

One only of the 3 skulls examined is accurately localized; this is a large male at P⁴M⁴, taken at West Popanyinning, 90 m. south-east of Perth (Pl. xxvii, fig. D). Its dimensions are as follows: greatest length, 76.0; basal length, 66.1; zygomatic breadth, 47.4; nasals, length, 31.5; nasals, greatest breadth, 14.5; nasals, least breadth, 6.6; rostrum, depth, 14.8; interorbital constriction, 14.5; palate length, 41.5; palate breadth inside M², 13.0; anterior palatal foramina, 3.9; diastema, 8.6; bulla, 17.0 x 12.5; facial index, 175; mandible, maximum breadth, 44.0; mandible depth below M₃, 11.0; mandible breadth asc. process, 17.6; P⁴ 8.8 x 3.5; Ms¹⁻³ 13.2; P₁ 7.0 x 3.0; Ms₁₋₃ 13.3.

A single skull from Coolgardie, 330 m. east of the Swan River district (in the subarid Goldfields environment) is closer to the means for lower South Australia.

No material of the typical race certainly localized in Shark Bay or the North-West Division of Western Australia, has been examined by the writer, but Shortridge's field measurements (in Thomas, 1907), indicate that the means for Bernier Island specimens are slightly higher than those of Central or South Australia, except for the ear which is equally shortened. Of pelage characters, little can be gleaned except that *fidc* Collett (1897) the apical blanching of the tail is less frequent in adults than in South and Central Australia.

The only detailed skull measurements of this typical form available to me are those of Waterhouse (1846, 205) based on a drawing by Owen and doubtfully comparable with the other data. However, as amplified by Collett and Thomas, it would appear that a very small bulla (considerably below the mean in any other group) exists in a comparatively large skull, and if this ratio is constant, it would provide a valid distinction from the series here studied. Collett

TABLE I
EXTERNAL DIMENSIONS OF THE "RACES" OF *Bettongia lesueurii*

	Head and Body	Tail	Pes	Ear
Lower South Australia. Bisexual 9 at P ⁴ M ⁴ . H.H.F....	286-385 (319)	276-330 (301) ²	97-108 (104)	34-37 (35) ¹
Lake Phillipson ♂. F.W.J.	370	300	105	40
Central Australia. Bisexual 8 at P ⁴ M ⁴ . H.H.F.	315-370 (344)	280-305 (293) ²	96-104 (101)	31-39 (35) ¹
Type of "grayi". Stuffed skin ♂. Recalculated ex Gould.	457	292	108 ³	27.5 ⁴
"grayi", Avon district, W.A. 1 ♂, 1 ♀, ex Shortridge	360-390 (375)	285-310 (297)	108-112 (110)	40-42 (41)
"lesueurii", Bernier Is., W.A. 1 ♂, 1 ♀, ex Shortridge	350-360 (355)	280-300 (290)	102-110 (106)	35-36 (35.5)

¹ From tragoid notch.

² From cloaca.

^{3, 4} Quoted by O. Thomas in *B. M. Catalog.* as 103 and 29 respectively.

mentions also a sagittal crest and a bicuspid canine; the former has not been noted but the latter occurs sparsely in South Australian skulls.

In taking a general view of the inter-relationships of the material reviewed, it is clear that, in cranial and dental characters at least, the three populations of *Bettongia lesueuri* in Central, South, and the south-western portion of Western Australia, form a metrical cline ascending in the sequence named, but with a wide overlap between succeeding groups. At each stage of the transition a few characters may be found to provide examples of lag or even reversion, but abrupt discontinuities, of a kind foreshadowing speciation, are not presented.

***Bettongia penicillata* Gray 1837, subsp.**

DISTRIBUTION AND HABITS: The presence of this species in Central Australia has not hitherto been recorded; Le Souef indeed (1926) expressly excludes it therefrom in his remarks on its distribution.

In 1932, Mrs. D. Bates at Ooldea, drew my attention to an aboriginal myth based on the karpitchi, an animal described as resembling *Caloprymnus* in size and appearance, in sharing also a nestmaking habit, but differing in its black brushed tail. A year later, in the Everard-Musgrave Range district, I learned that the karpitchi was a living entity and known by that name, both to the original Yankunjarra and to the Pitjanjarra, who partly supplanted them from the west. They compared it with the telungoo or metika (*B. lesueuri*), but confirmed the nestmaking and black caudal crest, and knew it as a sparsely occurring animal over a considerable area straddling the South and Central Australian border. In the next two years it was reported from Pundi (the most southerly point, about 85 miles south-west of Ernabella), at Unyaba Hill on the Officer Creek, at Mount Harriett, where a specimen was taken which was kept for a time by a white dogger as a pet, and near Mount Conner, approximately 70 miles west of north of Ernabella, on the Central Australian side. In none of these cases was I able to examine any material, but in the old collections of the South Australian Museum is a specimen taken near Waldana Spring, about 125 miles north-west of Ooldea, and this is the only example of the karpitchi here studied.

The species is also recognized by aborigines from specimens, and substantially similar accounts given of its habits, over large areas of the eastern and north-eastern parts of the Territory, where it has long ceased to exist. In the hill country of Huckitta the Ilyowra called it

indwarriteha; to the Worgaia on the Buchanan and Rankin Creeks it was windijarra, and probably the yelkamin of the mixed Warramunga and Walpari people east of the Murchison and Devonport Hills. North of the Barkly Tableland along the Gulflands both in Queensland and the Northern Territory it is probably still extant, and groups of mixed Alowa and Mara blacks from Tanumbirini and Nutwood, recently gave it the name, yamul. Elsewhere in the north there are but vague accounts of it at Mainoru, at the Katherine and possibly in the Finnis River district; but it may be noted that the vast areas of richly grassed eucalypt savannah south of the Arnhemland plateau, would by analogy with its habitats in the south, provide ideal stations for the species, but for the presence of stock.

In the winter of 1933, Michael Terry, while prospecting on the Western and Central Australian border, observed "spinitex rats" of which he has given some account in his book "Sun and Sand." This account, however, has a three species basis, involving *Lagorchestes asomatus*, *Lagorchestes hirsutus* and *Betlongia penicillata*. Among specimens sent by him to the South Australian Museum is a portion of a skull from an animal taken in July 1933 near the McEwin Hills in the Lake Mackay area about 470 miles north of the Waldana site, and in the sequel this is treated tentatively as a second and markedly distinct eremian phase of *B. penicillata*.

DISTRIBUTION ELSEWHERE IN AUSTRALIA: Much uncertainty prevails as to the former extent of the distribution of *B. penicillata* in Australia, with some conflict in existing accounts. While it is no longer possible to ascertain the full truth, a review of records State by State, will fill in other gaps than the Central and Northern Australian one, and clarify some obscurities.

Western Australia: The work of Shortridge (1910, and in Thomas 1907) and of Glauert (1933, 1950) has made the position clearer here than in the East. The northern record is at Shark Bay, whence it extended in a widening belt to the Pallinup River on the south coast. East of this line it is also accorded some tenure by these authors, but the extent of it is vague and leaves the question of linkage with the south and central populations unsolved. However, the Central Australian records given above are sited in eremian conditions much more severe than those of its presumed eastern frontier in Western Australia and go far to support the existence of such links, if not today, at least in the recent past.

South Australia: The early writings of Gray (1843), Gould (1852), Harvey (1840) and Waterhouse (1841) establish it on lower

Eyre Peninsula, at the head of St. Vincent Gulf and in the Adelaide district. Later, rural tradition following its extirpation, gives it a very wide, if not universal distribution over the southern parts of the State. It is less easy to trace in this way than *B. lesueuri*, however, and was sometimes confused with *Lagorchestes leporoides*, but when both bettongs were known, *B. penicillata* seems to have been the commoner species. Mainland records for South Australia supported by recent material locally available are limited to a few examples in the South Australian Museum (*infra*) which come from the west slopes of Mount Lofty and from Waldana, but sub fossil and native camp site specimens, many of the latter quite recent, confirm its presence in the lower South-East, the Fleurieu Peninsula, Murray Mallee, and Yorke Peninsula.

North of the 32° parallel, there are neither material records nor accounts which can be regarded as free from entanglement with *Lagorchestes*, except those of the Waldana and Musgrave-Everard Range area in the far North-West, noted under Central Australia. The karpitchi legend is not local to Ooldea but derived from visitors from the Musgraves. In spite of this wide hiatus in records in the subarid areas of the State, the Musgrave-Waldana occurrences support the view of a former complete north-south occupation of South Australia, as in the case of *B. lesueuri*, though it cannot be supported by evidence as with that species. At least one, possibly more insular representatives occurred in South Australian waters. A skull of the extinct St. Francis Island bettong has been examined (*infra*) and proves to be a form of *B. penicillata* as predicted by Wood Jones; and the "kangaroo" smaller than a cat, taken by Flinders' party on Flinders Island in 1802 (Cooper 1953) may also be referable to this genus. However, Flinders' accounts of the small macropods of these islands, like those of Baudin, Peron and Ronsard (Cooper 1952) are evidently a blend of *Thylogale eugenii* with smaller forms.

Extirpation of *B. penicillata* in South Australia appears to have followed much the same course as with *B. lesueuri*; the last three examples taken, of which I have been able to get reliable accounts, were at Riverton in the Lower North district in 1908, at Lameroo in the Murray Mallee in the same year and on the Wild Dog Creek in the Fleurieu Peninsula in 1910.

Of the several aboriginal words which have been applied to "kangaroo rats" in lower South Australian vocabularies, only one, the coolgar of Harvey (1840) at Port Lincoln on Eyre Peninsula can

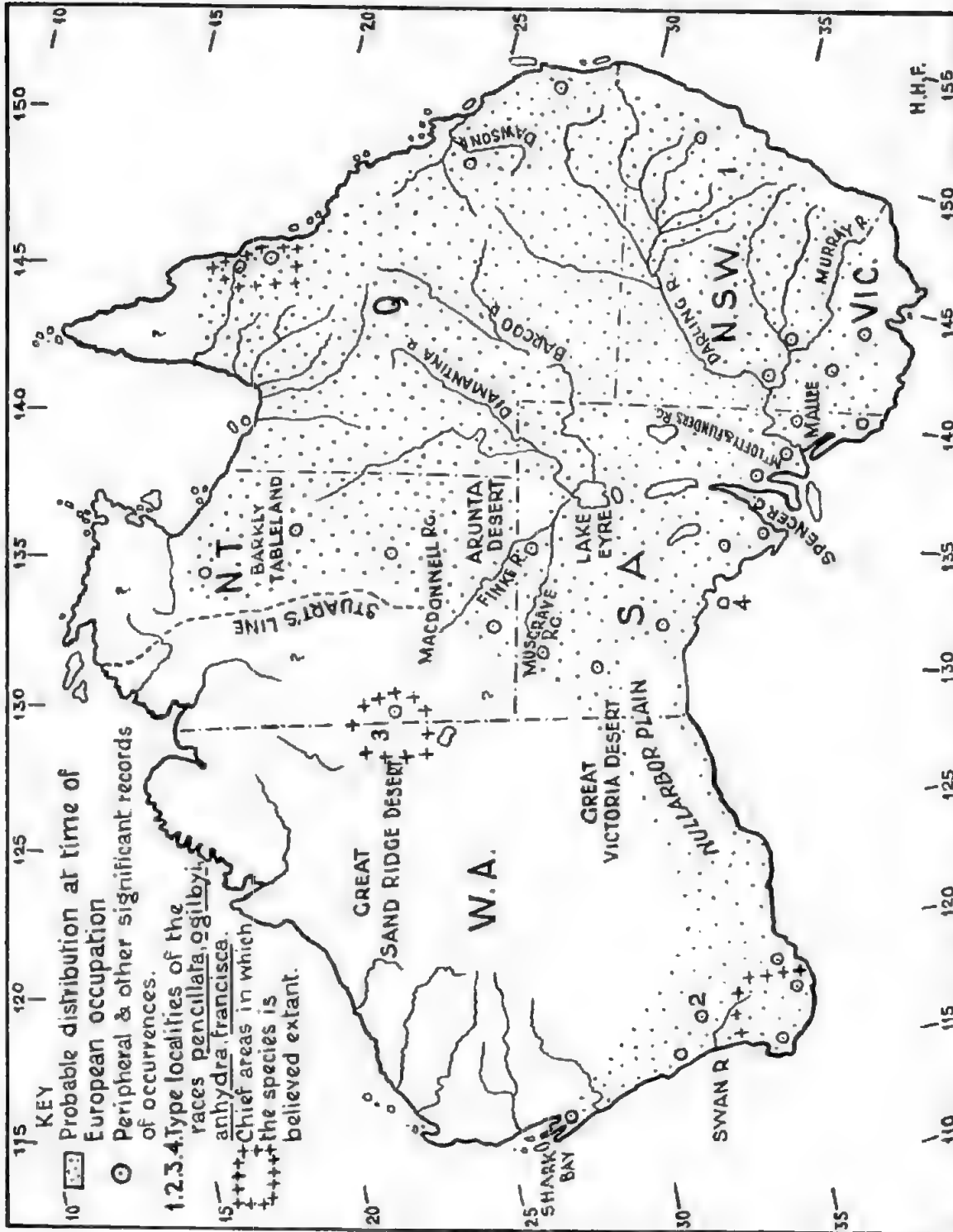


Fig. 2. Map of the distribution of *Bettongia penicillata*. Gray.

be applied with certainty to *B. penicillata*, the animal so-called having been identified by Gould in 1853. This is clearly equivalent to kulka of the later Parnkalla vocabularies of Eyre Peninsula and probably also to koka and kurka of the Kaurna of the Adelaide district. The names bukurra or bokra of Le Brun and Browne's providing, have been linked with *B. ogilbyi* (= *penicillata*) by Johnston (1943) but definitely belong to the burrowing species, *B. lesueurii*.

Victoria: There are several categorical and inclusive statements of the occurrence of *B. penicillata* in Victoria, viz., Forbes Leith and Lucas (1884) and Thomas (1888), but the extent of its occupation is uncertain. Brazenor (in Harper 1945) states that Victorian specimens are in the National Museum, Melbourne, and that the last record was in 1857. Later, however (1950), he omits *B. penicillata* from the list of Victorian mammals and substitutes *B. cuniculus* Ogilby, hitherto regarded as exclusively from Tasmania, where *B. penicillata* does not occur.

I have accounts of a nest building bettong from West Victoria generally in 1854, and the Grampians district in 1910. Nest building would not of course distinguish *B. cuniculus* from *B. penicillata*, but the South Australian populations in the lower South-East and Murray Mallee districts were almost certainly continuous into Victoria, and they are based upon a form with a small rounded extraverted scrotor, quite different from that of *B. cuniculus*.

New South Wales: The chief sources here are Gould and Krefft. The former (1841, 1852) had personal knowledge of it down the course of the Namoi to its junction with the Gwydir and on the adjacent Liverpool Plains. He accorded it also a wide distribution throughout New South Wales except for the coastal slopes of the Divide, where he considered it to be replaced wholly or in part by *gaimadi*, held by some to be a closely related, possibly subspecific form. Krefft (1864) recorded it in western New South Wales on the lower Murray between the Darling junction and Euston, 60 miles south-east, and made the interesting statement that at Gunbower Creek, 150 E. of Euston, it is completely replaced by *Acpyprymus*. He does not mention *B. penicillata* on the Victorian side of the river.

Queensland: The species is not listed for Queensland in any of the earlier accounts, and until quite recently, localized records were limited to the original one at Coomooboolaroo in the Dawson Valley. This was based upon the personal testimony to the writer of Charles Barnard (a well informed naturalist and son of Lamholtz's host), who

contributed largely to the latter's collection. W. Boardman (1943), however, published on an example from Pine Mountains in south-eastern Queensland (Aust. Museum Sydney, No. 1121). Three localities are so named in this area, and which is relevant is not known—a mean position for it is plotted on the distribution map. Tate (1948, 267 and 1952, 592) has given details of seven more in American museums, taken at Mount Spurgeon and Ravenshoe towards the western fall of the Atherton tableland; three of these were taken as late as 1932. Recent enquiry by the writer in the field suggests that it may still survive in the Gulf country of the north-west of the State adjoining the Northern Territory border, though no material is available in support.

The overall range of *B. penicillata* as outlined above, was probably as extensive as that of *B. lesueuri*. While it was absent from a considerable north-western sector occupied by the latter, its eastern and north-eastern extension was much greater, and this, containing the chief highlands of the country, adds much to the total diversity of habitats occupied. The Torresian occurrence is noteworthy as its northern extension nearly equals that of *Aepyprymnus rufescens*, which belongs exclusively to the east coast lands. Thomas' dictum of 1888, on the range of *B. penicillata* "all Australia except the extreme north" seems to have been at that time an expression of opinion rather than an ascertained fact, but in the sequel as developed above, it comes near the truth (fig. 2),

The status of the species is even more insecure than that of *B. lesueuri*. Probably 2/10ths of its former range is now empty of it and it survives only in three widely separated localities of North Queensland, the Western Centre, and the south-west of Western Australia. Its hold in the two former is slight and in the latter alone does there seem much hope of perpetuating it.

HABITS: The sites which furnish the above records present ecological contrasts of an extreme kind. They vary from North Queensland forests under a 50in. rainfall, to spinifex plains on the edge of the Sandridge Desert; from coastal dunes in Western Australia to 5,000ft. plateaux in New South Wales; and from thermal constancy under the monsoon in the north to marked seasonal changes and sharp winters in the south-east. Moreover, versatility in exploiting habitats is shown not only on this regional scale but in the frequently ubiquitous nature of its occurrence in restricted areas. In South Australia it was less selective in this regard than *B. lesueuri*

and occurred in the Mallee and in the higher stringy bark (*Eucalyptus obliqua*) tiers of the ranges, where the latter was rare or absent. On the Fleurieu Peninsula, much favoured nesting sites were the patches of blue gum forest (*Eucalyptus leucoxydon*) with a wiry tussock sedge (*Lepidosperma carphoides*) and sparse herbage on an otherwise rather open floor. At Cuballing in the south-west of Western Australia where in January 1926 I obtained part of the series examined below, a rather similar plant association occurs in Wandoo forest (*Eucalyptus redunca* var. *elata*); but here the terrain is varied with rocky ridges supporting thickets of a prickly shrub, *Dryandra nobilis*.

Nest making appears to be very characteristic of the species and in some form or another is exhibited in all types of country even in the spinifex flats of the Centre. But nests are not the only form of camps used; in Western Australia it is sometimes locally very abundant, as Shortridge records for Pingelly in 1904 and as I found it at Cuballing, where the animal was much more numerous than its nests in the quite restricted areas from which it was flushed. It is probable that at such times a proportion shelter in hollow logs and rock cavities on the *Dryandra* ridges. The type of nest made evidently varies somewhat with locality; Gould's account from New South Wales differing considerably from Gilbert's in the Swan River district of Western Australia. I have seen no examples in South Australia but they are described by those who knew them both here and in western Victoria, as rounded and woven of grass stems and there is no mention of the earth excavation at the base as in New South Wales nor of the use of sticks in place of grass and of a tubular entry porch as in Western Australia.

At Cuballing, those put up in the day time from grassy flats had a characteristic somewhat unwallaby-like gait with the head low, back much arched and the tail not rigidly curved but fluent and with the black brush displayed very conspicuously—it did not seem at all fast, under these conditions. Wood Jones records that it was used in coursing in South Australia under the name "Squeaker"; but this term was also applied in South Australia to a hare wallaby *Lagorchestes leporoides*, whose speed and saltatory powers were exceptional. In the evenings they were constantly about the enclosure at the homestead, and even when invisible could often be located by their soft grunting in the dusk. By means of freshly toasted bread they were enticed up on to the verandahs, where they were not at all abashed by the presence of three people, several cats and a lighted lamp; cats and bettongs were often within a few feet of one another

and neither animal showed the slightest interest in the other's presence. They were taken very easily in a crude form of box trap improvised for the purpose and baited with toast. Indeed it was often easier to get the animals into the trap than to take them out alive, for if less fierce than *B. lesueuri*, they are exceedingly quick and nimble and bite and struggle as the latter does, with remarkable strength. It shares with *B. lesueuri* and with most of the subfamily the phalangoid characteristic of a tender pelage, and large patches of fur and epidermis are easily lost in such encounters. A South Australian observer, M. S. Clark, stated that a local example taken in 1864 showed some slight prehensile power of the tail; I was not able to confirm this with living animals at Cuballing—either in the open or when trapped, but I am not prepared to follow Shortridge (1910, 821) in discounting either its ability, or habit, of carrying grass with the tail for nesting purposes. Gould's positive statements on the matter were apparently based on his own observations and were subsequently confirmed by animals in captivity. Photographic evidence of the same habit in *Potorous tridactylus* is provided by Le Souef (1926, Pl. 54).

Data on reproduction in the field is scanty; a female in my collection taken in July at Augusta in the extreme south-west of Western Australia, had a large furred pouch young of head and body length 210mm. D. L. Serventy (1953-55), who has given an interesting account of his observations in the same district as my own, records large pouch young at the end of March. These two records seem to indicate that the very rapid increase of its populations, which used to occur in Western Australia, were due to the species breeding several times in the year as Krefft (1862) suggested was the case with *B. lesueuri*. Krefft observed only single young in the pouch in New South Wales.

At Cuballing, the living animal was observed to have a strong and somewhat unpleasant smell. No ectoparasites were noted but ova of such were present in the fur.

RECENT MATERIAL OF *B. penicillata* EXAMINED: This is both less plentiful and more diverse than in the case of *B. lesueuri*. 1. For the characters of *B. penicillata ogilbyi* I have relied chiefly on 7 skins and skulls in my own collection, taken at several points in south-west Western Australia and fully authenticated, supplemented by 2 skins and 6 skulls in the South Australian Museum collection and believed to be of local origin. 2. The Waldana karpitchi (*supra*) in alcohol.

3. A markedly dwarfed skull of lower South Australian origin. 4. The holotype of *B. penicillata francisca* Finlayson. 5. The holotype of *B. penicillata anhydra* Finlayson.

Bettongia penicillata ogilbyi Gould

EXTERNAL CHARACTERS: Authentic material illustrating the external characters of the species, is available chiefly from Western Australia, and the following brief review is based on dried material representing 7 individuals from Cuballing, Popanyinning, and Augusta in the south-western district and is provided to parallel that of *B. lesueuri* (supra) and to draw attention to the marked variation in pelage which occurs there.

B. penicillata has been said to be the smallest of the genus, but the material in hand indicates that at comparable dental stages it is as large or larger, than the Central Australian *B. lesueuri*. In life the animal appears slighter and more trimly built than the latter, and its limbs are even more delicate, and tail, pes and ear, are all shorter in comparison to head and body length. The head is narrower, the ear broader at base and the upper lip less developed than in *B. lesueuri*. The mien is bold, alert and impish; characteristic of the genus and differing widely from the prevailing types of physiognomy in the Macropodinae (Pl. xxxi).

The upper margin of the naked tessellate rhinarium is produced upwards and backwards in the centre as a more or less acute spur. The mystacial vibrissae reach 40 mm. in length; the lower rows pale brown or whitish, but the remainder jet black; the genals and supra-orbitals, reaching 37 mm., are also black and less developed than in *B. lesueuri*. Eye lashes are weak, as is general in the subfamily, but crescentic rows of stout bristles (to 15 mm.) are strongly developed on the lower margin of the orbit and less so upon the upper. Of submentals and interramals few have survived undamaged in the material—these are colourless and transparent, and in the latter group, reach 12 mm. only.

The manus is similar in its main features to that of *B. lesueuri* but is somewhat longer and slighter and with longer digits and claws. The second digit is longer in relation to the third than in that species, but the digital formula is the same, and the thickening of the fourth digit is carried still further. The claws are yellowish white, have moderate curvature, are laterally compressed and taper little to the apex, in a superior view. The maximum length of the third claw is

14.5 (as against 11 mm. in *B. lesueuri*); the fourth claw is little inferior to the third. The palmar structures are not well shown. Of brachial vibrissae only the ulnar carpal has been seen; a colourless bristle of 12 mm.

The pes is also more slender than that of *B. lesueuri*, but agrees with it in the hairing of the plantar surfaces, which involves the same areas but is less dense; in this it differs markedly from *B. cuniculus* and *Aepyprymnus*, and also from Waterhouse's plate (1846, Pl. 12, fig. 5), which, however, may be based on an abraded example. The granulation of the sole is finer, averaging 19 per cm., and the colouration of integument and nails, though variable, is generally darker; in the darkest examples the sole is nearly black and the nails dusky brown, in contrast to the pale manus.

DIMENSIONS: Published dimensions of the species appear to have been derived chiefly from processed skins and are for the most part uncorrelated with maturity data; the pes measurements also are partly vitiated by inclusion of the nail.

The following are the conventional measurements in mm. taken in the flesh from two advanced subadult males (P³M³) at Cuballing: head and body, 330, 305; tail, 261, 279; pes, 107, 104; ear, 38, 38. In an adult female (P⁴M⁴), the pes reached 110 mm. The percentage relations to the head and body length in these two subadults, as compared with Central Australian *B. lesueuri* at the same dental stage, are respectively: tail, 79-91 (85), 100-122 (108); pes, 32-34 (33), 35-41 (37); ear, 11-12 (11.5), 13-14 (13.3).

PELAGE: This presents much of importance which does not emerge in existing accounts. In the adult unworn pelage the texture is variable; often crisp or even harsh as in *Aepyprymnus* and quite unlike *B. lesueuri*. Mid-dorsally the main pile of under fur, which is copious, reaches 20 mm., with guard hairs to 32 mm., and the length does not increase much elsewhere. The basal $\frac{3}{4}$ of the under fur is about blackish-plumbeous of Ridgway, followed by a subterminal band of snuff brown deepening to clove brown and black on the points. The guard hairs are profusely developed and the majority reach 26 mm.; the banding is the same as in the underfur, except that a narrow zone of dark brown separates the basal grey from the flattened subterminal segment, which is much lighter in colour, near cinnamon buff. A considerable proportion of guard hairs (much higher than in other species) are black throughout their length and more strongly flattened; they are so numerous as to constitute almost a third pile

reaching 32 mm. in length. The general dorsal colour is a rich grizzled brown near snuff brown and is determined by the admixture of brown, buff and black of the terminal and subterminal bands, the basal grey being entirely excluded from the surface. It is uniform over the head, body and limbs, the tail alone contrasting in darker and richer tones.

The sides are slightly paler; there is no lateral line of buff but a gradual transition to the ventral colour, which is greyish white washed with cream buff; areas of pure white are sometimes present on mid line of belly and throat. The muzzle is brown (near bistre) and not grizzled, the rest of the head like the back. The ear backs are well furred, snuff brown to the base and not grizzled nor darkened at margins and little contrasted with the crown; the inner surface sparsely clothed and somewhat lighter than the backs; the tuft at the tragoid notch, inconspicuous.

The manus and digits are well haired but the nails are not obscured. The colour variable; basally a deep brown, but bleaching irregularly on the surface to grizzled clay colour; the digits pale drab or near white. The pes also well haired and strongly fringed, the terminal bristles on fourth toe reaching 25 mm. but not obscuring the nail; metatarsus and digits usually darker than the manus but varying from bistre to buffy brown and paling proximally to buff; the margins may be either lighter or darker than the dorsum.

The fur of the tail base shares the body colour and length for 30 mm. or so, but is then shortened to 15 mm. and its colour enriched to a red brown (russet to tawny) which may extend over half or more of the dorsal and lateral surface. The fur is then progressively lengthened, darkened, and erected, forming a black or brown-black dorsal crest reaching 30 mm. at the apex. The lateral surfaces are coloured like the dorsum and may or may not contribute to the brush. The ventral surface in adults is always much lighter (cinnamon buff to cream buff) and the hair is bristly and adpressed distally, where scale exposure by abrasion may occur. The hairing and colour of the tail varies considerably, chiefly with age; the blackest and most extensive crests are in subadults, and in such there may be a coextensive blackening of the ventral surface, but never a ventral duplication of the crest.

The chief variations of pelage, which are of a marked kind, are clearly age characters and independent of sex and season. In subadults as late as the P³M³ stage, which may be almost full grown, the

coat is softer and looser in texture, and the overlay of guard hairs and the resulting grizzling much reduced. The subterminal band of the underfur pales to olive buff or buffy brown and of the guard hairs, to ivory or near white and the pale basal grey shows through to the surface—the resulting dorsal colour being a weak grey brown or drab. A fully furred pouch young (head and body ca. 210 mm.) shows a smooth adpressed coat about 13 mm. long dorsally, with a colour scheme similar to the adults, but even darker and richer.

The adult pelage of this Western Australian series as given above is notably different from other bettongs I have examined—darker, browner, and with less contrast between the subterminal band and the external colour. The darkest examples are quite close to the pelage of *Potorous tridactylus*. In subadults the difference is less and skins of all species which have been immersed for long periods in saline preservatives may justify Thomas' phrase "not definitely different."

The hair tracts in the above pouch young are in substantial agreement with Boardman's figures (1943, fig. 17 and 18) except in the vicinity of the eye. Here a strongly conspicillate effect is produced by radial tracts from its margins interrupting the general caudad flow on the face; that from the anterior canthus is a direct reversal of considerable extent and is marked off by strongly developed opposition ridges. On the tail, the distal flow of the lateral surfaces has an upward inflection, and the mid dorsal tract which is strictly distal, is separated from it by converging ridges; a similar condition occurs in *Caloprymnus* at the same stage. In adults the condition in *penicillata* is much as in *lesueuri*.

CRANIAL CHARACTERS (Pl. xxix, fig. A-F): The treatment of cranial and dental characters is made to cover some areas of conflict in existing accounts and to supplement these where possible and is chiefly based on a series of 14 skulls, drawn in equal proportion from south-west Western Australia and from lower South Australia. A preliminary comparison (infra) having shown it to be sufficiently homogeneous for treatment at subspecies level, I regard it as representing *B. penicillata ogilbyi* Gould, and use it as a standard for the definition of other forms. The comparisons made are with *B. lesueuri* unless otherwise stated, and where metrical, with the means of the three populations of that species studied (supra). Individual variation both metrical and nonmetrical is considerable, but much less than in *B. lesueuri*; the mean variation for 24 cranial measurements being 10 per cent.

In general form the skull is close to that of *B. cuniculus*. When fully adult it is longer than in *B. lesueuri* but narrower and shallower, so that the overall size as measured by the displacement volume (54 cc.) is scarcely greater than in Central Australian *B. lesueuri*. The ossification is lighter, and the surfaces smooth, with muscular impressions reduced; mean adult weight 16 g.

The chief regional difference is in the rostrum which is longer, yielding a rostral index of 43 and facial index of 226 as against 36 and 178 respectively; it is also relatively wide and deep basally and forms a steeply tapering cone without the lateral constriction or dorsal flattening of *B. lesueuri*. The nasal bones are both actually and relative to skull length, longer and narrower posteriorly, but their shape varies, partly at least as an age character. In subadults the posterior margins are often sinuous and irregular and invaded by spurs from the frontals and the lateral are suddenly constricted at the maxillo-premaxillary suture, giving shapes like some of the *B. lesueuri* variants. In adult and aged skulls the posterior margins are transverse and nearly rectilinear and are well in advance of the interorbital line; the junction is sharply angular with the lateral margin which converges evenly to the anterior nares, where it is suddenly constricted to a sharp apex, over-reaching the gnathion anteriorly—a condition different from any phase of *B. lesueuri*. The zygomatic arches are shorter as well as narrower, with the maximum width posterior to mid point, rarely anterior to it; the interorbital space wider, less concave and virtually unconstricted throughout life, an incipient post-orbital process impressed on their edges, and the temporal ridges scarcely evident before the tooth change, and always weak. The interparietal is variable, similar to *B. lesueuri* when present, but sometimes not developed or very early fusing with the parietals.

In lateral aspect, the premaxillae make a larger contribution to the wall of the rostrum, their nasal suture equal to or greater than, the maxillary; malar much weaker, its median depth but half that of *B. lesueuri*; the supratympanic canal is not completed by bone and the squamosal-frontal contact at the pterion, is invariable.

The palate is longer and wider than in *B. lesueuri* and differently shaped owing to the extraversion of the secutor and anterior divergence of tooth rows. The anterior palatal foramina are variable, with dimensions overlapping those of *B. lesueuri*, but yielding means above the Central Australian and about equal to the lower South Australian population of that species. The posterior vacuities vary both

in size and site, but in general are smaller and usually lie entirely within the palatine bone, whereas in *B. lesueuri* they are bounded anteriorly by the maxilla. The diastema is the longest in the genus, averaging 20 per cent of the basal length. The alisphenoid bulla is much smaller, its chief diameter relative to basal length being 25% lower; it is still, however, a prominent feature, quite similar in general shape, and in size, the second in the subfamily; it is not transparent as stated by Thomas, unless very greasy.

The mandible is slighter throughout, with most dimensions 10-15% below the *B. lesueuri* means, the diastema alone being longer. The lower border is less convex, the ascending process less erect, and the masseteric foramen, though variable, usually decidedly smaller.

Sexual differentiation cannot be adequately assessed, but is apparently slight, the female as large as the male. Age changes slight but more definite than in *B. lesueuri* and chiefly shown by the shorter rostrum and relatively wider nasals in the subadult skull and a lag in the expansion of the bulla and mandibular condyle.

DIMENSIONS: The following figures give the range and mean of skull dimensions in mm. for (1) 5 adults at P¹M¹, of both sexes; and (2) 5 subadults at P³M³ of both sexes: greatest length, 76.8-81.0 (78.3), 70.5-74.5 (72.4); basal length, 64.5-68.5 (66.1), 59.8-62.8 (61.1); zygomatic breadth, 39.6-42.7 (41.4), 38.7-40.1 (39.4); nasals length, 31.0-32.6 (31.8), 27.5-30.5 (28.9); nasals, greatest breadth, 12.0-14.3 (13.3), 13.0-13.7 (13.4); nasals, least breadth, 6.3-7.9 (7.3), 6.2-6.8 (6.5); rostrum depth, 14.3-15.9 (14.9), 12.6-15.0 (14.0); interorbital constriction, 16.8-18.4 (17.7), 16.3-18.0 (17.3); palate length, 42.0-45.4 (43.8), 38.5-41.4 (39.8); palate breadth inside M², 12.0-13.2 (12.4), 10.8-12.4 (11.8); ant. palatal foramina, 2.9-4.0 (3.4), 2.5-3.2 (2.9); diastema, 12.7-14.0 (13.5), 12.0-13.7 (12.7); bulla length, 13.8-15.0 (14.4), 12.8-14.2 (13.3); bulla breadth, 9.6-10.1 (9.9), 8.2-9.1 (8.5); basicranial axis, 19.2-22.3 (20.5), 18.3-20.0 (19.0); basifacial axis, 45.2-47.5 (46.2), 41.1-43.6 (42.5); facial index, 213-236 (226), 210-237 (224); mandible, maximum breadth, 38.5-43.0 (40.3), 35.9-39.1 (37.8); depth of ramus below M², 8.9-9.8 (9.2), 8.0-9.0 (8.4); breadth ascending process, 11.6-13.6 (12.7), 10.2-12.0 (11.3).

The series contains larger examples than have hitherto been recorded.

DENTITION (Pl. xxx, fig. A-J and O): The dentition is similar to that of *B. lesueuri* but less specialized and with a greater residuum of phalangeroid characters; it was regarded by Bensley as directly

linking the genus with *Hypsiprymnodon*. In most categories the dimensions overlap those of the Central Australian series of *B. lesueuri*, but are decidedly below the means of the three populations of that species reviewed above, and there is a general tendency to narrowness and slightness, though there are one or two exceptions to that. The mean variation in dimensions of functionally stable teeth is slightly lower (14%). In the following account the comparison throughout is with *B. lesueuri* unless otherwise stated.

The incisor rows meet at a narrower angle and are more separate from the canine. I^1 is a smaller tooth, rather less upright, and with its labial face lateral throughout life. Dorso ventral height 5.5-6.4 (5.8); anteroposterior length 2.2-2.5 (2.3). I^2 much narrower and with its anteroposterior length about equal to that of I^1 , not notably longer as might be inferred from Bensley's comparison with *Hypsiprymnodon*; it is the first of the prediastemal series to erupt; anteroposterior length 2.3-3.0 (2.5); transverse breadth 1.6-1.9 (1.8). I^3 with its crest more normally aligned in the incisor row; its shape much as in *B. lesueuri* and with similar changes with wear; dorso ventral height 2.8-3.7 (3.2); anteroposterior length 1.9-3.0 (2.4). The labial face of all three incisors is longitudinally grooved more frequently than in *B. lesueuri*, but there is much variation—fig. A shows a strongly grooved phase of I^1 and I^3 . I^4 longer and more slender, with a greater tendency to slight upward curvature weakly suggestive of *Petaurus* and *Distoechurus* in the Phalangeridae; anteroposterior length 11.4-14.5 (12.7); breadth 3.0-3.3 (3.1).

The canine is a larger tooth, showing similar variation in shape; dorsoventral height 4.5-4.8 (4.7).

Dental differences between *B. lesueuri* and *B. penicillata* culminate in the permanent premolars, the two species representing in this feature the extremes of specialization and conservatism, within the genus. The chief distinctions of P^4 in the latter are its smaller size, hypsodontism, and extraversion of its axis, and convexity of crest anteriorly.

In the present series, while the angle of rotation is fairly constant, the degree to which the posterior portion of the blade abstains, varies. The body of the tooth, however, is always decidedly curved, its outlines as seen from above following a shallow sigmoid, with a constriction at the posterior one-fifth and maximum breadth at the anterior one-third of its length. A posterointernal talon is always developed, but is quickly reduced by wear; an internal ledge scarcely

differentiated. In profile the unworn crest undulates; an anterior rounded and grooved portion, and a smooth posterior cusp, being separated by a shallow declivity, but equality of height is soon attained by wear. In contrast, the enamel wall of the crown is nearly twice as high anteriorly as posteriorly; its grooves are constantly seven on the buccal wall and are either vertical or converge to the centre of the crest; they are generally wider than in *B. lesueuri*. In unworn or slightly worn examples, anteroposterior length 7.0-7.4 (7.1); breadth 2.8-3.2 (3.0); height (of enamel) 4.3-4.6 (4.4).

The lower secator P_1 is simpler than its opponent, 10% shorter but with breadth and height slightly greater, relatively; extraversion of its axis is even throughout its length; its outline from above almost straight sided, with the greatest breadth near the anterior one-third; no talon is developed. The profile of the crest is quite straight and the enamel of the wall higher anteriorly; grooves constantly seven; anteroposterior length 6.2-6.7 (6.4); breadth 2.7-3.0 (2.9); height (of enamel) 4.1-4.3 (4.2).

P^3 is very much smaller than the secator, but generally similar to the anterior half of that tooth; evenly rotated outwards and with its maximum breadth median and its outline from above oval except for a re-entrance at the posterointernal corner; the profile of its crest straight or at most very slightly rounded; its enamel wall as in the secator; grooves constantly five. In the skull of a pouch young, the crest of P^3 which is erupting, shows no extraversion, but lies parallel to the midline of the palate; anteroposterior length 4.0-4.6 (4.4); breadth 2.4-2.7 (2.6); height of enamel 3.5-4.3 (4.0). P_2 similar to its opponent, scarcely reduced, but more evenly oval; grooves five; anteroposterior length 3.7-4.1 (4.0); breadth 2.5-2.7 (2.5); height of enamel 3.5-4.4 (3.9).

The upper deciduous premolar MP^1 is similar to that of *B. lesueuri*, but smaller; markedly smaller than M^3 ; the blade of the anteroexternal cusp is less developed and its crest more oblique to that of P^3 . It is the first of the cheek teeth to erupt, its appearance synchronising with I^2 and preceding P^3 . Its lower opponent MP_1 is also smaller, but with its anterior lobe relatively wider than in *B. lesueuri*; the crest of the anterointernal cusp is obscurely notched on its outer surface, and meets that of P_2 more directly than in the upper tooth. Dimensions of seven examples of MP^1 and MP_1 , respectively, showing slight to moderate wear are: anteroposterior length 3.0-3.6

(3.3); 2.8-3.5 (3.0); breadth anterior lobe 2.6-2.8 (2.7); 2.0-2.5 (2.3); breadth posterior lobe 3.0-3.3 (3.1); 2.4-2.7 (2.5).

The molar rows, which in relation to skull length are the shortest in the genus, diverge anteriorly in straight lines. The *absolute* size range of all molars as shown by the crown areas overlap the minimum for the combined *B. lesueuri* groups, but the means are decidedly lower (from 4 to 19%), the inferiority being greater in the second and third of both upper and lower series.

The interrelations of crown areas are generally similar to those of *B. lesueuri*, but there is an increase in the *relative* size of the first molars, both upper and lower, and a decrease in the second and third. In the upper jaw this creates a tendency towards subequality of M^1 and M^2 and in the lower jaw to dominance of M_1 over M_3 , both conditions being rare or of minor frequency in *B. lesueuri* and quite absent in *B. cuniculus* where the latter condition is excluded by a characteristic enlargement of M_3 . The index of reduction or ratio of largest to smallest molar, is lower (less steep) than in *B. lesueuri*, the mean values for the upper and lower series respectively being 2.9 and 2.0 as against 3.3 and 2.3 in the latter. The molar formulae and their approximate frequencies and the percentage relation of the crown areas of individual teeth to the corresponding first molars, is as follows: in the upper jaw $M^2 > M^1 > M^3 > M^4$ 50% $M^1 > M^2$ 42% $M^1 = M^2$ 8%; M^3 and M^4 being constant in the sequence; and M^1 100; M^2 90-107 (99); M^3 70-80 (75); M^4 26-43 (36). In the lower jaw $M_2 > M_1 > M_3 > M_4$ 83%; $M_1 = M_3$ 8%; $M_3 > M_1$ 9%; M_2 and M_4 being constant; and M_1 100; M_2 107-120 (113); M_3 90-103 (96); M_4 48-70 (56).

The size and shape relationships of the corresponding upper and lower molars and their variations, and the relation of anterior to posterior lobe, are much as in *B. lesueuri*; the breadth/length ratio tends to be slightly lower than the *B. lesueuri* means in the upper teeth, and slightly higher in the mandibular set.

The range and mean of the anteroposterior length, breadth anterior lobe, and breadth posterior lobe in the molars of the bisexual series of eleven skulls is as follows:— M^1 3.7-4.2 (4.0); 3.5-4.4 (3.9); 3.7-4.3 (4.0). M^2 3.6-4.5 (4.0); 3.8-4.4 (4.0); 3.5-4.2 (3.8). M^3 3.5-4.0 (3.7); 3.2-3.8 (3.6); 2.7-3.2 (3.0). M^4 2.2-3.0 (2.5); 2.0-2.9 (2.5); 1.7-2.3 (1.9). M_s^{1-3} length in situ. 11.0-12.7 (11.8). M_1 3.5-4.0 (3.7); 3.2-3.7 (3.5); 3.5-4.1 (3.6). M_2 3.8-4.2 (4.0); 3.7-4.1 (3.9); 3.6-4.0 (3.8). M_3 3.5-3.9 (3.7); 3.5-4.0 (3.7); 3.2-3.7 (3.4). M_4 2.7-3.5 (3.0);

2.7-3.2 (3.0); 2.7-3.2 (3.0); 2.1-2.7 (2.3). Ms_{1-3} length in situ, 11.1-12.5 (11.5).

The crown pattern of the molars is very similar to that of *B. lesueuri*, but with the cusps and lophs lower and less prominent. An accessory cuspule originating at cingulum level on the buccal wall of M^1 and M^2 and sealing that aspect of the median valley, is developed in about half the series, and more rarely appears on MP^4 and M^3 ; the analogous feature on the lower molars, mentioned by Bensley, has not been traced. M^4_1 are somewhat less variable than in *B. lesueuri* and simulate more or less crudely the main structural features of M^3_2 .

The series affords no example of the tooth change, but the eruption of P^4_1 may be delayed beyond that of M^4_1 ; this, however, is as likely to be due to precocity of M^4_1 as to retarded secators, as it occurs in skulls still metrically and suturally subadult. There is no instance in this series of the secator preceding the 4th molar as is frequent in *B. lesueuri* and *B. cuniculus*, so that, on the whole, a later tooth change seems indicated for *B. penicillata*.

SUBSPECIFIC DIFFERENTIATION IN *Bellongia penicillata*.

B. penicillata ogilbyi, Gould: The western representative of *B. penicillata* in the Swan River districts was early separated by Gould and Waterhouse (1841) from the type of New South Wales, as a full species under the name *B. ogilbyi*; while a single immature skin from South Australia, was made the type of a third species, *B. gouldi*, by Gray in 1843. Later examination of more material from all three localities revealed much local variation and overlapping, and Thomas in 1888 merged both names in *B. penicillata* Gray 1837, and it is only in recent years that they have reappeared in subspecific form, without, so far as I can ascertain, any new evidence in support of this course, being adduced.

I have examined no material certainly localized in New South Wales, but the local variation in south-west Western Australia outlined above is sufficiently wide to vitiate most of the pelage distinctions claimed for the eastern animal and the metrical differences implied by Waterhouse's and Gould's data, are not significant when compared with the range in the present series except possibly for the secator, which is confirmed by Tate for North Queensland (1948 *op. cit.*, 267). The eastern animal would appear to be very weakly differentiated, with at most a slightly greyer pelage, occasionally longer secator, and possibly some slight differences in nidification.

The South Australian animal, so far as it can be understood from material available here, is even less distinct from the western one. In the South Australian Museum are two skins and six skulls which although without reliable data, are probably of local origin; two of the skulls almost certainly so. A close and detailed comparison of the cranial and dental characters of these skulls with Western Australian material from the south-western districts only, discloses slight average differences of which the following are the chief. (1) The rostrum tends to be slighter in the South Australian skull. (2) The zygomatic process of the squamosal is also slighter, more concave above and the adjoining squamosal more inflated. (3) In the mandible the mandibular foramen is often larger. (4) The antemolar teeth are virtually identical, but in the molars the condition $M^1 > M^2$ is twice as frequent in the South as in the Western Australian group. The variation in all characters is high and this with the inadequacy of the samples, casts doubt on the significance of the differences, which in any case are somewhat less than those separating the Central and South Australian populations of *B. lesueuri*. The overall similarity of the two samples from localities so remote is much more impressive. The two South Australian skins present no characters which cannot be reconciled with the Western Australian range.

These findings appear to me to justify and confirm the clear statements of Gould and Waterhouse (*op. cit.*), often overlooked, that "*B. ogilbyi*" of the Swan River districts, also occurred with very slight modification in the State of South Australia, and if Krefft (1864) is right, extended far beyond it, into the lower Darling Basin of New South Wales.

The Waldana karpitchi: This was taken about 1897 by R. T. Maurice at Waldana Spring on one of the preliminary journeys which culminated in his traverse with Murray from Fowler's Bay to the Cambridge Gulf, in 1902. The locality is about 125 miles north-west of Ooldea in the arid western division of South Australia, and about 100 miles south of Pundi, whence came the most southerly of the reports I had of it from the Pitjanjarra in 1934. Maurice mentions having seen "kangaroo rats" in some plenty both south and north of Waldana, but what species are involved in this observation is doubtful.

The specimen (South Australian Museum, registered number M.4140) is an alcohol preserved female pouch young having the dimensions: head and body, 173; tail, 190; pes, 78; ear, 28. The pelage in its present condition is paler and more grizzled than is usual in *B. penicillata ogilbyi*, but it is a moot point how much of this is

due to bleaching during the 60 years of its partial immersion in spirit. The colour distribution on manus, pes and tail is quite as in *ogilbyi*; the tail darkening rapidly distally and forming a low but distinct black brush over the terminal third. The skull (greatest length 46.6 mm.) is functionally edentulous or nearly so, but I¹ and I² and the third and milk premolars of both jaws are sufficiently advanced for examination of their crowns after removal of soft tissue.

This is the only fleshed specimen of *B. penicillata* from an eremian district which I have examined and it is unfortunate that its immaturity and storage history render a full appraisal, at subspecies level, impracticable. In essentials it is reconcilable with the standard *ogilbyi* series reviewed and is quite distinct cranially from the form *anhadra* from 470 miles further north.

No skull of *B. penicillata ogilbyi*, strictly matched dentally with the Waldana specimen, has been available for comparison, and growth changes in the skull are so rapid at this stage, that differences between individuals are of doubtful significance. Nevertheless it seems questionable to me whether the Waldana skull at dental maturity would have attained to either the maximum length or relative rostral development of full scale *ogilbyi* and the length of MP¹, which is the most advanced of the teeth and appears to be fully formed, is below the mean of the standard series (2.9 cf. 3.3 mm.). If these three differences were realized in the adult it would suggest affinity with the small skulls next considered, with taxonomic implications which are there indicated.

“*B. penicillata gouldi*” Gray: The type of Gray’s *Bettongia gouldi* was a small skin without skull believed to be immature, but the second specimen reviewed by Waterhouse (1846, 22, Pl. 6, fig. 1) in the same connection was an adult skull of very small size. The present material includes a very similar skull, which, though not formally localized, may be inferred from associated material and other evidence to be from the western slopes of Mount Lofty; this has been closely compared with the standard *B. penicillata ogilbyi* series with the following results.

It is an advanced subadult at P³M³, and remarkably small in the relevant age group of *ogilbyi*; 18 of 23 linear dimensions studied falling below the range of these, with an average difference from the mean of —13%; its displacement volume is only 60% of that of *B.p. ogilbyi*. Differences in proportional development (shown by the percentage relationships of dimensions to the basal length) exceed

5% in 10 items; the chief changes being in anterior palatal foramina, length of bulla, breadth and depth of mandible (+8 to 12%) and palatal breadth and facial index (-12 and -11% respectively). Laterality in the posterior structures of the mandible is especially noticeable, the transverse breadth of condyle being +14%; the mandibular foramen of the same region, is both actually and relatively the widest in the series; otherwise nonmetrical differences are absent and the general appearance of the skull normal for *ogilbyi*.

The dentition as a whole is proportionately reduced, with, however, a slightly narrower I^3 and slightly stouter P_3^3 . The crown area sequences and percentage ratios are: M^2 103 > M^1 100 > M^3 73 and M_2 113 > M_1 100 = M_3 100 and the index of reduction (three teeth only) is 1.4 (upper) and 1.1 (lower); these size relations can all be closely matched in the standard series of *ogilbyi*.

The dimensions of this skull are:—greatest length 62.5; basal length 52.5; zygomatic breadth 36.0; nasals length 23.5; nasals greatest breadth 10.5; nasals least breadth 5.8; rostrum depth 12.0; interorbital constriction 14.5; palate length 32.8; palate breadth inside M^2 9.0; anterior palatal foramina 2.8; diastema 10.8; bulla 12.4 x 7.3; basiscranial axis 17.5; basifacial axis 35.0; facial index 200; mandible: maximum breadth 36.2; depth below M_2 8.2; breadth ascending process 10.6; breadth of condyle 4.8. Ms_{1-3} 9.7. Ms_{1-4} 9.6. P^3 and P_3 respectively; length 3.5; 3.3 breadth 2.5; 2.5 grooves 5; 5. The agreement with the older skull of Waterhouse, so far as it can be studied from his account, is very close. The palatal length given by Waterhouse (11 lines) is evidently a typographical error.

The general level of differentiation reached by these small skulls is quite appreciable and is distinctly greater for example than that shown by the South as compared with the Western Australian moieties of the *ogilbyi* series used as a standard. But though they are by no means mere miniatures of the *B. p. ogilbyi* skull, their taxonomic recognition raises biological objections and seems to me contraindicated. On the one hand, to treat them as representing a subspecies of *B. penicillata*, existing in very small numbers side by side with *B. p. ogilbyi* at widely separated points, is to violate the chief principle held to underlie the equilibrium between geographic races, by attributing to it a reproductive isolation which should not exist at subspecific level. On the other hand to treat them as representing a full species is clearly unjustifiable on morphological grounds.

The alternative is to regard them, as Waterhouse suggested, as dwarfed examples of *ogilbyi* owing their distinctions to individual and physiological rather than genetic causes. This is supported by the existence in the same region of similar though less marked dwarfism in the allied species *lesueuri*, where subspecific distinction could not be seriously considered. Dwarfism and gigantism within species of Australian mammals, especially under eremian conditions, offers an interesting field for the study of changes in proportional development with changing body size. The amplitude of the size difference in material otherwise strictly homogeneous at subspecies level, is often astonishing, as shown for example by Spencer (1896, 25) and Wood Jones (1923a, 106) for *Dasycerus* and which I have confirmed in the subspecies *hillieri* of the Lake Eyre Basin (1933), and in *Rattus villosissimus*.

"*B. gouldi*" as a form (either specific or subspecific) occurring between the head of Gulf St. Vincent and Mount Lofty in territory densely occupied by *B. p. ogilbyi*, under a 20-30 inch rainfall, is difficult to accept. But the case might be different if these localities were erroneous and the material were derived from further north. It might well then represent a subspecific eremian offshoot of *ogilbyi*, to which the Waldana specimen from 600 miles north-west of the head of the Gulf, should be referred.

In the absence of this evidence, I am confirmed in the rejection of these dwarf skulls from lower South Australia as representing a distinct race or species (whether "*B. gouldi*" or not) by the existence of two others in which the distinction of even smaller size, is reinforced by structural changes of a much more decided kind, and by adequate geographical isolation.

Bettongia penicillata francisca Finlayson, 1957: This form was based upon a portion of a skull in the old collections of the South Australian Museum (Registered number M. 5484), which came from St. Francis Island, Nuyt's Archipelago, off the Eyre Peninsula coast of South Australia in approximately 32° 35' S. lat. and 133° 20' E. longt.; no other details of its provenance are recorded.

The specimen lacks the occiput, nasals and mandible, but has a complete adult maxillary dentition, together with the two first incisors and I² of the right side. The dimensions available suggest a complete skull of about the same size as the Mount Lofty dwarf in its present subadult condition. As compared with *B. penicillata ogilbyi*

of the adjacent mainland, the rostrum, while normal in shape, is probably reduced in relative length though the rostral index cannot be determined. The interorbital breadth and breadth of palate are relatively greater, and the anterior palatal foramina longer.

The incisors are worn and damaged and little of differential value can be inferred from them, but the premolars and molars are well preserved, though the crowns of the latter show heavy wear. The secator, P⁴ (Pl. xxx, fig. M and N) conforms in a general way to that of *penicillata s. lat.* in its long axis being rotated outwards from the midline of the palate; in the wall of the crown, being twice as high anteriorly as posteriorly; and in the broad grooves. It differs from *B. p. ogilbyi* in the extraversion of the axis being less in degree and more even in mode, with less torsion of the crest; in reduction of the grooves from seven to six and in its greater breadth. The last distinction is critical; while the length of the tooth is reduced by nearly 20% as compared with the means for *ogilbyi* its breadth is actually increased by 6%, leading to a breadth/length ratio of .55 as against .42. The general appearance of the secator is similar to P³ of *ogilbyi*, but it differs in its distinct posterointernal talon and much greater bulk, which is 2½ times that of P³ in the Mount Lofty dwarf of the same cranial size.

The crown areas of all the molars (Pl. xxx, fig. N) are below the range for *ogilbyi*; the reduction being much less on M¹ and M² than on M³ and M⁴. The percentage size ratios calculated from the crown areas are: M² 105 > M¹ 100 > M³ 68 > M⁴ 24, yielding an index of reduction of 4.4 as against a maximum of 3.8 in *ogilbyi*.

DIMENSIONS: interorbital breadth, 15.0; palatal length, 34.5; palatal breadth inside M², 11.2; anterior palatal foramen, 3.2; Ms.¹⁻³, 10.4; P¹ length, 5.8; P⁴ breadth, 3.2.

The former presence of this bettong on St. Francis Island was recorded by Wood Jones (1923b), who inferred from the descriptions of those who had known it in life, that it represented *penicillata*. The external characters are otherwise unknown, and the present fragment, as far as I am aware, is the only material relic of the animal, which is believed to have become extinct some 70 years ago.

Bettongia penicillata anhydra Finlayson 1957: The type and only known specimen of this form, is a part skull with mandible (South Australian Museum, registered number M. 3582) from an animal in the flesh collected by M. Terry in July 1933 near the McEwin Hills

of the Lake Mackay area of Central Australia, in approximately 22° 2' S. lat. and 129° 47' E. longt. The external characters are not known with sufficient precision for recording.

The skull (Pl. xxix, fig. G and H) lacks the occiput, basioccipital and posterior portion of the bullae but has a complete mandible. Suturally and dentally it is fully adult but not aged, and the dentition which is complete, shows moderate wear. In general size it is inferior to *francisca* and is the smallest skull of the genus yet examined; its estimated displacement volume being 34 cc. approx. as against a mean value of 54 cc. in the standard series of *B. penicillata ogilbyi* and 53 cc. for the Central Australian *B. lesueuri*. In absolute dimensions, 17 of the 19 items tested fall below the minimum for *ogilbyi* with an average difference from the means of 20%. Proportional development as determined by the percentage relation of dimensions to the length, disclose a high order of distinction from *ogilbyi*, the mean difference in this category being 11%. The chief proportional changes are: zygomatic breadth + 13%; interorbital constriction - 13%; diastema - 24%; breadth of bulla + 25%; depth of mandibular ramus + 17%; breadth of ascending process + 26%. In addition the rostrum is much shortened, the rostral index falling to 34 as against 43 in *ogilbyi*.

Some of these changes indicate convergence towards *B. lesueuri*, but especially characteristic are the following: the narrowness and general weakness of the muzzle region; the narrowness of the nasals; the very short anterior palatal foramina and a strongly developed interorbital constriction, unique in the genus. The braincase is relative narrow and more tapered anteriorly than in either *B. lesueuri* of Central Australia or *B. penicillata ogilbyi* and the temporal crests, which are strongly developed, are differently disposed towards the midline. In the mandible, the proportions of coronoid, ascending process and mandibular foramen are nearer *B. lesueuri*, and the relative depth of the body of the ramus is actually greater than in that form.

In the dentition, the incisors show characters of both species, I² being broader than is usual in *B. penicillata ogilbyi* and I³ lacking the inturning of the crest, seen in *B. lesueuri*. The secator, P⁴ (Pl. xxx, fig. L and K) is actually longer and as broad as in the much larger *ogilbyi* skull, but its height is about 10% less and is more evenly distributed along its length. It shows many of the fundamental characters of the *B. penicillata* secator and in extraversion of its axis and torsion of crest is intermediate between *B. p. ogilbyi* and *B. p.*

francisca; its grooves are wide and seven or eight in number. Morphologically the tooth differs widely from its *B. lesueuri* analogue, in its relatively greater breadth; greater anterior height yielding a height/length ratio of .47 as against a mean of .42 in Central Australian *B. lesueuri*; and in the extraversion and torsion of its crest, which are not remotely approached by any specimen of *B. lesueuri* in the three populations studied, in which a straight crest and distinct introversion are invariable. The outturning of the lower tooth P₁ is less marked; its crest is straight and its grooves are reduced to seven.

The length of the molar rows *in situ*, and the crown areas of all the molars individually, are below the minima for *B. penicillata ogilbyi*. The reduction, as in *B. p. francisca*, is least on the first and second molars, and greatest on the third and fourth, but the colateral disparity between these pairs is even greater, and the fourth molars are extremely small teeth. M¹ on the other hand is particularly large and broad as in *ogilbyi*. These changes lead to an unprecedentedly high index of reduction (greatest crown area/least) in both upper and lower jaw as follows: *B. p. anhydra* 6.5 upper, 4.2 lower; ⁽¹⁾ *Central Australian B. lesueuri*, 1.9-5.1 (3.3), 1.5-3.2 (2.3); and *B. p. ogilbyi*, 2.4-3.8 (2.9), 1.7-2.3 (2.0). The size sequence of the molars and the approximate percentage relation to the first molar, as gauged by the crown areas, are: M¹ 100 > M² 94 > M³ 62 > M⁴ 15 and M₁ 108 > M₂ 81 > M₃ 26; these sequences occur in both *B. penicillata* and *B. lesueuri*, but are more frequent in the former. The upper molar rows are slightly curved and there are no supernumerary cusps on the anterior members. Dimensions: greatest length, 62.1; zygomatic breadth, 37.4; nasals, length, 23.7; nasals, greatest breadth, 9.5; depth of rostrum, 11.6; interorbital constriction, 12.2; palate length, 32.5; palate, breadth inside M², 9.4; anterior palatal foramina, 2.4; diastema, 8.0; bulla, anterior breadth, 10.4; mandible, depth below M₂, 8.7; breadth of ascending process, 13.3; P⁴ and P₂ respectively, length 7.5, 6.4, breadth 3.0, 2.8; Ms.¹⁻³, 10.5; Ms.₁₋₁₁, 10.2; I¹ dorsoventral height 5.3; anteroposterior length 2.1; I² anteroposterior length, 2.5; transverse breadth, 1.8; I³ dorsoventral height, 2.6; anteroposterior length, 2.2.

As stated in the original description, this skull presents a blend of the characters of *B. lesueuri* and *B. penicillata*, with a basis of intrinsic features. The combination, if constant, would undoubtedly merit recognition at full species level, but in the absence of any

(1) Wrongly cited in the original description as 3.9.

further material to supplement the holotype, I find the possibility of metrical anomalies introduced by dwarfing, and the lack of any information on the external characters of the animal, a sufficient deterrent to that course. While the balance of likeness is perhaps towards *B. lesueuri*, the highly diagnostic P⁴ is so different from the seccator of that species, and has so much in common with that of *B. penicillata*, that I have chosen to associate it provisionally with the latter as a subspecies.

The overall development of the *Bettongia penicillata* group though very imperfectly known, would seem to be served by the conception of *B. penicillata ogilbyi* as a dominant south-western race extending east from the Swan River districts by way of coast lands into South Australia and beyond into the eastern portions of the Darling basin of New South Wales. *B. penicillata penicillata* would then represent a poorly differentiated highland race distributed on a north-south axis chiefly on the western slopes of the Great Divide, and possibly extending into a subtropical littoral zone round the Gulf of Carpentaria both in Queensland and the Northern Territory. *B. gouldi* Gray as at present known is void and founded on local dwarfs of the *ogilbyi* populations, while *anhydra* and *francisca* may have arisen from similar dwarfs, stabilized and further differentiated under eremian and insular conditions respectively.

STATUS OF OTHER MEMBERS OF THE SUBFAMILY IN THE REGION.

Several aboriginal vocabularies contain words for animals which, while but vaguely known to the present generation, are suggestive of members of the present group, either from the general drift of the account or from the voluntary selection of known members of it, for comparison. One such is the *telunaki*, of the Pitjanjarra and Yankunjarra, which, though known to many of the older people, has not been seen nor taken for many years in the granite ranges about the 26th parallel, which was its locus. It is compared always, though in varying terms, to the *karpitchi* or the *tebungoo*. These last, representing *Bettongia penicillata* and *B. lesueuri* respectively, together with *Caloprymnus campestris* Gould of the Lake Eyre Basin are the only species of which there is definite evidence as living or recently living forms in the Centre and adjacent arid tracts.

Since I recorded the sudden increase of *Caloprymnus* in the Lake Eyre Basin (1932; 1936.) there have been few, if any, reliable reports of it. Bolliger (1938) published some observations on a rat kangaroo to which he gave this name, but he has since been good enough to inform me (in litt) that the identity was mistaken and that the animal (an unlocalized zoological gardens exhibit) was probably *Aepyprymnus rufescens*. All attempts to trace *Caloprymnus* as a living or recently extinct species beyond the limits mapped in 1932 have given only negative results, but the finding of skeletal remains in caves of the Eucla district (Lundelius 1957) tends to confirm Tate's statement (1879) of its presence at the head of the Great Australian Bight eighty years ago. This I was inclined to reject in 1932 as no material of the species is mentioned by Tate, while on the other hand, skulls in the old collection of the South Australian Museum, which had been labelled *Caloprymnus* (possibly by Tate), were actually *B. lesueuri*.

Potorous, as a genus of modern species, seems to be almost entirely subcoastal in its mainland distribution. Early compilers of faunal lists claim more than one species for lower South Australia, and there is a rural tradition that *tridactylus* occurred in the lower South-East District of the State, but Thomas's (1888, 120) record of a skull from the Murray River is the only material evidence in support. The extent of its inland diffusion is quite conjectural, but from what is known of the habitat preferences of the species, it is very unlikely that it occupied the subarid districts in modern times. Zietz's use (in Gill 1909) of *Potorous tridactylus* for an animal at Port Lincoln is probably based on *Bettongia penicillata*.

Several references to *Bettongia gaimardi* Desmarest exist in early lists of South Australian mammals, which may be derived from the statement of Waterhouse (1846, 207), but no confirmation of this has been obtained in the succeeding years. The forms described here as *B. penicillata anhydra* and *B. penicillata francisca* were closely compared with the standard descriptions of *B. gaimardi* but no evidence of any special affinity to that form could be found.

In the South Australian Museum is a skull of *Aepyprymnus rufescens* Gray of normal characteristics, labelled as from "Lake Eyre." The locality is some hundreds of miles west of the most inland of authentic records of the species and presents features radically different from the known habitats of *Aepyprymnus*. There is no other relevant data, and the anomaly should probably be attributed to a confusion of record.

POST-PLEISTOCENE REPRESENTATIVES OF THE
SUBFAMILY.

The mammal palaeontology of Central Australia except for the Lake Eyre Basin, is almost unknown and the writer has examined no relevant material from these areas. In lower South Australia, however, superficial deposits, ancient camp sites and cave deposits have yielded bones copiously, and the South Australian Museum has considerable collections of subfossils so derived, much of it gathered by N. B. Tindale and his associates in aboriginal archaeology. Small amounts in my own collection have also been available.

The chronology of the collections is in most cases, only vaguely known; the oldest are probably those from layer 11 of the Devon Downs beds which Tindale (1957) links with his Prepirrian culture with a possible age (based on radiocarbon data) of about 5000 B.P. At the other extreme, some of the superficial camp site bones may be coeval or nearly so with the European occupation, though very few specimens of many hundreds examined show signs of gross recency in the form of soft tissue or fat stain.

The Potoroinae in that portion of this material which has been available to me, is referable to known species and the greater part of it to *Bettongia lesueuri* and *B. penicillata*. Of the eleven sites ranging from Hawker in the north to Tantanoola in the extreme south which have yielded *Bettongia* remains, eight contain *lesueuri* and six *penicillata*, while only three contain both. Little or nothing on the former local status and distribution of the species can be deduced from the collection as a whole, however, which consists for the most part of chance surface finds not fully representative of the deposit. In the case of the Tantanoola, Kongarati and Devon Downs finds, where systematic excavation was made, *B. penicillata* was much the more numerous of the two. This accords with the modern status of the two species and probably indicates that it was locally still more dominant at that time, since the densely ossified skull of *lesueuri* is the more resistant to weathering and disintegration; cranial, as distinct from mandibular specimens occur more frequently with *lesueuri* than *penicillata*. Species of *Potorous*, broadly referable to *tridactylus* and *morgani* also occur sparsely. The latter is present for example in level 1 of the Devon Downs deposits of Murundian age and also in the deeper Mudukian beds of level 6. The possible northern extensions of earlier forms of such fossils into the Centre, and especially into the Lake Eyre Basin, derives interest from its bearing on the hypothesis

to which I have referred (1932, 165) of the evolution of *Caloprymnus* there, from a *Potorous* like ancestor, which would be a natural consequence if Spencer's ideas (*op. cit.*) on the evolution of the Diprotodonts, are well founded.

The archaeological site of Tartanga, which is adjacent to that of Devon Downs but considerably older was but sparsely mammaliferous and yielded no Potoroinae. It may be noted here in passing, that the Tartanga *Macropus* molar which was formerly regarded as anomalous with respect to *M. giganteus* and to which Tindale has reverted (1957.9) is probably reconcilable with that species. Examination of larger series than were available at the time has shown that a maximum breadth of 10 mm. in the anterior lobe of M_1 is occasionally reached in the local form, *M. giganteus melanops*. Gould.

A comparison of the cranial and dental features of the *Potoroinae* of these collections, with the series reviewed (*supra*) will be presented elsewhere. Treatment of the skeletal material is deferred pending completion of a review of the general osteology of the group, which is in hand.

REMARKS ON THE DISTRIBUTION AND BIONOMIC INTERRELATIONS OF THE POTOROINAE

In the modern wreck of this remarkable group of mammals the plan of its unfolding into the vast territories, which it formerly occupied, is but dimly to be seen. The contributions of palaeontology are yet to come,⁽²⁾ and the recent distribution, imperfectly known as it is, together with the phylogeny of its members at species level, are the main sources of such insight as may be had, and they leave much unexplained.

Deductions made on a continental scale from what is known of distribution, are apt to be fallacious here, unless due regard is had for the comparatively recent and unequal effects of aridity. This (whether it be a waxing or a waning influence) has undoubtedly left its mark on the range of some species, which were probably first occupied under climates very different from the present. Even such broad questions as the site of origin of the radiation and the directions in which species have diffused are largely speculative. It may

(2) If the molar figured by Johnston (1882) to which attention has recently been redirected by Edmund Gill (1957) is accepted as a member of this group, it would appear to be the earliest recorded occurrence. It came from the beds of One Tree Point, Tasmania, stated to be of Upper Tertiary age.

be noted that there is in a general way a tendency for concentration both of species and population, in the south and east and that Tasmania was occupied by both sections of the subfamily, whereas in the north and west representation is more sparse and neither section attained a footing in New Guinea.

Recent work on the phylogeny of the group by Pearson (1947; 1950), whose main theme in his later papers is the distinction of the rat kangaroos as a whole from the Macropodidae at full family level, has tended to obscure the deep cleavage between the potoroos and bettongs. This was first developed by Bensley (1903) from cranial and dental considerations chiefly and was considered by him to call for subfamily distinction. The merits and demerits of this are variously regarded, but it seems to derive some geographical support from what is known of the present occurrence of the most primitive forms of both sections. Unless the sites now occupied are to be regarded as mere fortuitous residual areas in a much wider former range, they might be accepted as points of origin of two distinct radiations, the one stemming from a *Hypsiprymnodon*-like ancestor in the north-east and yielding the *Bettongia* species and *Aepyprymnus*, and the other arising in the extreme south-west from a primitive *Potorous* species or potoromorph and leading, as Bensley believed, to *P. tridactylus* as its linear end point and to *Caloprymnus* as a highly aberrant offshoot. In both cases the evolution leads from dense scrub or jungle living forms of sedentary habit and restricted range to highly mobile, wide ranging denizens of open forest or plains. The similarity of *Bettongia* and *Caloprymnus* in somatic features is remarkably close but attained through convergence of phylogenetically distinct stocks. Spencer's postulate (1896.1.184) of a widely separate origin of *Bettongia* and *Hypsiprymnodon*, the former in the main east-central originating centre of the Diprotodonts and the latter in a north-eastern Torresian site, seems to clash with the generally accepted derivative relation of the two genera.

In the field relations of *Bettongia penicillata* with *B. lesueuri* and *Aepyprymnus rufescens* there is much that is interesting and significant. Morphologically and in relation to the main evolutionary trends of the genus, *B. penicillata* may be regarded as a basal and comparatively generalized form, while *B. lesueuri* and *Aepyprymnus* on the other hand are advanced in the same sense and have in addition adaptive specializations of an individual kind. There is little doubt that over much of South and Western Australia, *B. penicillata* and *B. lesueuri* were truly sympatric, camping and feeding over the same

areas and exploiting ecological combinations of a very similar kind. In the higher rainfall areas *B. penicillata* more than held its own and often maintained much denser populations than *B. lesueuri*. But with increasing aridity this proportion was reversed until in the Centre *B. lesueuri* vastly outnumbered *B. penicillata*, which in all probability was being rapidly eliminated there long before any of the adverse factors of European occupation operated against either species. Here under present day conditions, when population density in relation to total area available is always low, it is doubtful whether direct competition plays much part in the eliminating process, which is probably decided by adaptive deficiencies in the nest-building habit as compared with the fossorial one of *B. lesueuri*. *Caloprymnus*, a nest builder, succeeds in maintaining only a very tenuous hold on the Lake Eyre Basin, where it has no marsupial competitors on the same ecological level.

In eastern Australia, similar relations must have existed between *B. penicillata* and *Aepyprymnus*. Krefft indeed, quoting the blacks, stated that there were considerable discontinuities in the habitats of the two in New South Wales, but in many districts, the Dawson Valley for example, in Queensland, blending of territories or very close interdigitation of the same, must have occurred. The recession of *B. penicillata* from these fertile and well-watered districts, which was also largely independent of European influences, was much more probably due to direct competition, in which *Aepyprymnus*, also a nest builder, would be advantaged by its superior size, and more advanced herbivorous dentition and greater range of food plants.

The general distribution pattern of the species and their contrasting status, suggests that *B. penicillata*, as an earlier protean generalized form gained transeontinental distribution in the absence of competition, and under somewhat more pluvial conditions than now obtain. It was then encroached on by later developing and more specialized forms; *Aepyprymnus* ultimately replacing it in most of the north-eastern coastal areas, *gaimardi* in a portion of the Pacific Slope of the Divide, and *cuniculus* in a later insulated Tasmania; while in the south and west *lesueuri* reached equilibrium with it where the rainfall was assured and supplanted it in the Centre with the aid of increasing aridity. So far as is known, no species of *Bettongia* occurs in the eastern portion of the Lake Eyre Basin which is the present habitat of *Caloprymnus*; the failure of *B. lesueuri* to supplant the indigenous *Caloprymnus* in this area, which is near the eastern frontier of its advance in this latitude, is probably due, like other

similar anomalies in the Centre, to lack of sufficient population pressure in the former to provide the incentive for invasion of a habitat of such rigorous conditions.

SUMMARY

1. The results of field work on Central Australian representatives of the Potoroinae are summarized.

2. The continental distribution and status of *Bettongia lesueuri* Q. and G. and of *Bettongia penicillata* Gray is discussed and the distribution approximately mapped.

3. Detailed reviews of external, cranial and dental characters of authentically localized populations of these species are made and subspecific differentiation assessed in general terms.

4. There is brief treatment of habits, bionomic interrelations, post-Pleistocene representation and related topics.

EXPLANATION OF PLATES

(The dental elements figured are of the right side of the dorsal aspect of the skull unless otherwise stated.)

PLATE XXVII

The skull in *Bettongia lesueuri* Quoy and Gaimard, 1824.

Fig. A. Dorsal aspect in an adult ♂ from Mount Conner, Central Australia. A broad short muzzled phase (X 0.9).

Fig. B. Dorsal aspect in an adult ♂ from the Musgrave Range area of far north-west South Australia. A narrower, longer muzzled phase (X 0.9).

Fig. C. Dorsal aspect in an adult ♂ from River Light, lower South Australia (X 0.8).

Fig. D. Dorsal aspect in an adult ♂ from West Popanyinning, south-west Western Australia (X 0.8).

Fig. E. Palatal aspect of example figured at A (X 0.9).

Fig. F. Lateral aspect of the same (X 0.9).

Fig. G. Occipital aspect of the same (X 0.8).

Fig. H. Lateral aspect of right mandibular ramus of example figured at B (X 1.1).

PLATE XXVIII

Dentition of *Bettongia lesueuri* Quoy and Gaimard, 1824.

Fig. A. Labial and buccal aspects of the upper incisors, canine, P³ and MP⁴ in a subadult ♂ from Mount Conner, Central Australia (X 2.9).

Fig. B. The occlusal aspect of same (X 2.9).

Fig. C. Buccal aspect of the lower teeth P₃, MP₄, M₁, M₂ in an immature ♀ from the Musgrave Range area of South Australia (X 3.0).

Fig. D. Occlusal aspect of P₃ and MP₄ of the same (X 3.0).

Fig. E. Buccal aspect of P⁴ in an adult ♂ from the Musgrave Range area (X 2.9).

- Fig. F. Oclusal aspect of the same, showing strong development of the posterointernal (talon) cusp. (X 2.9).
- Fig. G. Oclusal aspect of unworn P⁴ in a young adult ♂ from the same locality, showing virtual absence of talon (X 2.8).
- Fig. H. Buccal aspect of P₄ of the same individual (X 3.1).
- Fig. I. Oclusal aspect of the same (X 3.0).
- Fig. J. Oclusal aspect of P₄ in a young adult from Ti-Tree Gully, lower South Australia; a taloned variant with sigmoid outline (X 2.8).
- Fig. K. Buccal aspect of P⁴ (of left side) in a young adult ♂ from Popauyinning, south-west Western Australia (X 2.8).
- Fig. L. Oclusal aspect of upper cheek teeth in the immature ♀ figured at C and D, showing unworn crown patterns in M¹ and M² (portion of M² in alveoli) (X 3.0).
- Fig. M. Oclusal aspect of M²-M⁴ in an adult ♂ from Mount Conner, Central Australia, showing moderate wear (X 3.0).

PLATE XXIX

The skull in *Bettongia penicillata* subsp.

- Fig. A. Dorsal aspect of an adult ♀ of *B. penicillata ogilbyi* Waterhouse from Augusta, south-west Western Australia (X 0.9).
- Fig. B. Dorsal aspect of a subadult of the same at P²M² from Mount Lofty, South Australia (X 1.0).
- Fig. C. Palatal aspect of the example figured at A (X 0.9).
- Fig. D. Lateral aspect of same (X 0.9).
- Fig. E. Occipital aspect of same (X 0.9).
- Fig. F. Lateral aspect of right mandibular ramus of same (X 1.1).
- Fig. G. Dorsal aspect of type skull of *B. penicillata anhydra* (X 0.9).
- Fig. H. Palatal aspect of same (X 0.9).

