RECORDS
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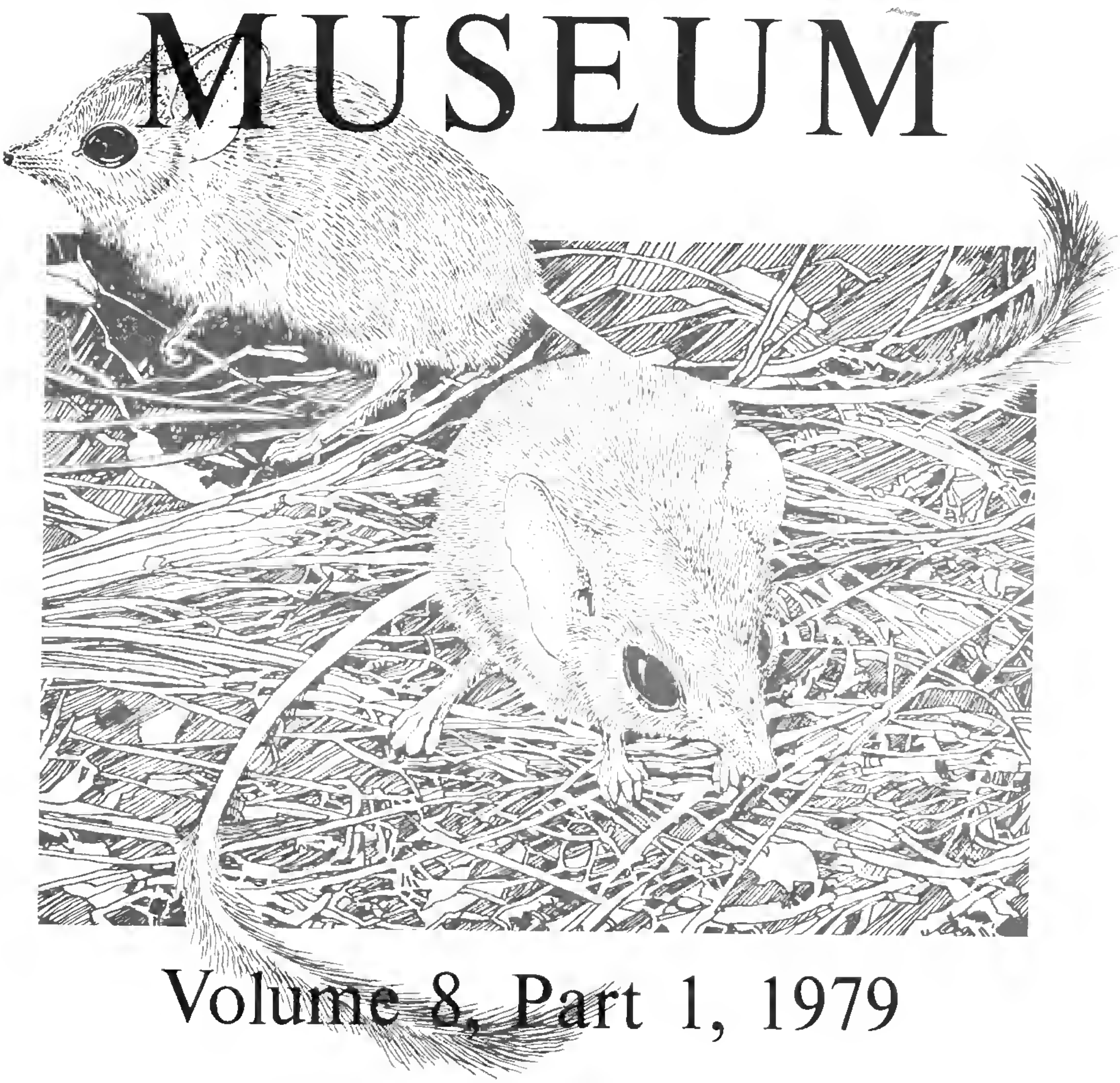

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Cover: Wuhl-wuhl (*Antechinomys laniger*), a small dasyurid marsupial from the arid and semi-arid regions of Australia, infrequently seen in this State.

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RECORDS OF THE WESTERN AUSTRALIAN MUSEUM VOLUME 8

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AN ANNOTATED CHECKLIST OF THE FISHES OF THE SWAN-AVON RIVER SYSTEM, WESTERN AUSTRALIA

C.F. CHUBB*
J.B. HUTCHINS**
R.C.J. LENANTON†
and
I.C. POTTER*

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ABSTRACT

The checklist of the fishes of the Swan-Avon River System in south-western Australia given in this paper is based on the collections and records held by the Western Australian Museum, and on the results of a recent extensive sampling programme carried out with beach seines, trawls and mesh nets. The latter study has also provided data on the distribution of many of the species within the river system. The 110 species recorded are predominantly of marine origin and can be regarded either as marine "stragglers," or as fish which utilize the estuary predominantly as a nursery area or adult feeding ground, or as an environment that can he exploited at various times during the life cycle. Several of the most abundant species are, however, represented by populations that can pass through the whole of their life cycle within the Swan-Avon River system. Although, as with other south-western Australian rivers, the indigenous freshwater fish component is highly impoverished, its abundance in this system has also suffered from the effects of damming, periods of "drying-up," eutrophication and run-off from agricultural land. At the same time, some of the changes brought about by damming have produced conditions favourable for the establishment of populations of certain introduced species. Comparisons between the fish fauna of the Swan-Avon River System and the limited data for other Western Australian coastal rivers suggest that Cape Naturaliste represents the approximate southern limit of the distribution of many northern species, while the corresponding point for the northwards extension of several southern species is in the region of the North West Cape.

* School of Environmental and Life Sciences, Murdoch University, Murdoch, Western Australia 6153.

** Department of Ichthyology, Western Australian Museum, Francis Street, Perth, Western Australia, 6000.

† Western Australian Marine Research Laboratories, Department of Fisheries and Wildlife, West Coast Highway, Waterman, Western Australia 6020.

INTRODUCTION

The Swan-Avon River System (lat. 32°04′, long. 115°44′) is defined by Jutson (1934) as comprising three rivers and their tributaries, namely the Swan-Avon, Helena and Canning. This river system is by far the most important commercial and recreational river in Western Australia, where it runs through the two principal cities of Perth and Fremantle (**Figs 1, 2**). During recent years, a number of studies have added to our knowledge of both the invertebrate fauna and the hydrological conditions existing in this river (see Hodgkin and Majer, 1976). By contrast, and despite the presence of a large amateur and viable commercial fishery, there is no comprehensive account of the composition of the fish fauna of the Swan-Avon River System and few publications on the ecology of individual species within this system. An exception to the latter generalisation is provided, however, by Kowarsky's studies (1973, 1975) on the Cobbler, *Cnidoglanis macrocephalus*. Moreover, broad-based ecological data on certain of the predominant and commercially important teleosts found in Western Australian estuaries, such as anchovies (Blackburn, 1950), mullets (Thomson 1950, 1951, 1954, 1955, 1957a, b, c, d, 1966) and whiting (Lenanton, 1970), were based to some extent on animals collected from the Swan-Avon River System. It is worth noting that the only published information on the general biology of many of the fish species found in a single Western Australian river system is that provided by Lenanton (1977a) in his account of the fish fauna of the Blackwood River Estuary.

The main objective of this paper is to provide an annotated checklist of the fish fauna of the Swan-Avon River System, providing details where possible on the distribution of the various species within the estuarine and fresh water components. The data have been compared with the results obtained for other south-western Australian estuaries in an attempt to interpret the distribution of fish in a zoogeographical context. In addition, the information on the biology of the more abundant species is used to provide a series of life cycle categories with respect to the way in which the species utilize the Swan-Avon River System.

DESCRIPTION OF THE SWAN-AVON RIVER SYSTEM

Although the mouth of the Swan Estuary is narrower than might be expected for a river of this size, it is in fact wider and deeper than that of most other estuaries in south-western Australia. This is mainly due to the dredging which has taken place in this region to remove sand sills and a rock bar to widen and deepen the entrance to Fremantle Harbour which constitutes the major Port of Western Australia (Seddon, 1972).

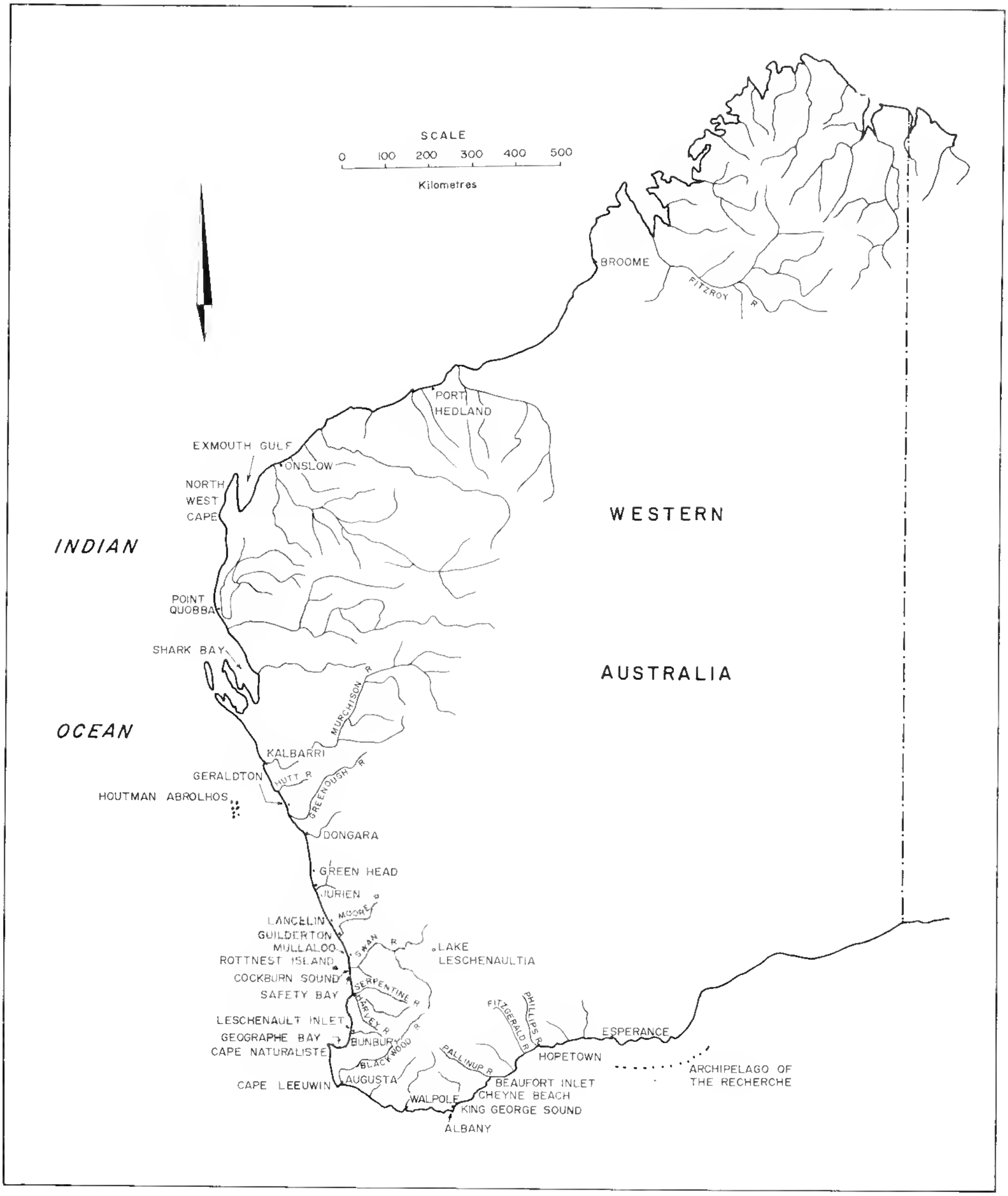

Fig. 1: A map showing the localities and rivers in Western Australia which have been mentioned in the text.
N.B. For convenience the cities of Perth and Fremantle have been omitted but are included in the detailed map of the Swan-Avon River System shown in **Figure 2.**

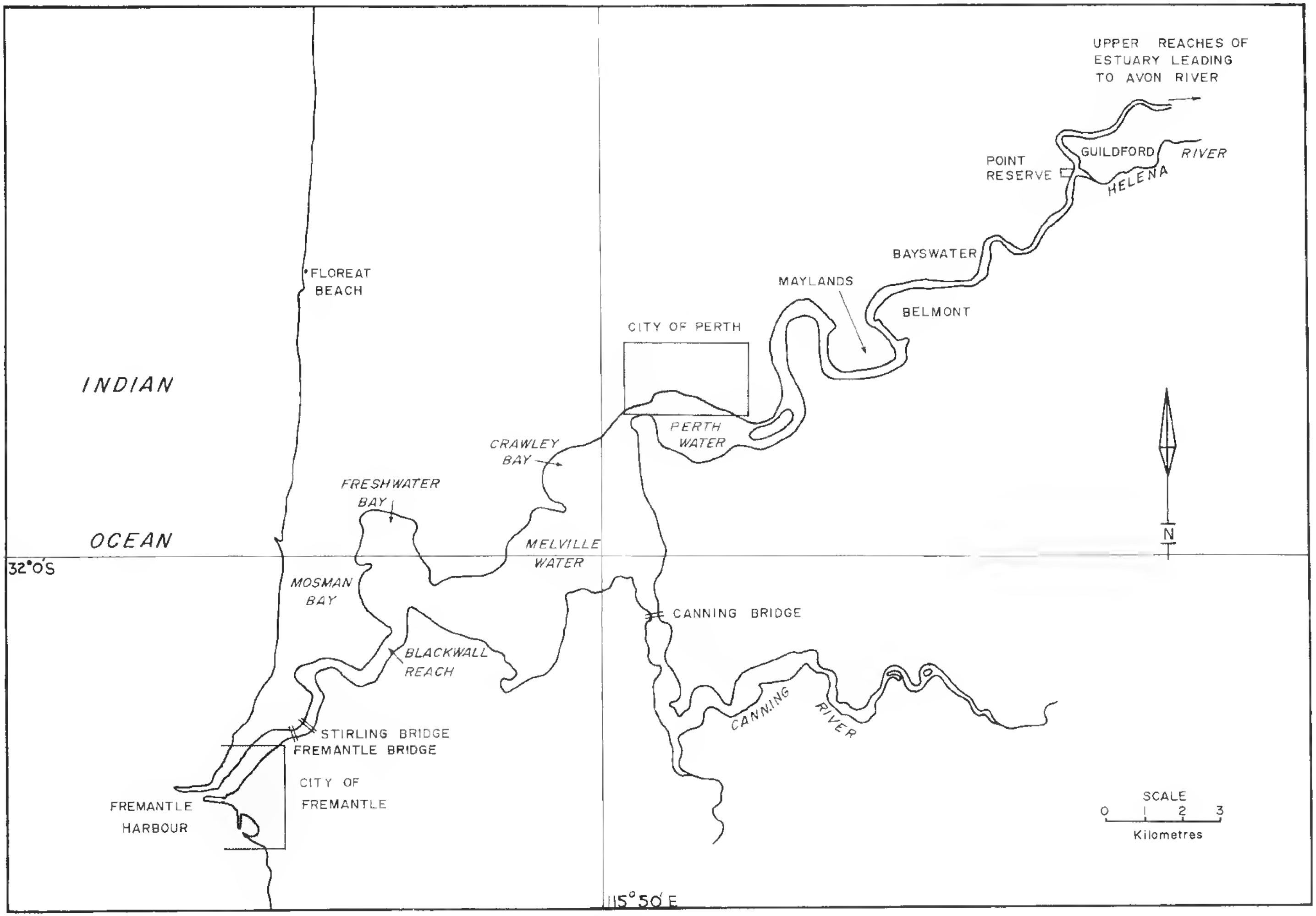

Fig. 2: A map of the Swan-Avon River System.
N.B. The extensive catchment constituting the upper Swan and Avon River are not included.

The physiographic and hydrological aspects of the Swan Estuary have been described by a number of workers, including Jutson (1934), Rochford (1951), Spencer (1956), Wilson (1964, 1968) and Jack (1977). Recently, Chalmer, Hodgkin and Kendrick (1976) suggested that, as a biotope, the estuary could be appropriately divided into a lower, middle and upper component. Although their definitions of the regions corresponding to lower, middle and upper estuary are followed in this paper, the term lower reaches is also used when, as is often the case, marine species have been found extending through the lower estuary into the bottom end of the middle estuary.

The lower estuary comprises an inlet channel region which meanders through a calcarenite limestone coastal ridge from Fremantle Harbour to, and including, Blackwall Reach (**Fig. 2**). The wider areas of Mosman and Freshwater Bays and the seaward end of Melville Water, which constitute the beginning of the middle estuary attain depths of 21 m. The increase in the width of the system in this region is developed even further immediately upriver in the main part of the middle estuary where Melville and Perth Waters reach maximum widths of approximately 4 and 1.5 km respectively. These latter two localities are permanently submerged flood plains with the former occasionally reaching depths of approximately 6 m. It should be noted that Chalmer *et al.* (1976) also regards the bottom and middle of the Canning River as belonging respectively to the middle and upper estuary of the Swan-Avon River System. The salinities in the upper estuary in 1977 ranged from maxima of about 30‰ at the lower end to approximately 20‰ near Guildford, which represented our most upstream sampling locality. Although the Canning and Helena Rivers, which have both been dammed for many years, pass through forests and are therefore relatively fresh, the Avon has become saline by receiving run-off from the extensively cleared agricultural land through which it passes (Kendrick, 1976).

In most years, the environmental conditions that prevail in the Swan-Avon River System during the winter differ markedly from those found in other months (Rochford, 1951; Spencer, 1956; Wilson, 1968; Hodgkin, 1974; Bayly, 1975; Jack, 1977). Thus, between approximately May and September, periods of heavy precipitation lead to extremely rapid increases in the volume and rate of freshwater discharge from the catchment tributaries. At these times, the salinity can drop markedly within 24 hours throughout the whole of the estuary and lead to the formation of marked haloclines, particularly in the deeper regions of the middle and lower estuary. During the other months of the year, the level of precipitation is very greatly reduced, a feature which results in little freshwater discharge taking place into the estuarine part of the system.

Since the normal tidal range in the lower reaches of the Swan Estuary, such as at Fremantle, used to be generally only about 50 cm (Bennett, 1940), and is now also still only about 70 cm (Fremantle Port Authority Records), astronomic tidal changes do not markedly affect the movement of water within most of the estuary in the summer months. This feature, together with the limited freshwater discharge, is the major reason why water levels generally change only slowly during this time of the year. The main factor producing water movement in the summer is in fact neither of these two components but the effect of changes in barometric pressure. For example, any sustained periods of high pressure and off-shore winds lead to a movement of water towards the sea which often leaves sand banks exposed for several days (Seddon, 1972). The high relative degree of stability of the estuarine region of the Swan-Avon River System in the warmer months is also reflected by the relatively slow changes that occur in salinities during this period. While the salinity in the middle estuary is maintained at levels just below full strength sea water, some shallow areas such as Alfred Cove (**Fig. 2**), become slightly hypersaline (c. 36.5‰) through evaporation.

BASIS OF CHECKLIST AND NOTES

Initially, a detailed analysis was made of the fish collections and records accumulated for the Swan-Avon River System since 1912 by the Western Australian Museum (WAM). These data were then supplemented by the results obtained in a comprehensive sampling programme carried out in the Swan Estuary between January 1977 and March 1978 using beach seines, trawls and mesh netting. This latter investigation resulted both in the addition of a few more species to the checklist and in the collection of sufficiently large samples to provide sound basic information on the biology of some of the more abundant species.

The popular names used in the species notes in general follow those given in Scott, Glover and Southcott's (1974) book on South Australian fishes, which is the only appropriate recent authoritative text that covers extensively the fish found in south-western Australian rivers and estuaries. It should be noted, however, that local Western Australian names are also given when they are widely used in this part of Australia. The checklist is arranged in phylogenetic sequence, following in the case of teleosts the scheme proposed by Greenwood *et al.* (1966), except in a few instances where recent studies have suggested the need for minor modification.

In the species accounts, where there were sufficient data on the biology of the fish, the term 'o-group' was used to denote those animals that were clearly in their first year of life. This distinction is of particular significance in the context of estuaries, since they are widely utilised as nursery areas by marine fishes (Cronin & Mansueti, 1971; Pollard, 1976). In contrast with this category are those marine fish which generally use the estuary as a feeding ground only at some stage after the first year of life. The term estuarine is only applied to populations of these species of fishes in the Swan-Avon where there is strong evidence that they can pass through the whole of their life cycle in the estuary. Another category of fish found in the Swan-Avon River System are the freshwater species which, depending on their osmoregulatory ability, may also occasionally be found in various regions of the estuary.

CHECKLIST

GEOTRIIDAE

GEOTRIA AUSTRALIS GRAY, 1851

Geotria australis Gray, 1851: 142 (Inkapinki River, South Australia).

The Pouched or Wide-mouthed Lamprey is an anadromous parasitic species which undergoes very marked morphological changes during its spawning migration, a feature which in the past has lead to a considerable confusion over its taxonomy (Potter & Strahan, 1968). Although this lamprey used to be observed occasionally in the Swan-Avon River System, and the Canning River in particular, there have been few confirmed reports of its presence in this region of Western Australia during the last few years. A recent laboratory study on this species has suggested that this may be related to the fact that its ultimate incipient lethal temperature is similar to temperatures (28-30°C) often now found in the Swan-Avon River System during the summer (Macey & Potter, 1978). It is clear from local reports that this lamprey used to be very abundant in the rivers of south-western Australia but that its numbers have declined in recent years.

Distribution

Tasmania, Victoria, South Australia to Fremantle in Western Australia and also in New Zealand and the southern part of South America.

HETERODONTIDAE

HETERODONTUS PORTUSJACKSONI (MEYER, 1793)

Squalus portusjacksoni Meyer, 1793: 71 (Port Jackson, New South Wales).

Only one specimen of the Port Jackson Shark has been recorded from the Swan-Avon River System, this being collected from the Maylands region of the river during May 1977.

Distribution

Southern half of Australia to the Houtman Abrolhos in Western Australia.

SPHYRNIDAE

SPHYRNA ZYGAENA (LINNAEUS, 1758)

Squalus zygaena Linnaeus, 1758: 234 (Europe and America).

One specimen of this hammerhead shark from Mosman Bay is housed in the WAM collections.

Distribution

Widespread in temperate waters of the world.

CARCHARHINIDAE

CARCHARHINUS LEUCAS (MÜLLER & HENLE, 1841)

Carcharias (Prionodon) leucas Müller & Henle, 1841: 42 (Antilles).

An extraordinary feature of the records for the Swan River Whaler is that this shark has been caught on several occasions in the Swan Estuary but never as yet in the surrounding oceanic regions. Furthermore, specimens have been reported from regions 320 km up the Fitzroy River in the Kimberley region of Western Australia (R. Emiliani, pers. comm.).

Distribution

Worldwide, preferring warmer waters.

RHINOBATIDAE

APTYCHOTREMATA VINCENTIANA (HAACKE, 1885)

Rhinobatus vincentianus Haacke, 1885: 488 and 508 (St. Vincent Gulf, South Australia).

One specimen of the Shovelnose Ray or Guitar Fish from Freshwater Bay is present in WAM collections.

Distribution

South Australia to Fremantle in Western Australia.