PLATE XXX

The dentition in *Bettongia penicillata* subsp.

- Fig. A. Labial aspect of upper incisors and canine of the left side in an immature ♂ of *B. penicillata ogilbyi* from Cuballing, south-west Western Australia (X 3.0).
- Fig. B. Oclusal aspect of same (X 3.0).
- Fig. C. Buccal aspect of P³ and MP⁴ in an advanced subadult ♂ in which the molar rows have been completed before the tooth change. Same locality (X 3.1).
- Fig. D. Oclusal aspect of the complete upper series P²-M⁴, in the same (X 2.8).
- Fig. E. Buccal aspect of the lower series in the same (X 2.8).
- Fig. F. Oclusal aspect of the same (X 2.8).
- Fig. G. Buccal aspect of P⁴ in an adult ♀ of *B. penicillata ogilbyi* from Augusta, south-west Western Australia (X 3.1).
- Fig. H. Oclusal aspect of same (X 3.1).
- Fig. I. Buccal aspect of P₄ in same individual (X 2.9).
- Fig. J. Oclusal aspect of same (X 2.9).
- Fig. K. Buccal aspect of P⁴ in the type of *B. penicillata anhydra* (X 2.8).
- Fig. L. Oclusal aspect of P⁴ and M¹-M⁴ of the left side of the same (X 2.8).
- Fig. M. Buccal aspect of P⁴ in the type of *B. penicillata francisca* (X 3.0).
- Fig. N. Oclusal aspect of P⁴ and M¹-M⁴ of the left side of the same (X 3.0).
- Fig. O. Oclusal aspect of P⁴ and M¹-M⁴ (right side) in an adult ♂ from lower South Australia, showing considerable wear and a well developed accessory buccal cusp on M² (X 2.8).

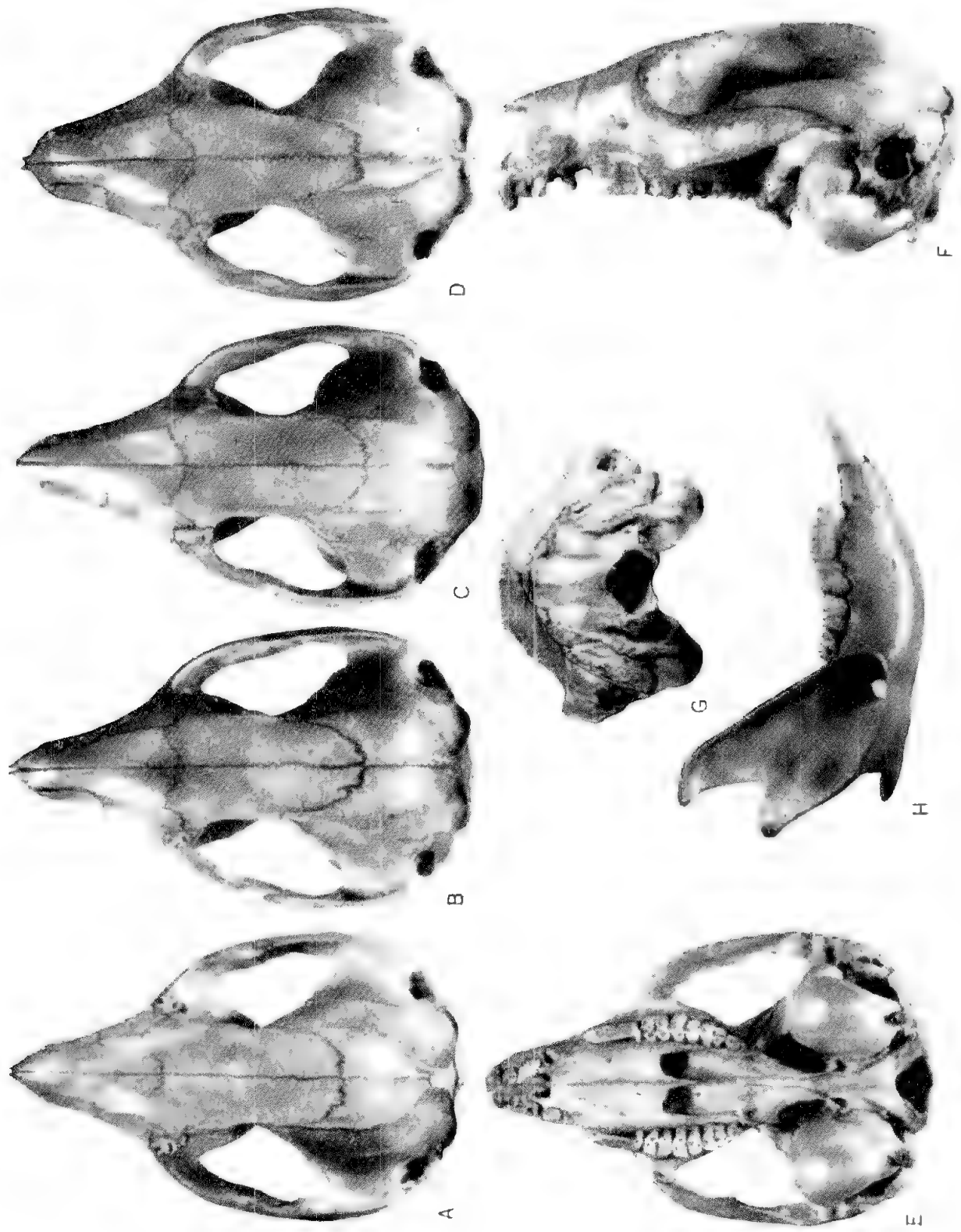
PLATE XXXI

The characters of the head in *Bettongia penicillata ogilbyi*; an immature ♀ from Cuballing, south-west Western Australia. (Photographed January, 1926.) (X 1.3ca.)

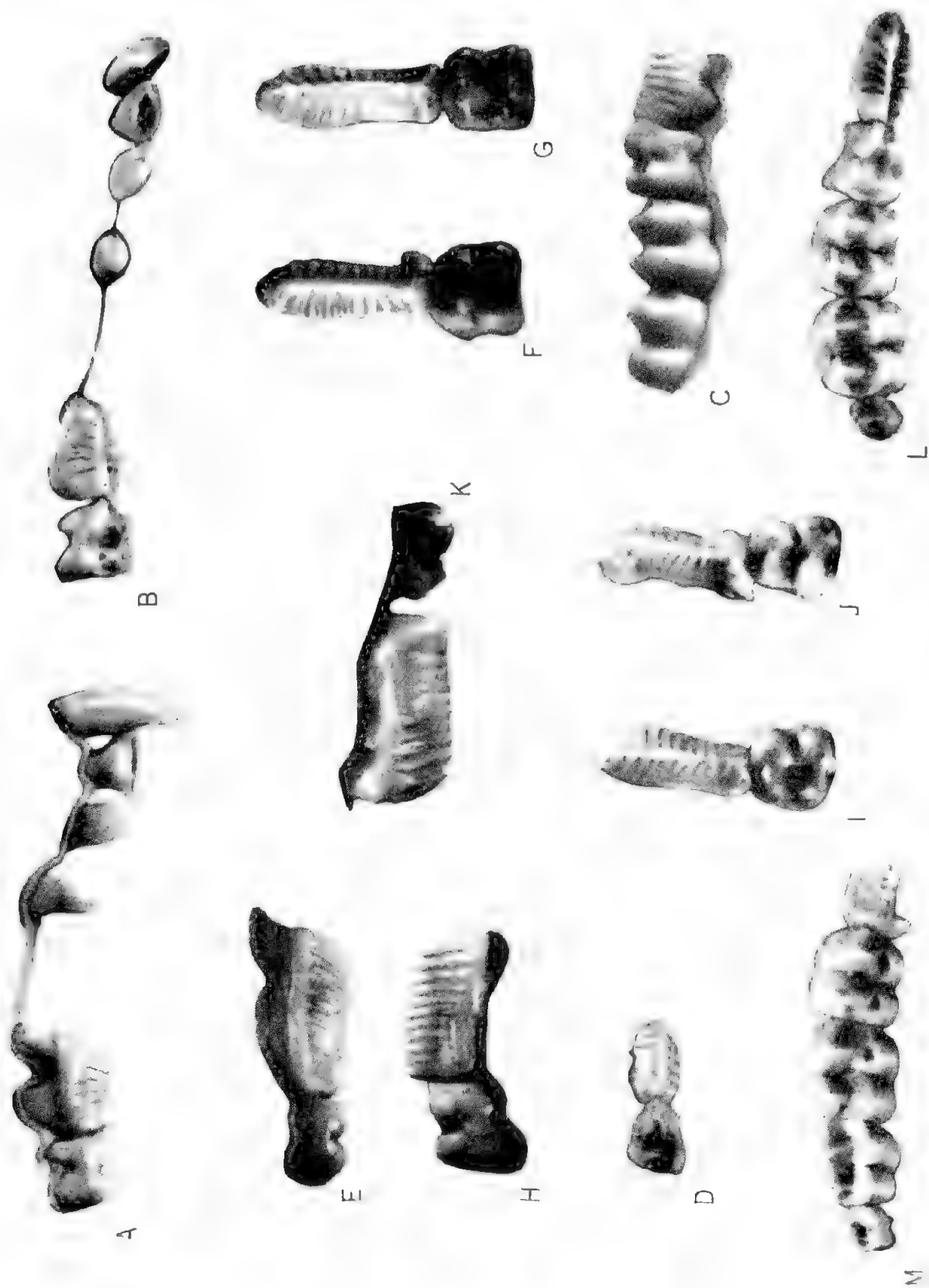
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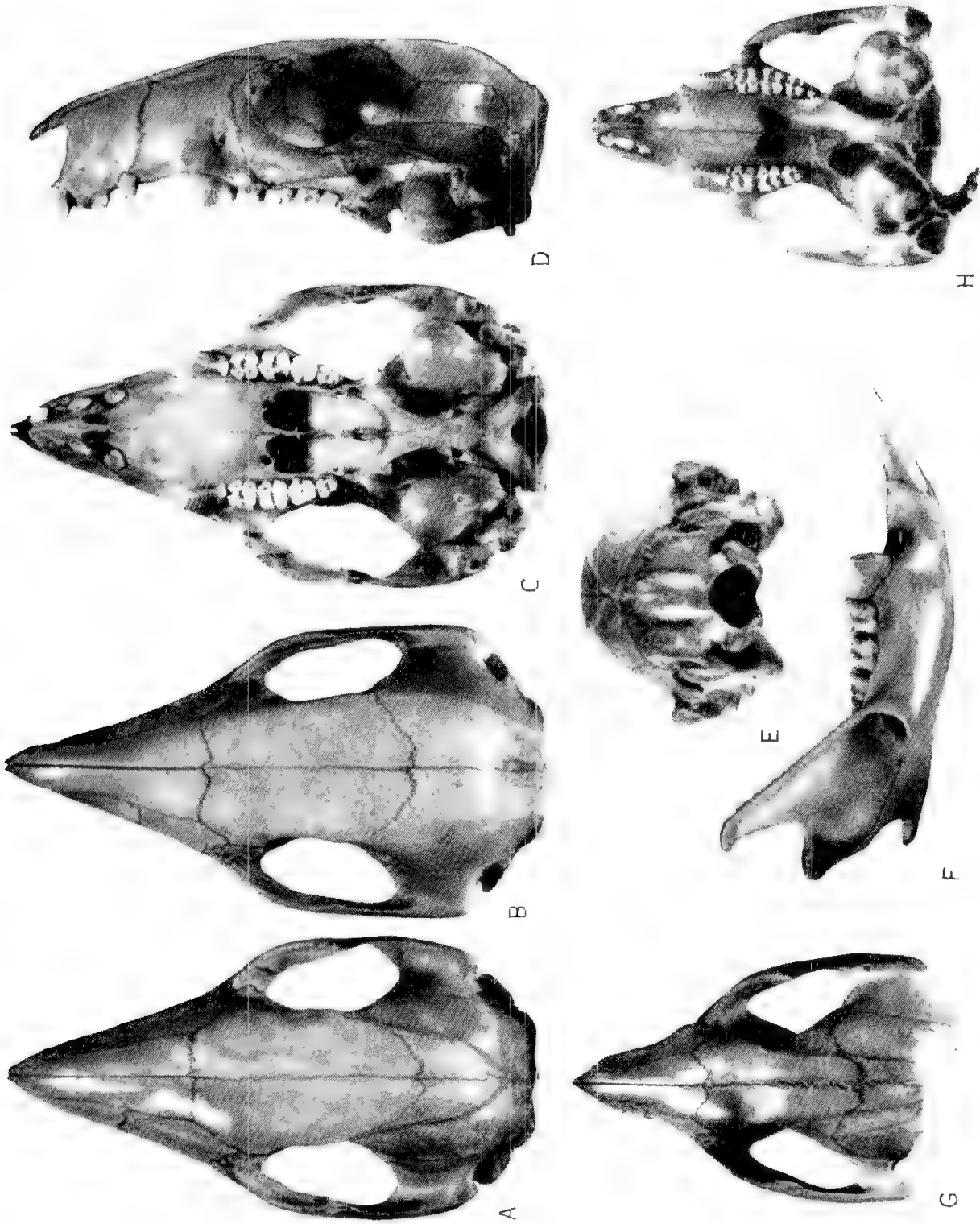
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The Skull in *Battogtia lasiocera* Q and G. Photo. by H.H.F.



Disposition of *Bellorgia fusca* Q and G. (Photo. by H.H.P.)



The Skull in *Beutonia picillata* Gray. (Photo. by H.H.F.)



Dentition of *Battus p. scabellus* Gm., (Photo, by H.H.F.)



Head of *Bettongia penicillata gilbyi* Waterhouse. (Photo by H.H.P.)

RECORDS
OF THE
SOUTH AUSTRALIAN MUSEUM

Vol. XIII, No. 3

Published by The Museum Board, and edited by the Museum Director

Adelaide, 2nd July, 1959

Printed in Australia by W. L. HAWES, Government Printer, Adelaide
Registered in Australia for transmission by post as a periodical

OBITUARY NOTICE

*SIR DOUGLAS MAWSON, O.B.E., F.R.S., D.SC., B.E.,
1882-1958*

It is with deepest regret that we have to record the death of Douglas Mawson on the 14th October, 1958, at the age of 76.

It truly may be said of him that he was the most notable and active of those who have served in an honorary capacity in the South Australian Museum.



Sir Douglas Mawson, O.B.E., F.R.S., D.Sc., B.E., 1882-1958.

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His association with this institution commenced fifty-two years ago—surely a record. For about fifty years he was Honorary Curator of Minerals; for many years a prominent member of the Museum Committee; and later, of the Museum Board, of which he was Chairman at his death.

He vigorously advocated the need for separating the Museum, Art Gallery and Public Library into independent departments, instead of all being controlled by a composite Board of Governors with unrelated interests. His representations were a major factor in bringing about the adoption of the system of separate control for each of these public institutions.

His scientific achievements and world-wide reputation are too well-known to need mention here. It is because of the high esteem in which he was held by those fortunate enough to have been closely associated with him that his passing will be so deeply mourned by all Members of the Board and Staff of this institution where, through his active interest, everyone was privileged to enjoy his quiet and modest disposition—always the sympathetic friend and wise counsellor.

Douglas Mawson was a noble figure physically; but also, in every sense, a great man—one long to be remembered.

**TOTEMIC BELIEFS IN THE WESTERN DESERT OF AUSTRALIA
PART I
WOMEN WHO BECAME THE PLEIADES**

BY NORMAN B. TINDALE, B.SC., SOUTH AUSTRALIAN MUSEUM

Summary

In Western Desert lore the Pleiades and the Morning Star are ancestral Women Beings, given various names (Kungkarunkara, Okaralja, Aragutja, Ilknarindja, etc.). They climbed into the sky and became stars to escape the attentions both of a man named Njiru, and of his son Jula. These women attacked Njiru with packs of dogs which they kept as their protectors. In the sky of autumn, the early morning appearance of the Pleiades, low down in the east, marks the beginning of the aboriginal New Year and the commencement of the season when dingo dogs (papa) give birth to their young. Since these pups serve as food for men, Increase Ceremonies for the dingo are a feature of the autumn season. The stories of the would be virgin women are made complex because the names of some of the principal beings are changed and even became transposed in some tribal versions of the stories.

TOTEMIC BELIEFS IN THE WESTERN DESERT OF AUSTRALIA PART I

WOMEN WHO BECAME THE PLEIADES

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Plates xxxii-xxxix and text fig. 1-8

SUMMARY

In Western Desert lore the Pleiades and the Morning Star are ancestral Women Beings, given various names (Kungkarungkara, Okaralja, Aragutja Ilknarindja, etc.). They climbed into the sky and became stars to escape the attentions both of a man named Njiru, and of his son Jula. These women attacked Njiru with packs of dogs which they kept as their protectors. In the sky of autumn, the early morning appearance of the Pleiades, low down in the east, marks the beginning of the aboriginal New Year and the commencement of the season when dingo dogs (papa) give birth to their young. Since these pups serve as food for men, Increase Ceremonies for the dingo are a feature of the autumn season. The stories of the would be virgin women are made complex because the names of some of the principal beings are changed and even became transposed in some tribal versions of the stories.

In this paper Mandjindjara, Pindiini, Pitjandjara, Ngadadjara and Jangkundjara outlines of the stories are given and a preliminary description also is given of a cave, Owalinja ('Walinja, O'walinja), on the northern side of the Musgrave Ranges, where Jangkundjara tribespeople held Increase Ceremonies for the Kungkarungkara, Papa and associated totems, in a sacred cave. They also depicted their Ancestral Beings on its walls.

INTRODUCTION

This is the beginning of a series in which it is proposed to set out basic data on some myths and totemic beliefs of the several peoples of the Great Western Desert of Australia.

It is planned to give an account of the material evidences for the totemic beliefs, and where possible to give texts and details of

song cycles and ceremonies. Stone arrangements, secret places, and associated markings and paintings will be described and ceremonial objects figured.

This data will be amplified with drawings made by aborigines themselves in illustration of statements they have made about their beliefs. There will be discussions on the significance of the stories.

Data is in hand for the Jangkundjara, Pitjandjara, Mandjindjara, Pindiini, Jumu, Kukatja, Pintubi, and Ngudadjara tribes among others in the eastern and central areas of the Desert, as well as much other data from the Wanman, Mandjildjara, and several other tribes of the northern and western portions of the Desert. The distribution of these tribes is shown in a map published by Tindale (1940) of which a new edition is in preparation. The name Pindiini relates to the tribe called Wongaii on the map. The name Pindiini is now preferred.

Observations on which this series is based commenced among Pintubi and Jumu people met at Mount Liebig, Central Australia, during a Board for Anthropological Research and South Australian Museum Expedition, August, 1932. During this University of Adelaide Expedition beliefs about the Pleiades group of stars and about the ancestral virgin women linked with them, were first brought to the personal notice of the author in their Jumu and Pintubi versions. Two years previously he had been shown the Aragutja Ikknarindja Ceremony of the Kukatja near Hermannsburg, Central Australia. These stories aroused his interest and it became evident that a detailed study might have high value in the understanding of native beliefs.

During a three-month-long journey in the Mann and Musgrave Ranges (May-August 1933) many sheets of drawings and associated data were collected from Jangkundjara and Pitjandjara men and a first attempt was made to learn the language of the Western Desert people and to collect their stories in text (see preliminary report by Tindale 1933). Jangkundjara men at this time depicted drawings and related outlines of myths connected with Owalinja, Aliwanjawanja, and other sacred places in the area, and gave details of the Kungkarungkara women. Ceremonies in which the activities of some of the Beings were enacted, were filmed at Konapandi and at Ernabella and were published (Board for Anthropological Research 16 mm. films Nos. 20, 26, and 27).

Field work continued at Ooldea in November 1934, among Pindiini and Mandjindjara men from west of Ooldea and with Jangkundjara people who had come south from the Everard Ranges. Men named Kakana, Mindjnkuli (the latter then about 50 years of age), Mana and some others of the Jangkundjara tribe had memories which went back to before the times of the Carruthers Survey of 1888-1890, when the aborigines made their first effective contacts with white men. Their kinsmen of course had had brief encounters with earlier explorers, including Giles (1874) who had an armed encounter with some 200 of the Musgrave Range aborigines at Officer Creek, on September 6, 1873.

In 1935, gathering of data, including drawings, was continued among Ngadadjara people during an Expedition led by the author to the Warburton Ranges in Western Australia. These people were then fully tribalised. Some of the drawings were obtained jointly with an associate on this occasion, and some of them have been described (Mountford 1937). It was agreed that he should apply himself more particularly to discussion of the artistic aspects of the work of these people, leaving the exposition of the mythological content to the present writer. Some details of the Wati Kutjara myth have been given in a paper published shortly after the Expedition returned, Tindale (1936, p. 169).

In 1939 field work was continued with some of the same Ngadadjara informants as were first encountered in 1935. By this date they had congregated in the vicinity of Laverton, Western Australia. Tribal disintegration, brought about in part by the establishment of the Warburton Range Mission, and by the transportation of some of the natives to the township, had enticed them many miles away from their own territories. Unfortunately few ever returned to their original homes and most of them were still missing from there when the area was visited again in 1957.

After a rather long break, occasioned by other activities during the war, Ooldea Soak was re-visited in 1949. Between the two visits Mr. and Mrs. R. M. Berndt had studied there, publishing their field notes in a series of reports in Oceania, Berndt and Berndt (1945). Because of the changing population at that Soak it is not certain that any of their data was obtained from people I met there earlier, and their notes touch only incidentally on stories referred to in this paper.

Some Pintubi and Ngalia aspects of the Kungkarungkara myth were studied again at Yuendumu, Central Australia in 1951.

Western Australian data, coming from tribes as far west as the Indian Ocean, were gleaned during a period of six months field work in 1953. Still further data was added at Haast Bluff, Central Australia during visits in 1956 and again in 1957. Tape recordings were made of several versions of the Kungkarungkara and associated myths. In between the two visits to Haast Bluff, the Jangkundjara and Pitjandjara tribal territories were re-visited as far west as Lightning Rocks, Western Australia, in company with Mr. W. B. MacDougall, Native Patrol Officer. Many ceremonial places were visited in the Rawlinson, Blyth, Cavanagh, Musgrave and Everard Ranges and southward to beyond Mount Lindsay. During this journey it was possible to visit Owalinja in company with one of the oldest of the western Pitjandjara men and to learn a little about the vast detail of paintings depicted in the Owalinja Rock Shelter. Subsequently it was possible to talk with several Jangkundjara men about the significance of this cave.

KUNGKARUNGKARA AND THE MAN NJIRU

While men were waiting for a party of young initiates to arrive at Oollea during one of the concluding stages of the minu initiation ceremonies of 1934, at which I was present by invitation, fourteen men took part in a discussion about the journeyings of the Wati tjitji tjukur of Koljorn. Those present included Pindiini (Wongaii), Mandjindjara, and Jangkundjara tribesmen, some of whom had never met each other before this series of ceremonies. The author happened to come on them on the 5th November just after discussions had begun and was able to watch old Pindiini and Mandjindjara men drawing circles, one by one, on the ground, joining them with single and multiple lines, as they described the encounter of the Being Njiru with the Minma (Okaralja, or Kungkarungkara) women. The occasion so fortunately and unexpectedly encountered, was the description by a Pindiini man, to a Jangkundjara audience, of the Mandjindjara and Pindiini versions of the myth. He was assisted by a Mandjindjara man.

Fig. 1 depicts a copy of the ground drawing, which, after over two hours of exposition, extended over the sand for a length of about 25ft. During this time the audience had shuffled and moved along the sandy ground, without rising to their feet and thus had kept pace with the growth of the pictographic record of the progress of the story.

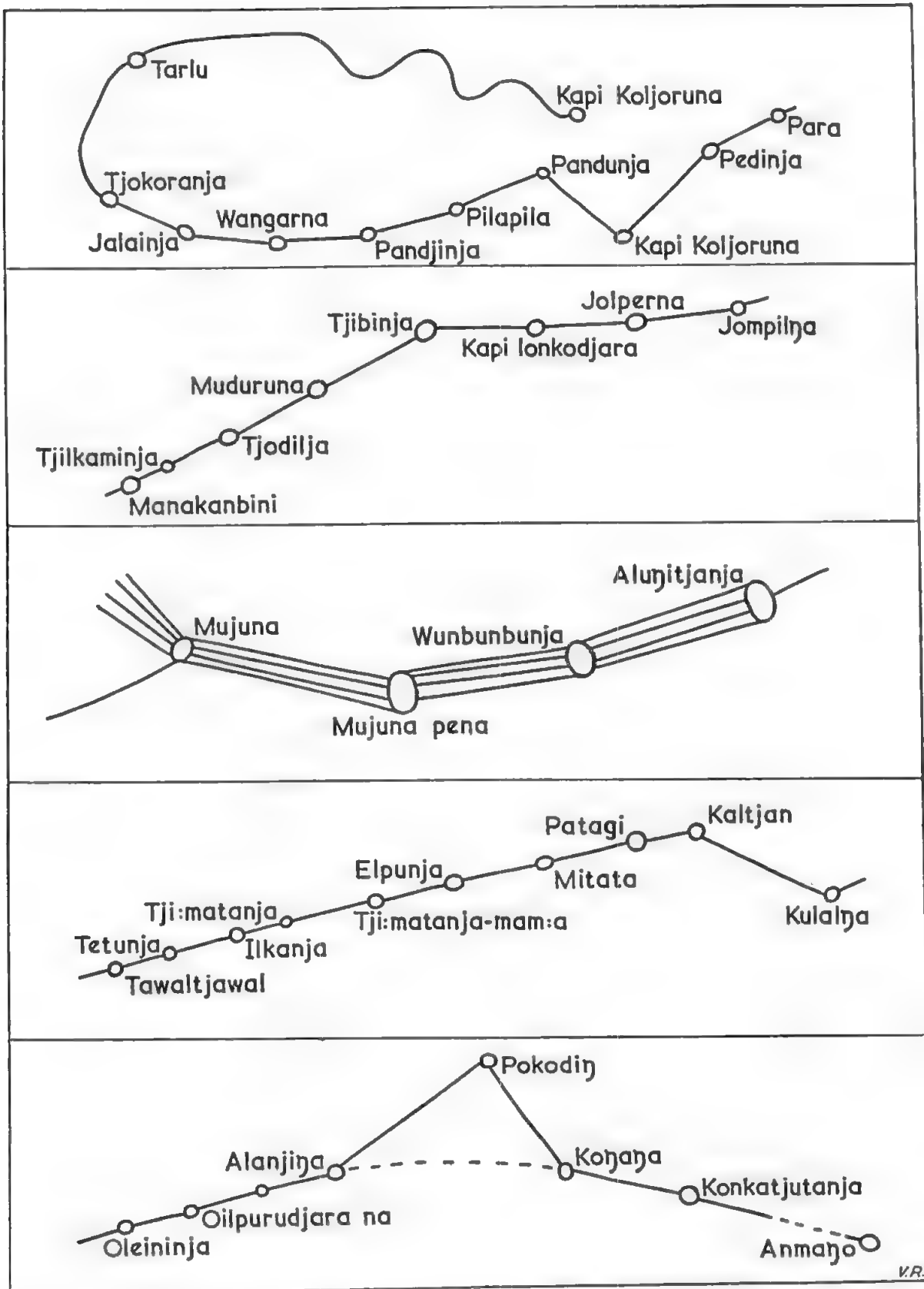


Fig. 1. Journey of the Wati Njiru from Koljoru to Anmango, as depicted in a ground drawing 25ft. long, at Ooldea, South Australia, 5th November, 1934. The design has been cut into five lengths so that Para is followed by Manakanbini and so on.

V.R.

The given outline of the journey was that known to Pindiini men in whose territory the place Koljoru, figuring largely in the story, was said to be.

Wati tjitji kotjo tjokotjoko (man child one small), who became the Ancestral Being Njiru appeared in the west as a child at Kapi Koljoruna, the Koljoru Water Place (Kaljoru, Koloru, Kaljorunga, etc.), which is south-east of the Warburton Ranges in Western Australia. Its position on the map was learned many years later.

Whence Njiru came no-one present knew, but he arrived from the north-east. He then travelled north-westward from Koljoru, but Mandjindjara men who knew of his track were not at Ooldea to tell of his earliest wanderings, as a boy. However Koko, a Pindiini man, who had been to Laverton, Western Australia and who spoke some English, thought Njiru had gone as far west as Tarlu (Lake Darlot) "near Meekatharra, but long before white man went there." In the west Njiru became a man. After he had been circumcised and subincised he journeyed south from Tarlu, and then eastwards to Tjokoranja and again eastward to Jalainja. One day when he went into Jalainja to drink water he was attacked by a pack of dogs belonging to Minma tjukur (women totem). These Minma or women were the Kungkarungkara (also called Kungkarara or Okaralja). Njiru fled into the bushland, trailing an injured member, forming a long water-course called Njirunjawipu (Njiru penis) extending to Wangarna. After this he travelled on to visit various waters, including Pandjinja, Pilapila and Pandunja, returning again to Kapi Koljoruna before going on to Pedinja. Near Pedinja at a place called Korukading he had an encounter with a Being named Korukadi of whom more will be said in a later paper. As he journeyed still further eastward towards Para, Njiru, now healed of the wounds to his wipu, made a line of sandhills extending north-eastwards. This is the Njirunatali, along which he caused small watering places to appear, at intervals. At Para he lay down on a sandhill (tali), leaving an impression of his body, known as the Talimurumuru. He then continued on to Tali Tjangara and Manakanbini. Following the same line of waters for seven or more stages to Jompilnga he again encountered the Kungkarungkara women, near Mujuna. The women who had fled from Jalainja after their Papa (dogs) had driven Njiru away, went to Papulnga where there was a Kapi tjangara (*i.e.*, a water depression) frequented by Koneia, a Snake Being. This Being had come from Koljoruna by a different track. The women killed the snake at Papulnga, causing the water to dry up, and then continued

in the direction of Mujuna. In the ground drawing, four lines made by running fingers through the sand marked the journey of the women towards Mujuna.

Near Jompilnga Njiru had discovered tracks of these four Kungkarungkara women walking separately across country to Mujuna from the north-west. He followed them, passing Mujuna, then the Mujunapena (Mujuna clay pan) and continued on their trail, first to Wumbunbunja, and then to Alungitjanja. Here the four women were seen to be together, and Njiru caught up with them, but they

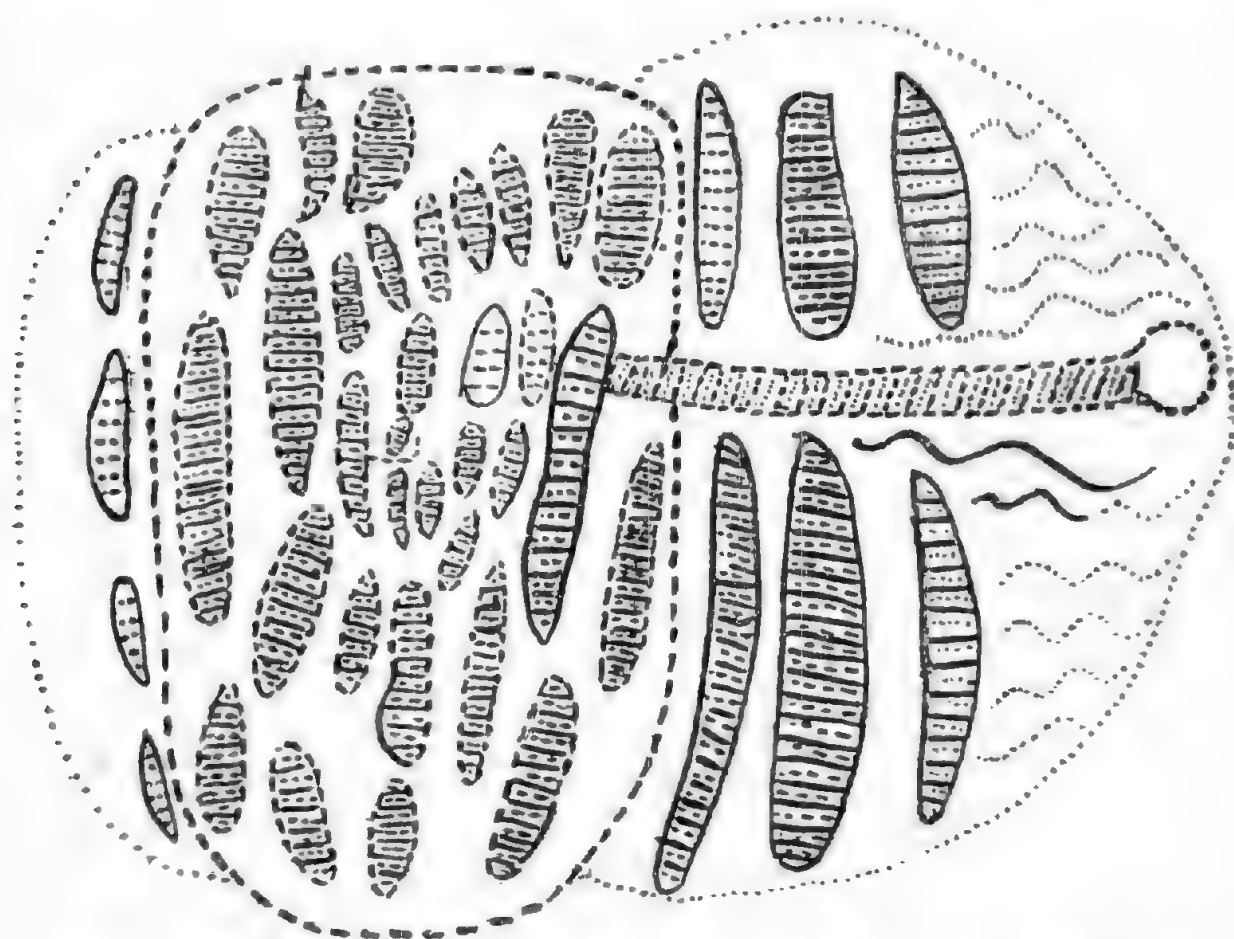


Fig. 2. Geographical drawing showing the vicinity of Koukakutjarana (place of two women) also called Minna Kutjara. The left half shows the jabu (hills) from which a watercourse, cutting across other hills, runs from Koljoruna to Kapi Pedinja (Petinga), represented by the circle. The watercourse runs in a north-easterly direction; wavy lines at right are runnels of water off the range, called "water snakes". The whole records an episode in the journey of Njiru from Koljoruna to Pedinja. It was drawn in black, red (represented by dots) and yellow (indicated by short lines) by Kakana, a Pindiini man at Ooldea, 9th November, 1934. It should be compared with Fig. 3b, depicting a separate event of the story, which represents this part merely by a line connecting two circles.

escaped again and fled in the same ENE direction to Tjawaltjawal (this is also the name of a sandhill-growing tobacco plant), to Tetunja, Ilkanja, and thence to Tjiimatanja-mama, visiting the main waterhole and also the camping place of Tjiimatanja. They then hastened on passing Elpunja, Mitata (a ngama waterhole), Patagi and Kaltjan, turned ESE to Kulalnga, and again NE to Oleininja and Oilpurudjarana. At Alanjinga, Njiru almost caught up with them but they took flight, like eagles, and escaped leaving no tracks (maka tjena). Unable to find them Njiru walked NE to Pokoding (Pokodinja), going a long way without seeing any signs of them. He then turned SE and at Konganga found stale tracks of the women. He followed these to Konkajutanja (women-many-place) a very long way. This is the western-most water used by the Jangkudjara tribesmen and situated south of Cheesman Peak (native name Pingkikaringa). At this point Piudini and Mandjindjara men "lost the story," for Njiru had gone into the territory of Pitjandjara people at Annango. Njiru became a star and Kelilbi the morning (and evening star) represents some of the women who kept dodging away from him. Every man has a share in this wapar (story) and each place mentioned in the above summary has its own song.

In the course of the next few days several men made drawings which brought out details of the story. Thus fig. 2 shows the geographical setting of events in the life of Njiru near Koljoru. Fig. 3 b suggests the activities of the Kungkarungkara after the attack by Njiru at Jalainja and fig. 4 a shows the line of sandhills made by Njiru between Pedinja and Para. All the places are west of Annango, which, I learned in 1957, is at the western end of a range close to and west of Cheesman Peak, near the border of Western and South Australia.

During the evening and night following this exposition of the journeyings of Njiru and the Kungkarungkara, the stars of Orion's Belt were pointed out to me as representing the Being Njiru. As the night progressed a series of three pairs of stars successively rising were indicated to be the footprints of Njiru (Njiru tjena). Some days later a man made a drawing of Njiru (fig. 4, b) wearing a wanigi (or string figure) made of puduru (fur string) to represent these Inna Njirunja tjena. The tips of such wanigi are decorated with tjurlpu tjaljurupa (bird feather decorations). In the night sky a very bright star near Orion's Belt is Tjantjalu; this star wears such tjurlpu feathers. These tjaljuru (taljuru) feathers, detached from wanigi and placed on a stick, are worn by young men in their

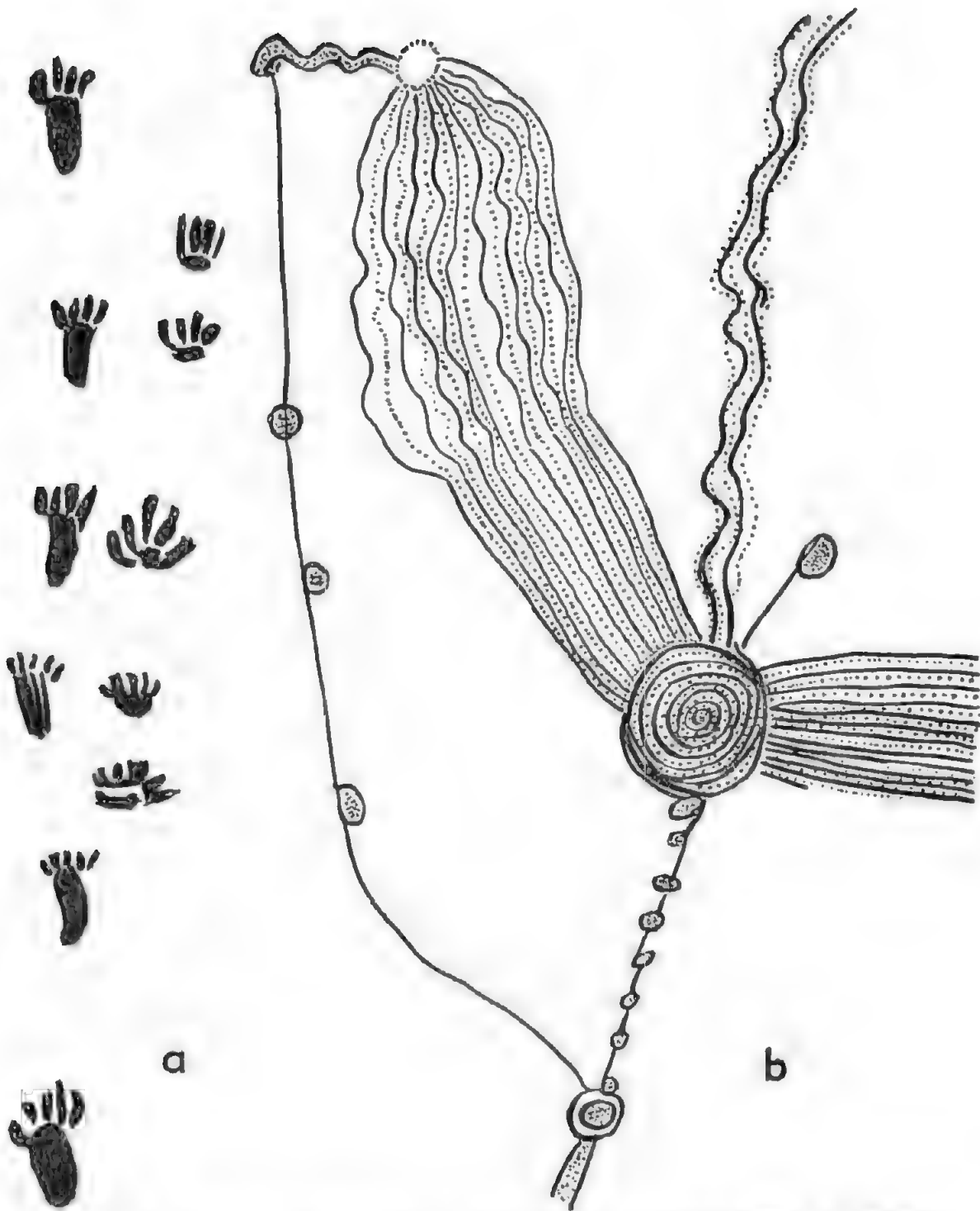


Fig. 3. a. Minma or woman following Papa (dog). Tracks as drawn by Lenggatjukur, a Pitjandjara man about 52 years old, at Umbukulu in the Mann Ranges, 2nd July, 1933. The original drawing was in white. b. Geographical drawing representing the tracks of the Kungkarungkara women as they fled wildly away from Jalainja (red circle, top left) with their dogs; drawing shows their change of pace as they neared Papulnga, where they found water in a small piti or rockhole (central spot) in a tjangara or large basin (large concentric spiral). The water was brought there by Koneia (a snake) from far away Koljorunja (down from top right). They killed the snake, so destroying the water, and travelled away northward (series of lines to right). The Being Njiru, having been bitten by the Papa (dogs) of the Kungkarungkara, at Jalainja, dragged his injured member, making a gorge or water channel, Njirunjawipu running to Wangarna (top left). He then made a track eastward through Pilapila, Pandunja, and Koljoruna to Pedinjakapi (double circle at bottom centre). Beyond the limit of the drawing he continued to Para and Manakambini. A line of waters from Papulnga to Pedinja shows the distance which separated Njiru and the women. These waters were Jaldainga, Japurunja, Pujudunja, Ngapartinja, Ngintajarunga, Porporidjun and Korukading (near Pedinja). Drawn by Kakana, at Ooldea, 13th November, 1934. Dots represent red, black lines are black in the original.

hair when they return to their homes after they have passed through the final stages of the minu ceremony of initiation.

After the stars representing Njiru tjena had risen in the sky the Kungkarungkara (also called Okaralja, Kungkarara and Minma) appeared in the early summer sky. These are the Pleiades. Still later, before dawn, a pair of stars were seen which are called Ipi

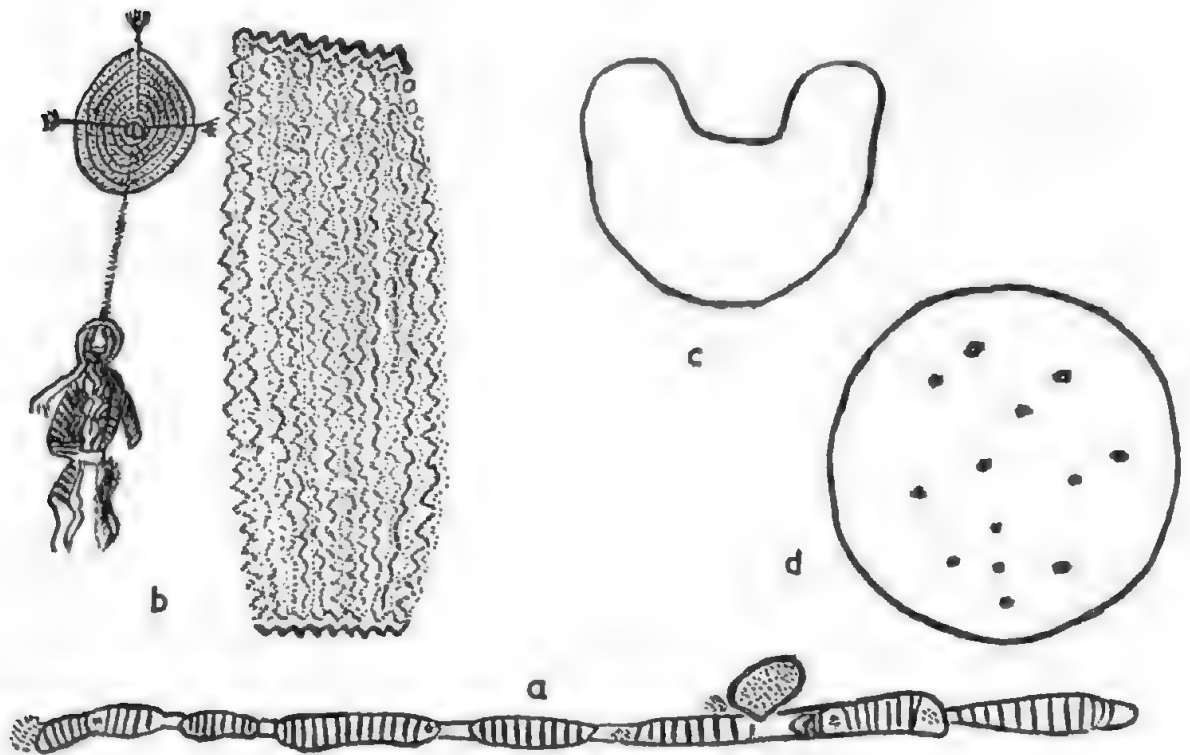


Fig. 4. a. Njirunjatali, a line of sandhills made by the Wati Njiru when travelling north-eastward from Kapi Pedinja, at the left, to Para, where he lay down in a depression beside the Talimurumuru and then continued towards the north-east. The sandhills (tali) are of the kind called Tali tjangara with long-lasting-water-bearing depressions in them. Red spots, depicted here by dots represent water places, the Talimurumuru is shown as a black-ringed red patch, the tali were yellow in the original; drawn by Kakana, November, 1934. b. Wati Njiru dancing with a wanigi of puduru (fur string) on his head. The wanigi has the extremities of the arms decorated with tjurlpu tjajjurupa (bird feather ornaments). Alongside him is depicted the minu walk, decorations painted on the bodies of minu (subinitiated men) as chest or back ornaments when they return to their families as fully initiated men. Drawn by Mana, November, 1934. c. Pitjandjara drawing showing Ipi, the two women who became the wives of the Wati Kutjara. They are called Kalka kutjara by the Ngadadjara. This design is painted in a cave at Mount Lindsay. d. Sand drawing, original about 2ft. in diameter, depicting the Kungkarungkara as the Pleiades in the sky. Drawn by a Pitjandjara man on the ground, with his finger, while talking about Owalinja Rock Shelter.

(the Women's Breasts, or Milk). The last named stars are, as I learned some years later, linked by the Pitjandjara with Japu Minma Tjukur, a Woman Ceremonial Stone, against which young girls press themselves to cause their breasts to grow and their milk to flow.

The Ipi themselves are depicted sometimes as in fig. 4, c. The Ipi women were wives of the Wati Kutjara.

JULA SON OF NJIRU AND THE KUNGKARUNGKARA

In Ngadadjara belief in the Warburton Ranges, Western Australia, Jula was of the Purungu class. He had come from the west to Kanamara, a place to the east of Lake Carnegie. He chased and married Pananka and Milangka women.

Ceremonies for him were held at Kapi Rera in the Warburton Ranges. At this place a ceremonial board, carved with intricate patterns, was enclosed in a ceremonial object made from fur string and displayed during a rite intended to increase the supply of dingo pups. Fig. 5, c shows a native drawing of the ceremonial object at Kapi Rera. Further north there was another place, at Jakoruka in the eastern Rawlinson Range. Jula arrived there from a place called Kumangura passing eastward along the Range to Jakoruka where there is a cave in which the Papa (dog) ceremony takes place.

A stone emblem, said to be that of Wati Jula, was seen at Jakoruka by Mr. W. B. MacDougall during his exploration of the area in 1950. He has shown me a photograph of it. It lay under a pile of fresh *Eucalyptus* leaves held down by stones. Each stone was of the size of a large ball. The stone emblem itself was about 2ft. long.

According to one statement the Being chased two Kungkarungkara women up the gorge in winter time (njenga), and his penis became so cold that it snapped off.

Ngadadjara men of the Western Rawlinson Ranges say however, that this object is the wipu (phallus) of Jula which had been bitten by Papa (dogs) belonging to the Kungkarungkara, and the stone balls represent the kuna or faeces of the Dog Beings. Ceremonies are held in the autumn season, aimed at expediting the rising of the Pleiades group of stars and stimulating the increase of dingo pups.

Jula is represented in the heavens as α and β Orion. The "belt of Orion" represents the 'toes' or tracks of Jula. His wives are represented by three red stars between α and β Orion.

After leaving Jakoruka Jula passed out of Ngadadjara territory in a south-easterly direction to Wankarei (= Wankari) where he went tarupango (he entered the ground or changed his state). Wankarei is near Poka, a water east of Trew Gap on the north side

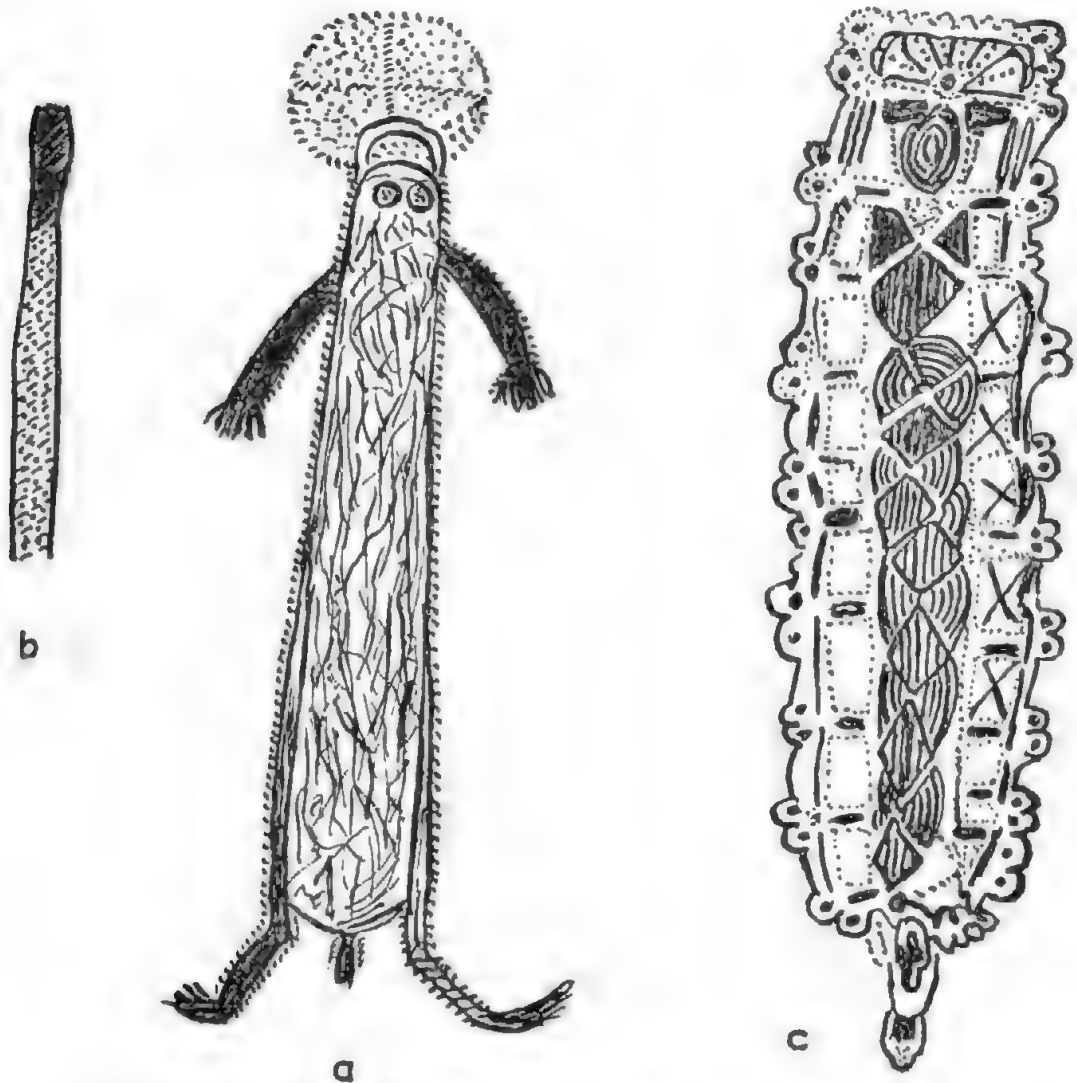


Fig. 5. a. Wati Julana, the man Jula at the place Ngaltabalunga, west of Anmango, bearing a wanigi or string cross on his head. b. Bullroarer, subibubi, of the man Jula, at Ngaltabalunga, whence he travelled eastward into Pitjandjara country. Drawn by Mindjukuli at Ooldea, 9th November, 1934. c. Wati Jula tingari tjukur, the man Jula secret totem, of the place Kapi Rera in the Warburton Ranges, Western Australia, drawn by Katabulka, a Ngadadjara tribe old man, 23rd May, 1939. Drawing shows extremely stylised human figure, incorporated into a representation of the secret board of Jula. In Ngadadjara Increase Ceremonies the tjurang board (middle of figure) is made the central feature of an elaborate string figure. The black spots in pairs along the margin represent highly stylised tjaljuru (tjaljira) or tufts of feathers terminating cross bars upon which the puduru or strings are bound. In the two main drawings contrasted here, one seems to be a highly stylised derivative of the other.

of the Mann Range. The name Njiru does not seem to appear in the Ngadadjara version of the myth and it is Jula who is attacked by the dogs of the Kungkarungkara.

In the Pitjandjara version Wati Julana, fig. 5 a, is the son of Njiru. He came into the Pitjandjara country from the far north-west, swinging a bullroarer (bubi bubi) fig. 5 b, and appeared first at Ngaltabalunga (place of good kurrajong trees). This water is west of Anmango, and west of the Tomkinson Range. Ngaltabalunga is on the border between Ngadadjara and Pitjandjara country. Fig. 5 a shows Jula carrying a wanigi at Ngaltabalunga. He journeyed east to a place called Jula, near Trew Gap in the Mann Range, where he attempted to mate with Mingari. He had just succeeded in doing so when he was attacked by Papa Kantju.

Papa Kantju, or Kantjanja, was a dog devil being (papa mamu tjukur). He attacked the Wati Julana, son of the Kungkarungkara, dragged out his testicles, and fed on them. In Pitjandjara story this event took place at Jula, west of and near Trew Gap in the Mann Range. Jula had travelled from Poka to Umbukulu and thence to Jula.

In ceremonies held in autumn the Pitjandjara enact this attack, which they ascribe to the place Warara. Freshly scraped wood shavings are made up into parcels and saturated with blood drawn from the arms of participants by lashing the upper arm and piercing a vein. The gory objects, kept highly oxidised by the fresh shavings, are then either tied to the head of the dancer representing Jula or held between the teeth of men acting the part of the Papa Kantju. 16 mm. films were taken of this ceremony by the present author in 1933 at Konapandi, and again at Ernabella in the Musgrave Ranges and these were published by the Board for Anthropological Research, University of Adelaide in their films Nos. 20 and 27.

PRELIMINARY NOTES ON THE PLEIADES MYTH OF THE JANGKUNDJARA

The central theme of the Jangkundjara myth of the women of the Pleiades is the life and behaviour of women of the dawn time as they try to avoid the efforts of a male Being, Njiru, to enter into incestuous relationship with them, for Njiru was "wrong" for them. Njiru in part was successful, and Jula, a second Being was his son. Jula had two sons, Milpali and Jungku by Mingari. The two lizard

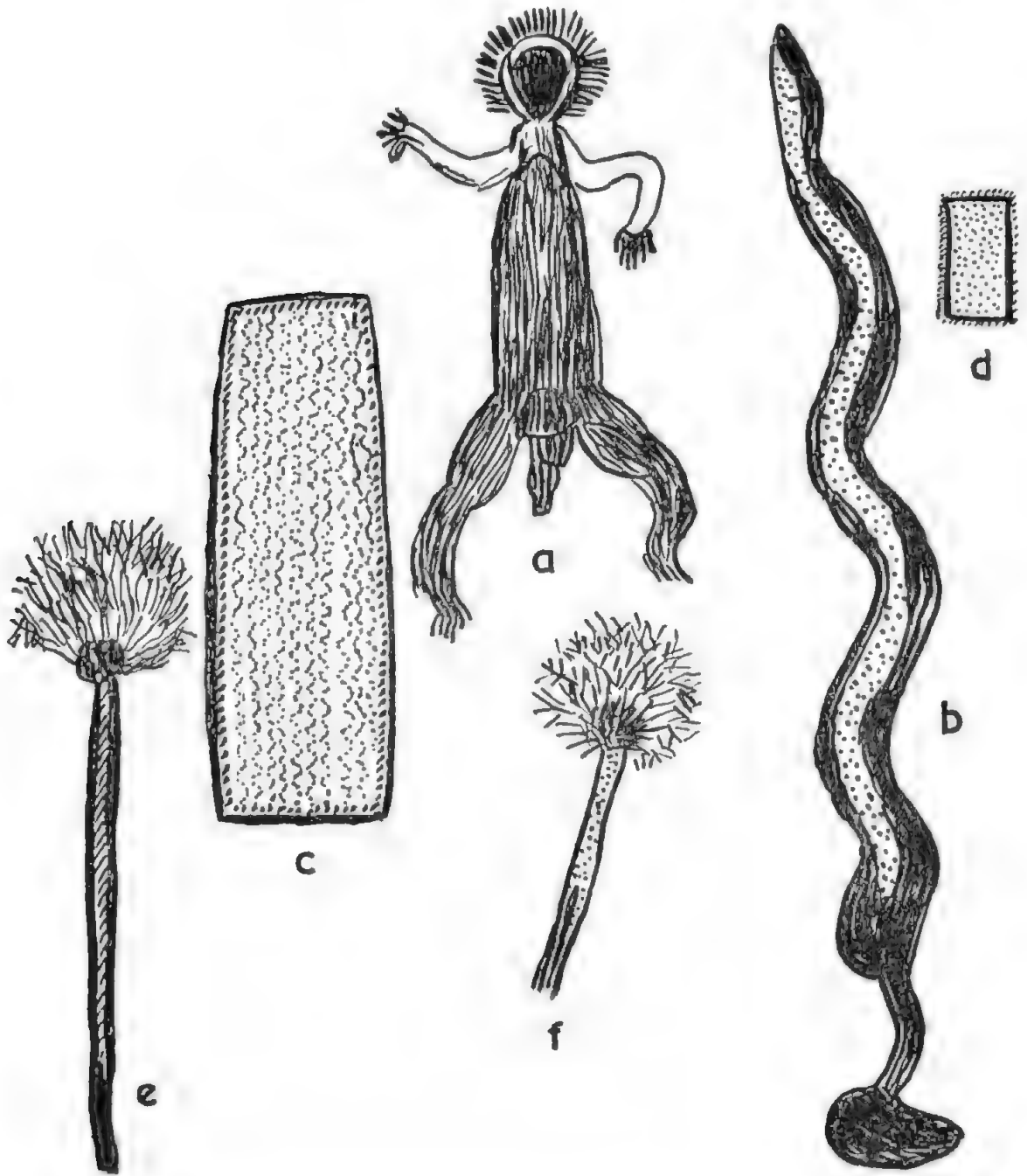


Fig. 6. The Wati Kantjeiri who attacked Jula, son of the Kungkarungkara. a. Wati Kanjeiri of Kandjanja. b. The Kanba (snake of the water Kandjanja. c. Inma kudidji bunu ngalta, ceremonial shield of kurrajong tree, used by the Being Kantjeiri, when he attacked Jula. d. Kudidji tjokotjoko, small shield (i.e., one of normal size) used by present day Jangkundjara people. e, f. Ngalta kanku, desert kurrajong (*Brachychiton gregorii*) growing at Kantjanja in the Everard Ranges. Drawn by Manana, 13th November, 1934.

men are the Wati Kutjara, who married the Ipi sisters. A genealogical tree makes this clear:—

NJIRU = Okaralja (Kungkarungkara)
 JULA = Mingari
 Ipi = MILPALI JUNGKU = Ipi

In Jangkundjara belief the activities of all these ancestral beings were closely linked together, they all lived their lives at about the same time and some of them were descendants of the others, all being associated with each other, as Jangkundjara folk are in their kinship system. In some ways this complicates the telling of details of the several myths. As a first step I have therefore chosen to give a brief outline of some of the activities of each of the principal ones and then where text material is available to give more intimate details. The Beings about whom details are available include:—

Jula, son of Njiru.

Mingari, the woman whom he chased (in animal form, the *Moloch* lizard).

Wati Kutjara, the two men, Milpali and Jungku (in animal form, two kinds of *Varanus* lizard or ngintaka) the sons of Jula and Mingari. In Western Australia these men are not called brothers (Tindale 1936, p. 171) and are known as Mumba and Kurnkadi.

Wati Malu, the Kangaroo man.

Kantju, a Dog Being who attacked Jula.

Wati Tawalpa (in animal form the tawal or hare wallaby *Onychogale lunata*).

Kalaia, the Emu man.

Korukadi, with whom Jula had an encounter at Korukading.

THE PLEIADES MYTH OF THE JANGKUNDJARA

An outline of the Jangkundjara version of the virgin women myth commences at the opposite end of their territory from Konkatjutanja, the place named in the Pindiini version, and begins with the appearance of the Kungkarungkara women from the north at Uluuru (Ayers Rock). Here in ancient times many different Beings met. An elaborate drawing of the place Uluuru is available and will be depicted in a later contribution when details of texts are being placed on record. The women attempted to kill Koneia, the great snake of

Uluru. There was a fight and the women fled. Journeying south from the vicinity of Ayers Rock the women, the Minna Kungkarungkalpa, sat down for a while at Junamba (Ju:naumba) which is the native water at the Yununba Hill of maps. They then travelled westward to Owalinja (O'walinja, 'Walinja).

About the time the women arrived at Owalinja a Being named Tawalpa who lived at Owalinja, provided stones with which Njiru, then a youth, was circumcised. He became a man. At Owalinja the Kungkarungkara women were camped with their dogs, when Njiru appeared to them as a man. He wished to cohabit with the Kungkarungkara. He attempted an assault but was frustrated by Papa, the dogs. Before the dogs drove him away he had had coitus with one of the women, as is depicted in the cave at Owalinja.

The Kungkarungkara women left Owalinja and crossed over the Musgrave Ranges to Aliwanjawanja (the Erliwanyawanya of maps) on the south side.

At Aliwanjawanja there is an outcrop of stone of a type (diorite) called *algara*, used in stone axe-making. The rocks around this place are likened to the shape of a woman's sex organs and the site is therefore connected with a ceremony of the Kungkarungkara, for in native belief the women caused the stone to appear there.

At Aliwanjawanja Njiru again attacked the women and the presence of the deep rockhole at this place is ascribed to his having penetrated the body of one of the women. The dogs again drove him away. In the cave beside the rockhole at Aliwanjawanja, Njiru is said to have left his 'walka (painting) showing himself in the act of mating. From this place the Kungkarungkara women passed in a westerly direction along the southern side of the Musgrave Ranges. They visited Ulparakindja, which is west of Kuli on the south side. They then went to Topalnga and Palingga. In the west Jula, son of Njiru, was born. Turning south across the sandhills and travelling a great distance, to the remotest place in Jangkundjara territory, the women arrived at Akandjudula. There they changed state or went into the ground (tarupango). They went up into the heavens (ilkari, alkari) and now appear in the early morning sky during the "cold time" (njenga) and "walk" across the sky. Their appearance in the sky is shown in a sand drawing made by a Pitjandjara man when discussing the Owalinja Cave (fig. 4, d).

Jangkundjara men who have travelled out of their own country have learned that the Kungkarungkara went south into the Pangkala

territory near Port Augusta with Njiru still in pursuit. They have the idea that the Beings made a circuitous eastward journey returning again to the north. During this journey Njiru and the Kelilbi (Star women) are supposed to have visited a big *jabu* (hill) beside the sea, south and east of Port Augusta (perhaps one or other of the peaks of the Flinders Ranges, Mount Remarkable, Mount Brown, etc., which possesses a deep gorge). The Beings then went north and the women are believed to have fled to Erumangara, a big plain "near Alice Springs".

TWO JANGKUNDJARA VERSIONS OF THE STORY OF JULA AND THE WOMAN MINGARI

Kongka Mingari (woman mountain-devil lizard) came from the west and arrived at Mingari (in the country of the informant's wife, a Pitjandjara woman). From the place Mingari, the Being went to Pilki, which is west of Walukutjara, and therefore somewhere to the west of 129° E. long. x 28° S. lat. She then travelled eastwards for a great distance to Tjalapina (Tjalpanbinja, Talbanbinja), the approximate position of which is near 131° E. long. x 28° 20' S. lat. She brought with her many *papa inura*, wild dogs. Today Tjalapina is both a *papa* and a *mingari tjukur* place. From here Mingari travelled south-eastwards to Kalaingga, situated on a line of waters running from Puntana to Ilii near the Everard Ranges, fetching her many dogs with her. Before the Kongka Mingari came, there were no dogs, only men *tjukur* in the country. One of the *papa inura*, named Bulgo, became lost at Kalaingga and the woman called to him, loudly 'Po:!' 'Po:!' Bulgo 'po:!' but no dog came. Mingari lay down. Bulgo returned during the middle hours of the night, lay down and went to sleep (*anggu*). Bye-and-bye Mingari rose to urinate (*kombo*) and to look about. She noticed that Bulgo had returned. The dog woke and pricked up its ears to listen, for it heard a noise in the ground.

It was the sound of the *kata* (son) of Njiru, named Julia, who was sneaking up to capture the woman. Bulgo leaped up and seized Julia by his penis (*kalu*). Then the whole pack of dogs surrounded Julia, who fled back towards Anmango. During his outward journey to steal the woman, Julia had travelled underground all the way from Anmango to Indinkarta (also called Indinkartu), a day's walk west of Kalaingga. On the way, at Tjalapina, he had urinated and a roaring sound, like *tji:::!* still can be heard there within the rockhole

as evidence of his passing. He had used his penis to dig a track. At Indinkarta he had emerged from the ground and travelling on the surface came to Kalaingga, where, while mating with Mingari, he was beset by her dogs, who chased him away to the north-west. Some of the dogs hung close to him all the way to Anmango whence he had come, others became tired, and some died at Okarta (not yet located). Bulgo was among those which disappeared and although Mingari called him he never returned.

Njiru, at Anmango, saw the plight of his son and picking up a kali (boomerang) in one hand and a branch in the other stood up to beat off the dogs, thrusting all black dogs on one side, brindle dogs on another and yellow ones in a third place. All the dogs were killed and were piled up in different heaps according to their markings.

Kongka Mingari followed after her dogs but gave up the chase at Julbudjaru and returned to the east. Having been assaulted by Jula she gave birth to the Wati Kutjara. It will be noted that the relationship between coitus and childbirth is recognized.

Mingari gave names to all her dogs, and Jangkundjara dogs today receive similar names according to their markings.

Names of the dogs of Mingari:

Bulgo—fawn dog.

Julpunj—yellow dog.

Njukali—black dog.

Tjerei—white dog.

Ngotjaru—another white dog.

Toldjaru—brindle dog.

Tjundalka—white nose and mouth.

Kongi—white and black slut.

Tjapina—black slut.

Karderu—white mark on legs.

Tjitangkanja—white mark on neck, otherwise brown.

Both Njiru and Jula remained thereafter at Anmango, the home of Njiru, in Pitjandjara country.

From the context it might appear that some of the details of this version were derived from the informant's Pitjandjara wife and Milina, the narrator, a middle-aged man, after telling his story said:—
“The old men may know more than this about the story of Mingari

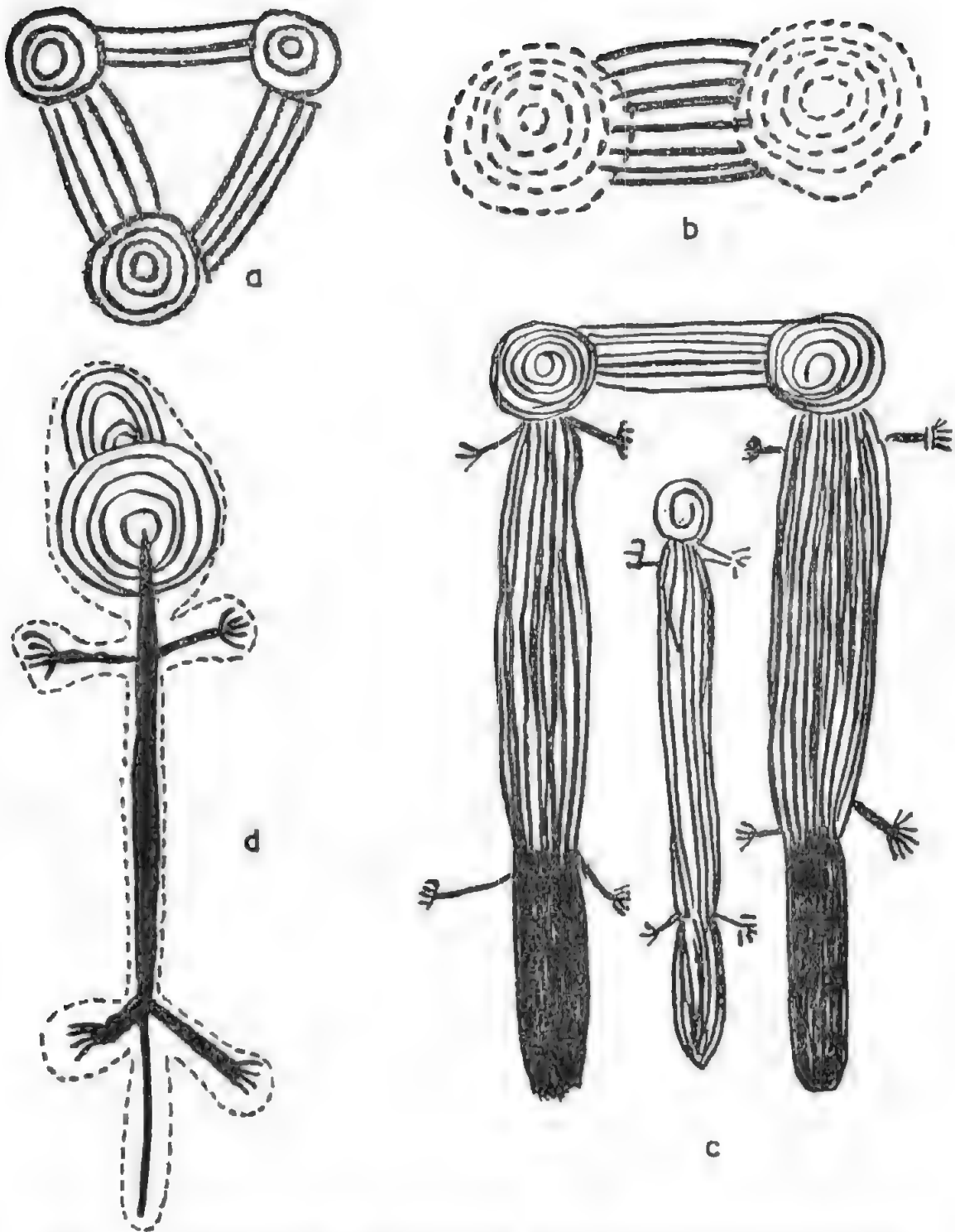


Fig. 7. a, b, left and right. Drawings of the Wati Kutjara (ngintaka) tjukurupa of the place Owalinja, in the form of concentric circles, called kuri kuri, as drawn by Moinkorei, a Jangkundjara old man, in August, 1933. These figures are depicted in Owalinja cave and are reproduced on the bodies of performers during the ngintaka tjukurupa ceremony. c. Drawing of the Wati Kutjara (ngintaka) of the place Ngankuru on the South side of the Mann Range, as drawn by a young man, Lankatjukurupa, of the Pitjandjara tribe, 18th August, 1933. Milpali and Junka (Jungku) are represented as together supporting the kuri kuri figure. d. Man carrying a wanigi in a ceremony as drawn in August 1933 by Djimindinja, a Pitjandjara old man of Peltadi in the Mann Range.

but sometimes they do not talk. Some tjilpi (old men) say there is more to be told".

In a second Jangkundjara version from the Everard Ranges, told by an older man, the Being who attacked Jula was a dog in human form, the Wati Kantjeiri (Kantju) who was associated with the place Kandjanja, north-east of Karumilnga. The name is identified with the Kandoenna Creek of maps, running north-eastward from Mount Carmeena (Karumilnga). This creek flows into the Alberga River.

In attacking Jula, the Being Kantjeiri carried a rectangular shield made from wood of the ngalta or kurrajong tree. A ceremonial drawing of the shield shows on it the same minu marks which were depicted on the body of the minu initiate at Ooldea, on his return to his people (fig. 6, c). Kandjanja, where ceremonies are performed for the Papa Kantjeiri tjukur being, is an important native water, at which lives a large snake, Kanba. Because the snake lives there the water is a permanent one.

Fig. 6 shows a native drawing of Wati Kantjeiri in human form, his inna kudidji bunu ngalta (ceremonial shield wooden kurrajong), the Kanba (snake) of Kandjanja, two ngalta kanku (kurrajong trees), and an ordinary shield.

OWALINJA CAVE AND THE KUNGKARUNGKARA WOMEN

Owalinja (Walinja, O'walinja) Cave is situated on the south side of a granitic outcrop on the plain north of the Musgrave Ranges. There is a second native place of this name near Ernabella. Data on it and indications of the association of the Kungkarungkara women with the cave was first obtained in May 1933, when the name appeared on several drawings made by aborigines, for example, fig. 7, a, b. This was during a journey to the Mann Range. Dr. C. J. Hackett and I passed too far south of the place to make a visit. The late Rev. J. R. B. Love later informed me that he knew the Owalinja Cave, and that it had many paintings in it. Its existence has been a matter of record since the days of the Carruthers Survey.

During May 1957 I was able to visit this cave in company with Mr. W. B. MacDougall, Native Patrol Officer, who earlier had informed me also of its interest and made arrangements for my visit. A few days after visiting the cave, Tommy Dodd (Tjundaka), the F₁ half-caste who had escorted Mr. C. P. Mountford on a trip to the

Mann Range several years previously, told me that they had passed near the cave but he had not thought to draw attention to it. From the published account by Mountford (1948, p. 124), it appears they were in some haste on this part of their journey. There are brief references to the myth in his book (p. 155).

The area in which Owalinja stands was until 1914 the territory of a northern group of the Jangkundjara, but following the serious drought of that and the following year, Pitjandjara men, forced eastward out of their usual living areas in the Mann and Tomkinson Ranges by the drying up of waters, successfully moved into the Owalinja country and deprived these people of their territory. They killed some and forced others to move south to the Everard Ranges. This shift forced some hordes of the Jangkundjara to attempt a migration still further south. They in their turn seem to have displaced some Kokata people, who from fear of the "Northerners," moved south-eastward, away from Ooldea towards Kingoonya; others went to the coast at Fowler Bay. In making this migration the Jangkundjara moved along the boundary zone between the Ngalea and Kokata peoples following the track of an ancient traditional trade route. Up to the year 1934 they still maintained links with their former mulga and sandhill territory in the north, but having continued to retreat towards Ooldea rather than towards the Everard Ranges whenever waters of the desert failed them, they finally settled down and now have become detribalised around the Mission on the coast near Yalata and at Koonibba. Those who survived the effects of contact with European diseases, etc., are now widely scattered. A few returned to the Everard Ranges, others are still living on the coast near Yalata and a few, when last encountered, were in camp near Port Augusta.

Of set purpose the exact position of Owalinja is not mentioned in this report pending official decision as to action to protect it from unauthorized visitors and vandalism. In the interest of science it is hoped that a carefully controlled archaeological excavation may be permitted since its rightful owners, the Jangkundjara no longer use it.

This rockshelter is possibly one of the most spectacular ones in Australia, and the layer upon layer of paintings on its walls will require much patient work and analysis by artists to ascertain the succession of styles, etc., depicted on its walls. The present preliminary account gives only a history of the known succession of

tribal visitors from Jangkundjara through Pitjandjara to Ngadadjara and will indicate the associations the cave has with some Jangkundjara beliefs about the Kungkarungkara, Njiru, the Wati Kutjara and kindred ancestral Beings.

To the usurping Pitjandjara who came from the west in 1915-1916 the cave was so far unimportant that even women and children were able to visit the rock and were permitted to camp at Owalinja, without much restriction. The usual camping places for women were on the northern and western sides of the hill. Here they sheltered from rain in the summer time. The southern, formerly very sacred cave, is visited only by Pitjandjara men. They say that as there are paintings of wanigi (ceremonial string figures) and other secret objects which must not be seen by the uninitiated, women cannot go there. Paintings of wanigi on the walls of the western shelter are ignored.

In legendary time Njiru, the Kungkarungkara, the Wati Tawatpa the lizard woman Milpali, the Wati Kutjara and the Wati Malu all visited Owalinja, leaving records of their passage in the cave. Fig. 8, a is a drawing of a wanigi of the Wati Kutjara by a Jangkundjara man in 1934 which is paralleled by wanigi of the same totem in Owalinja Cave, while fig. 8, b depicts a figure of the same totem drawn by a Pitjandjara man of the Mann Range in 1933. The last-named has below it the marks painted on the backs of the performers during Increase ceremonies for lizards at which the string figure is displayed. Njiru made his attack on the Kungkarungkara in the cave and Tawal (the hare wallaby, *Onychogale lunata*) after residing there left on a visit to Aliwanjawanja in company with the Milpali tjukurupa, before he went on a journey south to scatter knife-stones over country near Amaroodina, as will be related in another part of these records.

GENERAL DESCRIPTION OF OWALINJA MAIN CAVE

The main cave is entered from the south. It is under a great dome of granite which has been weathered out to form a chamber 35 yards long, 10 yards wide and 3 yards high at its highest point. Part of the floor at the western end, where it is lowest, is cluttered with smaller granite boulders and a ramp of sloping rock runs upwards at the east, ending in a narrow crevice. The front of the rockshelter is hidden by large native fig trees so that the cave is not very conspicuous from the south, and its size is only appreciated when at the western entrance. The whole of the walls and roof are painted

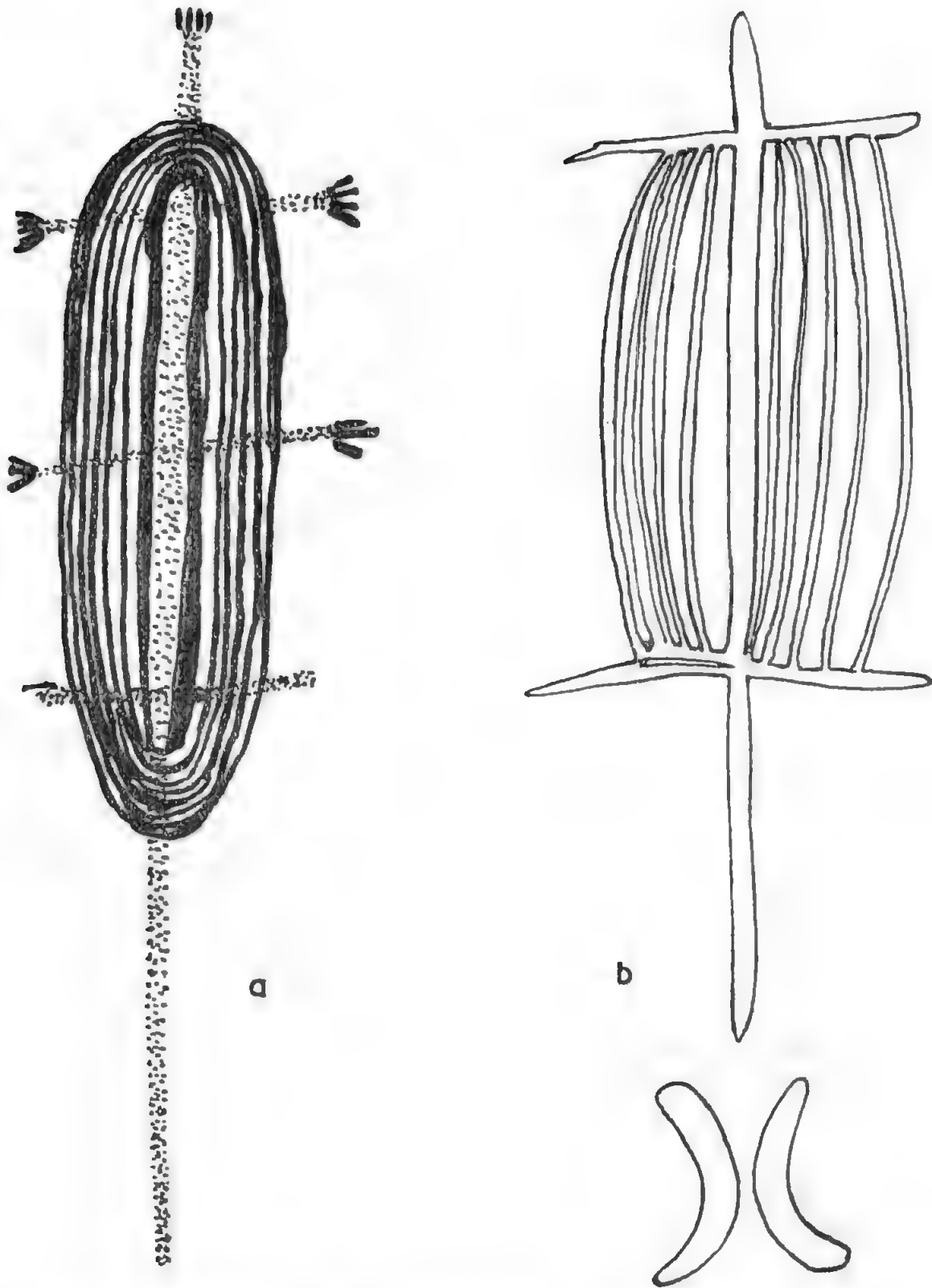


Fig. 8. a. Jangkunjajara wanigi (thread cross) of the Wati Kutpara and Milpali drawn by Manana, about 55 years of age, at Ooldea, 13th November, 1934. The memory of this man went back to before the Carruthers Survey; he was a middle-aged man before the Pitjandjara drove him and his companions away from the Owalinja area. The drawing is in red (dotted) and black. b. Pitjandjara wanigi of the Wati Kutjara ngintaka tjukurupa (men two lizard totem) drawn by Tjinguinja a newly initiated youth, on 6th June, 1933. The marks below, also in white are called inma tjana walka and are painted on the backs of performers during the Increase Ceremony for ngintaka; wanigi depicted in Owalinja and ascribed to the Wati Kutjara, closely resemble these drawings.

and overpainted again and again, designs continuing even on the lip-like overhang of the roof at the entrance, where they are in partial darkness except at the brightest time of day.

First impression is that most of the older paintings, and these include the earliest ones designated as being of the Minma Kungkarungkara, are in red ochre, but on closer examination there is seen to be great variety.

There are several very late ones in yellow ochre. A Pitjandjara old man, who accompanied us, ascribed these to recent visits by Ngadadjara men from the Warburton Range. These men had come over on a visit to the Ernabella Mission, since its foundation just before World War II. The newly painted yellow figures include, according to him, representations of a snake (leiro), one of a wati inma njurtidjara (man ceremonial object carrying), and a third group included some he could not identify.

It is of interest to note that a source of the yellow pigment (garnierite) is the nickel ore outcrop near Ero:tjo, north of Mount Hinekley. This is an important native place on the boundary between Ngadadjara and Pitjandjara tribal territories. The pigment itself is gathered from the rims of the nests of ants which mine the little pellets of it in the course of their burrowings.

Marks which my informant, and other Pitjandjara men had placed as an overlay on the older Jangkundjara figures since 1915 were recognized and pointed out. Some of those indicated as of recent Pitjandjara origin were of men riding camels. These and some of the other Pitjandjara drawings were in black and white, and all had been painted after 1915.

It is of some interest to note that drawings, in chalks of kinds issued by the Ernabella Mission, had been added in the western cave since a visit by MacDougall in the previous year, and our native guide was able to confirm that Pitjandjara people from the Ernabella Mission had camped at Owalinja during the summer of 1956-1957, hence the rockshelters preserve native records from ancient times right up to the present day.

THE CEREMONIAL PAINTINGS AT OWALINJA

The figure of the ancestral Being Njiru in coitus with the Kungkarungkara (Pl. xxxv. A) is a curious drawing; the posture is that of similar drawings I have seen elsewhere and can be best understood after an appreciation of the method of mating adopted by

Central Australians. Roth (1897, p. 179, fig. 433) gives a useful description and figure.

The oldest Minma Kungkarunkara paintings are depicted usually without mouths, in red, with their hair long and as pointed out to me by old man Peter, rolled up in a coil, folded in on the forehead, as was the fashion for Pitjandjara and Jangkundjara women, and was still the practice among the Ngadadjara in 1935 (Pl. xxxix, A). Photographs taken in 1903 by Basedow (1914) in the Musgrave Ranges, show this style, which in 1933 was still in vogue among both Jangkundjara and Pitjandjara people.

The later paintings of Njiru and the Women are in black, and are less elaborately done.

The Jangkundjara used to hold Increase ceremonies for Papa (dingo) in this cave. They depicted their dogs showing two eyes, in black outlined with white.

A flat stone on the western end of the Owalinja Cave was used in the Papa ceremony as a rubbing place for papa kuloinba or dog excreta, with the white powder of which some of the paintings were done, as part of the ceremony. During the rites a song was sung describing the effects of the attack on Njiru by the dogs belonging to the Kungkarunkara.

Song:—

I:	Njirunja	kalu	nalkur	
Exclamation	Njiru	penis	bitten	
	nari	keildjoro	keildjoro	itjarta
	lay	(bleeding)		spear
	Njirunja	kalu	nalkur	nari
	Njiru	penis	bitten	lay

The ceremony was performed in the cave because there was a close association between the Kungkarunkara Women and their dogs. Figures painted represent the papa (dogs) themselves, the inna puduru bulka (ceremonial-object string large), wanigi (string figure) and men carrying wanigi on their heads during the Papa ceremonies.

The Papa ceremony is shown by Pitjandjara to young men before circumcision. They are given only brief glimpses of highlights of the dances at this time. The proceedings at such a ceremony were witnessed by the author in 1933, at Konapandi on the southern side of the Musgrave Ranges. A film record of the ceremony, taken by

him, has been published as part of Film No. 20 in the 16 mm. series of the Board for Anthropological Research at the University of Adelaide.

Plates xxxii-xxxviii show some of the paintings in the two caves examined; an approximately complete coverage would require more than five times this number of figures. In the explanations to the plates notes are given on those recognized by Peter, our Pitjandjara informant. It is hoped to be able to take Jangkundjara men to the shelter. Some text and song detail already has been gathered and will appear in Part II of this series.

During my 1933 visit to Aliwanjawanja I happened to be examining the rockshelter there and sketching in my notebook when a Pitjandjara man followed my tracks into the cave. After watching me for a while he departed but later returned and began, of his own accord, making drawings in the shelter with charcoal as pigment. We each worked silently for some time, but when he had finished and had turned to go, I learned he had painted leiru or snake markings, in part over inma njurtidjara wati (men carrying ceremonial objects) in white paint. I photographed him (Pl. xxxix, B) at work.

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EXPLANATIONS OF PLATES

PLATE XXXII

- Fig. A. South side of Owalinja granite dome looking east, showing native fig trees concealing entrance to the main shelter.
 Fig. B. Shelter used by women and children on the western face of Owalinja; the protected area beneath the large central boulder is about 15ft. long and 10ft wide, with occupational debris present in a sand-floored alcove at the southern end.

PLATE XXXIII

- Fig. A. Fifteen feet of the back wall and roof at the western end of the main shelter at Owalinja, with Pitjandjara informant, Peter. Above his head a picture of man and horse, painted since 1915. The roof shows faintly visible substrata of large-sized human figures chiefly in red ochre overlain by black figures outlined in white.
 Fig. B. Lip of rock shelter near western end showing lines of small white figures and black ones, some outlined with white. On the right is the figure of Njiru with a Kungkarungkara woman (see Pl. xxxv, fig. A), and at upper left the figure of man with supposed horse (see also Pl. xxxv, fig. B).

PLATE XXXIV

- Fig. A. The upper figure of Pl. xxxiv shows a heroic sized figure of Njiru in red outlined in white, the nose is represented by a white line and there are traces of eyes; to the right are traces of red figures of the Kungkarungkara overlaid with black ones of Njiru outlined with white; the nose and eyes are shown. At the left the overlay consists of black figures of the Kungkarungkara, with spots representing stars on their bodies and the pudenda drawn as wide black openings; beneath them is the figure of one of their defending dogs, in black with the outline and paired eyes in white. At the lower right of middle is a cruder figure of a wanigi-bearing man in black outlined in bright yellow. This is one of those ascribed to recent Ngadadjara visitors. The background is a maze of red lines representing earlier paintings.
 Fig. B. This shows a portion of the wall approximately 12ft. wide a little more to the right and extending lower down on the back than the one above. There is some overlap. A central figure and one to the left are each of Njiru, in different styles but both painted in black, outlined with white; that on the left shows chest cicatrices. The white foot track painted over it, to the knowledge of our Pitjandjara informant, was done after 1915. At lower middle is the figure of a black dog, the Papa Kantju, outlined in white; above its tail is another inna njurti wati, painted entirely in yellow ochre; this overlay is ascribed to the recent Ngadadjara visitors. The emu (kalaia) figure at the left of middle is Kalaia tjukurupa, a Being who appears as a group of stars and as dark patches in the Milky Way; the spots on the body represent stars. Just to the left of the middle is a squatting figure of one of the Kungkarungkara in black, outlined with white; two similar figures with white spots on their bodies also represent Kungkarungkara women.

PLATE XXXV

- Fig. A. Enlarged view of the figure of Njiru cohabiting with one of the Kungkarungkara; the design is in black outlined with white; the white semicircular design is a later addition. The design was painted over an earlier figure, apparently of the same subject, in red ochre.
- Fig. B. Figures in red of two Kungkarungkara women. The smaller human figure and animal in black outlined with white was said to be a man with a horse. Below it is a supposed cattle brand added by a civilized aboriginal.

PLATE XXXVI

- Fig. A. Njiru (right) and a Kungkarungkara woman (left). These are painted over two kuri-kuri circles representing the Wati Kutjara, whose wanigi, thread cross or string figure is partly shown at the right.
- Fig. B. Portion of roof at eastern end of main shelter, about 15ft. wide, showing two large wanigi of the Wati Kutjara and kuri kuri or concentric circle marks representing the Wati Kutjara. The kuri kuri may be compared with text figure 7 (right), and the wanigi with those in text figure 8.

PLATE XXXVII

- Fig. A. Paintings in the Western or Women's cave. At left is a figure of a woman carrying wooden dishes on her head, below is a man riding a camel. The older paintings consist of white spots on a black surface, concentric circles, lines of emu tracks in white with an underlay of obscured figures in red ochre, and innumerable white spots.
- Fig. B. Central portion of the Women's cave showing some recent designs in crayons obtained from the Mission over smoke obscured white paintings. The central figure, said to represent a motor truck, is believed to have been done by Pitjandjara living at Owalinja in the summer of 1956. The concentric circles are in white and at the extreme right and extending beyond the picture are traces of wanigi designs in red overlain by white designs; they are shown in Pl. xxxviii.

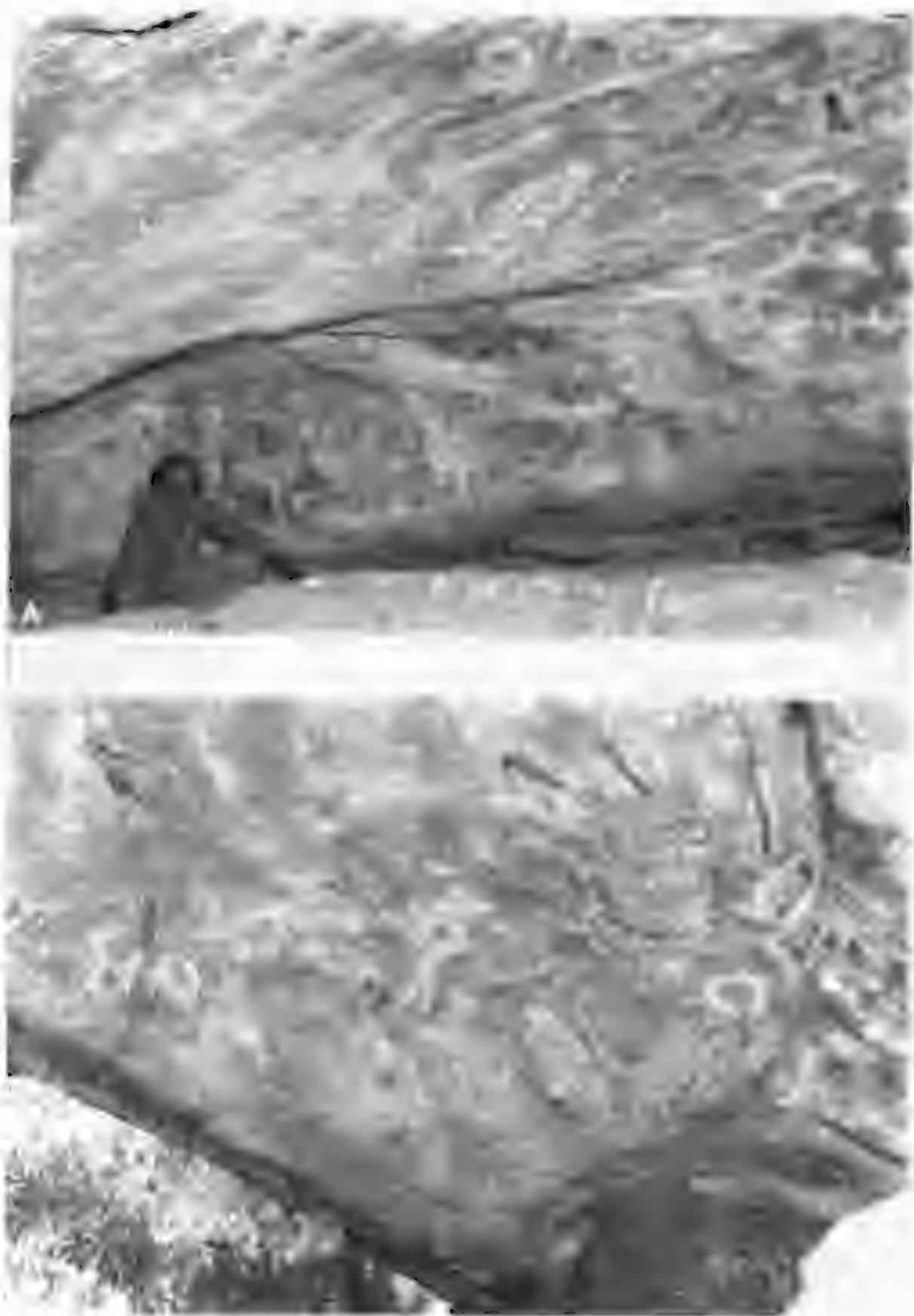
PLATE XXXVIII

- Two figures bearing wanigi (thread crosses) as depicted at the southern end of the Women's Cave (of the Pitjandjara). The main figure on the right of the middle is painted in red with a black face, and carries an inma njurti in red, outlined with white; the central part of the wanigi is black with red and white bars. The large wanigi in the middle is red outlined in white. There are two cross sticks in red and a central pole; the white outline appears to be an addition. It is supported on the head of a man figure painted in white with the face and body indicated in black. The lines of man, dog and kangaroo tracks were made after the wanigi design. All the designs in this shelter are darkened by smoke from camp fires.

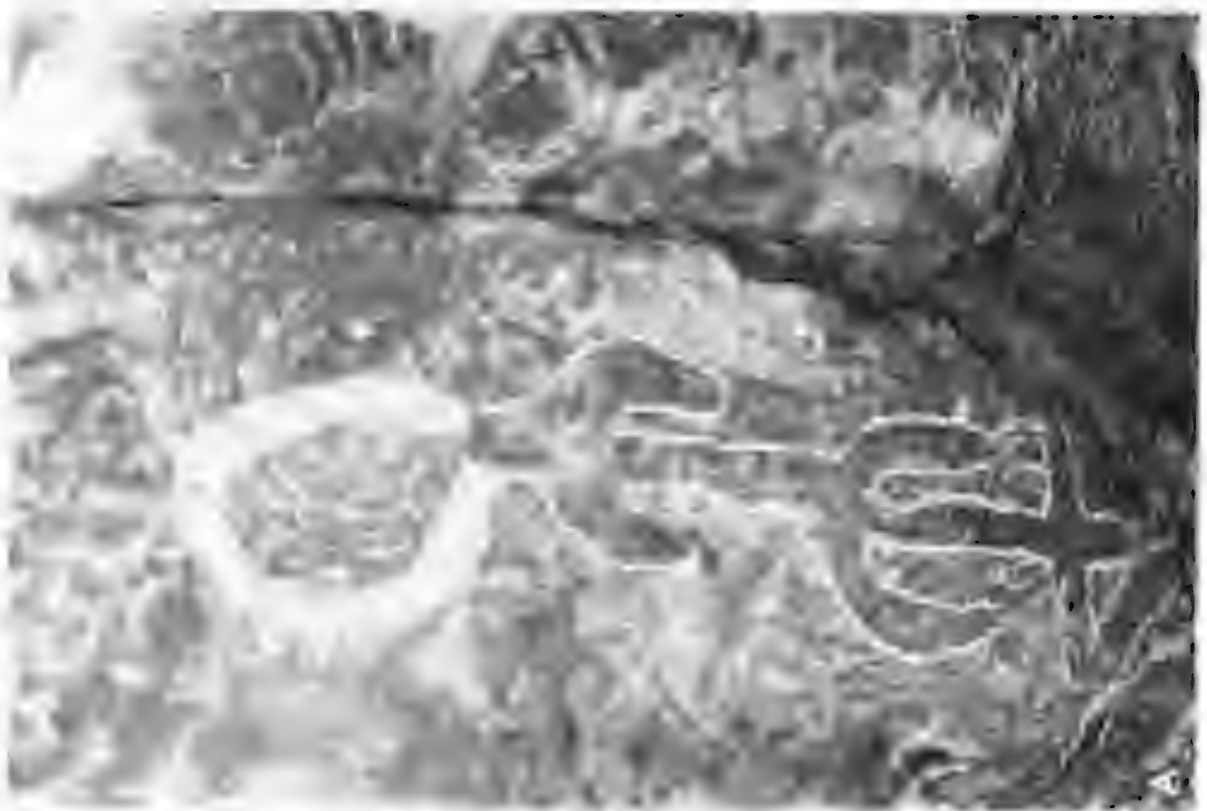
PLATE XXXIX

- Fig. A. Pitjandjara man making leiru or snake markings, in Aliwanjawanja (Erliwanyawanya of maps) Cave on 20th June, 1933; his efforts were superimposed on white figures of inma njurtidjara wati (ceremonial-object-carrying-men).
- Fig. B. Unmarried woman of the Ngadadjara tribe, Warupuju, Warburton Range, Western Australia, showing her hair folded in on the brow, as in Kungkarungkara women depicted in Owalinja Shelter (photograph by the late Mr. E. O. Stocker, taken during the University of Adelaide Expedition of August 1935).

















THE PIGMY SPERM WHALE ON SOUTH AUSTRALIAN COASTS (CONTINUED)

BY HERBERT M. HALE, DIRECTOR, SOUTH AUSTRALIAN MUSEUM

Summary

Some data concerning two young Pigmy Sperm Whales, *Kogia breviceps* (Blainville), are recorded. These examples were stranded on the shore of St. Vincent Gulf, South Australia. In one of them cartilaginous vestiges of the pelvis were present.

Passing references are made to post mortem changes of colouration in *Mesoplodon layardii* (Gray) and to the identification of *Pseudorca crassidens* (Owen) off the coast of South Australia.

THE PIGMY SPERM WHALE ON SOUTH AUSTRALIAN COASTS (Continued)⁽¹⁾

By HERBERT M. HALE, DIRECTOR, SOUTH AUSTRALIAN MUSEUM

Plate xl and text fig. 1-2

SYNOPSIS

Some data concerning two young Pigmy Sperm Whales, *Kogia breviceps* (Blainville), are recorded. These examples were stranded on the shore of St. Vincent Gulf, South Australia. In one of them cartilaginous vestiges of the pelvis were present.

Passing references are made to post mortem changes of colouration in *Mesoplodon layardii* (Gray) and to the identification of *Pseudorca crussidens* (Owen) off the coast of South Australia.

INTRODUCTION

On July 11, 1958, two small whales were noticed floundering in shallow water at Largs Bay, a residential and holiday resort on the eastern shore of St. Vincent Gulf in South Australia; here, at low tide, a considerable expanse of "flat" is exposed owing to the gently sloping sandy coast. Both examples were described by observers as being about 7ft. in length; they were stranded on the beach next day, unfortunately a Saturday, when crowds of visitors were present. With one of the Museum preparators (Mr. A. Rau), and his assistant, I went to the abovementioned beach soon after the specimens were reported, hoping that we might recover them. Regrettably, however, one example had been literally hacked to pieces and the skull smashed, but the remains on the beach showed it to be, without doubt, *Kogia*. Moreover, Mr. F. Johnson, a resident of Largs North, had secured two 35 mm. Ferrania colour photographs of this example, taken as it was thrashing about in very shallow water.

The second specimen had been removed by Mr. Howard Trotter and was exhibited during the week-end outside his refreshment rooms at nearby Outer Harbour. A description and measurements of this example were made and shortly afterwards the animal was brought to the South Australian Museum.

(1) See also Rec. S. Aust. Mus., viii, 1947, 531-546.

SPECIMEN No. 1. SEX UNKNOWN

The photographs reproduced on pl. xl are enlargements from the two colour photographs secured by Mr. Johnson. The portions which are dark in the half-tone prints were blue on the back (as in Boschma's illustration of 1951, fig. 1) merging into blackish brown on the upper part of the head and body. The light areas, however, are much more extensive than in examples previously recorded, the greater part of the snout, the belly, and the lateral parts of the body below the level of the eye, being white. The mottlings which appear on the caudal portion (pl. xl, upper) are apparently splashes of blood diluted with sea water. The colour pictures show the water nearby to be blood stained, and the animal to be bleeding from wounds on the front of the snout and dorsal fin, the edges of the flukes and the underside of the caudal parts.

The snout is blunt, somewhat as in the adult female previously described from South Australia (Hale, 1947, pl. xiv, upper fig.) and in Boschma's abovementioned figure; it is obviously longer than in the other juvenile (No. 2) described below. The dorsal fin is large and falcate, and the open blowhole is obvious in the lower photograph on pl. xl herewith.

The photographs alone must suffice as a record for this example, which, as already noted, was said to be 7ft. in length.

SPECIMEN No. 2. YOUNG MALE

Colour.—When examined by us the animal had been dead for about 48 hours. The colouration then was almost black above, lighter below.

External Characters.—The measurements of the young male *Kogia* were as follows:—

	mm.	per cent.
Total length to notch of tail flukes	1930	100
Tip of snout to vertical level of anterior corner of eye	180	9.3
Tip of mandible to vertical level of anterior corner of eye	140	7.3
Tip of snout to vertical level of anterior edge of dorsal fin	930	48.2
Tip of mandible to axilla	386	20.0
Tip of mandible to anterior point of genital slit	1270	65.8

The notch in the tail was well marked, approximately 25 mm. in depth.

The differences in the shape of the head, as shown in the photographs of the living example, reproduced on pl. xl and in the sketch of the dead young male (fig. 1) are quite marked.

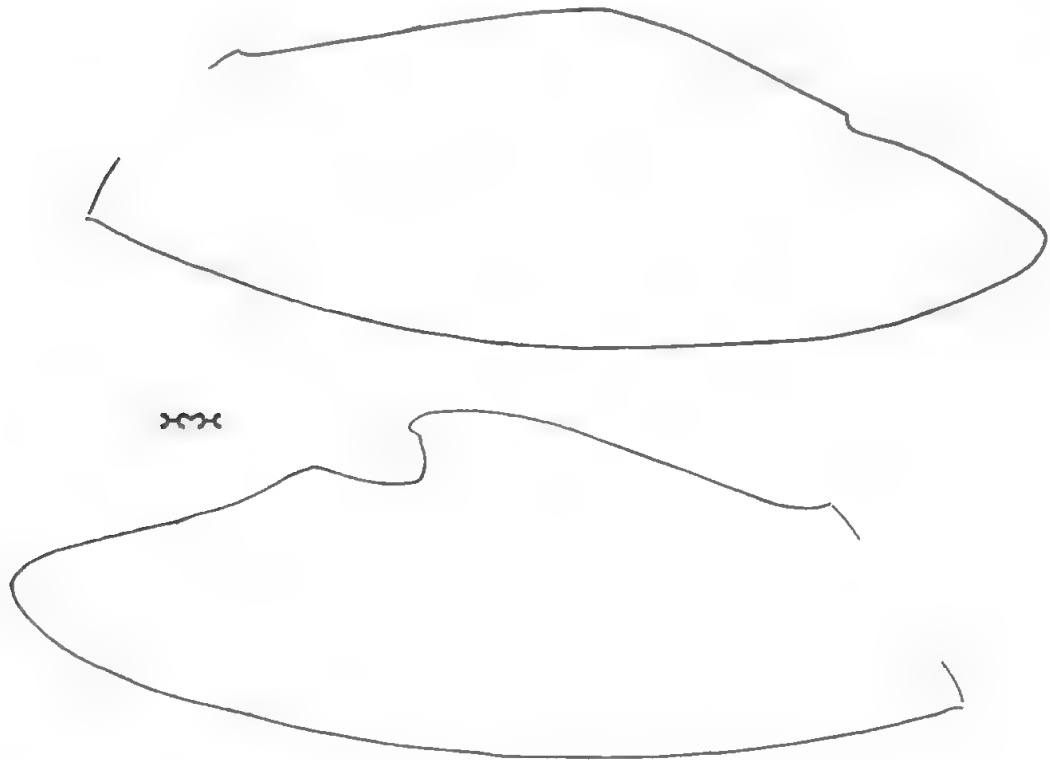


Fig. 2. Left (upper) and right flippers of *Kogia breviceps*, Largs Bay, South Australia. (Specimen No. 2, $\frac{1}{2}$ natural size.)

Skeleton.—The flesh has been largely removed from the skeleton, which is in process of maceration, pending further examination. In the partly fleshed skeleton, with the vertebrae all in place, a count showed a total of 57: cervical, 7; thoracic, 14; lumbar, 10; caudal, 26, the last being very small, only about 4 mm. in length.

Vestiges of the pelvis are present. They are hard, but are cartilaginous, as suspected by Glover M. Allen (1941, pp. 32-33), and are about 24 mm. in length, slightly curved and approximately five times as long as deep.

Skeleton in South Australian Museum, Reg. No. M6186.

ACKNOWLEDGMENTS AND REMARKS

My best thanks are due to Mr. F. Johnson for the colour slides of call No. 1, and to Museum Artist and Photographer, Miss M. Boyce, who is responsible for the half-tone enlargements therefrom. Also to Mr. Howard Trotter, who readily parted with the young male when he was informed that it was of scientific interest; and to Mr. A. Rau, who painstakingly and successfully searched for the pelvic cartilages.

It is a matter for regret that, in my experience, whenever small whales, or for that matter larger species, are stranded near populated areas, they are at once mutilated by visitors. In South Australia small whales cast up on beaches are almost invariably reported as "Blackfish," with, maybe, the remark that as "Blackfish" are common in our seas they cannot be of much interest. In all probability the smaller whales occurring off our coasts are by no means as rare as it would appear from published records. It is certain that many strandings are not observed, as whales surely must be cast up from time to time on uninhabited portions of the vast coastline of Australia.

It is worth stressing the fact that post mortem changes occur very rapidly in at least some of the small whales. In February, 1956, a young male Strap-toothed Whale (*Mesoplodon layardii*) was seen swimming off Rocky Point in the American River Estuary at Kangaroo Island, South Australia, for about a week. During that period it was studied by Prof. Richard Blackburn and Dr. James Forbes, competent observers, who described the colouration as bronze-brown on the dorsum, pale grey ventro-laterally grading to off-white on the underside.

Mr. F. J. Mitchell of the Museum staff, together with one of the preparators, went to the site 48 hours after this specimen, injured by gunshot, was stranded. Its colouration then was black above, grading to purplish-pink on the sides and with isolated grey patches on the underside of the head.

The animal, being in obvious distress, had been killed by Dr. Forbes soon after it came ashore and it was noted that the whale lost its life colouration immediately after death.

The complete skeleton and some measurements of the whole animal were secured; I am indebted to all the abovementioned for the data and material obtained concerning this *Mesoplodon*.

Opportunity is taken to correct an error in identification of a herd of whales stranded at Port Prime, on the eastern side of St. Vincent Gulf in South Australia. An extremely hurried visit was

made here by the late Prof. Harvey Johnston and me during the days of petrol rationing, the trip being made possible by one of the local newspapers. (Hale, 1956, p. 181) and the species was recorded as *Globicephalus ventricosus*. Later examination of all photographs secured at the time by a news photographer, and of a skull recovered by my friend Mr. E. A. Brooks, of nearby Buckland Park, shows that this herd consisted of examples of the False Killer Whale (*Pseudorca crassidens*).

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Young Dugong Sperm Whale aground in shallow water. (Specimen No. 1, Largs Bay, South Australia.)

REDESCRIPTION OF TWO OF CANESTRINI'S 1884 SPECIES OF AUSTRALIAN ACARINA

BY H. WOMERSLEY, SOUTH AUSTRALIAN MUSEUM

Summary

Fresh material referable to the two species of Acarina-Mesostigmata described and figured by Canestrini 1884, as *Laelaps dolicanthus* and *Laelaps coniferus* has now been studied and the species are redescribed and refigured. Two new genera *Cosmetolaelaps* and *Conolaelaps* are erected for the species respectively. The nymph of *dolicacanthus* and male and nymph of *coniferus* are described and figured for the first time.

REDESCRIPTION OF TWO OF CANESTRINI'S 1884 SPECIES OF AUSTRALIAN ACARINA

BY H. WOMERSLEY, SOUTH AUSTRALIAN MUSEUM

Fig. 1-3

SYNOPSIS

Fresh material referable to the two species of Acarina-Mesostigmata described and figured by Canestrini 1884, as *Laelaps doliacanthus* and *Laelaps coniferus* has now been studied and the species are redescribed and refigured. Two new genera *Cosmetolaelaps* and *Conolaelaps* are erected for the species respectively. The nymph of *doliacanthus* and male and nymph of *coniferus* are described and figured for the first time.

INTRODUCTION

In 1884 Canestrini described a number of species of Acarina from material collected in Queensland by Prof. Palle of Padova University. Amongst these were *Laelaps doliacanthus* n. sp. and *Laelaps coniferus* n. sp. neither of which has since been collected or recognized although Rainbow (1906) in listing Canestrini's records states that there are in the Australian Museum specimens which are probably this species collected by S. J. H. Moreau at Antonio, near Rydal, New South Wales. At my request for the loan of these specimens, Mr. A. Musgrave, Entomologist, Australian Museum has very kindly searched the collections, but failed to find the preparations. It must therefore be considered that the specimens have been lost over the years.

Recently, however, specimens which undoubtedly belong to *doliacanthus* were found on an old slide in the South Australian Museum collection. The slide was labelled "*Laelaps*, sp. off *Onthophagus laminatus* MacL., Townsville, Queensland—F. H. Taylor", without any date of collection. Taylor, however, was working in that area in the 1920's. Canestrini stated that he had several specimens from on a lamellicorn beetle, briefly described both sexes, and gave recognizable figures of the male venter and dorsum and of the male chela.

Laelaps coniferus n. sp. was described from specimens found in a vial of insects collected by Prof. Pulle in Australia. Canestrini shows (fig. 4) a recognizable figure of the ventral surface although it is now clear that it is not quite correct in certain details. Specimens referable to *coniferus* have recently been collected from millipedes in a rotting Eucalypt log at Hampton, 30 miles NE of Toowoomba, Queensland, October 3rd, 1956 by Dr. G. F. Bornemissza. Only the females were found by Canestrini, but Bornemissza's material comprised both sexes and a solitary ecdysing nymph.

As both the above species are unique amongst the Laelaptidae in many features, new genera are erected for them; viz., *Cosmetolaelaps* for *dolicacanthus* and *Conolaelaps* for *coniferus*.

Genus *Cosmetolaelaps* nov.

Laelaptidae with 2-tined specialised seta on palpal tarsus. Dorsal shield entire, covering almost the whole of the dorsum in both sexes, furnished with ca. 31 pairs of generally long and strong ciliated setae of which 3 pairs are laterad of the shield and all but the posterior pair are anterior of the mid-dorsal line.

Female without pre-endopodal shields; sternal shield much wider than long with 3 pairs of setae; metasternal shields absent, represented only by seta and pore; genital shield short and drop-shaped with one pair of setae; no ventral shield; anal shield broadly pear-shaped with the paranal setae in line with the posterior of anus, postanal seta the longest; endopodal shields of coxae III and IV well defined and free. Legs shorter than body, II somewhat stouter than others; tarsi with pad-like caruncle but without claws. Gnathosoma normal with 4 pairs of setae, the posterior two pairs ciliated. Tectum roughly triangular.

Male with the sternal, genital, metasternal and ventral shields coalesced, finely punctate with striate lines, the combined shield narrowest between coxae IV then expanding and narrowly separated by striate cuticle from the separate anal shield; sternal setae of moderate length and stronger than in female, metasternal setae strong and very long reaching to tip of ventral shield; genital setae also strong and long; ventral shield with two pairs of short lateral setae; anal shield with the postanal seta much longer than the paranals. Stigma between coxae III and IV with the peritremal shield extending shortly posteriorly and the peritreme running to coxae II. Gnathosoma as in female. Chelicerae similarly with each finger

stout and furnished with one strong tooth, movable finger with a long, backwardly directed spermatophore carrier, the tip of which itself is also chelate. Legs not longer than body, all tarsi with pad-like caruncles and no claws; leg II very stout, tarsus apically with 3 strong spines.

***Cosmetolaelaps doliacanthus* (Canest. 1884)**

Laelaps doliacanthus Canest. 1884. *Acari dell'Australia*. *Atti Ist. Veneto*, 2 Ser. VI: 709. tav. VII, fig. 2, 3; Rainbow, 1906. *Synopsis of Australian Acarina*. *Rec. Aust. Mus.* 6: 172.

Fig. 1 A-E, 2 A-F

A strong sclerotised brown species of oval form; with the above generic characters. The following specimens are described.

A single female of idiosomal length 750μ and width 520μ , and legs I 480μ long, II 480μ , III 460μ and IV 550μ . Dorsal shield 690μ long by 430μ wide, with a number of pores and 31 pairs of long to very long strong ciliated setae, the longest being the two posterior setae to 290μ . Ventrally the sternal shield is strongly and finely punctate with striate lines, 244μ wide by 108μ long medially, anterior margin lightly concave, posterior margin lightly concave with 3 excavations of which the median is the deepest, with 3 pairs of strong setae 47μ long, and two pairs of pores; metasternal shields only represented by a seta 45μ long and a small pore; genital shield as figured, slightly wider than long, 117μ by 94μ , with one pair of setae 42μ long; anal shield as figured, 117μ long by 125μ wide, paranal setae 40μ long, postanal seta 70μ long, cribrum present; on ventral entele with 9 pairs of small setae.

Two males, one of 800μ idiosomal length and 610μ width, the other 890μ length, 670μ width. Length of legs respectively, I 580μ (590μ), II 700μ (730μ), III 550μ (580μ), IV 730μ (812μ). The following measurements are from the smaller specimen; dorsal shield 754μ long by 600μ wide; posterior dorsal setae 450μ long; the combined sternal, metasternal, genital and ventral shield 440μ long, sternal portion 255μ wide, ventral portion 244μ wide, separated posteriorly from anal shield by 35μ ; anal shield 116μ by 116μ ; sternal shield with 3 pairs of normally placed setae 94μ long; metasternal setae very long to 235μ and strong; genital setae also very long to 155μ and strong; lateral setae on ventral portion 37μ long; paranal setae 80μ long, postanal 145μ . Legs as figured, femur, genu and tibia each

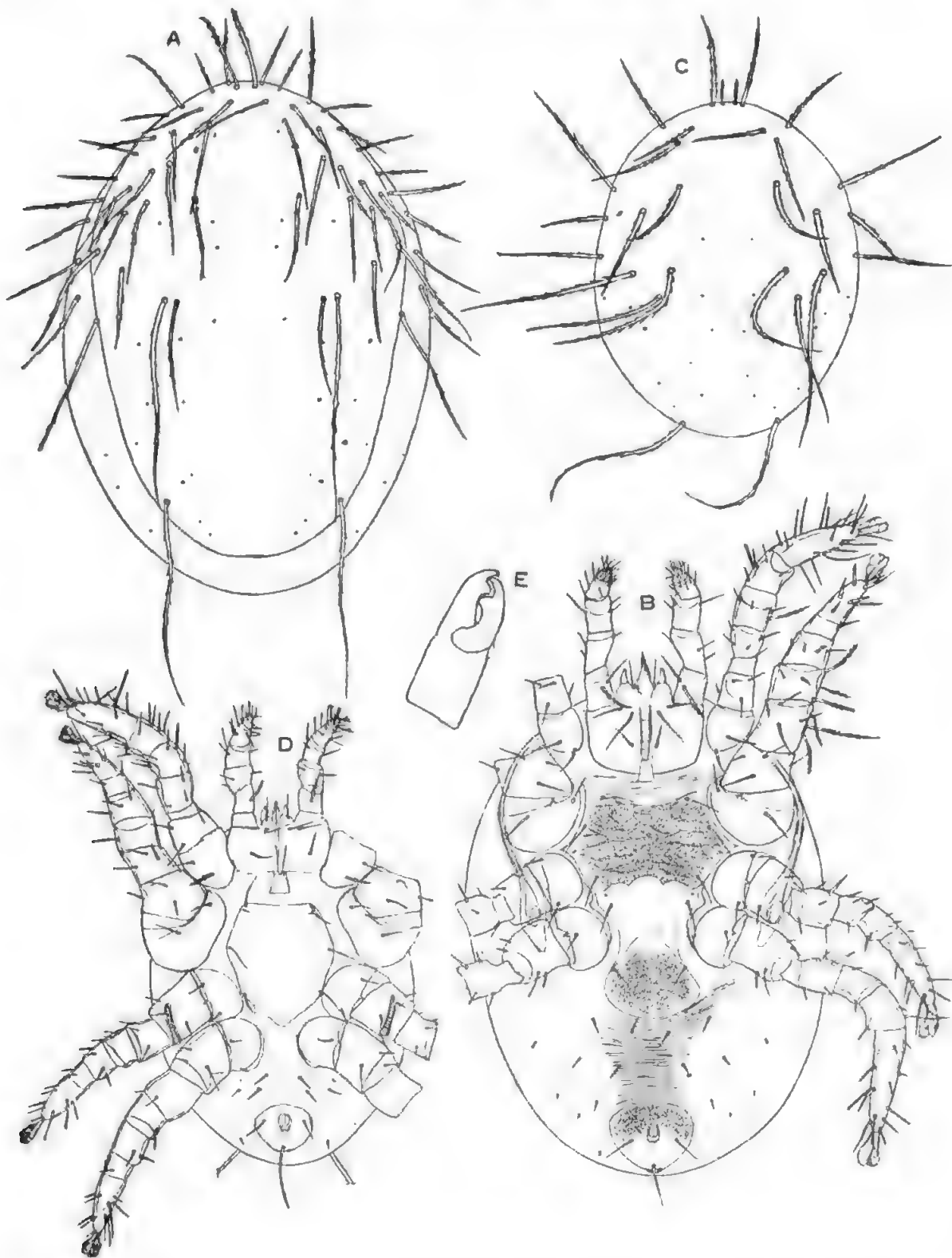


Fig. 1. *Cosmetolaelaps doliacanthus* (Canest. 1884). A-B. Female of 750 μ length mounted, A. Dorsum, B. Venter. C-D. Nymph of 510 μ length mounted, C. dorsum, D. venter. E. Chelicerae of female.

with apophyses on II, and tarsi II with 3 strong apical spines; leg IV with a small stout posterior spine on femur.

A single nymph of idiosomal length 510μ , width 360μ , as figured. Legs I 420μ long, II 406μ , III 370μ , IV 406μ . Dorsal setae as figured,

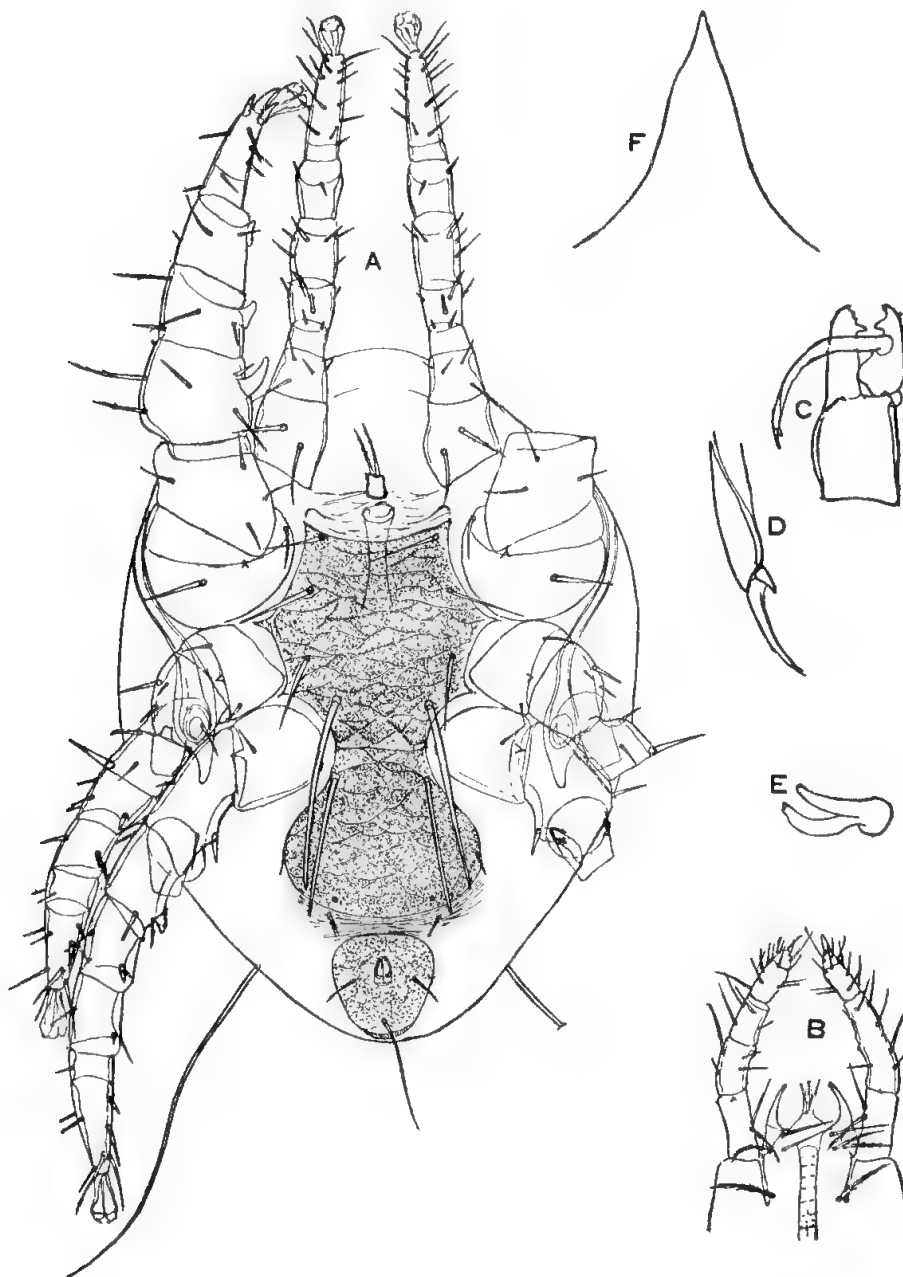


Fig. 2. *Cosmetolaclaps dolicanthus* (Canest. 1884). Male of 800μ length mounted. A. Venter. B. Gnathosoma and palpi. C. Chelicerae. D. Tip of spermatophore carrier much enlarged. E. Tined seta of palpal tarsus. F. Tectum.

14 pairs, posterior to 235μ long. Venter as shown with a shield-shaped sternal shield with 3 pairs of fine setae. Peritreme short and not extending beyond coxae III.

Locality. The above specimens were found mounted in "balsam" on an old slide in the S.A. Museum collections. The slide was labelled by the late F. H. Taylor as *Laelaps* sp. and the specimens had been collected by him at Townsville, Queensland (no date, but probably in the early 1920's) from *Outhophagus laminatus* Mael.

Remarks. No record of this species apart from the doubtful one by Rainbow (1906) has been made since Canestrini's original description of specimens collected by Prof. Pulle in Queensland from a lamellicorn beetle. Canestrini described both sexes, but only figured the male. The female and nymph are now described and figured.

Genus *Conolaelaps* nov.

Laelaptidae with 2-tined specialised seta on palpal tarsus. Of ovoid shape with entire dorsal shield completely covering body in both sexes. Dorsum with a number of pores and some exceedingly minute setae.

Female without pre-endopodal shields, sternal shield longer than wide with 3 pairs of setae, of which setae II and III are short and cone-like, anterior edge deeply excavate, posterior rounded; metasternal shields absent, only represented by small cone-like setae between the well developed free endopodal shields of coxae III and IV; genital shield small, flask-shaped with cone-like setae and widely separated from the oval anal shield; between the genital and anal shield with 4 pairs of cone-like setae; other setae on ventral cuticle minute and simple. Legs fairly stout and shorter than body, with normal setae except on coxae IV which has the seta cone-like, tarsi with strong pad-like caruncle and now claws. Stigma between coxae III and IV and peritreme extending to coxae II. Tectum a pointed cone. Gnathosoma and chelicerae normal.

Male with the facies of the female but smaller. With a combined sternal to anal shield with 7 pairs of small conical setae. Male genital opening in the anterior of the sternal shield. Legs stout as in female but tarsi I with a pair of strong claws and tarsi II-IV with 2-5 small cones ventrally. Chelicerae of male consisting of only the movable finger which is long as figured. Tectum conical with rounded apex.

***Conolaelaps coniferus* (Canest. 1884)**

Laelaps coniferus Canest. 1884. Acari dell'Australia. Atti ist Veneto 2 Ser. VI: 711. tav. VII, fig. 4.

Fig. 3 A-L

Redescription of Female. Body egg-shaped, widest between coxae II and III. Dorsal shield covering entire body and furnished with many pores and exceedingly minute setae difficult to distinguish from pores. Length of idiosoma to 670μ , width 410μ (Canestrini gives 530μ and 230μ respectively). Legs shorter than body and rather stout, length in a specimen of only 638μ idiosomal length, I 390μ , II 325μ , III 348μ , IV 440μ , setation generally minute and simple except the seta on coxae IV which is a small short cone; all tarsi with large caruncular pad and no claws. The sternal shield is shield-shaped with a deep anterior excavation within which are the minute simple sternal setae I, sternal setae II and III are small and coniform the posterior margin is deeply rounded and extends to inner angles of coxae III; only the endopodal shields of coxae III and IV are present, free and well defined; the metasternal setae only are present and are coniform; the genital shield is small, flask-like, with one pair of small coniform setae; the sternal shield is 141μ wide by 126μ long medially and the genital 56μ long by 33μ wide; the anal shield is as figured 70μ long by 70μ wide with minute setae. The stigma is between coxae III and IV but the peritreme is relatively short only reaching to between coxae II and III. The gnathosoma has probably the usual 4 pairs of setae but these are minute and difficult to ascertain. Chelicerae as figured with one medium sized tooth on each finger.

Description of Male. Of similar facies to female. Length of idiosoma 430μ , width 300μ . Legs I 370μ long, II 290μ , III 290μ , IV 350μ . Dorsum as in female. Ventrally all the shields are coalesced to form a single holoventral shield, the anterior sternal margin of which is excavate as in the female. Sternal setae I are minute and simple and lie within the anterior excavation, the holoventral shield itself with 7 pairs of small coniform setae and posterior of coxae IV 4 or 5 pairs of minute setae besides the anals. Legs are stout and similar, the tarsi armed as in the generic description. The chelicerae are considerably modified, the fixed finger being absent, the movable finger being elongate and untoothed as figured.

Description of Nymph. One specimen with idiosoma 508μ long and 300μ wide and legs I 380μ long, II 310μ , III 290μ , IV 380μ , shows

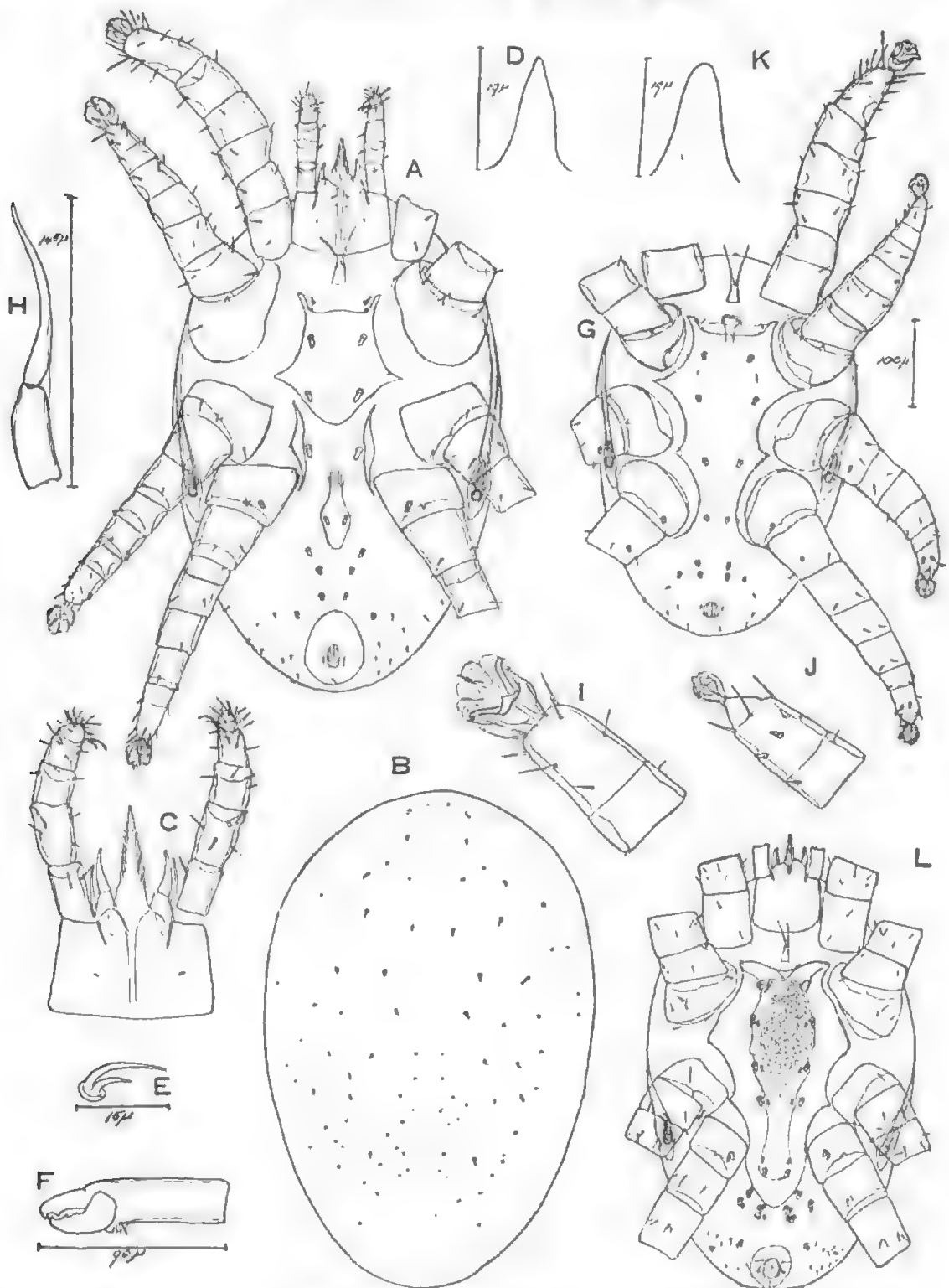


Fig. 3. *Conolaelaps coniferus* (Canest. 1884). A.-B., D.-F. Female of 640μ length mounted, A. venter, B. dorsum, D. tectum, E. lined seta of palpal tarsus, F. chelicerae. C., G.-K. Male of 430μ length mounted, C. gnathosoma from below, with right palpi from above, G. venter, H. chelicerae, I. tarsus 1 from below, J. tarsus IV from below, K. tectum. L. Nymph of 508μ length mounted showing ecdysis between proto- and deutonymphal stages.

the ? protonymphal features still within the skin of the next stage (? deutonymph), the various setae being duplicated as figured.

Locality. Four females, one male and one nymph from millipede under a Eucalyptus log, Hampton, 30 miles NE of Toowoomba, Queensland, 3rd October, 1956 (coll. G. F. Bornemissza).

Remarks. Canestrini described this species as *Laelaps coniferus* from specimens found in a tube of insect material collected by Prof. Pulle in Queensland. His description is somewhat brief and his figures inaccurate as far as the delineation of the genital and ventral shields are concerned. From his figure, although the characteristic coniform setae are arranged as shown it is evident that he failed to see the outlines of the genital and anal shields and the transverse line which he shows running between the coxae IV is erroneous. The sternal shield is as shown in his figure. Canestrini only had the female sex, but in the material collected by Dr. Bornemissza I found one male and one nymphal specimen which is evidently in process of ecdysis from proto-to deutonymph.

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A NEW SPECIES OF URODISCELLA (ACARINA, UROPODIDAE) FROM AUSTRALIA

BY H. WOMERSLEY, SOUTH AUSTRALIAN MUSEUM

Summary

The myrmecophilous genus *Urodiscella* Berlese 1903 is recorded for the first time from Australia. It is represented by the new species *Urodiscella nitida* sp. nov. described from a single female found on the larva of an ant *Myrmecia gulosa* Fabr. from Carlton, New South Wales.

A key to the known species of the genus, four from England and Europe and one from South Africa, besides the new species is given.

All the species with the possible exception of the South African one are myrmecophilous in habit.

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Fig. 1

SYNOPSIS

The myrmecophilous genus *Urodiscella* Berlese 1903 is recorded for the first time from Australia. It is represented by the new species *Urodiscella nitida* sp. nov. described from a single female found on the larva of an ant *Myrmecia gulosa* Fabr. from Carlton, New South Wales.

A key to the known species of the genus, four from England and Europe and one from South Africa, besides the new species is given.

All the species with the possible exception of the South African one are myrmecophilous in habit.

INTRODUCTION

The genus *Urodiscella* was erected by Berlese (1903b) for *Uropoda ricasoliana* Berl. 1889, *Uropoda philoctena* Trouessart 1902 and *Urodiscella alophora* n. sp. with *ricasoliana* as the genotype, all of which are associated with ants. All three species were figured in Berlese 1903c.

In 1918 Hull added a fourth species *U. signata* n. sp. from England, also myrmecophilous in habit.

More recently a fifth species has been described by Ryke (1958) from South Africa but this species was found in straw and not therefore definitely associated with ants.

Brief keys to the earlier species were published first by Berlese (1903b, c) and then Hull (1918). Ryke did not attempt to key his species. The brief descriptions of Berlese and Hull make their keys difficult to assess, but a tentative key to all the five known species is here attempted based on those of Berlese and Hull.

KEY TO THE SPECIES OF URODISCELLA

1. Dorsal setae strong and lanceolate.
 Female 625 μ long *potschefstroomensis*
 (S. Africa in straw.) Ryke 1958
 Dorsal setae smaller and tapering . 2
2. Dorsal shield medially with shallow punctures, ventral shields also pitted. Female 485 μ long *signata* Hull 1918
 (England; with *Lasius flavus*.)
 Dorsal shield smooth 3
3. All ventral shields smooth and shining 4
 At least the perigenital shield punctate 5
4. Length of female 570 μ *philoctena* (Trouest. 1902)
 (England, Ireland, Europe, with *Lasius* spp. and *Messor destructor*.)
 Length of female 812 μ *nitida* sp. nov.
 (Australia, with larva of *Myrmecia gulosa*.)
5. Ventral shields punctate. Female 750 μ long *ricasoliana* (Berl. 1889)
 (Europe and England with *Lasius* spp.)
 Ventral shields smooth and shining.
 Male 930 μ long *alophora* Berl. 1903
 (Luxemburg, in ants' nest.)

***Urodiscella nitida* sp. nov.**

Fig. 1, A-K

Type. Holotype female, from the collection of Dr. R. V. Southcott (No. ACA 484) from the larva of *Myrmecia gulosa* Fabr. (No. A 257) and collected at Carlton, N.S.W., 15th July, 1958 (coll. D. Miller).

The specimen presented to the South Australian Museum by Dr. Southcott has been dissected, one slide containing the gnathosoma, chelicerae and legs I, the other the remainder of the body.

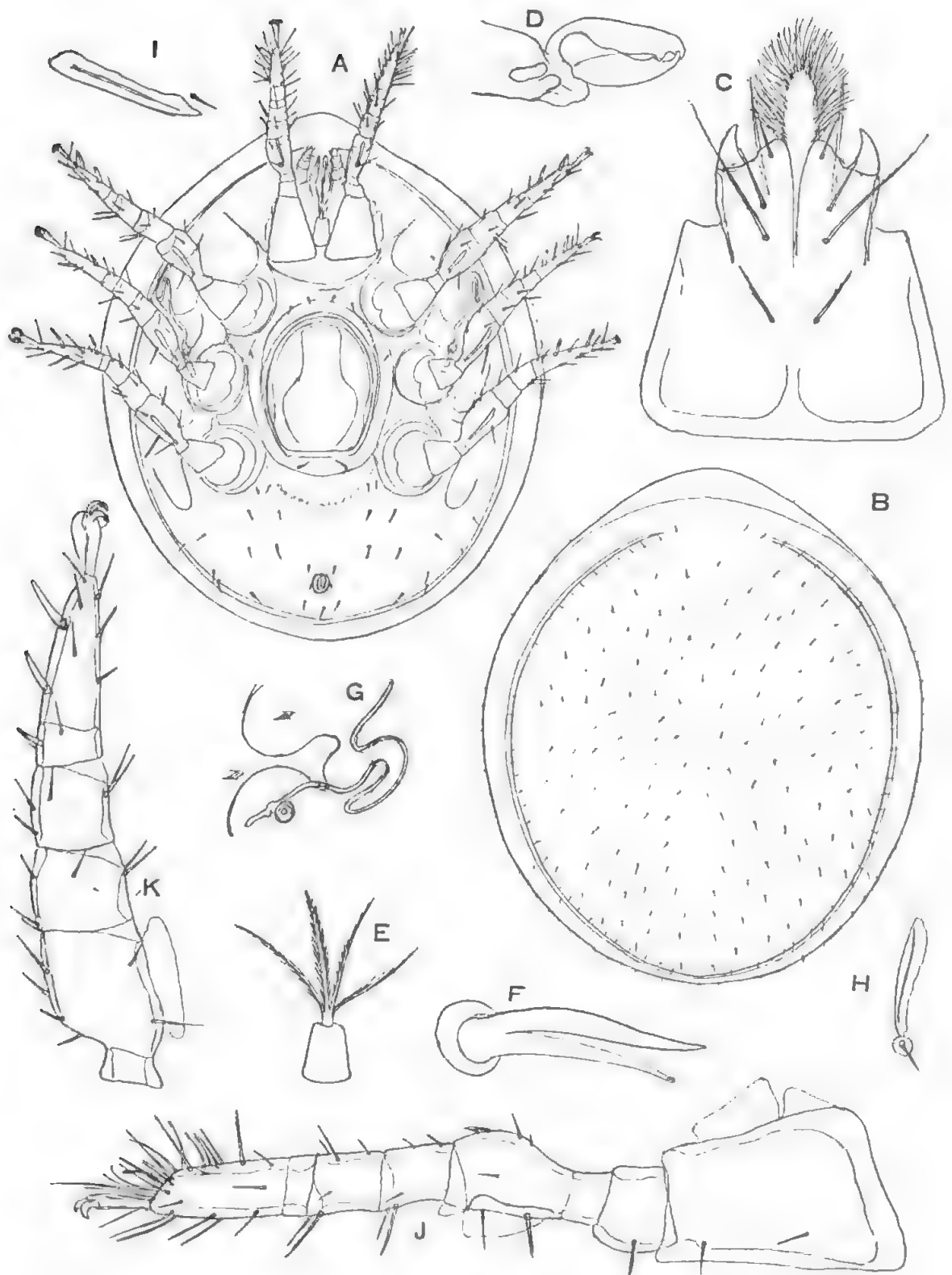
Description of Female. A broadly ovate almost rounded, dark brown convex species. Length of idiosoma 812μ , width 660μ .

Dorsum. The dorsal shield smooth and shining, with many minute fine setae; similar setae on the marginal shields. The marginal shields contour the dorsal shield and are entirely separated by a narrow strip of cuticle except anteriorly where they unite and are fused with the dorsal shield (fig. B).

Venter. As shown in fig. A. All shields smooth. All setae small and simple. An anterior pair of sternal setae (shown by Ryke for *potschefstroomensis*) cannot be seen and the four setae in a transverse row shown by Ryke as being on the anterior of the perigenital shield appear to be on the sternal shield (see fig. A); the perigenital shield otherwise has only two pairs of setae, one situated between coxae II and III, and the other pair at the posterior end; the margin of the perigenital shield is simple except in the region of coxae II where under high magnification it is seen to be finely crenulate. The genital shield is oval with truncate base; it is 232μ long by 166μ wide and extends from the middle of coxae IV to the middle of coxae II. The ventrianal shield bears approximately eleven pairs of setae besides the paranal and postanal setae, the paranals being placed well behind the anus. The leg grooves and exopodal shields are as shown. The peritreme is strongly folded (fig. G) with the stigma situated opposite coxae III and extending a short distance posterior of the stigma. The tritosternum is as shown (fig. E) with four laciniae.

Gnathosoma. The hypostome (fig. C) bears the usual four pairs of setae of which at least the posterior two pairs are ciliated or serrated; the second pair is much the longest. The labial cornicles are as figured, short and stout. The tectum is similar to that described and figured by Ryke for *potschefstroomensis*. The tined seta of the palpal tarsus is 2-tined (fig. F); the palpal tarsus bears two moderately long serrated setae. Chelicerae short and stout, each finger with one tooth (fig. D).

Legs. Coxae of leg I with outer laminae or crests as figured, at the base of which is a seta (fig. J and H); femora of other legs all with similar crests or laminae. Ambulacra of all legs well developed



Urodiscella nitida sp. nov. Female. A. Ventral view. B. Dorsum. C. Gnathosoma. D. Chelicerae. E. Tritosternum. F. Tined seta of palpal tarsus. G. Stigma and peritreme. H. Crest of femur I. I. Crest of femur IV. J. Leg I. K. Leg IV.

with long pretarsi, and paired claws. Legs I rather more slender than the others, to 464μ long, II and III 370μ long, IV 394μ long, some of the tarsal setae on legs II-IV strongly spinelike.

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**A NEW ASTERNOLAEELAPS FROM AUSTRALIA
(ACARINA, ICHTHYOSTOMATOGASTERIDAE)**

BY H. WOMERSLEY AND R. DOMROW

Summary

The mite family Ichthyostomatogasteridae Sellnick is recorded from Australia for the first time. It now includes two species, *Asternolaelaps fecundus* Berlese from Europe, and *A. australis*, sp. nov. from a bat cave in South Australia.

A NEW ASTERNOLAEELAPS FROM AUSTRALIA (ACARINA, ICHTHYOSTOMATOGASTERIDAE)

BY H. WOMERSLEY⁽¹⁾ AND R. DOMROW⁽²⁾

Fig. 1

SYNOPSIS

The mite family Ichthyostomatogasteridae Sellnick is recorded from Australia for the first time. It now includes two species, *Asternolaelaps fecundus* Berlese from Europe, and *A. australis*, sp. nov. from a bat cave in South Australia.

INTRODUCTION

In 1953 Sellnick erected a new cohort Ichthyostomatogasterina and family Ichthyostomatogasteridae, which were based on his new genus and species *Ichthyostomatogaster nyhleni* from the nest of the velvet skater duck, *Melanitta fusca* (L.), from the island of Stora Karlsö, off Göttnland, Sweden. His syntypes (two nymphs, four females, one male) are in the Entomology Department of the Stockholm Museum.

Berlese had earlier (1923, p. 252) described without figures both sexes of *Asternolaelaps fecundus* from humus and moss from Vallombrosa, Italy. His types are in the Stazione di Entomologia Agraria in Florence. This material has since been redescribed and figured in detail by Evans (1954), and shown to be conspecific with Sellnick's species. Evans therefore synonymised *I. nyhleni* Sellnick with *A. fecundus* Berlese, but retained Sellnick's cohort and family names, apparently in accordance with Recommendation 54 (1) (a) of the Copenhagen Decisions on Zoological Nomenclature.

A single male of a second species of *Asternolaelaps* very close to Berlese's species was found on a live bat in a cave at Naracoorte, South Australia. It is, however, probably not a true parasite of bats or any other animals. Although it possibly only represents a subspecies of *A. fecundus* Berlese, because of several small morphological differences and the widely separated localities, it is here briefly

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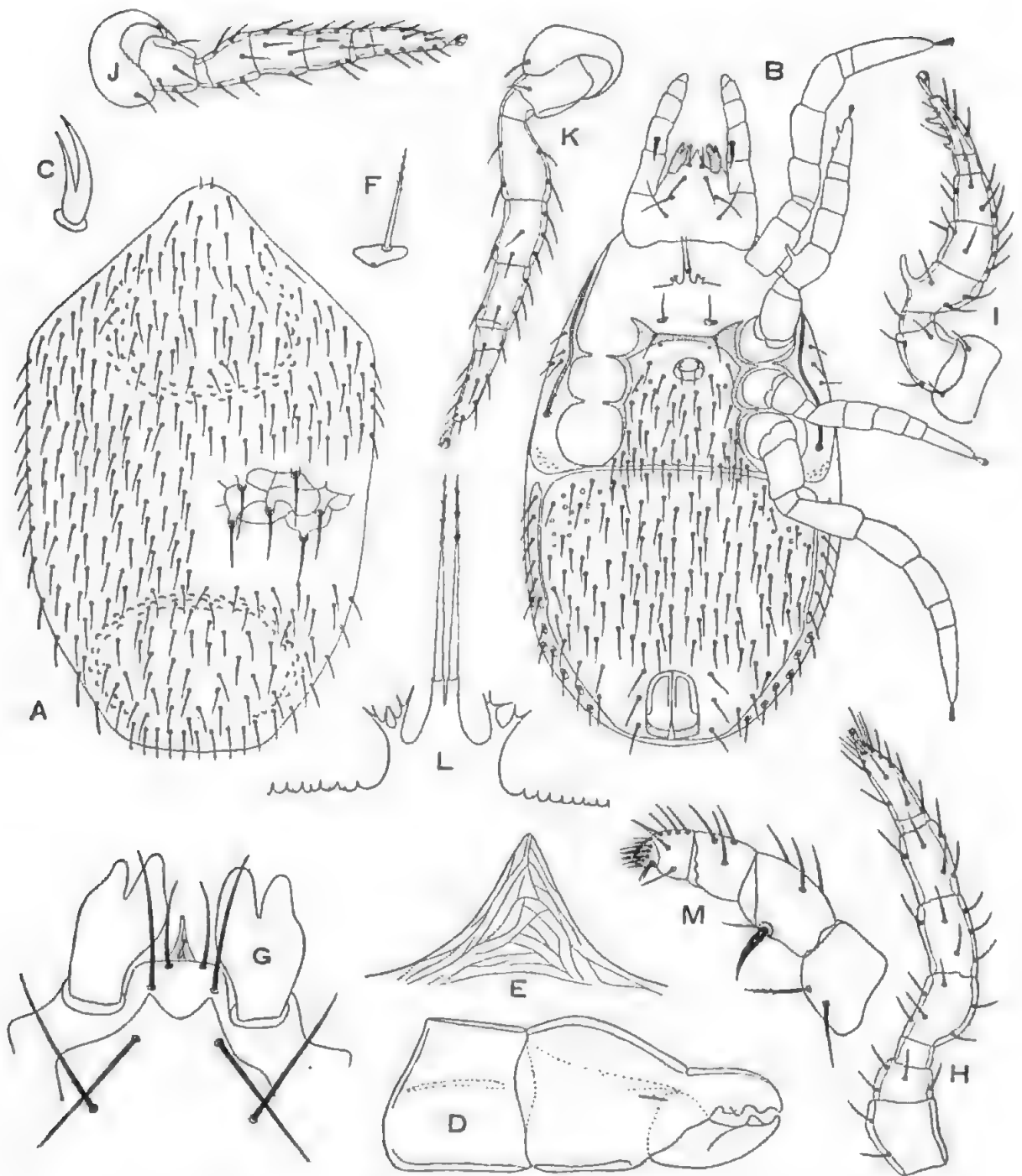


Fig. 1. *Asternolaclaps australis*, sp. nov. Male. A. Dorsal shield, with inset showing texture. B. Venter. C. Tined seta on palpal tarsus. D. Chelicera in lateral view. E. Tectum. F. Sternal platelet. G. Labial cornicles and gnathosomal setae. H. Leg I. I. Leg II. J. Leg III. K. Leg IV. L. Tritosternum. M. Ventral view of palp.

described as a new species in comparison with Berlese's, the only other species in the family. Pending publication of the London Decisions, the family name is left unchanged.

***Asternolaclaps australis*, sp. nov.**

Fig. 1, A-M

Type: Holotype male in South Australian Museum, Adelaide; associated with bats in a cave at Naracoorte, South Australia, 26. viii. to 2. ix. 1956, E. Hamilton Smith coll. The specimen is dissected, one slide containing the gnathosoma, the other the remainder of the body and the chelicerae.

Description of male: Similar to *A. fecundus* Berlese except in the following characters. Idiosoma 818μ long, 501μ wide (measurements calculated from text-figures A and B). Body setae rather uniform (to 42μ long), a few of the stronger ones being slightly ciliated. Sternal shield 176μ long medially, 146μ wide between coxae IV; anterior sternal setae slightly ciliated, 36μ long. Ventrianal shield 390μ long, 388μ wide anteriorly (the measurements of the sternal and ventrianal shields are direct from the specimen as dissected). Metapodal shields 176μ long, 26μ wide, with six setae along their length. Tectum triangular, with linear markings forming a network over its surface. Dorsodistal margin of palpal femur quite straight. Legs I 504μ , II 419μ , III 427μ , IV 523μ long. When first mounted a slight depression was seen both anteriorly and posteriorly on the dorsal shield; these are now difficult to distinguish as depressions in the dissected specimen.

NOTE: The following key will serve to recognize the new species.

KEY TO SPECIES OF *ASTERNO LAELAPS* BERLESE

- | | |
|--|--------------------------------|
| Metapodal plates without setae; tectum tapering twice to form distinct spine anteriorly; tectal striae spinulose in part; dorsodistal margin of palpal femur with process; European | <i>A. fecundus</i> Berlese. |
| Metapodal plates with six setae along their length; tectum tapering once, evenly triangular; tectal striae without spinulae; dorsodistal margin of palpal femur quite straight; Australian | <i>A. australis</i> , sp. nov. |

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**ON THE AUSTRALIAN SPECIES OF COON BUGS
(OXYCARENUS FIEBER, HETEROPTERA-LYGAEIDAE)**

BY GORDON F. GROSS, CURATOR OF INSECTS, SOUTH AUSTRALIAN MUSEUM

Summary

The three Australian species of *Oxycarenus* are described, and figured, and differentiated. Their status is discussed and it is concluded the three species concerned are *O. luctuosus* (Mont. And Sign.), *O. arctatus* (Walker), and a variety of *O. bicolor* (Fieber).

ON THE AUSTRALIAN SPECIES OF COON BUGS

(*Oxycarenus* Fieber, Heteroptera-Lygaeidae)

BY GORDON F. GROSS, CURATOR OF INSECTS, SOUTH AUSTRALIAN
MUSEUM

Plate xli

SYNOPSIS

The three Australian species of *Oxycarenus* are described, and figured, and differentiated. Their status is discussed and it is concluded the three species concerned are *O. luctuosus* (Mont. and Sign.), *O. arctatus* (Walker), and a variety of *O. bicolor* (Fieber).

INTRODUCTION

Every Australian entomologist is familiar with the small black and white Lygaeids of this genus. They often swarm in great numbers, when all stages from the earliest nymphs to single and pairing adults are present at the one time as large and fairly localized swarms in grassy paddocks and savannah areas. This curious swarming phenomenon is also found over much the same range in the south of Australia in the Pyrrhocorid *Dindymus versicolor* Schaeffer and in the southern part of the dry centre of the continent by the Coreid *Leptocoris mitellatus* Bergroth.

The name "coon bug" first appears in the literature for the Australian members of the genus in Froggatt 1901. It was in this paper that Froggatt fixed the name that almost without exception has since been used for all Australian *Oxycarenus*, namely *luctuosus* (Montrouzier and Signoret) and he figured what he thought was this species. Froggatt made it quite clear that he was aware that there were at least two species in Australia (something that Tillyard 1926 p. 147 was unaware of) and that the northern one was *luctuosus*. In spite of this he figured and described as *luctuosus* in this very same paper the species that is commonest in the southern half of the continent and does not occur in the northern half at all. What is more incomprehensible still, there are specimens of this southern

species labelled *O. frenchi* in the National Museum collections in Froggatt's handwriting. *O. frenchi* is apparently a Froggatt manuscript name; I can find no record of its publication.