MYLIOBATIDAE

MYLIOBATIS AUSTRALIS MACLEAY, 1881

Myliobatis australis Macleay, 1881: 380 (Port Jackson, New South Wales).

One specimen of this species of eagle ray has been collected from Melville Water.

Distribution

Southern half of Australia to Lancelin in Western Australia.

ELOPIDAE

ELOPS MACHNATA (FORSSKÅL, 1775)

Argentina machnata Forsskål, 1775: 68 (Red Sea).

The Giant Herring is a marine species which is caught at regular intervals throughout the Swan Estuary.

Distribution

Indo-West Pacific, preferring warmer waters. In Western Australia, it has been found as far south as Albany.

MURAENIDAE

GYMNOTHORAX WOODWARDI McCULLOCH, 1912

Gymnothorax woodwardi McCulloch, 1912: 80 (Pelsart Island, Houtman Abrolhos, Western Australia).

Woodward's Reef Eel is infrequently collected from the lower reaches of the Swan Estuary as far upriver as Melville Water.

Distribution

Western Australia only, from Albany to the Houtman Abrolhos.

OPHICHTHIDAE

CALAMURAENA CALAMUS (GÜNTHER, 1870)

Ophichthys calamus Günther, 1870: 74 (Fremantle, Western Australia).

The Fringe-lipped Snake Eel is a marine species which has been recorded only once for the Swan Estuary at Freshwater Bay.

Distribution

Western Australia only, from Geographe Bay to Exmouth Gulf.

OPHISURUS SERPENS (LINNAEUS, 1758)

Muraena serpens Linnaeus, 1758: 244 (southern European seas).

The Serpent Eel is a marine species which is frequently collected from as far upriver as Canning Bridge.

Distribution

Mediterranean, South Africa, Japan, New Zealand and temperate waters of Australia.

CLUPEIDAE

AMBLYGASTER POSTERA WHITLEY, 1931

Amblygaster postera Whitley, 1931: 144 (Fremantle, Western Australia).

The Scaly Mackerel is a marine species found toward the lower end of the estuary. It has been suggested that its relative abundance in the estuary is inversely proportional to that of the Perth Herring (Serventy, 1955).

Distribution

Western Australia only, from Albany to Port Hedland.

HYPERLOPHUS VITTATUS (CASTELNAU, 1875)

Meletta vittata Castelnau, 1875: 46 (Melbourne, Victoria).

The Sandy Sprat is a marine species which enters the Swan Estuary where it often occurs in sufficient numbers in the summer to be netted for use as bait by anglers.

Distribution

Southern half of Australia (except Tasmania) to Fremantle in Western Australia.

NEMATALOSA VLAMINGHI (MUNRO, 1956)

Fluvialosa vlaminghi Munro, 1956: 25 (Swan River, Western Australia).

During extensive sampling in 1977, all stages in the life cycle of the Perth Herring were found to be very abundant in the middle and upper estuary. Although the Perth Herring is sometimes caught at sea, and many large samples of this species have been collected in Cockburn Sound at times in both the summer and winter, there is evidence that this species can pass through the whole of its life cycle within the Swan-Avon River System.

Distribution

Western Australia only, from the Leschenault Inlet to Broome.

SPRATELLOIDES ROBUSTUS OGILBY, 1897

Spratelloides robustus Ogilby, 1897: 64 (New South Wales).

The Blue Sprat is a marine species which sometimes enters the lower reaches of the Swan Estuary in sufficient numbers to provide at times the basis for a commercial fishery.

Distribution

Southern half of Australia to the Houtman Abrolhos in Western Australia.

ENGRAULIDAE

ENGRAULIS AUSTRALIS (SHAW, 1790)

Atherina australis Shaw (in White), 1790: 296 (near Sydney, New South Wales).

The Southern Anchovy was very abundant in 1977 throughout much of the Swan Estuary. On the basis of vertebral counts, the form in Western Australia has been described by Blackburn (1950) as a separate subspecies, both from *E. australis australis*, which is found in Queensland and much of New South Wales, and from *E. australis antipodum*, which occurs farther south on the eastern seaboard and in Tasmania and South Australia. However, since no description has been published of the alleged Western Australian form, this "subspecies" is not recognized in this paper.

Distribution

New Zealand and the southern half of Australia to Shark Bay in Western Australia.

SALMONIDAE

SALMO TRUTTA LINNAEUS, 1758

Salmo trutta Linnaeus, 1758: 308 (Europe).

The Brown Trout is less abundant in the Swan-Avon River System than the Rainbow Trout but has been recorded in the Canning and Helena Rivers.

Distribution

Introduced into all Australian states except Queensland, and Northern Territory.

SALMO GAIRDNERI RICHARDSON, 1836

Salmo gairdneri Richardson, 1836: 221 (North America).

The Rainbow Trout is abundant in the Swan-Avon River System, particularly above the dam situated on the Canning River (see also Morrissy, 1972).

Distribution

Introduced into all Australian states except Queensland, and Northern Territory.

GALAXIIDAE

GALAXIAS OCCIDENTALIS OGILBY, 1899

Galaxias occidentalis Ogilby, 1899: 157 (south of Perth, Western Australia).

The Western Minnow, which is abundant in fresh water, was only twice caught in the estuary during the extensive sampling programme carried out in 1977 and 1978.

Distribution

Western Australia only, from Albany to Guilderton.

GONORYNCHIDAE

GONORYNCHUS GREYI (RICHARDSON, 1845)

Rhynchana greyi Richardson, 1845: 44 (south-west Western Australia).

The Sand Fish or Beaked Salmon is a marine species occasionally found in the lower reaches of the Swan Estuary.

Distribution

New Zealand and the southern half of Australia to the Houtman Abrolhos in Western Australia.

CYPRINIDAE

CARASSIUS AURATUS (LINNAEUS, 1758)

Cyprinus auratus Linnaeus, 1758: 322 (China).

The Goldfish or Golden Carp is a relatively common introduced species in the freshwater areas of the Canning and the upper catchment areas of the Swan-Avon River System.

Distribution

Worldwide. In Western Australia from the Moore River southwards.

PLOTOSIDAE

CNIDOGLANIS MACROCEPHALUS (VALENCIENNES, 1840)

Plotosus macrocephalus Valenciennes (in Cuvier & Valenciennes), 1840: 317 ('Timor'—probably an error as Kowarsky (1975, 1976) shows that this species is confined to temperate Australian waters).

The Cobbler or Estuary Catfish is represented by a population in the Swan-Avon River System that passes through its entire life cycle in the estuarine regions in which it exhibits seasonal movements (Kowarsky, 1975). Fin ray counts of representatives from the estuary are lower than those recorded for animals collected off the nearby Rottnest Island (Kowarsky, 1975).

Distribution

Southern Queensland, New South Wales, South Australia and to the Houtman Abrolhos in Western Australia.

TANDANUS BOSTOCKI WHITLEY, 1944

Tandanus bostocki Whitley, 1944: 260 (Serpentine River, Western Australia).

One large specimen of the Freshwater Cobbler is present in the WAM collections from the Canning River. This freshwater species is known to occur in the upper reaches of the Canning and Helena Rivers.

Distribution

South-western Western Australia only, from Walpole to Guilderton.

ANTENNARIIDAE

HISTRIO HISTRIO (LINNAEUS, 1758)

Lophius histrio Linnaeus, 1758: 237 (no locality given).

The Sargassum Fish has occasionally been recorded from the lower reaches of the Swan Estuary which it apparently enters from the sea in floating *Sargassum* weed blown in by the wind.

Distribution

Worldwide, preferring warmer waters. In Western Australia it has been found as far south as Safety Bay.

OPHIDIIDAE

DIPULUS CAECUS WAITE, 1905

Dipulus caecus Waite, 1905: 78 (off Fremantle, Western Australia).

Two specimens recorded from the Swan Estuary, the highest locality upriver being Freshwater Bay. The latter specimen is in the WAM collections. This species may be relatively abundant in the rather inaccessible areas of limestone reef of the lower reaches of the estuary.

Distribution

Western Australia only, from Cockburn Sound to Point Quobba, north of Shark Bay.

HEMIRAMPHIDAE

HYPORHAMPHUS REGULARIS REGULARIS (GÜNTHER, 1866)

Hemirhamphus regularis Günther, 1866: 261 (Australia and Western Australia).

Representatives of the Western River Garfish have been caught in various parts of the estuary.

Distribution

Western Australia, from Bunbury to Kalbarri.

HYPORHAMPHUS MELANOCHIR (VALENCIENNES, 1846)

Hemirhamphus melanochir Valenciennes (in Cuvier & Valenciennes), 1846: 41 (Port Western, Victoria).

One specimen of the South Australian or Sea Garfish has been recorded from the Swan Estuary (Collette, 1974: 74).

Distribution

Southern half of Australia to Rottnest Island in Western Australia.

POECILIIDAE

GAMBUSIA AFFINIS (BAIRD & GIRARD, 1853)

Heterandria affinis Baird & Girard, 1853: 390 (North America).

The Mosquito Fish is an introduced freshwater species that is common in the several tributaries of the Swan-Avon River System. From the many sites at which it has been collected in the upper estuary, this teleost is clearly capable of tolerating relatively high salinities in the Swan-Avon. The history of the introduction of *G. affinis* to Western Australia is given by Mees (1977).

Distribution

A species which has been widely introduced to the warmer regions of the world. In Western Australia, it is found from the Fitzgerald River, just west of Hopetoun, to the Hutt River, just north of Geraldton.

ATHERINIDAE

ATHERINOSOMA ELONGATA (KLUNZINGER, 1879)

Atherina elongata Klunzinger, 1879: 394 (King George Sound, Western Australia).

Representatives of the Elongate Hardyhead are found throughout the lower and middle estuary (J. Prince, pers. comm.).

Distribution

Southern half of Australia to Geraldton in Western Australia.

ATHERINOSOMA PRESBYTEROIDES (RICHARDSON, 1843)

Atherina presbyteroides Richardson, 1843: 179 (Port Arthur, Tasmania).

This species is found in large numbers in the middle and upper estuary (J. Prince, pers. comm.).

Distribution

Southern half of Australia to the Houtman Abrolhos in Western Australia.

PRANESUS OGILBYI WHITLEY, 1930

Pranesus ogilbyi Whitley, 1930: 9 (Moreton Bay, Queensland).

Ogilby's Hardyhead is a marine species found throughout the estuary, sometimes in large numbers in the lower and middle estuary.

Distribution

Southern half of Australia to Shark Bay in Western Australia.

VELIFERIDAE

METAVELIFER MULTIRADIATUS (REGAN, 1907)

Velifer multiradiatus Regan, 1907: 633 (north-west Australia).

One juvenile specimen of this species of veilfin was collected from Blackwall Reach.

Distribution

Southern half of Australia to Shark Bay in Western Australia. Also known from Lord Howe Island, Mozambique, Japan and Hawaii.

FISTULARIIDAE

FISTULARIA COMMERSONII RÜPPELL, 1835

Fistularia commersonii Rüppell, 1835: 142 (Red Sea).

One juvenile of this species of flutemouth has been collected from the area of Stirling Bridge near Fremantle. This tropical species has also been recorded from Rottnest Island.

Distribution

Tropical Indo-West Pacific to Fremantle in Western Australia.

SYNGNATHIDAE

HIPPOCAMPUS ANGUSTUS GÜNTHER, 1870

Hippocampus angustus Günther, 1870: 200 (Shark Bay, Western Australia).

Only two specimens of this species of sea horse have been recorded from the Swan Estuary, the highest locality upriver being Crawley Bay. This teleost is common in some sea-grass beds of Cockburn Sound.

Distribution

Western Australia only, from Cockburn Sound to Shark Bay.

STIGMATOPHORA ARGUS (RICHARDSON, 1840)

Syngnathus argus Richardson, 1840: 29 (no locality given).

The Spotted Pipefish is a marine species found in moderate numbers in the lower reaches of the estuary and in abundance in Cockburn Sound.

Distribution

Southern half of Australia to Dongara in Western Australia.

UROCAMPUS CARINIROSTRIS CASTELNAU, 1872

Urocampus carinirostris Castelnau, 1872: 200 (Melbourne, Victoria).

Representatives of the Hairy Pipefish have been caught as far upstream as Belmont. A comparatively rare species in Western Australian waters, having only previously been recorded from Geographe Bay.

Distribution

Southern half of Australia to Fremantle in Western Australia.

SCORPAENIDAE

GYMNAPISTES MARMORATUS (CUVIER, 1829)

Apistus marmoratus Cuvier (in Cuvier & Valenciennes), 1829: 416 ('Timor'—probably an error as this species appears to be confined to southern Australia).

The Devil Fish or South Australian Cobbler is a marine species relatively common as juveniles in the lower estuary. It is abundant in Cockburn Sound.

Distribution

Tasmania, Victoria, South Australia and to Fremantle in Western Australia. Also recently recorded from Port Hacking, N.S.W., by D. Pollard. (pers. comm.).

TRIGLIDAE

CHELIDONICHTHYS KUMU (LESSON, 1830)

Trigla kumu Lesson 1830: 214 (Bay of Islands, New Zealand).

The Red Gurnard is a regular visitor in small numbers to the Swan Estuary where it is caught in prawn seine nets, on handlines and in fish traps. It is common in the coastal waters off Fremantle.

Distribution

Southern half of Australia to Shark Bay in Western Australia. Also known from South Africa, Japan and New Zealand.

PTERYGOTRIGLA POLYOMMATA (RICHARDSON, 1839)

Trigla polyommata Richardson, 1839: 96 (Port Arthur, Tasmania).

The Sharp-beaked Gurnard or Latchet is a marine species found only infrequently in the Swan Estuary. One specimen located in the WAM collections came from a region near Canning Bridge and another has been recorded in Melville Water.

Distribution

Southern half of Australia to Fremantle in Western Australia.

PLATYCEPHALIDAE

PLATYCEPHALUS ENDRACHTENSIS QUOY & GAIMARD, 1824

Platycephalus endrachtensis Quoy & Gaimard, 1824: 353 (Shark Bay, Western Australia).

This flathead is an abundant species throughout the Swan Estuary which may be capable of spending the whole of its life cycle in an estuarine environment.

Distribution

Northern half of Australia southwards to at least Fremantle in Western Australia.

PLATYCEPHALUS HAACKEI STEINDACHNER, 1884

Platycephalus haackei Steindachner, 1884: 1081 (St. Vincent Gulf, South Australia).

The Long-headed Flathead is a marine species that has been infrequently collected from the lower reaches of the estuary. One specimen is present in the WAM collections.

Distribution

South Australia to at least Fremantle in Western Australia.

PLATYCEPHALUS ISACANTHUS CUVIER, 1829

Platycephalus isacanthus Cuvier (in Cuvier & Valenciennes), 1829: 245 (Burou and Waigiou).

One specimen of this marine species has been collected from the lower reaches of the estuary.

Distribution

Indo-West Pacific. Its southern limit in Western Australia is apparently Fremantle.

PLATYCEPHALUS LAEVIGATUS CUVIER, 1829

Platycephalus laevigatus Cuvier (in Cuvier & Valenciennes), 1829: 248 (Port Western, Victoria).

Two specimens of the Rock Flathead have been collected from near the Stirling Bridge at Fremantle. This marine species is moderately abundant in Cockburn Sound but rare in the Swan Estuary.

Distribution

Southern half of Australia to Cockburn Sound in Western Australia.

PEGASIDAE

PARAPEGASUS NATANS (LINNAEUS, 1766)

Pegasus natans Linnaeus, 1766: 418 (India).

A marine species found in relatively large numbers in the lower and seaward end of the middle estuary where it is often taken in prawn seine nets.

Distribution

Tropical Indo-West Pacific. Its southern limit in Western Australia is Cockburn Sound.

PERCICHTHYIDAE

BOSTOCKIA POROSA CASTELNAU, 1873

Bostockia porosa Castelnau, 1873: 126 (Western Australia).

Specimens of this freshwater species in the WAM collections came from the upper reaches of the Helena and Canning Rivers.

Distribution

South-western Western Australia only, from Albany district to Guilderton.

MACCULLOCHELLA PEELI (MITCHELL, 1839)

Acerina (Gristes) peeli Mitchell, 1839 (Peel River, New South Wales).

The Murray Cod was liberated in the upper reaches of the Swan-Avon River System in 1894. Although representatives of this species were recovered seven years later, there have been no further records (Morrissy, 1970).

Distribution

Native to the Murray-Darling river system. Also occurs in a few coastal streams in northern N.S.W. and southern Queensland. Has been successfully introduced into lakes and dams in New South Wales and Victoria.

TERAPONIDAE

AMNIATABA CAUDAVITTATUS (RICHARDSON, 1845)

Datnia? caudavittata Richardson, 1844-8: 24 (Harvey River, south-western Western Australia).

Although workers such as Lake (1971) and Grant (1975) list the Yellow-tailed Trumpeter or Yellow-tailed Perch as an essentially marine teleost, it would appear to live for the whole of its life cycle in predominantly estuarine environments in the Swan-Avon and neighbouring river systems. It is extremely abundant occurring throughout the estuary at least as far upstream as Point Reserve.

Remarks: note that Vari (1978) now uses *Amniataba* and not *Amphitherapon* for this species and that *Pelates* replaces *Helotes* in the case of the following teraponid genus.

Distribution

Northern half of Australia to Cape Leeuwin in Western Australia.

PELATES SEXLINEATUS (QUOY & GAIMARD, 1824)

Terapon sexlineatus Quoy & Gaimard, 1824: 340 (Shark Bay, Western Australia).

The Six-lined Trumpeter or Striped Perch is a marine species which utilizes the Swan Estuary as a nursery ground. Although it was extremely abundant in the extensive sampling periods of 1977 and early 1978 in the lower reaches, it was also present in relatively large numbers as far upstream as Belmont. Cockburn Sound is also utilized by this species as a nursery ground.

Distribution

Indo-West Pacific including Australia (except Victoria and Tasmania).

PELSARTIA HUMERALIS (OGILBY, 1899)

Therapon humeralis Ogilby, 1899: 177 (Houtman Abrolhos, Western Australia).

The Sea Trumpeter is a common marine species which has been recorded on two occasions from the lower reaches of the estuary.

Distribution

South Australia to the Houtman Abrolhos in Western Australia.

KUHLIIDAE

EDELIA VITTATA CASTELNAU, 1873

Edelia vittata Castelnau, 1873: 124 (Western Australia).

The Western Pygmy Perch is a freshwater species which inhabits the upper reaches of the Swan-Avon River System.

Distribution

South-western Western Australia only, from the Phillips to the Moore Rivers.

APOGONIDAE

APOGON RUEPPELLII GÜNTHER, 1859

Apogon rüppellii Günther, 1859: 236 ('Victoria'= Port Essington, Northern Territory).

The Gobbleguts is an abundant marine species in Western Australian waters represented by a large population in the Swan-Avon River System which can spend the whole of its life cycle in the estuarine region of this environment.

Distribution

Although recorded from marine environments near Albany, it has only been taken in estuaries to the north of the Blackwood River. The distribution extends into the Northern Territory.

SIPHAMIA CEPHALOTES (CASTELNAU, 1875)

Scopelus (Neoscopelus) cephalotes Castelnau, 1875: 46 (Adelaide, South Australia).

Two individuals of Wood's Siphon-fish have been caught in the lower estuary. This species is abundant in beds of sea-grass and algae in Cockburn Sound.

Distribution

Southern half of Australia to Fremantle in Western Australia.

PERCIDAE

PERCA FLUVIATILIS LINNAEUS, 1758

Perca fluviatilis Linnaeus, 1758: 289 (Europe).

The Redfin or European Perch is a freshwater species which was introduced into Lake Leschenaultia. Representatives of this species were recently collected by members of the Department of Fisheries and Wildlife.

Distribution

Introduced to many countries throughout the world.

SILLAGINODES PUNCTATUS (CUVIER, 1829)

Sillago punctata Cuvier (in Cuvier & Valenciennes), 1829: 413 (King George Sound, Western Australia).

The King George or Spotted Whiting, which is a marine species that occasionally enters the estuary during the first year of life, is much less abundant in the Swan Estuary than the Trumpeter Whiting, *Sillago maculata.*

Distribution

Southern half of Australia to Fremantle in Western Australia.

SILLAGO MACULATA QUOY & GAIMARD, 1824

Sillago maculata Quoy & Gaimard, 1824: 261 (Sydney, New South Wales).

The Trumpeter Whiting is a marine species which utilizes many areas in the estuary as a nursery ground, being found in large numbers in Perth and Melville Waters during the summer. Adults are present in marine embayments such as Cockburn Sound where they are very abundant during the summer months (Penn, 1977).

Distribution

Northern half of Australia to Fremantle in Western Australia. Also known from the Indo-Malay Archipelago.

SILLAGO SCHOMBURGKII PETERS, 1865

Sillago schomburgkii Peters, 1865: 391 (Adelaide, South Australia).

The Western Sand or Yellow-finned Whiting is a marine species normally utilizing the shallow sandy areas of the estuary as a nursery ground. Like *Sillaginodes punctatus,* it is much less abundant in the Swan than *Sillago maculata.*

Distribution

South Australia to Shark Bay in Western Australia.

POMATOMIDAE

POMATOMUS SALTATRIX (LINNAEUS, 1766)

Gasterosteus saltatrix Linnaeus, 1766: 491 (East Coast, North America).

The Tailor is a marine species which utilizes the estuary as a feeding ground at various times during post-larval life. In years of heavy freshwater discharge, the numbers are relatively much lower in the winter months.

Distribution

Worldwide.

RACHYCENTRIDAE

RACHYCENTRON CANADUM (LINNAEUS, 1766)

Gasterosteus canadus Linnaeus, 1766: 491 (Carolina, North America).

Juvenile specimens of this pelagic marine species, known as the Cobia or Black Kingfish, have been collected infrequently from as far upriver as Freshwater Bay.

Distribution

Worldwide (except eastern Pacific), preferring warmer waters. In Western Australia, it ranges as far south as Cape Naturaliste.

CARANGIDAE

ALECTIS CILIARIS (BLOCH, 1787)

Zeus ciliaris Bloch, 1787: 36 (East Indies).

One small juvenile of the Pennant Trevally has been collected from the channel region in the lower estuary. This tropical species has previously been collected from the sea off Floreat Beach, just north of Fremantle.

Distribution

Widespread in tropical regions of the world including Western Australia where this specimen constitutes its southernmost record.

CARANX GEORGIANUS CUVIER, 1833

Caranx georgianus Cuvier (in Cuvier & Valenciennes), 1833: 85 (King George Sound, Western Australia).

The Skipjack Trevally is a marine species which as juvenile stages frequently enter the middle and lower estuary.

Distribution

South Australia to the Houtman Abrolhos in Western Australia.

SERIOLA HIPPOS GÜNTHER, 1876

Seriola hippos Günther, 1876: 392 (Sydney, New South Wales).

The marine Samson Fish is occasionally caught in the lower reaches of the estuary. One specimen from Freshwater Bay is housed in the WAM collection. Juveniles of this species are sometimes found in large numbers in Cockburn Sound (Penn, 1977).

Distribution

Southern Queensland, New South Wales, South Australia and to Shark Bay in Western Australia.

TRACHURUS MCCULLOCHI NICHOLS, 1920

Trachurus mccullochi Nichols, 1920: 479 (South Australia).

Large numbers of o-group and young adults of this marine species, known as the Yellowtail Scad, are found in the middle and lower estuary, particularly during the warmer months.