There are actually three species of *Oxycarenus* in Australia recorded in the literature, but one of these, considered to be a form of the Asiatic *Oxycarenus bicolor* and possibly first recorded from Australia by Bergroth in 1918 seems to be rather uncommon and from the few specimens I have seen is restricted to the far north of the continent. It is easily distinguished from the other two in that in our specimens, except for a narrow costal stripe on the hemielytra, it has no white on the upper side and need not concern us for the moment in the following discussion on the status of *luctuosus*.

The original type of *luctuosus* seems almost certainly to be lost, the species was described from New Caledonia. In 1914 Distant figured (from New Caledonian specimens) what he took to be *luctuosus* and it is this species that is the only one of our prominently white marked species that occurs in the northern half of the continent.

The insect Distant figured was described by Kirkaldy in 1905 as a new species (*lifuanus*) and it seems likely that Kirkaldy was guided in this by Froggatt's figure. Kirkaldy says, "This may be *Macroplox luctuosus* Montr., but that species is described as finely granulated, with the clavus whitish "(my italics)" and the membrane brown. It is also a little larger than *O. lifuanus*." This white clavus is not mentioned in Montrouzier and Signoret's original description which is "Long. 4 mill.—Lifu (1) Petit, noir; partie coriace des homélytres blanche, avec une tache noire, arrondi au milieu; partie membraneuse rembrunie; tête très pointue, finement granuleuse, ainsi que le corselet."

In view of the solely southern distribution of the species that Froggatt figures and the apparent commonness of the species that Distant figured in New Caledonia there can be little doubt that Distant's figure is of the true *luctuosus* Montrouzier and Signoret and that this is our common northern *Oxycarenus*.

In 1872 Walker described *Anthocoris arctatus* from Australia and in 1901 Distant pointed out that this was actually a species of *Oxycarenus*. Specimens of the species figured by Froggatt have been sent to the British Museum for comparison with this species and Mr. R. J. Izzard, who compared the specimens, is in no doubt that it is in fact *Oxycarenus arctatus* (Walker).

The three species may be separated by the following key:—

1. The only white above being along the costal margin of the corium *Oxycarenum bicolor*
Fieber var.
- Coriaceous part of hemelytra with considerable white 2
2. Clavus black, corium with a large median black patch generally not reaching costal margin and a minute black point in the apical angles *Oxycarenum luctuosus*
Montrouzier and Signoret
- Clavus white, except behind tip of scutellum, corium with a large median black patch never reaching costal margin and a large black point in the apical angles *Oxycarenum arctatus*
(Walk.)

***Oxycarenum bicolor* Fieber 1851**

Oxycarenum bicolor Fieber 1851: Abh. König. Böhm. Gesell. Wissenschaft VII Prag: 463. Distant, 1903: Faun. Brit. Ind. Rhynch., 2: 44. Bergroth, 1918: Phillip. J. Sci., 13 (2-3): 73. Horvath, 1926: Bull. Soc. Ent. Fr., 136. Esaki, 1926: Ann. Mus. nat. hung., 24: 161. 1941: Proc. 6th Pacif. Sci. Congr., 4: 411. Usinger, 1946: Bull. Bernice P. Bishop Mus., 189: 29. Barber, 1958: B. P. Bishop Mus. Insect of Micronesia, 7 (7): 191.

Fieber described his species as follows, a copy of which was most kindly sent me by Mr. Izzard:—"O. *bicolor*, m. Fühler schwarz. Clavus bräunlich. Corium schwarz, Grundhälfte weiss, Wurzel bräunlich, Spitze dreieckig weiss, mit schwarzem Endpunkt. Membran rauchbraun, Innengrundwinkel mit dreieckigem weissen Fleck, Spitze weisslich. Aus Hinterindien von Dr. Helfer gesammelt. Länge 1½ Linien. Kopf, Pronotum, Schild weiss behaart, nebst Fühler und Schnabelscheide schwarz, Clavus bräunlich. Bauch schwarz, glatt glänzend. Brust schwarz, matt, grob-punktiert. Hinterbrustrand und Ecken weiss. Schenkel pechbraun, Schienbeine weisslich, am Grunde mit schwarzen Ringe, am Ende breit verwaschen und die Vorder-schienen braun."

Bergroth 1918 records typical *O. bicolor* from various places in Australia but I am inclined to think Bergroth actually had *luctuosus*

which fits Fieber's description very well except that it has a pale transparent membrane. Bergroth could have taken *arctatus* as being *luctuosus* on account of Froggatt's figure. Also if typical *bicolor* is as common in Australia as Bergroth says it is it should be in some of the collections before me.

The species I have before me is apparently widespread in Indonesia, Micronesia, Philippines, New Guinea and enters Australia in the Torres Strait area. Its identity has been accepted by all the authors after Distant and Bergroth listed in the reference above as *O. bicolor* Fieber. There is still some doubt on this score. My three specimens do not fit the description given by Fieber for his species (which came from "Hinterindien" which I take to mean Eastern India but which could also refer to Burma or Indo-China) in certain respects of colour pattern.

The three specimens I have before me are piceous black with sparse short erect white hairs all over and in addition with fairly dense adpressed hairs on head, pronotum, and prothorax. The clavus is not as piceous as the rest of the body and the corium in the main and the membrane is dark brown as are the tibiae, tarsi, and eyes. The corium has a broad costal white stripe running almost all of its length (the very apical angle is blackish) and this stripe is expanded basally and apically. The membrane is thinly margined with white and ventrally there is a broad medial white stripe on the hind tibiae and to hind margin of the metapleuron (broadly) and also the fore and mid acetabula are white. The head and pronotum are coarsely punctate. They range in length from 3.5-4.0 mm.

Mr. Izzard who has seen two of these specimens has compared them with Distant's specimen of *bicolor* from Burma. This specimen apparently agrees very well with Fieber's description and from it my specimens differ in not having "the white basal areas of corium, nor the triangular white patch at the apex with the small black point". Structurally my specimens agree with Distant's conception of *O. bicolor*.

Usinger 1946 mentions a whole series of variants which he places in this species. His Papuan specimens have the costal margins pale as do my specimens. His Pelelin specimens were smaller than the Guam specimens with pale at bases and apices of coria and apical margin of membrane faintly paler. The Guam series was very black, completely so beneath, with only the bases and subapices of coria white.

Bergroth 1918 apparently had this species in front of him from the Philippines but he is definite that it is *lugubris* Motschulsky (1859: *Etud. Ent.*, 8: 108 as *Stenogaster lugubris*, also Distant, 1901: *Ann. Mag. Nat. Hist.* (7) 8: 475. 1903: *Faun. Brit. Ind. Rhynch.*, 2: 44) and it certainly does fit the description of *lugubris* better than that of *bicolor*. Distant 1903 was of the opinion that *Rhopalus* ? *funeralis* Kirby (1891: *J. Linn. Soc. Zool.*, 24: 97 pl. IV p. 7) is a synonym of *lugubris* and Bergroth that *O. limbaticornis* Breddin (1899: *Jahr. Hamburg Wiss. Arstatt* 16: 174) from Lombok is one also.

There is quite sufficient reason, I think, to consider for the moment all of these forms as belonging to one species in which the costal margin tends to become whiter towards the New Guinea and Indonesian limits of its distribution, while the Guam specimens represent a blackish phase. Certainly the picture will not be clearer until much better series of specimens are obtained. For the moment Esaki and Usinger's determination of the species as *bicolor* has been permitted to stand. Usinger seemed somewhat inclined to regard *lugubris* as a variant of *bicolor* but Izzard (*in litt.*) is of the opinion they are distinct.

Specimens seen: Mabuiag I., Torres Straits, Queensland, C. T. McNamara, 1♂, and Bisiatabu, Port Moresby, Papua, W. N. Lock, 1♂, 1♀ (S.A.M.).

***Oxycarenum arctatus* (Walker) 1872**

Plate xli, fig. C

Anthocoris arctatus Walker, 1872: *Cat. Heter.*, 5: 153.

Oxycarenum arctatus Distant, 1901: *Ann. Mag. Nat. Hist.*, (7) 8: 475. Gross, 1957: *Rec. S. Aust. Mus.*, 13 (1): 137.

Cardiastethus arctatus Gross, 1954: *Rec. S. Aust. Mus.*, 11 (2): 133.

Oxycarenum luctuosus Froggatt (in part) 1901: *Agric. Gazette N.S.W. Misc. Publ.* 538 (fig. 6 and only part of text on p. 8).

Piceous or dark brownish black, with a few scattered short stiff erect white hairs. Clavus white except broadly along apical margin where it is black. Corium largely white with extreme apex black and a large irregularly shaped blackish spot in the middle, this latter is based on apical margin of corium and occupies it from apex of clavus to half way to apical black spot, this median large spot transversely placed but not reaching costal margin. Membrane hyaline. Fore

and mid acetabula and hind margin of metapleuron (broadly) white. All tibiae and tarsi lighter, mid and hind tibiae with a prominent broad white annulus in the middle. Eyes brownish. Head and pronotum prominently punctate, scutellum rather less punctate.

Length: 3.2-4.6 mm.

Localities:

Western Australia: 33-363/5 Tunney 2 ♂♂, 1 ♀ (W.A.M.).

South Australia: Underdale, 5 I 1958, coll. G. F. Gross, a large series: North Adelaide 19 II 1953, coll. G. F. Gross, Reg. No. 722, 1 ♀: ditto, 15 I 1953, 2 ♂♂, 3 ♀♀, Reg. No. E.S.I. 330; ditto, 23 XI 1954, 3 ♂♂, 2 ♀♀, Reg. No. E.S.I. 3687; Adelaide 2 I 1898, coll. J. G. O. Tepper, 1 ♂: Parachilna (this locality is doubtful it could also be from Owanigan Pound some miles to the east), 1 ♂: Spilsby I., N. B. Tindale, a series (S.A.M.).

Victoria: Murtoa, 29 VIII 1904, coll. T. A. Hill, on fence, large series: South Yarra, VI 1923, a series: Melbourne, 3 ♂♂, 3 ♀♀; Buckrabanyule, 20 II 1950, coll. H. Linnis, 2 ♂♂, 4 ♀♀ (N.M.).

***Oxycarenum luctuosus* (Montrouzier & Signoret) 1861**

Plate xli, fig. B

Macroplax luctuosus Montrouzier & Signoret, 1861: Ann. Soc. ent. Fr. (4) 1: 67.

Oxycarenum luctuosus Froggatt, 1901: Agric. Gazette N.S.W., Misc. Publ. 538: (text, but not fig. 6). Distant, 1914: Nov. Caledon. Zool., 1, pl. 12, p. 8. 1920: Ann. Mag. Nat. Hist. (9) 6: 153. Tillyard, 1926: Insects of Australia and New Zealand: 147. McKeown, 1945: Australian Insects: 81 (the last two apply also to *arctatus*).

Oxycarenum lifuanus Kirkaldy, 1905: Trans. ent. Soc. Lond.: 347, 1908: Proc. Linn. Soc. N.S.W., 32: 773.

Piceous black, with sparse short erect stiff hairs. Clavus entirely black. Corium white with a large median blackish spot in the same position and of much the same shape as in *arctatus*, but often reaching costal margin, apex of corium with a small black spot. Membrane hyaline.

* The following abbreviations of institutions have been used. N.M. (National Museum, Melbourne); S.A.M. (South Australian Museum, Adelaide); U.Q. (Entomology Department, University of Queensland, Brisbane); and W.A.M. (Western Australian Museum, Perth).

All tibiae and tarsi somewhat lighter in colour, hind tibiae with a broad medial white ring, mid tibiae with a narrower testaceous one. Fore and mid acetabula and hind margin of mesosternum (broadly), white. Margin of orifice of scent canal orange or whitish.

Head and pronotum coarsely punctate, scutellum fairly smooth.

Length: 3.2-3.9 mm.

Localities:

Southern South Australia: Melindie, 9 III 1958, coll. E. W. Lines, a series: Underdale, II 1959, coll. G. F. Gross, 1 ♀ (S.A.M.).

Northern South Australia: Moolooloo, 2,000ft. Flinders Ranges, 1921, coll. H. M. Hale, 1 ♀ (S.A.M.).

New South Wales: Tweed Heads, 16 VII 1958, coll. Coghill, a series (N.M.).

Queensland: Brisbane, 25 VI 1954, coll. K. L. S. Harley, 1 ♂, 1 ♀: ditto, III 1951, coll. Lipsett, 1 ♀: ditto, IV 1955, coll. N. J. Thompson, 1 ♂: ditto, 7 VII 1955, coll. D. Griffith, 1 ♂: ditto, 15 III 1956, coll. W. Jones, 1 ♀: ditto, 26 IX 1956, coll. I. Bonner, 1 ♂: ditto, 14 X 1956, coll. T. A. Bull, 2 ♀ ♀: ditto, 17 X 1956, coll. R. White, 1 ♀: ditto, X 1956, coll. J. O'Donohue, 1 ♂: ditto, 13 III 1957, coll. S. Sekhon, 1 ♂, 2 ♀ ♀: ditto, 24 V 1957, coll. G. Diatloff, 1 ♂, 1 ♀: ditto, 24 VIII 1957, coll. G. Eppershank, 1 ♂: ditto, 14 IX 1957, coll. B. R. Grant, 1 ♂: ditto, 20 X 1957, coll. M. Playne, 1 ♀: Bell-Bunga Road, S.E. Qld., 11 VIII 1955, coll. T. E. Woodward, a series: Lawes, 4 IV 1944, coll. J. Rosser, 1 ♀: ditto, XII 1954, coll. J. Thapa, 1 ♀: Carnarvon, 29 V 1954, coll. T. E. Woodward, 1 ♀: Victoria Pt., 11 IX 1954, coll. O. R. Byrne, 1 ♀: Bundamba, 17 VIII 1952, coll. J. Davis, 1 ♂: Gaythorne, 18 IV 1946, coll. A. R. Bird, a series: Manly, 18 III 1954, coll. G. Hooper, 1 ♂: Deception Bay, 25 III 1954, coll. Y. P. Beri, 1 ♂: St. George, West Qld., in peach tree, 12 I 1956, 2 ♀ ♀: Approx. 40 miles N. of Gympie, 20 VII 1952, 1 ♀: Bundaberg, 2 II 1949, coll. R. Boller, 2 ♀ ♀: Rockhampton, 10 I 1954, coll. K. S. Chang, 2 ♀ ♀: Canungra, 27 III 1937, coll. R. F. Langdon, 2 ♀ ♀: Lockhart R. Mission, Nth Qld., 8 VI 1956, coll. E. N. Marks, by sweeping grass and weeds, 3 ♂ ♂ (U.Q.); Magnetic Island, coll. G. F. Hill, a series: ditto, coll. A. M. Lea, a series: Rockhampton, 1 ♂, 1 ♀: Stuart R., I-II 1927, coll. H. M. Hale & N. B. Tindale, 1 ♂, 1 ♀ 1 ? (S.A.M.): Coen, 27 V 1951, coll. C. Oke, 1 ♀ (N.M.).

Northern Territory: Roper River, coll. N. B. Tindale, a series: Darwin, 1♂, 1♀ 2 nymphs (S.A.M.): Batchelor, coll. G. F. Hill, presented 6 VI 1917, 2♀♀ 1 nymph (N.M.).

North Western Australia: coll. Lea, No. 6362, 1♀ (N.M.). Millstream, in flowers of yellow hibiscus, 17 VII 1958, and Millstream, Deep Reach, 23 VII 1958, all coll. R. P. McMillan, a series (W.A.M.).

ACKNOWLEDGMENT

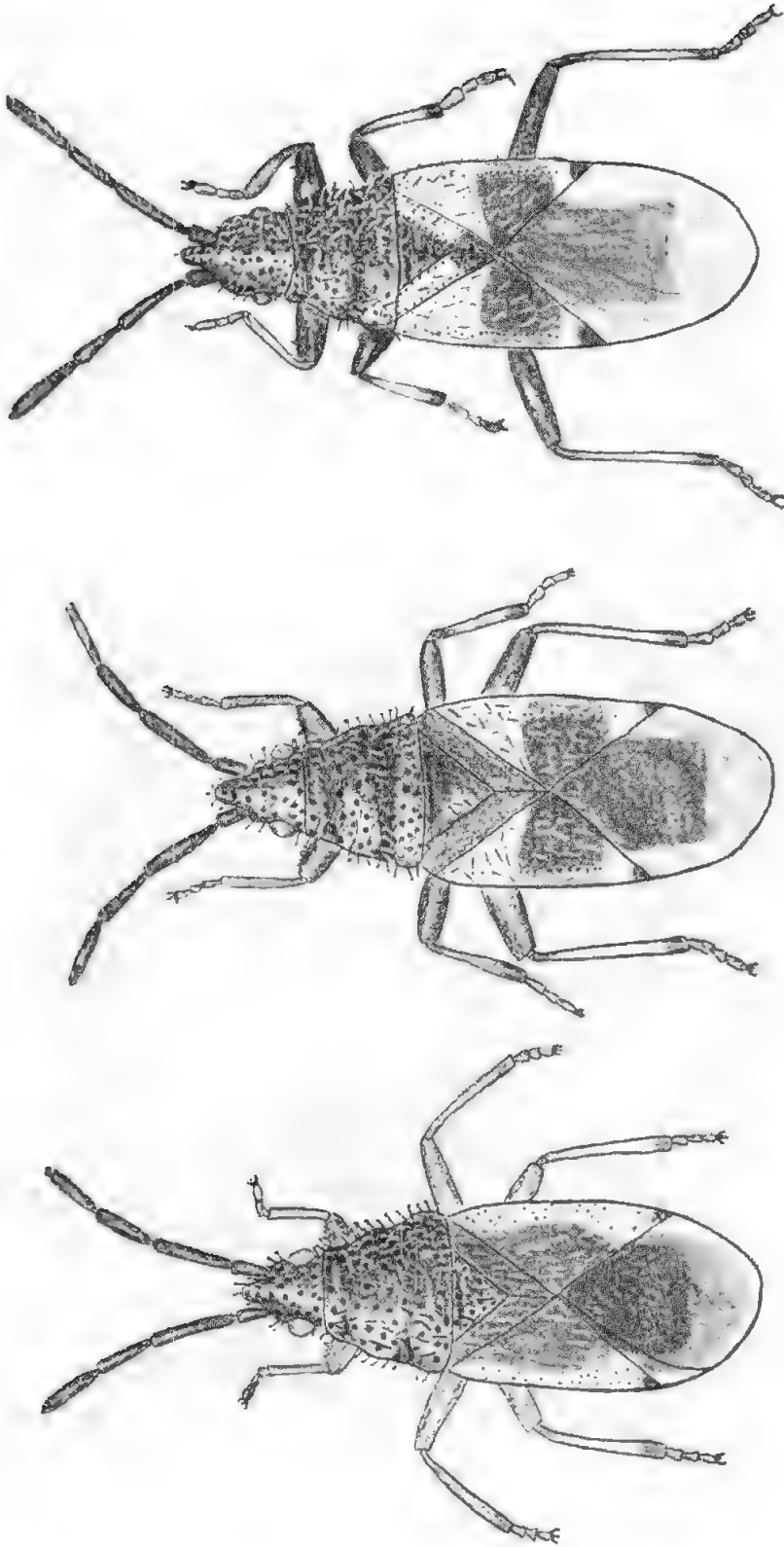
I am indebted to the Directors of the National Museum, Melbourne and Western Australian Museum, Perth, for permission to study the material in their collections and to Dr. T. E. Woodward for arranging the loan of material from the Entomology Department, University of Queensland.

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A

B

C

G. F. GROSS
D. I.

A. *Orgeremus bicolor* var.

B. *Orgeremus luctuosus*.

C. *Orgeremus arelatus*.

THE GEOLOGY AND LATE PRECAMBRIAN FAUNA OF THE EDIACARA FOSSIL RESERVE

*BY M. F. GLAESSNER, UNIVERSITY OF ADELAIDE,
AND B. DAILY, SOUTH AUSTRALIAN MUSEUM*

Summary

More than a decade has passed since Sprigg (1947) first found fossilized soft-bodied animals in what were then believed to be Lower Cambrian quartzites near the old Ediacara mining areas, some 380 miles (by road) north of Adelaide. In recent years the significance of these finds has received recognition in the palaeontological literature. At the same time further collecting has revived interest in the area and in May 1958, in view of its scientific importance, the area of the original discovery was proclaimed a fossil reserve, to be under the control of the Minister of Education and the authorities of the South Australian Museum.

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Plates xlii-xlvii and text fig. 1-2

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Fauna. By M. F. Glaessner.

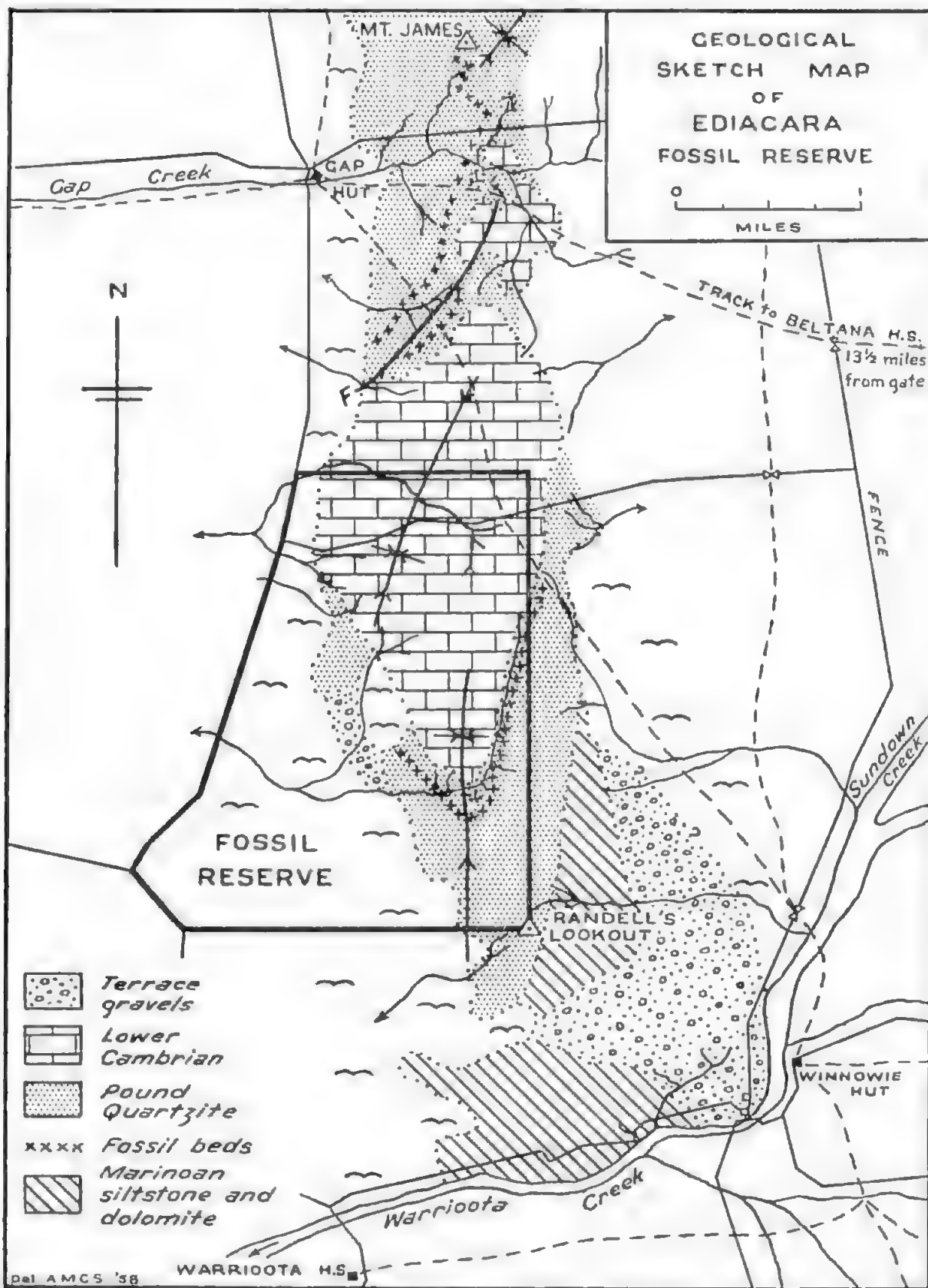
1. Annotated Catalogue of genera (with descriptions of two new species).
2. Conditions of preservation.
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References.

INTRODUCTION

More than a decade has passed since Sprigg (1947) first found fossilized soft-bodied animals in what were then believed to be Lower Cambrian quartzites near the old Ediacara mining areas, some 380 miles (by road) north of Adelaide. In recent years the significance of these finds has received recognition in the palaeontological literature. At the same time further collecting has revived interest in the area and in May 1958, in view of its scientific importance, the area of the original discovery was proclaimed a fossil reserve, to be under the control of the Minister of Education and the authorities of the South Australian Museum.

It was considered desirable to give now a brief account of the geology of the fossil reserve and the surrounding areas. This was compiled by the authors on the basis of field observations which they made first separately and then jointly (October 1958). This account is followed by a review of the fauna and its significance, including



descriptions of two identified and several other new species. For this part one of the authors (M.F.G.) is alone responsible, but he had the benefit of stimulating discussions of palaeontological problems and observations with his colleague.

Information and material were kindly placed at our disposal by Mr. R. C. Sprigg and Geosurveys of Australia Ltd., Mr. H. Mincham and Mr. B. Flounders who generously presented their rich private collections from Ediacara to the South Australian Museum, and Mr. I. M. Thomas of the Zoology Department, University of Adelaide. Dr. W. Häntzschel of the Geologisches Staatsinstitut in Hamburg and Dr. W. Struve of the Senckenbergisches Museum, Frankfurt, supplied casts, and Dr. F. C. Truter and Professor S. W. Carey sent photographs of South African fossils. Miss A. M. C. Swan (Geology Department, University of Adelaide) painstakingly drew the geological sketch map. Photographs not acknowledged to others in the explanations to the plates were produced by Miss M. P. Boyce at the South Australian Museum.

GEOLOGY

By M. F. GLAESSNER AND B. DAILY

1. STRATIGRAPHIC SEQUENCE

a. Adelaide System

The oldest rocks exposed in the area are red and purple well-bedded siltstones and sandstones. They are exposed in cliffs along the Warrioota Creek and on the hill slopes along its banks south of Randell's Lookout, as well as along the eastern foot of the range which culminates in this hill. Strong folding, the encroachment of sand dunes from the west and deep weathering in the east obscure the succession. Current-bedding is well developed and flute casts up to 2 in. in diameter, the direction of which indicates currents coming from the west, are seen on lower surfaces of some beds. Ripple marks are often found, trending N-S and also E-W. The siltstones contain large nodules and veins of barytes. These beds are overlain by well-bedded olive- to buff-coloured dolomites. This part of the sequence is assigned to the *Marinoan Series* of the Adelaide System (fig. 1).

Fig. 1. Geological sketch map of Ediacara Fossil Reserve and surrounding areas. The co ordinates of Mount James are 138° 09' E, 30° 46' S. Lands Department maps and aerial photographs and maps published by Segnit and Broadhurst have been used. F—F Gap Creek Fault.

It is followed by typically developed *Pound Quartzite* which forms the hilly slopes around Randell's Lookout in the south and Mount James in the north. The thickness of this formation is estimated to be about 2,000ft. The quartzites vary from thick-bedded to flaggy, with crossbedding, ripple marks, and mud pellets on the bedding planes. Casts of worm burrows were observed about 300ft. above its base near Randell's Lookout. Beds with abundant small siliceous nodules are scattered throughout the sequence. A prominent band of white quartzite forms a conspicuous zone in the upper part where red laminated siltstones also appear.

The *fossiliferous member* occurs 100-200ft. below the top of the formation. It is a fine- to coarse-grained quartzitic sandstone or quartzite, with varying amounts of weathered feldspars and irregular very thin argillaceous partings and lenses. The sandstone is white to grey when fresh and weathers to a deep rusty red to purple, with black stains in depressions. Exposed surfaces are bleached. The weathering produces flags of varying sizes which are rarely more than 2in. thick. Exposures of beds *in situ* on steep hill slopes show that the individual bedding planes are uneven and wavy and the beds are very strongly lenticular. Cross-bedding of various orders is present throughout. The better developed bedding planes are covered with ripples which are more or less irregular, with crests up to 2in. distant. A bed with contorted slump rolls up to 10ft. long was found near the southern end of the outcrop of the fossiliferous member. Slump structures also occur commonly towards the base of the fossiliferous member at the northern end of the area.

The beds above the fossiliferous member include lenticular bodies of more solidly silicified quartzite, some of which are distinguished in Segnit's mapping as "quartzite" from the "sandstone" of the rest of the formation. One of them forms a spectacular cliff about $\frac{3}{4}$ mile south of Gap Creek. Silicification is not confined to a single stratigraphic horizon but extends through at least the top 10ft. of the fossiliferous member in some places.

Broadhurst (1947) recognized the occurrence of *transition beds* between the (Pound) quartzite and the overlying (Ajax) limestones (which had not been named at that time). Such passage beds are now widely known throughout the Flinders Ranges and also at Kulpara on Yorke Peninsula (Daily 1956). Their occurrence proves that there is no stratigraphic break below the Lower Cambrian Ajax Limestone, as Segnit (1939) had suggested. Mineralization is frequent at this horizon but it is believed to be related to hydrological

conditions and the pronounced change in permeability and porosity on this boundary rather than to exposure and weathering. In agreement with regional observations, the top of the transition beds is now taken as the top of the Pound Quartzite and is placed a little lower than in Broadhurst's mapping. The position of the transition beds is shown in the sections (fig. 2). They can be described as interbedded sandstones and sandy and silty dolomites. They are white,

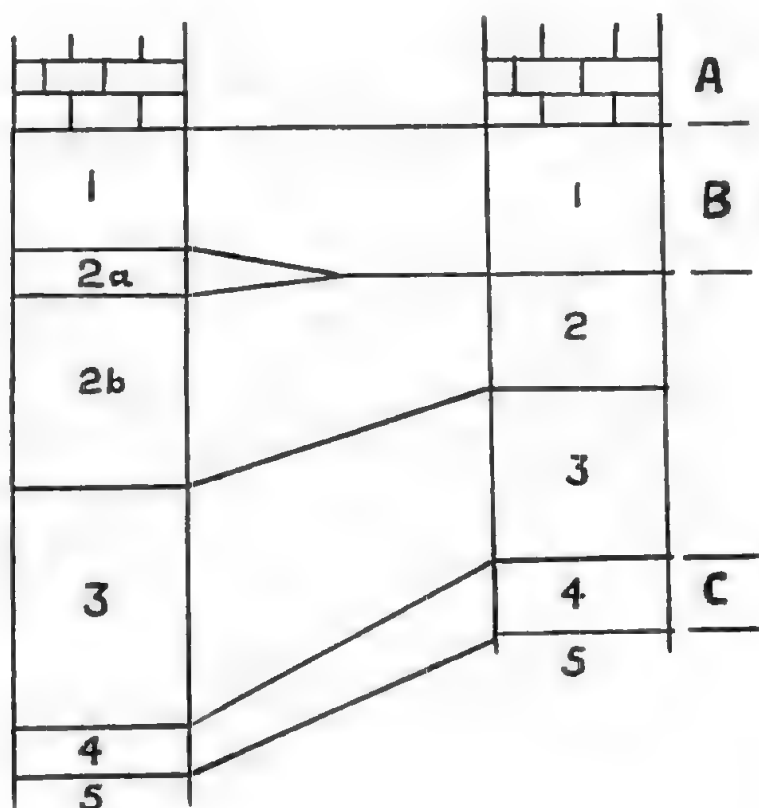


Fig. 2. Measured sections of the fossiliferous member of the Pound Quartzite and overlying strata. Left: Adit near south workings of the old Ediacara mine, near the southern end of the Cambrian outcrop. Right: In Gap Creek Fault valley, one mile south of Gap Creek. Top: Cross-bedded and well-bedded sandy and oolitic dolomitic limestone. 1—Interbedded argillaceous sandstone and sandy dolomitic limestone. 2a—Quartzite band. 2, 2b—White knotty sandstone. 3—White and reddish quartzite. 4—Fossiliferous flaggy quartzite, cross-bedded and ripple-marked. 5—Unfossiliferous white to red and purple quartzites and sandstones. A—Lower Cambrian, B—Passage Beds, C—Fossiliferous Member. Scale—lin. to 100ft.

yellow and purple, often leached, soft and poorly exposed while the overlying dolomites are hard and form good outcrops.

b. Lower Cambrian

Occupying the central position of the area and conformable with the underlying Pound Sandstone is a sequence of limestones and dolomitised limestones estimated by Broadhurst (1947) to be about 530ft. thick. On lithological and faunal grounds these beds are correlated with part of the Ajax Limestone which is exposed in the Mount Scott Range, 18 miles to the north-east.

The base of the Ajax Limestone is taken at the horizon where carbonate deposition becomes dominant and continuous. The Ajax Limestone is variable in colour and composition. It exhibits all gradations from a yellowish coloured dolomitised limestone, particularly near the base, to grey, blue-grey and buff coloured limestones above, either siliceous, dolomitised or both. Oolitic, often cross-bedded dolomitic limestones with well rounded quartz grains occur commonly at the base of the formation. Nodular structures, possibly referable to algae, intraformationally brecciated limestones, and large nodules of chalcedony are conspicuous features of the Ajax Limestone in this area as they are in the same formation in the Mount Scott Range (Daily, 1956).

Poorly preserved Cambrian fossils have been found in the uppermost 60ft. of the Ajax Limestone, the remainder of the formation still being under investigation. The fossils occur sporadically within grey and buff coloured partially dolomitised limestones but concentrations of small shell fragments are found in small lenses. The fossils include silicified archaeocyathids, phosphatic brachiopod fragments, and phosphatic-shelled tubular organisms of unknown affinities. A new brachiopod genus, represented by forms to which Tate referred as "*Ambonychia macroptera*," ranges throughout the 60ft. of beds investigated whilst a representative of another new brachiopod genus, known as *Micromitra* (*Paterina*) *etheridgei* (Tate), together with the enigmatic tubular organisms have been found in the top 30ft.

The "*Ambonychia*," "*Micromitra*" and tubular organisms are characteristic elements of the Lower Cambrian "Faunal Assemblage No. 2" (Daily, 1956), with which this assemblage is correlated. It is widespread and has been found in the Ajax Limestone near Mount Scott, in the Kulpara Limestone at Ardrossan and Curramulka, and in the Wilkawillina Limestone near Wirrealpa.

c. Cainozoic Gravels

A large area between Winnowie Hut and Randell's Lookout is covered with coarse, well-rounded quartz gravels. They form conspicuous cliffs near the bed of Warrioota Creek, opposite and above Winnowie Hut. Near the head of one of the minor tributaries of this creek where it is deeply entrenched, the base of the gravels is seen at least 100ft. above the level of the creek, resting on about 6ft. of strongly silicified quartz conglomerate which is lensing in a more sandy matrix. This conglomerate, in turn, overlies deeply weathered and mottled Marinoan silty shales which are here exposed to a depth of 30ft. The silicified sandstones and conglomerates have also been observed elsewhere in the area, *e.g.*, on low hills in the headwaters of the creek which flows around the southern end of the Cambrian dolomite outcrop. No direct evidence of their age has been found but they are thought to be part of the widespread mid-Tertiary continental sedimentary formations which elsewhere contain plant remains and which are invariably converted by silicification into part of the "durierust" of inland Australia.

The overlying terrace gravels are not related to recent drainage which has eroded them deeply. They could be either Late Tertiary or Pleistocene. No fossils have been found in them but in September 1958 Dr. R. Horwitz found a piece of freshwater limestone with abundant gastropods west of Winnowie Hut near the boundary between the terrace gravels and the Marinoan dolomite outcrops, and identical rocks were subsequently found *in situ* about $\frac{1}{2}$ mile west of the southern end of the Cambrian dolomite outcrop. At this locality, thin lenses of similar freshwater limestone with gastropods outcrop at the base of a terrace gravel which resembles closely that which was first found near Winnowie Hut. The gastropods have not been identified.

2. STRUCTURE

Earlier observers have already recognized the structure of the area as essentially synclinal. It is, however, not a simple syncline, nor is it as extensively faulted as Segnit's map (1939) had indicated. The axis of the syncline trends northward in the south, from near Warrioota Creek, but it is offset to the west and shows a more north-easterly trend in the central area, and a similar shift occurs near Mount James. The dips are generally low, between 10° and 20° , but the east flank is steeper, with dips up to 30° . There is only one distinct fault in the area. It trends SW from near Gap Creek. It was recognized by Segnit and correctly mapped by Broadhurst.

The faults shown on Segnit's map near Mount James and around the southern end of the Cambrian outcrop do not exist and the individual beds can be followed around it easily. The Marinoan siltstones and sandstones along Warrioota Creek are more strongly folded than the overlying formations and steeper dips and closer folds can be seen in the cliffs. It may be assumed that there is some incompetent folding of the softer siltstones beneath the hard quartzite but the structure of a large area occupied by Marinoan south of Warrioota Creek remains unexamined. Both limbs of the Ediacara Syncline disappear under alluvium. The flanking anticlines have not been observed.

3. DISTRIBUTION OF THE FOSSILIFEROUS STRATA

The fossiliferous member in the upper part of the Pound Quartzite was first discovered near the southern end of the Lower Cambrian dolomite outcrop. From that point on the creek which cuts across it and which leaves a small west-dipping outlier of dolomite on a low hill on its southern bank, the fossiliferous band can be easily followed up the creek northward to its headwaters. It may continue a short distance further up the east flank but it becomes difficult to follow where the soil cover of the eastern plains encroaches on the bedrock. The actual occurrence of fossils depends on the flagginess of the rock and decreases markedly where the rock becomes slightly more massive. On the western limb of the structure the fossiliferous band can be followed across a hill north of the main creek until it disappears under a patch of talus from the Cambrian dolomite hills.

The fossiliferous beds are also well developed near the northern end of the main dolomite outcrop. Here they are locally duplicated by a normal fault. This explains the reference by Sprigg (1949, p. 73) to two distinct fossiliferous horizons found by Mawson "in the northern extensions of the fossil occurrences". They can be followed north across Gap Creek and up the southern slopes of Mount James where they are less rich owing to a gradual change in lithology and where they are cut off by erosion and obscured by talus from above. The entire northern outcrop of the fossiliferous strata is outside the fossil reserve area.

The horizon in the Pound Quartzite corresponding to the fossiliferous member has been seen in many parts of the Flinders Ranges but has not been found anywhere, except on the north-western end of the Mount Scott Range, to be developed in the flaggy facies which has proved surprisingly suitable for the preservation of fossils.

Two areas nearer to Ediacara where the Cambrian-Precambrian transition is likely to be exposed and where it could contain equivalents of the fossiliferous member remain to be examined. They are in the southern extension of the range of hills about 8 miles south of Warrioota Creek near Mount Michael, and near Beltana Hill about 4 miles south of Beltana H.S.

FAUNA

BY M. F. GLAESSNER

1. ANNOTATED CATALOGUE OF GENERA (with descriptions of two new species)

It is estimated that to date about 800 specimens of fossils have been collected from the fossiliferous member near the top of the Pound Quartzite at Ediacara. The study of such abundant material will take several years and will require extensive comparative investigations on recent as well as fossil specimens. The work of the last 12 months has, however, revealed several facts of outstanding significance which make it desirable to review briefly our present knowledge of this fauna.

1. The fauna consists not only of Medusae believed to represent the Scyphozoa and Hydrozoa but there are also Anthozoa (Octocorallia) and Annelida and at least two entirely new types of invertebrates.

2. Certainly one and possibly more elements of this fauna show relations to the fauna of the Nama System of South Africa.

3. Stratigraphic and palaeontological evidence supports the placing of this fauna in the Late Precambrian rather than the Lower Cambrian.

Apart from factual evidence in support of these statements, it seems desirable to record here some observations on the type specimens of Sprigg's fossils from Ediacara (1947, 1949). These types are deposited in the palaeontological collections of the University of Adelaide. Sprigg considered all his species as probable hydrozoan or scyphozoan medusae. Their taxonomic position was recently reconsidered by Harrington and Moore (1956) and briefly reviewed by Caster (1957). There has not yet been an opportunity of making careful comparisons between the types and the abundant new material of medusa-like fossils. Such further studies are

expected to influence morphological interpretations and systematic placement of at least some of the taxa, on the specific as well as on higher levels. As a basis for such future work, an annotated catalogue of all genera described by Sprigg and others is here given in alphabetical order; descriptions of some of the new forms are included in it. Numbers prefixed "P" refer to specimens in the South Australian Museum. Others refer to Adelaide University palaeontological collections.

Beltanella Sprigg

Beltanella Sprigg, 1947, Trans. Roy. Soc. S. Aust., 71, p. 218.

Beltanella Sprigg, 1949, Trans. Roy. Soc. S. Aust., 73, p. 81.

Beltanella Harrington and Moore, 1956, Treatise Inv. Paleont., p. F70.

This genus was placed by Sprigg in the Suborder Trachymedusae (Trachymedusina) and left in this position by the later authors. There is only one species, *B. gilesi* Sprigg, represented by a single specimen, and no further specimens have been assigned to it. (Holotype No. T 3-2056.)

Cyclomedusa Sprigg

Cyclomedusa Sprigg, 1947, Trans. Roy. Soc. S. Aust., 71, p. 220.

Cyclomedusa Sprigg, 1949, Trans. Roy. Soc. S. Aust., 73, p. 91.

Cyclomedusa Harrington and Moore, 1956, Treatise Inv. Paleont., p. F153.

Ediacaria (part) Harrington and Moore, 1956, Treatise Inv. Paleont., p. F74.

This genus (type species *C. davidi* Sprigg, Holotype No. T 5) was described by Sprigg (1949) together with other "medusoid problematica", and Harrington and Moore discussed it under the heading "Medusae incertae sedis". These later authors combined the species *C. radiata* with *Tateana inflata* and considered both as "exumbrellar impressions" of *Ediacaria flindersi*. A preliminary study of the types indicates that Sprigg had correctly placed *C. radiata* in the same genus as *C. davidi*. *Tateana inflata* does not seem to be distinguishable generically and possibly even specifically from *C. radiata*. Fossils of the same general type, with variations due to preservation, are found very commonly and are well represented in the new collections. The holotype of the third species, *C. gigantea* (No. 2035) is not easily matched by any other specimen. This applies at present also to the two incomplete specimens described by Sprigg

(1947, pl. 5) as *Ediacaria flindersi*. It is therefore undesirable to accept Harrington and Moore's procedure and to place the species *C. radiata* and the genus *Tateana* in the synonymy of *Ediacaria flindersi*. Russian workers on Lower Cambrian faunas, particularly I. Zhuravleva, (personal communication) have expressed the opinion that *Cyclomedusa* may be related to certain saucer-shaped Archaeocyatha which they have found in shale and sand facies of the Lower Cambrian. The external resemblance is undeniable but no evidence of the distinctive double wall of the Archaeocyatha has been found in *Cyclomedusa*.

Dickinsonia Sprigg

Dickinsonia Sprigg, 1947, Trans. Roy. Soc. S. Aust., 71, p. 221.

Dickinsonia Sprigg, 1949, Trans. Roy. Soc. S. Aust., 73, p. 95.

Dickinsonia Harrington and Moore, 1955, Kansas Geol. Survey, Bull. 114, pt. 5.

Dickinsonia Harrington and Moore, 1956, Treatise Inv. Paleont., p. F24.

Dickinsonia Glaessner, 1958, Trans. Roy. Soc. S. Aust., 81, p. 188.

Dickinsonia Glaessner, 1959, Geol. Rundschau, 47.

Sprigg (1949) had considered the affinities of this genus as "extremely uncertain" but had concluded that "the coelenterate category seems the most logical association for the present". Harrington and Moore established for the genus *Dickinsonia* the new Class Dipleurozoa. I have stated that it resembles certain worms more than any coelenterates. No finality can be reached until the entire material which now amounts to well over 100 specimens ranging in length from 10 to 330 mm. is examined. The type species is *D. costata* Sprigg (Holotype No. T 6-2055).

Ediacaria Sprigg

Ediacaria Sprigg, 1947, Trans. Roy. Soc. S. Aust., 71, p. 215.

Ediacaria Sprigg, 1949, Trans. Roy. Soc. S. Aust., 73, p. 83.

Ediacaria (part) Harrington and Moore, 1956, Treatise Inv. Paleont., p. F74.

The genus which is represented by the imperfectly preserved holotype of *E. flindersi* Sprigg (No. T 1) and one other doubtful specimen, was considered by Sprigg as representing the Semaestomatida but listed under Trachylinida incertae sedis by Harrington

and Moore, who placed in its synonymy the genus *Tateana* and the species *Cyclomedusa radiata*. I have stated above that they cannot be separated from other *Cyclomedusa*. At present no other specimens can be identified as *Ediacaria* and its reconstruction (Sprigg, 1949, fig. 5) rests on uncertain grounds.

Madigania Sprigg

(See *Spriggia* Southcott)

Medusina Walcott

(See *Protolyella* Torrell)

Papilionata Sprigg

Papilionata Sprigg, 1947, Trans. Roy. Soc. S. Aust., 71, p. 233.

This genus was described for the single specimen of its type species *P. eyrci* Sprigg (No. T 8). It was not mentioned by Sprigg in 1949 and was listed by Harrington and Moore (1956, p. F159) as "problematic form of unknown affinities, not a medusoid". It appears to be a poorly and incompletely preserved specimen of a *Dickinsonia*.

Parvancorina Glaessner

Pl. xlvii, figs. 5, 6

Parvancorina Glaessner, 1958, Trans. Roy. Soc. S. Aust., 81, p. 187.

Parvancorina, Glaessner, 1959, Geol. Rundschau, 47.

This form, of unknown affinities, originally described from a single specimen, is now represented by 16 individuals ranging in length to 25 mm. The only additional morphological detail which has been observed is a division of the two lateral areas by about 7 or more fine oblique lines on either side of the main anchor-shaped depression. They are slightly convex towards the narrow (posterior?) end of the body and join the lateral margins at approximately right angles. They may represent traces of appendages. The main anchor-shaped depression is unsegmented in all specimens. The type species is *P. minchami* Glaessner (Holotype No. P 12774).

Protodipleurosoma Sprigg

Protodipleurosoma Sprigg, 1949, Trans. Roy. Soc. S. Aust., 73, p. 79.

Protodipleurosoma Harrington and Moore, 1956, Treatise Inv. Paleont., p. F79, F87.

This is a rare form which has been assigned to the Leptomedusae, i.e., the medusoid forms of Calyptoblastina (Hydrozoa). The genus was based on a single specimen of its type species, *P. wardi* Sprigg. (Holotype No. T 36-2023.)

Protolyella Torrell

Harrington and Moore (1956, p. F153) have shown that Walcott's name *Medusina* which Sprigg (1949, pp. 89, 90) had used for three new species, is inapplicable. They extended the generic concept of *Protolyella* to accommodate them. A preliminary study of the types shows that "*M.*" *asteroides* (Holotype No. T 40-2021) is probably identical with "*M.*" *mawsoni* (Holotype No. T 39), while the position of the third species, "*M.*" *filamentus* (Holotype No. T 68) is in doubt. The examination of the numerous new specimens should clarify the status of these species.

Protoniobia Sprigg

Protoniobia Sprigg, 1949, Trans. Roy. Soc. S. Aust., 73, p. 77, 79.

At the end of his description of *Protoniobia wadea* from Western Australia Sprigg states: "A second example of *Protoniobia* has been discovered amongst material from Ediacara . . . The example occurs on the same quartzite fragment as fossil No. 2010". This fossil, now numbered T10-2010 is a hypotype of *Cyclomedusa radiata*. The small specimen on the same rock face is not a *Protoniobia* but represents the new form described below as *Tribrachidium heraldicum* nov. gen., nov. spec.

Pseudorhizostomites Sprigg

Pseudorhizostomites Sprigg, 1949, Trans. Roy. Soc. S. Aust., 73, p. 87.

Pseudorhizostomites Harrington and Moore, 1956, Treatise Inv.

Paleont., p. F52.

Sprigg has compared this monotypic genus with the Jurassic *Rhizostomites* and placed it in the "Rhizostomae" (Scyphozoa). Harrington and Moore considered these fossils as "?Scyphomedusae incertae sedis". Recent collecting has proved them to be common; some 75 specimens are known. They show no trace of any umbrellar margin. The branching of the grooves is variable and the centre is usually depressed. Some specimens, however, show a more or less irregular convex area in or near the centre. "*Medusina*" *filamentus* closely resembles these specimens which also provide a link with *Pseudorhopilema* which cannot be distinguished from *Pseudorhizostomites*.

Pseudorhopilema Sprigg

Pseudorhopilema Sprigg, 1949, Trans. Roy. Soc. S. Aust., 73, p. 88.

Pseudorhopilema Harrington and Moore, 1956, Treatise Inv. Paleont., p. F51.

This genus and its type species, *P. chapmani* Sprigg, are based on a single, somewhat eroded specimen (No. T 74-2036). There seems to be intergrading between the typical specimens of *Pseudorhizostomites* with depressed centres and others with the branching impressions extending around convexities. These forms are generally much less regular than had been expected on the basis of the first few specimens. The separation of the genus *Pseudorhopilema* from *Pseudorhizostomites* cannot be maintained.

Pteridinium Gürich

Pteridium Gürich, 1930, Zeitschr. deutsch. Geol. Ges. 82, p. 637 (nom. preocc., non Scopoli 1777).

Pteridinium Gürich, 1933, Palaeont. Zeitschr., 15, p. 144.

Pteridinium Richter, 1955, Senckenb. Leth., 36, p. 246.

This genus was established for specimens which have since been lost. Richter later discussed it in great detail on the basis of relatively abundant material from the type locality in the Kuibis quartzite of the Nama System of South Africa, from which he selected a neotype (Richter 1955, pl. 1, fig. 1). This genus is included in the present catalogue because of the close resemblance with the neotype of two specimens (pl. xlvi, figs. 3, 4) on one slab (No. P 12744). Neither these nor any other specimens in the present collection resemble closely such specimens as were figured by Richter (1955) on pls. 3-6. The problems connected with their peculiar preservation and *Conularia*-like appearance are beyond the scope of this discussion.

The present specimens are each about 70 mm. long and 16-17 mm. wide. They show a median depression which takes a more or less indistinct zig-zag course, as a result of weaker transversal furrows joining it alternately, separating between them faint and slightly curved elevated transverse ribs which are about 2 mm. wide. 8 or 9 ribs occupy about 20 mm. along the axis. The lateral margins are indistinct but there is a gentle convergence towards that end which is faced by the concave side of the curvature of the lateral ribs. In the specimen in which the ribs are less faint, they extend 4 mm. and then flatten out markedly.

The differences between these specimens and the neotype of *Pteridinium simplex* Gürich are their smaller size, less distinct and narrower ribs, and narrower shape. The specimens from Ediacara may be referred to as *Pteridinium* sp. Gürich and Richter have considered *Pteridinium* as closely related to *Rangea*. This view is undoubtedly correct and on the South Australian material alone no generic distinction would have been made.

Rangea Gürich

Rangea Gürich, 1930, C.R. 15th Int. Geol. Congr., 2, p. 680.

Rangea Gürich, 1930, Zeitschr. deutsch. Geol. Ges., 82, p. 637.

Rangea Gürich, 1933, Palaeont. Zeitschr., 15, p. 139.

Rangea Richter, 1955, Senckenb. Leth., 36, p. 264.

Rangea Wells and Hill, 1956, Treatise Inv. Paleont., p. F478.

The most striking and unexpected discovery is the common occurrence of representatives of the genus *Rangea* in the Ediacara fauna. This genus was first described from the Kuibis quartzite of the Nama System of South-west Africa, where it is rare. About 40 specimens of fossils which cannot be generically separated from *Rangea* are now known from Ediacara. Sprigg (1949, p. 73) has referred to some of them as algae. Gürich compared *Rangea* (type species *R. schneiderhöhni* Gürich) with the Ctenophora, without assigning it to any Class. Richter (1955) placed it with *Pteridinium* in a new family Pteridiniidae which he assigned to the Order Gorgonaria, Suborder Holaxonia, of the Anthozoa (Octocorallia). This family is not mentioned in the Treatise on Invertebrate Paleontology where Wells and Hill (1956) refer to Gürich's comparison of *Rangea* with Ctenophora as very doubtful. The new material makes it possible to assign the genus to the Order Pennatulacea of the Anthozoa (Octocorallia).

Rangea arborea sp. nov.

Plate xliii, figs. 1-4; pl. xlv, figs. 1-3; pl. xlvi, fig. 1.

(a) Description

This description is based on a large number of specimens, some of which differ considerably in appearance. Existing transitions indicate that at least some of these differences are not of any taxonomic value but due to differences in preservation. Others may

indicate the presence of more than one species but all available specimens are more or less incomplete and there is not enough evidence, particularly from measurements, on which to base specific diagnoses.

The species *Ranqea arborea* is characterized by a leaf-shaped *main body* consisting typically of a *median field*, the sides of which converge towards the distal end. It may appear convex (pl. xlv, fig. 1; pl. xliii, fig. 4) or concave (pl. xliii, fig. 1), and may have a zig-zag shaped structure impressed on it (pl. xlv, fig. 2), or it may consist only of such a structure (pl. xliii, fig. 3) or become reduced to a zig-zag groove (pl. xlvi, fig. 1). A variable number of transversely directed *lateral furrows* divide the lateral portions of the leaf into convex or flatly moulded areas or *branches*. The furrows extend from the median field or groove outward at angles varying between 60° and 80°. The bases of the branches overlap the median field partially, giving the impression of being inserted in it with their narrowing, down-turned bases (pl. xliii, fig. 4). They alternate in position on the sides of the axis, irregularly or more regularly, which accounts for the zig-zag structure. In the best-preserved specimens a division of some of the lateral branches by closely set *secondary furrows* is seen. They are 1-3 mm. apart, mostly more distinct on the proximal margins of the branch, and set at approximately right angles to the lateral furrows so that they trend obliquely across the leaf from the outer margin inward towards the axis. Other specimens (pl. xlv, figs. 2, 3) show hardly any trace of secondary furrows and the lateral furrows grade into bundles of fine grooves arising from the median field in a similar manner to that observed in more typical forms. This field may also be marked by similar but longitudinally directed grooves. The entire structure appears to consist mainly of impressions of bundles of spicules, some of which may be up to 40 mm. long. Details of their shape and surface sculpture cannot be recognized, as the width of the individual grooves is close to or even less than the average grain size of the quartzitic matrix.

The lateral margins of the main body are often clearly marked by more or less sinuous lines. The ratio of length to width appears to have been variable and some leaves are broad while others are very long and narrow. As all specimens are incomplete, this ratio cannot now be used for specific distinctions. The width of the branches also varies conspicuously but is believed to be to some extent a function of growth. Several specimens have a *peduncle* attached to

the proximal end. It can be up to 12in. (30 cm.) long, with parallel sides, and about 20 mm. wide. In other specimens the peduncle is shorter or less well defined, or the proximal end of the main body is obscured or broken off. The maximum width of the body is about 4½in. (over 11 cm.), the maximum length (without peduncle) about 9in. (23 cm.) but all specimens are incomplete. Holotype: No. P 12891.

(b) Comparison

Because of the marked differences of opinion concerning the morphology and taxonomy of *Rangea*, a neutral terminology was used in the description of the new species. It will also be used in its comparison with *R. schneiderhöhni* Gürich. This species shows clearly the leaf-shaped main body with its median field, and the lateral branches which are separated by transverse lateral furrows and subdivided by secondary furrows arising from their proximal margins. The similarity in these characters is the basis for the generic identification of the new form with the genus *Rangea*. In addition, there is the downward turn and the narrowing of the bases of the lateral branches and their partial overlap over the median field in the distal part of the body which puzzled Richter (1955, p. 266). The differences are considered as specific. They are seen mainly in the more regular arrangement of the lateral branches, the more distinct secondary furrows, and the sharp outer margin, with certain lateral impressions ("Aussenfeld") beyond it in *R. schneiderhöhni*. In comparing a single specimen (*R. schneiderhöhni forma turgida* Gürich is too obviously distorted to be of much use) with the rich new material it is difficult to decide which of its features may be due to accidents of preservation of this individual. Such an accident may explain the lateral projections which are seen only on one side of the holotype specimen, and also the duplication of some furrows. However, the regular outline and the arrangement of furrows shown by this specimen have no parallel among the many specimens from Ediacara and specific distinction seems justified on this basis. *Rangea ? brevior* Gürich, a single specimen which has since been lost, cannot be considered.

(c) Interpretation

Gürich had considered, and rightly rejected, the possibility of his specimens representing tracks (1930a, p. 679; 1933, p. 141). He then compared them briefly with *Pennatulula* but rejected this as a lead to

their interpretation because they showed clearly an outer margin of the leaf-shaped body. He interpreted them as meridional sectors of melon-like bodies, and this led him to a comparison with the *Ctenophora*.

Richter (1955, p. 266) re-interpreted some of the structures of *Rangea* and revised some of Gürich's descriptions. It is his conclusion (p. 285) that these fossils are thin membranaceous leaves and not remains of spherical bodies, and that therefore they are not *Ctenophora*. He had abundant material of *Pteridinium* but no new specimens of *Rangea* and his conclusion that both these fossils represented *Gorgonaria* was based mainly on *Pteridinium*.

The study of the new material of *Rangea* places it clearly in the vicinity of the *Pennatulacea*. This assignment explains (a) the peduncle, (b) the leaf-shaped main body, (c) the median field which represents the median "dorsal track" of the *Pennatulacea*, (d) the zig-zag junction of alternating branches which corresponds to the "ventral track", (e) the lateral branches which are comparable to the "leaves" of the *Pennatulidae*, and their secondary divisions which reflect the placing of the autozooids on them, and (f) the spicular impressions in some of the fossils.

Some difficulties remain, but they are to be expected when an attempt is made to place a very ancient fossil in the system of recent forms. The difficulty which led Gürich summarily to reject relationships between *Rangea* and *Pennatula* still requires an explanation. In *Pennatula* the polyps sit on lateral extensions of the rhabdium which are generally known as "leaves," while in *Rangea* the lateral branches appear to have been fused to form the single leaf-shaped main body which shows a well marked outer edge in a number of specimens. One exception from this was recognized by Richter who described the distal ends of *R. schneiderhöhni forma turgida* as freely projecting. Some specimens of *R. arborea* suggest a certain measure of separation and mobility of the lateral branches. Even a solid single leaf with a regular arrangement of polyps in lateral transverse rows would not be in conflict with the basic structure of the *Pennatulacea*, though this particular type of organization is not represented in the living fauna. In *Renilla* which is leaf-shaped with an undissected outline the polyps are irregularly distributed and occur on the "dorsal" side only, while in *Pennatula* they sit on separate lateral leaves on the "ventral" side. In *Rangea* the position of the polyps is not yet known but they must have occurred in transverse rows supported by

major spicular sclerites as in *Pennatula*, on a leaf-shaped expansion of the rhachis similar to that of *Kenilla*.

The assignment of *Rangea* to the Pennatulacea supports the view that the different characters of some specimens are due to different types of preservation, though a later separation of additional species within the genus is not excluded. The preservation of the forms with "spicular" structure seems to have occurred after some maceration of the fleshy body had exposed the spicules which in living specimens are embedded in the flesh. It is further suggested that the ventral aspect of *Rangea* is represented by the forms with a median zig-zag groove (pl. xlvi, fig. 1) where the lateral branches, comparable to the "leaves" in living Pennatulidae arise in close proximity to the middle portion of the rhachis, leaving between them a groove ("ventral track") instead of a median field ("dorsal track"). In other specimens the ventral and dorsal aspects are superimposed.

The relationship of *Pteridinium* and *Rangea* suggests that *Pteridinium* also belongs to the Pennatulacea rather than the Gorgonacea. This seems more satisfactory but a re-interpretation of *Pteridinium* will be possible only after re-examination of the South African material.

Rangea? sp.

Plate xlvi, fig. 2

A very striking but unique specimen is here tentatively assigned to the genus *Rangea*. It is 70-75 mm. wide, with partially well marked lateral margins, but its distal and proximal portions are broken off. The fragment is 16 cm. long. It shows a median zig-zag line from which branches arise at angles of only 30-40°. These branches are separated by distinct sub-parallel furrows which are 16-20 mm. distant from each other. There are also secondary furrows about 5 mm. apart, diverging from the primary furrows at right angles and almost but not quite crossing from one to the next. A relationship with *Rangea* is suggested by its similarity with *R. arborea* in the presence of primary and secondary furrows on a leaf-shaped body and with its suggested ventral aspect in the development of a median zig-zag line. Differences are seen in the strong, widely spaced primary and secondary furrows and in the sharply defined straight outer margin. The secondary furrows do not seem to be confined to the proximal margins of the lateral branches if these are taken to diverge distally as in *R. arborea*. In the absence of the peduncle

the orientation of this unique fragment is still uncertain and the discovery of further specimens will have to be awaited before it is fully described. (See Addenda, pp. 396-397.)

Spriggia Southcott

Madigania Sprigg, 1949, Trans. Roy. Soc. S. Aust., 73, p. 93.
(*Madigania* nom. preocc., non *Madigania* Whitley 1945).

Madigania Harrington and Moore, 1956, Treatise Inv. Paleont., p. F154.

Spriggia Southcott, 1958, S. Aust. Naturalist, 32, p. 59.

This monotypic genus (type species *Madigania annulata* Sprigg, Holotype No. T 2031) differs from *Cyclomedusa* in the complete absence of radial ornamentation at least from the inner portions of the discs. More than 15 specimens are known at present. Harrington and Moore (1956) listed this fossil as "medusae incertae sedis".

Spriggina Glaessner

Spriggina Glaessner, 1958, Trans. Roy. Soc. S. Aust., 81, p. 158.

Spriggina, Glaessner, 1959, Geol. Rundschau, 47.

Since this fossil was first described, four additional specimens were found which do not contribute anything new to the knowledge of its characters. This is at present one of the rarest of the identifiable fossils from Ediacara. All specimens clearly belong to the type species, *S. floundersi* Glaessner (Holotype No. P 12771, pl. xlvii, fig. 1). One of the additional specimens is 24 mm. long and about 9 mm. wide, apparently complete with about 23 segments. The other (pl. xlvii, fig. 3) is 37 mm. long and about 11 mm. wide, incomplete, with about 29 segments preserved and the tail end broken off. The third specimen is 15 mm. long and 5.5 mm. wide. The fourth is very small and indistinct.

Tateana Sprigg

Tateana Sprigg, 1949, Trans. Roy. Soc. S. Aust., 73, p. 86.

Ediacaria (part) Harrington and Moore, 1956, Treatise Inv. Paleont., p. F74.

As stated above, this genus which was based on the type species *T. inflata* Sprigg (Holotype No. 2017, hypotype No. 2018) is not considered distinguishable from *Cyclomedusa*. It may be specifically identical with *C. radiata*.

Tribrachidium gen. nov.Type species: *T. heraldicum* sp. nov.

Characters as described for the type species.

Tribrachidium heraldicum sp. nov.

Plate xlvii, figs. 7, 8

Holotype No. P 12898.

Material: 23 specimens.

Description: All specimens are preserved as sub-circular impressions up to 26 mm. in diameter, with a sharply impressed outer rim and a distinctly sculptured surface. This sculpture consists of three hooked ridges of similar size and shape, radiating from the centre, and ending along the periphery in a fringe of tentacular projections. No such type of organisation has ever been observed in any known organism, and no specific descriptive terminology is available for it. Until more is known about this new organism, only general descriptive terms will be used, and they are not intended to carry any implications of homology. The basis of the following descriptions is not the fossil as it is observed but its artificially produced counterpart, all known specimens of the fossil being considered as external moulds. The reason for this interpretation is the observation that the marginal projections in the fossil merge with the matrix which rises steeply above them to the general level of the rock face, and that they end against a deeper depression away from the periphery. Reversal of the sculpture by casting shows the tentacular fringe arising from the outer slopes of three smoothly convex arms and ending as three-dimensional objects a little above the level of the surrounding rock. This seems a more likely interpretation of the original organic structure, and what follows is based upon it.

The centre of the structure is very slightly depressed but not sharply outlined, the inner ends of the three arms tapering slightly towards it. The arms then radiate, for a distance of about 5 mm. in the holotype, at equal angles. A convex, somewhat irregular area, here termed a *bulla*, is seen in each of the three interspaces, but these bullae do not rise to the level of the upper surface of the arms. The arms then turn at right angles, all in the same plane and in the same direction (dextrally in the artificial casts, sinistrally in all the natural specimens). Their distal portions are convexly curved so as to conform to the subcircular periphery of the structure. A peripheral tentacular fringe commences on the bend, extending to the tip of the

arm which is indistinct because of overlap by the beginning of the fringe of the next arm. The tentacles number about 18 on each arm; they extend from its flank to the periphery and their length decreases gradually towards the tip of the arm. They are generally slightly curved in the same direction as the arm and are not perfectly regularly arranged, some diverging more than others. They are not seen to branch or bifurcate. The coarse grain of the matrix obscures observation of their finer structure. In a few places suggestions of similar tentacular projections can be seen also on the inner sides of the arms, directed towards the bullae. These bullae lie within the curvature of the arms but each seems to be more closely joined to the radial portion of the arm next to that which curves around it. If that is correct then the bullae arise from the arms in a direction opposite to that of their hooked distal branches and about half-way between the centre and the angle. The periphery is sharp, surmounted by the blunt distal ends of the tentacles.

Remarks: This animal, though imperfectly known, is excluded from all known major groups by its three tentaculate arms. A superficial resemblance to certain echinoderms (Edrioasteroidea) which comes to mind must be discounted because of the complete absence of skeletal plates. That the body was soft and fleshy but tough can be concluded from the slight distortion of the outlines of the various specimens and of the tentacles in the fringes; but the arms must have been rigid lophophores as their position never varies. These fossils are sufficiently numerous to make it clear that the characters described above are of taxonomic value and not accidental features. The mouth was not in the centre, its position remains unknown. The organism could be considered an aberrant coelenterate, or else remotely related to one of the other groups of tentaculate invertebrates; but tri-radiate symmetry of structures supporting tentacles which is obvious in the present fossil is otherwise unknown.

A number of undescribed fossils from Ediacara correspond in size and outline with this new form. They are flatly conical impressions, with indistinct, broad, radial ridges and furrows. About 8 of these impressions have been collected. The possibility of considering them as casts of the reverse side of *Tribrachidium* should be kept in mind though at present there is no evidence for such a supposition.

The specific name was chosen because of the striking similarity of the pattern of this fossil to the well-known heraldic design of three radially arranged arms or legs, as in the coat-of-arms of the Isle of Man.

Unidentified Fossils

In addition to the fossils listed or described in this catalogue there is a relatively small number of others. One group of these comprises bodily preserved animal remains which are represented by insufficient numbers of specimens. About 6 of them are similar in appearance and vaguely suggest affinities to Siphonophora (pl. xlvii, fig. 9). Being irregular in shape and different in details, probably as a result of compression in various directions, they cannot be satisfactorily described on the basis of the present material. Another group consists of traces of life activities such as tracks, trails or burrows. There are several types of casts which were probably produced by sediment-feeding worm-like organisms. They are remarkably rare in relation to the large number of other fossils in these beds. There are also problematical flat casts in the shape of what appears to be a flat spiral, vaguely resembling a distorted and flattened string of beads. There is no evidence of actual coiling and no proof of their organic origin (see p. 395).

2. CONDITIONS OF PRESERVATION

The study of the preservation of these remarkable fossils is essential, firstly, for the full understanding of their morphology and taxonomic characters, and secondly, for the reconstruction of the environment in which the animals lived and became entombed.

All fossils are seen as elevated or depressed areas on bedding planes of the quartzite. According to Sprigg (1949, p. 215) they occur "always on the upper surface of these slabs". Mincham (1958, p. 217) has observed that they "appear mostly, if not entirely, on the lower surface of each stratum". Some confusion is likely to have resulted from the fact that it is easier to find the fossils on loose blocks which cover the hillsides below the outcrops, than on outcropping rock slabs *in situ*, and that on loose blocks they are more easily seen on the rain-washed upturned than on the soil-covered lower surfaces. Thus it is easy for the collector to gain the impression conveyed by Sprigg, yet special studies in the field have shown that the fossils are almost, though not entirely, confined to the lower surfaces of the quartzite slabs. In fact, the favoured technique in recent collecting consists in the wholesale upturning of slabs jutting out of hillside outcrops in the hope that the rain (amounting only to a few inches a year) will wash away the soil and decomposed rock with which the lower surfaces are almost invariably clogged, and so expose the fossils.

A search was made for counterparts which should appear on the opposing upper surfaces. As a rule, upper surfaces show nothing at all. There is only one known exception. Dr. B. Daily has photographed a medusa-like fossil appearing as usual as a convexity on the lower surface of a large slab, together with its concave counterpart on the opposing upper surface of the bed below. He has also collected a sequence of three adjoining layers of quartzite (No. P 12900 A, B, C) from an outcrop. The bottom of the top layer (A) shows a *Dickinsonia* and medusae. The top of the middle layer (B) contains no counterparts. Its bottom shows a *Tribrachidium*. There is again no counterpart of this on the opposing top of the lower layer (C), while its bottom contains *Cyclomedusa*. Loose slabs cannot be reliably orientated as they represent usually single or incomplete sets of cross laminae. Yet for some specimens in the collection orientation is suggested by observed textural features and this makes it probable that at least one specimen of *Dickinsonia* (Adelaide University coll. No. T65-2024) is preserved on the strongly ripple-marked upper surface, while tubular worm casts project from and along what appears to be the lower surface. Three specimens collected by H. Mincham and B. Flounders are very unusual in appearance and seem to have come from the same bed. They are covered with long, narrow, leaf-like specimens of *Rangea*. One slab, No. P 12716, shows on the opposite face an impression of *Tribrachidium heraldicum* in the usual preservation. This appears to be the lower surface. These are the only specimens with fossils both on the upper and on the lower surface of a single slab. The extreme rarity of fossils on upper surfaces, and of counterparts, can be explained with a high degree of probability by the embedding of the organisms in thin layers and films of clay and the subsequent casting of either the organic bodies or their impressions by the overlying sand. The thin clay layers which are responsible for the flagginess are destroyed by the weathering which separates the flags or slabs from each other. Traces of very thin clay lenses are seen on fresh vertical fractures of some quartzite beds but the rock is so strongly welded around them by silicification that it has not yet been possible to obtain fossils by splitting along such lenses. Fossils can be found *in situ* by opening up flags in outcrop and removing the weathered material separating them, but some weathering has so far proved essential for the discovery of fossils. The same conditions were reported to exist in the fossiliferous Kuibis quartzite in Southwest Africa (Richter 1955).

The distribution of fossils throughout the thickness and outcrop area of the fossiliferous strata seems to be essentially random, and the more frequent species are found frequently associated on single slabs in considerable numbers. Parallel orientation, presumably by currents, has been found on one or two slabs containing elongate types of *Rangea*. Most other forms which are rounded in outline, do not show orientation or accumulation by transporting forces though some of them occur in groups. There is no evidence of fossils or bedding laminae being distorted by scavengers and nothing points to functional interrelations of the various types of organisms.

Sprigg has observed and discussed the important fact that all fossils represent soft-bodied organisms. This has been fully confirmed by later collecting. In addition to the evidence of the medusae, there is the distortion and folding over, before or during embedding, of specimens of *Parrancorina*, *Dickinsonia* and *Rangea*, proving that their tissues were soft. The outlines of the medusae and of *Tribrachidium* vary slightly and specimens of *Spriggina* show sigmoidal curvature. There is no evidence of hard parts other than impressions of spicules in *Rangea*.

The orientation of the organisms relative to the bedding planes during burial still presents difficulties of interpretation as they are practically all new so that their appearance and orientation in life are unknown. All *Parrancorina*, *Tribrachidium* and *Spriggina* (in this instance judging from the head which must have been convex) are preserved as impressions or "negatives". *Beltanella*, all or most *Cyclomedusa*, *Spriggia*, and "*Protolyella*" are preserved as flat or high (*Beltanella*) convexities on the lower surfaces of the beds. Cross sections through some medusoid fossils show evidence of considerable compaction and of even greater original convexity. This creates some difficulty in the comparison with recent medusae which are mostly found stranded in convex-upward position (Schäfer 1941). Further studies of these convex-downward genera and also of *Pseudorhizotomites* which differs from them in preservation are required. The genera preserved as "negatives" appear to be external moulds of actual individuals embedded in clay partings which have vanished, while *Rangea* seems to represent casts of impressions made by individuals in different positions.

The preservation of *Dickinsonia* has yet to be studied, but at least some specimens are clearly impressions on the lower surfaces of the beds and are therefore to be interpreted as external moulds.

3. CONCLUSIONS

a. Composition of the fauna

The Ediacara fauna can no longer be considered as consisting almost exclusively of medusa-like fossils, though these constitute the majority of specimens collected. The following seven genera can be recognized:—

- Pseudorhizostomites* Sprigg
- Beltanella* Sprigg
- Ediacaria* Sprigg
- Protodipleurosoma* Sprigg
- Cyclomedusa* Sprigg
- ?*Protolyella* Torrell
- Spriggia* Southcott

Much detailed and comparative work remains to be done on the hundreds of medusoid specimens which are available. The latest published taxonomic revision (Harrington and Moore, 1956) places the first of these genera in the Scyphomedusae, the second and third in the Trachymedusae (Trachylinida), the fourth in the Leptomedusae (Calyptoblastina), and lists the representatives of the remaining three as "Medusae incertae sedis". These assignments and the underlying morphological interpretations are subject to further revision in the light of the abundant new material.

The Phylum Coelenterata is represented in the fauna not only by possible Scyphozoa and Hydrozoa but also possibly by Siphonophora and by Anthozoa Octocorallia. The genera

- Rangea* Gürich and
- Pteridinium* Gürich

have been recognized and placed in the Order Pennatulacea. The first of these is a common element of the fauna.

The Phylum Annelida is represented by

- Spriggina* Glaessner

which resembles the living Tomopteridae. This Phylum could also include the common genus

- Dickinsonia* Sprigg,

of which abundant material has yet to be examined. Life activities of annelid (and possibly other) worms are represented by tracks and burrows which, however, are not very common.

Two entirely new types of invertebrates complete the fauna as it is known at present. They have been described as new genera

Parnancorina Glaessner and

Tribrachidium Glaessner,

each represented by a single new species.

b. Ecology

The fauna is marine and consists of pelagic and benthonic elements. Sprigg has discussed the fossils which were known to him with reference to living medusae and their pelagic mode of life. Little can be added to the discussion of this part of the fauna at the present stage of the investigations. We know now more about the conditions of embedding and preservation of soft-bodied animals (Schäfer 1941). The preferred orientation of the medusa-like fossils in a convex-downward position is puzzling and requires explanation. A prominent benthonic element in the fauna are the sessile Pennatulacea. Their living representatives occur in upright position in varying depths of water, with the peduncles buried in sandy sediment. They lived probably not far from their place of burial. There is evidence of worms burrowing in the sandy sediment. *Spriggina* could have lived either on the sea floor or in the water above it. The mode of life of *Parnancorina* and *Tribrachidium* is unknown. Representatives of these three genera were trapped on muddy ground, probably by receding water. That the sedimentary environment was a very unstable one is proved by the ubiquitous cross-bedding and ripple marking of the fossiliferous strata and by slump rolls and mud pellets. The nature and direction of the currents remains to be established by modern methods of analysis of cross-bedding. Sandstone casts of mud surfaces with drying cracks have been found and drying cracks on ripple-marked surfaces ("*Mauchuriophycus*", see Häntzschel 1949) also occur. These occurrences prove that the water was shallow enough to make occasional emergence of newly deposited sediment possible. Some of the soft-bodied animals could have been preserved by desiccation, and in this sense Sprigg was justified in visualizing the area as one of "fossil beaches". If the problematic markings (pl. xlv, fig. 3) are in fact identical with the foam impressions described by Häntzschel and Richter (1954) which they resemble more than any known traces of organic activities, they would support the available evidence of emergence and drying of bedding planes.

c. Biostratigraphic relations

Sprigg (1947, 1949) had considered the age of the Ediacara fauna as Lower Cambrian, at a time when the place of the previously discovered Cambrian fossils in the general time-stratigraphy of that System was unknown and when the Pound Quartzite was thought to represent the Lower Cambrian. Daily (1956) has since placed the overlying Archaeocyatha limestones in the lower part of the Lower Cambrian. The occurrence of a rich new fauna without any known Lower Cambrian elements below these limestones is a valid reason for placing the Pound Quartzite at the top of the Precambrian and for considering its age as Late Proterozoic. Sedimentation was regionally continuous from Precambrian to Cambrian and has produced again and again through long spans of time similar rock types, so that there is little difference between the Marinoan and the Lower Cambrian dolomites, or the quartzites in the lower part of the Marinoan, the Pound and the Lower to Middle Cambrian. As in the time stratigraphy of later geological periods, only biostratigraphic observations can determine the position of the base of the Cambrian. Below that horizon only absolute measurements of geological time can be used, with the exception of the possible time significance of the Proterozoic ice ages—and of the Late Proterozoic fauna.

With the recognition of elements of the fauna of the Kuibis quartzite of the Nama System in the Ediacara fauna, this stands no longer alone and the way to its use in inter-regional correlation is opened. The occurrence of *Rangea* in the Ediacara fauna, together with *Pteridinium* and medusoid fossils which are at least similar to *Paramedusium africanum* Gürich is a strong argument in favour of placing the fossiliferous part of the Nama in the Late Precambrian. Medusoid fossils have been reported from the Late Proterozoic of other parts of Australia and from the Algonkian Naukoveap Group of the Grand Canyon of Arizona. Detailed comparisons of these fossils and further collecting in Late Precambrian fossiliferous strata should be stimulated, because of not only their palaeozoological but also their biostratigraphic interest, by the discovery of a rich and varied Late Proterozoic fauna in South Australia.

ADDENDA

While this paper was in press, several publications were received to which reference should be made. Their titles have been incorporated in the list of references below but no alterations have been made in the text above.

Ford (1958) described Precambrian fossils from Charnwood Forest in Leicestershire, England, as *Charnia masoni* Ford and *Charniodiscus concentricus* Ford. The first name refers to frond-like bodies about 10-25 cm. long and up to 4.5 cm. wide, consisting of oblique lobes which meet alternately at a sinuous median groove. Each of these lobes is divided by secondary furrows, at right angles to the lateral furrows, into about 13 secondary "segments". The structure is almost identical with that described here (p. 387, pl. xlv, fig. 2) as *Rangea?* sp. This fossil which is about twice as large as the Charnian type specimen should now be known as *Charnia* sp., as it is closer in structure to this genus than to *Rangea*. Specific identification must await the discovery of other, more complete specimens at Ediacara.

The occurrence of *Charnia* among the Late Precambrian fossils of South Australia raises further points concerning the nature of these fossils, in addition to its obvious bio-stratigraphic interest. The English fossils end proximally in "blunt stalks" which are 2 cm. wide. This confirms the view that *Charnia* and *Rangea* represent similar organisms; what has been demonstrated concerning the Pennatulacean affinities of *Rangea* should apply to *Charnia*. Ford (1958, p. 214 f.) states that *Charnia* resembles *Rangea schneiderhöhni* Gürich and rightly rejects the view that these fossils are Ctenophora or Gorgonaria. His conclusion, however, is that "*Charnia masoni* may most rationally be interpreted as an algal frond". He suggests that *Charniodiscus concentricus* Ford ("a disc-like organism 5-30 cm. in diameter with a rough-surfaced central area surrounded by a smooth flange which may or may not bear concentric corrugations") may be the basal part of the same alga. "In one case only are frond and disc apparently associated". "If *Charniodiscus* were considered alone, it could be compared favourably with one or the other of the various forms of medusae such as those in the Lower Cambrian of Australia". This is of extraordinary interest, as the possibility of some medusoid fossils from Ediacara being the bases of the stalks of *Rangea* had been considered but put aside for lack of decisive evidence. Stalk-like projections from the centres of medusoid fossils have been observed but none of them shows a *Rangea* or *Charnia*-frond at the other end. A further search for such specimens will be made in the field. Ford's statement concerning the affinities of his fossils concludes: "The only likely alternative is that they represent a primitive coelenterate of unknown affinities". The new material of *Rangea* suggests that this alternative view is preferable, and that

these Precambrian Coelenterates were closely related to the Pennatulacea.

The stratigraphic range of this group seems to have been extended to the Lower Palaeozoic by the discovery of a *Pennatula*-like stalked frond about 12cm. long and less than 2 cm. wide, which was very briefly described by Tremblay (1941) from a coarse sandstone lithologically resembling the Upper Cambrian Potsdam sandstone, but found at a locality 90 miles down the St. Lawrence from Ottawa, where the geological map of Canada shows only Ordovician. Häntzschel (1958) has recently reviewed doubtful fossil Octocorallia and prefers to consider most of them as tracks of unknown animals. He admits, however, that Tremblay's fossil, though not definitely assignable, is comparable with Pennatulacea.

Finally, curious projections on lower surfaces of sandstone beds of Early Palaeozoic age have been described by Howell and Hutchinson (1958) from Washington and referred to *Bergaueria* Prantl, originally described from the Ordovician. Prantl thought them to be infillings of cavities occupied by Ceriantharia-like coelenterates and Howell and Hutchinson conclude that their fossils may have held the stalks of pennatulid-like animals.

EXPLANATION OF PLATES

PLATE XLII

- Fig. 1. View of Mount James. Looking north across the outcrop of massive quartzite and the underlying fossiliferous strata, from just below the base of the Cambrian, about one mile north of the Ediacara fossil reserve. Photo. M.F.G.
- Fig. 2. Outcrop of fossiliferous strata below top of Pound Quartzite, about one mile south of Gap Creek. Photo. B.D.
- Fig. 3. Outcrop of fossiliferous strata below top of Pound Quartzite, near locality of Fig. 2. Photo. M.F.G. Length of scale 9in.

PLATE XLIII

- Figs. 1-4. *Rangea arborea* nov. sp. Fig. 1. Holotype. Large specimen on weathered surface. Note distinct left lateral margin and secondary furrows mainly on right lateral branches. No. P 12891. Fig. 2 Specimen with distinct lateral margins, median field and lateral furrows. No. P 12890. Fig. 3 Specimen with zig-zag trace of median field, with "spicular" structure (compare with Pl. XLV, Fig. 2). No. P 12892. Fig. 4. Fragmentary specimen, with traces of secondary furrows on lower margins of lower left lateral branches. No. P 12896.
- Fig. 5. *Rangea schneiderhöhni* Gürich. Photograph of latex mould of holotype, forwarded by Dr. W. Häntzschel, Geol. Staatsinstitut, Hamburg, Germany. Scale in centimetres.

PLATE XLIV

- Figs. 1-3. *Rangea arborea* nov. sp. Fig. 1. Specimen with long peduncle, on ripple-marked, eroded surface. The main body with its median field, lateral branches and secondary furrows is seen above a medusoid fossil, probably *Protolyella? mawsoni* (Sprigg). No.

P 12888. Fig. 2. Specimen showing "spicular" structure of median field, and lateral margins, partly folded over on left. Natural size. No. T 94-2015. Fig. 3. Specimen showing "spicular" structure of median field and lateral branches. $\times 0.9$. No. T 93-2016. Photographs 2 and 3 by Mr. K. P. Phillips.

PLATE XLV

- Figs. 1-2. *Rangca arborea* nov. sp. Fig. 1. Several individuals, partially overlapping, showing "dorsal" and "ventral" aspects, preserved on upper surface of bed. No. P 12716. Fig. 2. Fragmentary specimen (upper right), preservation intermediate between Pl. XLIII, figs. 2 and 3. Below are two unidentified medusoid fossils. No. P. 12895.
- Fig. 3. Unidentified casts. No. P 12893.

PLATE XLVI

- Fig. 1. *Rangca arborea* nov. sp. "Ventral" aspect. Compare with Pl. XLIII fig. 3. $4/3$ natural size (length of scale 1 cm.). No. P 12894.
- Fig. 2. *Rangca?* sp. Specimen with straight lateral margins and median zig-zag groove. Natural size. No. P 12897.
- Figs. 3-4. *Pteridinium* sp. Two specimens from one slab, poorly preserved. Natural size. No. P 12744.

PLATE XLVII

- Figs. 1-4 *Spriggina floundersi* Glaessner. Fig. 1. Holotype, $5/4$ natural size. No. P 12771. Fig. 2. Paratype, $5/4$ natural size. No. P 12772. Fig. 3. Specimen No. P 12899, $4/3$ natural size. Fig. 4. Median portion of specimen No. 12772 enlarged to show acicular setae, attached to parapodia. $\times 2.4$.
- Figs. 5-6 *Parvancorina minchami* Glaessner. Two specimens showing oblique traces of possible appendages on the lateral areas. The apparent "tail" of fig. 6 appears to be due to fortuitous grooving of the bedding plane. Fig 5. $\times 1.2$, No. P 12901. Fig. 6 natural size, No. P 12887.
- Figs. 7-8. *Tribrachidium heraldicum* nov. gen., nov. sp. Fig. 7. Holotype, natural size. No. P 12898. Fig. 8. Paratype, natural size, No. P 12889.
- Fig. 9. Problematic fossil, possibly belonging to the Siphonophora. $4/3$ natural size, No. P 12734.

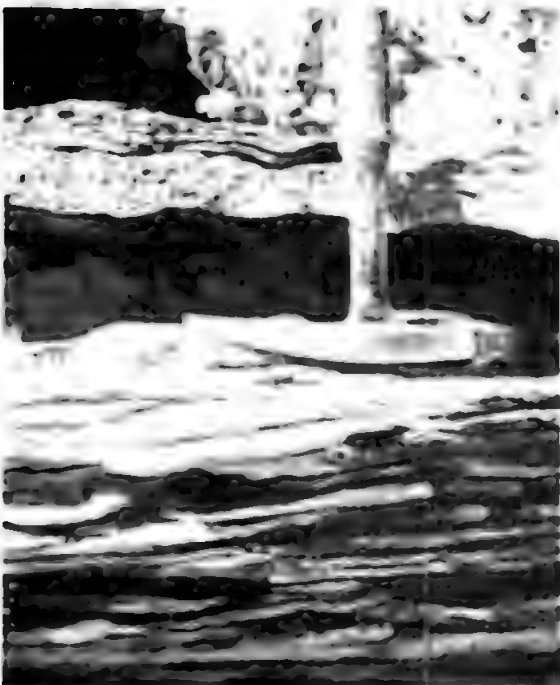
Specimens represented by figs. 1-8 are preserved as concave impressions but lighting chosen for clarity may give the appearance of reversed sculpture.
Photographs of figs. 4-7 and 9 by Mr. B. Flounders.

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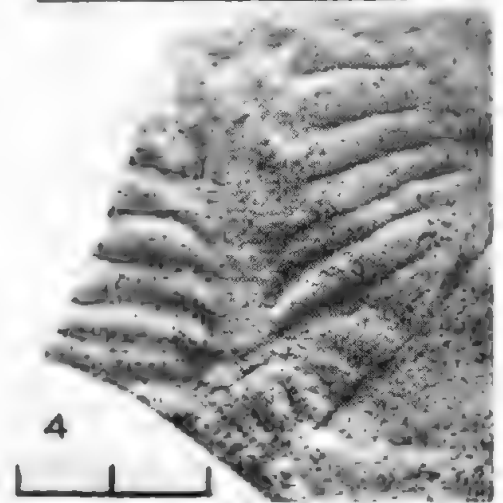
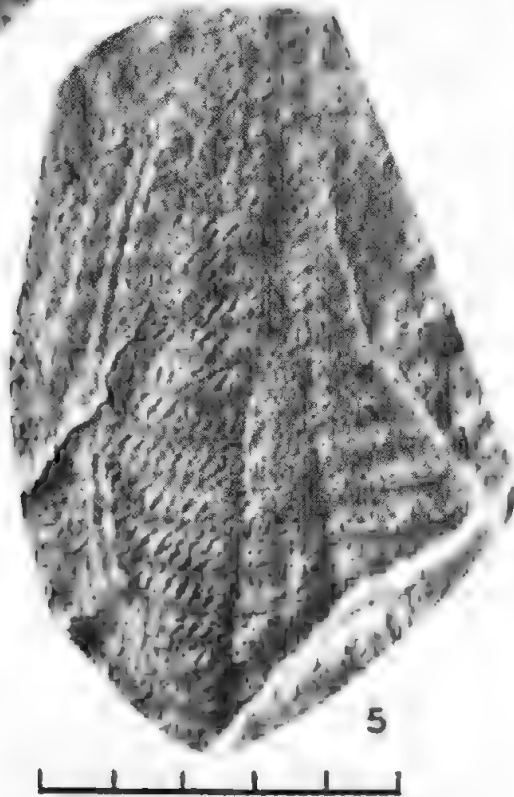
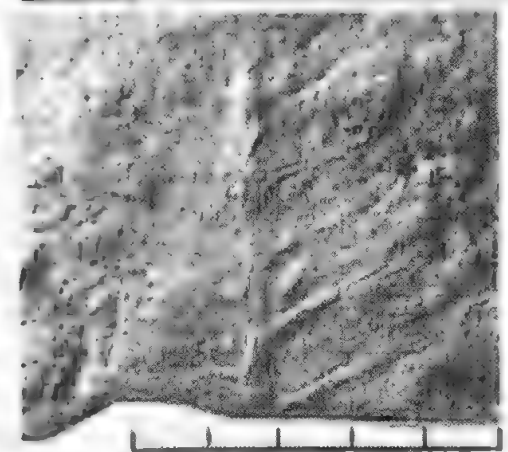
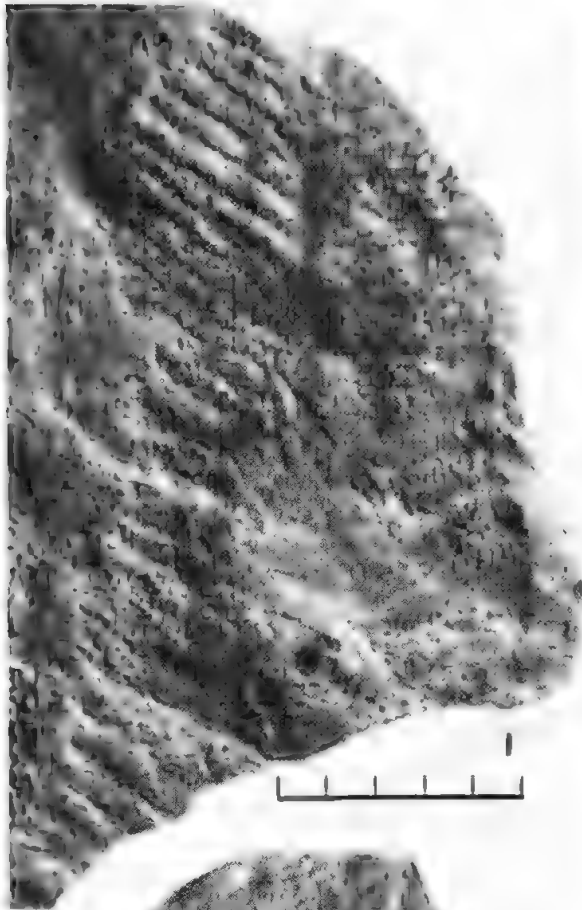
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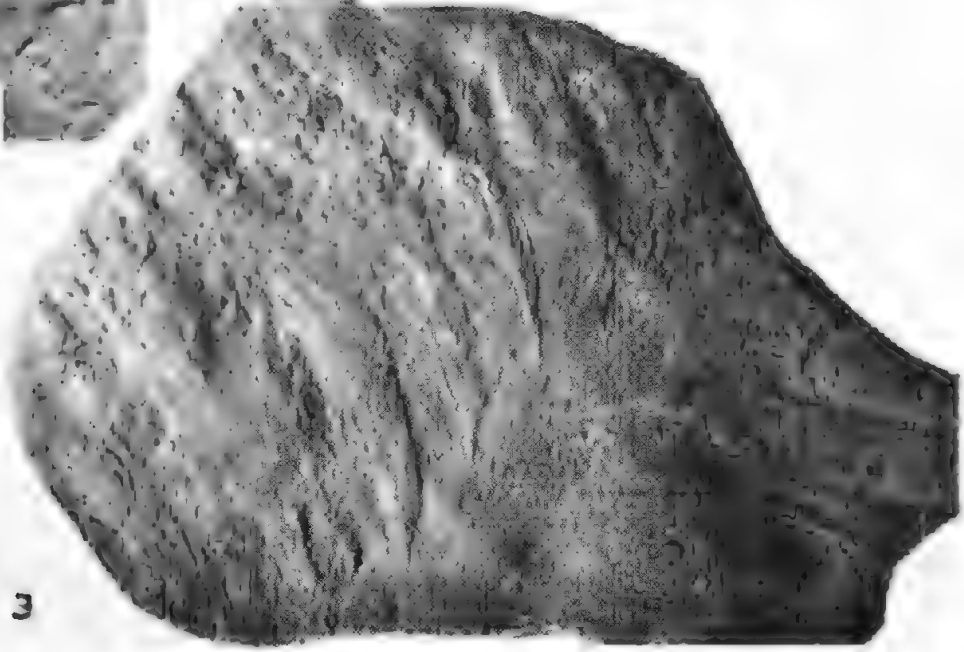




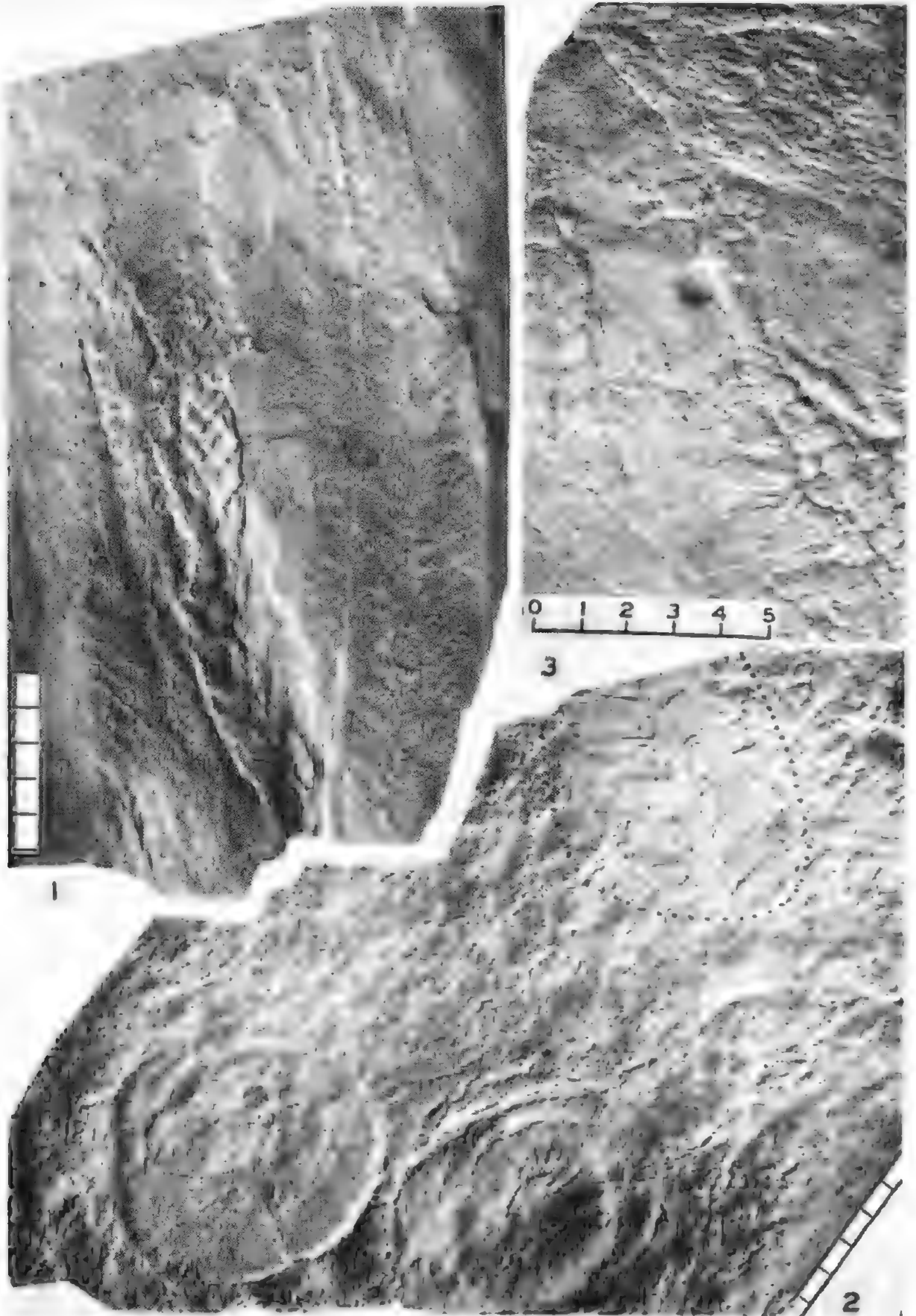
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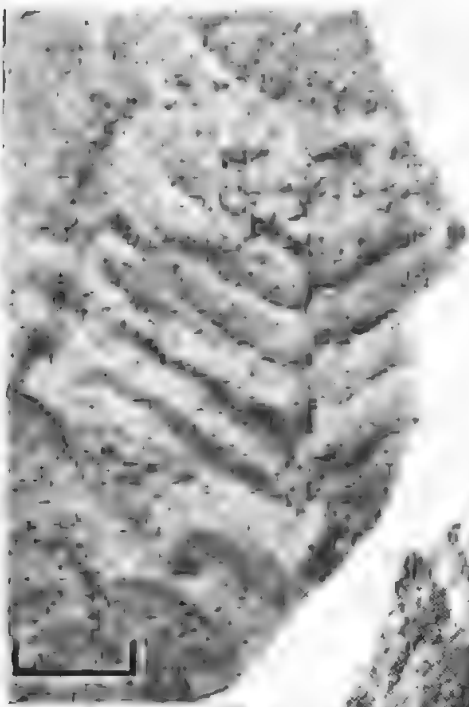


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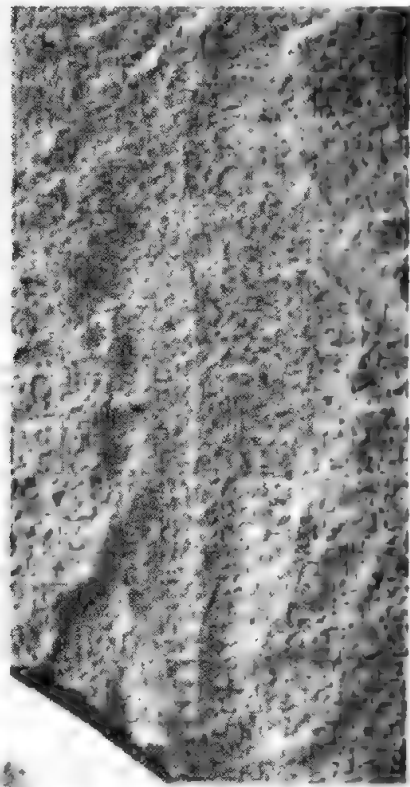


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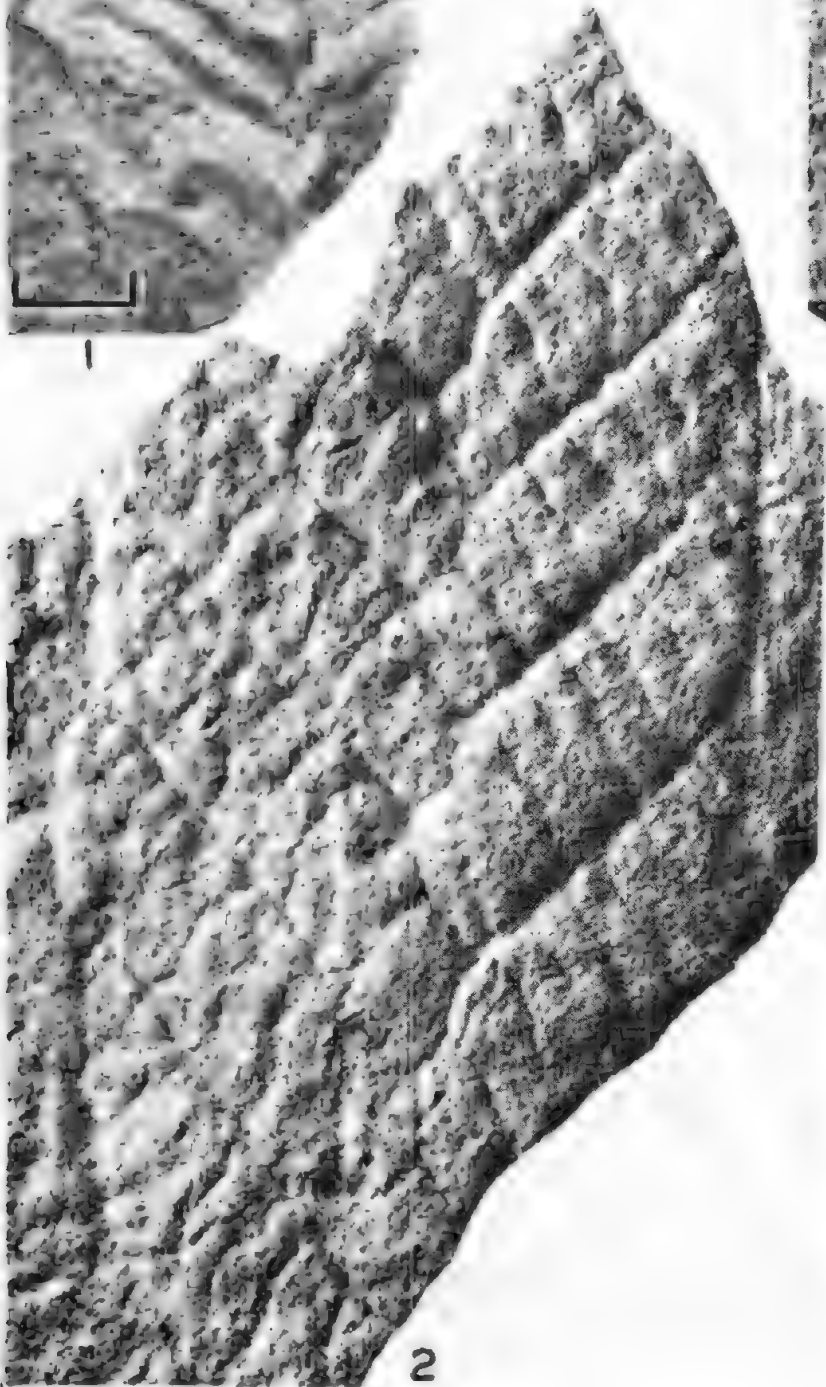




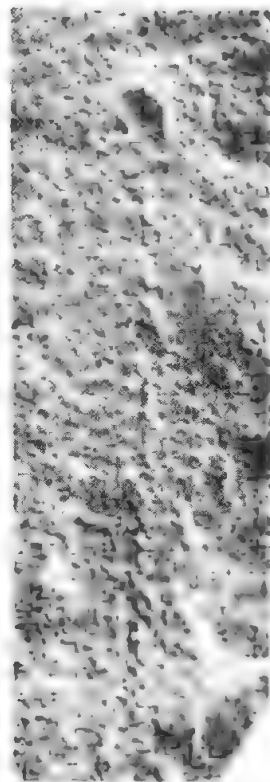
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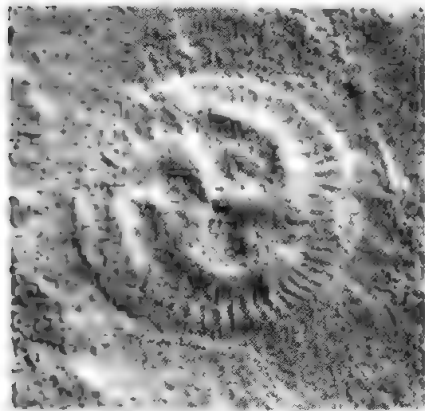
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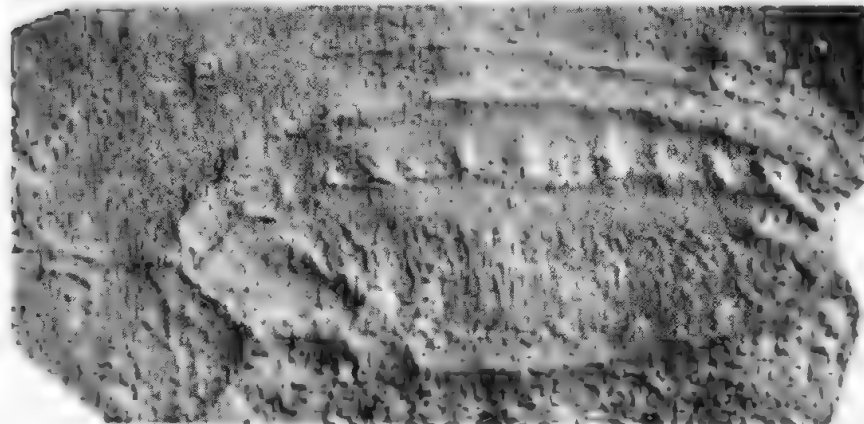
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RECORDS
OF THE
SOUTH AUSTRALIAN MUSEUM

Vol. XIII, No. 4

Published by The Museum Board, and edited by the Museum Director

Adelaide, 30th July, 1960

ISSUED 19TH AUGUST, 1960

Printed in Australia by W. L. HAWES, Government Printer, Adelaide
Registered in Australia for transmission by post as a periodical

**A REVISION OF THE GENUS LEPTOCORIS HAHN
(HETEROPTERA: COREIDAE: RHOPALINAE)
FROM THE INDO-PACIFIC AND AUSTRALIAN REGIONS**

BY GORDON F. GROSS, CURATOR OF INSECTS, SOUTH AUSTRALIAN MUSEUM

Summary

The species of the genus *Leptocoris* Hahn 1831 (= *Serinetha* auctt.) for many years have been difficult to separate in the Indo-Pacific region.

My first introduction to this problem was an attempt to identify the Australian specimens of the genus in the various Australian Museum collections. Most of the medium sized species were labelled *lurida* (Dallas), the larger *abdominalis* (Fabr.) and a small unnamed species from Central Australia was evidently *vulgaris* Bergroth. In an effort to find more satisfactory taxonomic characters I dissected out the male and female genital capsules of a series of specimens and it was soon evident that there were only three very distinctive species involved. The medium sized group belonged to two species and it was possible to identify one section of these with the name *mitellata* Bergroth because of the presence in most (but not all) of a distinctive red spot on the hemelytra; this is mentioned in Bergroth's description. The remaining medium sized specimens belonged to the same species as the small *vulgaris* whilst the largest specimens represented another species.

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Plate xlviii and text fig. 1-4

ACKNOWLEDGMENTS

I am indebted to the following individuals and Institutions for loan of specimens, comparison of types and all the other courtesies and kindnesses without which such a revision as is presented here would be impossible:—Dr. W. E. China and Mr. R. J. Izzard and the Trustees of the British Museum (Natural History); Dr. H. C. Blöte and the Rijksmuseum van Natuurlijke Historie, Leiden; Dr. A. J. Nicholson and the C.S.I.R.O., Division of Entomology, Canberra; Dr. J. W. Evans, the late Mr. A. Musgrave and the Trustees of the Australian Museum, Sydney; Mr. C. W. Brazenor, Mr. A. N. Burns and the Trustees of the National Museum, Melbourne; Dr. W. D. L. Ride and the Trustees of the Western Australian Museum, Perth; Dr. J. L. Gressitt, Bernice P. Bishop Museum, Honolulu, and other Institutions providing material for the Insects of Micronesia project; Dr. T. E. Woodward and the Department of Entomology, University of Queensland, Brisbane; Dr. Hans Saetlehen and the Deutsches Entomologisches Institut, Berlin-Friedrichshagen (for the loan of Breddin's type of *Serinetha spectabilis*); Dr. R. Malaise and the Naturhistoriska Riksmuseet, Entomologiska Avdelningen, Stockholm (for the loan of Stål's type of *Serinetha corniculata*); Mr. O. L. Cartwright and the Trustees of the United States National Museum; Dr. W. Hackman, Helsinki; Dr. J. O. Hüsing and the Zoologisches Institut, Martin Luther Universität, Halle-Wittenberg; Dr. S. L. Tuxen and Dr. Anker Nielsen, Universitets Zoologiske Museum, Copenhagen; Dr. T. Jaczewski and the Institute of Zoology, Polish Academy of Sciences, Warsaw (for the loan of Dohrn's type of *Serinetha dallasi*); and Mr. B. A. O'Connor and the Department of Agriculture, Suva, Fiji Islands.

ABBREVIATIONS

The following abbreviations have been used for Institutions in which the material used in this revision is lodged. A.M., Australian Museum, Sydney; B.M., British Museum (Natural History); B.P.B.M., Bernice P. Bishop Museum, Honolulu; C.N.H.M., Chicago Natural History Museum, Chicago; C.S.I.R.O., Commonwealth Scientific and Industrial Research Organization, Canberra; K.U., Kyushu University, Fukuoka; N.M., National Museum, Melbourne; R.M., Rijksmuseum, Leiden; S.A.M., South Australian Museum, Adelaide; U.Q., Entomology Department, University of Queensland, Brisbane; U.S.N.M., United States National Museum, Washington; W.A.M., Western Australian Museum, Perth; and Zool. Inst. Halle, Zoologisches Institut, Halle-Wittenberg.

INTRODUCTION

The species of the genus *Leptocoris* Hahn 1831 (= *Serinettha* auctt.) for many years have been difficult to separate in the Indo-Pacific region.

My first introduction to this problem was an attempt to identify the Australian specimens of the genus in the various Australian Museum collections. Most of the medium sized species were labelled *lurida* (Dallas), the larger *abdominalis* (Fabr.) and a small unnamed species from Central Australia was evidently *vulgaris* Bergroth. In an effort to find more satisfactory taxonomic characters I dissected out the male and female genital capsules of a series of specimens and it was soon evident that there were only three very distinctive species involved. The medium sized group belonged to two species and it was possible to identify one section of these with the name *mitellata* Bergroth because of the presence in most (but not all) of a distinctive red spot on the hemelytra; this is mentioned in Bergroth's description. The remaining medium sized specimens belonged to the same species as the small *vulgaris* whilst the largest specimens represented another species.

The search for the correct names of these latter two species involved examination of specimens from many collections ranging over the whole of the Indo-Pacific region, while even some African and the two American species were examined for possible synonymy. This survey revealed that the male genitalia belonged to only seven very distinct types and that using the male genitalia as a basis of classification a variety of forms quite different in general appearance belonged to the same species, whereas in other cases specimens of

almost identical appearance in colour and general shape belonged to different species. The female genitalia were not quite so distinctive in many cases, but in the several species (*abdominalis* and *rufomarginata*) where a number of varied individuals came together in the range of one species, whilst others very similar were referable to the other on the basis of the male genitalia, the female genitalia proved to be very different from each other and gave the same result.

The number of male genital types seen has now been extended to thirteen (following the examination of some unique types) and it appears that each one of these represents a distinct species. The names applied at various times to the Indo-Pacific species of *Leptocoris* number thirty-one. The types of five of these can no longer be traced (*tagalica* Burmeister, *rufus* Hahn, *mitellata* and *vulgaris* Bergroth, *laprobanensis* Dallas, and *taitensis* Guérin). One of the thirteen species appears to be new.

SYSTEMATIC

Genus *Leptocoris* Hahn 1831

Leptocoris Hahn 1831: Wanz. Ins., 1: 200. Burmeister, 1835: Handb. der Ent. 2: 305. Stål, 1870: Kongl. svensk. Vetens. Akad. Handl., 9 (1): 226. Distant, 1882: Biol. Centr. Amer. Peter., 1: 172. Uhler, 1886: Check List, 13. Kirkaldy, 1905: Trans. ent. Soc. Lond., 350. 1908: Entom., 41: 123. Distant, 1908: Entom., 41: 47. Van Duzee, 1917: Cat. Hem. Nth. Mexico, 123.

Serinetha Spinola, 1840: Essai sur les Hémipt., 247. 1850: Tavola Sinot., 37. Dallas, 1852: List. Hemipt. Ins., 2: 459. Stål, 1862: Stett. ent. Ztg., 23: 306. 1865: Hem. Afr., 2: 112. 1873: Kongl. svensk. Vetens. Akads. Handl. 11 (2): 98, 99. Lethierry & Severin, 1894: Cat. gén. Hém., 2: 122. Distant, 1902: Faun. Brit. Ind. Rhynch., 1: 418. Bergroth, 1913: Mém. Soc. ent. Belg., 22: 164. Villiers, 1952: Hémipt. de l'Afrique noire, 108.

Lygæmorphus Blanchard, 1840: Hist. des Ins., Hémipt., 116.

Pyrrhotes Westwood, 1842: Cat. Hem. Ins. Coll. Hope, 2: 6.

Tynotoma Amyot and Serville, 1843: Hémipt., 220.

Boisea Kirkaldy, 1910: Proc. Haw. Ent. Soc., 2: 123 (as a subgenus).

The species of this genus in this region belong to several groups if the shape of the male genital capsule is taken as the sole guide.

In the first group the ventral part of the penultimate segment of the capsule is produced beyond the furthest posterior extension of its

dorsal part but it is never produced very far or thrown into distinct lobes or processes. To this group belong *augur* (Fabr.) and *minuscula* Blöte and also some African species (*e.g. intermedia* Dist.).

In *coimbatorensis* sp. nov. and *corniculata* (Stål) the ventral part of the penultimate segment is not very much more produced than in the *augur* group, but is thrown into four short or medium sized lobes. To this group also belong the two American species *trivittatus* (Say) and *rubrolineata* Barber (both of these seem to have almost identical male genitalia and may be only sub-specifically distinct) and some African species (*e.g. fulcratus* Germ.)

In the Australian *mitellata* Bergroth is seen the first development of the general Indonesian and Pacific region type of male capsule in which the male penultimate segment is produced markedly posteriorad by being thrown into two prominent lateral lobes (parandria) and medially into a slender laminate (in the vertical plane) or triangular (in the horizontal plane) process which extends posteriorad up between the claspers. In *mitellata* these parandria are vaguely triangular in cross section and somewhat bifid at apex.

In *vicina* (Dallas), *subrufescens* (Kirby), *coxalis* (Kirby), and *abdominalis* (Fabr.) the parandria are circular in cross section and nearly as long as the claspers.

In *rufomarginata* (Fabr.) *tagalica* Burmeister, *isolata* (Distant) and *marquesensis* Cheesman the parandria are flattened or even shallowly concave on the upper and inner face and rounded below and are therefore vaguely semicircular in cross section. This is the only type to be found in the Eastern Pacific.

The males can be separated by the following key. The female genitalia in several cases are not so distinctive and it has not always been possible to key right down to species.

Key to Indo-Pacific species of *Leptocoris*—Males:—

1. Male genital capsule with ventral part of penultimate segment (pygophore) produced posterioriad to about the level of, or just surpassing anal segment. Apex of penultimate abdominal segment truncate or sinuate but never produced into distinct lobes 2

- Male genital capsule with ventral part of penultimate segment surpassing level of anal segment, and its apex thrown into two cylindrical or flattish lobes or four short lobes 3
2. Apical margin of penultimate segment of genital capsule almost truncate. Clasper with a prominent outwardly and downwardly directed process on its outer margin about halfway along its length, and with a concave area on its ventral surface near apex *augur* (Fabr.)
- Apical margin of penultimate segment of genital capsule sinuate. Clasper without a ventero-lateral tooth but fairly thin and only slightly concave on the under surfaces *minuscula* Blöte
3. Ventral apical margin of pygophore sinuate with only two vague lobes, one either side of mid line. Lateral margin widened at level of clasper, produced inwards and bearing a short cylindrical process alongside the clasper. A prominent tubercle on either side of head in front of eye *corniculata* Stål
- All lobes of apical margin of pygophore whether two or four more massive and conspicuous. Without a conspicuous tubercle on either side in front of eye, although there may be an oblique keel running down from centre of vertex to insertion of antennae 4
4. Apical margin of penultimate segment of genital capsule thrown into four flattish lobes. Claspers flattish *coimbatorensis*, sp. nov.

- Apical margin of penultimate segment of genital capsule thrown into two long lobes, cylindrical, flattened, or semicircular in cross section. Claspers never completely flat, but always in some section semicircular or semicircular with a concave ventral surface 5
5. Lobes of penultimate segment of genital capsule flattened circular in cross section, slightly bifid at tip. Claspers massive *mitellata* Bergroth
- Lobes of penultimate segment of genital capsule never bifid at tip. Claspers usually slenderer 6
6. Lobes of penultimate segment of genital capsule circular in cross section 7
- Lobes of penultimate segment of genital capsule vaguely semicircular in cross section, with the upper surface often slightly concave 10
7. Male claspers in the form of a longitudinal somewhat curved plate basally, giving off distally a sinuate elongate process *abdominalis* (Fabr.)
- Male claspers broader, rounded above, slightly concave below, very nearly the same size for all their length 8
8. Lateral lobes (parandria) of penultimate segment of genital capsule curved inwardly towards apex *coxalis* Kirby
- Parandria almost parallel 9
9. Parandria with a noticeable groove running most of their length above *subrufescens* (Kirby)

- Parandria smooth dorsally, without a prominent groove *vicina* (Dallas)
10. Parandria of pygophora as long as claspers, markedly concave on upper and inward surface. Parameres fairly thin and not very elaborate *tagalica* Burmeister
- Parandria not as long as claspers, less concave above 11
11. Parameres prominently hooked at apex, thence becoming broad and laminate before roughly circular basal part. Produced ventral part of pygophore only vaguely triangular. Large species (13-29 mm.) *rufomarginata* (Fabr.)
- Parameres hooked at apex but narrowing between hooked region and base and not becoming laminate. Produced plate of ventral part of pygophore elongate triangular, noticeably keeled. Smaller species (under 23 mm.) 12
12. Parameres long with a prominent dorsolateral tubercle near the apex, ventral produced part of pygophore elongate *marquesensis* Cheesman
- Parameres not as long and without a prominent tubercle, ventral produced part of pygophore not so elongate *isolata* (Distant)

Key to Indo-Pacific species of *Leptocoris*—Females:—

1. Female genital capsule with upper pair of visible valves not produced as club like processes but represented by two thickish short plates with a few long hairs at apex, devoid of spines *abdominalis* (Fabr.)

- Female genital capsule with upper pair of visible valves produced as club like processes (in some views of *L. mitellata* they may appear at first as elongate laminae), in all but one case (*rufomarginata* (Fabr.)) bearing spines 2
2. Club like upper valves devoid of spines, smallish and rounded with a long pilosity *rufomarginata* (Fabr.)
- Club like upper valves generally larger, always with prominent spines 3
3. Upper valves very convex, largish, spines fairly numerous, apparently in a single row or virtually so 4
- Upper valves, generally flattened on the inner surface, not so in one species, but spines always scattered over the surface of the club, numerous or few 5
4. Upper valves elongate claviform, often appearing laminate at first view, lateral valves small and fairly elongate *mitellata* Bergroth
- Upper valves more freely clavate, lateral valves fairly massive *coimbatorensis* sp. nov.
5. Upper valves large, not noticeably flattened on the inner surface, fairly circular in cross section, spines always numerous *tagalica* (Burmeister)
isolata (Distant)
- Upper valves generally not so large, noticeably flattened on the inner side, outer and terminal parts moderately convex giving a club shaped impression 6

6. Upper valves with club shaped portion very small with only a few spines *subrufescens* (Kirby)
- Upper valves with club shaped portion moderately large and with a moderate number of scattered spines 7
augur (Fabr.)
minuscula Blöte
vicina (Dallas)
7. Lateral valves prominent as two plates just beneath club shaped upper valves *vicina* (Dallas)
- Lateral valves as two plates hardly visible beneath the club shaped upper valves *augur* (Fabr.)
minuscula Blöte

***Leptocoris augur* (Fabricius) 1781**

Fig. 1 A-C, 4 B

- Cimex augur* Fabricius, 1781: Spec. Ins., 2: 366. 1787: Mantissa Ins., 2: 301. Gmelin (in part) 1788: Syst. Nat., 1 (4): 2174. (Type in Bank's Collection in British Museum checked by Mr. R. J. Izzard.)
- Lygaeus augur* Fabricius (in part), 1794: Entom. Syst., 4: 161. 1803: Systema Rhyngot., 226.
- Leptocoris augur* Burmeister, 1835: Handbuch der Ent., 2: 305.
- Serinetha augur* Dallas, 1852: List Hem. Ins., 2: 460. Stål, 1868: Kongl. Svensk. vet. Akad. Handl., 7 (11): 68. 1873: *loc. cit.*, 11 (2): 99. Distant, 1902: Fauna Brit. Ind. Rhynch., 1: 420. Maxwell-Lefroy, 1909: Indian Insect Life, 684. Hoffman, 1933: Lingnan Sci. J., 12 (1): 22 (biology), figs.
- Lygaeus chalcocephalus* Fabricius, 1803: Systema Rhyngot., 226 which has been placed in the synonymy of this species is based on a composite specimen from two species according to Stål 1868.
- Serinetha dallasi* Dohrn, 1860: Stett. ent. Ztg., 21: 42 (*typ. vid.*). Distant, 1902: Faun. Brit. Ind. Rhynch. 1: 420. (New synonymy.)
- Reddish or reddish ochraceous in the main; rarely pale cyclamen coloured or yellow. Pilosity black.

Antennae piceous, basal segment reddish brown at base, sometimes almost to apex. With a short but thickish black pilosity.

Head fairly broad, tylus somewhat longer than jugae. A tumescence behind and in front of eyes and apex of tylus with a few short black hairs. Head otherwise fairly glabrous, not punctate, a short longitudinal impressed line beginning just behind base of tylus and reaching back to about ocelli. Ocelli on small raised tumescences, a fraction nearer to base of eye than each other.

Rostrum brownish piceous, two basal segments the palest, reaching about middle of third true abdominal segment.

Pronotum with lateral margins straight and not laminate, anterior margin very slightly concave, posterior almost straight, slightly sinuate. With two obliquely directed flattish blackish depressed impunctate areas in the anterior third (calli) which extend from the mid line to the lateral margin. In front of their outer edges a tumescence in each of anterior lateral angles of the pronotum connected to the one on the other side by a raised triangular impunctate region, the apex directed posteriorad and the sides adjacent to the apex forming the anterior margins of the smooth depressed areas. Remainder of pronotum finely but densely punctate, hind margin depressed. A fairly prominent keel running from anterior depressed areas back. Pronotum in general pretty glabrous but lateral margins and anterior raised triangular area with a fairly sparse black pilosity.

Scutellum somewhat elevated with disc flat and a slight tendency for the lateral margins to be keeled. Depressed at apex and transversely just behind base of pronotum. Impunctate and only slightly pilose.

Corium and clavus finely but densely punctate with an extremely fine short and sparse pilosity, probably greyish. Membrane black tending brownish black broadly along the hind margin. One specimen, presumed to be from Ceylon, in the collection of the Institut zoologique de Warszawa has the membrane greatly reduced and the hemelytra just surpass the middle of the abdomen.

Legs (except basal part of trochanters and coxae which are concolorous with main body) piceous black with short black hairs.

Male genitalia as figured. Hind ventral margin of penultimate segment of capsule almost truncate, very pilose, extending only a little behind apex of anal segment. Male clasper fairly elaborate with a ventrally and exteriorly directed tooth on the outer ventral margin and about half way to apex and a concave area on ventral face near apex.

The clasper of *minuscula* Blöte is on the contrary fairly simple and without any prominent tooth.

Female genitalia as figured, they are not easy to distinguish from certain other species (*minuscula* Blöte, *vicina* (Dallas)) except in that the clubs are not very convex and the inner margin is flat. These have numerous brown spines and a few long whitish hairs. Long whitish hairs also scattered elsewhere on the genital capsule.

Length: 11-16 mm. Width: 3.5-5 mm.

Distribution. In the British Museum and Rijksmuseum are specimens from Formosa, Tonkin, Laos, South India and Java. The species apparently is wide spread and abundant on the South East Asian mainland and penetrates into Indonesia.

Loc.

Formosa: Hans Sauter, acquired 1908 1♂ Cat. No. 3 and 1♀ Cat. No. 4 and both also labelled No. 58. The female has an additional pencil label with Takao 22 XI 07 (R.M.). Takao, No. 153, H. L. Parker collection, 1♂ (U.S.N.M.).

Tonkin: Hanoi, Feb. 1917, R. V. de Salvaza, 1♂ and 2♀♀. Guang Yen, 7 V 1916, R. V. de Salvaza, 1♂ and 1♀ (B.M.).

Laos: Vientiane, 22 X 1919, 1♂ and 20 III 1917 1♀, R. V. de Salvaza. Na Peng, 25 X 1919, R. V. de Salvaza, 1♂. Haut Mekong, Ban Quang, 24 IV 1918, R. V. de Salvaza, 1♀ (B.M.).

Siam: Nan, 20 XII 1927, T. D. A. Cockerell, 1♀. Nonteburi, 9 II 1923, Hugh Smith, 1♀ (U.S.N.M.).

North India: Punjab and United Provinces, VI-X (no year), R. L. Wogbum Coll., 1♂ and 1♀. Calcutta, No. 58, no collector or date, 1♂. Silhet, P. R. Uhler, 1♂ (U.S.N.M.).

Java: 1♀ simply labelled Java, Reinn and Cat. No. 2 (R.M.).

Indonesia: 1♂ labelled "Indes or INT H. de Saussure" and another "Indes or" with on back of label what looks like "Puil, July" (U.S.N.M.).

***Leptocoris minuscula* Blöte 1934**

Fig. 1 D-F, 4 C

Leptocoris minuscula Blöte, 1934: Zool. Meded., 17: 267, fig.

Reddish or reddish ochraceous. Pilosity black.

Antennae blackish brown, with a short but fairly dense blackish pilosity.

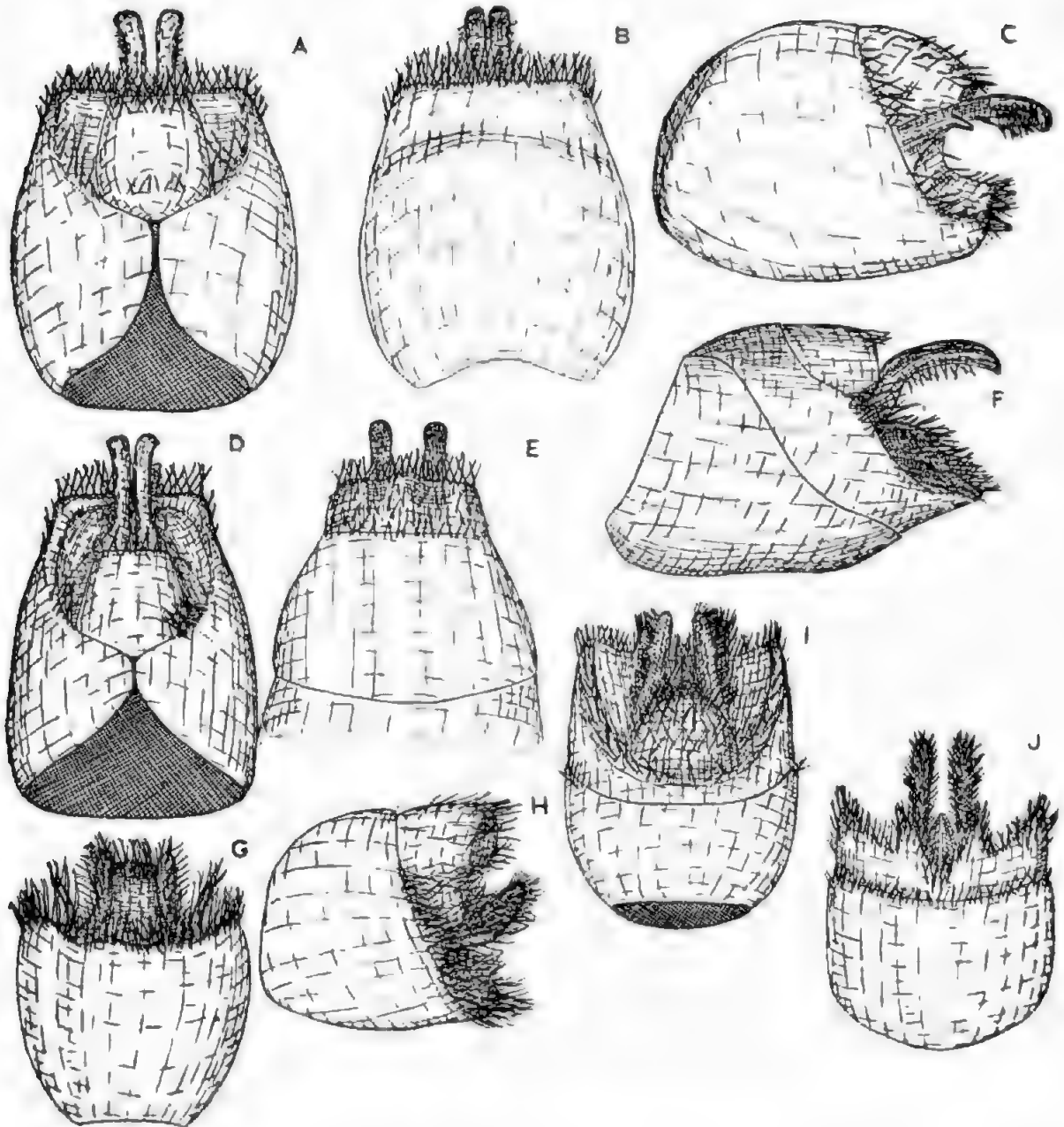


Fig. 1: A-C *Leptocoris augur* (Fab.), A—male genital capsule from above, B—same from below, C—same from left hand side. D-F *Leptocoris minuscula* Blöte, D—male genital capsule from above, E—same from below, F—same from left hand side. G-H *Leptocoris corniculata* (Stal), G—male genital capsule from above, H—same from left hand side. I-J *Leptocoris coimbatorensis* sp. nov., I—male genital capsule from above, J— same from below.

Head blackish brown, fairly broad. Tylus only slightly longer than jugae. A swollen tumescent area behind each eye (which in some specimens is paler), and a slightly swollen one in front of eyes and apex of tylus with a short pilosity. Head otherwise fairly smooth. Eyes and ocelli red. Rostrum reddish black, reaching second abdominal segment.

Pronotum shaped very much as in *augur* but the two anterior smooth areas (calli) are not so oblique, depressed or flat. There is no tumescence on the margin in front of smooth areas nor a raised anterior region of the pronotum in front of them. The calli are blackish. Hind two thirds of pronotum fairly closely and densely punctate.

Scutellum blackish, the two specimens I have seen do not give much idea of its form as the pins have been driven through at this point.

Hemelytra with corium and clavus reddish or reddish ochraceous, finely punctured, also wrinkled. Membrane brown. The male from Koepang has only a clavus left on the left side and corium and clavus on the right. The corium of this specimen is rounded at its apical angles and together with its rather square pronotum leads me to believe that this specimen was brachypterous. Brachyptery was up until now unknown as far as I can tell in *Leptocoris*, but in both this species and *augur* there is evidence of its occurrence.

Legs brownish black, coxae yellowish in their basal 2/3. Most of mesosternum and mesopleura (except the postero-lateral areas), a patch on the propleura above the coxal insertion and most of the visible metapleura brownish black.

Male genitalia as figured. Ventral apical margin of penultimate segment sinuate, vaguely three-lobed, very pilose. Claspers fairly thin, only slightly concave on their ventral surface.

Female genitalia as figured, very similar to *augur* in general appearance. The clubs are flat on their inner surface and not very concave on their outer surface. With rather fewer large spines than *augur*. Apparently closely related to *augur*.

Length: 9-12 mm.

Loc.

Timor: Macklot, Cat. No. 5. Paratype ♀ (R.M.). Koepang, 6-21 June 1929, I. M. Mackerras, one brachypterous ♂ (C.S.I.R.O.). The type series was from Macklot.

Dr. Blöte has kindly checked my genitalia drawings with his type series and confirmed the status of this species.

Leptocoris corniculata (Stal) 1866

Fig. 1 G, H, 3 D

Serinetha corniculata Stål, 1866: Berl. ent. Ztg. 10: 381. 1873: Kongl. svensk. Vetens.-Akad. Handl., 11 (2): 99. Distant, 1902: Faun. Brit. Ind. Rhynch., 1: 420. (*Typ. vid.*)

Reddish ochraceous with a fine whitish or yellowish pilosity.

Distal segments of antennae brownish black, base of second segment and whole of first segment reddish brown.

Head broad with a tumescence behind, and a short but prominent tubercle in front, of each eye. Eyes concolorous with rest of head, ocelli yellowish.

Depressed areas of pronotum vaguely oblique, fairly flat. Region of pronotum in front of these calli raised but somewhat declivous towards anterior margin. A strong keel runs back from between the calli to the hind margin which is depressed and broadly curved. Lateral margins behind calli curved laminate, the whole lateral margin gives the impression of being strongly notched in the region of the calli as the laminate lateral margins cease at this point and in front of the calli the collar is produced laterally as a little lobe on each side. In the type only the centre of the hind pronotal disc is flat, towards the lateral margins it is inclined upwards and the lateral margins behind the calli are actually the highest parts of the pronotum. The pronotum is coarsely punctate. Scutellum with sides vertical, upper surface flat. Hemelytra very finely punctate with a pale yellowish pubescence, membrane black.

Underside mostly yellowish ochraceous. Rostrum (except tip which is black) and legs including coxae reddish. Dorsal margins of abdominal segments and apical regions of seventh abdominal segment also red. An area above coxae on both meso- and metapleuron blackish and a faint one on propleuron tending fuscous. Each ventral segment laterally with a blackish area running from near dorsal margin almost to venter and from anterior margin almost to hind margin, the hind margin of each segment (except the seventh which is red) is therefore yellowish ochraceous and this ochraceous band is wider ventrally than dorsally.

The male genitalia of the unique type are as figured. The ventral surface of the pygophore is produced forward and the apical margin is sinuate with an obsolete lobe either side of the mid line. Laterally the margin of the pygophore is flattened and directed inwards, towards the clasper, alongside of which it gives off a thinnish but fairly long process, this process is hard to see amongst the pilosity, and due also to its proximity to the clasper. The claspers are laterally flattened and very pilose, their dorsal margin is straight but the ventral one tends to be convex. Anal tube elongate. The ventral and lateral margins of the pygophore, the external faces and the ventral margins of the claspers and the apical margin of the anal tube are very markedly pilose and this pilosity tends to conceal the structure of the base of the claspers and the margins of the pygophore.

The female genitalia are unknown.

Length: 14 mm.

Loc.

Western India. Düben. Reg. No. 364; 58.

Stål's Holotype Male (Naturhistoriska Riksmuseet, Stockholm).

***Leptocoris coimbatorensis* sp. nov.**

Fig. 1 I, J, 4 D

Reddish or reddish ochraceous. Pilosity black or white.

Antennae castaneous or black, basal segment reddish, sometimes with a little black on top. Segments with a very short pilosity.

Head moderately broad with a tumescence behind each eye and in front of eyes an oblique fold beginning near midline of head about as far back as line joining centres of eyes and proceeding forwards, outwards and downwards to insertion of antennae. This fold with a shallow sulcus in front of its anterior margin. In one specimen the head is suffused in front with black. Ocelli small but on obvious tumescences, much nearer eyes than each other.

Rostrum almost reaching fifth abdominal segment, mainly brown, last segment in the main almost black.

Pronotum very similar in shape to *augur* but with the lateral margins rolled like a selvage and anterior depressed smooth areas somewhat convex.

Scutellum with centre raised, flat, and somewhat infuscated; lateral margins tending to be slightly raised above this as low keels, reddish.

Corium and clavus as well as scutellum and hind part of pronotum covered with a very fine pilosity. Corium and clavus very finely punctate in some specimens with smallish yellow patches. Membrane brownish black.

Underside with a fine white pilosity, an area of black on each of the pleurae above the insertion of the coxae, largest on the metapleurae. Legs brownish, coxae red.

Male genital capsule as figured. Very distinctive. Ventral apical margin of penultimate segment of capsule very pilose, thrown into four short lobes, extending well behind apex of anal segment, concave on its upper surface beneath the claspers. Claspers fairly broad with flattened faces and set at an angle to one another. Ventral face with a very dense pilosity giving the clasper somewhat of the aspect of a toothbrush. A blunt tooth along the external (and due to the inclination) dorsal margin about two-thirds of the way to apex.

Female genital capsule as figured. Upper valvulae very club-shaped, not elongate with at most two rows of spines running from near base to past apex. About 12 spines all told on each valvula and of course the usual long hairs. Lateral valvulae fairly massive and conspicuous.

Length: 10-15 mm.

Loc.

South India: Bolampatti Valley, Coimbatore District 20 IV 37, B.M.-C.M. Expdn. to South India IV-V 1937. Reg. No. B.M. 1947-469. Holotype ♂, allotype ♀, paratype ♂ and two paratype ♀♀ in the collection of the British Museum (Nat. Hist.).

***Leptocoris mitellata* Bergroth 1916**

Fig. 2 A-C, 4 E

Plate XLVIII

Leptocoris mitellatus Bergroth, 1916: Proc. Roy. Soc. Victoria 29: 31.

Woodward, 1951: Trans. Roy. Soc. N.Z., 79 (2): 207.

Leptocoris (Serinetha) sp. Evans, 1928: Ann. Mag. Nat. Hist., 10 (2): 463.

Ranging in colour from a purplish red to brick red. Long pilosity black, short pilosity whitish.

Antennae piceous with a moderately close black pilosity shorter than width of segment.

Head broad with a tumescence behind eyes and an oblique ridge in front of eyes running down to insertion of antennae very much like *coimbatorensis*. Tylus and a quadrate patch on vertex with its apex at base of tylus and running back to base of head with the ocelli placed on its lateral margins black or brownish black. Sometimes also jugae and tumescences behind eyes infuscated. Head with a few sparse black hairs which are more numerous on the calli behind the eyes, the oblique ridges in front of them and the tylus and jugae.

Rostrum black, reaching to base of second or third abdominal segment.

Pronotum very finely punctate in the posterior two thirds, with two oblique smooth and slightly oblique blackish or purplish calli in the anterior third which are separated from the anterior margin by a slightly raised triangular smooth area. This anterior smooth area and the lateral margins with moderately dense stiff black hairs. Hind margin of pronotum depressed and with a fine whitish pilosity: the disc with a median keel beginning between the calli and evanescent towards middle on base.

Scutellum raised, flat on top, blackish or purplish, with a fine whitish pilosity.

Corium and clavus very finely punctate, in the purplish red specimens there is usually a small quadrate bright red spot at the inner apical angle of the corium, also the humeral angles of the corium are somewhat reddish and this extends a little along the lateral margin. These two red areas are sometimes not obvious even in purplish red specimens and especially so in brick red ones. Membrane black, apically brownish.

Underside with black or purplish patches on anterior parts of pleurae and sometimes lateral (and sometimes also ventral parts of 4, 5 and 6 ventral segments) of 2-6 segments blackish or purplish.

Male genital capsule as figured, pygophore thrown into two lateral lobes (parandria) which are conspicuously notched at apex, almost bifid. Claspers massive, elaborately constructed, with tips turned downwards. Anal segment flattened dorsally. Ventral part of penultimate segment blackish.

Female genital capsule as figured, upper valvulae produced into two elongate clubs which are not as convex on the ventral surface as in some species and are flat on the inner posterior surfaces. These clubs with for the most part a single row of spines running from about one

third of their length from base to apex, changing direction at apex and possibly becoming two rows. Lateral valvulae small but easily distinguishable. Ventral valvulae not distinct.

Bergroth's type cannot be traced but there is no doubt on the identity of the species.

Length: 11-16 mm.

Loc.

This is apparently the commonest of the Australian species and is the only species in Southern Australia. It appears to occur almost always south of the tropic of Capricorn and is apparently absent from Tasmania. It is very abundant in the drier centre of the continent.

Loc.

Western Australia: 77 miles east of Balladonia, June 1914—696, 1 ♂, 1 ♀ (W.A.M.)

Northern and Arid South Australia: 407 miles west on Transcontinental Railway 4 X 20 coll. Troughton & Wright, 2 ♂ ♂, 2 ♀ ♀, Reg. No. K45478 (A.M.); Ooldea, VII 21 coll. J. A. Kershaw 1 ♀ (N.M.); Ooldea, T. D. Campbell, 1 ♂ : Ooldea, no other data, 1 ♂ : Barton, A. M. Lea, 1 ♂, 1 ♀ : 20 miles west of Kychering Soak, Transcontinental Railway S. to W.A., 11-08, M. Chandler 26 V 04, 2 ♂ ♂, 1 ♀ (N.M.): Kingoonya, Coll. R. Harvey, 1 ♀ : dead on salt, south-west gulf of Lake Gairdner, 18 III 50, coll. G. F. Gross & F. J. Mitchell, 1 ♂, Reg. No. E.S.I. 363: Mullaroo Peninsula, Lake Gairdner, 17-19 III 1950, G. F. Gross 1 ♂, 1 ♀ : Bookaloo Siding, 19 VIII 1948, coll. G. F. Gross, 2 ♂ ♂, 1 ♀ : Whittata Stn. Andamooka Rgs., 19 August 1948, 2 ♀ ♀, and 21 August 1948, coll. G. F. Gross 3 ♂ ♂, 2 ♀ ♀ : Wongamoodla Ck., Andamooka Rgs., 26 VIII 1948, coll. G. F. Gross, 2 ♂ ♂, 4 ♀ ♀, and many nymphs: Birthday Well, Cariewerloo Stn., 9-12 III 1950, coll. G. F. Gross, 2 ♂ ♂, 2 ♀ ♀ ; near Frazers Hut, Cariewerloo Station, III 1950, coll. G. F. Gross (all S.A.M.); Iron Baron, 4 IV 48, coll. D. S., 2 ♂ ♂ and 4 ♀ ♀ (N.M.): Whyalla, XI 1952, coll. Hans Mincham, 1 ♀ ; Hammond, X 1950, II. V. Mincham, 1 ♂, 1 ♀ (A.M.); Mern Merna, Flinders Rgs., 15 II 1949, coll. G. F. Gross, 2 ♂ ♂, feeding on Bullock Bush (*Heterodendron olaciformum*) in large numbers, 8-15 II 1949, coll. G. F. Gross, 5 ♂ ♂, 6 ♀ ♀ : Wilpena Pound, N. Flinders Rgs., 27 X 1955, coll. E. T. Giles, 1 ♀ : Well 4 miles east of Oraparinna Stn., Flinders Rgs., 12 II 1956, at light, coll. G. F. Gross, 1 ♂, 1 ♀ ; Wirrealpa Stn., N. Flinders Rgs., 28 X 1955, at light, coll. E. T. Giles, 1 ♀ : Italowie Gorge, N. Flinders Rgs., 30 X 1950, coll. E. T. Giles, 2 ♂ ♂, 2 ♀ ♀ : Owieandana, N. Flinders Rgs., coll. H. M. Hale & N. B. Tindale, 1 ♀ : Arcoona Spring

(now Aroona Reservoir) nr. Copley, 30 XI 1951, coll. G. F. Gross, 1 ♀ : Mt. Painter, N. Flinders Rgs., coll. H. G. Stokes, 1 ♂, 1 ♀ : Flinders Rgs., 26 V 47, no collector, 5 ♂♂, 2 ♀♀ : Lake Frome 30 VIII 1952, coll. K. Peake Jones and Party, Reg. No. E.S.I. 169 (S.A.M.) ; Mt. Lyndhurst, 20 miles east of Farina, coll. E. Troughton, 3 ♂♂, 3 ♀♀, Reg. Nos. K42721 & K42731 : Berri, damaging garden figs, 28 III 1939 (A.M.). Between Renmark and Mildura, on "bullock bush" (*Heterodendron olaciformum*) 10 V 1959, M. Kenny, 1 ♂ and a series of nymphs (S.A.M.).

Southern and Temperate South Australia: Karkoo near Pt Lincoln, coll. D. Kimber, 1 ♀ : Bundaleer Forest, Southern Flinders Ranges, 9 I 1927, 1 ♂ : "Kurlge" Blackwood, 850ft. at mercury vapor light, coll. N. B. Tindale, 19 X 1955 and 70°F., 1 ♂, 1 XI 1957 and 75°F., 1 ♀, 14 XI 1957 and 74°F., 1 ♀, and 23 XI 1957 and 77°F., 1 ♂ : Mt. Gambier, VII, coll. J. W. Rose, 1 ♀ and 3 nymphs : Kangaroo Island, coll. S. H. Shandon, 1 ♂ (S.A.M.) ; Clarendon, 27 X 1946, coll. H. M. Cane, 1 ♀ (C.S.I.R.O.).

Northern Territory: Hermannsburg, 7 ♂♂, 3 ♀♀ : Jay Creek, VI 1938, coll. C. Barrett : Finke R., coll. J. W. Rose (S.A.M.). Bergroth's types were from near Glen Helen, Macdonnell Rg. and Ilamurta, James Range.

Victoria: North Victoria, XI 1942, coll. R. Pescott, 1 ♂, 3 ♀♀ (A.M.) ; Murray River, coll. J. E. Dixon, presented Jan. 1940, 2 ♂♂, 3 ♀♀ : Mallee, Murray River, IV 1919, coll. J. E. Dixon, presented I 1940, 1 ♂, 1 ♀ : Murray River, coll. C. French, presented 15 XI 1911, 2 ♀♀ : Murrabit, 31 III 1947, No. A3, 1 ♂, 1 ♀ : Kerang, 21 IV 1946, coll. R. E. T. 4 ♂♂, 3 ♀♀, and 11 V 1946, 2 ♂♂, and 30 VI 1946, 8 ♂♂ and 24 XI 1946, 1 ♂ ; Echuca, 25 IV 1955, coll. E. M., 10 ♂, 2 ♀♀ : Mallee District, coll. J. E. Dixon, presented 3 III 1914, 1 ♀ : Lake Hattah, coll. J. E. Dixon, presented I 1940, 3 ♂♂, 3 ♀♀ : Hattah, III 1914, coll. J. E. Dixon, 1 ♂ : Lake Hattah, 2 XI 1915, coll. J. E. Dixon, 2 ♂♂, and 1918 2 ♀♀ : Hattah, no other data, 2 ♀♀ : Ouyen, 29 XI 1916, coll. J. E. Dixon, 3 ♂♂, 2 ♀♀ : Sea Lake, IV 1916, coll. D. Goudie, 1 ♀ ; Inglewood, no other data, 2 ♀♀ : Gypsum, N. W. Viet., XI 1926, coll. J. E. Dixon, presented I 1940, 2 ♂♂, 1 ♀ : Kiata, X 1928 coll. F. E. Wilson, 2 ♀♀ (N.M.) ; Yackarandah, coll. W. D. Davey, 1 ♂ (S.A.M.).

New South Wales: Florida North, Moree, 4 I 1938, coll. Miss G. Grace, Reg. No. K66769, 2 ♂♂ : Watercourse at Moree, XI 1933, coll. A. Musgrave, 1 ♀ (A.M.) ; Moree, 1919, coll. W. W. Froggatt 1 ♂ and 1 ♀ and 1920 1 ♀ : Therribri, XI 1932, coll. Mackerras, 1 ♂, 3 ♀♀ ; Goan Water Hole, 4 V 1950, coll. R. Key, 1 ♂ : New England National Park,

19 III 1954, coll. E. F. Riek 1 ♂, 4 ♀ ♀ (C.S.I.R.O.); Mullaley, XI 1957, coll. F. E. Wilson, 1 ♀ (S.A.M.); Curlewis, 29 X 1933, coll. A. Musgrave & T. Iredale 1 ♂; Coonamble, XI 1906, coll. W. W. Froggatt, 1 ♂, 2 ♀ ♀; Trangie, 2 V 1950, coll. P. C. Minter, 1 ♂, 1 ♀: 9 miles on the Dandaloo Road from Trangie, 25 VIII 1950, coll. L. Chinnick and B. Cameron, 2 ♂ ♂, 1 ♀; Trangie, 23 XI 51, coll. B. Cameron, 1 ♂, 3 ♀ ♀ (C.S.I.R.O.); Bogan River, coll. J. W. Armstrong, Reg. No. K64293, 2 ♂ ♂, 1 ♀; Tennamungamie via Dubbo, 4 IX 1947, coll. Mrs. G. Bakewell, 5 ♀ ♀; Dubbo, XI 1928, coll. A. J. Barrett, Reg. No. K5864, 1 ♂ (A.M.); Newcastle, 3 IV 1946, No. R. 3, 1 ♀ (N.M.); Marsden, I 1940, coll. Mrs. R. B. Sanderson, 1 ♂, 3 ♀ ♀ (C.S.I.R.O.); Lannigan's Creek, Geelong Caves District, near Yerranderie, 18 VII 1927, coll. T. G. Campbell, Reg. No. 56574, 1 ♀ and 10 XI 1927, coll. A. Musgrave and T. G. Campbell, Reg. No. K56908, 1 ♀; Savernake, 24 XI 1948, 1 ♂, 1 ♀; Lookout Tank near Broken Hill, 6 IV 1942, coll. Chadwick, 1 ♂ (A.M.); Red Gum, Deniliquin, 1926, 1 ♀ (C.S.I.R.O.).

Queensland: Clermont XI 1929, coll. Dr. K. K. Spence, Reg. No. K62359, 1 ♂ (A.M.); Biloela, 5 XII 1926, coll. E. Bollard, 1 ♂ (U.Q.); Eidsvold, V 1929-IV 1930, coll. T. L. Baneroff, 1 ♂ (C.S.I.R.O.); Morven District, IV 1941, coll. N. Geary, 2 ♂ ♂, 1 ♀; Bunya Mts., 18 XII 1937; 3000', coll. N. Geary, 1 ♂, 1 ♀ and 22 I 1938, 2000', 1 ♂; Cunnamulla, X 1944, N. Geary, 1 ♀ (A.M.); Brisbane, 28 VIII, 1911, coll. H. Hacker, 1 ♀; Beaudesert, 30 V 1942, coll. F. W. Witbraham, 1 ♂, 2 ♀ ♀; Plateau, Killarney, 14 XI 1932, coll. H. Hacker, 1 ♀; Killarney, 1 XI 1932, coll. H. Hacker, 1 ♂ (U.Q.); Stanthorpe, no other data, 1 ♀; Lawes, 13 III 1952, coll. G. Saunders, 1 ♀, (S.A.M.),

Australia: Unlocalized, but presumed from Queensland, Koebele, no other data, abdomen missing (U.S.N.M.).

New Zealand: A single *Leptocoris* specimen has been recorded from New Zealand and is mentioned in Evans 1928. If the identification and locality were correct it could well be this species, or perhaps *tagalica* Burmeister which occurs also in Samoa.

***Leptocoris vicina* (Dallas) 1852**

Fig. 2 D, E, 4 F

Serinetha vicina Dallas, 1852: List. Hem. Ins., 2: 460. Distant, 1902: Fauna Brit. Ind. Rhynch., 1: 420 (exclude reference to *coxalis*). (Type in British Museum checked by Mr. R. J. Izzard.)

Astacops nigricornis Walker, 1872: Cat. Het. 5: 36. (Type in British Museum check by Mr. R. J. Izzard.) New synonymy.

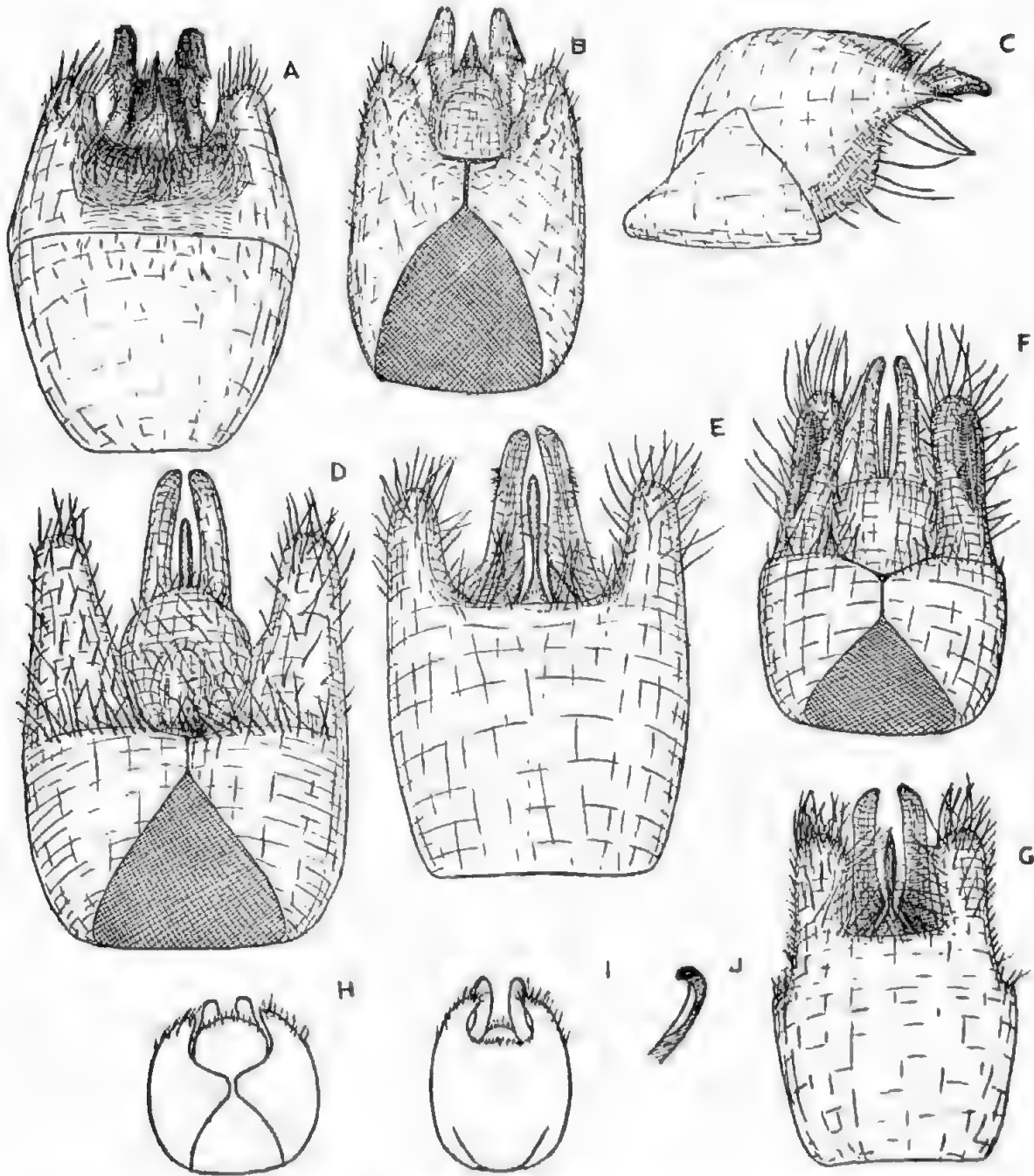


Fig. 2: A-C *Leptocoris mitellata* Bergroth, A—male genital capsule from above, B—same from below, C—same from left hand side. D-E *Leptocoris vicina* (Dallas), D—male genital capsule from above, E—same from below. F-G *Leptocoris subrufescens* (Kirby), F—male genital capsule from above, G—same from below. H-J *Leptocoris cozalis* (Kirby) (drawn from the type male in the British Museum by Mr. R. J. Izzard and not to same scale as remainder), H—male genital capsule from above, I—same from below, J—paramere in dorso-lateral view.