Distribution

Southern half of Australia to North West Cape in Western Australia.

ARRIPIDAE

ARRIPIS GEORGIANUS VALENCIENNES, 1831

Centropristis georgianus Valenciennes (in Cuvier & Valenciennes), 1831: 451 (King George Sound, Western Australia).

A number of specimens of the Australian Herring or Tommy Rough were collected from the Maylands region of the river during May 1977. Observations by fishermen suggest that this species is a regular visitor to the river in the late summer and autumn.

Distribution

Southern half of Australia to Shark Bay in Western Australia.

ARRIPIS TRUTTA ESPER WHITLEY, 1951

Arripis trutta esper Whitley, 1951: 66 (Fremantle, Western Australia).

The Australian Salmon is a marine species which is reported occasionally to enter the lower reaches of the Swan Estuary.

Distribution

Tasmania, Victoria, South Australia and to Shark Bay in Western Australia.

NEMIPTERIDAE

PENTAPODUS VITTA QUOY & GAIMARD, 1824

Pentapodus vitta Quoy & Gaimard, 1824: 294 (Shark Bay, Western Australia).

The Butterfish, which is a common marine species in Cockburn Sound (Penn, 1977), enters the lower reaches of the Swan Estuary in small numbers.

Distribution

Western Australia only, from Cockburn Sound to Exmouth Gulf.

GERRIDAE

GERRES SUBFASCIATUS CUVIER, 1830

Gerres subfasciatus Cuvier (in Cuvier & Valenciennes), 1830: 477 (Port Jackson, New South Wales).

This species of silverbelly is apparently represented in the Swan-Avon by populations which pass through the whole of their life cycle in the estuary.

Remarks: The identity of this species is not certain. It has been referred to as *G. australis* (misidentification), *G. ovatus* and possibly *G. baconensis*. The oldest available name is used here.

Distribution

Northern half of Australia to Cockburn Sound in Western Australia.

SPARIDAE

ACANTHOPAGRUS BUTCHERI (MUNRO, 1949)

Mylio butcheri Munro, 1949: 191 (Gippsland Lakes, Victoria).

The Black Bream is an abundant species in the Swan-Avon River System, living predominantly in the upper and middle estuary. It may occasionally be found, however, in the lower reaches and can be flushed out to sea during periods of heavy freshwater discharge. In this context it is worth noting that collection sites for paratypes include Shark Bay and Houtman Abrolhos.

Distribution

Southern New South Wales, Tasmania, Victoria, South Australia and to at least Kalbarri, in Western Australia.

CHRYSOPHRYS UNICOLOR QUOY & GAIMARD, 1824

Chrysophrys unicolor Quoy & Gaimard, 1824: 299 (Shark Bay, Western Australia).

A large adult specimen of the Pink Snapper has been recorded from Blackwall Reach. Although juveniles of this species are known to enter more southern estuaries, there is no current evidence that it passes into the Swan Estuary at this stage in its life cycle. This contrasts with the situation in Cockburn Sound where large numbers of o-group individuals are present (Lenanton, 1974b). Recent data obtained by Penn (1977) also suggests that Cockburn Sound is an important nursery and breeding ground for this species.

Distribution

South Australia to Shark Bay in Western Australia.

RHABDOSARGUS SARBA (FORSSKÅL, 1775)

Sparus sarba Forsskål, 1775: 31 (Red Sea).

The Tarwhine or Silver Bream is a marine species which very occasionally enters the lower and middle estuary.

Distribution

Indo-West Pacific. Southern limit in Western Australia is Beaufort Inlet, east of Albany.

SCIAENIDAE

ARGYROSOMUS HOLOLEPIDOTUS (LACÉPÈDE, 1802)

Labrus hololepidotus Lacépède, 1802: 448 (locality not known).
Sciaena antarctica Castelnau, 1872: 100 (Melbourne, Victoria).

The Mulloway or River Kingfish is a marine species which utilizes the estuary as a nursery area and adult feeding ground. It is also abundant in Cockburn Sound where it is an important angling fish (Penn, 1977).

Distribution

From Cape York, around the southern coastline of Australia to Onslow in north-western Western Australia.

MULLIDAE

PARUPENEUS FRATERCULUS (VALENCIENNES, 1831)

Upeneus fraterculus Valenciennes (in Cuvier & Valenciennes), 1831: 524 (Seychelles).

Two juveniles of the Blackspot Goatfish have been collected from the region of the Stirling Bridge at Fremantle. This tropical species is relatively common in some shallow water areas at Rottnest Island.

Distribution

Widespread in the Indo-West Pacific including Western Australia where Rottnest Island is its southern limit.

PEMPHERIDAE

PEMPHERIS KLUNZINGERI McCULLOCH, 1911

Pempheris klunzingeri McCulloch, 1911: 47 (King George Sound, Western Australia).

One specimen of this marine species, commonly known as the Rough Bullseye, has been recorded from the lower reaches of the estuary.

Distribution

South Australia to the Houtman Abrolhos in Western Australia.

KYPHOSIDAE

KYPHOSUS SYDNEYANUS (GÜNTHER, 1886)

Pimelepterus sydneyanus Günther, 1886: 368 (Port Jackson, New South Wales).

The Silver Drummer or Buffalo Bream is a common marine species represented in the records for the Swan-Avon River System by a single juvenile taken from Blackwall Reach.

Distribution

Southern half of Australia to the Houtman Abrolhos in Western Australia.

SCORPIDIDAE

NEATYPUS OBLIQUUS WAITE, 1905

Neatypus obliquus Waite, 1905; 65 (Houtman Abrolhos, Western Australia).

There is only a single specimen from the Swan-Avon River System of the Footballer Sweep in the WAM collections, this coming from Guildford. This marine species is common, however, on the reefs off Fremantle.

Distribution

Western Australia, from the Archipelago of the Recherche to the Houtman Abrolhos.

ENOPLOSIDAE

ENOPLOSUS ARMATUS (SHAW, 1790)

Chaetodon armatus Shaw (in White), 1790: 254 (Sydney, New South Wales).

The Old Wife is a marine species and has been recorded from just north of the Fremantle Bridge and at Blackwall Reach. It is a rare visitor to the Swan Estuary and does not apparently penetrate far into the system.

Distribution

Southern half of Australia to the Houtman Abrolhos in Western Australia.

CICHLIDAE

TILAPIA ZILLII (GERVAIS, 1848)

Acerina zillii Gervaise, 1848: 203 (Tuggurth, Algeria).

This freshwater species was found during July 1975 in a system of closed and open drains and small ponds in the Bayswater area adjacent to the upper estuary. This population is believed to have been successfully removed by members of the Department of Fisheries and Wildlife and the Western Australian Museum employing seine nets and rotenone in August 1975. The fish were apparently brought into Western Australia for the aquarium trade and later discarded into this drainage system. Biological analysis of the specimens collected showed that many were in an immediate pre-spawning condition (M. Walker, pers. comm.).

Distribution

North Africa, Jordan and Syria.

CHEILODACTYLIDAE

CHEILODACTYLUS GIBBOSUS RICHARDSON, 1841

Cheilodactylus gibbosus Richardson, 1841; 21 and 102 (Western Australia).

The Crested Morwong is a marine species frequently encountered in the Swan Estuary and is represented in the WAM by specimens from as far upriver as Belmont.

Distribution

Western Australia only, from the Archipelago of the Recherche to Shark Bay.

MUGILIDAE

ALDRICHETTA FORSTERI (VALENCIENNES, 1836)

Mugil forsteri Valenciennes (in Cuvier & Valenciennes), 1836: 141 (New Zealand).

Representatives of o-group and adults of the Yellow-eye or Freshwater Mullet have been taken in large numbers in many areas of the Swan Estuary throughout the year. While this species moves out to sea during the winter to spawn in Western Australia, it breeds in the summer in other parts of Australia (Thomson, 1957d, 1966).

Distribution

Southern half of Australia to Shark Bay in Western Australia.

MUGIL CEPHALUS LINNAEUS, 1758

Mugil cephalus Linnaeus, 1758: 316 (European seas).

Like the Yellow-eye Mullet, the Sea Mullet uses much of the Swan Estuary at various stages of its life cycle and spawns in the winter at sea (Thomson, 1957d, 1966; Chubb *et al.*, unpublished data). However, the adults of the Sea Mullet are predominantly detritivores, whereas those of the Yellow-eye Mullet are omnivorous (Thomson, 1957, 1966).

Distribution

Worldwide, in temperate and tropical seas.

SPHYRAENIDAE

SPHYRAENA OBTUSATA CUVIER, 1829

Sphyraena obtusata Cuvier (in Cuvier and Valenciennes), 1829: 350 (Port Jackson, New South Wales).

One small specimen of the Striped Sea Pike has been collected from the Stirling Bridge area at Fremantle. This marine species is common in the waters off Fremantle.

Distribution

Indo-West Pacific and southern Australia.

ODACIDAE

NEODAX BALTEATUS (VALENCIENNES, 1839)

Odax balteatus Valenciennes (in Cuvier & Valenciennes), 1839: 303 (no locality given).

Several specimens of this species of rock whiting have been collected from the Stirling Bridge area at Fremantle. It is relatively common in the shallow sea-grass beds of Cockburn Sound.

Distribution

Southern half of Australia to Fremantle in Western Australia.

NEOODAX SEMIFASCIATUS (VALENCIENNES, 1839)

Odax semifasciatus Valenciennes (in Cuvier & Valenciennes), 1839: 299 (Indian Ocean).

The Blue Rock or Weedy Whiting is found in small numbers in the weed beds in the lower reaches of the estuary.

Distribution

Southern half of Australia to Lancelin in Western Australia.

OLISTHOPS CYANOMELAS RICHARDSON, 1850

Olisthops cyanomelas Richardson, 1850: 75 (King George Sound, Western Australia).

The single specimen of the Herring Cale from the Swan Estuary in the WAM collections is the only known record of this marine teleost from a Western Australian estuary.

Distribution

Southern half of Australia to Lancelin in Western Australia.

BLENNIIDAE

OMOBRANCHUS GERMAINI (SAUVAGE, 1883)

Petroscirtes germaini Sauvage, 1883: 158 (New Caledonia).

One small individual of Germain's Blenny has been collected from Blackwall Reach. This tropical species is common at Rottnest Island.

Distribution

Tropical western Pacific and Western Australia where Cockburn Sound is the southern limit of its range.

PICTIBLENNIUS TASMANIANUS (RICHARDSON, 1849)

Blennius tasmanianus Richardson, 1849: 129 (Port Arthur, Tasmania).

This marine species of blenny is frequently found living around wharf piles at least as far up the Swan-Avon River System as Canning Bridge.

Distribution

Southern half of Australia to the Houtman Abrolhos in Western Australia.

CLINIDAE

CRISTICEPS AUSTRALIS VALENCIENNES, 1836

Cristiceps australis Valenciennes (in Cuvier & Valenciennes), 1836: 402 (Tasmania).

The Crested Weedfish is a marine species, which frequents sea-grass beds, and is represented in the WAM collections by a small number of specimens from the lower reaches of the estuary.

Distribution

Southern half of Australia to the Houtman Abrolhos in Western Australia.

CALLIONYMIDAE

CALLIONYMUS GOODLADI (WHITLEY, 1944)

Calliurichthys goodladi Whitley, 1944: 270 (Cheyne Beach, Western Australia).

Goodlad's Dragonet, which is found in abundance in Cockburn Sound, is present in some numbers in the lower estuary.

Distribution

Western Australia only, from Cheyne Beach east of Albany to Exmouth Gulf.

CALLIONYMUS PAPILIO GÜNTHER, 1864

Callionymus papilio Günther, 1864: 197 (Melbourne, Victoria).

The Painted Stinkfish or Painted Dragonet is a marine species which is found in small numbers in sea-grass beds in the lower estuary.

Distribution

Southern half of Australia to Rottnest Island in Western Australia.

DACTYLOPUS DACTYLOPUS (VALENCIENNES, 1837)

Callionymus dactylopus Valenciennes (in Cuvier & Valenciennes), 1837: 31 (no locality given).

One specimen of the Fingered Dragonet, which is a marine species, has been collected in a fish trap set in Blackwall Reach (WAM collections). This is one of several examples of a tropical species being found in an estuary at the limit of its range.

Distribution

Indonesia, Malaysia and the Philippines to northern Australia where Cockburn Sound appears to be its southern limit in Western Australia.

GOBIIDAE

AMOYA BIFRENATUS (KNER, 1865)

Gobius bifrenatus Kner, 1865: 177 (Sydney, New South Wales).

The Bridled Goby is apparently a true estuarine species found in moderately large numbers through the Swan Estuary, particularly in the middle and upstream areas where it burrows into 'muddy' substrates.

Distribution

Southern half of Australia to Fremantle in Western Australia.

FAVONIGOBIUS LATERALIS (MACLEAY, 1881)

Gobius lateralis Macleay, 1881: 602 (southern Australia).

The Long-finned Goby is present throughout the estuary in moderately large numbers, more particularly in the middle and lower estuary. It is also common in Cockburn Sound.

Distribution

Southern half of Australia to the Houtman Abrolhos in Western Australia.

FAVONIGOBIUS SUPPOSITUS (SAUVAGE, 1880)

Gobius suppositus Sauvage, 1880: 41 (Swan River, Western Australia).

The South-west or Long-headed Goby is found in moderate abundance in the Swan-Avon River System, particularly in the more upstream reaches.

Distribution

Western Australia, from Albany to Guilderton.

PSEUDOGOBIUS OLORUM (SAUVAGE, 1880)

Gobius olorum Sauvage, 1880: 43 (Swan River, Western Australia).

The Blue-spot Goby, which has been found in fresh water lakes (N. Sarti, pers. comm.) and in saline lakes (Mutton, 1973), is present in many regions of the estuary.

Distribution

Western Australia, from Esperance to Kalbarri.

TRIDENTIGER TRIGONOCEPHALUS (GILL, 1858)

Triaenophorus trigonocephalus Gill, 1858: 17 (China).

The Japanese Goby is an estuarine species which has been introduced from Japan, probably through shipping activities (Hoese, 1973). Ten individuals have been collected in recent years.

Distribution

Japan but also reported from Los Angeles Harbour and San Francisco Bay, U.S.A., and Sydney Harbour, Australia.

SCOMBRIDAE

THUNNUS ALBACARES (BONNATERRE, 1788)

Scomber albacares Bonnaterre, 1788: 140 (Madeira).

One specimen of this pelagic marine species, commonly known as the Yellow-fin Tuna, has been recorded from Perth Water.

Distribution

Indian and Pacific Oceans.

BOTHIDAE

PSEUDORHOMBUS JENYNSII (BLEEKER, 1855)

Platessa jenynsii Bleeker, 1855: 15 (Tasmania).

Two specimens of the Small-toothed Flounder from the Swan-Avon River System are present in the WAM collections. Many representatives of o-group individuals and adults of this marine species were also caught in numbers in the lower end of the estuary during the 1977-78 survey.

Distribution

Southern half of Australia to Shark Bay in Western Australia.

PLEURONECTIDAE

AMMOTRETIS ELONGATUS McCULLOCH, 1914

Ammotretis elongatus McCulloch, 1914: 123 (South Australia).

Three specimens of the Elongate Flounder taken in Freshwater Bay are located in WAM collections. WAM records suggest that this marine teleost may sometimes be present in numbers on the sand flats of the lower reaches of the estuary.

Distribution

South Australia to Fremantle in Western Australia.

CYNOGLOSSIDAE

CYNOGLOSSUS MACULIPINNIS RENDAHL, 1921

Cynoglossus maculipinnis Rendahl, 1921: 17 (north-west Australia).

This species of tongue sole is found in some numbers in the lower estuary.

Distribution

Northern half of Australia to Fremantle in Western Australia.

MONACANTHIDAE

BIGENER BROWNII (RICHARDSON, 1844-8)

Aleuterius? brownii Richardson, 1844-8: 68 (Australia).

One juvenile specimen of the Spiny-tailed Leatherjacket has been recorded from Blackwall Reach. This marine species is common in Cockburn Sound.

Distribution

Southern half of Australia (except Tasmania) to Lancelin in Western Australia.

CHAETODERMA PENICILLIGERA (CUVIER, 1817)

Monacanthus penicilligerus Cuvier, 1817: 185 (no locality given).

One specimen of the Weedy Leatherjacket has been collected from near Stirling Bridge at Fremantle. This tropical species is infrequently taken in Cockburn Sound.

Distribution

Indo-West Pacific to Geographe Bay in Western Australia.

EUBALICHTHYS MOSAICUS (RAMSAY & OGILBY, 1886)

Monacanthus mosaicus Ramsay & Ogilby, 1886: 5 (Port Jackson, New South Wales).

Specimens of the Mosaic Leatherjacket from Mosman Bay and Maylands are located in the WAM collections. Although this marine species prefers offshore reefs, juveniles are occasionally taken from estuaries. However, it would not be expected to penetrate very far up river.

Distribution

Southern half of Australia to Beagle Island, south of Geraldton, in Western Australia.

MEUSCHENIA FREYCINETI (QUOY & GAIMARD, 1824)

Balistes freycineti Quoy & Gaimard, 1824: 213 ('Mauritius'—an error, should be Australia).

Juveniles of the Six-spined Leatherjacket collected from sea-grass beds at Blackwall Reach are present in the WAM collections, and have also been obtained in trawls and seines from the same area. In the estuaries further south, however, the o-group and young adults are relatively common, with the adults inhabiting offshore waters.

Distribution

Southern half of Australia to Mullaloo, just north of Fremantle in Western Australia.

MONACANTHUS CHINENSIS (OSBECK, 1765)

Balistes chinensis Osbeck, 1765: 147 (China).

The Fan-bellied Leatherjacket is relatively common in the lower reaches of the estuary especially near Fremantle Harbour. Specimens have been collected in sea-grass beds at Blackwall Reach. Although this species is considered marine, it appears to be able to tolerate reduced salinities (Hutchins, unpublished data).

Distribution

Indo-West Pacific, including Western Australia where Cockburn Sound appears to be its southern limit.

SCOBINICHTHYS GRANULATUS (SHAW, 1790)

Balistes granulata Shaw (in White), 1790: 295 (near Sydney, New South Wales).

The Rough Leatherjacket is commonly represented by o-group individuals in the lower reaches of the estuary.

Distribution

Southern half of Australia to Shark Bay in Western Australia.

OSTRACIONTIDAE

ANOPLOCAPROS LENTICULARIS (RICHARDSON, 1841)

Ostracion lenticularis Richardson, 1841: 21 (Australia).

One specimen is this marine species, known as the White-barred Boxfish, has been recorded for the Swan-Avon from Melville Water.

Distribution

South Australia to Lancelin in Western Australia.

ARACANA AURITA (SHAW, 1798)

Ostracion auritus Shaw, 1798: pl. 338 ('Islands of the Pacific Ocean,' possibly Tasmania).

One specimen of the marine Shaw's Boxfish or Shaw's Cowfish has been recorded from the Swan Estuary in Crawley Bay.

Distribution

Victoria, Tasmania, South Australia and to Kalbarri in Western Australia.

TETRAODONTIDAE

AROTHRON HISPIDUS (LINNAEUS, 1758)

Tetraodon hispidus Linnaeus, 1758: 333 (India).

The Lined Pufferfish was recorded from the Swan-Avon River System as *Ovalides reticularis* by Glauert (1949: 45). The above specimen is in the WAM collections, together with another from the Fremantle region of the estuary. The presence of this coral reef species in the Swan is surprising in view of the fact that it has not been recorded in the waters off Fremantle. However, as Bennett and Pope (1953: 141) point out, warmer water species may temporarily extend their range into colder waters by living in the shallower areas of estuaries where the summer water temperatures are considerably higher than those encountered in the nearby ocean.

Distribution

Tropical Indo-West Pacific to Fremantle in Western Australia.

CONTUSUS RICHEI (FRÉMINVILLE, 1813)

Tetrodon richei Fréminville, 1813: 250 (no locality given).

Three specimens of the Prickly Pufferfish or Prickly Toadfish have been recorded from Blackwall Reach and another from Freshwater Bay. This marine species is apparently rarer in the Swan Estuary than in the more southern estuaries and embayments of Western Australia.

Distribution

Southern half of Australia to Green Head, just north of Jurien Bay in Western Australia.

LAGOCEPHALUS SCELERATUS (GMELIN, 1788)

Tetrodon sceleratus Gmelin, 1788: 1444 (New Caledonia).

One specimen of the North-west Blowfish or Silver Toadfish has been recorded from the Swan Estuary in Crawley Bay.

Distribution

Indo-West Pacific to the southern waters of Western Australia.

TORQUIGENER PLEUROGRAMMA (REGAN, 1903)

Tetrodon pleurogramma Regan, 1903: 300 (New South Wales).

The Banded Toadfish or Common Blowfish has clearly been extremely abundant for many years in the lower and middle estuary.

Distribution

Southern Queensland, New South Wales, Lord Howe Island, South Australia and to Shark Bay in Western Australia.

DIODONTIDAE

ATOPOMYCTERUS NICTHEMERUS (CUVIER, 1818)

Diodon nicthemerus Cuvier, 1818: 135 (Indian Ocean).

One specimen of the Globe Fish, which is a marine species, has been recorded in the Swan Estuary from Blackwall Reach.

Distribution

South Australia to Lancelin in Western Australia.

DISCUSSION

The checklist presented in this paper demonstrates that a relatively abundant fish fauna is present in the Swan-Avon River System. It is also clear that most of the 110 species, representing 64 families, are fishes whose life cycles are spent in predominantly marine or estuarine conditions.

Indigenous and introduced freshwater species

Indigenous freshwater teleosts are represented in the Swan-Avon River System by only one galaxiid *(Galaxias occidentalis),* one plotosid *(Tandanus bostocki),* one percichthyid *(Bostockia porosa)* and a single kuhliid *(Edelia vittata).* The paucity of this fauna parallels the situation found in other south-western Australian rivers (Lake, 1971). There are however certain factors which have also almost certainly contributed to the relatively small populations representing each of these indigenous species. For example, two of the main tributaries, the Canning and the Helena, are not only of relatively small length but are also dammed. Moreover, the third, namely the Avon, although consisting of a widely ramifying catchment system, suffers from eutrophication, periods of extensive 'drying-up' and an increased ionic concentration due to run-off from the surrounding agricultural land (Kendrick, 1976; Morrissy, pers. comm.).

While only four indigenous freshwater species are currently found in the Swan-Avon, this river system does contain a number of introduced freshwater teleosts which have flourished in the changed conditions brought about by damming. Thus, Goldfish, *Carassius auratus,* Brown Trout, *Salmo trutta,* Rainbow Trout, *Salmo gairdneri,* and Redfin Perch, *Perca fluviatilis,* have taken advantage of either the sluggish areas or the continuous flow that have resulted from the construction of dams. The same is also true of the Mosquito Fish, *Gambusia affinis,* which was introduced in an attempt to control local mosquito populations (Mees, 1977). Other introduced species include *Tilapia zillii,* which was brought into Western Australia as an aquarium fish, but in recent years has been found only in one small tributary (M. Walker, pers. comm.). The remaining introduced species, the Murray Cod, *Maccullochella peeli,* was brought into the Avon from South Australia (Morrissy, 1970). Since individuals later attained weights of nearly 20 kg, they were clearly capable of feeding and growing for at least a short period of time. The lack of any subsequent records for this species can apparently be attributed to the absence of conditions suitable for spawning. The success, however, of some of the above introduced fish must also be another factor which has contributed to the current paucity in the numbers of the indigenous freshwater teleost fauna.

The Swan Estuary as a nursery habitat and adult feeding ground

In common with most estuaries, the Swan Estuary acts as a nursery ground for a number of marine teleosts. Two species that enter the estuary in large numbers, and predominantly only in their first year of life, are the Six-lined Trumpeter, *Pelates sexlineatus*, and the Trumpeter Whiting, *Sillago maculata,* which start their inwards movement during the summer months. The Yellow-eye and Sea Mullets, *Aldrichetta forsteri* and *Mugil cephalus*, represent another group of teleosts that is abundant in the Swan Estuary, but in this case utilize the estuary extensively as an adult feeding area as well as a nursery habitat. These species, and in particular the Sea Mullet, sometimes spend, however, a considerable time at sea, including their spawning period (Thomson, 1957d; 1966). Other abundant species that follow a similar life cycle pattern in the Swan and other south-western estuaries are the Tailor, *Pomatomus saltatrix,* and the Mulloway, *Argyrosomus hololepidotus*.

Marine teleosts, which use the estuary predominantly after the completion of their first year of life, are represented by such species as the Common Blowfish, *Torquigener pleurogramma.* This fish is often so numerous that samples taken in our 103m long beach seine have sometimes contained nearly 1000 individuals with total lengths generally falling in the range of 10-20 cm.

Species which can pass through the whole of their life cycle within the Swan-Avon River System

One aspect emerging from our recent regular sampling programme is that evidence is now available that a number of species in the Swan-Avon River System are represented by populations that can pass through the whole of their life cycle in an estuarine environment. There would appear to be little doubt, for example, that several gobiids, such as the Long-headed, *Favonigobius suppositus*, Bridled, *Amoya bifrenatus*, and Blue-spot Gobies, *Pseudogobius olorum*, fall into this category. This view is also supported by the observations of Lenanton (1977a) on these species in the Blackwood River. Another fish which has been termed by Lenanton (1977a) as estuarine in the Blackwood is the Black Bream, *Acanthopagrus butcheri.* Our study indicates that, although representatives of this species may occasionally be swept out to sea in the winter, all year classes are abundant in the upper and middle estuary during the summer. This estuarine mode of life in the Swan-Avon contrasts with their marine distribution in South Australia (Weng, 1970).

The Cobbler, *Cnidoglanis macrocephalus,* differs from the Black Bream in that it is represented by populations in the estuarine regions of the Swan-Avon River System and in the sea. Moreover, the populations off the nearby Rottnest

Island have been shown to differ in meristic and other characters (Kowarsky, 1975).

In the context of estuarine populations, the Yellow-tailed Trumpeter, *Amniataba caudavittatus*, which is numerous in the Swan-Avon River System, provides another parallel with the Black Bream. Thus, while our studies strongly suggest that this species rarely goes out to sea in the region surrounding the Swan-Avon, it has been found in marine embayments, such as those of Shark Bay to the north (Lenanton, 1977b). Its restriction to the estuarine regions of the Swan-Avon in the Perth area of Western Australia is of interest as it is known to be able to tolerate salinities of 52‰ in the lagoon regions of Shark Bay (Lenanton, 1977b).

Our studies on the last few species highlight the problem of establishing whether several of the fishes in the Swan-Avon River System should be regarded as true estuarine species. A further instance of this dilemma is provided by the Perth Herring, *Nematalosa vlaminghi,* which is abundant in the Swan-Avon throughout the year and for which there is evidence that breeding takes place in the upper regions of the river. At the same time, it must be noted, however, that large numbers of individuals have been taken occasionally from Cockburn Sound in the summer and the winter. At the present time, we are of the opinion that in the Swan-Avon region of Western Australia, the Perth Herring is an estuarine species which may sometimes move into oceanic marine embayments.

Although there can be little doubt that the Perth Herring, in common with the closely related *Nematalosa come* (Thomson, 1957e), occasionally moves for considerable periods into low salinities, or even freshwater, the same cannot apparently be said for the Gobbleguts, *Apogon rueppellii.* During our recent sampling programme, populations of this latter species moved in under the halocline during the winter, a feature which may well be an adaptation to reduce its exposure to declines in salinity brought about during periods of freshwater flushing. This species, which can undoubtedly pass through the whole of its life cycle in the estuary, is also abundant at all stages in Cockburn Sound and in small numbers off Rottnest Island. Another teleost which we currently consider as estuarine is the western form of the Anchovy, *Engraulis australis.* This species, which was extremely numerous in the Swan Estuary during 1977, is also very common in several other south-western Australian estuaries.

It is clear from the presence in the Swan-Avon of large populations of several of the species just mentioned that this river system possesses certain characteristics conducive to their spending the whole of their life cycle in estuarine conditions. Our future studies will be aimed at elucidating the factors which are responsible for the success in the Swan-Avon River System of such species as the Perth Herring, Yellow-tailed Trumpeter and Gobbleguts.

Marine stragglers

The aforegoing attempt at categorising the teleosts found in the Swan River on the basis of data on their life cycle was restricted to the more abundant species. By far the majority of the fish in our checklist were, however, what might be termed marine 'stragglers.' In other words, they are species, usually represented by older individuals, that are typically marine, but which have entered the lower reaches of the estuary for a restricted period. One such species is the Red Gurnard, *Chelidonichthys kumu*, which has been caught in small numbers in several different years, while more limited records are available for other teleosts such as the Lined Pufferfish, *Arothron hispidus,* the North-West Blowfish, *Lagocephalus sceleratus,* and the White-barred Boxfish, *Anoplocapros lenticularis.*

Cartilagenous fishes

In terms of the cartilagenous fishes, it would clearly appear from the checklist that this group is poorly represented in the Swan. Thus, in addition to single records for a hammerhead shark, *Sphyrna zygaena,* the Port Jackson Shark, *Heterodontus portusjacksoni,* the Shovelnose Ray, *Aptychotremata vincentiana,* and an eagle ray, *Myliobatis australis,* the only other elasmobranch recorded from the Swan-Avon River System is the Swan River Whaler, *Carcharhinus leucas,* which, in addition to the records mentioned under the species notes, has been caught on lines used for catching Mulloway. A study of the biology of this species would be of considerable interest in view of the lack of records from nearby marine habitats.

Comparisons with other Western Australian Estuaries.

The checklist and brief notes on the biology of some of the more abundant fish species in the Swan-Avon River System can be compared with the results of Lenanton's (1977a) extensive study of the Blackwood River Estuary, approximately 252 km to the south. In considering the species whose distribution range clearly encompasses both river systems, the most notable differences reside in the virtual absence or small numbers in the Swan of the Pink Snapper, *Chrysophrys unicolor,* and the restricted numbers of the Sea Garfish *Hyporhamphus melanochir,* Silver Bream, *Rhabdosargus sarba,* Six-spined Leatherjacket, *Meuschenia freycineti,* and the Western Sand and King

George Whitings, *Sillago schomburgkii* and *Sillaginodes punctatus*. Most of these are represented by large numbers in the Blackwood and in inlets to the south of the Swan-Avon, as well as being very common off the coastal regions around Perth where they make a considerably contribution to the commercial and amateur fishery. In this context, it is therefore probably of significance that the underwater observations of one of us (J.B.H.) demonstrate that these fishes in particular tend to move away from areas of disturbance. These species may thus tend to avoid entering the Swan-Avon because of the frequent and extreme disturbance created in the water and river bottom by the movement of the many large ships that enter the narrow Fremantle Harbour which is located in the lower estuary.

A major difference can also be observed between the fish fauna of the two most studied Western Australian estuaries by the fact that four of the currently most abundant teleosts in the Swan-Avon, are absent from the Blackwood. Furthermore, the numbers of these species, namely the Perth Herring, Yellow-tailed Trumpeter, Gobbleguts and a species of silverbelly, *Gerres subfasciatus*, apparently decline abruptly in a region to the south of Perth. This point is well illustrated by the contrast between their absence in the Blackwood and their relatively high abundance in Leschenault Inlet only 117 km further to the north (R.C.L. unpublished data). It should also be noted that the Giant Herring, *Elops machnata*, is the only predominantly northern species that has been found in the Blackwood (Lenanton, 1977a). The Swan Estuary by contrast is characterised by possessing several species of tropical 'stragglers,' a feature which is largely responsible for the fact that it contains almost twice as many species as have been found in the Blackwood Estuary.

The current studies of Lenanton (unpublished) make it clear that the Murchison River, which is located 511 km to the north of Perth, contains a fauna similar in composition to that of the Swan-Avon. Thus, the predominant fishes are species such as the Perth Herring, Gobbleguts, Black Bream, Yellow-tailed and Six-lined Trumpeters, and Sea Mullet, all of which have also been recorded further north. The only real exceptions in the fauna of the Murchison reside in the presence of the Jumping or Flat-tail Mullet, *Liza argentea*, and the higher proportion of 'stragglers' of genuine tropical species. The large numbers of *L. argentea* in the Murchison, and also in the Greenough approximately 142 km further south, is surprising in view of the fact that this species is also present in South Australia (Scott *et al.*, 1974), but not in the estuaries of the south west (Lenanton, 1974a, 1977a).

Although the amount of information on Western Australian coastal rivers and estuaries is extremely limited, it would clearly appear from the above data, and from marine records, that some of the fish found in north-western Australia have distributions which extend southwards to a region corresponding approximately to Cape Naturaliste. This finding parallels the situation described by Wilson & Gillett (1974) for gastropods, who regard the latter area as representing the most southern location to which representatives of their Northern Australian Region (Tropical) extend.

From a sampling programme carried out in south-western estuaries by Lenanton (1974a), it is apparent that the fauna of the Blackwood is characteristic of other open estuaries along the south coast. However, many of the species found in these estuaries do extend in numbers northwards, but generally only as far as the Shark Bay and North West Cape region of Western Australia. Such teleosts include the Yellow-eye Mullet, Western Whiting, Australian Herring, Black Bream, Pink Snapper, Skipjack Trevally and Common Blowfish. Thus in this case also, a close parallel can be drawn with the conclusions of the studies of Wilson and Gillett (1974), who regard the North West Cape area as the northern limit of the distribution of gastropod representatives of their Southern Australian Region (Temperate).

In addition to the above species with a wide distribution in the river systems of south-western Australia are those which, probably because of their relatively low tolerance to high temperatures (see e.g. Macey & Potter, 1978), are more restricted in their distribution and have been found in numbers in recent surveys only in the rivers to the south and east of Cape Leeuwin. These include the anadromous parasitic lamprey, *Geotria australis,* which has been caught in both the saline and freshwater regions of various river systems and the Long-snouted Flounder, *Ammotretis rostratus,* which has been taken in several estuaries. Certain freshwater species which are also only found in south coast rivers, include the Black Stripe Minnow, *Brachygalaxias nigrostriatus,* the Trout Minnow, *Galaxias truttaceus,* the Salamander Fish, *Lepidogalaxias salamandroides*, and Balston's Perchlet, *Nannatherina balstoni.*

In contrast to the above groups there are also some species which have a wider distribution around the whole of Australia. One such teleost that is abundant in many estuaries and falls into this category is the Sea Mullet.

While it is not the purpose of this paper to explore at length the degree to which the distribution regions outlined briefly above coincide with those of other workers, a few comparisons are worth recording at this time. For example, while Bennett & Pope's (1953) extensive study on the distribution of invertidal fauna agrees essentially with the pattern described by Wilson & Gillett (1974) and with our preliminary observations, their Dampierian-tropical province is shown as extending around the south-west tip of Western

Australia to the Albany region of the State. From the limited data available to him on fish distributions at the time of his study, Briggs (1974) drew attention to the apparent significance of the Shark Bay region south of the North West Cape as a point which he regarded as separating temperate and tropical faunas. This latter study, and our findings, thus disagree with the line drawn by Whitley (1932) which shows a division of these two categories just south of Geraldton.

SUMMARY AND CONCLUSIONS

There is still a paucity of detailed information on the estuarine teleost component of many Western Australian coastal river systems, particularly those above the North West Cape. Our extensive sampling programme, which was carried out at very regular intervals during the year, has provided, however, detailed information on the movements and biology of many species within the Swan-Avon River System. Such information facilitated the categorisation of some of the fishes of marine origin into groups according to the way in which they use the estuarine component of the river. Thus, these species were separated into those that employed the estuary predominantly either as a nursery area or adult feeding ground, or as an environment that is exploited at various times during the life cycle. A further group was recognised which consisted of 'marine stragglers' that normally remain in oceanic environments. Yet, one of the most interesting findings was that populations of some species constituted another group in which the whole of the life cycle was spent in an estuarine environment. It is hoped that these data, which also facilitate broad distinctions to be made between stenohaline and euryhaline species, will be of value to ichthyological systematists who often only list fishes as having a marine or fresh water distribution. It is also evident that, because of the movement patterns of many species within Western Australian river systems, any sampling programmes aimed at further elucidating zoogeographical patterns in this region should ideally be based on samples taken at different times of the year.

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MAMMALS OF THE WARBURTON REGION, WESTERN AUSTRALIA

A.A. BURBIDGE*

and

P.J. FULLER*

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ABSTRACT

Interviews with local people, examination of the literature and Museum records and our own field work reveal that 28 species of indigenous mammals have been recorded in modern times from the Warburton Region of arid Western Australia. Only three species of bats have been collected and additional work will doubtless add further species. Five species of exotics have become established. Aboriginal names for most species are given.

Eight species appear to be extinct in the Region — *Onychogalea lunata, Lagorchestes hirsutus, Bettongia lesueur, Isoodon auratus, Perameles eremiana, Dasyurus geoffroii, Myrmecobius fasciatus* and *Leporillus* sp. — all of which are intermediate in size between the relatively common larger kangaroos and smaller rodents and dasyurid marsupials. The only intermediate sized marsupials remaining in the region — *Petrogale* sp., *Trichosurus vulpecula* and *Macrotis lagotis* — have declined in numbers.

Reasons for the extinction or decline of so many species are unknown but the establishment of exotic predators is a likely cause. Changes in the extent and frequency of fire may have contributed in some cases.

INTRODUCTION

Many mammals of the arid regions of Australia have undergone drastic changes in distribution and status since European man first settled the continent (Finlayson, 1961; Philpott & Smyth, 1967; Ride, 1970). Within Western Australia recent publications and collecting expeditions have shown that many species once present in the Gibson and Great Victoria Deserts

* Western Australian Wildlife Research Centre, Department of Fisheries and Wildlife, P.O. Box 51, Wanneroo, W.A. 6065.

are now apparently absent — even after periods of high rainfall (Burbidge *et al.* 1976; McKenzie & Burbidge, 1979). However, few data are available on the area of Western Australia east of Warburton which contains stony ranges and Mulga (*Acacia aneura*) dominated vegetations not found in the

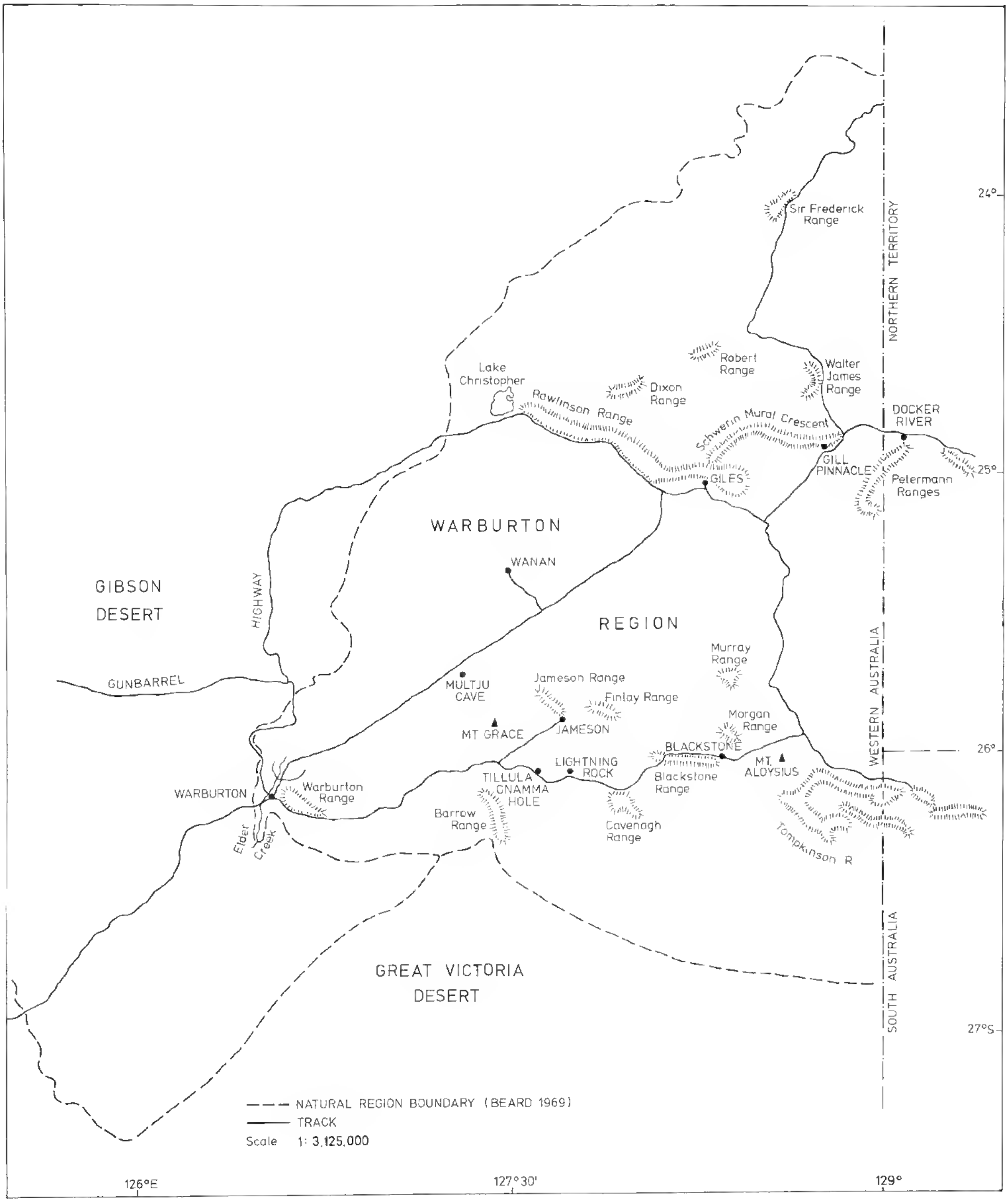

Fig. 1: The Warburton Region.

deserts. This paper records the mammals which occurred in this region in modern times and documents their present status.

Beard (1969) has described and delineated the deserts of Western Australia. This publication refers to the term 'Warburton Region' as defined by Beard (see Fig. 1). The vegetation of this area has been mapped by Beard (1974) who has also described the climate.

Data recorded here have been derived from the following sources:

1 Discussions with the Aboriginal people of Warburton, Jameson, Cavenagh Range, Blackstone, Docker River, Giles and Wanan during January and June 1977. These included people who spoke the Ngaanyatjarra, Pitjanjatjarra, Ngaatjatjarra and Pintupi dialects of the Western Desert Language.

2 Records of the Western Australian Museum and in the literature.

3 Our own collecting. Specimens collected by us are lodged in the Western Australian Museum, accession numbers M15368-15376.

ANNOTATED LIST OF THE MAMMALS

Records from areas surrounding Warburton (and occasionally from even further away) are presented in some cases in order to clarify distributions and the overall status of a species. Species discussed but not known to occur in the Region are placed in brackets.

Macropus robustus Gould — Euro

Aboriginal names: Kanyarla, Nyatunya

The Euro is widespread and plentiful in all rocky country.

Megaleia rufa Desmarest — Red Kangaroo

Aboriginal name: Marlu

Red Kangaroos are fairly common in mulga country, especially where the ground cover is tussock grasses rather than spinifex. The Red Kangaroo is keenly hunted by the local people.

Onychogalea lunata (Gould) — Crescent Nail-tailed Wallaby

Aboriginal name: Tjawalpa

All Aboriginal groups we spoke to told us that this species no longer occurred in the region. Philpott & Smyth (1967) also failed to locate it. Finlayson (1961) reported material from the Cavenagh Range and stated that it was present in central Australia as late as 1956.

We were told that the Nail-tailed Wallaby inhabited mulga country and creek country where there are River Gums (*Eucalyptus camaldulensis*).

Ride (1970, p. 198) reported that W.H. Butler found the remains of an *O. lunata* in 1964 near the Warburton Range. He said that the specimen appeared to have been killed by a Fox some short time previously. Ride (pers. comm.) was reporting a comment made to him by Butler and stated that the identification was based upon a small mandibular fragment that was still greasy.

Butler (pers. comm.) collected three specimens of *Onychogalea lunata* at locations in the vicinity of the Laverton-Warburton Road. A mandibular fragment (WAM palaeontological collection 76.6.28, formerly M5239) with ligaments still attached was collected in 1962, together with skeletal fragments of *Dasyurus geoffroii* and *Trichosurus vulpecula*, from a breakaway cave near Muggan Rockhole (27°00'S, 125°20'E) in the Great Victoria Desert. The specimens appear to be remains left in the cave by a predator and it is not possible to say how long they have been there. A further mandibular fragment (WAM 63.1.30) was collected in 1962 from Prideaux Cavern (approx. 26°46'S, 126°12'E, Gibson Desert), but this appears to be fossil (A. Baynes, pers. comm.). A third specimen (of which there is no record) Butler recalls collecting in 1964. It comprised skeletal fragments and decomposing tissue and was found on the edge of the Laverton-Warburton Road near Gahnda Rockhole (26°36'S, 125°52'E) in the Gibson Desert. None of these specimens was found in the Warburton Region as defined in this paper. Moreover, the two mandibular specimens, one of which presumably is that identified by Ride, are only doubtfully modern.

Lagorchestes hirsutus (Gould) Western Hare-wallaby

Aboriginal name: Mala

We were told that Hare-wallabies were once plentiful and occurred in spinifex country but that they were now no longer present in the region.

The W.A. Museum has one specimen (M1572) collected 2 km south of Warburton in 1931. Finlayson (1961) recorded this species from south of the Cavenagh Range, south-west of the Barrow Range, and north of Sladen Waters between the Rawlinson Range and the Robert Range.

Parker (1973) reported recent records from the Tanami Desert Wildlife Sanctuary in the Northern Territory; these are the only known mainland colonies.

(*Lagorchestes conspicillatus* Gould Spectacled Hare-wallaby)

None of the Aboriginal people from the Warburton Region knew this species. Finlayson (1961) reported its presence in country to the west of the Macdonnell Range. The closest locality he gives is 'Mareeni Plain' —

presumably near Mereeni Bluff (23°38'S, 131°56'E). Recent records from the Northern Territory are in its northern half (Parker, 1973), and the closest Western Australian records are from the Pilbara.

Petrogale ? lateralis Gould Black-flanked Rock-wallaby

Aboriginal name: Warru

We were told that Rock-wallabies still occurred in the region, mostly in rock outcrops rather than in the larger ranges. Finlayson (1961) reported that Rock-wallabies were widespread in central Australia but were, at that time, much reduced in numbers compared with observations he made in 1932-1935. In Western Australia he reported them from Barrow Range.