Serinetha longirostris Dallas, 1852: List. Hem. Ins., 2: 461. (From the sketch of the female genitalia supplied by Mr. Izzard this species is probably a synonym of *vicina*.) New synonymy.

Leptocoris nigricornis Blöte, 1934: Zool. Meded., 17: 269.

Leptocoris carnivorus Usinger, 1946: B. P. Bishop Mus. Bull., 189: 25, fig. (*Paratyp. vid.*) New synonymy.

There is just a slight doubt that *vicina* is actually the final name for this species. *L. vicina* was described from the Philippines as was *tagalica* Burmeister. If the type of this latter species is ever found it could possibly turn out to be this species, not the species which I believe is *tagalica*. (See discussion under *tagalica*.)

Purplish or yellowish red. Long pilosity black, fine pubescence greyish.

Antenna black or purplish red, with short stiff dense black hairs. Head moderately broad with a tumescence behind the eyes and an oblique ridge running down in front of the eyes like *coimbatorensis*. Eyes a darker red than rest of head. Head with sparse stiff hairs more concentrated on the tumescence behind the eyes and the tylus and jugae.

Rostrum reaching to apex of second abdominal segment, black or blackish brown.

Pronotum very similar in shape and structure to *augur*, but the depressed anterior smooth areas (calli) are slightly convex, purplish. Pronotum in some specimens infuscated posteriad.

Scutellum very similar in structure to *augur*, flat on top.

Corium and clavus very finely punctate with a fine greyish pubescence. In some specimens the clavus and the inner half of the corium is infuscated. Membrane blackish brown.

Propleurae above coxae and most of mesosternum, mesopleura, metasternum, and metapleurae and the ventral part of all abdominal segments I-V generally blackish. Legs blackish brown.

Male genital capsule as figured, pygophore thrown into two lobes (parandria) which are round in cross section and with a long yellow pilosity. Claspers fairly simple, curved downwards at apex and feebly concave on the underside in the terminal half. In the basal half the under surface changes inclination by 45° and becomes broader and less concave. Ventrally the pygophore is produced posterioriad between the claspers as a narrow lamina (hypandrium?) with its broad face in the perpendicular plane.

Female genital capsule as figured, not easily distinguished from those of *augur* and *minuscula* on first sight. Upper valvulae produced as two clublike processes which are flat on their inner surfaces and with numerous fairly long scattered spines on their outer surfaces and a few long hairs. Lateral valvulae visible as two plates under the upper valvulae and with a few long hairs at their apex. Ventral valvulae somewhat convex.

Length: 12-15 mm.

Loc.

Indonesia: Java: Semirang, coll. E. Jacobson, 1 ♀, Cat. No. 2: Java, no other data, 1 ♂, Cat. No. 7 (R.M.). Coral Island, Djakarta Bay, 15 V 1929, coll. I. M. Mackerras, 1 ♂ (C.S.I.R.O.).

Soembawa: Coll. v. Lansberge, no other data, 1 ♂, Cat. No. 1 (R.M.).

Wetter: coll. C. Schädler, acquired 1898, 1 ♀, Cat. No. 2 (R.M.).

Philippines: Luzon: Mt. Banahao, coll. P. I. Baker, 1 ♂ (U.S.N.M.); Mt. Banahao, 2000' North Luzon, coll. G. Böttcher, 1 ♀: Bataan Province, coll. G. Böttcher, 1 ♂, 1 ♀ (B.M.); Mt. Makiling, coll. Baker, 1 ♂, 2 ♀ ♀; Los Banos, coll. P. I. Baker, 1 ♂, 1 ♀ (U.S.N.M.).

Mindanao: Port Banga, South Mindanao, coll. G. Böttcher, 1 ♀ (B.M.).

Micronesia: Marianas: Saipan: Afenia-Charanka, 4 VII 1939, coll. Teiso Esaki, 1 ♀ (K.U.).

Rota: VI 1952, coll. Y. Kondo, 1 ♂, 3 nymphs (B.P.B.M.).

Guam: Cetti Bay, 28 V 1936, coll. R. L. Usinger, 1 ♂, 1 ♀ (Paratypes of *L. carnivorus* Usinger) (B.P.B.M.); Inarajan, 28 IX 1938, No. 1240, on *Ficus* sp. and *Colubrina asiatica*, coll. K. G. Oakley, 6 ♂ ♂, 1 ♀. No precise locality or date, No. 1187, coll. D. T. Fullaway, 1 ♀ (U.S.N.M.). Ritidian Point, 2 VI 1936, coll. Swezey, 1 ♂ (Paratype of *L. carnivorus* Usinger); Ritidian Point, 29 V 1945, by beating vegetation, coll. H. S. Dybas, lot 2082, 3 ♂ ♂, 3 ♀ ♀ (C.N.H.M.). Ritidian Point, 30 V 1945, coll. G. E. Bohart & J. L. Gressitt, 1 ♂, 1 ♀: VI 1945, coll. J. L. Gressitt, 4 ♂ ♂, 6 ♀ ♀. Ditto, on beach, 6 VI 1945, coll. G. E. Bohart & J. L. Gressitt, 2 ♀ ♀. Ditto, 1 VIII 1945, coll. J. L. Gressitt, 1 ♂. Point Oca, VI 1945, coll. J. L. Gressitt & G. E. Bohart, 6 ♂ ♂, 3 ♀ ♀. One mile S.E. of Asan, 4 XI 1947 and 30 X 1949 altitude 600-800 feet, coll. H. S. Dybas, 2 ♀ ♀ (B.P.B.M.).

Western Carolines: Palau Islands: Ngariungs Islet, Ngaiangl (Kayangel) Atoll, 16 XII 1952, No. 5622, coll. J. W. Beardsley, ex

fern, 1 ♂, 5 ♀ ♀. Same locality and date, coll. J. L. Gressitt, 1 ♂. Koror Island, limestone ridge S. of Inlet, 22 I 1948 coll. H. S. Dybas, 1 ♂. Koror Island, IV 1954, coll. J. W. Beardsley, 1 ♀, Peleliu Island, Mt. Amiangal, 23 XII 1952, coll. J. L. Gressitt, 2 ♂ ♂, 3 ♀ ♀. Peleliu Island, East Coast, 31 VII 1945, coll. H. S. Dybas, one male with mutated genital capsule (B.P.B.M.).

Pulo Anna Island: 13 IX 1952, coll. N. Krauss, 1 ♂, 1 ♀, 1 nymph (B.P.B.M.).

Yap Islands: Mt. Metade near Yaptown, 12 VII 1946. No. 1087, coll. H. K. Townes, 1 ♀. Rumung Island, 19 VI 1957, coll. C. W. Sabrosky, 3 ♂ ♂ (B.P.B.M.).

Ulithi Atoll: Falalop Islet, 4 X 1952 and 1 X 1952, coll. N. L. H. Krauss, 2 ♀ ♀ (B.P.B.M.).

Woleai Atoll: Falalis Islet, 20 IX 1952, coll. N. H. L. Krauss, 2 ♂ ♂ (B.P.B.M.).

***Leptocoris subrufescens* (Kirby) 1888**

Fig. 2 F, G, 4 G

Lygaeus subrufescens Kirby, 1888: Proc. Zool. Soc. Lond., 553, 1900:

Monogr. Christmas Island, 128. Plate 15, fig. 3. (Type in British Museum checked by Mr. R. J. Izzard.)

Shining brown, with a pale brown pilosity. Antennae concolorous with rest of body. Head not very broad, structure very similar to *vicina*. Eyes and ocelli red. Rostrum reaching to about middle of fourth abdominal segment.

Pronotum shaped very much as in the preceding species. Punctuation of the portion behind the smooth areas more obvious. Scutellum also shaped as in *vicina*. Corium and clavus more conspicuously punctured than in the other species. Membrane the same brown colour as the rest of the body.

Beneath the body is a pale brownish yellow with perhaps some darkenings on the pleurae above the coxae. Legs brown.

Male genital capsule as figured, very similar in outline and also the shape of the claspers to the preceding but the prominent lateral lobes (parandria) of the pygophore are conspicuously grooved on their upper surfaces for a good part of their length.

Female genitalia as figured. The upper valvulae are produced as clubshaped processes which are flat on their inner side. They are however smaller than in *vicina* and with a lot fewer spines, apparently not more than 10. The lateral valvulae are apparent as plates beneath the upper valvulae with a few terminal hairs. Ventral valves fairly convex.

Length: 11-14 mm.

Loc.

Christmas Island, Indian Ocean, 1 IV 1933, 1 ♂, 1 ♀ (B.M.).

***Leptocoris coxalis* (Kirby) 1891**

Fig. 2 H-J

Serinetha coxalis Kirby, 1891: Journ. Linn. Soc. Lond., Zool., 24: 93.

Serinetha vicina Distant (in part) 1902: Fauna Brit. Ind. Rhynch., 1: 420.

This species is only represented by the unique male type in the British Museum, figures of whose genitalia have been done for me by Mr. Izzard and comprise fig. 2 H-J of this work.

The species is evidently distinct from *vicina* although it belongs to the *vicina* group.

Kirby describes the species as "Red; antennae, except at extreme base beneath, scutellum, membrane, legs except the coxae, pectus, and ventral surface of abdomen except at the sides and extremity black.

Easily recognizable by the conspicuous red coxae on a black background."

Length: 14 mm.

Loc.

Ceylon.

***Leptocoris abdominalis* (Fabricius) 1803**

Fig. 3 A-C, 4 H

Lygaeus augur (in part) Fabricius, 1794: Ent. Syst., 4: 161, 88.

Lygaeus abdominalis Fabricius, 1803: Syst. Rhyng., 226. (Type checked in Copenhagen by Dr. A. Nielsen against sketches of genitalia.)

- Leptocoris abdominalis* Burmeister, 1835: Handbuch der Ent., 2: 305. Blöte 1934: Zool. Meded., 17: 266.
- Lygaeomorphus abdominalis* Blanchard, 1840: Histoire nat. des Insectes 3: 116.
- Pyrrhotes abdominalis* Westwood, 1842: Cat. Hem. Coll. Rev. Hope, etc., 2: 26.
- Serinetha abdominalis* Dallas, 1892: List Hem. Ins., 2: 460. Stål 1868: Kongl. svensk, Vetens.-Akad. Handl., 7 (11): 68. 1873: *Loc. cit.* 11 (2): 99. Tryon, 1892: Ann. Qld. Mus., 2: 22. Lethierry & Severin, 1894: Cat. gén. Hém., 2: 122. Distant, 1901: Ann. Mag. nat. Hist. 7 (7): 428. 1902: Fann. Brit. Ind. Rhynch., 1: 419, fig.
- ?*Leptocoris rufus* Hahn, 1831: Wanz. Ins., 1: 201, f. 102. (The type of this species cannot be located and its position here is only conjectured, and traditional.)
- Serinetha taprobanensis* Dallas, 1852: List. Hem. Ins., 2: 461. (Type presumed lost.) New synonymy.
- Leptocoris bahram* Kirkaldy, 1899, Bull. Liverpool Mus., 2: 46. (Type in British Museum checked by Mr. R. J. Izzard.) New synonymy.
- Leptocoris marginata* Blöte, 1934: Zool., 17: 267, fig. (Type checked in Leiden against sketches of genitalia.) New synonymy.

Excepting the original references of Fabricius, and the references to *taprobanensis*, *bahram* and *marginata*, practically all of the other references probably refer also in part to the next species *rufomarginata* (Fabr.). Most series I examined labelled either *abdominalis* or *rufomarginata* were a mixture of both species.

Both are very variable species and *abdominalis* can be separated at the moment into at least three subspecies on colour and colour pattern and the development of the keel on the disc of the pronotum and also on the convexity of the pronotal disc. These are:—

***Leptocoris abdominalis taprobanensis* (Dallas) 1852**

Is the extreme western variant of the species, occurring on the Islands of Ceylon and Socotra. Distant 1902 p. 419 also mentions the "pale form *taprobanensis* Dall.—is not infrequent at Calcutta." The general colour is a bright honey yellow, the eyes and ocelli are red and the antennae, rostrum, all thoracic sterna and pleurae (except the dorsal margins broadly of the pleurae, especially of the first and the hind margin of the metapleura narrowly, which are yellow) and all the

ventral abdominal segments (except for a broad stripe along their dorsal margins and except the last and those of the genital capsule which are yellow) and membrane black. Pronotal keel fine. This subspecies is fairly broad in relation to its length. Although Dallas' type cannot now be found in the British Museum, there is no doubt it was this form he had for it is common in all collections from Ceylon which I looked over.

***Leptocoris abdominalis abdominalis* (Fabr.) 1803**

Is the central variant and the type race of the species occurring in Indonesia and the Philippines. The general colour is a dark brick red but the distribution of red and black is the same as for the previous subspecies. The disc of the pronotum just behind the impressed smooth area tends to be rather more convex than in either of the other two subspecies and in one specimen (paratype of *marginata* Blöte) I have seen it is conspicuously so. The pronotal keel is almost obsolete, and the subspecies is fairly broad in relation to its length.

***Leptocoris abdominalis blötei* subsp. nov.**

Is the eastern variant of the species and confined so far as I know to New Guinea. The general colour is a honey yellow, the head tending to be a little suffused with red or blackish brown. Eyes and ocelli red. The distribution of yellow and black beneath is exactly as for the subspecies *taprobanensis* and the membrane is black with a greyish tinge, but above the pronotum has a large semicircular black patch with its diameter on the hind margin of pronotum and occupying three-quarters of this hind margin. This spot extends forward to at least half way to apex of pronotum. The pronotal keel and impressed smooth areas are also black and in one specimen most of the collar in front of these, as is the scutellum, clavus and all the corium except for a broad longitudinal stripe along the whole length of the outer margin which is yellow. The pronotal keel is more distinct, possibly because it is outlined with black in the region of the pronotum anterior to the large black posterior spot. This subspecies is also conspicuously more elongate in relation to its width than the other two subspecies.

The description of the species with allowances for the subspecific variations is as follows.

General colour dark brick red (subsp. *abdominalis*) or honey yellow (subsp. *taprobanensis* and *blötei*). Pilosity on antennae black, long pilosity on body greyish, short pilosity golden.

Antennae black, with a fairly thick short pilosity, Head broad, with two obliquely placed sulci running from just in front of insertion of antennae to join in middle of vertex at about level of middle of eye thence continuing to base of head as a single longitudinal sulcus, the three sulci in the form of a Υ . Head dark brick red (subsp. *abdominalis*), honey yellow (subsp. *taprobanensis*) or honey yellow suffused with red or brown (subsp. *blötei*). Eyes and ocelli always red. Rostrum black.

Pronotum with the two somewhat depressed narrow smooth areas running from centre line to lateral margin and somewhat obliquely placed, yellow or yellowish brown in the subspecies *taprobanensis*, red in *abdominalis* and black or piceous in the subspecies *blötei*. The narrow collar of the pronotum in front of these depressed smooth areas very raised and more annulus shaped than in most other species. In the subspecies *blötei* often suffused with black. Lateral margins of pronotum behind the depressed smooth areas fairly rounded, not nearly as straight as in the eight preceding species although in the subspecies *blötei* they are not as rounded as in the other two subspecies. Hind margin sinuate. Disc of hind portion of pronotum coarsely punctate and often convex or tumescent near the centre in the subspecies *abdominalis*, more finely punctate in the other two. Hind part of pronotum brick red in *abdominalis* golden yellow in *taprobanensis* and golden yellow with a large semi-circular black spot with its diameter about three quarters of the hind margin and extending forward to at least middle of the pronotum. Keel from where it emerges from this large spot on the pronotum to where it terminates at the impressed areas black in *blötei*.

Scutellum slightly raised flat on top, yellow in *taprobanensis*, brick red in *abdominalis* and black in *blötei*. Impunctate smooth.

Corium and clavus very finely and fairly sparsely punctate, honey yellow in *taprobanensis*, brick red in *abdominalis* and black, except for an outer margin of the corium which is broadly yellow in *blötei*. Membrane black, or with a greyish or metallic greenish tinge in the case of *blötei*.

Hind part of pronotum, scutellum and coriaceous part of hemelytra covered by a fine golden pubescence.

Underside largely black or blackish brown. Underside of head, dorsal margin of propleura broadly, and dorsal margin of meso-pleura and upper half of posterior margin of metapleura narrowly yellow in *taprobanensis* and *blötei*, red or reddish brown in *abdominalis*. Genital

capsule, last visible ventral segment and a broad longitudinal streak running along the dorsal parts of abdominal segments 1-5 yellow suffused with sanguineous in *taprobanensis*, yellowish brown in *blötei* and reddish brown in *abdominalis*.

Male genital capsule as figured. Penultimate segment thrown into short lobes which are circular in cross section, convergent, and very strongly pilose. Claspers as figured, in the form of a longitudinal segment of a hollow cylinder basally, becoming a cylindrical and somewhat sinuate process apically.

Female genital capsule as figured. Upper valves unlike all other species are not in the form of clubs but are small plates beneath the anal segment and with a few long terminal hairs. Lateral valves visible, a similarly shaped set of plates below these again, and ventral valves fairly convex.

Length: 14-21 mm.

Loc.

Ceylon (subsp. *taprobanensis*): 3 V 93, coll. Sir G. T. Smith, 2 ♀♀: Colombo, I 1915, coll. I. Mc Ech'n, 1 ♀ (S.A.M.); coll. Schaum, no other data, 1 ♂ Cat. No. 46 (R.M.): no data, 1 ♂; no data except Walkers Catalogue 52, 62, 1 ♀ (B.M.), Peradeniya, X 1910, coll. R. L. Woglum, 3 ♂♂, 3 ♀♀, Peradeniya, 12 X 1903, coll. W. F. Rosenberg, 4 ♀, Peradeniya, No. 59, no other data, 1 ♀ (U.S.N.M.).

Indonesia (subsp. *abdominalis*): Boloang Mengon don Modajag, North Celebes, IX 1917, coll. W. Kaudern, 1 ♀, Cat. Nat. No. 2: Fort de Koek, Sumatra, XI 1913, coll. Edw. Jacobson, 1 ♂, Cat. No. 33 (R.M.). Java, from P. R. Uhler coll., 1 ♀ (U.S.N.M.).

Philippines (subsp. *abdominalis*): Bataan Province, Luzon, coll. G. Böttcher, 1 ♂ (B.M.). Baguio Benguet, coll. Baker, 2 ♂♂ 1 ♀. Samar Island, coll. Baker, 1 ♂. North west of Panay Island, coll. Baker, 1 ♀ (U.S.N.M.).

Formosa (subsp. *abdominalis*): Grove, 1.5 miles S. of Nodoe, 13 VII 1929, coll. on Lingnan University 5th Hainan Island Expedition 1929, 1 ♂, 1 ♀ (U.S.N.M.).

Eastern Asia (subsp. *abdominalis*): Assam: No. 57, coll. W. Ashmead, 1 ♂ (U.S.N.M.). Siam: Singora, VI 1929, coll. H. M. Smith, 1 ♂. Tha Lo 30 IX 1931, coll. Hugh Smith, 1 ♀ (U.S.N.M.). Vietnam: Annam-Cana, Phanrang Province in *Pinus merkusii* belt at altitude 0-600 metres, 18-22 VIII 1932, coll. M. Poilane, 1 ♀ (U.S.N.M.).

New Guinea (subsp. *blötei*): "Mist Camp" of Netherland Indies—American New Guinea Expedition, 1800 metres, 9 I 1939, coll. L. J. Toxopeus, Holotype ♂, Allotype ♀, 1 paratype ♂, 2 paratype ♀♀ (R.M.). Krisa, Vanimu, Nth. New Guinea, IV 1939, coll. L. E. Cheesman, 1 paratype ♂, Reg No. I 20, 103 (S.A.M.); Goroka, 1550 metres, 10 VI 1955, in light trap, coll. J. L. Gressitt, 1 paratype ♀ (B.P.B.M.).

Leptocoris rufomarginata (Fabricius) 1794

Fig. 3 E-G, 4 I

- Lygaeus rufomarginatus* Fabricius, 1794: Ent. Syst., 4: 152. (Type checked in Copenhagen against sketches of genitalia by Dr. Anker Nielsen.) 1803: Syst. Rhyng., 220 (exclude reference to *stolli*).
- Serinetha rufomarginata* Dallas, 1852: List Hem. Ins., 2: 460. Stål, 1868: Kongl. svensk. Vetens.-Akad. Handl., 7 (11): 68. Lethierry & Severin, 1894: Cat. gén. Hém., 2: 123. Distant, 1902: Faun. Brit. Ind. Rhyneh., 1: 419. Esaki, 1926: Ann. Mus. nat hung., 24: 157.
- Leptocoris ruformarginatus* Kirkaldy, 1905: Trans ent. Soc. Lond., 350.
- Lygaeus taitense* Guérin, 1830 (1838): Voy Coquille Ins., 2: 178, pl. 12, fig. 15. (Type presumed lost.)
- Serinetha fimbriata* Dallas, 1852: List. Hem. Ins., 2: 462. (Imperfect type in British Museum checked by Mr. R. J. Izzard.)
- Lygaeus flavomarginatus* Matsumura, 1913: Thous. Ins. Japan. Addit., 1: 141, tab. 14, f. 4.
- Leptocoris spectabilis* Breddin, 1901: Allg. Zeitschr. Ent., 6: 113-115. (*Typ. vid.*)
- Leptocoris insularis* Kirkaldy, 1908: Proc. Linn. Soc. N.S.W., 33: 353. (The type cannot be located but all the large specimens of *Leptocoris* seen from Fiji have been *rufomarginata*) China, 1930: Insects of Samoa 2 (3): 103. Blöte, 1934: Zool. Meded., 17: 267.
- Leptocoris fimbriata* Blöte, 1934: Zool. Meded., 17: 267.

As mentioned after the synonymy of *L. abdominalis* in most collections the series labelled *abdominalis* or *ruformarginata* have each been a mixture of these two species. Therefore most of the references above (except Fabricius' or Breddin's original descriptions and references to *insularis*) refer in part also to *abdominalis*.

This is undoubtedly the most variable species in the whole *Leptocoris* complex of the East Asian and Pacific area. It cannot be clearly differentiated into geographic races as can *abdominalis*, or at least not on the material before me. As one example, most female specimens from the Solomon Islands I have seen are typical "*rufomarginata*", very similar to those from the Philippine Islands, whilst males from the Solomon Islands are very similar to some rather fuscous reddish specimens amongst the Queensland Coast series.

The ground colour varies enormously. It is often black, with in the case of the two specimens from Lombok, bright yellow lateral margins to head, pronotum and corium, or in the case of the type "*rufomarginata*" form a reddish head and wide reddish lateral margins to pronotum and corium. The black however may become very reduced or even absent from above making the ground colour red or yellowish; in a pair of ♀ specimens from Misima Island in the Louisiade Archipelago the black on the pronotum is restricted to the collar and depressed callous areas and a large quadrate patch in the hind part of disc, the scutellum is black, but the clavus and inner corium are merely infuscated; in most Micronesian specimens there are two longitudinal black lines on the pronotum (rarely fused into one or absent) and the clavus and inner corium are infuscated. In many specimens the only black above is the black antennae, and in others the membrane, the depressed smooth areas on the pronotum, and the antennae are concolorous with the main reddish or yellow above.

Amongst the forms in which the black is more or less reduced or absent the ground colour is very variable. In specimens from Penang (also one from Siam), the Nicobar Islands, and Sumatra and the Misima Island females it is a bright brick red. In most of the Queensland Coast specimens there is a tendency for a purplish red, and this is very well developed in nearly all the specimens of the small form from Fiji, Samoa and Tonga. From Sipangkat there are three specimens which are a yellowish cyclamen colour, one of these has the central pronotum longitudinally, the scutellum, clavus, and inner corium vaguely infuscated, *i.e.*, the pattern of the *rufomarginata* form. The two males I have seen from Misima Island and the Micronesian specimens are reddish ochraceous and fairly small, one from Misima has two elongate large longitudinal blackish spots on hind part of pronotum and this is generally the case in the Micronesian specimens. The form "*spectabilis*" Breddin is ochraceous above except for the black membrane and brown antennae.

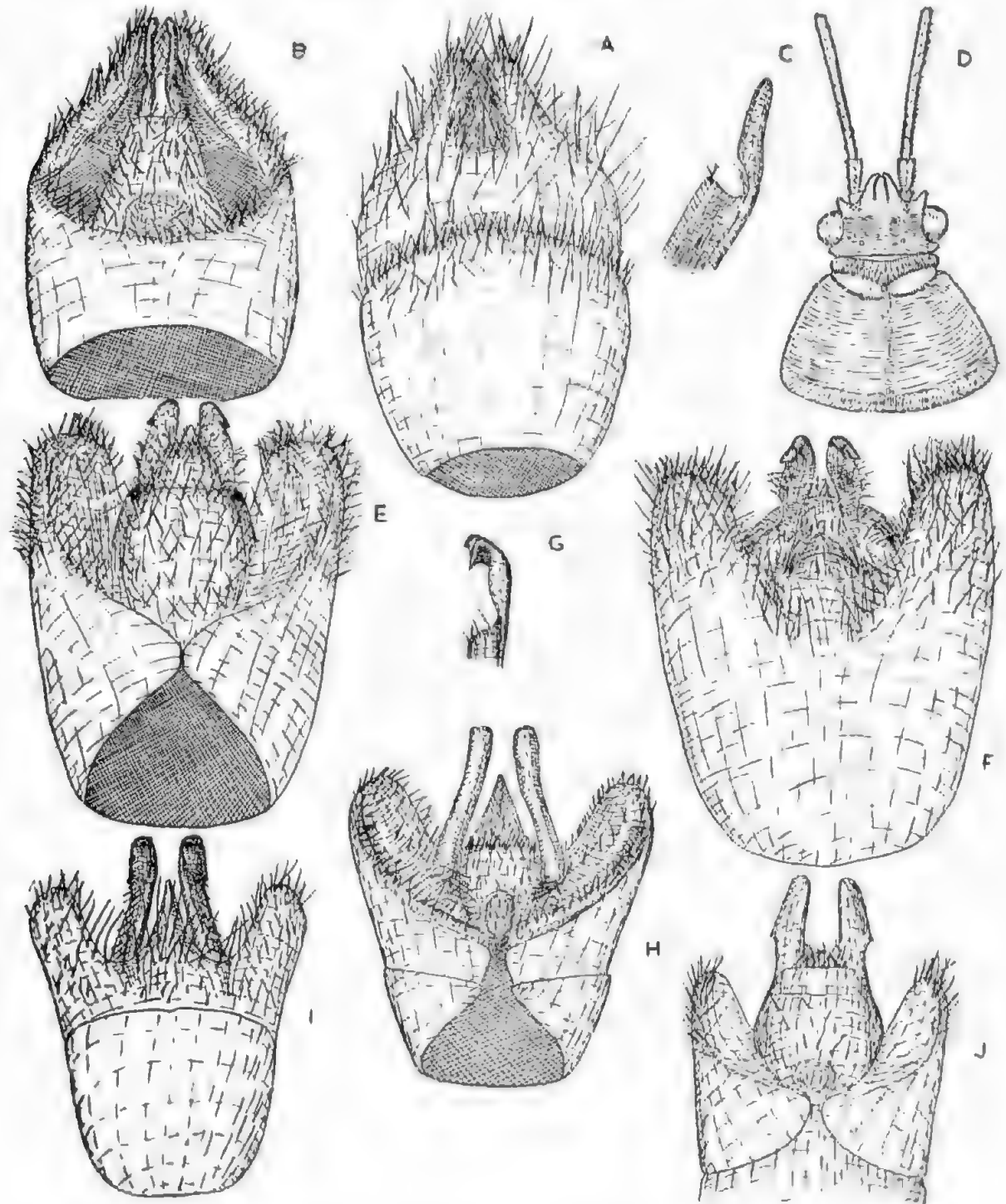


Fig. 3: A-C *Leptocoris abdominalis* (Fab.), A—male genital capsule from above, B—same from below, C—right paramero from above. D *Leptocoris corniculata* (Stal), head and pronotum. E-G *Leptocoris rufamarginata* (Fab.), E—male genital capsule from above, F—same from below, G—right clasper from right hand side. H-I *Leptocoris tagalica* Burmeister, H—male genital capsule from above, I—same from below. J *Leptocoris isolata* (Distant), male genital capsule from above.

Beneath the species is generally black except for the underside of head and the lateral margins of propleura (broadly), mesopleura and metapleura (also upper hind margin of latter) and dorsal margins of abdominal segments broadly (except the sixth which is completely red or yellow) concolorous with pale colour of above surface. In the Sipankat specimens the underside is yellowish cyclamen tinged with only the merest suggestion of fuscous where there is black in most of the other specimens of the species. The legs, antennae and rostrum of the Sipankat specimens are a dark cyclamen colour. The two specimens from Lombok with the narrow yellow margins above are bright yellow beneath with black legs (except coxae), antennae, and rostrum, and a black spot on each of mesosternum, mesopleura, and metapleura. The Queensland Coast specimens tend to have little black on the abdomen and a black patch on the underside of head; or to be infuscated only on the pleurae. This is also true of one Sumatran and one Luzon example. Many of the specimens have a white encrustation over the black beneath. The abdomen of Polynesian specimens tends to be a vaguely infuscated reddish beneath.

Structurally the species is very similar in size and form to *abdominalis*. Polynesian specimens tend to be rather smaller than is usual for the species. The head is shorter and broader, there is a central longitudinal sulcus running back from the base of the tylus. There are two grooves running down obliquely from midline to insertion of antennae but they are very shallow and very broad. The rostrum reaches base of second abdominal segment.

The pronotum is narrow anteriorly, broad posteriorly as in *abdominalis* but the disc is fairly raised posteriorly and the lateral margins are not so curved outwards. The anterior portion of the pronotum is rather depressed, thus the pronotum is not so nearly coplanar as in some species. The central keel is fairly obsolete.

The species can easily be distinguished from all others on the shape of the genital capsules. Through all this series of varied coloured specimens I have examined I have seen only the one type of capsule in each sex. I have had no hesitation in lumping all these forms together under this one species solely on this character alone. It is apparent in the other species of the genus that where specific differences do occur the variation in the genitalia, especially those of the male are very marked. In fact in only two species is there even a semblance of difficulty in separating them on male genital characters, i.e., *tagalica* Burmeister, and *isolata* (Distant). In *rufomarginata* the genitalia of the male and female are very distinctive and very constant.

The male genital capsule has the penultimate segment produced into two broad latero-ventrally flattened pilose lobes. These lobes are feebly convex on the ventero-lateral surfaces and almost flat on the dorsal interior ones. Ventrally the penultimate segment is produced between the claspers as a triangular shaped, short arched plate, directed upwards at about 45°. The male claspers are quite elaborate, they begin basally almost triangular in cross section, then become almost flat, broadish, and sinuate and apically they turn ventrally and have a lateral hook on the outer surface.

The female genital capsule has the upper valves produced as club shaped, very pilose processes which are flat (or even slightly concave) on their inner surfaces like most other species but these clubs are completely devoid of spines. The lateral and ventral pairs of valves are also quite distinct. The basal parts of the ventral valves are convex only near their inner margins and beneath appear to give off membranous processes which protrude up under the lateral valves.

In both sexes the genital capsules are reddish or yellowish with yellow pilosity.

As already referred to this species has often been confused with the preceding, amongst the various collections before me there are specimens, male and female, of both species labelled *abdominalis* Fabr. Sometimes the similarity is very great indeed. Amongst the Rijksmuseum material are two specimens, both males, that look almost identical from above and below, both are red and would in the past have been put confidently as *abdominalis*. One of these (Cat. No. 33) from Fort de Kock, Sumatra, is an *abdominalis*, the other (Cat. No. 27) from Pulu Pandjang, Sumatra, is a *rufomarginata*.

The two species can be separated at a glance by the genitalia, and generally the essential genital characters can be seen without even dissecting the genital capsule out. In the male of *abdominalis* the lateral lobes of the penultimate segment are rounded and convergent whilst in *rufomarginata* they are broad, flattish and somewhat divergent. The claspers of *abdominalis* are a long sinuous spine apically becoming a curved plate basally, the claspers of *rufomarginata* are hooked apically and have a short spine on their outer surface, thence they widen and become a sinuous plate and finally basally become almost triangular in cross section.

The upper valves of the female capsule in both species are entirely devoid of spines (unlike all other species of the genus from the region) but have a long pilosity. But in *abdominalis* the upper valves are

in a primitive condition and are in the form of not particularly prominent plates, in *rufomarginata* they are club shaped and very prominent like all other species of the genus.

Length: 13-29 mm.

Loc.

Lower Siam: Trong, coll. Dr. W. L. Abbott, 1 ♀ (U.S.N.M.).

Nicobar Islands: No precise locality, 1903, coll. G. Rogers, 1 ♀ (B.M.).

Malay Peninsula: Penang, Rosenberg Collection, 1 ♂ (headless), 1 ♀ (U.S.N.M.).

Indonesia: Sumatra: Pulu Pandjang, Sim, Sumatra, V 1913, coll. E. Jacobson, 1 ♂, Cat. No. 27: no precise locality, coll. Muller, 1 ♀, Cat. No. 2 (R.M.). Padang, no other data, 2 ♂ ♂ (Zool. Inst. Halle).

Java: Samarang, I 1910, coll. E. Jacobson, 1 ♀, Cat. No. 41 (R.M.); Bogor, I, coll. A. M. Lea and wife, 1 ♀ (S.A.M.). No precise locality, No. 53, P. R. Uhler collection, 1 ♂ (U.S.N.M.). No precise locality or date, 1 ♀ (Zool. Inst. Halle).

Borneo: Labuan Island, coll. C. T. McNamara, 1 ♀: Sandakan, coll. C. T. McNamara, 1 ♀ (S.A.M.). Sandakan, coll. Baker, 6 ♂ ♂, 4 ♀ ♀, 2 without abdomens. Mt. Kinabalu, North Borneo, coll. G. Haslam, donated B.P. Clark, 4 ♂ ♂, 1 ♀ (U.S.N.M.).

Celebes: Tondano, no other data, 1 ♀, Cat. No. 2 (R.M.). Toli-Toli, North Celebes, XI-XII 1895, coll. H. Fruhstorfer, 1 ♀, Reg. No. 40, Breddin coll. and Breddin's type of *Serinetha spectabilis* (Deutsches Entomologisches Institut Berlin-Friedrichshagen). Same date, No. 4, C. F. Baker Collection 1927, 1 ♀ (U.S.N.M.).

Lombok: Rindjani: Segard Anak, 2000 metres, IX 1936, coll. R. van de Veen, 1 ♀ (R.M.).

Sumbawa: Col. van Lansberge, no other data, 1 ♀, Cat. No. ? (R.M.).

Sipangkat: 10-14 IX 1929, coll. Snellius Expedition, 2 ♂ ♂, 1 ♀ (R.M.).

Timor: Coll. Muller, no other data, 1 ♂, Cat. No. 3 (R.M.).

There are a further five specimens of this species in the collection of Zool. Inst. Halle, 4 ♂ ♂, 1 ♀, 3 of them belonging to an interesting yellow form very similar in appearance to *L. abdominalis taprobanensis* which are utterly without label but I think probably come from somewhere in the Indonesian Archipelago.

Philippines: Luzon: Mt. Makiling, coll. Baker, 1 ♂, 2 ♀ ♀. Manilla, No. 18, P. R. Uhler collection 1 ♀ (U.S.N.M.).

Samar: Coll. Baker, 1 ♀ (U.S.N.M.).

Mindanao: Surigao, coll. Baker, 3 ♂ ♂, 2 ♀ ♀ (U.S.N.M.). Surigao, from Tacuber Collection, 1 ♂. Momungan, North Mindanao, coll. G. Böttcher, 1 ♂ (B.M.).

Caroline Islands; Palau Islands: Koror I., limestone ridge S. of Islet; 21 I 1948, coll. H. S. Dybas, 1 ♀. Koror I., IX 1952, coll. N. L. H. Krauss, 1 ♀. Koror I., XII 1954, coll. J. W. Beardsley, 2 ♂ ♂, 2 ♀ ♀, 3 from *Allophylus* sp. Koror I., 18 IV 1957, coll. C. W. Sabrosky, 3 ♂ ♂. Ngerkabesang I., 24 IV 1957, coll. C. W. Sabrosky, 1 ♀. Urukthapel (Ngurukdabel) I., 16 VIII 1953, No. M. 455, 1 ♀ (B.P.B.M.).

Ponape: Kolonia-Jokaji, 24 VII 1939, coll. Teiso Esaki, 1 ♀ (K.U.). Nanue Islet, VI-IX 1950, coll. P. A. Adams, 1 ♀ (B.P.B.M.).

New Guinea: Mt. Lamington, North East Papua, 1,300-1,500 feet, coll. C. T. McNamara, 1 ♀; Misima I., Louisiade Archipelago, coll. Rev. R. J. Andrew, 1 ♂, 1 ♀ and coll. H. K. Bartlett 1 ♂, 1 ♀ (S.A.M.). Normanby I., Papua, Wakaiuna, Sewa Bay, 8 I 1957, coll. W. W. Brandt, 1 ♀ (B.P.B.M.).

Solomon Islands: No precise locality, VII-VIII 1909, coll. W. W. Froggatt, 1 ♂, 1 ♀ (C.S.I.R.O.). Guadalcanal, XII 1920, coll. J. A. Kutsche, 6 ♂ ♂, 9 ♀ ♀. Ditto, 1 1921, coll. J. A. Kutsche, 2 ♂ ♂, 1 ♀ (B.P.B.M.).

Fiji Island Group: Suva, Viti Levu, 11 IX 1921, coll. Saunders, 1 ♀ (Fiji Dept. Agr.); Suva, Beach Road, 14 II 1933, coll. C. H. Edmondson, 1 ♂. Moala I., ex coconut, 7 IX 1924, coll. R. H. Beck, 31 ♂ ♂, 2 ♀ ♀. Mothe-Lau, 14 VIII 1924, coll. E. H. Bryan Jr., 1 ♀ (B.P.B.M.).

Tonga Islands: Fua I., 8 V 1928, coll. H. S. Ladd, 2 ♂ ♂, 4 ♀ ♀ (B.P.B.M.).

Samoa Island Group: Savaii Island, coll. W. von Bülow, 1 ♀, Cat. No. 1 (R.M.). Upolu Island, Afiamalu, 19 VI 1940, 2,200 feet, at light, coll. Swezey & Zimmerman, 1 ♀. Same data, except date 10 VI 1940, 2 ♂ ♂. Same data, except date 18 VI 1940, 1 ♀. Same data except date 24 VI 1940, 9 ♂ ♂, 12 ♀ ♀. Same data, except date 30 VI 1940, 1 ♂, 3 ♀ ♀. Tapatapao, 17 VI 1940, 1,000 feet, at light, coll. Swezey & Zimmerman, 2 ♀ ♀. Apia, IX 1926, coll. G. P. Wilder, 1 ♂ (B.P.B.M.).

Queensland: Rockhampton, no other data, 1 ♀: Kuranda, coll. F. P. Dodd, 1 ♀ (S.A.M.); Ayr, 25 XI 1954, coll. G. Saunders, 1 ♂; Lawes, 21 XII 1952, coll. E. Jones, 1 ♀; Brisbane, 12 VI 1952, coll. M. W., 1 ♂; Brisbane, V 1949, coll. Talbot, 1 ♀ (U.Q.).

***Leptocoris tagalica* Burmeister 1834**

Fig. 3 H, J, 4 J

Plate XLVIII

Leptocoris tagalicus Burmeister, 1834: Nov. Act. Acad. Leop., 16: Suppl., 299.

Serinetha tagalica Dallas, 1852. List Hem. Ins. Brit. Mus., 2: 460.

Serinetha lurida Dallas 1852: *loc. cit.*, 461. Dist., 1901; Ann. Mag. nat. Hist., (7) 7: 429. (Type in British Museum checked by Mr. R. J. Izzard.)

Leptocoris vulgaris Bergroth, 1916: Proc. R. Soc. Vic., 29: 32. (Type presumed lost.)

Leptocoris taitensis Cheesman, 1926: Ann. Mag. nat. Hist., (9) 18: 369, figs. (nec Guérin). (Type in British Museum checked by Mr. R. J. Izzard.)

Leptocoris ahunei Cheesman, 1927: Trans. ent. Soc. Lond., 75: 156 (n. name for *taitensis* Cheesman).

This, like the previous species, is one of the most wide spread of the species of the genus in the region, ranging from Tahiti to the Philippines and far into Central Australia. It is variable in size and also in ground color and it is not surprising that it has been described under such a variety of names.

It is far from certain that the correct name is *tagalica*. Burmeister's original type cannot be traced and it is completely unsafe to try and place any Indo-Pacific species of *Leptocoris* of this size and color without an examination of the genitalia. In Dallas' description of *vicina* which follows immediately after his reference to *tagalica* he mentions several differences between his *vicina* and what he has listed as *tagalica*. This species fits Dallas' concept of *tagalica*, but we cannot be sure Dallas' *tagalica* is Burmeister's *tagalica*. If the type is ever traced it could turn out it is what I have called *vicina* and will replace that name, then the next available name for this species is *lurida* Dallas. *Tagalica* and *vicina* were both described from the Philippines, hence the type localities are of little help.

The ground colour is generally a purplish red, but it is often brick red (this is usually the case with the small Central Australian form described as *L. vulgaris* by Bergroth) or scarlet or even a brownish yellow as is the case in a series of specimens from Cloncurry, Queensland. Two specimens in the Rijksmuseum collections identified by H. C. Blöte as *longirostris* Dallas have the pronotum brownish yellow (except for the smooth depressed areas which are purplish red and in one specimen the lateral margins behind the calli are tinged with red) whilst the rest of the body above (except antennae) is purplish red. Specimens from Saipan and Tinian are a deep chocolate brown with a black head.

The long hairs on the head, antennae, legs and sides of pronotum are blackish brown, the fine pilosity of the body is golden yellow.

The antennae are brownish black or black, generally the first segment is paler near base, and with a moderate thickness of short stiff blackish brown hairs. The head is as broad basally as in all the other species but the region of the tylus and the jugae seems narrower and more elongate. There are generally a few scattered stiff hairs on the head and a fine golden pilosity. The eyes and ocelli are generally purplish red but in the yellow Cloncurry specimens are bright red. There is a short longitudinal impressed line just in front of the ocelli, a tumescence behind each eye and an oblique curved ridge in front of the eye leading down to insertion of antennae. The pronotum has the anterior smooth areas convex and almost transverse, in most specimens they are concolorous with, or only slightly darker than the ground colour (including the Cloncurry specimens where they are yellow) but in the two Rijksmuseum specimens with the yellow pronota they are a purplish red. In front of these calli the pronotum is elevated into a narrow quite raised shallowly triangular area which often has a few sparse hairs. The lateral margins of the pronotum behind the calli are rather selvaged and almost straight or very shallowly concave. The posterior margin is very feebly convex and slightly depressed. The disk of the pronotum behind the calli is flat or almost so, becoming depressed before the lateral margins and immediately before the hind margin. There is a fine longitudinal keel running from the calli to almost the hind margin. The lateral margins have a moderately dense development of stiff black hairs.

The scutellum is elevated and flat or even slightly concave on top, the lateral margins are strongly depressed and the disc is depressed before the apex.

The coriaceous parts of elytra, scutellum, pronotum and head are covered with a fine golden pubescence. The membrane is black becoming broadly brown near the apex. Specimens from the Mariana Islands have a paler membrane.

Rostrum and legs (except coxae) concolorous with antennae, brownish black or black. Thoracic pleurae in southern specimens generally mainly blackish with a red or yellow spot (depending on the ground colour) well above each coxa, also a thin line along apical margin of several of the ventral abdominal segments blackish. In Indonesian and Polynesian specimens these latter black areas become very obsolete or absent altogether. The coxae are always reddish or yellowish depending on the ground colour. The rostrum reaches to or almost to base of the fourth abdominal segment. In specimens from Saipan and Tinian the abdomen beneath is paler than the ground colour.

The genital capsules of both the males and females are not such a reliable guide to the identity of the species. They readily distinguish it from all the preceding species, but the female is hardly distinguishable from the next species, and in the male the characters are not as clear cut as we have been encountering so far.

The male genital capsule has the penultimate segment produced laterally into prominent pilose lobes which are convex on the ventero-lateral surface and noticeably concave and more pilose on the inner dorsal surfaces. Ventrally the penultimate segment is produced between the claspers as a prominent triangular process. The claspers are fairly simple and are feebly hooked on their underside towards the apex and turn somewhat though not markedly ventrad. The claspers lack the elaborate structure of the preceding species and the lateral lobes of the penultimate segment are much longer in relation to the length of the claspers than in either the preceding species or in the one following. The capsule is generally the same general colour as the rest of the insect but in Saipan and Tinian specimens it is black.

The female genital capsule has the upper valves produced into club-like structures which are pilose and have a number (>20) of strong spines. The clubs are flat on their inner surfaces. The lateral valves are just perceptible as flat plates with a terminal pilosity beneath the upper valves. Ventral valves fairly convex.

Length: 9-13 mm. Specimens from Central Australia are consistently small and could be considered perhaps as a separate race to which the name *vulgaris* Bergroth would have to apply. They are

also more uniformly reddish than the Queensland Coast specimens. On the other hand specimens from Central New South Wales and Central Queensland tend to bridge the gap between the typical *vulgaris* type and the purplish red or yellow coastal forms in both colour and size. It is perhaps best to leave this point to be clarified later in the light of additional material from inland New South Wales and Queensland. Specimens from Saipan and Tinian are also very small and could possibly also be regarded as a good subspecies, but again, it would be desirable to see material from more Micronesian localities.

Loc.

Philippines: North Luzon: Pr. Bontoc Tinglayan, 1000 metres, coll. G. Böttcher 1 ♀; Los Banos, coll. G. Böttcher 1 ♂; Mt. Banahao, 2000, coll. G. Böttcher, 1 ♀ (B.M.).

Mariana Islands: Saipan: Chalan Kanoa, Haw. 4061, 11 I 1949, No. 2951, on *Physalis peruviana*, 4 ♂♂. No precise locality, Haw. 4645, 25 II 1949, No. 6318, 3 ♂♂, 3 ♀♀ (U.S.N.M.). No precise locality, 11 I 1949, coll. K. L. Maehler 2 ♂♂, 4 ♀♀. Ditto, 25 II 1949, 4 ♂♂, 1 ♀. As Lito, II 1958, coll. N. H. L. Krauss, 1 ♀ (B.P.B.M.).

Tinian: Tinian Harbour, 20 III 1945, coll. H. S. Dybas, 2 ♂♂ (C.N.H.M.). 9 VI 1946, No. 493, coll. H. K. Townes, 2 ♂♂ (B.P.B.M.).

Indonesia: Sumatra: Tanjong Morawa, Serdang, N.E. Sumatra, coll. Dr. B. Hagen 1 ♂, Cat. No. 22 and 1 ♀, Cat. No. 8 (R.M.).

Celebes: Bankala, coll. J. G. van Hasselt, 1 ♂ (B.M.).

Soembawa: Sima, 27 VI 1929, coll. L. M. Mackerras, 2 ♂♂, 1 ♀ (C.S.I.R.O.).

Polynesia: New Hebrides: Tanna, IX 1930, coll. L. E. Cheesman, 1 ♂ (B.M.).

Samoa: Utunapu, Upolu, 7 XI 1954, coll. R. A. Cumber, 2 ♂♂, 3 ♀♀ (U.Q.).

Society Is.: Tahiti, 6 III 1925, coll. L. E. Cheesman, 1 ♀ (B.M.).

Australia: Queensland: Dunk Island, 25 VIII 1927, coll. F. A. Perkins, 1 ♀ (U.Q.); Magnetic Island, coll. G. F. Hill, 1 ♀ (B.M.): same data, 1 ♂, 1 ♀ (S.A.M.); Cloncurry, 8 IV 1947, coll. H. Bell, 1 ♂, 5 ♀♀, 2 nymphs; Julia Creek, 1 I 1946, coll. H. Bell, 1 ♀ (U.Q.); Powella, Aramac, VII 1920, coll. F. Bradshaw, 1 ♂, 2 ♀♀, Reg. No. K43437 (A.M.); Rockhampton to Yeppoon, 5-15 V 1956, coll. J. Baldwin, 1 ♂ (S.A.M.); Brisbane, on wild hop seed (? *Dodonaea* sp.), 11 XII 1927, coll. McLachlan, 1 ♂; Brisbane, Botanic Gardens, 3 XI 1952, coll. Dr. T. E. Woodward, 3 ♂♂, 3 ♀♀; Brisbane, III 1955, coll. J. Thapa, 1 ♀:

Brisbane, 3 IV 1955, coll. D. J. Woodlard, 1 ♀ : Brisbane, VII 1956, coll. J. O'Donohue, 1 ♂ : Stanthorpe, 10 XI 1922, coll. F. A. Perkins, 1 ♀ (U.Q.) : Stanthorpe, 9 X 1922, 2 ♂ ♂ (B.M.). No precise locality from C. French Junior collection presented 15 XI 1911, 1 ♂, 1 ♀ (N.M.) : Cunnamulla, 22 X 1938, coll. N. Geary (A.M.).

New South Wales: Gordon, 30 V 1943, coll. A. Musgrave, 1 ♀ : Watercourse near Moree, XI 1933, coll. A. Musgrave 2 ♂ ♂ (A.M.) ; 40 miles west of Wanaaring, 30 X 1949, coll. S. J. Paramonov, 2 ♂ ♂, 2 ♀ ♀ : Brewarrina, 1914, coll. W. W. Froggatt, 1 ♀ (C.S.I.R.O.) ; Yanda, 4 I 1954, coll. K. M. Moore, 1 ♂, 1 ♀ (A.M.) ; Belmont, 11 IX 1953, coll. A. W., 1 ♀ (U.Q.) . Upper Williams River, X 1926, coll. A. M. Lea & F. E. Wilson, 1 ♂ (N.M.).

Northern Territory: McArthur Station, 6 II 1912, coll. G. F. Hill, 1 ♂ (N.M.) : Murchison Range, 1932, coll. Basedow, 1 ♂, 1 ♀ : Coniston Station, coll. M. W. Mules, 5 ♂ ♂, 5 ♀ ♀ (S.A.M.) ; 59 miles N.W. of Alice Springs, 7 V 1952, coll. N.W. Australian Party from Aust. Mus., 1 ♂, 2 ♀ ♀ (A.M.) ; Undulya Gap, 6 VIII 1947, coll. C. W. Brazenor, 1 ♂ (N.M.) : 1 mile E. of Simpsons Gap, 27 VI 1951, coll. W. L. Brown, 2 ♂ ♂ : Palm Valley, 30 VIII 1956, coll. N. B. Tindale, 1 ♂ : Palm Valley, VIII-IX 1957, coll. N. Mollett, 1 ♂, 2 ♀ ♀ : Henbury Station, 14 X 1953, coll. G. F. Gross, 1 ♂, 2 ♀ ♀, Reg. No. E.S.I. 1181 (S.A.M.).

Western Australia: Beverley, 1913, coll. D. Bone (C.S.I.R.O.).

***Leptocoris isolata* (Distant) 1914**

Fig. 3 J, 4 A

Serinetha isolata Distant, 1914: Ann. Mag. nat. Hist., (8) 13: 179. 1920: *op. cit.* (9) 6: 148. (Type in British Museum checked by Mr. R. J. Tizzard.)

Leptocoris isolata Blöte, 1934: Zool. Meded., 17: 267.

Leptocoris lariversi Usinger, 1952: Proc. Hawaii ent. Soc., 14: 520. fig. (*Paratyp. vid.*) New synonymy.

This is a species of uniform (and in *Leptocoris* average) size and pretty constant appearance occurring only so far as is known along coastal New Guinea, the Solomon Islands, some islands between these two (Lousiade Archipelago), and the Marshall Islands.

The ground colour is fuscous brown, reddish, or reddish ochraceous above. In infuscated specimens the lateral regions of the head, anterior and lateral margins of pronotum and the outer base of hemelytra are

ochraceous, reddish ochraceous, or reddish. Antennae, membrane and legs black or blackish brown. The calli on the pronotum, usually the scutellum and sometimes a small quadrate area between eyes in otherwise not infuscated specimens blackish or purplish.

The longer hairs of head, antennae, legs and sides of pronotum and the overall very fine pilosity golden or whitish.

Antennae as in all other members of the genus with a short thick golden (or perhaps blackish) pilosity. The head is very similar in appearance to the preceding species, the eyes and ocelli are bright red.

The anterior smooth areas of the pronotum are not quite transverse, convex. In infuscated specimens they are concolorous with the fuscous centre of the pronotum, in others they range from red through bright purple and black and all stages may be seen in a series of specimens from any one locality. In front of these the pronotum is slightly raised into a narrow, shallowly triangular area which terminates laterally as two feeble pilose tumescences. The lateral margin of the pronotum behind the calli is shaped like a selvage, almost straight but with a feeble concavity just behind the ocelli. The hind margin is convex, ovate and depressed. The disc of the pronotum behind the calli is flat or almost so, becoming depressed before the lateral and hind margins, there are five feeble tumescences along the line where it dips to meet the hind margin. There is an obsolete central longitudinal keel.

The scutellum is elevated and flat or even slightly concave on top, the lateral margins are strongly depressed and the disc is depressed before the apex.

Rostrum and legs (except coxae) concolorous with antennae, reddish or brownish black or black. Thoracic pleurae generally blackish or infuscated with broad ochraceous or reddish borders, sterna ochraceous or reddish. Abdominal sterna and pleurae blackish with upper half of pleurae ochraceous or reddish, last segment wholly reddish or ochraceous. Rostrum reaching to middle of third true (2nd visible) abdominal segment.

The male genital capsule is not very distinct from that of the preceding species and I cannot find characters in the female genitalia to distinguish the two.

The male genital capsule has the penultimate segment produced laterally into prominent pilose lobes which are convex on the ventero-lateral surfaces and noticeably concave and more pilose on the inner

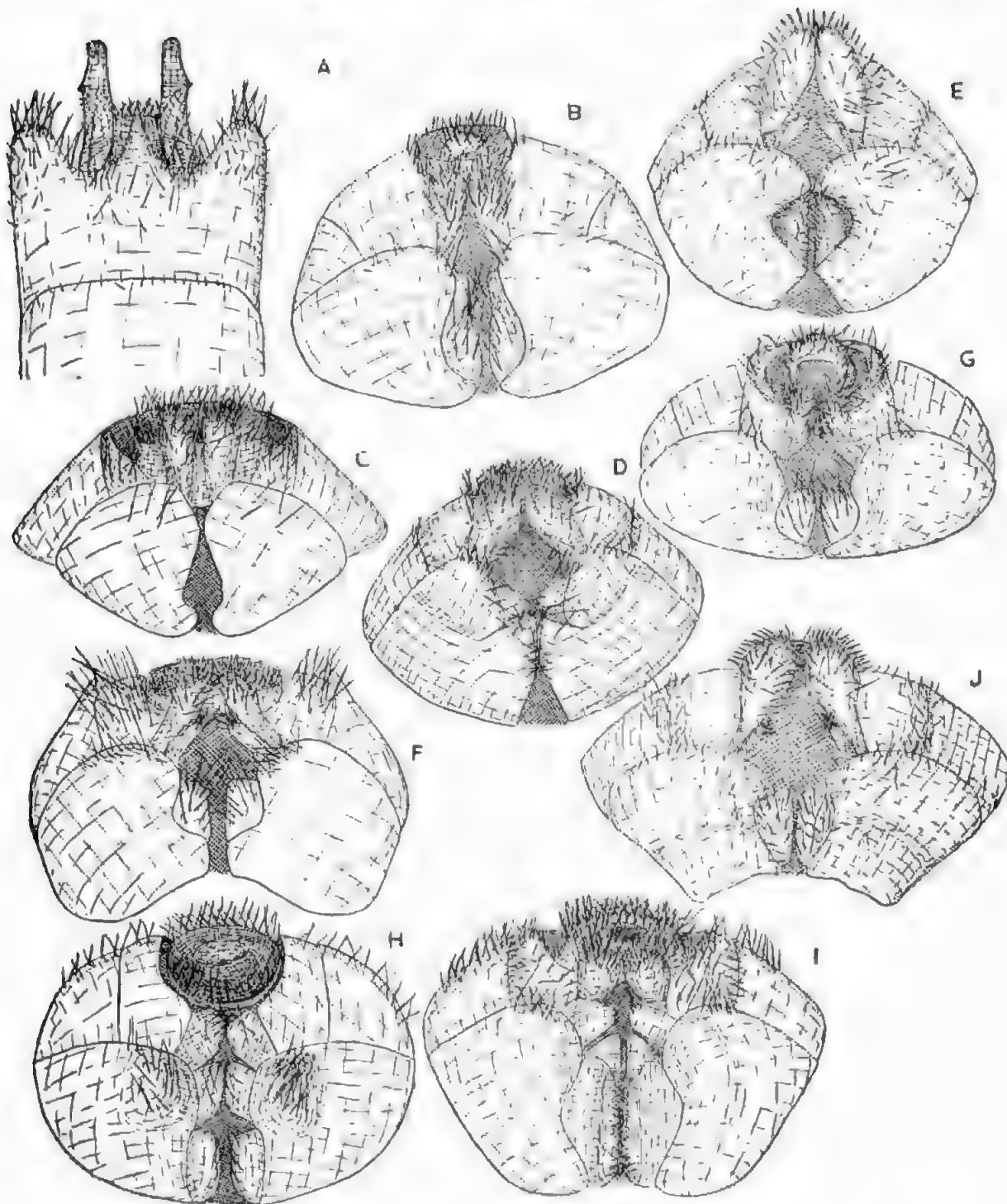


Fig. 4: A *Leptocoris isolata* Distant, male genital capsule from below. B *Leptocoris uigur* (Fab.), female capsule from below. C *Leptocoris novaeuscula* Blöth, female genital capsule from below. D *Leptocoris combatorensis* sp. nov., female genital capsule from below. E *Leptocoris mitellata* Bergroth, female genital capsule from below. F *Leptocoris vicina* (Dallas), female genital capsule from below. G *Leptocoris subrufescens* (Kirby), female genital capsule from below. H *Leptocoris abdominalis* (Fab.), female genital capsule from below. I *Leptocoris rufomarginata* (Fab.), female genital capsule from below. J *Leptocoris tagalica* Burmeister, female genital capsule from below.

dorsal surfaces. Ventrally the penultimate segment is produced between the claspers as a fairly prominent triangular process. The claspers are more robust than those of *tagalica* and are strongly hooked on their underside toward the apex, and somewhat excavated beneath in the middle. They turn somewhat but not markedly ventrad at the apex. The claspers are much longer in relation to the parandria than those of *tagalica* and this is the one definite distinguishing feature between the species. The genital capsule is also paler than *tagalica* and in New Guinea and Louisiade Archipelago specimens the claspers are a bright yellow.

The female capsule is to all intents and purposes the same as that of *tagalica*.

Length: 11-16 mm.

Loc.

New Guinea: Toem, Dutch New Guinea, 10 II, 20 II and 20 IV 1945, coll. B. B. Vogtman, 3 ♂♂. Nadzab, Markham River Valley, VI 1944, coll. K. V. Krombein 1 ♂ (U.S.N.M.). Pt. Moresby, Papua, IX 1949, coll. N. H. L. Krauss, 1 ♀. Normanby Island, Papua, Waikuna, Sewa Bay, 21-31 XII 1956, coll. W. W. Brandt, 1 ♀ (B.P.B.M.).

Louisiane Archipelago: Misima Island, coll. Rev. H. K. Bartlett, 4 ♂♂, 4 ♀♀ (S.A.M.).

Solomon Islands: Guadalcanal, II 1921, coll. J. A. Kuseche, 4 ♂♂ 4 ♀♀ (B.P.B.M.).

Marshall Islands: Kwajalein Atoll; Bwije Island, 30 I 1945, coll. H. S. Wallace, No. 1247, 2 ♂♂, 2 ♀♀. Berlin Island, 30 I 1945, coll. H. S. Wallace, No. 1256, 2 ♂♂, 2 ♀♀. Kwajalein Island, the airfield, 17 VIII 1946, coll. R. G. Oakley, No. 1593, 1 ♀; no precise locality, 22 IV 1948, coll. K. L. Maehler, 6 ♂♂. Namu Atoll; Majkon (Kaginen) Island, 25 X 1953, on *Allophylbus*, coll. J. W. Beardsley, 7 ♂♂, 5 ♀♀ (B.P.B.M.). Jaluit Atoll; Imroj Island, 24 VIII 1946, No. 1851, coll. Townes, 1 ♂. Paratype of *Leptocoris lariversi* Usinger (U.S.N.M.). Majuro Atoll; Uliga Island, 3 XI 1953, on *Allophylbus*, coll. J. W. Beardsley, 5 ♂♂, 1 ♀. Arno Atoll; Ine Island, 30 VII 1950, coll. Ira La River, 1 ♂, 6 ♀♀. No precise locality, 19 VII 1950, coll. Ira La Rivers, most of the specimens also bear the name Earl Stone on a single label, 7 ♂♂, 3 ♀♀, 1 nymph (B.P.B.M.). Ratak Island Chain; no precise locality, coll. A. von Chamisso, 1 ♀ (R.M.). Ratak Island Chain; no other data except one specimen (♂) bears the name *indecorus* Esch. (= Eschscholz ?) which appears to be a *nomen nudum* as I cannot trace its publication, 2 ♂♂ (Zool. Inst., Halle).

***Leptocoris marquesensis* Cheesman 1926**

Leptocoris marquesensis Cheesman, 1926: Ann. Mag. nat. Hist., (9) 18: 368, figs. 1927: Trans. ent. Soc. Lond., 156.

I have not seen this species. From the original description it is fairly close to *isolata* Distant, but differs in that the claspers have a dorso-lateral tubercle on the outer sides. This point has been checked for me by Mr. Izzard. The female is unknown.

Deep red, ocelli bright red; tylus, vertex, calli of pronotum, basal two thirds of disc of pronotum, hemelytra (except basal half of costal margin) suffused with black and showing a dark purplish colour. Antennae, rostrum, legs (except the red coxae and trochanters) and hemelytral membrane black. Vertex with second to fifth segments obscurely suffused with black.

Tylus arched, vertex strongly sculptured. Rostrum reaches beyond middle of third abdominal segment. Disc of pronotum densely but finely rugosely punctate, calli transverse. Pronotal collar with anterior margin lightly reflexed and sides tuberculate; disc slightly rounded at the base. Hemelytra exceeding abdomen by one fifth of their length.

Length: 12 mm.

Loc.

Marquesas Islands (Fatu-hiva).

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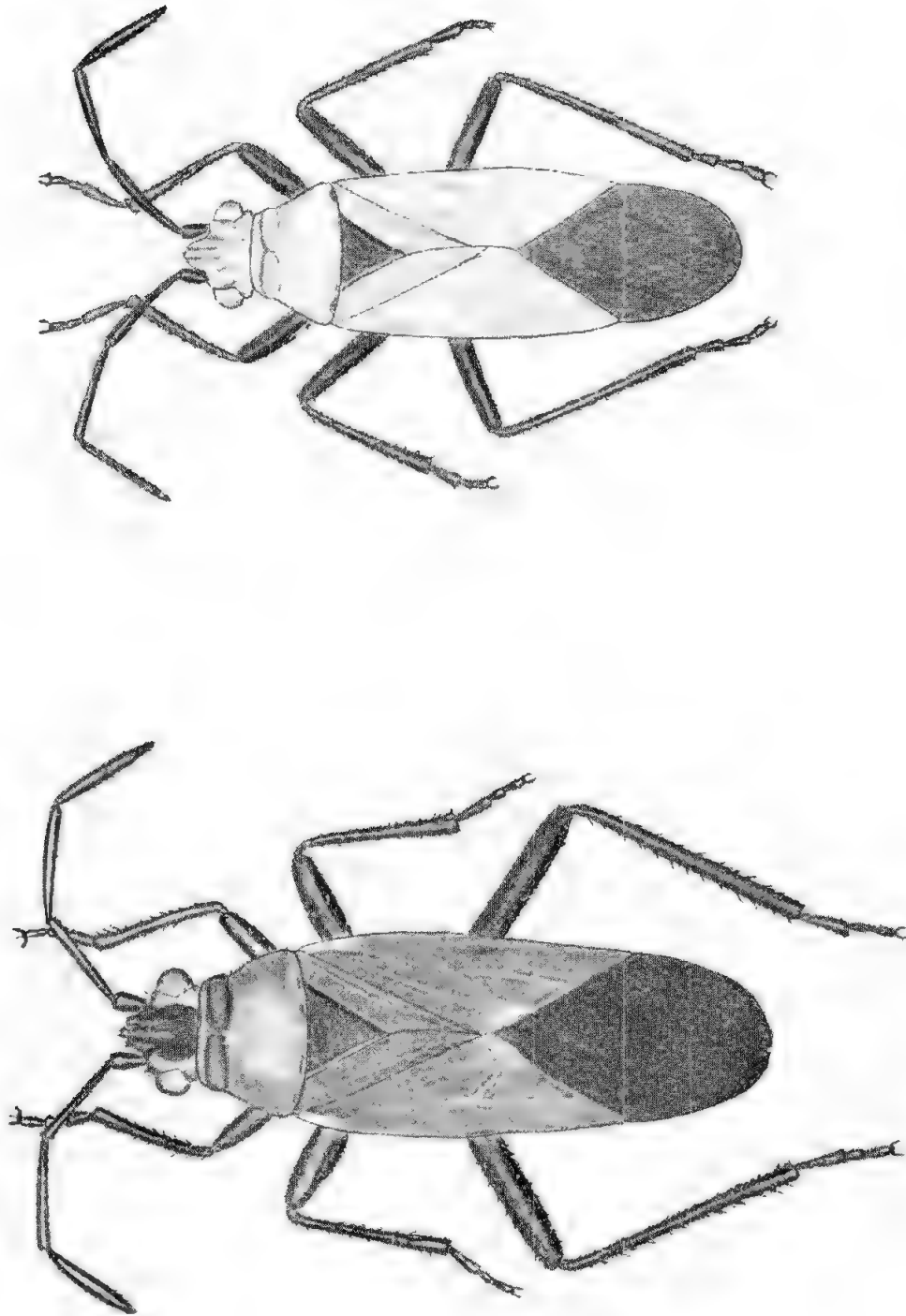
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Left, *Leptocoris mitellatus* Bergroth. Right, *Leptocoris lapidica* Burmeister, small pale "vulgaris" form from Central Australia.

**THE GENUS BLAENA WALKER (=MACRYMENUS SIGNORET)
WITH THE DESCRIPTION OF FOUR NEW SPECIES AND
A KEY TO THE KNOWN FORMS (HEMIPTERA: CYDNIDAE)**

BY RICHARD C. FROESCHNER

Summary

In 1868 Walker described as new the genus *Blaena* with the inclusion of a single species, *setosa*, from an unknown locality. In 1880 Signoret described *Macrymenus membranaceus* as a new genus and species from Australia. Distant, in 1899, pointed out the synonymy of the two names and reduced Signoret's scientific name to synonymy – *Blaena* taking precedence over *Macrymenus* by virtue of both being based on the same species and Walker's generic name having twelve years priority. This treatment is here confirmed.

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Plates xlix-l, fig. 1-13

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The present paper is based on specimens from two sources: from the South Australian Museum, made available through the kindness of The Museum Board and Dr. E. T. Giles; and from the Museum of Comparative Zoology, Harvard University, loaned by Drs. J. Bequaert and P. J. Darlington. To the curators of these institutions the author is grateful. He also wishes to thank Dr. W. L. Brown, of the Museum of Comparative Zoology, for aid in locating certain Australian localities as they appeared on specimens. The illustrations are by my wife, Elsie Herbold Froeschner.

The format used in this paper follows that of the author in his Monograph of the Cydnidae of the Western Hemisphere which is now in press. Measurements are given in millimeters and are based on one to five specimens of each sex. If less than five were used the number is indicated.

(1) Dept. Zoology and Entomology, Montana State College, Bozeman, Montana, U.S.A. Contribution from Montana State College Agricultural Experiment Station, M.S. 38, paper No. 432 Journal Series.

(2) After this paper had been submitted for publication a grant from the National Science Foundation (NSF G7118) made possible personal examination of the types concerned. As above, the results supported Distant's contentions and not Bergroth's (1912, Amer. Mus. Nat. Hist., Bull. 31: 343-348) belief that they were separate species.

Genus *Blaena* Walker

1868 *Blaena* Walker, Catal. Hemip.-Heterop. Brit. Mus., part 3, p. 537.

1880 *Macrymenus* Signoret, Bull. Soc. Ent. France, ser. 5, vol. 10, p. xviii.

1899 *Blaena* Distant, Ann. Mag. Nat. Hist., ser. 7, vol. 4, p. 224.

Diagnosis: The short corium, which occupies less than half (about two-fifths) of the hemelytral length, plus the obliquely stylated eyes will separate members of this genus from any other Cydnidae.

Description: Medium sized, elongate, sides subparallel; dorsum flattened to weakly convex. *Head*: Little wider than long, dorsally flat to weakly convex with coarse, crowded punctures; lateral margins diverging from preocular emarginations; juga meeting anterior to clypeus, distinctly though narrowly reflexed marginally, apex rounded, truncate or slightly produced; dorsally with several scattered or many long bristles in addition to primary bristles; eyes small, higher than long, prominent, oblique, moderately stylated; ocelli very small, placed far behind line connecting hind margins of eyes, much closer to eyes than to midline of head; antennae five segmented, I and II shorter than III, IV and V usually longer than latter and variable in relation to each other; bucculae much higher than labial II, equally elevated for full length, abruptly terminated posteriorly at base of head; labium surpassing anterior coxae, sometimes reaching to bases of midcoxae, I shortest, II and III each longer than IV, II compressed but not dilated. *Pronotum*: Length more than half of width; lateral margins usually entire, narrowing from near base, sinuate or not at ends of transverse impression; dorsal surface of both lobes coarsely and closely punctate nearly or quite to lateral edge; anterior margin strongly concave; lateral submargin with a row of two, six or more setigerous punctures, only one or two posterior to transverse impression; disc usually with several to many scattered long hairs. *Scutellum*: Width distinctly greater than length, subtriangular, apex a broad, rounded, obtuse angle; disc, except for oblique areas in basal angles, strongly and closely punctate. *Hemelytra*: Corial areas well-defined, membranous suture oblique, strongly and angularly emarginate at end of radial vein; costa sharp, weakly explanate, strongly incurved apically so as to expose densely punctate connexivum, submarginally without or with five or fifteen setigerous punctures; membrane about twice as long as basal width, nearly two-thirds of hemelytral length, dusky, usually paler at base; veins darker, simple with few branches or mostly reticulate. *Propleuron*: Shining, densely and strongly

punctate; prosternal carinae either low and indistinct or thick and high enclosing a labial trough deeper than height of labial II; anterior margin nearly straight, slightly emarginate between prosternal carinae. *Mesopleuron*: (fig. 6) Nearly flat, closely and distinctly punctate, including evaporatorium which follows posterior margin to lateral margin of sclerite; posterior margin entire; medioventral line strongly carinate. *Metapleuron*: (fig. 6) Nearly flat, evaporatorium extensive, but not reaching lateral margin, punctate; osteole opening prominently and ventrally at base of elongate (length four to five times width), partially sulcate, polished and elevated peritreme. *Legs*: Moderately long; anterior tibia (fig. 10) subterete to somewhat widened toward apex, not prolonged beyond tarsal insertion, with six to eight distinct to strong spines dorsally; tarsal II shortest; middle and posterior tibiae terete, latter in male simple or variously contorted, spined and haired according to species; middle and posterior femora variously armed ventrally according to species. *Sternites*: Convex, with numerous prominent punctures, with or without setigerous tubercles; sometimes with a strong channel within lateral margins (fig. 9); trichobothria typical of the subfamily Cydninae. *Terminalia*: Male genital capsule opening dorsally or subdorsally; gonostyli uniformly of one type in all species (fig. 8); female genital plates of type usually found in pentatomoids.

Genotype: *Blaena setosa* Walker, monobasic. The genotype of *Macrymenus* is *M. membranaceus* Signoret by virtue of the monobasic original proposal of the genus. The present study confirms this synonymy which was first pointed out by Distant in 1899 (Supra).

Distribution: The range of this genus, from the more than fifty specimens at hand, appears restricted to the continent of Australia.

Discussion: Members of this genus appear especially noteworthy due to the stylated eyes and the strongly modified hind legs of the males of some species. The relatively simple anterior tibiae coupled with such strongly contorted hind tibiae would suggest that these forms are not adapted to a burrowing habit. However, three of the specimens examined were labelled from "soil at base of talus", "under dead [?] log". Observations on habits are needed.

The genus, as determined during the present study, may easily be assigned to the subfamily Cydninae as redefined by Froeschner (in press) since it possesses the necessary trichobothrial arrangement, primary setigerous punctures on head and pronotum, venation of hind wing and other features. The exposed abdominal sternites in this as

in other Cydnidae are actually segments III to VII, with I and II reduced and hidden under the posterior lamellar expansion of the metapleuron and VIII being telescoped into VII. This interpretation is used in the descriptions in the present paper.

Considering the obvious clues to specific distinctions which are furnished by the modifications of the hind tibiae of the males as well as sculpturing and vestiture it is surprising that not more than one species was described under each of the proposed generic names. In this paper five species are considered. They may be separated by the following key designed to work with both sexes:—

KEY TO THE SPECIES OF *BLAENA* WALKER

1. Lateral pronotal margins strongly and broadly constricted between lobes (fig. 4) *coarctata* sp. nov.
 Lateral margins straight or faintly sinuate between lobes 2
2. Prosternal carinae high, forming sides of a labial trough as deep as height of labial II; abdominal sternites without or with only a vague sublateral groove 3
 Prosternal carinae vague, only faintly elevated; abdominal sternites sublaterally with a distinct, broad, deep groove (fig. 9), the punctures within it much finer than those not in groove *setosa* Walker
3. Median line of pronotum and scutellum with a prominent, calloused carina; transverse impression of pronotum deep, abruptly interrupted sublaterally (fig. 5) *mediocarinata* sp. nov.
 Median line of pronotum not or only vaguely carinate; transverse pronotal impression neither deep nor interrupted sublaterally 4

4. Scutellum weakly and broadly sulcate on midline of basal half; connexivum with a single, subapical setigerous puncture marginally on each segment *subsulcata* sp. nov.

Scutellum not sulcate on median line; connexivum with three or more setigerous punctures marginally on each segment *multitricha* sp. nov.

***Blaena coarctata* sp. nov.**

Fig. 4, 7, 12

Diagnosis: The strong, wide emargination of the lateral margin of the pronotum opposite the ends of the transverse impression (fig. 4) marks both sexes of this species as distinct from others in the genus. The strongly hooked apex of the hind tibia is also uniquely distinctive of the male.