The Western Australian Museum has specimens from Lightning Rock (M3532, collected May 1959; 26°04'S, 127°45'E); 19 km south-east of Warburton Mission (M4988, August 1961; 26°14'S, 126°39'E) and the Warburton Range (M9872, 1973; 26°06'S, 126°30'E). Ride & Savage (1969) reported that Rock-wallaby droppings were present at Lightning Rocks [*sic*] in 1967.

We inspected Lightning Rock on 13 June 1977 and could find no evidence of Rock-wallabies. However, on an isolated rockpile at Bilbring Waterhole, about 1 km south of Lightning Rock, there were recent droppings which we attributed to this species. Daylight and after dark traverses using spotlights and head torches were, however, not successful in proving its presence.

Local people told us there were Rock-wallabies on hills near Tillulla Gnamma Hole (26°04'S, 127°38'E) but we could find no signs of them. We did find very old droppings attributed by us to this species on a hill at the edge of the Jameson Range. The local people also said there were Rock-wallabies near Mt Grace (25°53'S, 127°28'E), in the southern Cavenagh Range and in the Morgan Range (25°55'S, 128°23'E). We did not investigate these sites.

Although Rock-wallabies are present in the region it appears that their numbers are fairly low and may be declining.

(*Bettongia penicillata* Gray Woylie)

The Woylie is recorded from Central Australia by Finlayson (1961). There are no records from the Western Australian side of the border.

Parker (1973) believes Finlayson's records are probably referrable to *Lagorchestes conspicillatus.*

Bettongia lesueur Quoy & Gaimard — Boodie

Aboriginal names: Mitika, Tjungku

Although the Boodie appears to be extinct in the Warburton region, as it is throughout the Australian mainland, it was well known to the older people we spoke to. We were told that they lived in burrows in sandhill country. Parker (1973) listed a wider range of habitats.

The Western Australian Museum has a skull from the Rawlinson Range area, accessed in 1933. Finlayson also reported a specimen from this area. Giles (1889) found *B. lesueur* to be numerous in low limestone ridges in the dry bed of Lake Christopher, north-west of the Rawlinson Range.

Trichosurus vulpecula Kerr — Brush Possum

Aboriginal name: Wayurta

The possum is another species which was once widespread and plentiful in the centre (Finlayson, 1961) but which has suffered a drastic decline in range and numbers. Some people told us that they had seen possums recently while others said they had not seen them for a long time and they were 'finished'. We were told that possums inhabit country with eucalyptus trees containing suitable hollows for shelter. Parker (1973) listed several recent records of *T. vulpecula* from the southern half of the Northern Territory.

The Western Australian Museum has no specimens from the Warburton Region but Finlayson (1961) recorded specimens from the Warburton Range.

We found old droppings attributable to this species in Multju Cave (approx. 25°42'S, 127°14'E).

Isoodon auratus (Ramsay) — Golden Bandicoot

Aboriginal names: Windtaru, Makurra, Nyulu

Once again this is a species which was common and widespread but which has now apparently disappeared from the region. We were told it lived in spinifex country.

The Western Australian Museum has one specimen from the Rawlinson Range area (M1733, 1933) and another specimen (M1574) accessed in 1931 labelled 'Windarra, 26°15'S, 126°30'E', i.e. about 15 km south-west of Warburton, with a note that Windarra is the native name. It was collected by an expedition led by the surveyor, H.L. Paine, which worked between Laverton and Warburton and east to Lightning Rock. A report of the expedition (published by Tomlin & Cleave, 1966) and Paine's Journal (Paine, 1931) make no mention of this specimen and it seems likely that someone has confused the Aboriginal name for the animal with the name of the locality. Finlayson (1961) recorded *Isoodon* from further east. He also stated that it inhabited extensive spinifex tracts. Parker (1973) stated that the last authentic record from central Australia was a specimen from The Granites (20°34'S, 130°21'E) in the Tanami Desert, taken in May 1952. The species still survives in the Kimberley (McKenzie *et al.*, 1975) and in northern Northern Territory (Parker, 1973), and an island form occurs on Barrow Island (Ride, 1970).

Perameles eremiana Spencer — Desert Bandicoot

Aboriginal name: Walilya

The Desert Bandicoot has also disappeared from the Warburton region. We were told it lived in spinifex country and built a small burrow with a nest at the end.

Finlayson (1961) found *P. eremiana* to be 'fairly plentiful' in this region in 1932-35 but reported that it was absent or rare by 1961.

(*Perameles bougainville* Quoy & Gaimard — Barred Bandicoot)

We enquired of this species, describing it as similar to *P. eremiana* but with stripes on the rump, but none of the people we spoke to recognised it. Finlayson (1961) also could not obtain evidence of *P. bougainville* in central Australia. The Western Australian Museum has a *Peremales* identified as *bougainville*, from the Gibson Desert at Gahnda Rockhole (26°36'S, 125°52'E). This specimen (M1575, collected by the H.L. Paine expedition in 1931), is, we believe, attributable to *P. eremiana*. Paine (1931) records the name 'Walleela' for the animal in his Journal.

(*Chaeropus ecaudatus* [Ogilby] — Pig-footed Bandicoot)

We could gain no evidence that the local people knew of this species. Only one man (from Docker River) appeared to recognise it. He called it 'Walputju' and stated it lived in mulga country. Finlayson (1961) stated that the Pitjanjatjarra name for *Chaeropus* is 'Kunjilba'. A more acceptable transliteration for this is 'Kuntjilpa'. Parker (1973) lists locality records for central Australia.

Macrotis lagotis (Reid) — Rabbit-eared Bandicoot

Aboriginal names: Nirnu, Marara

This species was well known to all the groups we spoke to. Although its numbers have declined drastically it still occurs sporadically in suitable country. Smyth & Philpott (1968) have described the ecology of a population near Warburton. They also obtained specimens from 19 km south-west of Mt Aloysius (Philpott & Smyth, 1967).

According to the local people the main strongholds of *M. lagotis* are to the north and north-west of Warburton and to the west of the Jameson Range as well as south of the Cavenagh Range. We were shown burrows and diggings attributed to this species near Warburton and to the west of Jameson. Following our January visit an animal was captured near Warburton and sent to Perth. The W.A. Museum has three specimens from near Warburton taken in 1965.

Finlayson (1961) described a similar drastic reduction in numbers from adjacent parts of South Australia and the Northern Territory.

Dasyurus geoffroii Gould — Western Native-cat

Aboriginal name: Parrtjarta

The native-cat was well known to some groups but others knew it only vaguely or not at all. We were given conflicting statements as to its habitat — most people said it lived in spinifex and sandhill country but some said it inhabited mulga. All groups agreed that it had now disappeared.

Finlayson (1961) reported that this species was widespread in central Australia and that he had recent reports indicating that it survived in parts of the southern Northern Territory.

(*Phascogale calura* — Red-tailed Wambenger)

We showed pictures of both *P. calura* and *P. tapoatafa* to several groups but, apart from one group, they did not recognise them.

People at Jameson Range seemed to recognise the pictures and called the animal 'Taling-go-won'. They said it lived on the ground. K. Liberman (pers. comm.) thinks this is probably 'Talingka' one — the one who lives in sandhills (tali).

Neither species has been recorded in the Warburton Region. *P. calura* was collected in central Australia at the turn of the century (Parker, 1973) but has not been recorded in the centre since. Finlayson (1961) stated that Glauert (1933) recorded *P. tapoatafa* (as *P. penicillata pirata*) from the 'Sandridge Desert of Western Australia' at about lat. 21°50'S. However, a search of this publication does not reveal any such statement and there is no specimen in the Western Australian Museum which fits this description. There is a specimen (M3151), identified by M. Archer as *P. calura*, in the South Australian Museum. It was collected at Well Number 44 on the Canning Stock Route (21°01'S, 126°07'E) in April/May 1931 (P.F. Aitken, pers. comm.).

A group of Aboriginal people from Warburton who were shown a *P. calura* skin at the W.A. Museum a few years ago called it 'Pitji-pitji' — the same name they applied to *Antechinomys laniger* (D.J. Kitchener, pers. comm.).

We believe that the weight of evidence suggests that the Aboriginal people from the Warburton Region do not know this species but are confusing it with others.

Dasycercus cristicauda (Krefft) Mulgara

Aboriginal name: Mingkiri

Among the Aboriginal people there was some confusion between this species and some others, probably because of our difficulty in describing the animal and our not having good pictures of it. It was not until late in our second trip that we obtained the name 'Mingkiri' for this species. We gained the impression that it had declined in numbers but still occurred in some areas.

Parker (1973) stated that *Dasycercus* is 'not uncommon following good seasons' (p. 9). The W.A. Museum has specimens from 'Warburton Range Area' collected in late 1967 or early 1968 (M7742-7744). Burbidge *et al.* (1976) obtained skeletal material from fresh owl pellets in the Gibson Desert.

Antechinus macdonnellensis (Spencer) Red-eared Antechinus

Aboriginal names: Nyaluti, Murrtja

Antechinus was not well known, presumably because of its cryptic habits. The name 'Nyaluti' was given by various groups to pictures of a variety of small mammals which they found hard to recognise and it may be used for more than one species. Finlayson (1961) recorded it (as 'Narloodi') as one name for *Dasycercus.* However, people from Jameson had no hesitation in naming *Antechinus* as Nyaluti when we showed them live specimens. At Docker River we were told that Murrtja was the Pitjanjatjarra name for Nyaluti which is used primarily by Ngaanyatjarra and Pintupi people.

We trapped *Antechinus macdonnellensis* in the Jameson Range (1 ♂, 1 ♀), Blackstone Range (2 ♂, 1 ♀) and the Scherwin Mural Crescent near Gill Pinnacle (1 ♂). All were from rock piles with little vegetation or from scree slopes of the ranges. The W.A. Museum has specimens from Lightning Rock (M8927-8, 8930-33, 8937-8 and 8942) collected in 1967 (Ride & Savage, 1969). It has also been collected recently in 'Breakaway' country in the Gibson Desert (Burbidge *et al.*, 1976; McKenzie & Burbidge, 1979).

Finlayson (1961) recorded it from adjacent parts of the Northern Territory but considered it 'not a common form at the present day'. However, Parker (1973) stated that, in the Northern Territory, it is widespread and in some areas common.

Ningaui sp.

We obtained skeletal fragments of a *Ningaui* from superficial deposits at the foot of a vertical shaft at the entrance to Multju Cave (approx. 25°42'S, 127°14'E).

Sminthopsis crassicaudata (Gould) — Fat-tailed Dunnart

This species has been collected at Warburton (WAM M7736, 1967/68). It is also known from adjacent parts of the Northern Territory and South Australia (Finlayson, 1961; Parker, 1973). We did not attempt to discuss it with Aborigines because of difficulties in recognition from pictures.

Sminthopsis hirtipes Thomas — Hairy-footed Dunnart

This species has also been collected near Warburton (WAM M5783, Elder Creek, 1963; Parker, 1973). We did not discuss this species with the local people.

Sminthopsis ooldea Troughton

We obtained skeletal fragments, thought to be of this species, from superficial deposits at the foot of a vertical shaft at the entrance to Multju Cave (approx. 25°42'S, 127°14'E).

The W.A. Museum has a specimen from Warburton collected in 1964 (M6361).

Antechinomys laniger (Gould) — Wuhl-wuhl

Aboriginal names: Wuurl-wuurlpa, pitji-pitji

Apparently quite common in suitable country, this species was known to some groups and not others. The W.A. Museum has about 20 specimens from the vicinity of Warburton collected between 1962 and 1968.

Myrmecobius fasciatus Waterhouse — Numbat

Aboriginal name: Walpurti

The Numbat was well known to all groups but everyone told us it had now disappeared. Men aged about 45 to 55 told us they had seen them when children or young men. We were told it lived in mulga country.

The W.A. Museum has a flat skin of the Numbat from Warburton, accessed in 1948. Finlayson (1961) recorded it from south of the Cavenagh Range and north and west of the Rawlinson Range and stated that the last specimen was taken in 1933.

Notoryctes typhlops (Stirling) Marsupial-mole

Aboriginal names: Yirtarrutju, Yirtarri-yirtarri

Most people knew this animal and said it still occurred in sandhill country. The W.A. Museum has a specimen from Warburton taken in 1968.

Finlayson (1961) recorded the Marsupial-mole from extensive areas of central Australia.

Leporillus spp. Stick-nest Rats

Aboriginal names: Tjuwalpi, Yininma

Although neither species of *Leporillus* has been collected alive in Western Australia, old nests constructed by Stick-nest Rats under rock overhangs or 'breakaways' still occur in many parts of the State.

Skeletal material of *L. apicalis* (Gould) has been recovered from nests in the Gibson Desert (A. Douglas, pers. comm.).

Most of the Aborigines we spoke to knew *Leporillus* and described stick-nests in breakaway country and caves. Nobody claimed to have seen the animal recently but some people said they must still be around because the nests 'are still growing'. Ride & Savage (1969), Gratte (1972) and Burbidge *et al.* (1976) reported that nests in the Gibson Desert included fresh material but they found no conclusive evidence of the presence of *Leporillus.*

One old man from the Cavenagh Range accurately described nests built from sticks on the ground, around a shrub. *L. conditor* constructs this type of nest on Franklin Island but also builds in caves (Robinson, 1975). Giles (1889) saw this type of nest in the Warburton Region (e.g. at Mt Squires in the Barrow Range) and elsewhere in central Australia but Parker (1973) attributes these to *L. apicalis.*

Notomys alexis Thomas Spinifex Hopping-mouse

Aboriginal name: Tarrkawarra

A widespread species in the interior, *N. alexis* is by no means restricted to spinifex and sand situations (Parker, 1973; Burbidge *et al.*, 1976). The W.A. Museum has a number of specimens from the vicinity of Warburton. We obtained skeletal material from Multju Cave (approx. 25°42'S, 127°14'E).

(*Zyzomys* spp. Rock Rats)

We showed the local people a picture of *Z. argurus* but they did not recognise them. *Z. pedunculatus* was recorded in the Macdonnell and James Ranges late last century. Finlayson (1961) reported specimens from the Northern Territory taken in 1950 and 1951 but he did not examine these himself. Parker (1973) recorded an additional specimen from Haast's Bluff Settlement in the western Macdonnell Ranges taken in 1960.

Pseudomys hermannsburgensis (Waite) — Sandy Mouse

This species has been collected near Warburton (e.g. WAM M8941) and near Lightning Rock (e.g. WAM M8918). It has a wide range in the more arid parts of the continent.

We obtained skeletal material from Multju Cave (approx. 25°42'S, 127°14'E).

Mus musculus Linnaeus — House Mouse

We obtained two specimens, one from a tussock grassland adjacent to the Blackstone Range and the other from a dry creek bed near Gill Pinnacle in the Scherwin Mural Crescent.

The W.A. Museum has numerous specimens from Warburton. This and other mice are known collectively as 'Wiltjin' by the Aborigines.

Nyctophilus geoffroyi Leach — Lesser Long-eared Bat

N. geoffroyi has been collected in the Warburton Range (WAM M6074, 1963) and at Bungabiddy Rockhole in the Walter James Range (WAM M8421, 1971).

The local people have at least three names for bats — Patjupirri, Parturta and Tintinti. We were not able to tell whether these were applied to different species.

Eptesicus pumilus caurinus (Thomas) — Little Bat

We obtained one specimen, a female, from the Blackstone Range. It was shot, using the floodlighting technique of Youngson & McKenzie (1977) at 1915 hrs, approx. two hours after sunset. This is, apparently, the first record from the Warburton Region of this widespread species.

Chalinolobus gouldii (Gray) — Gould's Wattled Bat

This bat has been collected in the Warburton Range area (M7740, 41, 1967/68; M6036, 1963) and at Bungabiddy Rockhole in the Walter James Range (M8422, 1971).

Tachyglossus aculeatus (Shaw) — Echidna

Aboriginal name: Tjilkamarta

The Echidna was well known to all groups. We were told it lived mainly in rocky country. We saw droppings and diggings of this animal in all the ranges we visited.

Oryctolagus cuniculus (Linnaeus) Rabbit

Aboriginal name: Nani, Pinytjatanpa

The European Rabbit is common in the Warburton Region. It favours stony plains near the base of the ranges and is also plentiful around smaller rock outcrops. It appeared to be less plentiful in mulga country and absent from sandhill regions. The Rabbit is a major food item for Aborigines.

Camelus dromedarius Linnaeus Camel

The Camel is well established in the region and tracks were seen in all types of country except the steep ranges and rocky hills.

Canis familiaris dingo Meyer Dingo

Aboriginal names: Papa, Ngupanu, Yinura

Another widespread and common species. Tracks were seen in all types of country.

Vulpes vulpes (Linnaeus) Fox

Although the Fox is widespread it appeared to be much less common than the Dingo or the Cat. It was most plentiful in mulga country.

Finlayson (1961) records that the Fox was present in small numbers in the Everard and Musgrave Ranges in 1932 and reached the Basedow Range in 1933.

Felis catus (Linnaeus) Feral Cat

Aboriginal names: Ngaya, Wiilyka

A widespread and plentiful species, tracks being seen in all types of country where imprints could be made. It seemed especially common in sandhills and mulga.

It is not known when Cats first entered central Australia but it was probably during the nineteenth century. Finlayson (1961) reports that the Elder Expedition of 1891 saw a Cat 160 km south-west of Mt Squires in the Great Victoria Desert (at approx. 27° 30'S, 126° 30'E).

DISCUSSION

Twenty-eight species of indigenous mammals have been recorded from the Warburton Region. Only three of these are bats and further collecting will doubtless reveal further species, e.g. *Taphozous georgianus*, *T. flaviventris*, *Macroderma gigas*, *Tadarida australis*, *T. planiceps*, *Chalinolobus morio* and *Nycticeius greyi*.

The status of the indigenous mammalian species known from the Region is presented in Table 1. Status is given as Common, Moderately Common, Rare or Extinct and has been assigned from data in this paper compared with our knowledge of mammal status elsewhere in Western Australia and data presented by Ride (1970) and Parker (1973).

TABLE 1

Indigenous mammals recorded or reliably reported from the Warburton Region and their present status in the Region.

Species	Present status
Macropus robustus	Common
Megaleia rufa	Common
Onychogalea lunata	Extinct
Lagorchestes hirsutus	Extinct
Petrogale ? lateralis	Rare
Bettongia lesueur	Extinct
Trichosurus vulpecula	Rare
Isoodon auratus	Extinct
Perameles eremiana	Extinct
Macrotis lagotis	Rare
Dasyurus geoffroii	Extinct
Dasycercus cristicauda	Moderately common
Antechinus macdonnellensis	Common
Ningaui sp.	Not known — probably common
Sminthopsis crassicaudata	Common
Sminthopsis hirtipes	Not known — probably common
Sminthopsis ooldea	Not known — probably common
Antechinomys laniger	Common
Myrmecobius fasciatus	Extinct
Notoryctes typhlops	Moderately common
Leporillus sp.	Extinct
Notomys alexis	Common
Pseudomys hermannsburgensis	Common
Nyctophilus geoffroyi	Common
Eptesicus pumilus caurinus	Common
Chalinolobus gouldii	Common
Tachyglossus aculeatus	Common
Canis familiaris dingo	Common

Of the 25 known terrestrial mammals it appears that eight species are locally extinct — *Onychogalea lunata*, *Lagorchestes hirsutus*, *Bettongia lesueur*, *Isoodon auratus*, *Perameles eremiana*, *Dasyurus geoffroii*, *Myrmecobius fasciatus* and *Leporillus* sp. It is noteworthy that all of these fall into the 'intermediate' size category of the Region's mammals; those which are considerably larger like the kangaroos and those which are much smaller like *Antechinus*, *Antechinomys*, *Sminthopsis*, *Notomys* and

Pseudomys, are still plentiful. Apart from the common and widespread *Tachyglossus aculeatus* the only intermediate sized mammals remaining in the Region are *Petrogale ? lateralis*, *Trichosurus vulpecula* and *Macrotis lagotis*, all of which have declined in numbers.

The reasons for the decline or disappearance of so many species of mammals must remain conjectural. It is noteworthy that extensive clearing of land for agriculture, one cause of mammal decline elsewhere in Australia, has not taken place here.

One obvious possible reason is the establishment of exotic mammals; both carnivores like the cat and fox and herbivores like the rabbit. When we questioned Aborigines as to the reasons for the disappearance of the native mammals they often told us it was due to predation by cats. Cats have apparently been responsible for the local extinction of *Lagostrophus fasciatus* and *Bettongia lesueur* on Dirk Hartog Island but have not eliminated two species of *Pseudomys* which occur there (Burbidge & George, 1978). Similarly, *Largorchestes conspicillatus* and *Isoodon* cf. *auratus* disappeared from the Monte Bello Islands following the establishment of cats there (Burbidge, 1971).

Another possible reason for the decline of some species is the changes in the timing, extent and frequency of fires in the interior, especially in spinifex country, following the concentration of the Aboriginal population at a few settlements. Aborigines used fire in hunting (e.g. of *Lagorchestes hirsutus*, Finlayson, 1936) and to encourage the regeneration of food plants, and it is thought that numerous areas of low fuel prevented the development of extensive summer fires. Bolton & Latz (1978) consider that the Tanami Desert populations of *L. hirsutus* owe their existence to consistent winter burning resulting in a tight mosaic of vegetation in various stages of fire succession. Today comparatively infrequent but very extensive summer fires are the rule rather than the exception.

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We are most grateful to Amee Glass of Warburton and Susan Tod Woenne of the Anthropology Department, University of Western Australia, who gave us considerable help with Aboriginal names; Ken Liberman, formerly of the Western Australian Museum, also helped in this regard. Our visits to the Warburton Region were made easier because of the help of Pat and Wanda Green of Warburton and Robert Collins of Jameson. Mr Alex Baynes and Dr Darrell Kitchener of the Western Australian Museum and Dr Michael Archer of the Queensland Museum identified the rodent and dasyurid skeletal remains from Multju Cave.

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REVISIONARY NOTES ON THE GENUS *VERMICELLA* (SERPENTES, ELAPIDAE)

G.M. STORR*

[Received 30 March 1979. Accepted 21 May 1979. Published 30 November 1979.]

INTRODUCTION

Since my revision of *Vermicella* (Storr, 1967) collections made in critical areas have necessitated changes in the taxonomic status of several forms, especially the elevation of certain subspecies to full species. *Cacophis warro* is redescribed and removed from *Vermicella*.

For the loan of specimens I am grateful to Mr J.C. Wombey of the CSIRO Division of Wildlife Research, Canberra, and Mr G.F. Gow of the Northern Territory Museum, Darwin. All other specimens cited in this paper, apart from the holotype of *V. minima*, are lodged in the Western Australian Museum.

VERMICELLA BERTHOLDI SPECIES-GROUP

This group comprises the species *bertholdi, littoralis, anomala* and *minima.* Because of their allopatry and obviously close relationship, the first three of these taxa were previously regarded as subspecies of *bertholdi.* Many more specimens have subsequently been collected but none shows any evidence of hybridization or primary intergradation, despite in many instances their geographic proximity. It has thus become clear that these 'subspecies' are in fact parapatric or marginally sympatric species. Also, but for different reasons, the fourth taxon *(minima)* is now elevated to a full species.

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* Department of Ornithology and Herpetology, Western Australian Museum, Francis Street, Perth, W.A. 6000.

VERMICELLA MINIMA (WORRELL)

Diagnosis

Very like *V. anomala* in scutellation but differing markedly in coloration, especially the absence of dark bands on body and tail.

Distribution

Dampier Land (southwest Kimberley, Western Australia).