Description: Male: Parallel-sided, slender for the genus. *Head:* length little more than three-fourths width, 0.93 (0.85-1.04); 0.98 (0.93-1.04); interocular width, 0.60 (0.58-0.63); anterior outline parallel in front of eyes, rounded at apex; jugum mostly flat, slightly elevated marginally, with few long hairs submarginally and discally; clypeus weakly convex, strongly and closely punctured; antennals, I, 0.26 (0.24-0.29): II, 0.37 (0.31-0.43): III, 0.57 (0.53-0.66): IV, 0.79 (0.75-0.83): V (only one specimen with this segment), 0.88; labium reaching bases of middle coxae, segments, I, 0.27 (0.24-0.29): II, 0.55 (0.54-0.56): III, 0.57 (0.55-0.60): IV, 0.42 (0.41-0.43). *Pronotum:* Length more than half width, 1.30 (1.25-1.43): 2.07 (1.90-2.32); discally with scattered hairs; side margins slightly expanded, broadly rounded on anterior half, and broadly emarginate opposite ends of transverse impression (fig. 4), with a submargin row of seven setigerous punctures; hind margin broadly sinuate medially. *Scutellum:* Distinctly broader than long, 1.23 (1.17-1.36): 1.17 (1.10-1.30); somewhat convex, median line usually vaguely carinate. *Hemelytron:* Punctures of costal area weaker and less distinct than those of clavus and disc; costal margins without setigerous punctures but with scattered hairs similar to those of disc; membrane reaching middle of last tergite, leaving genital capsule exposed, veins straight and simple. *Connexivum:* Segments IV, V, VI and VII each with a strong, subapical setigerous puncture on margin. *Propleuron:* Densely and coarsely punctate except in lateral

submarginal line; prosternal carinae very low and indistinct; mid-ventral line sharply carinate. *Meso- and Metapleura*: Virtually as in fig. 6. *Legs*: Anterior tibiae subterete, slightly expanded on apical third; anterior femur with a few low setigerous tubercles ventrally; middle femur with numerous small setigerous tubercles ventrally; posterior femur with low blunt tubercles on anteroventral margin and several more-prominent, acute tubercles on posteroventral margin; hind tibia as in fig. 12, slender, concavely curved on basal four-fifths, abruptly decurved at apical fifth armed ventrally from base to subapical bend with a series of tubercles increasing in length until they form stout spines. *Sternites*: Densely and uniformly punctate across full width except for a narrow strip laterally on III, IV and V; surface with numerous minute, inconspicuous setigerous tubercles; posterior margin finely denticulate. *Terminalia*: Genital capsule a little finer and more densely punctate than sternites; posterior margin deeply emarginate, with a prominent bluntly triangular projection medially (fig. 7); gonostylus similar to fig. 8. Length of body, 5.46 (5.10-5.85).

Female (based on three specimens): Similar to males but hind legs not modified as there. *Head*: Length: width:: 0.90 (0.85-0.93): 0.97 (0.96-1.00); interocular width: 0.59 (0.58-0.60); antennals, I, 0.26 (0.26-0.27): II, 0.31 ((0.31-0.32): III, 0.54 (0.53-0.55): IV, 0.75 (0.72-0.79): V, 0.82 (0.80-0.84); labials, I, 0.32 (0.30-0.36): II, 0.50 (0.50-0.51): III, 0.51 (0.50-0.53): IV, 0.42 (0.41-0.43). *Pronotum*: Length: width:: 1.25 (1.20-1.35): 2.05 (2.03-2.06). *Scutellum*: Length: width:: 1.15 (1.11-1.18): 1.17 (1.16-1.20). Length of body, 5.13 (5.08-5.17).

Type Data: Holotype male and allotype female, both in the collection of the South Australian Museum, are labelled "Woodforde Cr., Andamooka Rgs., 31, Aug. 1948, G. F. Gross". Paratypes: same data as types, two males (SAMus, RCF); "Mulwala, N.S.W., 1-16-53, F. E. Wilson", one female; "Ultima [Victoria], 8-1915", two males and one female (SAMus).

Distribution: So far this species is known only from the southeastern part of Australia as indicated by the data above.

Discussion: This is the most slender and shining of the species of the genus. The distinctly emarginate lateral pronotal margins suggested the specific name.

***Blaena mediocarinata* sp. nov.**

Fig. 5

Diagnosis: The distinctly carinate midline of the pronotum coupled with the abrupt and very deep triangular impression on either side of the scutellum will separate this species from others in the genus, even from *subsulcata* with which the male of this agrees in having the straight, simple, hind tibia.

Description: (Based on a single male.) *Male*: Elongate oval, sides parallel. *Head*: Shorter than wide, 0.84: 1.10; interocular width, 0.73; anterior outline parallel in front of eyes, flatly rounded apically; jugum convex above, forming a ridge paralleling elevated, punctate clypeus, lateral margins broadly recurved, submargin with a single setigerous puncture in addition to the preocular one; antennals, I, 0.23: II, 0.14: III, 0.56: IV, 0.53: V, 0.68; labium reaching between bases of middle coxae, segments, I, 0.33: II, 0.54: III, 0.53: IV, 0.44. *Pronotum*: Length more than half width, 1.43: 2.40; lateral margin distinctly explanate with a single setigerous puncture on anterior lobe and one on the strong prebasal angular projection; transverse impression deep, abruptly interrupted by carinate midline and again half way to lateral margins; punctures of anterior lobe rounded, of posterior lobe (except umbones) with elongate, crowded punctures making surface appear rugose; anterior lobe with a transverse row of four setigerous punctures in front of transverse impression; posterior margin weakly bilobed. *Scutellum*: Width greater than length, 1.47: 1.10; median line in part prominently carinate; decidedly elevated basal third coupled with deep lateral impressions causing apical two-thirds to appear abruptly depressed; punctures sparser on apical part. *Hemelytron*: Distinctly punctate to costal margin, with no setigerous punctures; membrane with a whitish spot basally at outer and inner angles; venation irregularly branched, more distinctly so marginally. *Connexivum*: Segments V, VI and VII each with a single subapical setigerous puncture on margin. *Propleuron*: Coarsely and closely punctate except in lateral submarginal line; prosternal carinae thick and very much elevated, enclosing a labial groove deeper than height of labial II. *Meso and Metapleura*: Virtually as in fig. 6. *Legs*: Anterior tibia terete, weakly expanding toward apex; hind femur and tibia simple, not specially modified. *Sternites*: Not impressed laterally; punctation laterally dense and coarse, absent from broad lateral band on V and VI, very widely scattered and much finer on broad medioventral area; without setigerous tubercles. *Terminalia*: Genital

capsule punctate to rugo-punctate, hind margin weakly concave, with no medioapical prominence; gonostylus similar to fig. 8. Length of body, 4.7 mm.

Female: Unknown.

Type Data: Holotype male, "Margaret River, S. W. A., No. 5, Harvard Austr. Exp., P. J. Darlington", in Museum of Comparative Zoology at Harvard University.

Distribution: The species is known only from the type locality in the southwestern corner of Australia in the State of Western Australia.

Discussion: As usual, there is considerable risk in describing a new species from a single specimen, but if that specimen contains more than one superficial difference from its nearest relatives such risk is greatly reduced. Here characters of the antenna (II much shorter than I, 14:23), pronotum (carinate median line, lateral sub-basal angle bearing a single setigerous puncture, transverse impression deep, punctation of posterior lobe greatly elongate), and scutellum (transverse, elevated basal third, very deep triangular impressions laterally, broad low median carina, two arrangements of punctures), are all unique with this species and any one of them will separate it from the others in the genus. In a group as poorly known as the Cydnidae there is more advantage to calling such a form to the attention of other workers than there is in burying it among the unplaced specimens in one's collection.

***Blaena multiricha* sp. nov.**

Fig. 13

Diagnosis: As the species name suggests, one of the outstanding features is the abundance of long hairs on dorsal (except membrane) and ventral surfaces and legs. The hind leg of the male has the ventral femoral armature including several large teeth on apical half and the tibia distinctly bisinuate (fig. 13).

Description: *Male* (one specimen): Elongate oval, sides subparallel. *Head*: Length: width:: 0.98:1.13; interocular width 0.70; surface with numerous long hairs; anterior outline subparallel in front of eyes, broadly rounded apically; juga flat with lateral margins slightly raised; clypeus subconvex, punctate; antennals, I, 0.23: II, 0.30: III, 0.50: IV, 0.66; labium surpassing front coxae but not reaching middle ones, segments, I, 0.36: II, 0.53: III, 0.54: IV, 0.38. *Pronotum*: Length more than half width, 1.36: 2.60; discally with many long hairs, these

more abundant anteriorly and laterally where they completely confuse the submarginal row of setigerous punctures; lateral margin entire, straight at ends of nearly obsolete transverse impression; punctation on posterior lobe weakly elongate; posterior margin broadly and very weakly emarginate. *Scutellum*: Length: width:: 1.30: 1.49; discally with numerous scattered long hairs. *Hemelytron*: Clavus and corium with numerous long easily abraded hairs, costally these much longer and about six to fifteen in number; membrane reaching onto genital capsule, venation moderately distinct, reticulate. *Connexivum*: Margin of each segment with several strong setigerous punctures making the edge appear denticulate. *Propleuron*: Densely and coarsely punctate except in lateral submarginal line; prosternal carinae thick, high, enclosing a labial groove about as deep as height of labial II. *Meso- and Metapleura*: Virtually as in fig. 6, metapleural evaporatorium a little less expanded. *Legs*: All with several to numerous long hairs, of which many are as long as or longer than the spines; anterior tibia not markedly widened; posterior femur with three or four (variable on two femora of lone specimen) long, strong teeth (fig. 13); posterior tibia bowed, thickened medially and apically and with tubercles and hairs as illustrated (fig. 13). *Sternites*: Punctation coarse and dense except for impunctate lateral margin of IV and antero-lateral angle of V; without setigerous tubercles but with numerous short, erect or nearly erect hairs; hind margins finely denticulate, with a small but strong spine near ends. *Terminalia*: Genital capsule coarsely and closely punctate, apical margin with broad, median emargination which is convex medially; gonostylus similar to fig. 8.

Female (two specimens): Similar to male except that it usually has more hairs, posterior legs are not modified as there, sternites IV and V punctate to margin, and sublateral spine on posterior margin of sternites less distinct or absent. *Head*: Length: width:: 0.97 (0.88-1.06): 1.16 (1.12-1.20); interocular width, 0.70 (0.70-0.70); antennals, I, 0.25 (0.25-0.26): II, 0.33 (0.33-0.34): III, 0.50 (0.50-0.51): IV, 0.68 (0.66-0.71): V, 0.65 (missing on one); labials, I, 0.37 (0.33-0.41): II, 0.51 (0.50-0.53): III, 0.39 (0.37-0.41). *Pronotum*: Length: width:: 1.43 (1.30-1.56): 2.62 (2.47-2.77). *Scutellum*: Length: width:: 1.47: 1.69 (other damaged). Length of body, 5.48 (5.12-5.84).

Type Data: Holotype male and allotype female, both in collection of the South Australian Museum, are labelled "Cunnamulla, Q., II. Hardecastle", the allotype having been damaged by dermestids. *Paratypes*: Woodforde Ck., Andamooka Rgs., South Australia, 1, Sept., 1948. G. F. Gross, two females (SAMns, RCF).

Distribution: To date this species is known only from South Australia and Queensland in Australia.

Discussion: The species name was suggested by the abundant long hairs on the dorsal (except membrane) and ventral surfaces as well as on all legs.

***Blaena setosa* Walker**

Fig. 1, 2, 3, 6, 8, 9, 10, 11

1868 *Blaena setosa* Walker, Cat. Hemip. Brit. Mus., 3: 537.

1880 *Macrymenus membranaceus* Signoret, Ann. Soc. Ent. France, 1880: xviii.

Diagnosis: The virtual absence of prosternal carinae coupled with the lack of an emargination in the lateral margins of the pronotum easily separate this species from others in the genus. The male may be readily recognized by the strong curvature of the basal two-thirds of the hind tibiae (fig. 11).

Description: Male (fig. 1): Elongate oval, parallel-sided. *Head:* Length: more than four-fifths width, 1.10 (1.07-1.14): 1.26 (1.23-1.28); interocular width, 0.78 (0.76-0.80); anterior outline diverging from preocular emargination, rounded at apex; jugum flat, margins narrowly reflexed, mesoapical angles produced, submarginally with two setigerous punctures anterior to preocular one; clypeus convex, punctate; antennals, I, 0.26 (0.24-0.28): II, 0.41 (0.37-0.43): III, 0.51 (0.50-0.54): IV, 0.65 (0.64-0.66): V, 0.62 (0.60-0.66); labium surpassing front coxae but not reaching base of middle coxae, segment, I, 0.30 (0.30-0.31): II, 0.53 (0.53-0.54): III, 0.51 (0.48-0.53): IV, 0.40 (0.38-0.43). *Pronotum:* Length about half of width, 1.54 (1.49-1.59): 3.00 (2.86-3.09); lateral margins not emarginate; lateral submargin with a row of a dozen setigerous punctures; anterior lobe with numerous scattered long hairs; posterior lobe with a transverse row of similar vestiture; hind margin broadly and shallowly concave medially. *Scutellum:* Length less than width, 1.49 (1.49-1.51): 1.71 (1.69-1.75); median line weakly or obsoletely carinate. *Hemelytron:* Punctures of costal area weaker and finer than on rest of corium; subcostal row of five setigerous punctures; membrane reaching onto genital capsule, veins simple or furcate, sometimes with a few closed cells. *Connexivum:* Lateral margins of each segment with three or four prominent setigerous punctures. *Propleuron:* Coarsely punctate; prosternal carinae absent; medioventral line distinctly carinate. *Meso- and Metapleurae:* As in fig. 6. *Legs:*

Anterior femur with setigerous punctures ventrally; anterior tibia (fig. 10) weakly expanding; middle femur with setigerous punctures and with one or two movable spines apically on both ventral margins and two or three stout spines medioventrally on basal half; posterior femur (fig. 11) ventrally with five stout spines, the median one distinctly stouter and longer; posterior tibia (fig. 11) with basal two-thirds strongly bowed outward, apical third straight, ventral margin of basal two-thirds with a double row of strong tubercles which become finer toward distal end of curvature and numerous long hairs which become sparser toward base; distal end of curvature marked by a strong, triangular tooth directed basad. *Abdomen*: Sublaterally with a strong, continuous trough reaching from base to base of genital capsule (fig. 9), punctures in this furrow much finer than elsewhere on sternites; sternites ventrad of furrow with scattered coarse punctures interspersed with numerous setigerous tubercles, these more abundant along moderate median band. *Terminalia*: Genital capsule coarsely and closely punctate, apical margin slightly concave and without median prominence; gonostylus as illustrated (fig. 8). Length of body, 6.46 (6.21-6.77).

Female: Mostly similar to male but with unmodified hind legs and no setigerous tubercles on abdominal sternites. *Head*: Length: 1.02 (1.01-1.03): 1.18 (1.15-1.24); interocular width, 0.75 (0.73-0.80); antennals, I, 0.24 (0.23-0.26): II, 0.35 (0.31-0.40): III, 0.43 (0.41-0.47): IV, 0.55 (0.53-0.61): V, 0.55 (0.53-0.58); labials, I, 0.29 (0.28-0.31): II, 0.45 (0.42-0.50): III, 0.49 (0.46-0.53): IV, 0.41 (0.40-0.44). *Pronotum*: Length: width:: 1.53 (1.40-1.69): 2.69 (2.55-2.94). *Scutellum*: Length: width:: 1.37 (1.31-1.55): 1.52 (1.43-1.69). Length of body, 5.80 (5.28-6.23).

Type Data: Walker's type of *Blaena setosa* was described from a female whose place of origin was indicated by a question mark as being unknown; it is now in the British Museum of Natural History. Signoret's types "proviert del'Australie", and are in the Signoret collection in the Naturhistorisches Museum in Vienna. The male now labelled type is hereby designated the lectotype and the associated female lectoallotype.

Distribution: The more than thirty specimens examined had all been taken on the continent of Australia from the States of Western Australia, South Australia, Queensland and Victoria.

Discussion: Since this species is the genotype its accurate fixation was imperative. Notes and sketches kindly furnished by Dr. W. E.

China of the British Museum and Dr. Max Beier of the Naturhistorisches Museum confirmed without doubt Distant's earlier report that Walker's and Signoret's generic and species names were based on the same species.

A comparison of the full-figure illustration in the present paper and Signoret's habitus and head drawings on plate 15, fig. 204 in his "Revision" (Ann. Soc. ent. France, ser. 6, vol. 3) reveals that his figures are erroneous in several features including the generically important stylated eyes and the uniquely modified hind legs of the male.

Notes on three specimens from Victoria indicated that they had been taken "in soil" and "under dead logs". Collection records were for the months of September, October, December and January.

Specimens Examined: 18 males, 11 females. *Australia*: Queensland: Bluff, 1 male (SAMus). South Australia: Lake Eyre, Dec. 1951, G. F. Gross, one female (SAMus); Mt. Remarkable, Oct. 1925, F. E. Wilson, one male (SAMus); Pt. Lincoln, one male (SAMus); Woodforde Ck., Andamooka Rgs., 1, Sept., 1948, G. F. Gross, eight males, three females (SAMus, RCF). Victoria: Carumley, 13 Jan., 1887, Tepper, one male, two females (SAMus). Western Australia: Beverley, E. F. Boulay, two males, three females (SAMus); Geraldton, Oct. 11, P. J. Darlington, four males, one female (MCZ); Mullewa, W. D. Dodd, one male, one female (SAMus).

***Blaena subsulcata* sp. nov.**

Diagnosis: The broad, shallowly sulcate median line of the scutellum gives a ready means for separating this species from the others in the genus. The males of this and *mediocarinatus* are the only ones within the genus with straight, unmodified hind tibiae.

Description: *Male* (one specimen): Elongate oval, sides subparallel. *Head*: Slightly wider than long, 1.16:1.10; interocular width 0.74; anterior outline weakly diverging from preocular emargination, broadly rounded at apex and with mesoapical angles usually slightly produced; juga convex, forming a strong but irregular ridge either side of prominent, punctate elypons, lateral margin distinctly reflexed, with submarginal preapical setigerous puncture in addition to preocular one; antennals, I, 0.23: II, 0.23: III, 0.64, IV, 0.76: V, 0.76; labium reaching bases of middle coxae, segments, I, 0.33: II, 0.53: III, 0.73: IV, 0.43. *Pronotum*: Length more than half width, 1.51: 2.70; lateral margins weakly explanate, virtually straight opposite ends of transverse impression, with submarginal row of five or six setigerous

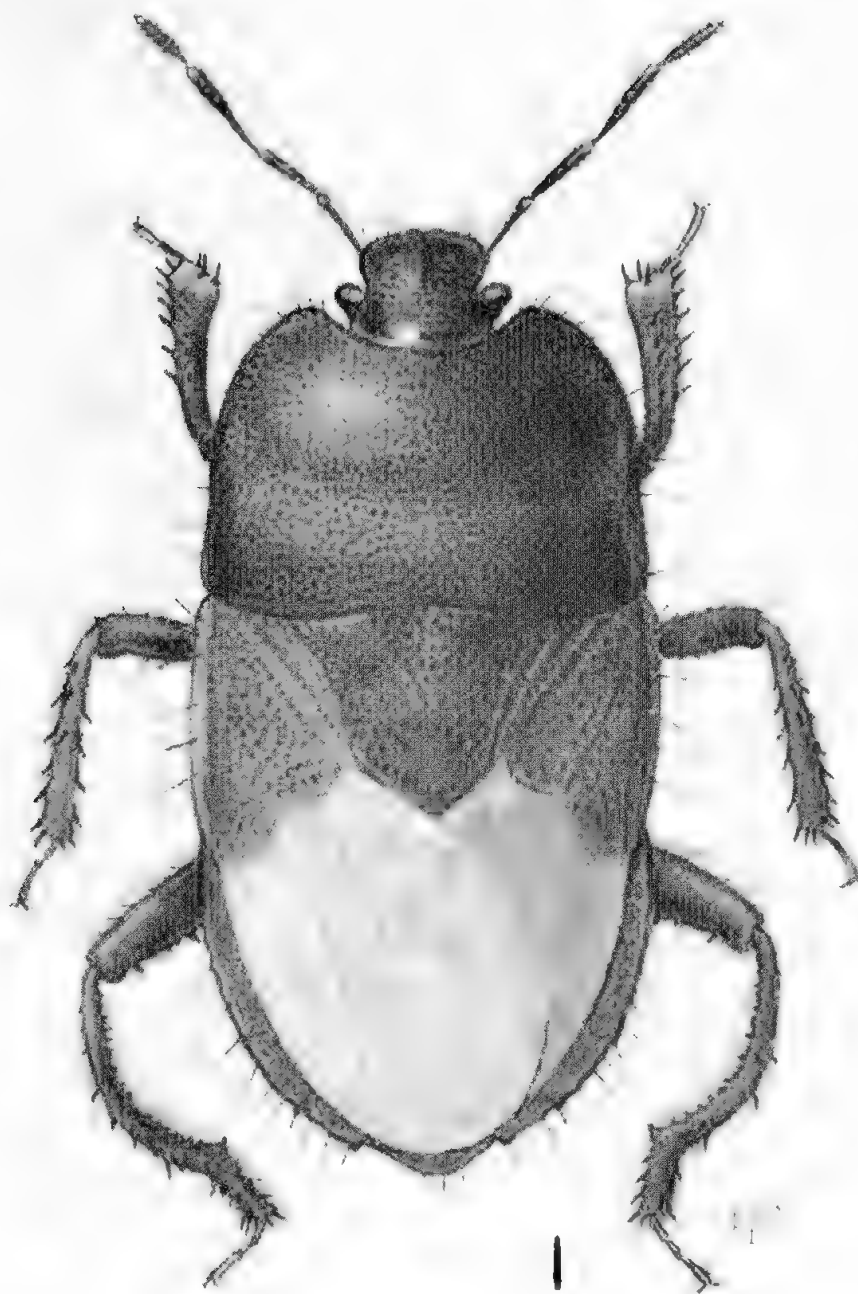


Fig. 1. *Blaesius setosus*, general habitus, dorsal view.

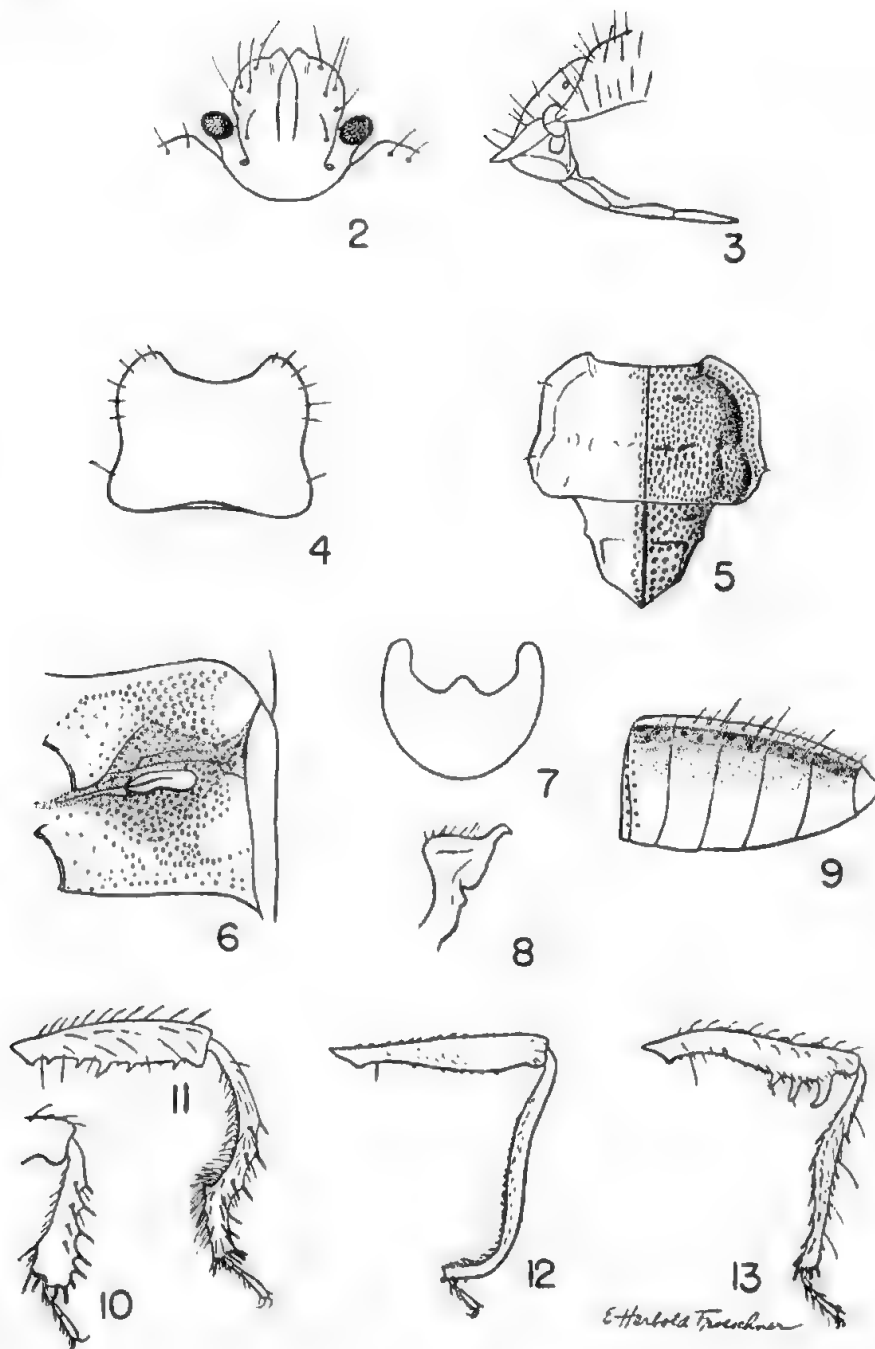


Fig. 2. *Blaena setosa*, head in dorsal view, X 14. Fig. 3. *Blaena setosa*, head in lateral view, X 14. Fig. 4. *Blaena coarctata*, pronotum in dorsal view, X 10. Fig. 5. *Blaena medicarinata*, pronotum and scutellum in dorsal view, X 10. Fig. 6. *Blaena setosa*, meso- and metapleura in ventral view, X 10. Fig. 7. *Blaena coarctata*, male genital capsule in posterior view, X 25. Fig. 8. *Blaena setosa*, gonostylus in mesal view, X 32. Fig. 9. *Blaena setosa*, abdomen in lateral view, X 8. Fig. 10. *Blaena setosa*, anterior leg in anterior view, X 10. Fig. 11. *Blaena setosa*, posterior leg in anterior view, X 10. Fig. 12. *Blaena coarctata*, posterior leg in anterior view, X 12. Fig. 13. *Blaena multitricha*, posterior leg in anterior view, X 12.

punctures, including a single one on posterior lobe; anterior lobe obsoletely elevated laterally, with a transverse row of four setigerous punctures just anterior to transverse impression; hind margin almost straight. *Scutellum*: Length equal to width, 1.38: 1.38; disc somewhat convex with midline broadly but weakly sulcate from base to past middle. *Hemelytron*: Costal area explanate, broadly and weakly recurved, without setigerous punctures; membrane reaching on to base of genital capsule, venation strongly reticulate. *Connexivum*: Segments V, VI and VII only each with subapical setigerous punctures on margins. *Propleuron*: Densely and coarsely punctate except in lateral submarginal line; prosternal carinae thick and very prominent, enclosing a labial groove deeper than height of labial II; midventral line not carinate. *Meso- and Metapleura*: Virtually as in fig. 6. *Legs*: Anterior tibia subterete; posterior femur and tibia unmodified. *Sternites*: Weakly impressed sublaterally; punctation just mesad of spiracular row most dense and deepest, becoming weaker and sparser laterally and toward midline; IV with a broad, marginal, impunctate line laterally; without setigerous tubercles. *Terminalia*: Genital capsule more densely punctate than sternites, apical margin flared, entire; gonostylus similar to fig. 8. Length of body 5.87.

Female (three specimens): Generally similar to male but lacking impunctate lateral margin on sternite IV. *Head*: Length less than width, 1.07 (1.02-1.16): 1.22 (1.20-1.26); interocular width, 0.80 (0.77-0.83); antennals, I, 0.25 (0.24-0.29): II, 0.26 (0.24-0.28): III, 0.62 (0.61-0.66): IV, 0.73 (0.71-0.76): V, 0.79 (0.75-0.86); labials, I, 0.35 (0.31-0.39): II, 0.61 (0.58-0.64): III, 0.69 (0.64-0.73): IV, 0.44 (0.43-0.46). *Pronotum*: Length: width:: 1.57 (1.49-1.62): 2.87 (2.79-2.93). *Scutellum*: Length: width:: 1.44 (1.43-1.48): 1.58 (1.51-1.71). Length of body, 6.05 (6.00-6.14).

Type Data: Holotype male and allotype female are labelled "Coen, C.[ape] York, VII-6 '32, Q.[ueensland], Australia, Harvard Exp., Darlington" and are in the collection of the Museum of Comparative Zoology at Harvard University. *Paratypes*: Four females with same data as types (MCZ, RCF).

Distribution: The type series comes from the large peninsula at the northeast corner of Australia; this is the only known locality of occurrence.

Discussion: The unmodified hind leg of the male is noteworthy in that it occurs on only one other species in the genus, *mediocarinatus*.

CAVE PAINTINGS IN THE MOUNT LOFTY RANGES, SOUTH AUSTRALIA

*BY CHARLES P. MOUNTFORD, (DIP, ANTHRO., CANTAB.),
HONORARY ASSOCIATE IN ETHNOLOGY, SOUTH AUSTRALIAN MUSEUM*

Summary

During this century, a number of examples of aboriginal cave paintings, all of which are in shallow caves or rock shelters, have been found in the Mount Lofty Ranges of South Australia. Stirling (1902, pp. 205-211), illustrated a few of the aboriginal paintings which he had found in a cave on the banks of the South Para River, near Gawler. Tindale and Sheard (1927, pp. 14-17), later revisited this cave, publishing a complete record of the designs at the site as well as others they had found in some smaller shelters further downstream.

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Plate li and text fig. 1-2

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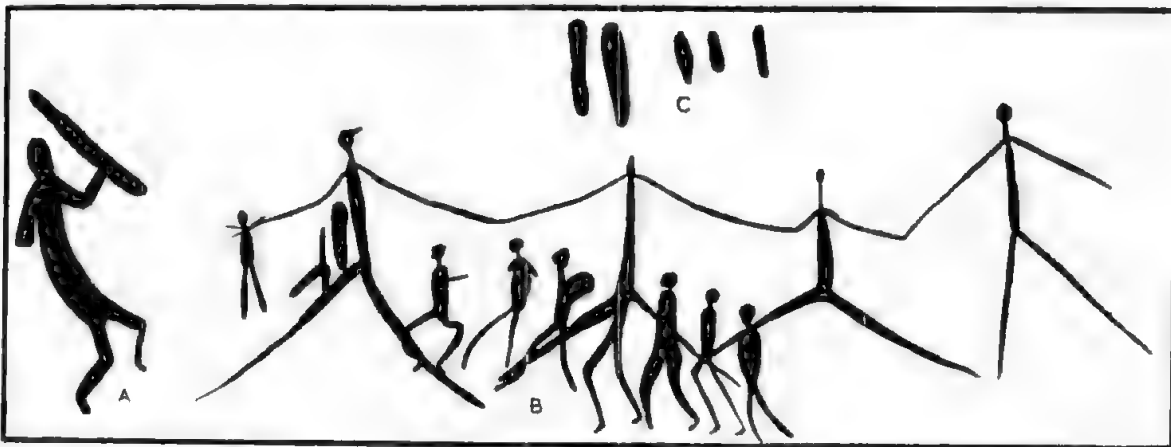


Fig. 1. Cave paintings in the Mount Lofty Ranges, 1/10th full size. Photograph—
C. P. Mountford.

Hossfeld (1926, pp. 287-297), described a group of cave paintings on the River Marne, in the Eden Valley district. Many of these paintings, like those described in the present paper, show human beings in strong movement.

No further examples of cave paintings were recorded from the Mount Lofty Ranges until Mountford (1957, pp. 102-115), drew



Fig. 2. Cave paintings in the Mount Lofty Ranges. 1/6th full size.
 Photograph—C. P. Mountford.

attention to three additional localities where cave paintings had been found, *i.e.*, Native Valley, Kanmantoo, Harrisons Creek, Tungkillo, and Cooks Hill.

The present paper records a number of faded cave paintings, recently found by Mr. Colin Griffiths, in a low rock shelter (Pl. li, A), on section 2639, Hundred of Macclesfield. These paintings (illustrated on Pl. li, B and fig. 1 and 2), are entirely in red, and so faint that the outlines of some of them could not be traced until they were sprayed with water.

On the right wall of the shelter (Pl. li, A), which is less than three feet high, are four human figures (fig 1, B), legs outstretched and hands joined, who appear to be performing a dance. At their feet is a line of six people walking. A, is an incomplete figure of a man with a shield in his hand and C, a group of five parallel marks.

Shown on fig. 2, are drawings of the remainder of the paintings, which are scattered around the wall of the cave. A and K are representations of men carrying shields in their hands, B and D, simple "stick" figures, and C, a dancer, associated with an incomplete circle. F, is probably a woman, with a digging stick in her hand and a carrying bag over her shoulder. J, is a similar design, except for a small circle near the knee. This painting is also illustrated at Pl. li, B.

At E are two dancers, which somewhat resemble those on fig. 1, B; G, a simple dancing figure, H, another dancer associated with some kangaroo-like creature, and at L, two human beings, the taller with a shield in his hand, and the smaller in the position of dancing.

DISCUSSION

These cave paintings have several unusual characteristics; they are painted entirely in red, all, with the exception of the kangaroo at H, picture human beings, and most of them show action. In fact, with the possible exception of those recorded by Hossfeld on the River Marne (1926, fig. 1-4), they are the most spirited cave paintings that I know of in South Australia.

It is not possible to estimate the age, nor to define the function of these cave paintings, but the fact that there is no overpainting, except, perhaps, the walking figures at fig. 1, B, and that the figures have been painted entirely in red, suggests that they may have depicted some mythical story belonging to the ceremonial life of the tribe.

SUMMARY

This paper records an unusual group of cave paintings in the Mount Lofty Ranges of South Australia. The designs are figured, described and their possible function discussed.

ACKNOWLEDGMENTS

I wish to acknowledge the assistance of both Dr. T. D. Campbell and Mr. H. Bowshall, who motored me to the site and assisted in tracing the cave paintings in situ.

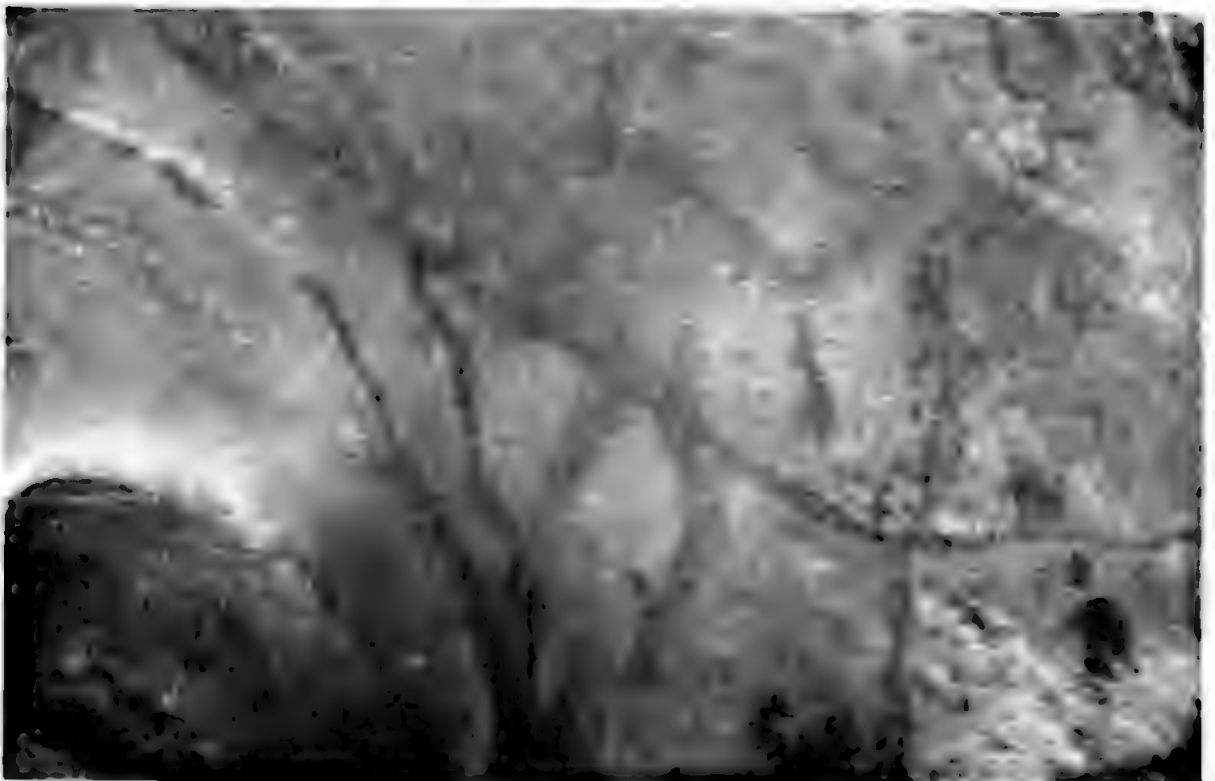
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EXPLANATION OF PLATE

PLATE LI

A—Rock Shelter in which paintings were located. B—Faint cave painting of woman with carrying bag on back. Photographs—C. P. Mountford.



**A NEW COPROPHILOUS UROPODID MITE,
CILLIBA COPROPHILA SP. NOV. FROM A BAT CAVE
IN SOUTH AUSTRALIA (ACARINA-CILLIBIDAE)**

BY H. WOMERSLEY, SOUTH AUSTRALIAN MUSEUM

Summary

A new Uropodid mite, *Cilliba coprophila* sp. nov. living in the damp guano of a bat cave at Naracoorte, South Australia, is described and figured from the adults of both sexes, as well as from the larval, proto-, deuto-, and tritonymphal stages. It is shown to be strongly negatively phototropic in behaviour.

A NEW COPROPHILOUS UROPODID MITE, CILLIBA COPROPHILA SP. NOV. FROM A BAT CAVE IN SOUTH AUSTRALIA (ACARINA-CILLIBIDAE)

H. WOMERSLEY, SOUTH AUSTRALIAN MUSEUM

Fig. 1-3

SYNOPSIS

A new Uropodid mite, *Cilliba coprophila* sp. nov. living in the damp guano of a bat cave at Naracoorte, South Australia, is described and figured from the adults of both sexes, as well as from the larval, proto-, deuto-, and tritonymphal stages. It is shown to be strongly negatively phototropic in behaviour.

Family Cillibidae Trägårdh.

Trägårdh, I., 1944. Zur Systematik der Uropodiden—Ent. Tidsk., 65: 171.

Genus *Cilliba* v. Heyden

von Heyden, 1896. Isis Oken., 19: 613.

***Cilliba coprophila* sp. nov.**

Fig. 1 A-L, 2 A-G, 3 A-D

Types. The holotype female, allotype male and morphotypes of the larval and nymphal stages as well as numerous paratypes in the collection of the South Australian Museum.

Locality and Biotope. Found in very large numbers in the damp guano on the floor of a bat cave at Naracoorte, South Australia, August 26th to September 2nd, 1956 and collected by members of the Cave Exploration Group of South Australia led by Mr. E. Hamilton-Smith.

Description.

Holotype female. Fig. 1 A-K, M-N. A dark brown, strongly sclerotised and broadly oval species with convex dorsum and somewhat flatter venter; length of idiosoma 930 μ , width 670 μ .

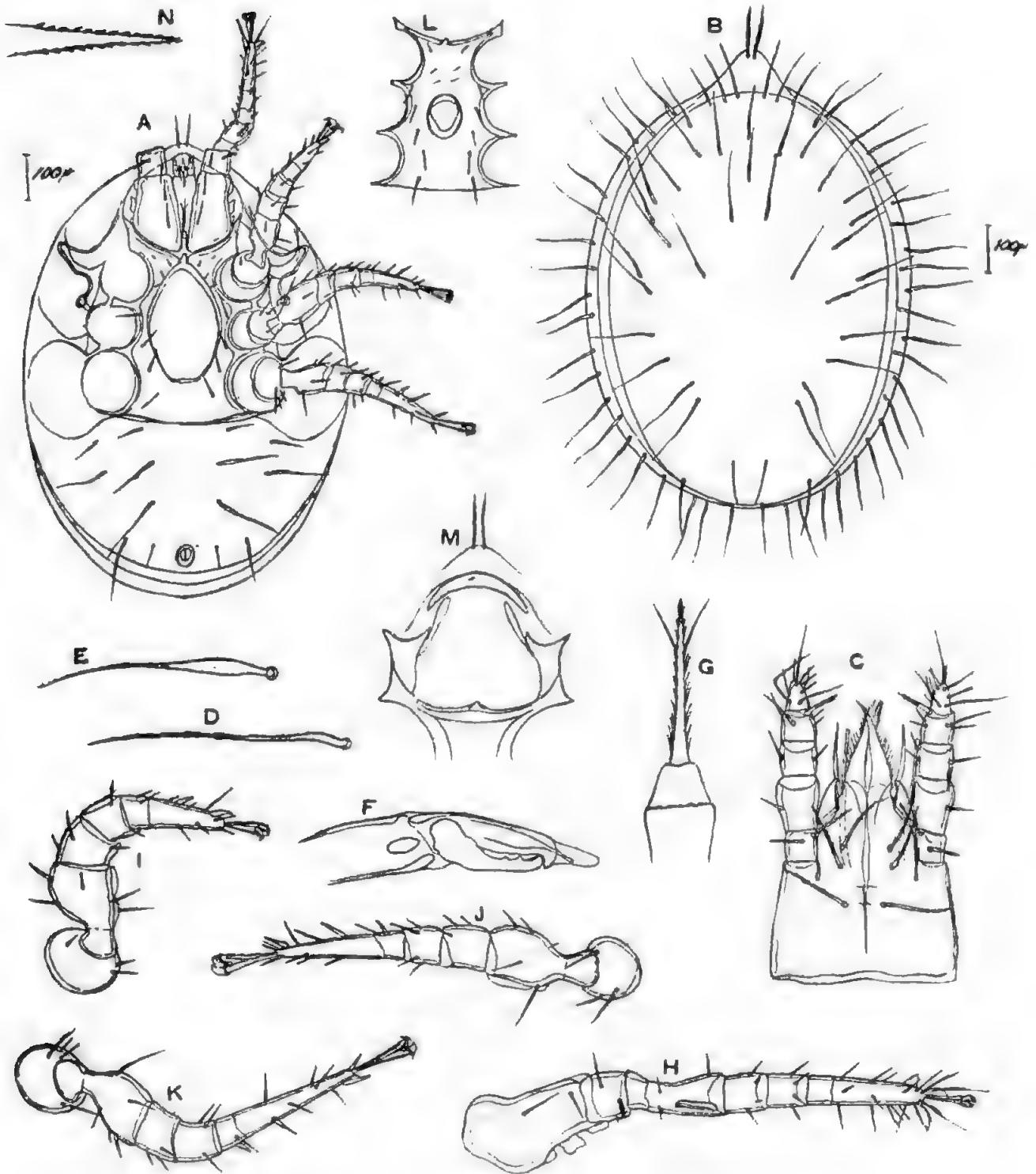


Fig. 1. *Cilliba coprophila* sp. nov. A-K, M-N Female. A—venter, B—dorsum, C—gnathosoma, D—dorsal seta, E—ventral seta, F—chelicerae, G—tritosternum, H—leg I, I—leg II, J—leg III, K—leg IV, M—camerostome, N—tectum, L—male, intercoxal shield.

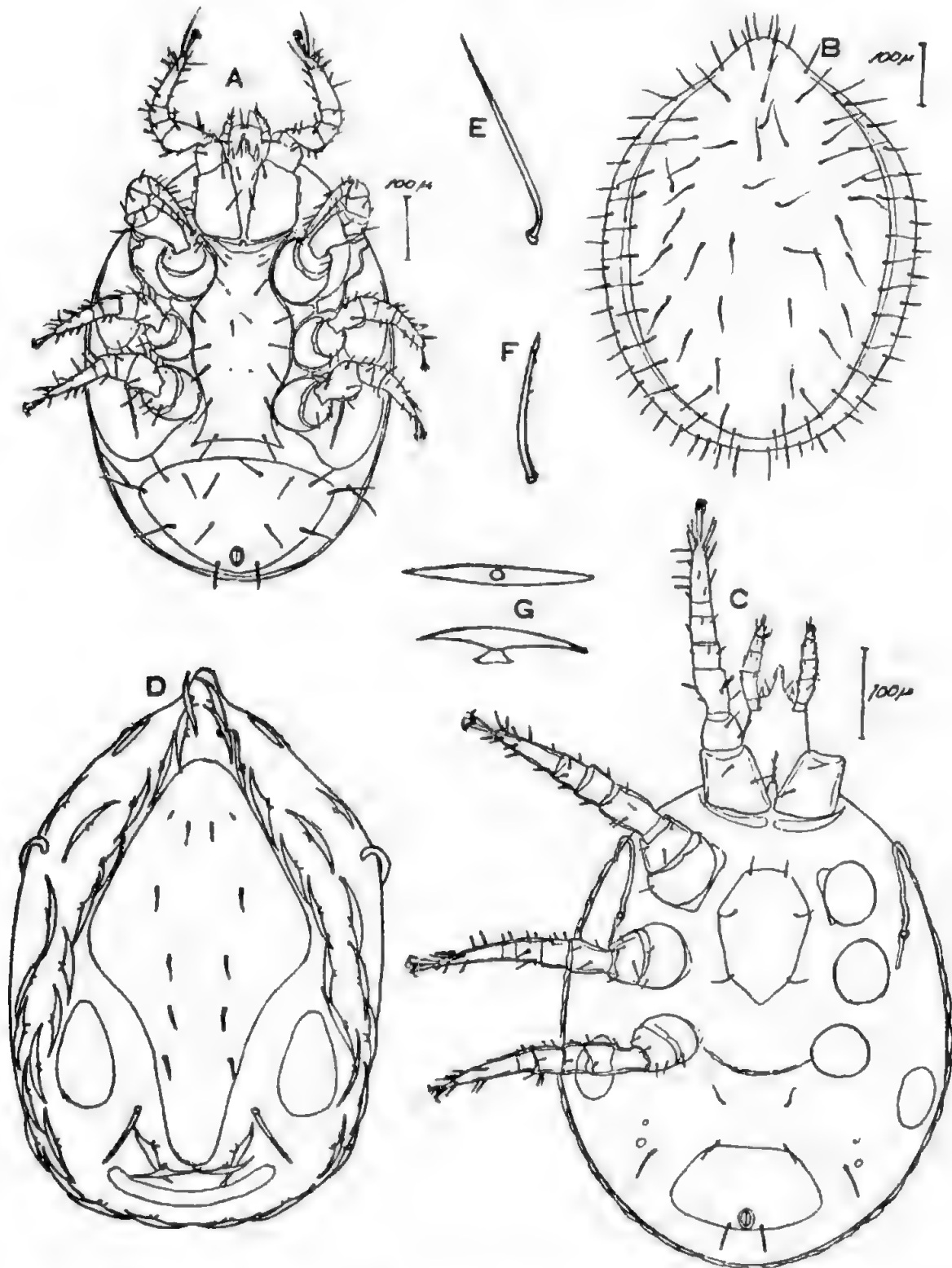


Fig. 2. *Cilliba coprophila* sp. nov. A-B, tritonymph, A—venter, B—dorsum, C-G deutonymph, C—venter, D—dorsum, E—posterior dorsal seta, F—posterior ventral seta, G—dorso-lateral and marginal setae in lateral and dorsal view.

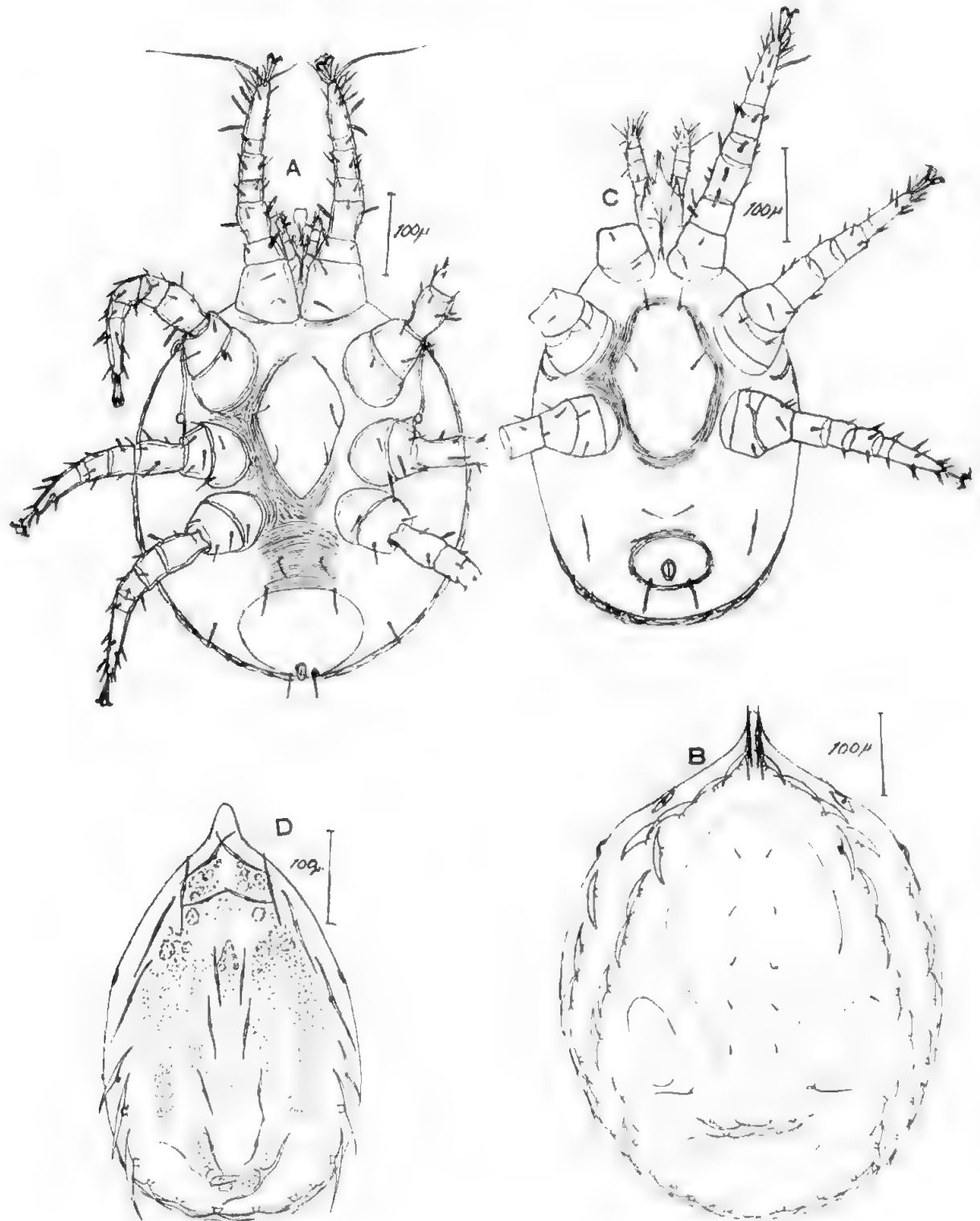


Fig. 3. *Cilliba coprophila* sp. nov. A-B protonymph, A—venter, B—dorsum. C-D larva, C—venter, D—dorsum.

Dorsum fig. 1 B; smooth and shining, idiosoma almost completely covered by an entire dorsal shield which is only separated by a narrow strip of cuticle from the narrow marginal shields, anteriorly the marginal shields coalesce with the dorsal shield while posteriorly they are only separated therefrom at the most by a thin suture line, anterior of the dorsal shield is the cone-shaped "vertex" shield which is somewhat less sclerotised and bears a pair of long 96μ vertical setae, the dorsal shield is furnished with ca. 20 pairs of long 180μ setae, fig. 1 D, which are slightly swollen at the base and distally barbed, the marginal shields carry a double row of about 20 pairs of similar setae on each side, in addition both dorsal and marginal shields are furnished with a number of small pores.

Venter fig. 1 A; anteriorly with a large camerostome, fig. 1 M, in which are situated the gnathosoma, coxae of legs I and the tritosternum; the tritosternum, fig. 1 G, is exposed between coxae I and consists of a two-segmented basal part and a single ciliated lacinia which is trifid distally; the ventral shields consist of a sterno-genital shield extending from the posterior margin of the camerostome to the posterior edge of acetabula IV where it is separated from the large and expanded ventri-anal shield by a strong suture line, the anterior margin of the sterno-genital shield is lightly curved and 192μ wide and forms the posterior margin of the camerostome, in the middle of the shield and extending from the anterior margin of acetabula I to the middle of acetabula IV is a large oval perigenital ring in which lies the close fitting similarly shaped epigynial shield, laterad of the perigenital ring the sterno-genital shield carries 7 pairs of simple setae and one pair of small anterior lyriform pores, the anterior three pairs of setae are small and lie between coxae II, the other pairs are longer and lie between coxae III and IV with the last pair posterior of the perigenital ring, the perigenital ring is 240μ long by 150μ and anteriorly has a small conical projection which divides the anterior margin of the shield; the ventri-anal shield occupies the whole of the venter posterior of acetabula IV where it is marked off by a posteriorly curved "metapodal line", the shield carries 6 pairs of medium to long setae which are distinctly swollen basally, fig. 1 E, and to 154μ long, as well as a pair of paranal setae; the endopodal shields are coalesced with the sterno-genital shield while the exopodals are strongly sclerotised to form the edges of the "fovealae pedales"; the stigma is situated between coxae II and III with a convoluted peritreme as figured.

Gnathosoma fig. 1 C; ventrally with four pairs of long, strong setae of which the capitular and both pairs of post-rostral setae are ciliated, the rostral nude; the tectum, fig. 1 N, is a long dentate hyaline spike; *palpi* 5-segmented, the basal segment carries two ciliated setae of which the inner is short and blunt, the tarsus is supplied with a number of long setae and its basal specialised seta is 2-tined; *chelicerae* as in fig. 1 F, strongly sclerotised, the fixed digit with only one strong tooth and an apical blunt hyaline lobe within which can be seen a canal which runs back through the digit, movable digit with two strong teeth.

Legs fig. 1 H-K; all short and six-segmented, the basal segments of II-IV lying within distinct foveae, leg I is the slenderest and furnished with coxal and femoral laminae as figured, legs II and III also with femoral laminae, all tarsi with long caruncle and paired claws and on II-IV with some strong spines: leg I 560 μ long, II 468 μ , III 468 μ , IV 526 μ .

Allotype male. Of the same general facies and size as in the female, differing only in the sterno-genital shield in the centre of which between coxae III lies the rounded genital orifice and shield (fig. 1 L). The *chelicerae* are similar to those of the female.

Morphotype tritonymph. Fig. 2 A-B; of the same general facies as in the female, but much less sclerotised and lighter in colour: length of idiosome 725 μ , width 550 μ .

Dorsum: dorsal and marginal shields as in adults, the dorsal setae plain or only indistinctly barbed distally, and to 80 μ long, the marginal setae slightly shorter.

Venter fig. 2A; sternal shield extending from posterior margin of camerostome to slightly beyond acetabula IV with a lightly concave posterior margin well separated from anterior margin of the ventri-anal shield, the anterior margin is 144 μ wide, the lateral margins closely contour the coxae but are separated from the endopodal shields by a very narrow strip of cuticle, the shield carries 8 pairs of setae and two pairs of pores, the third and fourth pairs of setae are in a transverse row, the anterior pores are lyriform and near the anterior margin, the other pair are small and round and lie between the sixth pair of setae, the shield is 326 μ long and its setae from 30 μ to 48 μ long: the ventri-anal shield is as figured, 360 μ wide and 182 μ long and furnished with long 80 μ setae as in the female.

Gnathosoma as in female.

Legs as in female, I 292 μ long, II-III 351 μ , IV 374 μ .

Morphotype deutonymph fig. 2 C-G; smaller and less sclerotised than the tritonymph; length of idiosoma 655μ , width 468μ .

Dorsum fig. 2 D; with four dorsal shields; a large median shield 410μ long, rounded anteriorly then widening gradually to 222μ in a line with coxae III and then contracting sharply to a rounded end just in front of the posterior shield, it is furnished with 5 pairs of simple setae 24μ , and one pair of lyriform pores anterior of the first pair of setae which are much nearer together than the other pairs; the posterior shield is transverse with concave anterior margin 176μ wide by 23μ long and without setae; laterad on each side of the posterior constricted portion of the median shield is an elongate widely oval shield 117μ long by 59μ wide and between the posterior end of these shields and the median shield is a long strong blunt barbed seta 59μ ; the marginal shields are not demarcated, only being indicated by two longitudinal rows of very peculiarly shaped setae, these setae are on papillae with a very short peduncle and then a pickaxe-head shaped seta with an expanse to 90μ , owing to the short peduncle or haft these setae are closely adpressed to the body surface, dorsally each seta is lightly convex and in dorsal view is a long narrow pointed ellipse (fig. 2 G), two other pairs of these setae lie close to the posterior tip of the median shield and in front of the posterior shield.

Venter fig. 2C; sternal shield small, 164μ long by 105μ wide, extending from anterior of acetabula II to posterior of acetabula III with the posterior margin tapering to a blunt angle, with 3 pairs of setae 35μ long; anal shield trapezoidal, anterior margin straight 100μ , lateral margins divergent and posterior margin lightly convex 175μ , with only the paranal setae 35μ long and the anus posterior, its length is 105μ ; a pair of oval shields just posterior of acetabula IV 82μ long by 35μ wide; a posteriorly curved suture line, in which is a pair of small rounded pores, runs between acetabula IV, between this line and the anterior margin of the anal shield are two pairs of fine setae and on each side laterad of the anal shield is a stronger seta with a pair of rounded shieldlets close by.

Gnathosoma as in tritonymph.

Legs as in tritonymph, I 355μ long, II 351μ , III 331μ , IV 346μ .

Morphotype protonymph fig. 3 A-B; very similar to the deutonymph but of smaller size; length of idiosoma 514μ , width 336μ .

Dorsum fig. 3 B; with the shields of the same conformation as in the deutonymph, median shield 413μ long by 384μ wide, with 5 pairs

of fine setae 20μ long, posterior shield 274μ wide by 14μ long, lateral shields 125μ long by 64μ wide; setae between lateral and median shields 61μ long, the pickaxe-head shaped setae to 91μ in expanse.

Venter fig. 3 A; much as in deutonymph, as figured; sternal shield 168μ long by 111μ wide reaching posteriorly to level of anterior of acetabula IV, only demarcated by discontinuity of cuticular striations, with 3 pairs of setae 34μ long; anal shield more rounded than in deutonymph, 173μ wide by 122μ long with only the paranal setae; the postero-lateral shields of the deutonymph are wanting; stigma and peritreme much as in the deutonymph.

Gnathosoma including palpi and chelicerae as in the deutonymph.

Legs as in deutonymph, I 360μ long, II 360μ , III 345μ , IV 384μ .

Morphotype larva fig. 3 C-D: small, length of idiosoma 480μ , width 288μ , with only 3 pairs of legs.

Dorsum fig. 3 D; without any definite shields except the posterior which is 125μ wide by 22μ long; with a medial double row of 5 pickaxe-head shaped setae which are very thin with an expanse to 67μ , marginally or submarginally with longitudinal row of 10 similar setae on each side, of which the first 4 are thin, the others thicker and shaped as in the deutonymph, just in front of the posterior shield is a pair of similar setae with an expanse of 125μ ; the dorsal surface is irregularly ornamented by pitting as figured.

Venter fig. 3 C; as in protonymph, but the sternal shield is only indicated by the break in the cuticular striations, it is 160μ long by 102μ wide with 3 pairs of setae 23μ long; the anal shield is even more rounded than in the protonymph, 91μ wide by 63μ long; between the sternal and the anal shield is a single pair of fine normal setae and laterad of these a very fine pickaxe-head shaped seta; the peritreme is only slightly developed and the stigma is just posterior of coxae II.

Gnathosoma, palpi and *chelicerae* much as in protonymph.

Legs as figured, I 336μ long, II 336μ , III 312μ , IV 326μ .

Remarks. This is an interesting and remarkable species in the sudden and extreme morphological change in the form of the dorsal and marginal setae from the pickaxe-head shape in the larva, protonymph and deutonymph, to the normal type of seta found in the tritonymph and adults. The pickaxe-head setae in the earlier stages may possibly be of assistance in enabling the mites to traverse the pellets of guano in which the mites live.

The collection of these mites, many thousands, was from a 2 lb. treacle tin of moist guano collected from the bat cave and sent to the Museum. When first opened the surface of the guano was a seething mass of living mites, but within seconds of being exposed to the light, they had all disappeared below the surface. This negative response to light was repeated many times.

THE ARCHAEOLOGY OF KANGAROO ISLAND, SOUTH AUSTRALIA

BY H. M. COOPER, ASSOCIATE IN ANTHROPOLOGY, SOUTH AUSTRALIAN MUSEUM

Summary

This paper refers to the archaeological stone implements of Kangaroo Island, an uninhabited land at the time of its discovery by Captain Matthew Flinders, R.N., H.M.S. Investigator in March 1802.

The various groups, including some smaller types hitherto unnoticed, are described and compared, where applicable, with similar material found upon the adjacent mainland. It is suggested that the smaller implements may have been used concurrently with the dominant large pebble implement industry of Kangaroo Island termed Kartan.

The diverse problems relating to the islanders' time and direction of arrival and, in addition, their departure or local extinction are referred to and some conjectural solutions discussed.

THE ARCHAEOLOGY OF KANGAROO ISLAND, SOUTH AUSTRALIA.

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Map and text fig. 1-48

SUMMARY

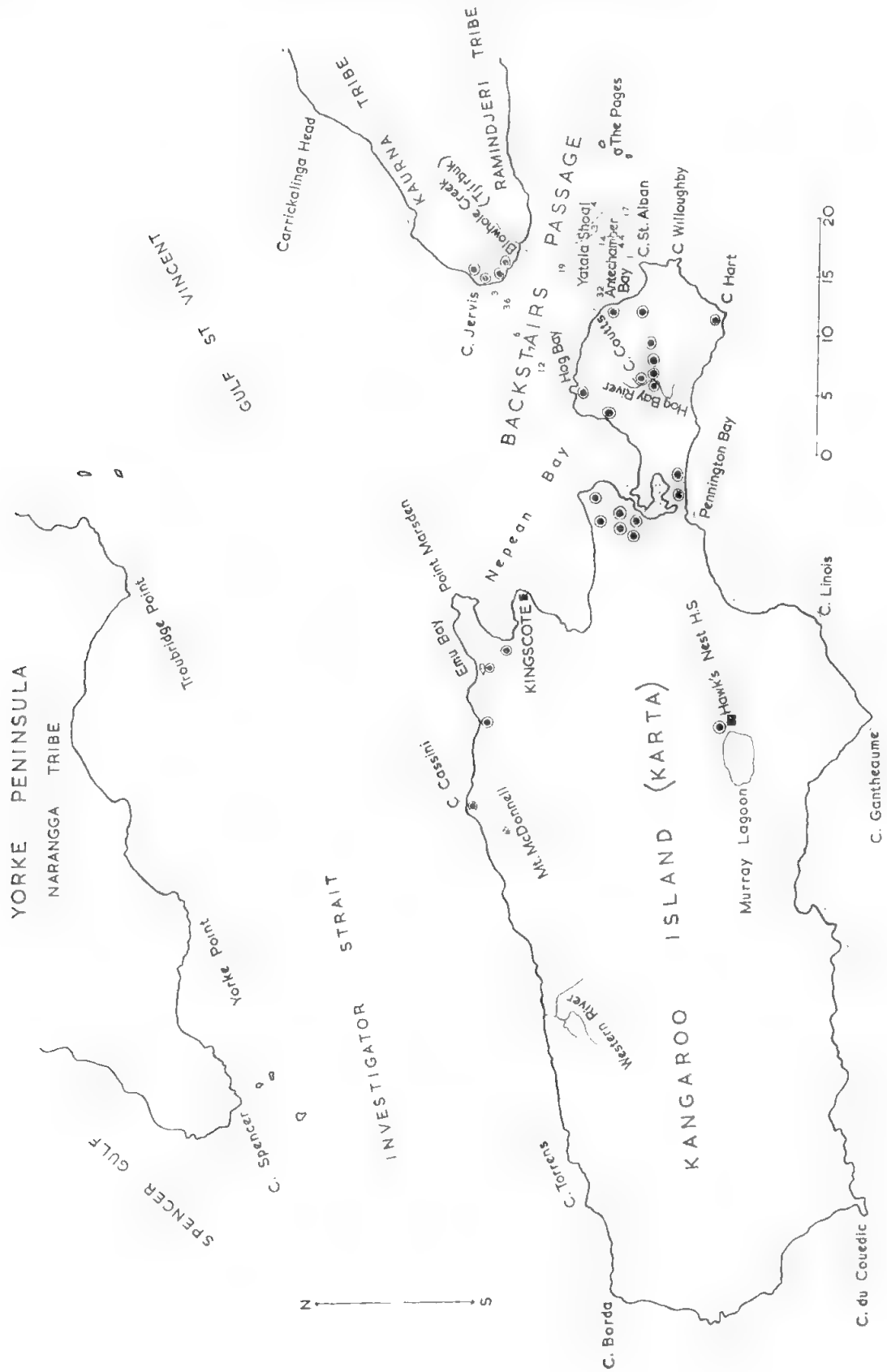
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PHYSICAL FEATURES OF KANGAROO ISLAND

Kangaroo Island, which extends more than 90 miles in an east-west direction and has a maximum width of 30 miles, is separated from the mainland to the north-east by Backstairs Passage with a minimum width of nine miles and in a northerly direction by Investigator Strait which is about 25 miles wide. The ocean to the south of the island deepens rapidly offshore with the exception of a few outlying reefs and rocks, the 100 fathom line approaching the coast in one area to within a distance of 30 miles. The interior of Kangaroo Island, shortly after Captain Flinders' discovery, was found to be covered in many places with dense, sometimes impenetrable scrub and in others with forests of Eucalyptus trees. The rainfall varies between 17 and 30 inches, the climate of the island, due to its position being cool, temperate and equable. Fish, birds, kangaroos, wallabies, opossums and seals abound. The highest official physical feature is Mount Macdonnell—984 feet.



DISCOVERY AND FIRST TRACES OF PRIMITIVE MAN

Captain Flinders, when running along the north coast of the island in *H.M.S. Investigator* during March 1802, wrote thus in his journal:—

“Neither smoke nor other marks of inhabitants has as yet been perceived upon the southern land.”

This observant officer, describing the kangaroos seen feeding, continued:—

“Our landing gave them no disturbance . . . The poor animals suffered themselves . . . in some instances to be knocked on the head with sticks . . . There was little doubt, however, that this extensive piece of land was separated from the continent for the extraordinary tameness of the kangaroo . . . concurred with the absence of all traces of men to show that it was not inhabited . . . That the natives of the continent did not visit it was demonstrated if not by the want of all signs of such visit yet by the tameness of the kangaroo, an animal which on the continent resembles the wild deer in timidity.”

Captain Flinders revisited Kangaroo Island a week later and after going ashore near his former landing wrote:—

“A party was sent to shoot kangaroos . . . The kangaroos were found to be less numerous than at the first anchoring place, and they had become shy so that very few were killed.” Early settlers subsequently confirmed the soundness of Captain Flinders’ deductions—that his discovery was an uninhabited land.

Definite evidence of an archaeological native occupation, however, was established with the discovery by Howchin (1903) of some hammerstones at Hawk’s Nest Station adjoining Murray’s Lagoon. Tindale and Macgraith (1931) found further examples at the same locality in association with some massive trimmed pebble implements and Cooper (1943) made an extensive examination during the period 1934-9 which disclosed the existence of numerous camping places distributed widely throughout most of the island. 1,400 pebble choppers and “horsehoof” shaped trimmed cores were collected during the course of this survey and, in addition, more than 150 hammerstones.

This preliminary inspection appeared to indicate that the massive trimmed pebble chopper/core implement industry was a completely pure one with the exception of one or two small flakes with secondary trimming which appeared to be merely fortuitous. A careful examination of these and additional sites during a further survey, however, disclosed the existence of a former well established small

and medium sized implement industry with the finding of more than 160 implements and, furthermore, a large number of small discarded workshop cores which confirmed their origin. This material, which has never been described, is referred to in a later section of this paper.

THE LARGE STONE IMPLEMENTS OF KANGAROO ISLAND

The large trimmed pebble chopper/core block implement industry has been described as previously stated and a brief allusion to it will suffice in this place, for comparison, before proceeding with a description of the small and intermediate forms which constitutes a principal section of this paper.

The large implements are prepared by hammer flaking most or nearly all of one side of water-worn fine grained quartzite pebbles, usually oval in shape. The lower periphery of this side, after being roughly flaked to the desired shape, is secondarily trimmed with considerable skill to produce a fairly thin and often stepped working edge. Treatment of the upper portions of this prepared side is confined to rough flaking and only to such an extent that the pebble could be held conveniently in the hand during use.

The typical pebble chopper implement of Kangaroo Island, therefore (fig. 1), is a semi-uniface core implement whose massive form when completed is attained by primary and secondary hammer flaking and trimming as described above. A fully uniface pebble chopper type exists but sparingly.

The lower or working edge of pebble choppers, as indicated by the existence of numerous well used examples, gradually retreats backwards from its original form owing to wear and retrimming until it becomes vertical and probably too blunt and obtuse to carry out its original functions. The heavily crushed and bruised edges of many, however, appear to indicate their conversion for some other purpose in the concluding stages of their useful life.

An interesting feature of many of these pebble choppers is the existence of well defined pitting and bruising upon the nether surfaces suggesting their reversal when required for hammers. The exercise of this function is also evident upon massive trimmed angular blocks from Hallett Cove, Cooper (1959), and also on similar material which the writer has recently collected upon campsites extending along the banks of the River Wakefield.

Large core-like implements with stepped secondary trimming, made chiefly from angular blocks, are relatively common upon

Kangaroo Island. They are, with few exceptions, of "horsehoof" shape as in fig 2. Their working edges, when reduced by wear and retrimming, become obtuse similarly to the pebble choppers, or even concave in extreme cases, when the apex overhangs the trimmed working base. (Cooper, 1943, fig. 2 and 3.) The Kangaroo Island industry is practically devoid of millstones both upper and lower.

The existence of large assemblages of implements around many lagoons and upon the banks of creeks, mostly inland, indicates that such localities were favoured when selecting the sites for important camps. Primitive man upon Kangaroo Island, however, inhabited many parts of the tableland country, especially in places where there exist saucer shaped depressions or pans of various diameters and a few feet deep with a tenacious clayey bottom often overlain by a thin layer of sand. An examination of these places reveals the occurrence, here and there, of a depression around the margin of which two or three stone implements may be found. The choice of any particular pan appears to have been related to its superior capacity for retaining water. The comparative fewness of implements in these surroundings appears to associate them with the wanderings and temporary presence of a small group or single family moving about from place to place in search of food and water.

The existence of implements in almost impenetrable scrub country is difficult to explain. They may have been lost or discarded by hunters during or after setting fire to the surrounding country—a favourite means of rounding up animals and reptiles for food—or they could be relics of a more rigorous climatic period and less vegetation if their age were sufficiently remote.

The beauty and symmetry of many pebble implements indicate that at some period at least the Kangaroo Islanders possessed craftsmen capable of producing work of no mean order.

COMPARISON OF KANGAROO ISLAND AND MAINLAND LARGE TYPES

It appears probable, from material gathered during the last 25 years, despite the existence of relatively few small implements, that the dominant feature of the Kangaroo Island material culture was the large trimmed pebble industry and that the "horsehoof" shaped trimmed core may have been a contemporary. The relative ratios of these types collected at two localities—Hog Bay (Willson) River and Discovery Lagoon near Flinn Bay—are interesting owing to their

similarity. There are no means of estimating, however, whether this affinity is merely coincidental or presents some unknown significant factor:—

	Trimmed Pebble Choppers	“Horsehoof” Trimmed Cores
Discovery Lagoon	363	29
Hog Bay (Willson) River	337	23

The aggregates of pebble choppers and “horsehoof” cores collected from all island campsites by the writer—1,277 and 118 respectively—and the total absence of the latter from many sites, appear to indicate that these were too few in number to represent a separate culture period.

It is an interesting feature, but one difficult to explain, that none of the camping grounds known upon the neighbouring main, many of which are within visible distance of the island, show any trace whatever of a dominant pebble implement culture although large numbers of pebbles exist, at least at present, along its shores, including the vicinity of Cape Jervis, near which place the writer discovered over 90 “horsehoof” trimmed cores, fashioned from angular, irregular blocks, upon one spot alone. No dominant pebble implement industry, moreover, has yet been discovered elsewhere in South Australia although scattered examples have been found, apparently as a subsidiary type, in association with many large implements such as at Artipena water, Cooper (1943) and elsewhere.

The existence of the “horsehoof” upon Kangaroo Island, in limited numbers upon some sites and its complete absence from others, may indicate that it was a type already known to the islanders before their arrival there and that its use was relatively unimportant in comparison with the pebble implement culture which, owing to the scarcity of other large forms, appears to have been evolved and developed as a conventional type shortly afterwards.

SMALL KANGAROO ISLAND IMPLEMENTS

The writer, during extensive field work in the early thirties, found a few small well defined implements of quartzite in association with the large pebble implement industry. Others, derived from milky quartz, with unmistakable secondary trimming were also discovered but the relative scarcity of the latter did not account for the presence of many small discarded working cores in that material, of which over 200 were collected. A more thorough examination at a later date of

many flakes scattered about clearly indicated that there existed amongst them, primitive endscrapers and other types, with crude secondary trimming, which had been overlooked by the very nature of their extreme primitiveness. The presence, moreover, of a number of simple but keen edged flakes, devoid of any secondary trimming, many of which bore chipping upon their nether sides, indicating wear from use, suggests their definite employment as knives. The existence of so many discarded milky quartz cores and simple flakes, often showing their bulbs of percussion, together with the scarcity of well worked small implements upon numerous campsites reveals that many of these simple flakes must have been deliberately made to serve as cutting tools.

This small implement assemblage includes trimmed end and "nosed" scrapers, discoidal and irregular shaped adzstones, knives/saws, awls, prepared cores and some solitary types which are included in the accompanying drawings. All those discovered by the writer are derived from milky quartz and quartzite with a few exceptions which are referred to in their proper place.

The number of small Kangaroo Island implements available, although rather circumscribed, is sufficiently large to enable a tentative comparison to be made with those existing elsewhere in South Australia. This indicates that they are comparable in some cases with, but scantily representative of, some types to be found upon the nearby main although the island examples as a whole exhibit cruder workmanship. Some allowance should be made, however, for those derived from milky quartz, which constitute the majority, because accurate primary and secondary flaking of this material is most difficult to control. The finish upon those produced from quartzite is somewhat better.

Most of the small Kangaroo Island implements, the majority of which retain their bulbs of percussion, have been struck from prepared cores but a few are merely random milky quartz natural blocks or fragments which have received rough secondary trimming to provide the necessary working edge. The preference for milky quartz appears to be due to its prevalence upon the surface at or near many campsites whereas quartzite had to be transported inland from restricted spots situated upon the coast. The scarcity of small quartzite working cores appears to indicate that some implements in this material had their origin in flakes of suitable size and shape discarded during the manufacture of large trimmed pebble choppers. A number of types widespread upon the mainland, however, such as the beautifully

executed Pirri and Woakwine points, geometric and other microliths, slate scrapers and polished axeheads have not been found upon the island.

It is most difficult to determine whether the smaller implements of Kangaroo Island were employed concurrently with the large pebble implement industry or whether they represent some other period in its occupation by primeval man. Stratified deposits throughout the world, generally, disclose the existence of the larger and progressively improved stone implements in the lower (earlier) layers which in turn were displaced, at least principally, by smaller, lighter and better designed forms—the result of experience and the demand for them in the manufacture of a wider range of domestic, hunting and fighting equipment.

The large and massive stone implements, improvised by primitive man in earlier periods were eminently suitable for carrying out heavy work such as cutting boughs for shelters and the shaping of his rudely designed clubs and spears. There would be other purposes, however, which would need some small simple or trimmed flakes even at that period such as making skin cloaks, for ceremonies and cutting in general. In the absence of any well defined or established small implement types, which upon the mainland are indicative of later cultural periods, representatives of which occur there in vast numbers, it is possible that the somewhat limited and ill defined small forms of Kangaroo Island, suitable for the performance of lighter duties such as those just referred to, were contemporaries of the large pebble implements of that area.

THE CAPE CASSINI HOARD

This interesting and perplexing series was found in a little shallow rocky hollow upon the top of the coastal cliffs at Cape Cassini and within a few feet of their seaward edge. It includes several microliths, some of which appear to possess pressure flaking, and also several discarded working cores of microlithic form from which they have been struck. A small quartzite hammerstone was found nearby and may have been used to fashion them. The importance of the find justified the collection of all the discarded flakes for future reference—82 in number. The material, identified by the late Sir Douglas Mawson as a cherty flint, was considerably weathered and from the general deposition of the assemblage it is apparent that the implements were made where they lay and not transported, although the cherty flint itself may have been derived from elsewhere.

The construction of the individual specimens, which constitute the Cape Cassini hoard, makes it difficult or even impossible to associate them with other Kangaroo Island implements. They appear to resemble, in many respects, forms which exist in South East South Australia and also in rock type, but their appearance in such an isolated situation, if this be true, is surprising. There is convenient access, however, to the cliff top where they lay, from an extensive flat rocky platform a few feet above sea level. It is possible that they may be relics of a forced or chance landing from seawards in pre-historic times, or, on the other hand, disclose the presence of a workshop site made by a mainland native several of whom were known to have been captured at the commencement of the European occupation by roving undesirables and forced to accompany them.

CONSTITUTION OF THE CAPE CASSINI HOARD

Discarded flakes	82
Discarded working cores	5
Microlith endscraper	1
Irregular shaped knives	2
Microlith knives	2
Endscrapers	3
Worn adze	1
Concave adzes	4
Irregular shaped adzes	2
	<hr/>
Total	104

A TASMANIAN POST-EUROPEAN STONE IMPLEMENT INDUSTRY

During historic times—shortly after Captain Flinders' discovery in 1802—sealers, whalers and adventurers from Bass' Strait and elsewhere established camps at Antechamber Bay and Cape Hart bringing Tasmanian women with them. Small well trimmed flint implements, similar to those found in Tasmania, have been collected at both sites associated with fragments of iron, glass and European gun flints. Those discovered by the writer at the Cape Hart campsite comprised more than 70 trimmed implements chiefly "nosed" scrapers, adzestones and cores. Water-worn flint nodules upon the adjoining beach indicate the source of material. It is interesting to observe that in contrast with the island's early inhabitants the Tasmanian women ignored the quartzite pebbles amongst the flint nodules. This Stone

Age-European phase was of brief duration and ceased to exist with the advent of permanent settlement and a stabilised administration. These two sites were described by Tindale (1937), Alison Harvey (1941) and Cooper (1948).

FOOD REMAINS

Cooper (1943) referred to the existence of sea shells upon three eroded campsites in association with large pebble implements, hammerstones and, in one case, burnt hearth stones. A more recent examination of two of these sites by the writer revealed additional extensive erosion exposing, in one locality, a mound of burnt earth containing many mussel shells and in the other a partly exposed stratum of further mussel shells, two inches below which a simple quartzite flake was embedded *in situ*. Both these species are living forms in the nearby waters of Pelican Lagoon.

The sole surviving proof of primitive man's occupation of Kangaroo Island rests upon the existence of many stone implements which is indisputable evidence but the significance of the shell food remains in association with them upon three scattered campsites continues unsolved until it is determined later by a Carbon 14 dating. There is just a possibility that they may represent the feasts of the Tasmanian women already referred to or other wanderers in the early 1800s. The association of these shells with pebble choppers in the situations stated above suggests their contemporaneity and if confirmed by a dating would be invaluable in providing a firm foundation upon which to base investigations so necessary in the solution of the problems still remaining.

ARRIVAL OF THE KANGAROO ISLANDERS

The date and direction of the Kangaroo Islanders' arrival, the duration of their occupation and, in addition, their departure—or extinction *in situ*—are all at present unknown and impossible of solution with the meagre details available. Some possibilities, all of them purely hypothetical however, may be advanced and discussed.

Their arrival at what is now Kangaroo Island could have been accomplished in various ways three of which may be mentioned as possible:—

- (1) *Via* an unbroken landbridge when it was still part of the main.

- (2) By means of a crossing which included a series of deep water channels, shoals and dry land, involving walking, swimming, wading and the use of canoes or rafts.
- (3) By crossing the water in canoes or rafts by one of the channels somewhat similar to those in existence today such as Backstairs Passage or Investigator Strait. (*Vide* accompanying map.)

The occupation of the island or its equivalent at that time would present no difficulties if the conditions referred to in (1) prevailed but if those in (2) or (3) existed a crossing in such circumstances would have been difficult although not impracticable in the former but well nigh impossible in the latter with the facilities which it may be supposed the natives of that period would have at their disposal. There is nothing to indicate that they were better equipped than at the time of the European occupation but before proceeding further it may be useful in this place to describe the two stretches of water which separate the island from the main.

Investigator Strait has a minimum width of about 22 sea miles. Its bed is remarkably uniform in contour, a line of soundings drawn from shore to shore in the vicinity of Point Marsden and Trounbridge Point giving the following successive depths in fathoms:—3, 17, 16, 17, 17, 18, 18, 18, 17, 18, 17, 16, 16, 15, 15, 14, 13, 10, 9 and 5. Investigator Strait is free of offshore dangers with the exception of those fairly close in under the land such as the Althorpe Isles.

The soundings in Backstairs Passage with a minimum width of only nine miles, however, are very irregular deepening and shoaling rapidly as for example from 17 fath. to 31, 7 to 31 and 4 to 18. They range between 44 fath. off Cape St. Albans and 3 on the Yatala Shoal. An examination of charts of Backstairs Passage indicates that deeps, shallow banks and the Yatala Shoal lie, generally, in a northwest-southeast direction and if this be due to scour, the tide which sets through the passage in much the same direction, may be a contributing factor.

The narrowness of Backstairs Passage, the irregular soundings and the strength of the tidal stream, more especially when opposed by contrary winds, all combine to cause rips, races and a steep breaking sea which are dangerous even for a small well found boat. These are the prevailing conditions with which the native would have had to contend frequently when attempting a crossing.

The Kaurna (Adelaide) Tribe, whose territory extended southwards to Cape Jervis, possessed neither canoes nor rafts at the time of the European occupation nor did the Narangga of Yorke Peninsula. The natives of the lower River Murray used primitive bark canoes and those living around the lakes, just above its outlet to the sea, had frail and flimsy rafts of reeds in addition. Both types of craft were believed to have been propelled solely by means of poles before the advent of the European which would restrict navigation to waters no more than a few feet deep. Any successful crossing of Investigator Strait or Backstairs Passage as they exist today, their most convenient directions of approach, either in a frail bark canoe with a few inches of freeboard or upon a crazy reed raft, would need skill and much good fortune even in tolerably fine weather and if propelled by poling, apparently their only means of propulsion, an obvious impossibility. There is the chance, however, of an isolated enforced crossing or two due to being driven over before the wind.

A NATIVE LEGEND OF KANGAROO ISLAND

The former inhabitants of Kangaroo Island having disappeared before its discovery in 1802 no local legends are available and it is necessary to depend solely upon information secured from tribes who lived upon the adjacent mainland such as the Kaurna (Adelaide), the Jarildekald and other peoples of the Encounter Bay area. Both the Kaurna and Jarildekald natives believed Kangaroo Island to be the home of the spirits of departed ancestors, Pindi in the former's language meaning the spirit of departed humans, hence one of their names for Kangaroo Island—Pindingga—the abode of spirits. Several variations survive of an interesting legend relating the wanderings and feats of Ngurunderi, a great ancestral spirit of the Jarildekald. His field of activities included Kangaroo Island and as it is rather applicable, at least in theory, to certain references in this paper, the legend, as recorded by Berndt (1941) is referred to briefly as follows.

Ngurunderi, during one of his epic achievements, having travelled down the River Murray along which he made many features of the country as he proceeded upon his way, arrived on the shores of Encounter Bay, where he caused Granite Island and other islets to emerge from the sea. He hastened thence westward in search of his two fleeing wives whom he perceived at last hastening ahead of him near Tjirbuk (Blowhole Creek) where Ngurungai, the land of spirits (Kangaroo Island), is clearly visible. Ngurungai, at that time, was almost connected with the main so that it could be reached by walking

and wading and this the fugitives attempted to do. Ngurunderi, in very bad humour, had arrived meantime at Tjirbuk and pausing until his unfaithful wives had reached mid-channel he called with thunderous voice for the sea to rise and overwhelm them.

Cawthorne (1846), surveying from the neighbouring cliffs the scene of Ngurunderi's revenge as enacted in the native legend, wrote as follows in his diary:—

“Away upon the breeze is borne
From setting sun to rising morn
Bounding from crag to reedy pool
The voice of great Ooroondool.”

(Ooroondool is a variant spelling of Ngurunderi.)

Great waves, Berndt's account continues, rapidly arose and falling upon his wives they were overwhelmed and swept away. Ngurunderi thereupon transformed them into two little rocky islets called Meralang (Muralang) now The Pages and a reed basket carried by the younger became a nearby reef.

Ngurunderi continued his journey to Kangaroo Island where after proceeding westward he created a great Casuarina tree and rested in its shade. He then walked to the end of the island where he hurled his last remaining spear into the ocean whence rocks appeared from which he dived into the sea after which he rose up into the sky where he resides until this day in the spirit world. Ngurunderi, before bidding his Jaralde people farewell, told them that after death they would follow his tracks to Kangaroo Island, the spirit world, and there they would reside with him.

It may be observed in relation to the above legend that as The Pages are to the east of Tjirbuk, Ngurunderi's irresistible advance of the sea would have entered Backstairs Passage from the westward, that is through Investigator Strait and thus isolated the island from the north.

Ngurunderi's achievements, as related in this piece of interesting folklore survival, cannot, of course, have any direct bearing upon the cause of Kangaroo Island's insularity but if its severance by natural changes occurred after the first arrival of primitive man upon the neighbouring main, there may be just a possibility that the event, for which the great Ngurunderi might quite naturally have been given full credit, has survived in folklore as related above. The legend, upon the other hand, may be totally imaginary and not a highly coloured version of an actual happening in which case it is devoid of significance.

The following is a list of names, some mere variants, which have been attached to Kangaroo Island by the natives of adjoining mainland tribes:—Karta, Kukakun, Kukakungar, Narunggawi, Ngurungani, Peendeka, Peendingga, Pindeka and Pindingga.

DURATION OF THE OCCUPATION—DISAPPEARANCE

It is impossible to suggest, with the information available, even an approximate date for the first of Kangaroo Island's settlers arrival there nor is it possible, in the absence of skeletal remains, to identify them as of Tasmanoid, Australoid or other origin. The implements themselves, the only unassailable proof of man's former presence there, do not offer sufficient evidence which could indicate whether these people comprised a small community whose stay was prolonged over a considerable period of time or whether they are due to a large group and a brief occupation. In the event of the island having become insulated from the main, perhaps after their arrival by way of a partial or complete land bridge, the relative scarcity of the implements and the widely scattered nature of their occurrence might suggest the presence of a small group who wandered far and wide over the island for some considerable time. If this be true, the absence of any well defined small culture types such as the beautifully fashioned pirris, microliths, scrapers and adzes whose members occur in large quantities upon the main, might indicate that the island dwellers' isolation from outside interference and the continuation of their own relatively pure and dominant large pebble implement culture persisted over a prolonged period. The development in the local fauna and flora of many sub-species and variants in comparison with comparable forms upon the adjacent main, and the total absence of others, favour a considerable period of insularity.

There appear to be at least two logical alternatives for the ultimate disappearance of the Kangaroo Islanders—their departure or extinction *in situ*—but any theories relating to them are purely hypothetical and precariously based.

The natives, after an occupation of unknown duration, may have been forced to retreat northward owing to the advent of rigorous climatic conditions—assuming their arrival was early enough—using, perhaps, the same land bridge as before if it still existed or even because the same land bridge itself was threatened with extinction. It is possible, therefore, that their former home, subsequent to its conversion to an island, may have remained deserted until historic times although

in the event of such an evacuation it is strange that no traces exist upon the adjacent main of their pebble implement industry with its characteristic trimming.

The only alternative to the disappearance of the Kangaroo Island people, if it were not due to their departure elsewhere, appears to be that they finally succumbed in the country wherein they had dwelt. The local native community, more especially if it were small from the outset and isolated from contact with the outside world over a long period, may have deteriorated to such a degree from reasons now unknown including, possibly, disease, intermarriage, climatic conditions and internecine tribal fights as to finally lead to their extinction. There is no evidence, unfortunately, to confirm the likelihood of any of these causes being responsible or even contributory. The reference in the preceding paragraph to the total absence of the Kangaroo Island pebble choppers upon the nearby mainland strengthens the possibility of the islanders succumbing in the land where they lived and that their pebble implement culture died with them.

LATER VISITORS TO KANGAROO ISLAND.

The question naturally arises whether Kangaroo Island was visited subsequently by parties from the mainland, more especially after the waters which now surround it attained their present form. The vision of Kangaroo Island, an unknown land, to a venturesome European, laid out as it were almost at his feet and separated by a slender thread of sea, would arouse his curiosity when viewed from the main.

It is reasonable to suspect, however, that the neighbouring tribesmen may have had very good reasons of their own for avoiding its shores. They were men of the stone age in its most primitive form whose minds were inextricably steeped in superstition and possessed, in addition, an unshakable belief in the workings of magic as inherited from their forefathers. The knowledge imparted by their ancestral legends, that the island was the dwelling place of departed souls and, in addition, the total absence of smokes arising from this mysterious land—a familiar indication to them of the presence of primitive man—would tend to strengthen their belief that the place was truly a land of the dead.

There may be reasonable grounds for supposing, therefore, that no planned visits may have been made to Kangaroo Island during recent years, although the possibility of casual forced landings due

to stress of weather, as already mentioned, should not be overlooked if water transport by frail canoe or clumsy raft were available. Such an adventure could explain the presence of the Cape Cassini hoard.

CONCLUSION

It can be said without fear of contradiction—and the writer readily agrees—that the portion of this paper dealing with the arrival and departure or disappearance of the old inhabitants of what is now Kangaroo Island offers nothing indisputable enough to determine, free from doubt, the perplexities involved or, indeed, any salient feature relating to them. The purpose of the possibilities proffered herein—and they are purely hypothetical and tentative in their conception—is that they may assist in evolving sounder and more logical ones with which to at least lessen the obstacles standing in the way of solving the problem of the Kangaroo Islanders.

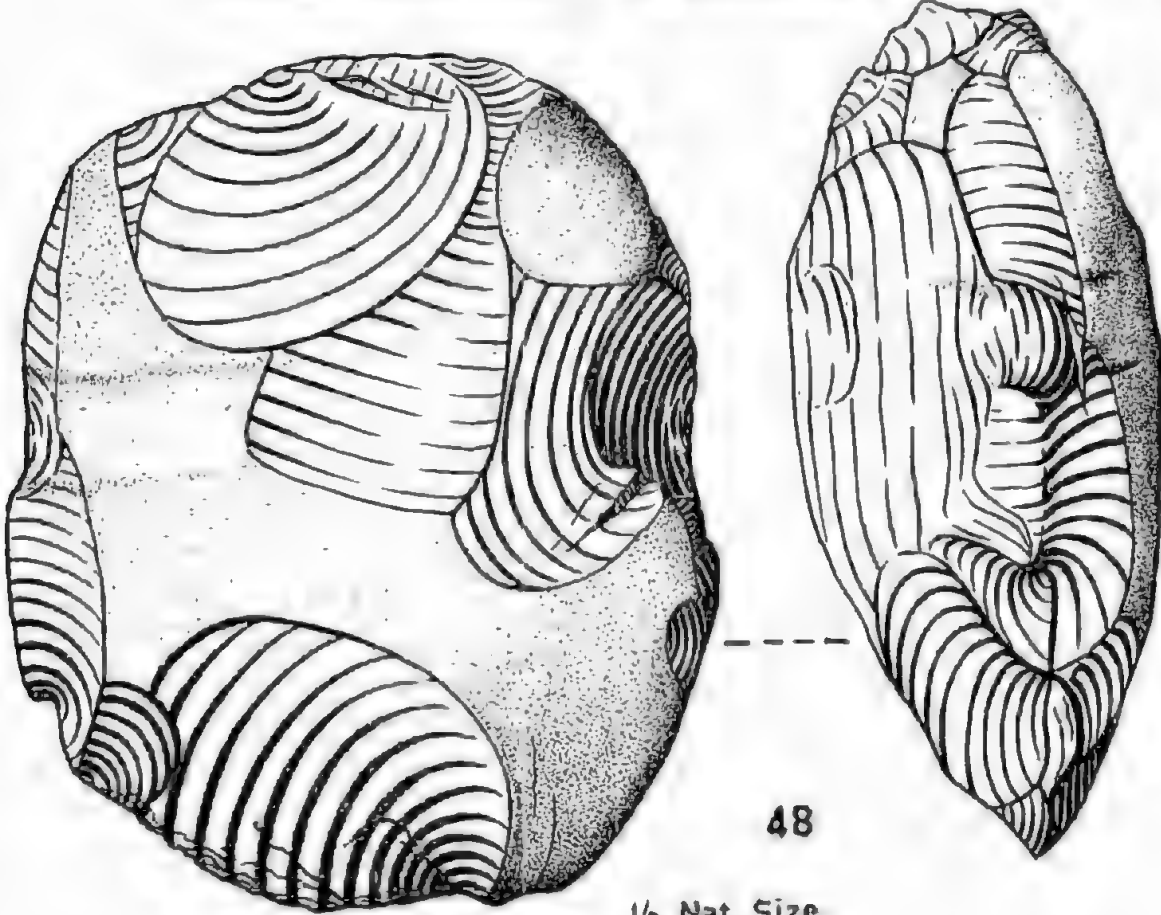
The writer, meanwhile, offers with some hesitation, a final problematical succession of events but with the proviso that it is as hypothetical and unconfirmed as those in this paper which precede it.

There is a possibility that:—

- (1) The old Kangaroo Islanders were Tasmanoids.
- (2) They arrived by way of a land bridge, partial or complete.
- (3) They were a small party.
- (4) Their home subsequently became an island.
- (5) They thenceforth pursued a life of isolation and solitude.
- (6) They died where they had lived.

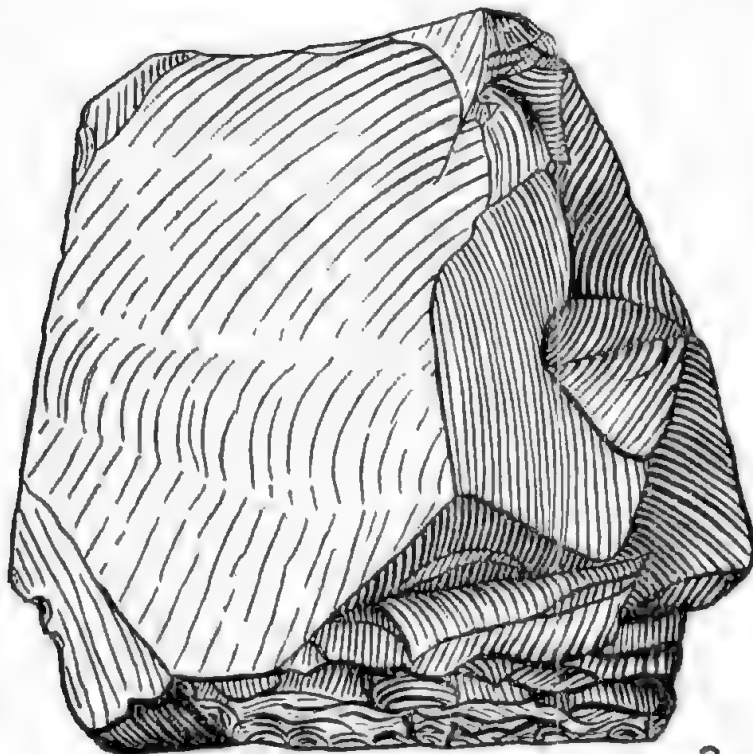
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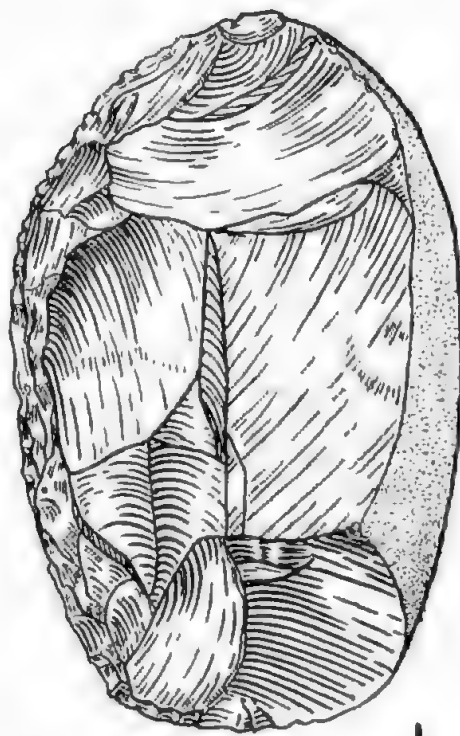
48

1/2 Nat. Size



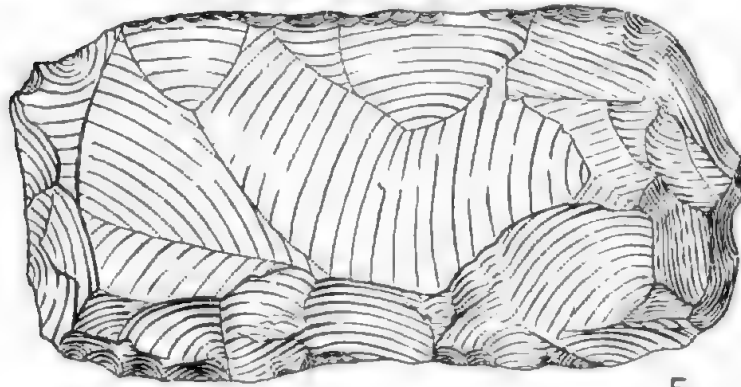
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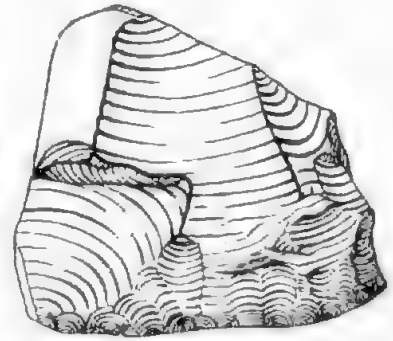


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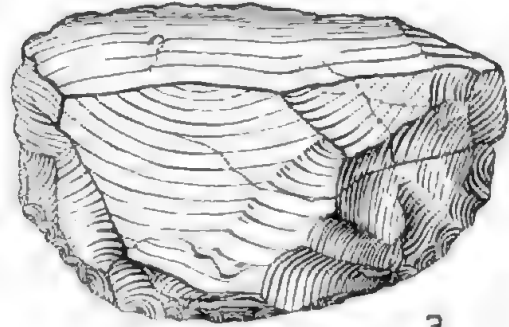
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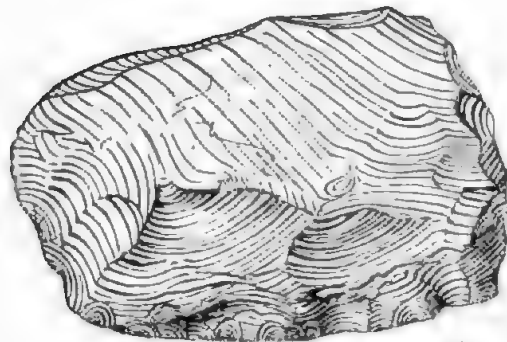
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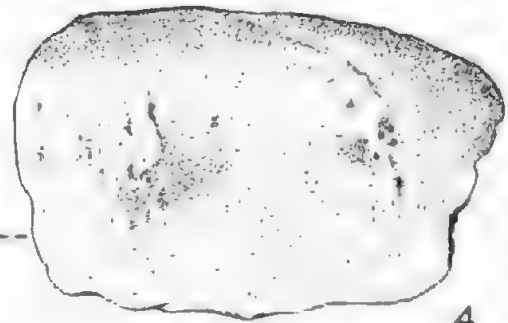
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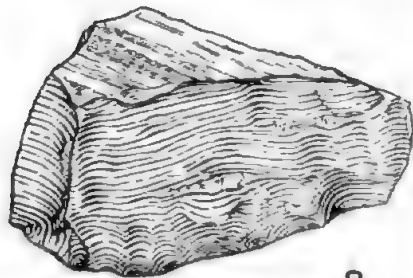
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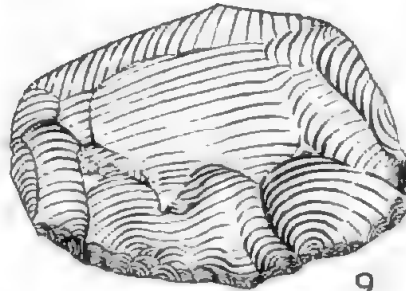
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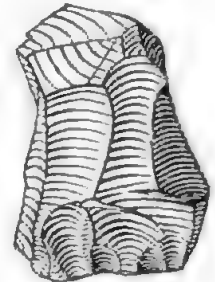
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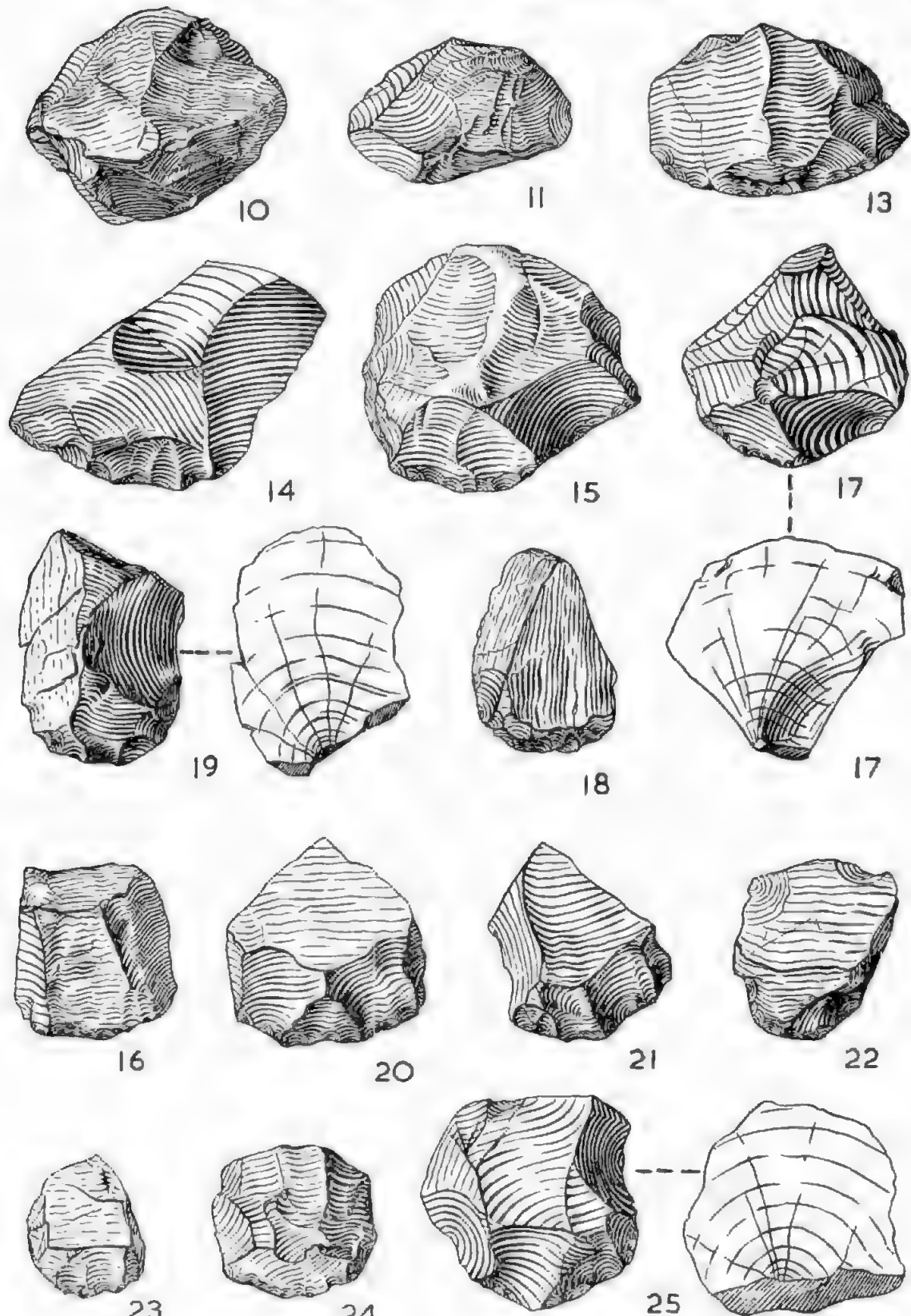


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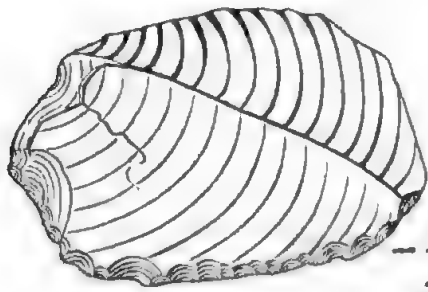


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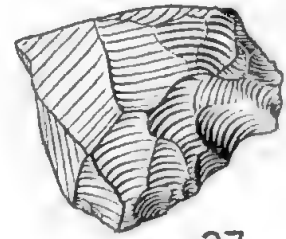
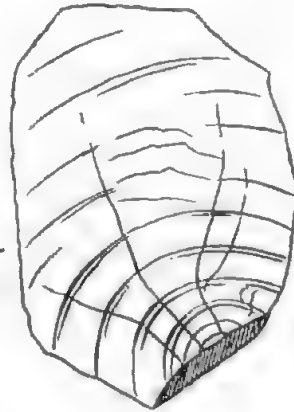
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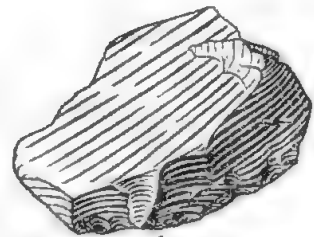
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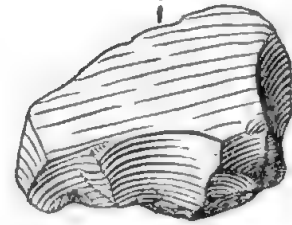
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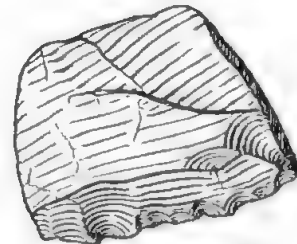
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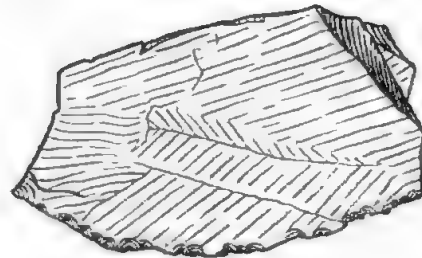
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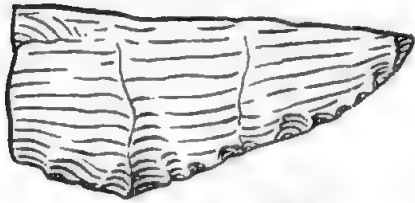


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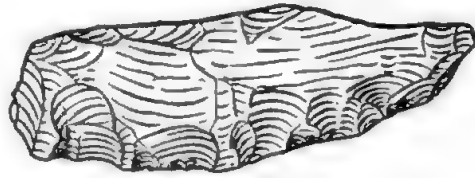


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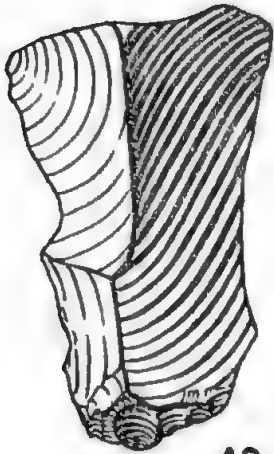
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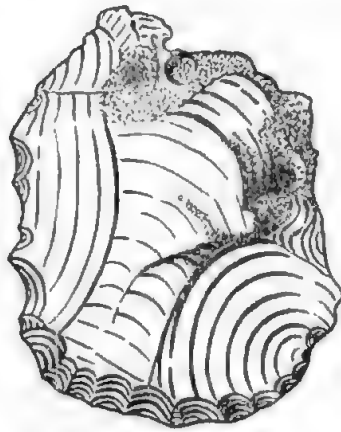
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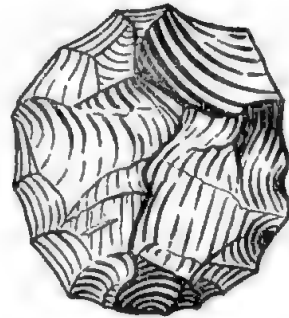
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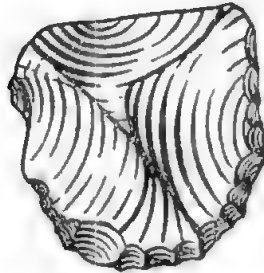
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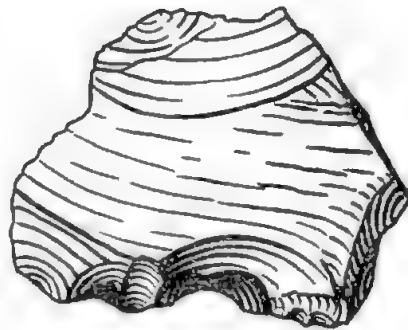
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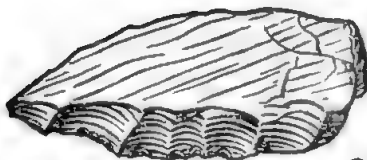
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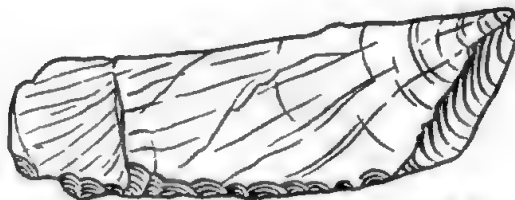
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DESCRIPTION OF FIGURED SPECIMENS

- Fig. 1. A typical Kangaroo Island semi-uniface trimmed chopper. Made from a rounded pebble.
- Fig. 2. A "Horsehoof" shaped core with stepped trimming; showing overhang due to wear and consequent retrimming.
- Fig. 3 and 4. Small semi-uniface pebble choppers; a reversed view of Fig. 4 shows pitting due to its use as a hammerstone.
- Fig. 5. Rectangular uniface chopping or scraping implement; made from a rounded pebble.
- Fig. 6. A small "Horsehoof" shaped core with well defined stepped trimming.
- Fig. 7. This specimen, with heavily battered surface, appears to be a throwing ball.
- Fig. 8. Adzestone derived from a small natural angular block.
- Fig. 9. Adzestone made from a flat pebble.
- Fig. 10, 11 and 12. Three working cores from which flakes have been deliberately struck to manufacture small implements.
- Fig. 13, 14 and 15. Fairly thick adzestones derived from flakes.
- Fig. 16. Small trimmed core; "Horsehoof" type.
- Fig. 17-23. Flake endscrapers. An examination of these seven implements and many other examples indicates that there was no preconceived attempt at uniformity in striking off flakes even faintly similar in shape. The utilisation of any piece of stone, which could be roughly fashioned into an implement with a secondary trimmed scraping end, shows the primitiveness of the industry. This crudity in manufacture and vagueness in shape refer also to Fig. 32-37 and, indeed, to many other of the figured specimens.
- Fig. 24 and 25. Adzestones roughly discoidal in shape. Flake implements.
- Fig. 26. Adzestone made from a thin ovate flake.
- Fig. 27. Roughly trimmed adzestone made from a flint flake.
- Fig. 28. Adzestone flake derived from a piece of clear quartz crystal.
- Fig. 29. Awl made from a flat flake.
- Fig. 30. Semi-biface adze flake.
- Fig. 31. "Slug" shaped trimmed flake.
- Fig. 32-37. Knives or saws. All are flake implements except Fig. 37 which has been made from a small natural block.
- Fig. 38. Abrupt trimmed point which may have been pressure trimmed.
- Fig. 39, 40 and 41. Small trimmed knives.

CAPE CASSINI HOARD

- Fig. 42. Microlith endscraper with pressure flaked trimming.
 Fig. 43. Small endscraper.
 Fig. 44. Concave adzestone.
 Fig. 45. Adzestone of irregular shape.
 Fig. 46. Discoidal adzestone.
 Fig. 47. Appears to be a worn and retrimmed adzestone.

A LARGE STONE POUNDER

- Fig. 48. This massive implement, 6½ lb. in weight, has been made from a large water-worn quartzite pebble. The battered condition of its working edge indicates use as a pounder for some type of very heavy work. A definite groove upon each of its narrow edges suggests that it was mounted in some form of wooden handle or withy which would increase its effectiveness. It was found by the writer recently in association with pebble choppers near a fresh-water swamp inland from American River.

ROCK TYPES OF WHICH FIGURED SPECIMENS ARE
COMPOSED

Fig. 1 and 2 were drawn by the late Miss G. Walsh and the remainder by Miss V. Richardson, South Australian Museum, whose assistance is acknowledged with appreciation. Miss Richardson also prepared the excellent sketch plan of Kangaroo Island.

Milky quartz: 7, 10, 11, 16, 17, 18, 19, 20, 21, 22, 23, 24, 29, 33, 35, 36, 37, 38, 39, 41 and 46.

Quartzite: 1, 2, 3, 4, 5, 6, 8, 9, 12, 13, 14, 15, 25, 26, 30, 31, 32 and 34.

Clear quartz crystal: 28.

Cherty flint: 42, 43, 44, 45 and 47.

Flint: 27.

Smoky quartz: 40.

Dr. B. Daily, Curator of Fossils and Minerals, South Australian Museum, kindly identified the various rocks selected generally by the natives in the manufacture of their implements.

LOCALITIES OF FIGURED SPECIMENS

Near Muston, Pelican Lagoon: 3, 5, 7, 8, 10, 11, 12, 14, 17, 18, 19, 20, 21, 22, 23, 28, 34, 36, 37, 38, 39, 40 and 41.

Discovery Lagoon, Emu Bay: 4, 6 and 9.

Bay of Shoals: 13 and 15.

Hog Bay (Willson) River: 2, 16, 25, 26, 27, 29, 31 and 35.

East of Pennington Bay: 24 and 33.

Near Kingscote: 30.

Cape Cassini: 32.

Point Morrison: 1.

Cape Cassini Hoard: 42, 43, 44, 46 and 47.

DECORATED ABORIGINAL SKIN RUGS

*BY CHARLES P. MOUNTFORD (DIP. ANTHRO., CANTAB.),
HONORARY ASSOCIATE IN ETHNOLOGY, SOUTH AUSTRALIAN MUSEUM*

Summary

The aborigines of Southern Australia and Tasmania used rugs, made from the skins of animals, to keep themselves warm at night and during the inclement weather. The inside surface of some of these rugs was plain; others were decorated with a series of elaborate patterns which had been scratched on the skin with sharp mussel shells and darkened by an application of charcoal and grease. Dawson (1881, facing p. 8), illustrated an aboriginal woman from Victoria wearing one of these decorated skin rugs (Pl. lii, A).

DECORATED ABORIGINAL SKIN RUGS

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Plate lii and text fig. 1

The aborigines of Southern Australia and Tasmania used rugs, made from the skins of animals, to keep themselves warm at night and during the inclement weather. The inside surface of some of these rugs was plain; others were decorated with a series of elaborate patterns which had been scratched on the skin with sharp mussel shells and darkened by an application of charcoal and grease. Dawson (1881, facing p. 8), illustrated an aboriginal woman from Victoria wearing one of these decorated skin rugs (Pl. lii, A).

A number of Australian authors, Dawson (1881, p. 8), Smyth (1878, p. 294), Worsnop (1897, p. 51), Howitt (1904, p. 742) and Parker (1905, p. 121), have described both the methods of manufacture and the decorations on aboriginal skin rugs, while Continental authors, Ratzel (1896, p. 364), and Van Gennep (1905) illustrated examples of these skin rugs.

Yet, in spite of the interest shown in these rugs by the early ethnologists, and the fact that many thousands of these rugs were in use during the early days of the colonisation of Australia, remarkably few examples have been preserved. The rug described by Van Gennep was destroyed at Leiden, and that of Ratzel, at present in Berlin, is in an exceedingly bad state of repair.

Within the last year or so, however, the author has been able to locate several additional examples of decorated skin rugs; one (No. 5803) at the Smithsonian Institution, Washington, which was brought from South Australia by the 1838 Wilkes' expedition, and two in the ethnological collection of the National Museum of Victoria. One (No. 1627), collected at the aboriginal station of Condah during 1872, and the other (No. 16724), from the aborigines at Echuca during 1853. Two single decorated skins have also been located, one from South Australia, in the collection of the National Museum of Victoria (No. 9243), and the other (No. 4571), from New South Wales, in the collection of the British Museum.

This paper deals briefly with the Victorian rug from Condah. A more extensive paper, in the course of preparation, will describe the remaining examples of rugs and single skins, and discuss more fully the methods of manufacture, the decorations and the uses of these aboriginal skin rugs.

The Condah rug, still in an excellent state of preservation, and made up of forty-nine decorated and one undecorated skin, is seventy-five inches in length, and fifty-six inches in width. The following note is attached to the rug.

“Aboriginal possum rug, obtained about 1872 by Mr. Begg, Principal of the Academy of Hamilton, from the maker and wearer, a black living at the aboriginal mission station at Condah. The decorations on the back of the skins are of genuine native design and the rug is a fair example of those worn as cloaks before Victoria was colonised by Europeans. It is sewn with the sinews of the tail of a kangaroo.”

A number of writers, Howitt (1904, p. 742); Parker (1905, p. 121); Smyth (1878, p. 288); Frazer (1893, p. 201) and Greenway (1901, p. 198), have either stated or inferred that the marks on the decorated skin rugs, or at least some of them, are the totemic marks of the owners. The statement that the aborigines marked belongings with their totemic marks is more or less supported by the “signatures” of the nine aborigines who signed the infamous document (Pl. lii, B), by which Batman claimed a large area of aboriginal land adjacent to Geelong (Dawson, 1881, facing p. 111). Dawson (1881, p. 111), commenting on these signatures states, “the marks of the nine chiefs are the genuine and usual signatures which they were in the habit of carving in the barks of trees and their message sticks.” No doubt, these aborigines would have used similar marks on their skin rugs.

An examination of the Condah rug shows a wide range of abstract designs. It is possible however, that the oft-repeated lozenge-shaped motifs are the totemic marks of the owner.

SUMMARY

This paper describes a decorated aboriginal skin rug from Condah, Victoria. The rug is illustrated and the method of manufacture, function and the designs are briefly discussed.

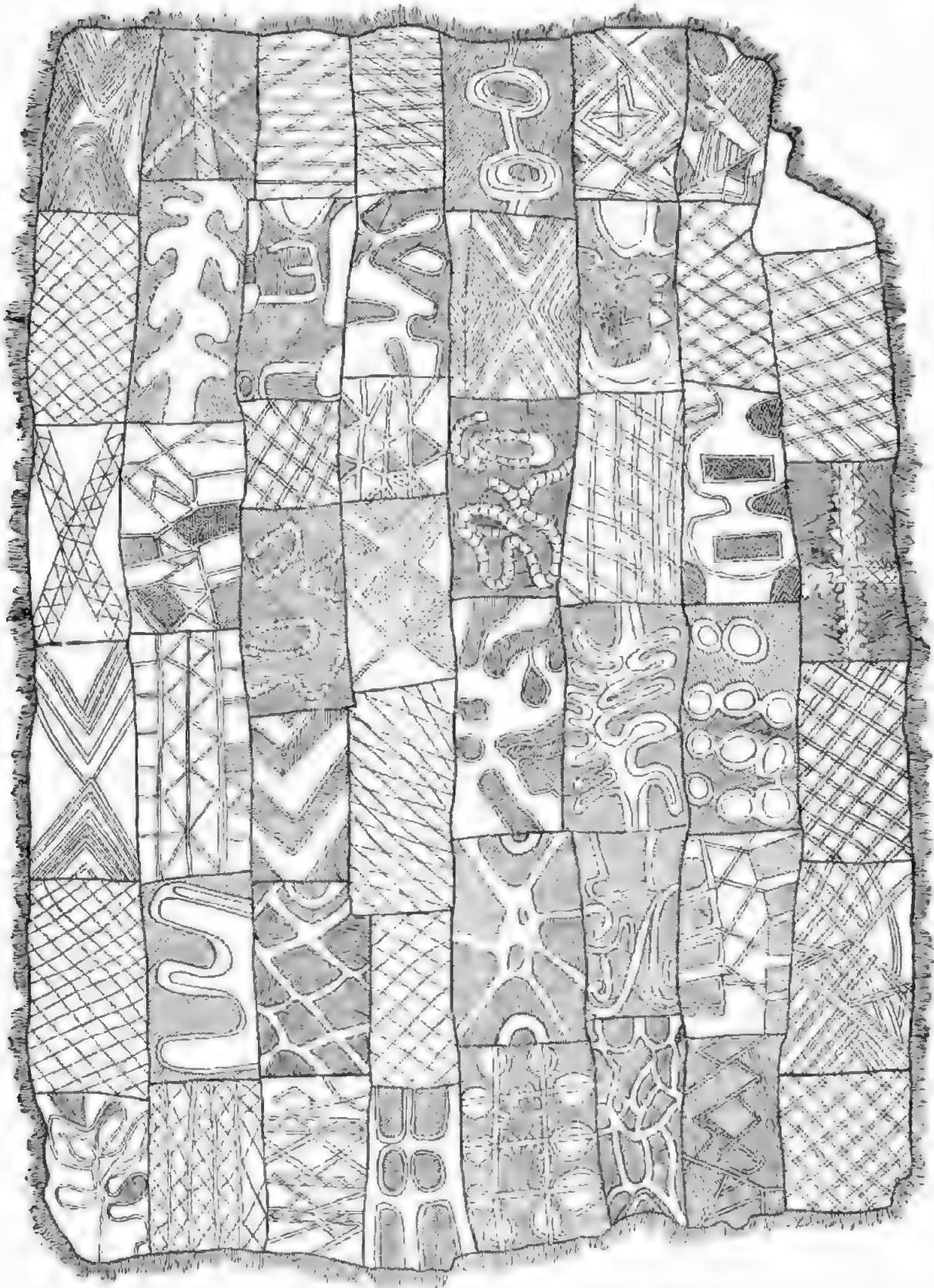


Fig. 7. Aboriginal skin rug from Condah, Victoria.

ACKNOWLEDGMENTS

The author wishes to acknowledge his indebtedness to the Trustees and Director of the National Museum of Victoria for permission to photograph this and other specimens in their ethnological collection, and to Mr. A. Massola for his willing assistance on this and all occasions.

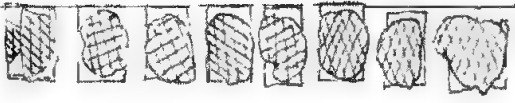
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ending crops from getting harbours
 the whole neck or back of land.
 resents delineated and marked out by us
 of the said tract of land **TO HOLD** the
 his heirs and assigns for ever to the
 and and place thereon sheep and cattle
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Jagajaga-
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Yanpan-
Mowohpe
Mommamalar
John B. Mowohpe

B



Victorian Aboriginal Woman working Decorated Opossum Skin Reg.

Signatures of Aborigines on Batman Document for Sale of Land.

THE PIRRI – AN INTERESTING AUSTRALIAN ABORIGINAL IMPLEMENT

BY T. D. CAMPBELL, HONORARY ANTHROPOLOGIST, SOUTH AUSTRALIAN MUSEUM

Summary

This study consisted of an examination of a large number of pirris in order to give a more concise typological account of the implement than provided hitherto. Measurements of length, breadth and thickness and detailed data of other features have been recorded on over eight hundred specimens.

THE PIRRI—AN INTERESTING AUSTRALIAN ABORIGINAL IMPLEMENT

By T. D. CAMPBELL, HONORARY ANTHROPOLOGIST, SOUTH
AUSTRALIAN MUSEUM

Fig. 1

SUMMARY

This study consisted of an examination of a large number of pirris in order to give a more concise typological account of the implement than provided hitherto.

Measurements of length, breadth and thickness and detailed data of other features have been recorded on over eight hundred specimens.

Mathematical analysis of the data confirms the general observation that two forms of the pirri occurred; a northern and a southern type to which the names Eyrean and Fulham are applied.

Examination of available collections shows that the distribution of the typical pirris had fairly definite geographical limits; these tend to distinguish the pirri as what might be termed a South Australian type of stone implement.

Several minor variations in form and the types of raw material used are described.

Suggested possible uses of the implement are discussed.

The interest and importance of the pirri give ample scope for further research.

INTRODUCTION

In the manufacture of his stone implements, the Australian aboriginal was a highly efficient craftsman. The biface pressure trimmed, symmetrical point, sometimes called the Kimberley Point, and the widely distributed microlithic forms in the shape of small geometrics and segments, are fine examples of lithoclastic art. The uniface trimmed point known as the Pirri, is another example of skilled technique in producing an attractive, shapely implement.

Apparently the first record of recognition of the pirri as a native artifact, was that of the specimens received by the South Australian Museum from H. Y. L. Brown, then South Australian Government

Geologist. He collected them in the latter part of last century in the region of Euclolo Creek, north-west of Port Augusta; but no account was made of these specimens at that time. The pirri was first described, illustrated, and so named, by Horne and Aiston (1924). Later it was discussed by Hale and Tindale (1930) and by Howchin (1934). Campbell and Noone (1943) illustrated and described the pirri, including a more concise typological account than had hitherto been presented. In a memoir on the stone implements of Australia, McCarthy, Bramell and Noone (1946) provided a comprehensive list of previous publications which referred to this implement; they also described some of its special typological features. More recently, Mitchell (1949), Tindale (1957) and McCarthy (1958) have discussed the pirri at some length. Mitchell added useful factual data; the observations of the other two authors dealt mainly with their views on its so-called cultural significance.

The object of the present paper is to present results of a further study on the typology and distribution of the typical pirri. It seems obvious that until information on these aspects of this implement is clarified, its significance in relation to the development and sequence of other implements in Australian material culture cannot be properly assessed.

Regarding the work of Horne and Aiston, it should be mentioned that for the name "pirrie", used in their original account of the implement, the more desirable spelling "pirri" has since become generally adopted. And although their work did not provide a detailed typological account of the pirri, there is no doubt to which particular implement they gave this name—their illustrations (H.&A. fig. 57) adequately confirm this.

TYPOLGY

The pirri is a uniface trimmed, symmetrical point; produced from a narrow lanceolate flake of trigonal cross section, with its median ridge on the outer surface. The outer surface is trimmed by removal of small flakes from the lateral margins up to the median ridge; with subsequent finer edge trimming. The flaking of the two faces of the outer surface is continuous from the point to the butt end. It is considered that this secondary trimming was done by pressure. The implement varies in size and shape; but occurs mainly in a somewhat narrow leaf-shaped form, in which the maximum width is about one third of the length of the implement. Its length ranges from occasional large examples reaching up to 60 to 70 mm., down to many of micro-lithic dimensions (30 mm. and under). Its maximum thickness is

about one third of its maximum breadth. (See fig 1 a, b, c.) More precise and detailed data on its dimensions are provided in Table I of the statistical analysis. In the more completely trimmed examples—over 50 per cent of those examined in detail—the butt end was shaped to a thin rounded margin, by removal of the striking platform and the adjacent part of the median ridge. In these, near the butt end, the implement is of a thin plano-convex cross section which then becomes of an isosceles outline and tapering to a small equilateral triangle towards the point end. The best examples of these completely trimmed pirri are fine specimens of symmetry and delicate workmanship. This account describes the particular type of implement first presented and illustrated by Horne and Aiston as the pirri (pirrie).

A similar, but smaller implement although differing in some features from the above typical account, must be included as a form of pirri. This implement was called the "Fulham Point" by Campbell and Noone (1943). A number of them were among the material collected from campsites in that locality near Adelaide, and were in the South Australian Museum collection at the time of their survey.

As it is desirable that some specific names be given to the original and to the southern, smaller form of pirri, they are herein referred to as "Eyrean" and "Fulham" types respectively. The term Eyrean seems suitable as the first described and illustrated pirris came from an area just to the east of Lake Eyre. Large numbers of this typical form have been collected from sites in other areas which are part of, or adjacent to, the "Eyrean Basin"; and most of them were made from materials which are geologically typical of that large region. The term "Fulham" is retained for the southern type of this implement; and on account of some significant differences from the typical northern pirri, it is described in the following section.

THE FULHAM PIRRI

This implement is a small form of pirri and occurs fairly often among the various pointed types collected from areas—many of them coastal sites—near to, and south of Adelaide. Moreover it is the prevailing form of the pirri from all districts to the immediate north; to which must be added Yorke and the southern part of Eyre Peninsulas.

A survey of available collections shows that there are several features in which the Fulham type differs from the typical Eyrean form. Most significant is the fact that with few exceptions, the former tends to be of microlithic size. In relative dimensions, it is

much thicker than the northern form (see Table 1), and it was made from different materials. Larger sizes tend to increase in numbers going northwards, towards the region of the Eyrean pirri. The statistical analysis of the measurements shows definitely that the Fulham pirri is of distinctly different form (see fig. 1 d).

Somewhat similar in form is the "Adelaide point" (Campbell and Noone) the shaping of which was limited to only abrupt trimming of the lateral margins. This southern form has been subjected to the same details of examination as the Eyrean pirri.

The measurements of these implements were made with vernier callipers in millimetres; other features are recorded by descriptive data.

It is hoped that the results of the present observations will provide some useful data to supplement what has already been written on this implement. Certain features have been examined and recorded in greater detail than hitherto, in order to increase our knowledge of this fine example of our aboriginal stone implements.

TABLE 1

		Mean	Variance	Standard Deviation	Range	Approximately 75 per cent of population lies between—
Length—						
Groups	1—6	40.60	70.73	8.41	24.6—77.5	31.1—48.5
	7—8	30.01	52.30	7.23	21.1—48.5	24.1—34.0
Breadth—						
Groups	1—6	16.73	4.00	2.00	9.6—26.5	14.6—19.0
	7—8	13.15	5.29	2.30	9.1—19.5	10.6—15.0
Thickness—						
Groups	1—6	6.01	1.07	1.04	3.4—10.6	4.8— 6.9
	7—8	6.09	1.29	1.14	3.6— 9.6	4.8— 7.2

(Groups 1—6, Eyrean; Groups 7—8, Fulham.)

STATISTICAL ANALYSIS OF DATA

The relationship and differences between the Eyrean and Fulham form raise some points of interest. The following notes have been derived from an analysis carried out at the C.S.I.R.O. Division of Mathematical Statistics. This involved a consideration of the three measurements made on the pirris examined in this study, from which a compound linear index has been derived.

If the length, breadth and thickness are represented by x_1 , x_2 and x_3 respectively, the method has been applied to derive the linear function of these three measurements: $X = \lambda_1 x_1 + \lambda_2 x_2 + \lambda_3 x_3$ which will best discriminate between the Eyrean and Fulham groups, on the basis of measurements alone.

The discriminate function X is:

$$X = 0.000167x_1 + 0.000963x_2 - 0.0001058x_3$$

Since only the ratios of the coefficients are required, for greater convenience, the coefficient of length may be taken as 1; then the coefficients for breadth and thickness are 5.76 and -6.32 , so that the function now takes the form:

$$X = x_1 + 5.76x_2 - 6.32x_3$$

The average value of X for the two groups is: Eyrean form 99.91 and Fulham form 65.89. The mean difference is 34.02 with a standard deviation of 1.38; and this being 23 times its standard deviation, is very strongly significant. The linear function thus calculated, therefore definitely discriminates between the two groups.

The general summarising statistics individually show that the groups are quite distinct, but it is of considerable importance that after allowing for the correlations which exists between the measurements, the compound measurement also yields this clear distinction.

The general difference in form between the two groups may be due to several factors. It seems likely that the difference mainly arose from the differences in the nature of the raw material available in the two regions concerned. The aboriginal workman in both regions deliberately aimed at making pirris; probably by the same basic technical procedures; but in each region he recognised the working properties of his raw material, the result being two different forms of the one kind of implement—the pirri.

In any case, on the basis of the measurements alone, a clear distinction in form exists. A second use of the linear compound is to classify a specimen of unknown origin, by using only its length, breadth and thickness. The following table shows values of the compound X in the region where the two groups overlap, along with the probability of misclassification.

Value of X	Probability
60	1 in 192
70	37
80	10
90	17
100	70
110	435
120	3333

Examples: A specimen giving a value for X of 60 would, if it were a northern form, be wrongly classified as a southern type only once in 192 trials. Similarly, for values of 70 and 80, with corresponding probabilities of 1 in 37 and 1 in 10. As the value 90 exceeds the point midway between the two means (65.89 and 99.91) the form of statement changes—thus a specimen giving a value of $X = 90$ would if it were really a southern form, be wrongly classified as a northern form 1 in 10 times. Similarly for values of 100, 110 and 120. Beyond 60 and 120 there would be no difficulties at all. It will be seen therefore, that only in a small region from 80 to 95 (where the two groups principally overlap) the odds against misclassification are rather weak.

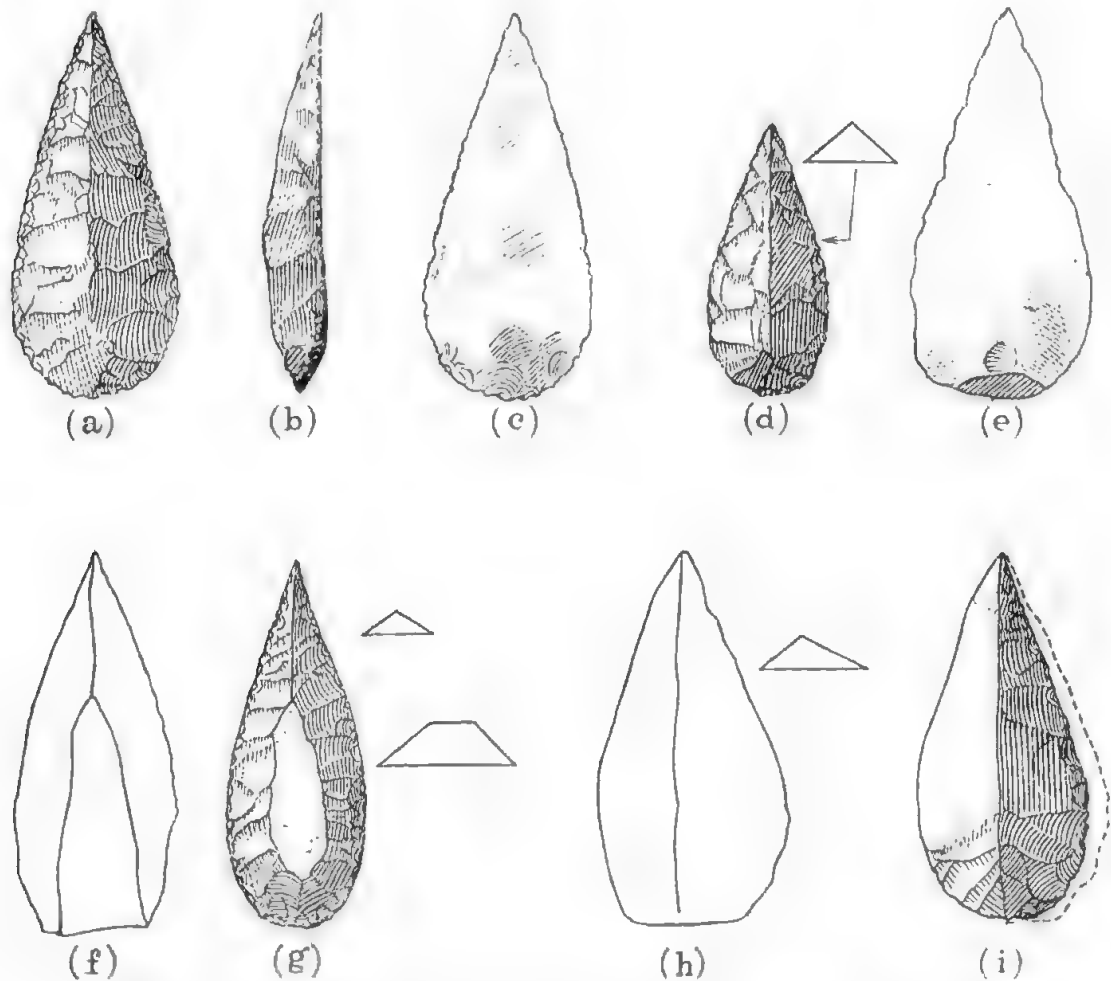


Fig. 1 (a), (b) and (c) are drawn to mean measurements of Table 1.

DISTRIBUTION

On the basis of its known distribution the pirri, might, with some justification, be considered as, almost exclusively, a South Australian implement.

From assessment of available collections and data, the typical Eyrean pirri occurs as follows. It belongs to an area, the northerly limit of which approximates to the latitude of the southern margin of the Simpson Desert. Occasional specimens have been collected in areas which might be geographically termed central Australia; but these are obviously adventitious occurrences. The southern boundary of the northern type would roughly correspond with the latitude of the northern end of Spencer Gulf. In its easterly distribution, it occurs in areas reaching into south-west Queensland and north-west New South Wales and to the south along the Darling River. These State borders are based on certain lines of longitude and latitude and bear no relation to so-called "natural regions". Mitchell, writing of certain areas adjacent to the River Darling, states "Although scarce, pirris occur; Lake Eyre, their provenance, is 500 miles away to the west, and these two areas are apparently near the limit of their eastern distribution." Tindale (1957) has stated that "The Pirrian culture has now been reported from almost all parts of Australia excepting only Cape Yorke Peninsula, coastal Queensland and parts of eastern New South Wales; in these three places insufficient collecting has been done to regard their entire absence as established beyond doubt." McCarthy (1958) stated that his examination of "many thousands of knapped implements in the Australian Museum amassed by a number of collectors over a period of over forty years from surface sites on the south coast of New South Wales failed to reveal a pirri industry." Black (1949) who collected extensively in the north-west of New South Wales, stated concerning the pirri: "I have never found any pirris south of the Broken Hill—Menindee railway and very few east of the Paroo River in the Darling River Valley."

As yet, it has not been established how far the pirri occurs westwards; but examples have been collected near Coober Pedy in the north-west of South Australia and some rather poor specimens from Ooldea. The southern limit of the pirri appears to correspond very definitely with the River Murray. Although a few specimens have been collected from campsites on what might conveniently be termed the southern bank of that stream, the typical pirri does not occur in regions to the south of the Murray in South Australia, where large collections of implements have been made over the last thirty years. Mitchell who

has collected extensively over Victoria for many years considers the pirri was unknown in that State; the present writer also is acquainted with many Victorian sites, but nothing resembling a pirri has ever been obtained there.

Like its northern counterpart, the Fulham pirri appears to have had a fairly definite range of distribution. In the south, it extends to the River Murray which, as stated above, is the southerly limit for all pirris. Its northerly boundary corresponds with the southerly limit of the Eyrean type; although occasional instances of overlapping of the two kinds have been noted. As a general observation, it seems that as one goes away from the main areas of the northern pirri, that is to the south, south-west, and south-east of pirri distribution, the Fulham type tends to become scarcer and with increasing percentage of the smaller sizes. The peripheral south-eastern sites apparently produce mainly the smaller implements; for example, regarding the Darling River region and up towards south-west Queensland, Mitchell states "As one proceeds westward, pirris increase in numbers; but they are small compared to those at Lake Eyre and are seldom longer than 30 mm. In size and shape many are similar to the Fulham pirri of South Australia described by Campbell and Noone (1943)."

To the west, this smaller type predominates on sites on Yorke and on the southern part of Eyre Peninsula. An interesting fact is that on the Eyre Peninsula area especially, this Fulham pirri mingles with a small triangular type of trimmed point, some of which show complete biface trimming—the latter type of implement has not as yet been described in detail.

There have been reports of the occurrence of the pirri on sites well removed from the regions outlined above. It is likely that some of these have been mistakenly described as pirri. But where the technique of pirri manufacture was obviously an established part of aboriginal stone industry, the implements occur in relatively large numbers; and as stated above, these particular regions are somewhat circumscribed.

MATERIALS USED

The major proportion of the Eyrean specimens concerned in this study came from two main areas. First: the region from which the originally described pirris were obtained—an area in the vicinity of, and north of, Cooper Creek, where the Birdsville Track traverses the far north-east of South Australia, east from Lake Eyre. Second: large numbers from the region to the immediate west of Lake Torrens.

With these regions—which might be considered part of the Eyrean Basin in its broadest sense—are associated the so-called desert sandstones and those materials which come under the general category of the chalcodonised, fine-grained sandstones and clays; the porcellanites, jasper, opal and agate. In addition, many implements were made from fine-grained quartzites which abound in the abovementioned areas in the form of the well-known "gibbers"; although exceedingly tough in texture, it was obviously a favoured material from which many well finished examples were made. These materials are part of the so-called duricrust formation, attributed to the late Cretaceous and subsequent periods. All of these materials are noted for their conchoidal fracture and are amenable to smooth primary and secondary flaking. The finer grained the material, generally the better and more delicately finished are the implements.

As with most other implements of the Adelaide area, the vast majority of the Fulham pirris were made from varieties of quartzite derived from local rocks of the Mount Lofty Ranges. The fine-grained chalcodonised materials, characteristic of the northern pirri, were not readily available; the small numbers of implements made from the latter materials are examples most likely acquired from further north, or made from imported materials.

It is interesting to note that proceeding north from the Adelaide districts, an increasing number were made from a better type of material—mostly in the form of smooth cherts.

When the available material was mainly the coarse, tough textured quartzites, the preparation of a core, and knapping of long, lanceolate or leaf shaped flakes was not an easily controlled procedure. While the craftsmen no doubt strived for, and utilised, primary flakes of suitable shape, some of the smaller type of pirri give the impression that possibly the median ridge of the finished implement was formed mainly during the secondary flaking process, rather than that it was an essential part of a primary flake with a trigonal cross section. The statistical results show that the thickness of these small implements is greater, relative to their general dimensions, than with the northern pirri. This tends to bear out the idea of the difficulty in securing the longer, more shapely primary flake. It is a remarkable tribute to the skill of the southern workers that so many well made implements were fashioned from these tough, intractable materials.

BUTT END

Apart from the excellent shaping of the pirri, by flaking from the lateral margins up to the mid-ridge, its further development was effected by trimming the butt end.

Trimming of the butt was apparently carried out in several fairly definite stages—as revealed by the conditions seen in the collection of pirris examined in this study.

First: those specimens showing the neat lateral flaking, but with the butt end intact, its striking platform practically untouched. An important feature in this stage is that the surface of the platform slopes downwards to the inner surface of the implement (see fig. 1e).

Second: in this stage, the platform had been partly trimmed away—on the outer surface—this being readily effected owing to the acute angle at the platform outer margin. This partial removal of the platform resulted in only a limited shaping of the butt end.

Third: here the striking platform had been completely trimmed away by further flake removal on the outer surface, which also reduced the butt end of the mid ridge; and so this end of the implement was shaped to a neat rounded margin.

Fourth: this stage seems to have been a supplemental treatment of the butt end of some implements where further reduction of butt end thickness was desired. At the third stage, the platform had been completely eliminated, so that it was then possible to detach flakes from the inner surface of the butt end. In effect, this reduced the convexity of the bulb of percussion and resulted in a thin, sharp edge to the rounded butt margin (see fig. 1 c).

This last mentioned treatment of the butt end involved some trimming of the inner surface of the implement; but it affected only a small area and served the special purpose of reducing some of the bulb convexity, by detaching a few small flakes. The slight inner face trimming gives no justification for considering the pirri a biface trimmed implement—term which has a definite and accepted connotation; as for example, the Kimberley point.

A likely variant of this butt treatment is seen in some specimens, the inner surface of which is quite flat. This may have been the result of deliberately striking off the butt end of the partly formed implement, to remove extra thickness due to a marked bulb convexity; after which the usual thin rounded margin was completed. In these examples, nothing remains of the bulb curvature.

The following figures have been derived from records made on this particular feature in the specimens examined.

Recorded on 650 implements.

Butt end not trimmed	84
Butt end partly trimmed	193
Butt end fully trimmed	373

Mitchell states that of 235 pirris he collected at Mulka—in the area of the originally described pirri—36.1 per cent showed either trimming or thinning on the butt; the striking platform being intact on the remainder.

From the above figures in this study, it is seen that 57 per cent of the implements so examined, show complete peripheral trimming; that is, with finished butt end as well as lateral trimming.

Included in the "fully trimmed" records are the variations of the rounded butt margin.

Also in this examination of butt trimming, 43 per cent showed some flaking of the inner surface. This inner flaking was somewhat irregular; often only a partial reduction of the bulb convexity was effected, but generally sufficient to attain the apparently desired thin margin.

Some attention was directed to ascertaining what might have been the main factor which facilitated the forming of the thin rounded margin of the butt. The type of material was observed. Finer grained, more tractable material should have made it easier to obtain the neat butt margin; but it was found that among the best finished implements, a wide variety in texture of material was evident. The robustness or thickness of the primary flake might have affected the reduction of the butt end; but this approach showed that many thick implements have a thin, rounded butt margin. Perhaps this neat finish to the butt end of so many of the implements may have been—as Howchin suggested—a matter of the artistry and pride of the worker at the time of making any particular implement.

Whatever was the purpose of this thin, rounded margin—functional or otherwise—the various conditions in the implements examined showed that the aboriginal craftsman carried out a definite sequence in their shaping. When all these stages of pirri manufacture were carried out to finality, exceedingly beautiful implements were produced.

SOME VARIATIONS IN FORM

There are a few variations in form which call for comment. The number of specimens showing features by which they differed from

the typical pirri, were few in number out of the large total examined. They are good evidence that the skilled aboriginal workman knew exactly what he was doing—when circumstances called for some departure from customary procedures, he nevertheless produced the desired result.

Cross Section. The vast majority of pirri were fashioned from a primary flake, trigonal in cross section. The inner surface being the base of the triangle; its apex represented by the outer midrib, which in the finished tool is trimmed away at the butt end. Some of the primary flakes used, had a midrib which bifurcated into two ridges, ending at the lateral margins of the platform. The lateral trimming reaches the single median ridge for part of the length of the implement; and then up to the two separated ridges, leaving an untrimmed triangular portion of the outer surface, towards the butt end. Less than 3 per cent of the hundreds of specimens examined showed this variation (see fig. 1, f and g).

Unilateral trimming. Another variant is the specimen made from a primary flake the cross section of which must have been scalene, rather than the outline of an equilateral or isosceles triangle (fig. 1, h). This is another example of convenient adaptability in technique. By trimming the wider of the two outer faces of the unworked flake, the removal of material ultimately increased the angle of that margin, to correspond with that of the untrimmed side. Thus producing the customary symmetrical form with a cross section being brought more to the equilateral form (see fig 1. i). In the total of over 800 implements for which details were recorded, less than 3 per cent were of this unilateral trimmed form. But apart from having one face untrimmed, in other respects this variant has the main features of the typical pirri; the flaking of the trimmed face is continuous from point to butt end and involved the whole face up to the mid ridge; and generally with the butt trimmed and rounded. The final result gave the outline of the typical trimmed symmetrical point.

Dentate margins. In a few rare examples, a final trimming of the flaked margins of the implement produced a dentate effect to the borders, not unlike that seen in many of the Kimberley Points.

USE OF THE PIRRI

Regarding the question of the use of the pirri, no satisfactory answer has yet been provided. On account of its general shape, the possibility of its use as a spear point has been the customary suggestion but other uses have been submitted.

Horne and Aiston (1924) wrote of its use “. . . as a graving tool to make decorative marks on wooden weapons, and occasionally it is used as a drill for light boring work.” In the South Australian Museum collection are a number of specimens purported to be wood-working tools, with pirri mounted in gum. These came from the district where Aiston lived for many years and were made by aborigines there. In their volume, they state that these natives were not conversant with the making of pirri; furthermore, the mounting of these pirri on the wood handles varies—on some, the inner surface of the stone tool faces one way, and on other handles in the opposite direction. Such inconsistency in mounting these stone tools rather suggests that these natives really knew nothing about the main use of the pirri and mounted them according to a use suggested to them.

Hale and Tindale (1930) stated “It seems possible that this artifact may have been a spearhead.”

Howchin (1934) expressed doubt as to their use as a spearhead. He also discussed its possible use as a tool for scribing fine, decorative lines on wooden objects. He wrote “Among the more highly finished examples were some that possessed exceedingly sharp points that could not bear the pressure used with a graving tool without fracture; it is, therefore, possible that these beautifully finished and delicately pointed specimens were held as a matter of pride as to execution rather than as tools.”

Tindale (1957) stated “that the pressure flaked biface blade culture of North Western Australia is likely to have been a direct development from the pirrian.” He further stated “The most characteristic implement, the pirri itself . . . was a spearpoint.” His illustration (fig. 4) in support of this contention and on examination of the partly trimmed point concerned, show that this isolated example is obviously not a typical pirri point.

The stone headed spears in the South Australian Museum were carefully examined by the late H. V. V. Noone who considered the few odd specimens with small trimmed points were not typical pirri and quite fortuitous among the much larger, untrimmed trigonal stone flakes on Central Australian spears.

The resemblance in some respects of the pirri to the Kimberley point spearhead has been cited in favour of the pirri having been so used. But typologically there are several obvious differences between the typical pirri and the Kimberley point; especially when regarding them both as spearheads. Both are symmetrical trimmed points and the pirri is also regarded to have been produced by pressure flaking.

A parallel examination of collections of both types of point does not give the impression of a strikingly close resemblance. In general, the Kimberley point is a much larger implement; it is much broader and thinner relative to its length; it is a biface trimmed point; its lateral margins are consistently serrated or dentate. Above all, the Kimberley point has the appearance of being a spearhead of marked potential for penetration and wounding for which purposes the pirri would be almost completely ineffective, both in size and form. The writer has subjected a range of over one hundred Kimberley points of various shapes and sizes to the same measurements as made on the pirri. There are obvious differences in size and form; only four Kimberley specimens out of the total are of microlithic size.

It has been shown that the pirri is often of microlithic size; predominantly so with the Fulham type. With the customary Australian practice of mounting a stone spearhead in gum, very little of most of these implements would be exposed for such a functional purpose. On account of their size, it might be more fittingly suggested that it would have been suitable as an arrow head; but there is no record of the Australian aboriginal having known the use of the bow and arrow. Moreover, the pirri bears no resemblance to the typical stone arrow heads which are so well known from many parts of the world. Or again, on the score of size, it would have been more suited for the head of something in the form of a small hand lance; but here again its mounting and fitting to a shaft would leave it a very ineffective point for serious, much less lethal, damage. However, this is another aspect of the pirri calling for continued research.

DISCUSSION

A study of a large collection shows the fine craftsmanship involved in the production of the completed form of the typical pirri. It presents features which clearly reveal that those responsible for its making had a clear idea of the kind of implement they set out to produce, and also had the technical skill to make it.

The figures given above show that the pirri, in both its northern and southern forms, is a relatively small point. The former was sometimes made in microlithic size and occasional specimens are "outsized" in length—Mitchell has recorded specimens up to 90 mm. But in general, the standard deviation for the dimensions of both types is fairly low in value; some variation in length, but consistently low for breadth and thickness. The prevalence of microlithic forms among the southern type is interesting.

From present knowledge, the occurrence of the pirri appears to have had fairly definite geographical limits which make it almost exclusively a South Australian implement.

The northern form was made from materials well suited for the skilled technique applied to its manufacture; they are characteristic of certain geological formations of the region and thus constitute a factor in the distribution of this particular form of the implement. The finest examples are always associated with the availability of the fine grained chalcidonised materials. For many of the Adelaide region the available materials were mainly tough, coarse grained quartzites which seems to have been the important factor in the predominant occurrence of those of microlithic size.

The use of the pirri is a question for which, as far as present knowledge goes, no satisfactory answer has arisen. Its use as a spearhead has been suggested on somewhat superficial morphological grounds. But the occurrence of so many implements of small and of microlithic dimensions seems rather against it having been an effective and useful kind of spearhead.

It is unfortunate that the term pirri has, by some writers, been applied to a variety of implements which bear little or no resemblance to the pirri. As stated above, it is a symmetrical, uniface trimmed point with certain definite typological features. There are many kinds of "points" of symmetric and asymmetric form, showing varied degrees of secondary trimming. These range from the slightly retouched leaf-shaped flake, to more fully worked types, like the bilateral abrupt trimmed points. Because these may have the general shape of the pirri, there is no justification whatever for them being classified as such. Various types of trimmed points were produced by the aboriginal craftsman, but for most of them very little or nothing is known of their function; therefore their classification must rest mainly upon morphology. Unless the typology of the various forms be based on clearly definable specific features, confusion must prevail in their classification. Many leaf shaped points of more or less symmetrical form occur, with indications of secondary trimming which may or may not have been abortive or discarded attempts at producing a pirri; but the typical pirri has been collected in such large numbers and shows definite features in the stages of its production, that indiscriminate application of the term pirri to partly and irregularly chipped flakes is not warranted.

The present study shows that the pirri is an intriguing Australian stone implement. Its skilful manufacture and meticulous finish make it an object for admiration; its limited distribution and its own specific features of interest provide ample scope for further research.

In addition to that of the writer, these observations were made on the following collections: South Australian Museum and the private collections of Messrs. E. M. Mudie, S. R. Mitchell, H. M. Cooper and Dr. Ian North.

The writer's thanks are due to the following for generous assistance in the preparation of this paper. Mr. H. M. Hale, Director, S.A. Museum; Professor E. A. Cornish, C.S.I.R.O. Division of Mathematical Statistics for analysis of the dimensional data; Dr. H. Marston and Mr. Murray C. Childs of the C.S.I.R.O. Nutrition Laboratories for the preparation of illustrations; Drs. P. S. Hossfeld and B. Daily for advice on geological notes; Mr. H. M. Cooper and Miss B. Pearce in the preparation of the notes.

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