Description (based on two specimens)

Total length (mm): male 172; female 217. Length of tail (% total length): male 13.3; female 9.2.

Rostral much wider than high, apex obtuse and reaching back 30-40% of way to frontal. Suture between internasals 1.2-1.3 times as long as suture between prefrontals. Frontal 1.2-1.4 times as long as wide, 0.6-0.8 times as long as parietals, and 1.8-2.0 times as wide as supraoculars. Nasal contacting preocular, which is narrowly separated from frontal. Postoculars 2 (1 on one side of one specimen), lower smaller. Temporals 1 + 1 + 2, primary much the largest and broadly contacting lip. Upper labials 5, last largest and widely separated from fourth. Scale rows 15 at midbody, 15 or 17 on neck, 13 just before vent. Ventrals: male 125; female 127. Subcaudals: male 22; female 19; the first 3-5 undivided.

Head blotch black, reaching forward to anterior edge of frontal or a little past it and back to a little past end of parietals, and narrowing as it descends to side of lower jaw. Nuchal blotch black, 3-4 scales wide, narrowing as it descends side of neck, encircling body in one specimen (but less than half a scale wide on under surface), and separated from head blotch by 4-5 scales. Rest of coloration whitish, except for blackish brown edges to rostral, internasals, dorsals and supracaudals, and greyish brown clouding on chin and throat.

Remarks

Previously I regarded the holotype of *minima* as a freakishly coloured individual of *anomala*. However, the collection of another specimen (of the opposite sex, but almost identical in coloration) forces me to revise my opinion.

In scutellation *minima* seems to differ from *anomala* only in its relatively shorter frontal. In coloration there are the negative differences of absence of bands and shorter nuchal blotch. Much more significant is the positive difference of dark edging to dorsal scales in *minima* (the interannular dorsals of *anomala* are not dark-edged). This difference separates two other species in the *V. bertholdi* group, i.e. yellow interannular scales edged with red in *bertholdi*, not edged in *littoralis*.

V. minima and *V. anomala* are sympatric at Broome and must be treated as full species. For a photograph of the holotype of *minima* and line drawings of its head scales see the original description (Worrell, 1960).

Material

Kimberley Division (W.A.): 4 km SE of Coulomb Point (60910); Broome (holotype, R16494 in Australian Museum).

VERMICELLA APPROXIMANS (GLAUERT)

Diagnosis

Distinguishable from all subspecies of *V. semifasciata* by the extremely broad dark bands (at least five times as wide as pale interspaces), the less strongly upturned snout, and the less oblique suture between internasal and prefrontal; and from *V. fasciolata* by the nasal contacting preocular. Further distinguishable from *V. s. semifasciata* by 6 (rather than 5) upper labials and primary temporal never fused to secondary.

Distribution

Western arid zone of Western Australia from Broome south to Mileura and Wiluna; also Barrow I.

Partial redescription

Total length (mm): males 122-362 (N 13, mean 290); females 122-356 (N 5, mean 293). Tail (% total length): males 8.9-9.8 (N 13, mean 9.4); females 6.7-7.6 (N 5, mean 7.2).

Rostral extending back 40-50% of way to frontal. Suture between internasal and prefrontal transverse or slightly oblique. Secondary temporal never fused to primary but occasionally fused to scale behind it (upper tertiary) or to last labial. Scale rows 17 at midbody, 17-21 (usually 19) on neck, 17 just before vent. Ventrals: males 158-181 (N 11, mean 171.0); females 173-181 (N 5, mean 177.6). Subcaudals: males 22-27 (N 13, mean 25.3); females 19-21 (N 5, mean 20.4).

Body crossed by 45-81 very dark brown bands, 2-5 scales wide at midbody and separated by whitish interspaces ⅓-¾ scale wide (interspaces often represented by rings of pale spots rather than continuous bands, and in one specimen they are completely absent). Bands on tail: 8-15 in males; 6-9 in females.

Remarks

Previously I treated *approximans* as a subspecies of *V. semifasciata,* first because it was clearly the representative of that species in north-western Western Australia, second because the two forms seemed to intergrade at Wiluna. However, recent collections indicate that though there may have been some gene flow between *approximans* and *semifasciata* in the past there is none now and these taxa behave as good species in the Wiluna district.

In October 1977 J.C. Wombey collected the two forms within 8 km of each other: a *V. approximans* (R1780) in mulga woodland 10 km ESE of Wiluna; and a *V. s. semifasciata* (R1789) on a red sand dune clothed with spinifex 17 km SE of Wiluna. Both specimens are normal in coloration and scutellation.

At the northern end of its range *V. approximans* has now been collected within 170 km of the known range of *V. semifasciata roperi.* A specimen of *approximans* from Broome shows no tendency towards *roperi* from Derby.

Additional material (in W.A. Museum)

Kimberley Division: Broome (56833).

North-west Division: Barrow I. (47438); Bullara (36140); Tom Price (45657-8); Marandoo (56096, 61631); Newman (37034); Karalundi (42658-60); Mileura (44960).

Eastern Division: Rudall River (40317).

'CACOPHIS' WARRO DE VIS

Under various generic names recent authors have treated this species, usually with some hesitation, as congeneric with *"Brachyurophis" semifasciata* Günther. Through the courtesy of Mr G.F. Gow I have had the opportunity of examining three Queensland specimens of *warro* in the collection of the Northern Territory Museum, viz. R1148-9 (presumed males from Mareeba) and R2967 (a presumed female from Ayr). I describe them in the same terms as in my revision of *Vermicella* (Storr, 1967).

Description

Body and tail short. Head depressed, broad, wider than neck. Snout produced beyond mouth but not tipped with cutting edge. Total length (mm): males 250, 305; female 333. Tail (% total length): males 10.6, 12.0; female 7.8.

Rostral much wider than high, apex rounded and reaching about one-third of way back to frontal. Internasals considerably smaller than prefrontals. Suture between internasals almost as long as suture between prefrontals. Frontal 1.6-1.7 times as long as wide, about as long as parietals, and about twice as wide as supraoculars. Nasal entire; widely separated from preocular. Postoculars 2, lower smaller. Temporals 2 + 2 + 3. Upper labials 6. Scale rows 15 at midbody, 17 or 19 at neck, 15 or 13 just before vent. Ventrals: males 136-138; female 151. Subcaudals: males 20-23; female 15.

Head blotch dark brown to blackish brown, diffuse and ill-defined. Nuchal blotch brownish black, sharp-edged, 7-11 scales long. Dorsals and supracaudals brownish white, edged with dark brown (margins thickest at apex of scales).

Remarks

In its coloration, short tail, flattened head and small eyes, *warro* is similar to several species of *Vermicella*. However these features are not exclusive to *Vermicella* but appear in other Australian genera, e.g. *Furina* and *Pseudonaja*. The hall-mark of *Vermicella* is the large single primary temporal which reaches or nearly reaches to the lip. *C. warro* has two primary temporals; they are small and well separated from the lip. I therefore believe that *warro* is not a *Vermicella*. The possibility should be explored of placing it in *Furina*, to which it is superficially similar except for the extremely short tail.

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A NEW GENUS AND FIVE NEW SPECIES OF CHIGGERS (ACARI: TROMBICULIDAE) FROM *ZYZOMYS ARGURUS*[1]

M. LEE GOFF*

[Received 14 June 1978. Accepted 9 November 1978. Published 30 November 1979.]

ABSTRACT

Zyzomyacarus gen. nov. is described. *Zyzomyacarus arguri* sp. nov., *Z. napierensis* sp. nov., *Ascoschoengastia setosa* sp. nov., *Guntheria kethleyi* sp. nov., and *Cotrombicula rugosa* sp. nov., are described from the Common Rock Rat, *Zyzomys argurus* (Thomas, 1889) (Rodentia: Muridae) from Western Australia.

INTRODUCTION

Examination of chiggers from the Common Rock Rat, *Zyzomys argurus*, in Western Australia has revealed a new genus and five new species. Collections of chiggers were made under the direction of Dr F.S. Lukoschus, Catholic University of Nijmegen. Holotypes are deposited in the collection of the Western Australian Museum (Perth), and paratypes there and in the collections of the Bishop Museum (Honolulu), Field Museum of Natural History (Chicago), U.S. National Museum of Natural History (chigger collection currently housed at the Bishop Museum, Honolulu), and Catholic University of Nijmegen. All measurements are given in the holotypes in microns, followed by the means and ranges of type series in parentheses. Terminology follows Brennan & Goff (1977).

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* Department of Entomology, Bishop Museum, P.O. Box 6037, Honolulu, Hawaii 96818, U.S.A.

ZYZOMYACARUS GEN. NOV.

Type species: *Zyzomyacarus arguri* sp. nov.
Referred species: *Zyzomyacarus napierensis* sp. nov.

Diagnosis

Trombiculine larvae. Palpal tarsus 5B; palpal subterminala absent; palpal claw 3-pronged; galeala B; cheliceral blade with tricuspid cap; sensilla slightly expanded to narrowly clavate, with setules along entire length; legs 7-7-7 segmented; 2 genualae I, genuala II and III; tibiala III, subterminala and parasubterminala I; no mastisetae on leg III.

Remarks

Zyzomyacarus is similar to *Cricacarus* Vercammen-Grandjean, 1966, in form of sensilla and shape of scutum, but differs in having only 5B on the palpal tarsus (7B or 7BS in *Cricacarus*), galeala B (N in *Cricacarus*) and lacking long, whip-like dorsal and PL setae. In having 5B on the palpal tarsus, *Zyzomyacarus* is similar to *Guntheria* Womersley, 1939, but differs in having only slightly expanded to narrowly clavate sensilla (broadly clavate to globose in *Guntheria*), eyes free on cuticle (ocular plate in *Guntheria*) and lacking attenuated, finely ciliated, apically nude setae (resembling mastisetae) on distal segments of legs III. *Zyzomyacarus* may be separated from the New World genus *Hyponeocula* Vercammen-Grandjean, 1960, in having only 5B on the palpal tarsus (7B in *Hyponeocula*), AM > AL (subequal in *Hyponeocula*) and lacking mastitarsalae III. Having expanded sensilla and lacking mastisetae on leg III along with setation of the palpal tarsus serve to separate *Zyzomyacarus* from *Neotrombicula* Hirst, 1925.

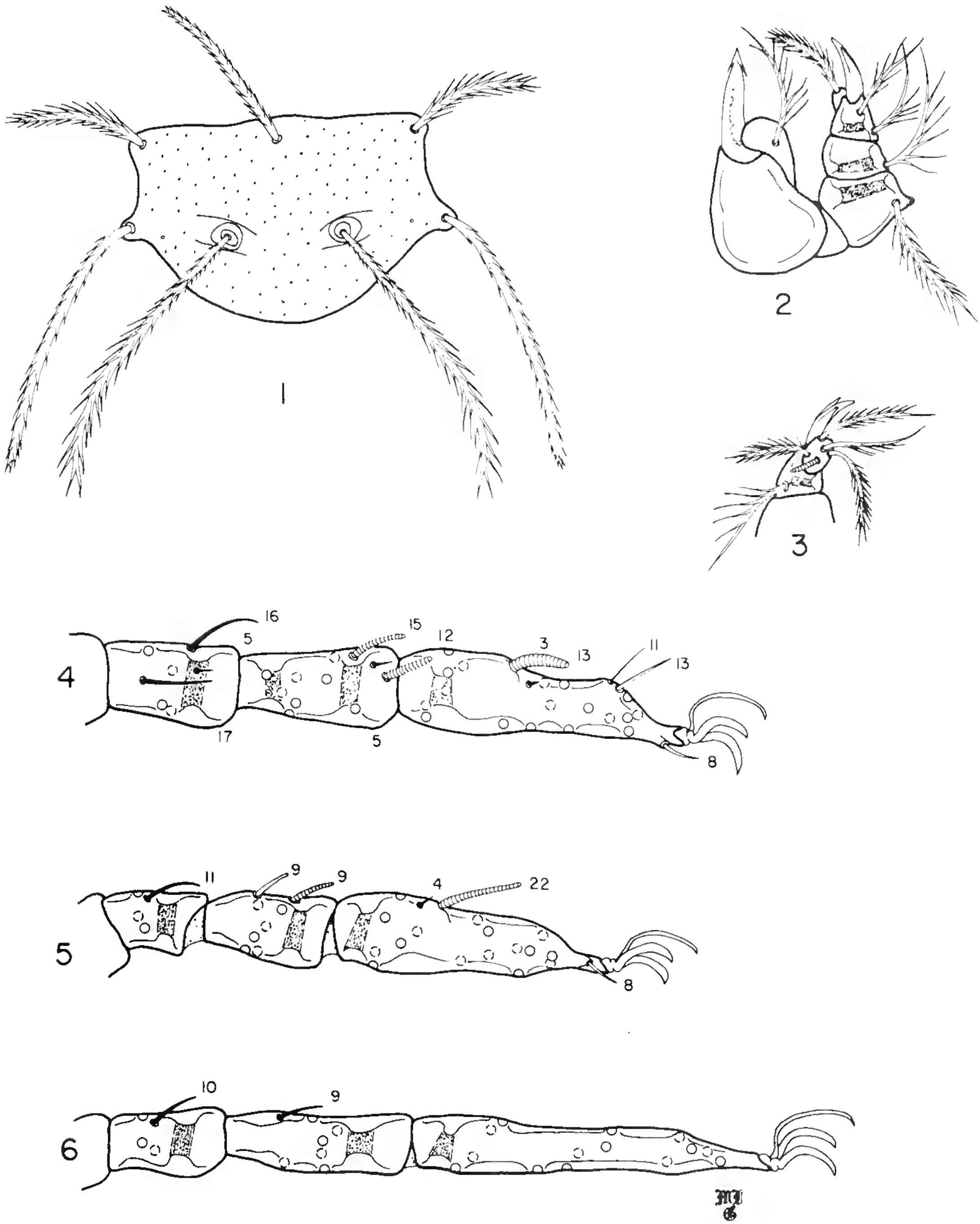
ZYZOMYACARUS ARGURI SP. NOV.

(Figs 1-6)

Type data: Holotype (WAM 79.1581) and 15 paratypes from Western Australia, Kimberley Range, Napier Downs, from 3 *Zyzomys argurus* (2632, 2637, 2660), 31.VIII-14.IX.1976.

Description of species

Larvae. *Idiosoma:* 270 x 170 (engorged). Eyes 2/2, anterior larger, free on cuticle. One pair of humeral setae, 42-56 long; 32 dorsal body setae, 37-58 long, arranged 8-6-6-6-4-2; 2 pairs of sternal setae, anterior 35-37 long, posterior 30-32 long; 22-26 preanal setae, 21-28 long; 14-16 postanal setae, 28-35 long; total body setae = 74-80. *Gnathosoma:* Palpal setal formula



Figs 1-6: Larva of *Zyzomyacarus arguri* sp. nov. Scutum (Fig. 1). Dorsal aspect of gnathosoma (Fig. 2). Ventral aspect of palpal tibia and tarsus (Fig. 3). Distal 3 segments of legs I-III showing specialized setae (measurements in micrometers) and bases of branched setae (Figs 4-6).

B/B/BBB/5B; palpal claw 3-pronged; galeala B; cheliceral blade (26 long) with tricuspid cap; palpal femur with lateral cusp. *Scutum:* Sparsely punctate; anterior margin sinuous; posterior margin evenly rounded; AM base in line with AL bases; SB in line with or slightly posterior to PL bases; PL > AM > AL; sensilla slightly expanded, with setules along entire length; PW/SD = 1.39-1.54. Scutal measurements: AW 61 (60, 57-63); PW 72 (72, 68-74); SB 26 (27, 26-29); ASB 29 (28, 23-30); PSB 21 (22, 20-23); AP 20 (20, 16-22); AM 39 (39, 41-44); AL 30 (29, 21-32); PL 70 (65, 56-72); sens. 70 (66, 56-71). *Legs:* 7-7-7 segmented, terminating in a pair of claws and claw-like empodium. Onychotriches absent. IP = 818-825. *Leg I:* 272-277; coxa with 1 branched seta (1B), trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, 2 genualae, microgenuala; tibia 8B, 2 tibialae, microtibiala; tarsus (69 x 18) 18B, tarsala (12-13), microtarsala, subterminala, parasubterminala, pretarsala. *Leg II:* 245-252; coxa 1B; trochanter 1B; basifemur 2B; telofemur 4B; genu 3B, genuala; tibia 6B; 2 tibialae, tarsus (63 x 16) 16B, tarsala (21-22), microtarsala, pretarsala. *Leg III:* 295-296; coxa 1B; trochanter 1B; basifemur 2B; telofemur 3B; genu 3B, genuala; tibia 6B, 2 tibialae; tarsus (82 x 14) 14B.

ZYZOMYACARUS NAPIERENSIS SP. NOV.

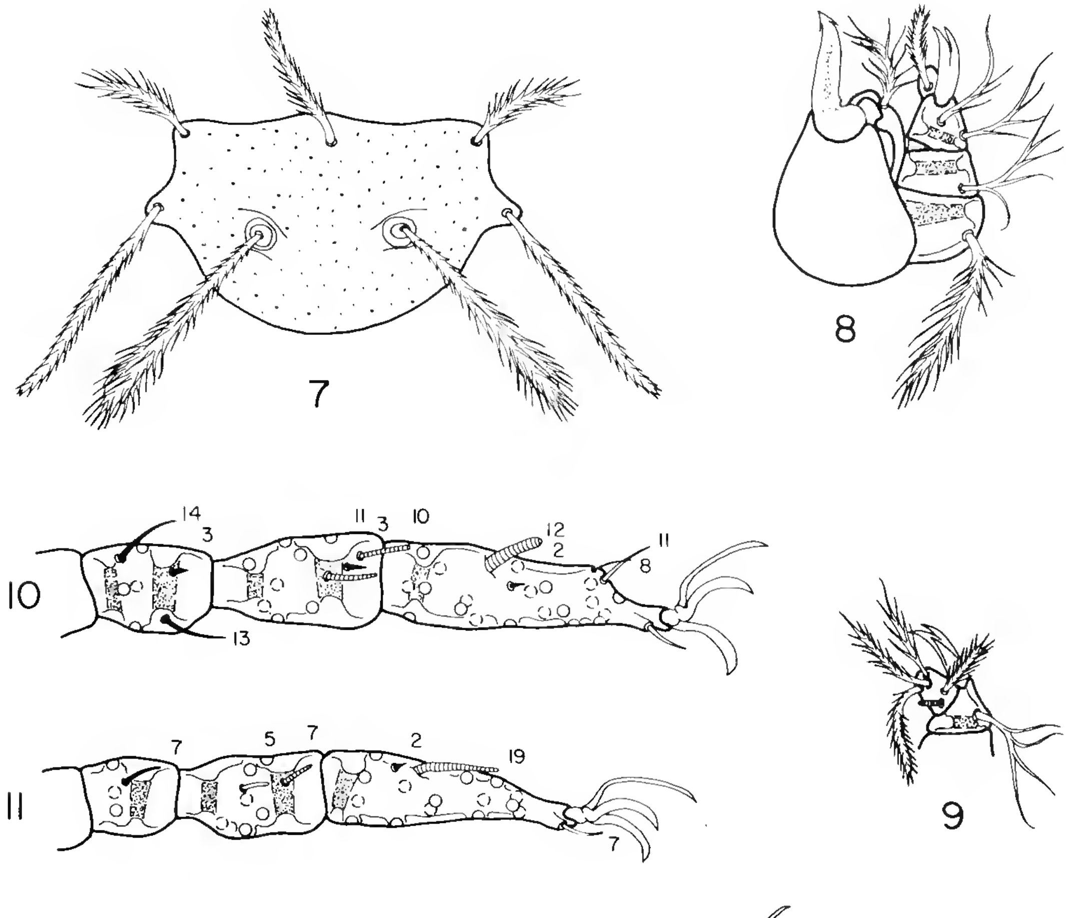
(Figs 7-12)

Type data: Holotype (WAM 79.1582) and 5 paratypes from Western Australia, Kimberley Range, Napier Downs, from 2 *Zyzomys argurus* (2638, 2641), 31.VIII.1976.

Description of species

Larvae. *Idiosoma:* 278 x 183 (engorged). Eyes 2/2, anterior larger, free on cuticle. One pair of humeral setae, 49-51 long; 32 dorsal body setae, 33-44 long, arranged 8-6-6-6-4-2; 2 pairs of sternal setae, anterior 35-40 long, posterior 32-34 long; 20 preanal setae, 28-31 long; 8 postanal setae, 29-30 long; total body setae = 66. *Gnathosoma:* Palpal setal formula B/B/BBB/5B; palpal claw 3-pronged; galeala B; cheliceral blade (25 long) with tricuspid cap. *Scutum:* Lightly punctate; anterior margin shallowly biconcave, posterior margin evenly rounded; AM base in line with or slightly posterior to AL bases; SB posterior to PL bases; PL > AM > AL; sensilla narrowly clavate, with setules; PW/SD = 1.31-1.55. Scutal measurements: AW 60 (62, 60-66); PW 72 (71, 67-76); SB 29 (28, 26-31); ASB 26 (26-28); PSB 23 (23, 22-24); AP 17 (17, 16-18); AM 31 (31, 30-33); AL 24 (27, 24-30); PL 55 (56, 55-58); sens. 56 (57, 56-59). *Legs:* 7-7-7 segmented, terminating in a pair of claws and claw-like empodium. Onychotriches absent.

IP = 702-728. *Leg I:* 231-240; coxa 1B; trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, 2 genualae, microgenuala; tibia 8B, 2 tibialae, microtibiala; tarsus (63 x 20) 20B, tarsala (10-12), microtarsala, subterminala, parasubterminala, pretarsala. *Leg II:* 220-226; coxa 1B; trochanter 1B; basifemur 2B; telofemur 4B; genu 3B, genuala; tibia 6B, 2 tibialae; tarsus (57 x 17) 15B, tarsala (19), microtarsala, pretarsala. *Leg III:* 251-262; coxa 1B; trochanter 1B; basifemur 2B; telofemur 3B; genu 3B, genuala; tibia 6B, genuala; tibia 6B, tibiala; tarsus (7? x 14) 14B.



Figs 7-12: Larva of *Zyzomys napierensis* sp. nov. Scutum (Fig. 7). Dorsal aspect of gnathosoma (Fig. 8). Ventral aspect of palpal tibia and tarsus (Fig. 9). Distal 3 segments of legs I-III showing specialized setae (measurements in micrometers) and bases of branched setae (Figs 10-12).

Remarks

Z. napierensis may readily be distinguished from *Z. arguri* in having clavate sensilla and lacking a lateral cusp on the palpal femur.

ASCOSCHOENGASTIA SETOSA SP. NOV.

Type data: Holotype (WAM 79.1577) and 8 paratypes from Western Australia, Kimberley Range, Brooking Springs, from *Zyzomys argurus* (2854), 30.IX.1976.

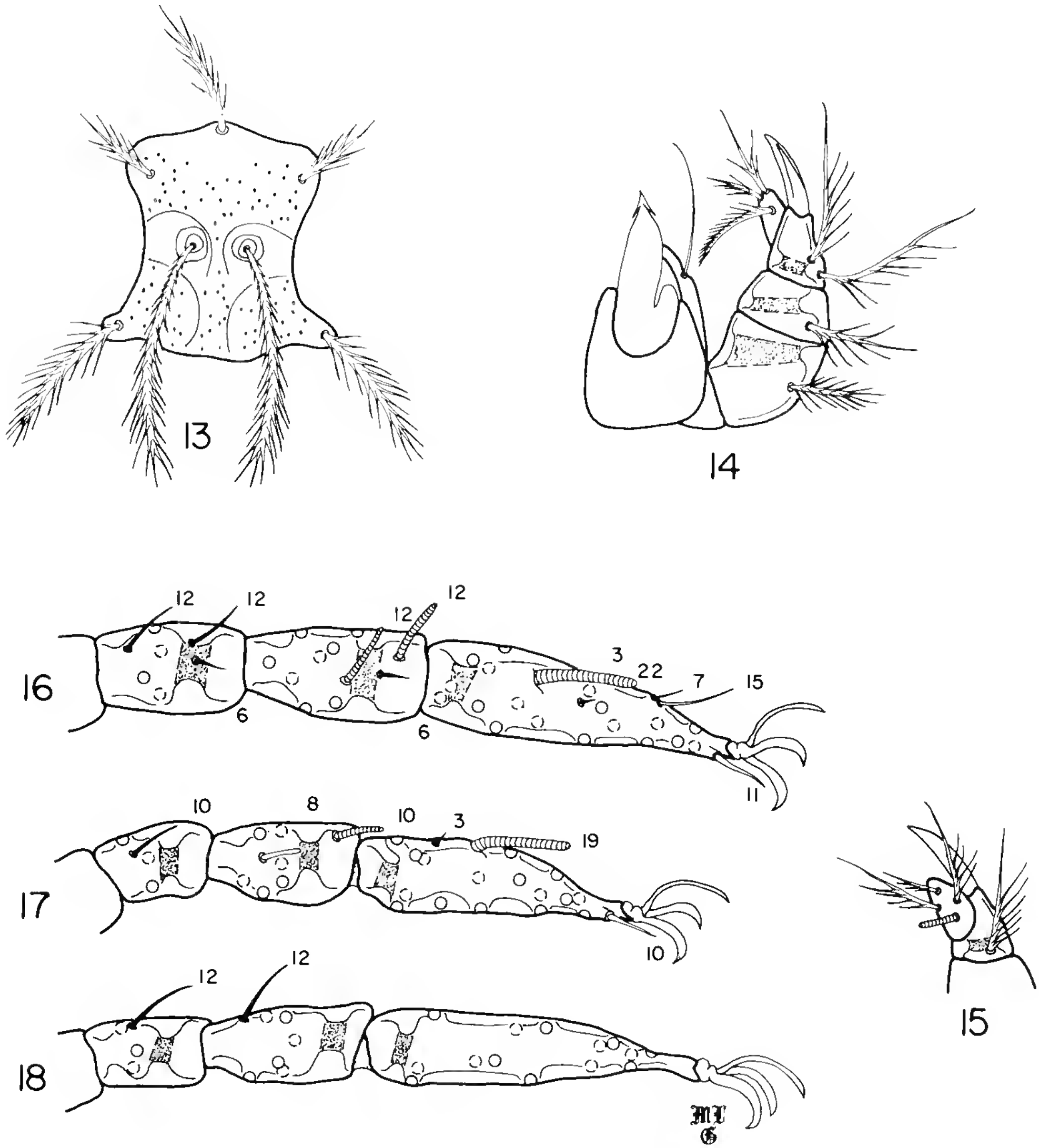
Description of species

Larvae. *Idiosoma:* 640 x 420 (engorged). Eyes 2/2, inconspicuous, anterior larger, free on cuticle. One pair of humeral setae, 32-34 long; 36 dorsal body setae, 26-35 long, arranged 8-8-6-6-4-4; 2 pairs of sternal setae, anterior 22-28 long, posterior 18-20 long; 38 preanal setae, 16-20 long; 10 postanal setae, 19-25 long; total body setae = 90. *Gnathosoma:* Palpal setal formula B/B/BBB/6B; palpal claw 2-pronged, axial prong internal; galeala N; cheliceral blade (28-31 long) with tricuspid cap. *Scutum:* Lightly punctate; anterior margin sinuous with anterolateral shoulders; posterior margin convex; AM base anterior to AL bases, SB anterior to PL bases; PL > AM > AL; sensilla narrowly expanded with setules along entire length; PW/SD = 0.76-1.02. Scutal measurements: AW 35 (34, 31-37); PW 43 (41, 36-47); SB 11 (12, 11-13); ASB 25 (24, 22-26); PSB 21 (21, 19-23); AP 29 (29, 26-30); AM 23 (24, 21-26); AL 16 (18, 16-19); PL 28 (28, 26-31); sens. 48 (46, 43-48). *Legs:* 7-7-7 segmented, terminating in a pair of claws and claw-like empodium. Onychotriches absent. IP = 654-675. *Leg I:* 222-237; coxa 1B; trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, 2 genualae, microgenuala; tibia 8B, 2 tibialae, microtibiala; tarsus (57 x 16) 18B, tarsala (19-22), microtarsala, subterminala, parasubterminala, pretarsala. *Leg II:* 198; coxa 1B; trochanter 1B; basifemur 2B; telofemur 4B; genu 3B, genuala; tibia 6B, 2 tibialae; tarsus (52 x 14) 16B, tarsala (17-19), microtarsala, pretarsala. *Leg III:* 234-240; coxa 6-7B; trochanter 1B; basifemur 2B; telofemur 3B; genu 3B, genuala, tibia 6B, tibiala; tarsus (66 x 12) 14B.

Additional specimens examined (13): Western Australia, Kimberley Range, Brooking Springs, 28-30.IX.1976, 4 *Zyzomys argurus* (6); Napier Downs, 31.VIII-2.IX.1976, 3 *Z. argurus* (7).

Remarks

Among Australian species of *Ascoschoengastia*, *A. setosa* may be easily distinguished by the 6-7 branched setae on coxa III and the narrowly expanded sensilla. The scutum of this species appears similar to those of the New World species of *Speleocola* Lipsovsky, 1952. Scutal setae in *A. setosa* are unusual in being heavily branched. As noted by Nadchatram & Dohany (1974), scutal setae in *Ascoschoengastia* are most frequently sparsely branched or nude.



Figs 13-18: Larva of *Ascoschoengastia setosa* sp. nov. Scutum (Fig. 13). Dorsal aspect of ghathosoma (Fig. 14). Ventral aspect of palpal tibia and tarsus (Fig. 15). Distal 3 segments of legs I-III showing specialized setae (measurements in micrometers) and bases of branched setae (Figs 16-18).

GUNTHERIA KETHLEYI SP. NOV.

(Figs 19-24)

Type data: Holotype (WAM 79.1580) and 14 paratypes from Western Australia, Kimberley Range, Napier Downs, from *Zyzomys argurua* (2637), 31.VIII.1976.

Description of species

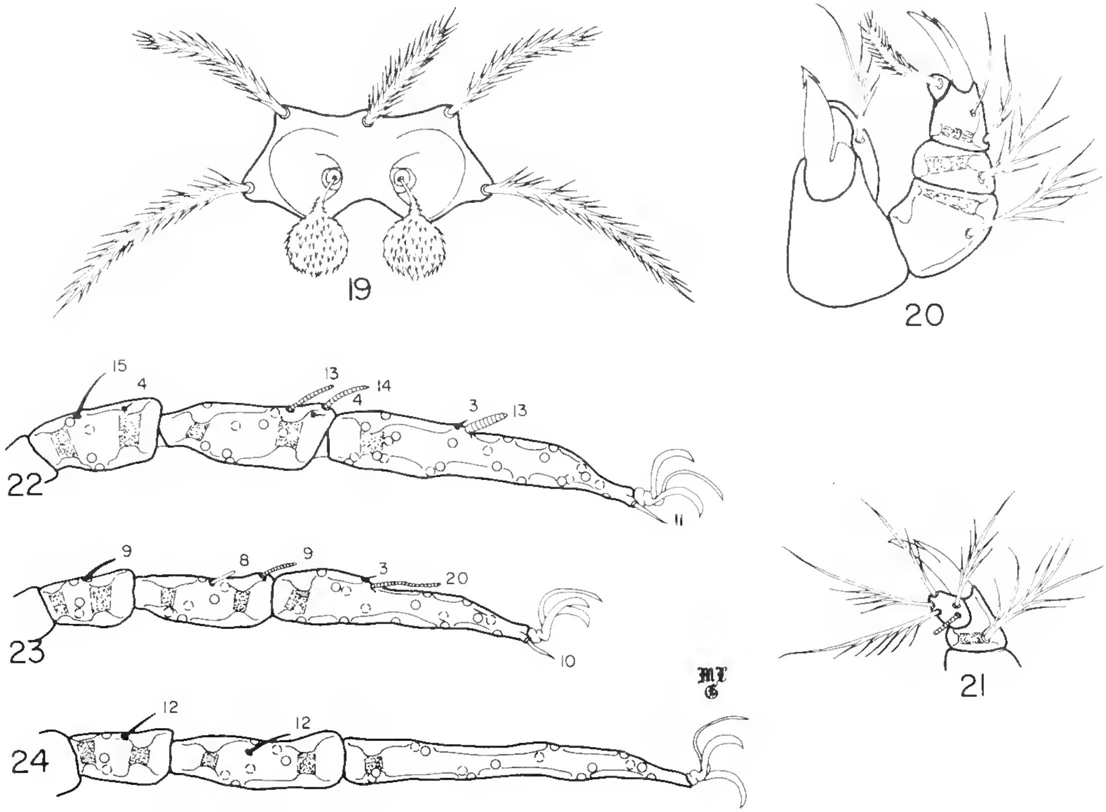
Larvae. *Idiosoma:* 490 x 310 (engorged). Eyes 2/2, anterior larger, on ocular plate. One pair of humeral setae, 50-54 long; 28 dorsal body setae, 38-47 long, arranged 6-6-6-6-4; 2 pairs of sternal setae, anterior 45-50 long, posterior 38-40 long; 16 preanal setae, 30-38 long; 16 postanal setae, 31-35 long; total body setae = 66. *Gnathosoma:* Palpal setal formula B/B/NBB/5B; palpal claw 3-pronged; galeala B; cheliceral blade (27 long) with tricuspid cap. *Scutum:* Sparsely punctate; anterior margin biconcave; posterior margin biconvex; AM base in line with AL bases; SB anterior to PL bases; PL > AL > AM; sensilla capitate, head with setules; PW/SD = 2.05-2.54. Scutal measurements: AW 53 (49, 46-53); PW 89 (77, 70-89); SB 23 (22, 18-27); ASB 23 (23, 20-24); PSB 12 (12, 11-13); AP 26 (25, 24-27); AM 38 (39, 35-41); AL 58 (60, 55-70); PL 63 (68, 63-72); sens. 27 (28, 27-29), head 18 x 18. *Legs:* 7-7-7 segmented, terminating in a pair of claws and claw-like empodium. Onychotriches absent. IP = 895-920. *Leg I:* 300-310; coxa 1B; trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, genuala, microgenuala; tibia 8B, 2 tibialae, microtibiala; tarsus (85 x 17) 23B, tarsala (11-13), microtarsala, pretarsala. *Leg II:* 270-275; coxa 1B; trochanter 1B; basifemur 2B; telofemur 4B; genu 3B, genuala; tibia 6B, 2 tibialae; tarsus (107 x 12) 15B. *Leg III:* 325-335; coxa 1B; trochanter 1B; basifemur 2B; telofemur 3B; genu 3B, genuala; tibia 6B, tibiala; tarsus (107 x 12) 15B.

Additional specimens examined (47): Western Australia, Kimberley Range, Napier Downs, 31.VIII-2.IX.1976, 9 *Zyzomys argurus* (33); Brooking Springs, 28.IX.1976, 1 *Z. argurus* (8); Port Warrender, 28.IX-1.X.1976, 3 *Conilurus penicillatus* (6).

Remarks

Among Australian species of *Guntheria* having a single genuala I, only *G. cassiope* (Womersley, 1952), *G. sphinx* Domrow, 1972, *G. daniae* Domrow, 1971, and *G. kethleyi* sp. nov., lack pygosomal plates. *G. kethleyi* may be separated from *G. cassiope* and *G. daniae* by palpotibial setation NBB (NNN in *G. cassiope* and BNB in *G. daniae*), shape of the scutum and lacking both subterminala and parasubterminala I (both present in *G. cassiope* and *G. daniae*). *G. kethleyi* is similar to *G. sphinx* in lacking subterminala and parasubterminala I as well as in the shape of the scutum. Palpotibial setation (NNB for *G. sphinx*), branched galeala (N in *G. sphinx*), PL > AL (AL > PL in *G. sphinx*) and scutal measurements (AW 52-53, PW 73-74 for *G. sphinx*) serve to separate *G. kethleyi* from *G. sphinx*.

This species is named in honour of Dr John B. Kethley, Field Museum of Natural History, in recognition of his contributions to acarology.



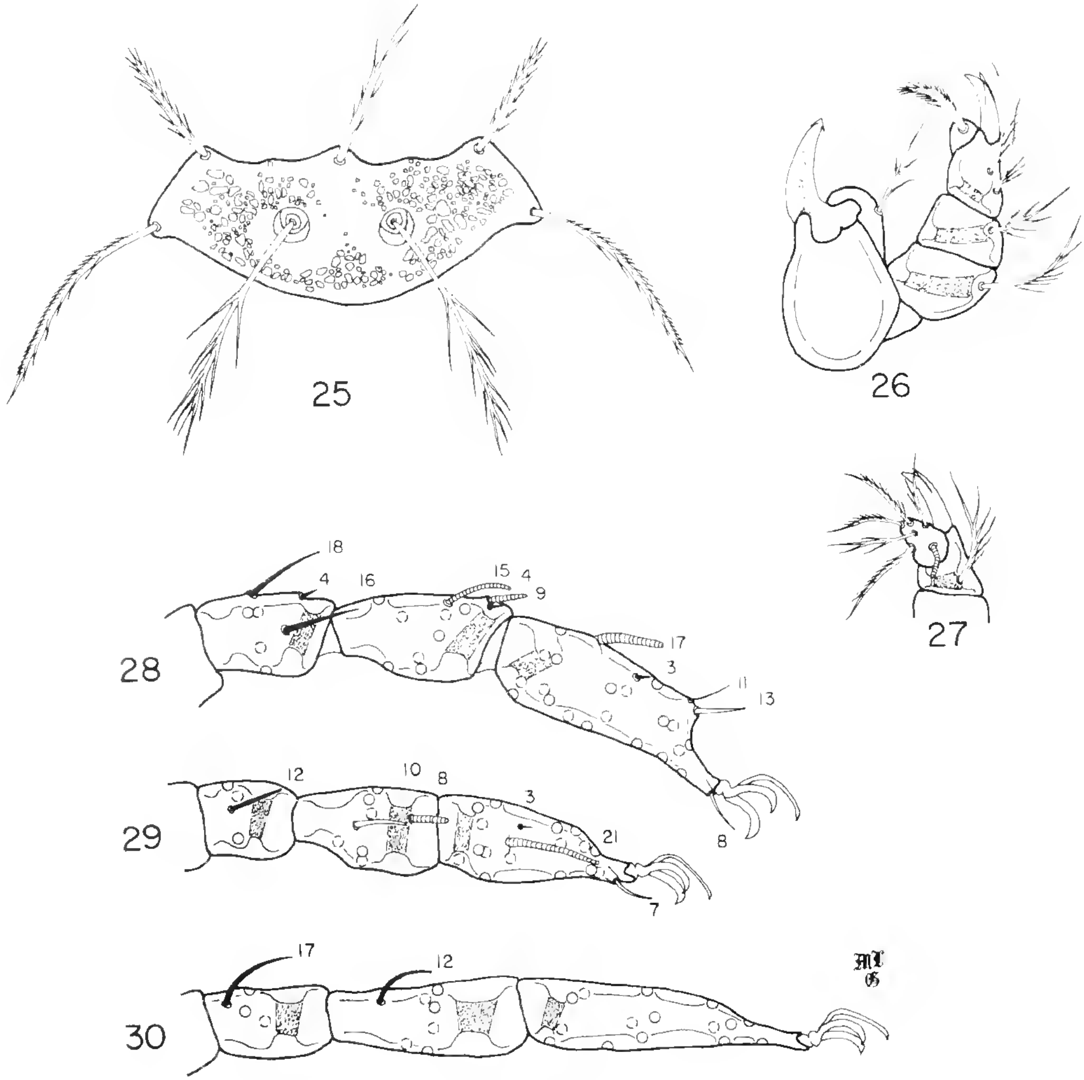
Figs 19-24: Larva of *Guntheria kethleyi* sp. nov. Scutum (Fig. 19). Dorsal aspect of gnathosoma (Fig. 20). Ventral aspect of palpal tibia and tarsus (Fig. 21). Distal 3 segments of legs I-III showing specialized setae (measurements in micrometers) and bases of branched setae (Figs 22-24).

COTROMBICULA RUGOSA SP. NOV.

Type data: Holotype (WAM 79.1579) and 5 paratypes from Western Australia, Port Warrender, from *Zyzomys argurus* (3156) 31.X.1976.

Description of species

Larvae. *Idiosoma:* 157 x 177 (unengorged), appearing truncate in unengorged specimens. Eyes 2/2, anterior larger, free on cuticle. One pair of



Figs 25-30: Larva of *Cotrombicula rugosa* sp. nov. Scutum (**Fig. 25**). Dorsal aspect of gnathosoma (**Fig. 26**). Ventral aspect of palpal tibia and tarsus (**Fig. 27**). Distal 3 segments of legs I-III showing specialized setae (measurements in micrometers) and bases of branched setae (**Figs 28-30**).

humeral setae, 41-44 long; 28 thin dorsal body setae, 30-43 long, anterior rows longer, arranged 8-6-6-4-4; 2 pairs of sternal setae, anterior 35-36 long, posterior 30-31 long; 14 preanal setae, 27-32 long; 4 postanal setae, 28-30 long; total body setae = 52. *Gnathosoma:* Palpal setal formula B/B/BBB/6B; palpal claw 3-pronged, galeala branched; cheliceral blade (26-28 long) with tricuspid cap. *Scutum:* with large, irregular pitting, scrobiculate; anterior margin sinuous; posterior margin convex; AM base in line with AL bases;

SB in line with or slightly anterior to PL bases; PL > AM > AL; sensilla flagelliform with branches on distal 2/3; PW/SD = 2.13-2.19. Scutal measurements: AW 60 (59, 56-60); PW 79 (78, 76-79); SB 21 (21, 20-22); ASB 17 (18, 17-20); PSB 19 (17, 14-19); AP 17 (18, 17-19); AM 35 (31, 26-35); AL 28 (24, 22-28); PL 50 (52, 50-56); sens. 53 (53, 50-56). *Legs:* 7-7-7 segmented, terminating in a pair of claws and claw-like empodium. Onychotriches absent. IP = 680-692. *Leg I:* 235-238; coxa 1B; trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, 2 genualae, microgenuala; tibia 8B, 2 tibialae, microtibiala; tarsus (55 x 19) 20B, tarsala (13-17), microtarsala, subterminala, parasubterminala, pretarsala. *Leg II:* 206-213; coxa 1B; trochanter 1B; basifemur 2B; telofemur 4B; genu 3B, genuala; tibia 6B, 2 tibialae; tarsus (46 x 18) 16B, tarsala (21-22), microtarsala, pretarsala. *Leg III:* 239-241; coxa 1B; trochanter 1B; basifemur 2B; telofemur 3B; genu 3B, genuala; tibia 6B, tibiala; tarsus (58 x 14) 15B.

Remarks

Cotrombicula rugosa is unusual in being recorded from a rodent, as species of *Cotrombicula* are most frequently associated with bats. The species name is derived from the large, irregularly-shaped pits on the scutum.

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Rec. West. Aust. Mus., 1979, 8 (1)

SPECIES OF CHIGGER (ACARI: TROMBICULIDAE) FROM THE ORANGE HORSESHOE BAT *RHINONICTERIS AURANTIUS*[1]

M. LEE GOFF*

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ABSTRACT

Chiroptella (Neosomia) geikiensis sp. nov., from the Orange Horseshoe Bat *Rhinonicteris aurantius* (Gray, 1845) (*Chiroptera*, Hipposideridae), in Western Australia is described and illustrated.

INTRODUCTION

Vercammen-Grandjean and Nadchatram (1965) proposed the subgenus *Neosomia* in the genus *Reidlinia* Oudemans, 1914, for *Reidlinia (Neosomia) audyi* which had extrascutal PL setae, 2 genualae III and a femorala III. Nadchatram (1966) transferred the subgenus to *Chiroptella* Vercammen-Grandjean, 1960. A second species of this subgenus, from bats in the Kimberley Range of Western Australia, is described and illustrated below. All measurements are of the holotype in micrometers, and followed by means and ranges of the type series in parentheses. Terminology follows Brennan & Goff (1977). Collections were made under the direction of Dr F.S. Lukoschus, Katholieke Universitiet, Nijmegen, and Dr J.B. Kethley, Field Museum of Natural History, Chicago.

CHIROPTELLA (NEOSOMIA) GEIKIENSIS SP. NOV.

(Figs 1-6)

Type data: Holotype and 9 paratypes from Western Australia, Kimberley Range, Geikie Gorge, from 3 Orange Horseshoe Bats *Rhinonicteris aurantius*

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* Department of Entomology, Bishop Museum, P.O. Box 6037, Honolulu, Hawaii 96818, U.S.A.

(2971, 2973, 2975), 8.X.1976. Holotype (WAM 79.1578) in Western Australian Museum (Perth) and paratypes there and in Bishop Museum (Honolulu), Field Museum of Natural History (Chicago), University of Nijmegen and U.S. National Museum of Natural History (currently housed at Bishop Museum).

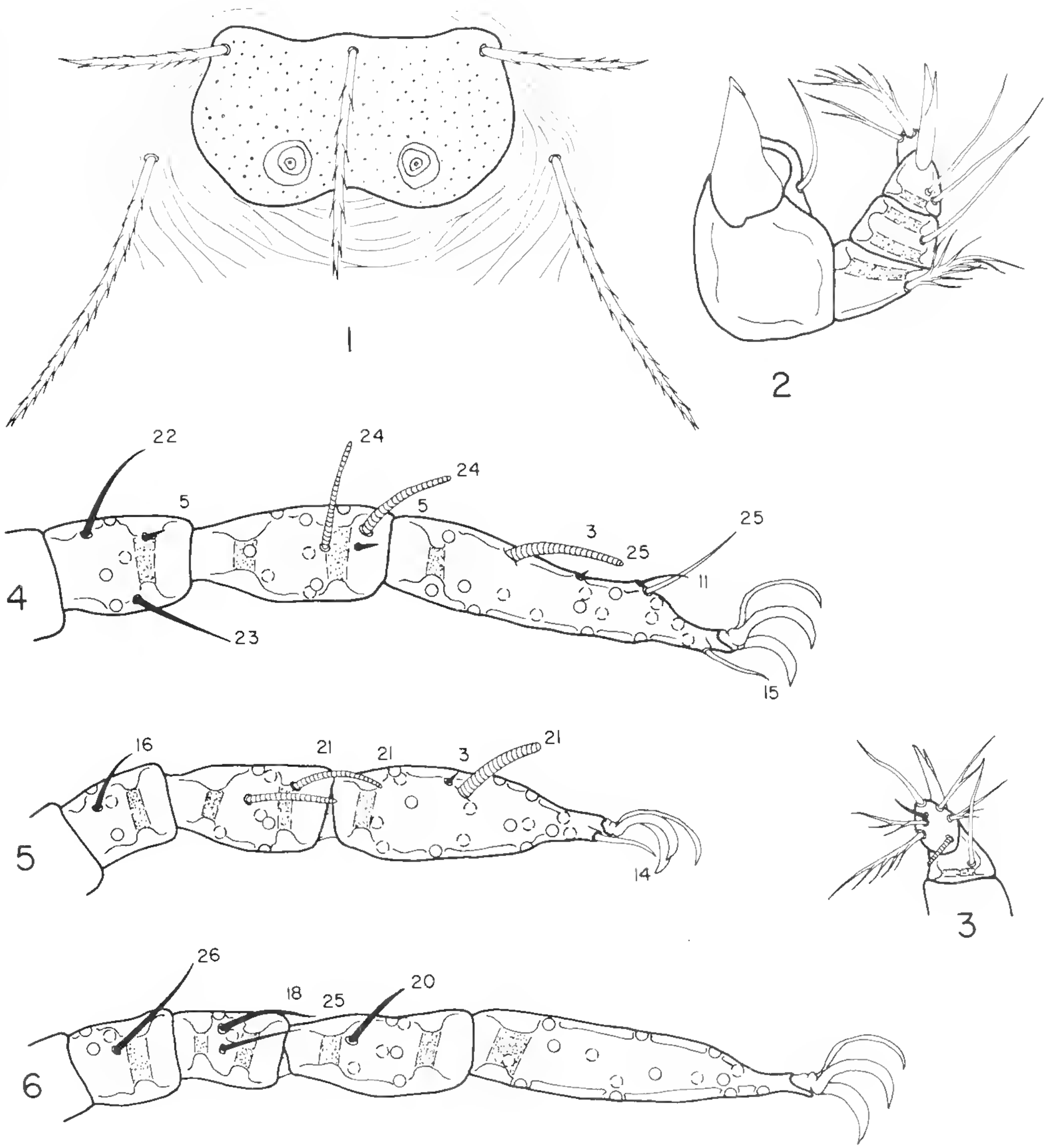
Description of species

Larvae. *Idiosoma:* 675 x 570 (engorged). Eyes absent. One pair of humeral setae, 50-55 long; 28 dorsal body setae, 49-64, arranged 8-8-6-4-2; 2 pairs of sternal setae, anterior 37-39, posterior 48-50, 4 preanal setae, 45-51; 22 postanal setae, 40-59; total body setae = 60. *Gnathosoma:* Palpal setal formula B/N/NNN/6BNS; palpal claw 2-pronged, axial prong internal; galeala N; cheliceral blade (27-30 long) broad basally, triangular in side view, with ventral subapial tooth. *Scutum:* Moderately punctate with shallowly biconcave anterior margin; posterior margin biconvex; PL setae extrascutal; AM base in line with AL bases; PL > AM > AL; sensilla missing from all specimens. Scutal measurements: AW 56 (58, 55-62); SB 27 (29, 27-35); ASB 33 (30, 26-33); PSB 10 (10, 9-11); HM 48 (49, 48-51); AL 35 (33, 27-36); PL 75 (69, 65-75). *Legs:* 7-7-7 segmented, terminating in pair of claws and claw-like empodium. Onychotriches absent. *Leg I:* 288; coxa with 1 branched seta (1B); trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, 2 genualae, microgenuala; tibia 8B, 2 tibialae, microtibiala, tarsus (71 x 21) 10B, tarsala (23-25), microtarsala, subterminala, parasubterminala, pretarsala. *Leg II:* 259; coxa 1B; trochanter 1B; basifemur 2B; telofemur 4B; genu 3B; genuala; tibia 6B, 2 tibialae; tarsus (56 x 20) 16B, tarsala (19-21), microtarsala, pretarsala. *Leg III:* 283; coxa 1B; trochanter 1B; basifemur 2B; telofemur 3B, femorala (26); genu 2B, 2 genualae, tibia 6B, tibiala; tarsus (76 x 16) 15B.

Remarks

Among species of *Chiroptella*, only *C. geikiensis* and *C. audyi* have extrascutal PL setae. *Chiroptella geikiensis* may be separated from *C. audyi* by the shape and measurements of the scutum, having a subterminala and nude seta on the palpal tarsus (palpal tarsus 7B in *C. audyi*), as well as AM > AL (AM < AL in *C. audyi*). In addition, the prominent perirostral collar described for *C. audyi* was not observed in *C. geikiensis*.

The reduction in numbers of branched setae on the telofemur and genu III in species of *Chiroptella*, appears to be correlated with an increase in the number of eupathids. Most species of Trombiculinae have 4 and 3 branched setae, respectively, on these segments, but *Chiroptella* species have only 3 and 2. In species of *Chiroptella*, there is a single eupathid, or femorala, on telofemur III (absent in other Trombiculinae) and 2 eupathids, or genualae, on genu III (1 in most other Trombiculinae). Thus, in both the usual pattern and the pattern exhibited by species of *Chiroptella*, the total number for each segment remains constant at 4.



Figs 1-6: *Chiroptella (Neosomia) geikiensis* sp. nov. Scutum (Fig. 1). Dorsal aspect of gnathosoma (Fig. 2). Ventral aspect of palpal tibia and tarsus (Fig. 3). Distal 3 segments of legs I-III, showing specialized setae (measurements in micrometers) and bases of branched setae (Figs 4-6).

A parallel situation exists for genu III in species of *Sasatrombicula* Vercammen-Grandjean, 1960, where there are 2 eupathids on genu III and only 2 branched setae. In the leeuwenhoekiine genus *Odontacarus* Ewing, 1929, North American species, all in the subgenera *Odontacarus* and *Tarsalacarus* Vercammen-Grandjean, 1968 have 6 branched setae and 1 eupathid, or tibiala, on tibia III (Goff & Loomis, 1977). In species of the Australasian subgenus *Leogonius* Vercammen-Grandjean, 1968, tibia III has 4 branched setae, 1 eupathid and 2 mastisetae. In both instances, the number of setae on this segment remains constant at 7, although the structure of the setae involved varies. The presence of actinochitin in all 3 kinds of setae, combined with the numerical constancy for each segment, indicate a probable common origin for these setae, although function undoubtedly differs.

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ASCID AND AMEROSEIID MITES PHORETIC ON AUSTRALIAN MAMMALS AND BIRDS[1]

R. DOMROW*

[Received 1 September 1978. Accepted 27 October 1978. Published 30 November 1979.]

ABSTRACT

Various mites of a normally predacious or blossom-feeding habit are recorded from Australasia (including Western Australia), some associated with nectar-feeding vertebrates. Ascidae: the cosmopolitan *Blattisocius tarsalis* (Berlese), *B. keegani* Fox and *Proctolaelaps pygmaeus* (Müller) with various labels, including the lattermost from a native mouse, *Pseudomys nanus* (Gould) (Muridae); and *P. spencerae* sp. nov. from the honey possum, *Tarsipes spencerae* Gray (Tarsipedidae). Ameroseiidae: *Neocypholaelaps africanus* Evans from a lory, *Charmosyna pulchella* Gray (Psittacidae); *Hattena panopla* Domrow from *Melithreptus albogularis* Gould and *Myzomela obscura* Gould, and *H. cometis* sp. nov. from *Meliphaga flava* (Gould), *M. gracilis* (Gould) and *Acanthorhynchus tenuirostris* (Latham), all honey-eating birds (Meliphagidae); and the cosmopolitan *Kleemannia plumosa* (Oudemans) with various labels, including specimens from *P. nanus*. *Asperolaelaps* Womersley is newly synonymised with *Neocypholaelaps* Vitzthum.

INTRODUCTION

This contribution to the ectoparasites of Western Australia collected by Dr F.S. Lukoschus, Catholic University, Nijmegen, lists those few mesostigmatic mites — *Proctolaelaps* Berlese (Ascidae), *Kleemannia* Oudemans

[1] Results of Western Australia Field Programme 1976-1977, Field Museum of Natural History, Chicago, and Western Australian Museum, Perth. Participation of mammalogists made possible by generous gift of William S. and Janice Street, Ono. Aided in part by Grant R87-111 from Netherlands Organisation for Advancement of Pure Research (Z.W.O.), The Hague. Work at Bamaga, Queensland, aided by grant to R. Domrow from Australian Biological Resources Study. Dr D.A. Chant, University of Toronto, confirmed my identifications of species of *Blattisocius* Keegan. Miss Cobie Rudd prepared the illustrations.

* Queensland Institute of Medical Research, Brisbane, Australia.

(Ameroseiidae) — associated only casually with rats, their normal habit being predacious, insecticolous, pollen-feeding etc. Such chance, but regular, transfers to blossom-feeding birds were reviewed by Fain, Hyland & Aitken (1977b).[2]

I also add a new species of *Proctolaelaps* with Western Australian Museum labels from the honey possum, ameroseiids in the genus *Hattena* Domrow collected from Queensland birds, and related snippets in my institute (including some from Western Australia).

The term 'holotrichous' refers to the setal condition in typical free-living dermanyssids (Evans & Till, 1965; Evans, 1969). Hosts are after Ride (1970) and Leach (1958). Depositories are abbreviated: WAM Western Australian Museum, Perth; FMNH Field Museum of Natural History, Chicago; QIMR Queensland Institute of Medical Research, Brisbane; QM Queensland Museum, Brisbane; CU Catholic University, Nijmegen.

ASCIDAE

This section is arranged after Lindquist & Evans (1965).

BLATTISOCIUS TARSALIS (BERLESE, 1918)

This widespread predator sometimes causes annoyance to workers handling insect-infested stored food products (Hughes, 1976). The only previous Australian records are those of Womersley (1954) from the Australian Capital Territory and South Australia.

Hosts and Localities

On crushed rape seed, Moora, W.A., 24.V.1973, Co-operative Bulk Handling (3 ♀♀, 2 pn, 1 1). In QIMR.

On stored sorghum, Darwin, N.T., 4.II.1974, C.S. Li (2 ♀♀, 1 ♂). In QIMR.

BLATTISOCIUS KEEGANI FOX, 1947

This widespread predator sometimes causes annoyance to workers handling insect-infested stored food products (Hughes, 1976). I know of no previous Australian record.

[2] *Hypoaspis rhinaria* Vitzthum, 1935 (emend.) also fits in this category, though its author considered it a predator on other mites on its host (a neotropical hummingbird, *Sericotes holosericeus* [Linnaeus] [Micropodiformes: Trochilidae]).

Host and Localities

Free-living, Arramall Cave, Arrowsmith River, near Dongara, W.A., 3.XI.1973, J.W.J. Lowry (2 ♀♀, 1 ♂, 1 pn). In QIMR.

Annoying man, symptoms first noted at Casino, N.S.W., but specimen taken at Brisbane, Q., 20.VII.1975, W.H.T. Yarrow (1 ♀). In QIMR.

PROCTOLAELAPS PYGMAEUS (MÜLLER, 1859)

This cosmopolitan predator may cause annoyance to workers handling mite-infested stored food products (Hughes, 1976), or be associated with small mammals (Domrow & Nadchatram, 1978). Australian records include specimens from Western Australian timber shipped into South Australia (Womersley, 1956; Domrow, 1974).

Hosts and Localities

On western chestnut native mouse, *Pseudomys nanus* (Gould) (Rodentia: Muridae) (3045), Mitchell Plateau, W.A., 21.X.1976 (1 ♀). On *P. nanus* (3092), Port Warrender, W.A., 25.X.1976 (3 ♀♀). In WAM, FMNH, QIMR, CU.

On laboratory colony of a species of *Metallactus* Suffrian (Coleoptera: Cryptocephalidae), Sherwood, Q., X.1975, R. Gallagher (2 dn, 1 pn, 2 11). In QIMR.

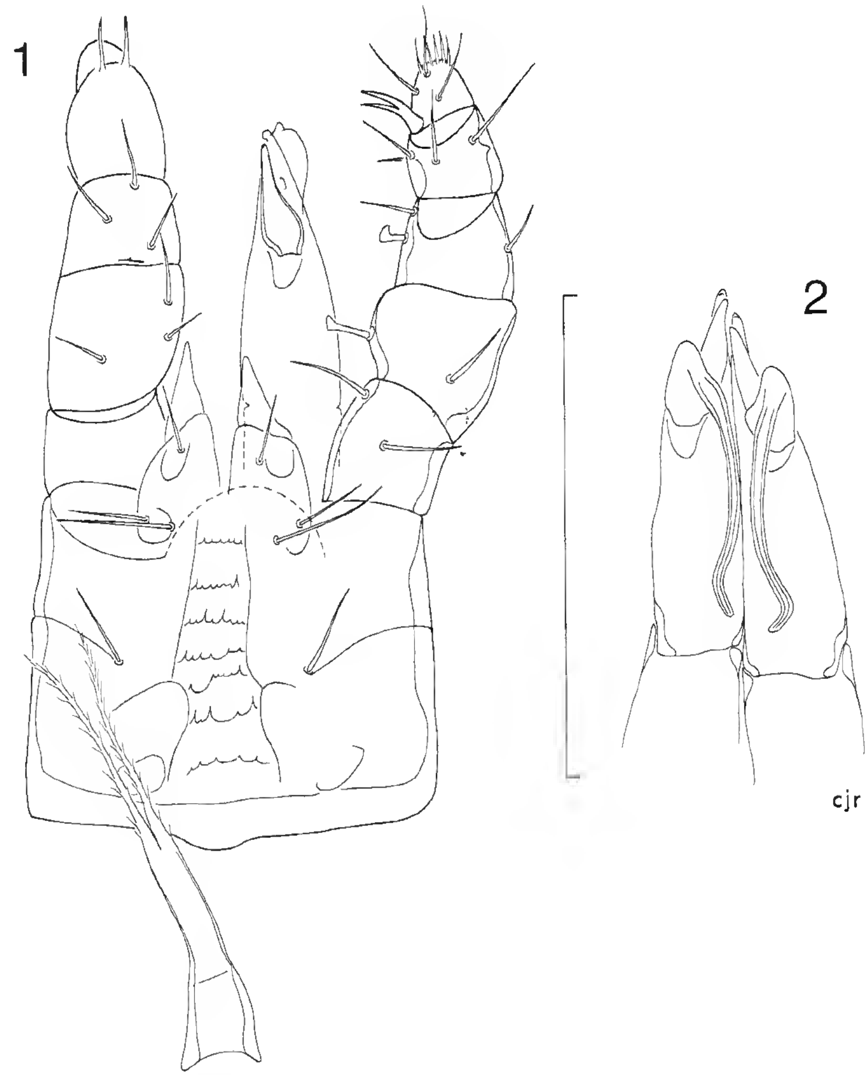
On coconuts, intercepted at quarantine in Melbourne, Vic., from Fiji, 6.VII.1976, M.L. Mekhamer (2 ♀♀, 3 ♂♂). In QIMR.

PROCTOLAELAPS SPENCERAE SP. NOV.

In showing an accessory lobe rather than a pilus dentilis on the chelicerae in the female, and legs IV armed in the male, the new species fits in the atypical group of four recently described by Fain, Hyland & Aitken (1977a, b) from neotropical hummingbirds. However, it is distinct from them all in the structure of the insemination apparatus and in showing setae $Z_{1\text{-}5}$ on the dorsal shield subequal; setae j_1 and z_3, the deutosternal details, the outline of the female sternal shield and the width of the male ventrianal shield provide additional help in diagnosis. Further collecting will doubtless bridge the zoogeographical gap.

Female (Figs 1, 3-4): Basis capituli slightly wider than long, with setae *c* slender, exceeding sides of deutosternal groove, but barely reaching those of basis. Deutosternal denticles in seven irregular rows, the fifth and sixth opposite a break in margins of groove (cf. *P. dendroctoni* Lindquist &

Hunter, 1965, *P. subcorticalis* Lindquist, 1971 etc.). Hypostome with setae $h_{1\text{-}2}$ subequal, shorter than h_3; cornicles distinct, but weak; internal malae and labrum not seen. Epistome a short rounded lobe not exceeding palpal trochanters. Palpal trochanter-genu and probably tibia holotrichous; seta *al* on femur and al_2 on genu clavate; tarsus shown diagrammatically, but with about three slender ventral setae, cluster of terminal rods and bifid claw. Chelicerae with basal segment short and digits occupying 35% of total length; fixed digit edentate, except for tip and indication of low tooth at midlength, pilus dentilis replaced by narrow diaphanous lobe externally, dorsal seta and pore not seen; movable digit edentate, except for tip; corona not developed.



Figs 1-2: *Proctolaelaps spencerae* sp. nov. 1: Capitulum and tritosternum ♀ (ventral, but true right palp dorsal). 2: Chelicerae ♂ (ventral). (All scales = 100 µm.)

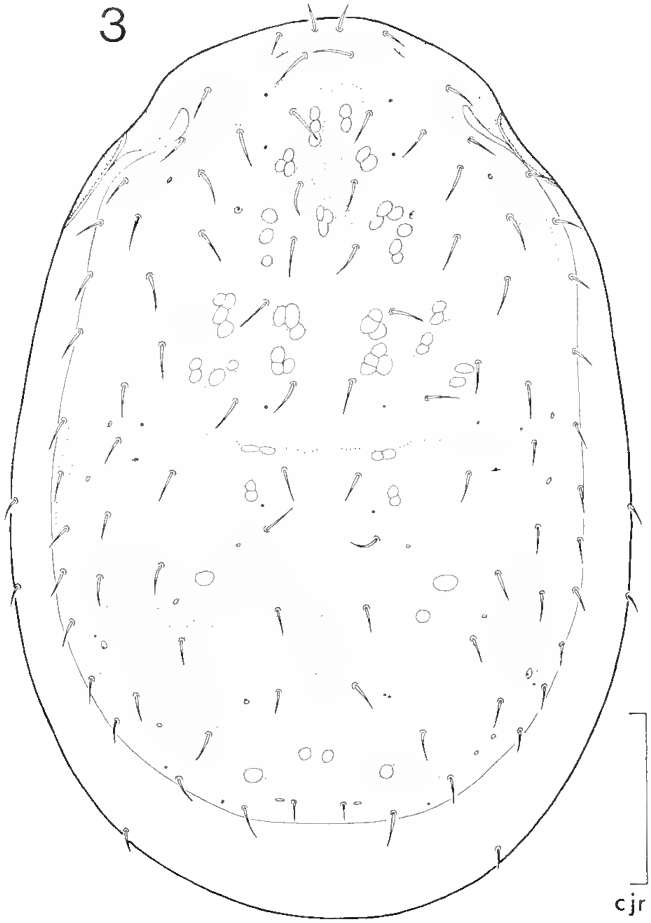


Fig. 3: *Proctolaelaps spencerae* sp. nov. Dorsum ♀.

Idiosoma 445-505 μm long, 295-350 μm wide (non-gravid); 515-525 μm long, 350-360 μm wide (gravid). Dorsal shield entire laterally, but with strong reticulation giving some indication of podonotal and opisthonotal limits; paired muscle insertions and pores (except strong pair of latter between setae $S_{3\text{-}4}$) less clear; podonotal portion hypertrichous (23 pairs, comprising holotrichous 22 plus r_6); opisthonotal portion also hypertrichous (21 pairs, comprising holotrichous 15 plus $R_{1\text{-}6}$ — occasionally $R_{1\text{-}5}$ — on margin; intercalary *px* wanting). Dorsal cuticle with about three pairs of setae.

Tritosternal base unarmed; laciniae divided only in distal three-fifths, lightly ciliated. Presternal cuticle striate, bearing two transverse jugular shields. Sternal shield subquadrate, anterior margin slightly convex, posterior margin variable (usually slightly concave, but sometimes transverse or even slightly convex); with exaggerated cornua reaching out between coxae I-II; surface reticulate, especially around margins, bearing three pairs of setae and two pairs of pores. Setae *mst* and pores on small shields distinct from larger endopodal shields III-IV. Genital shield slightly expanded and slightly rounded behind coxae IV; surface textureless, except for weakly rayed and short operculum; setae *g* set in from margin, but associated pores well free of shield. Anal shield variably ovate, surface with muscle insertions and distinct reticulations; cribrum narrow; anus centrally placed, almost wholly behind setae *aa*, but well in front of *pa*. Metapodal shields distinct. Ventral cuticle with 10 to 12 pairs of setae and some paired pores. Peritremes distinctly crenulate, short, reaching forward only to level of condyles of coxae II; peritrematal shields fused humerally with dorsal shield, but free of exopodal shields II-IV. Insemination apparatus visible as increasingly thick adductor canals leading to medusoid maturation pouches. Only three specimens (from Ferdacuttup) gravid, egg ovate, 225-255 µm long, 140-145 µm wide; shell textureless.

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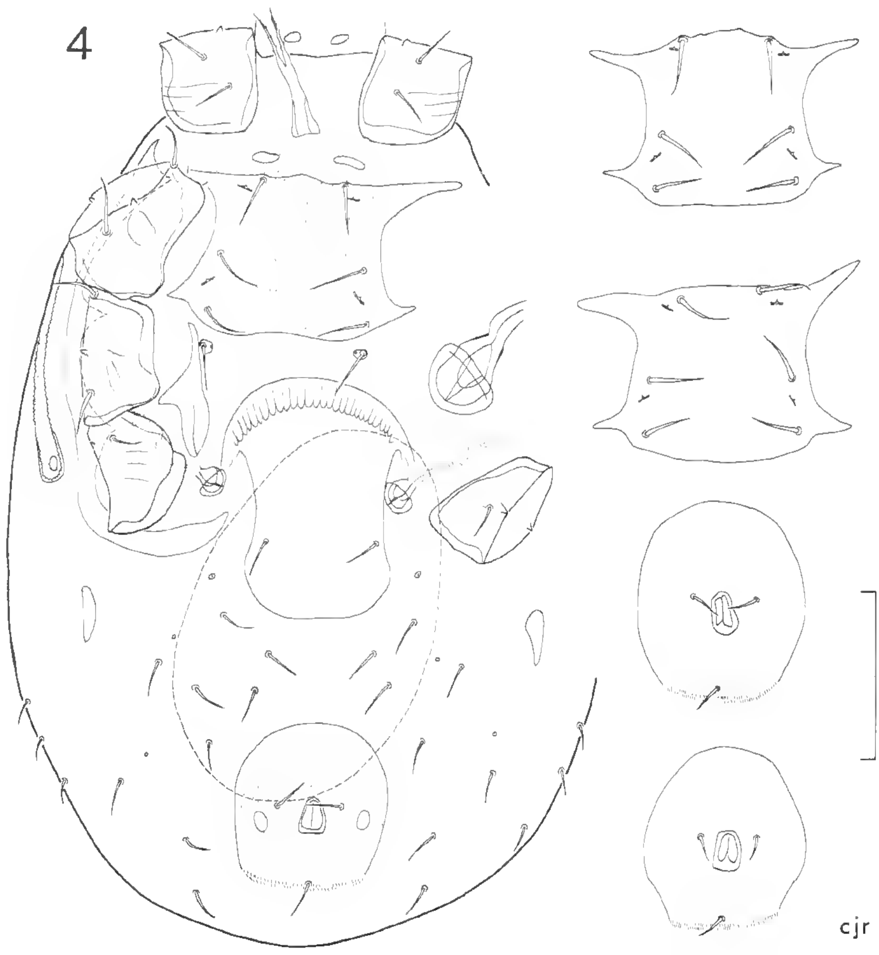
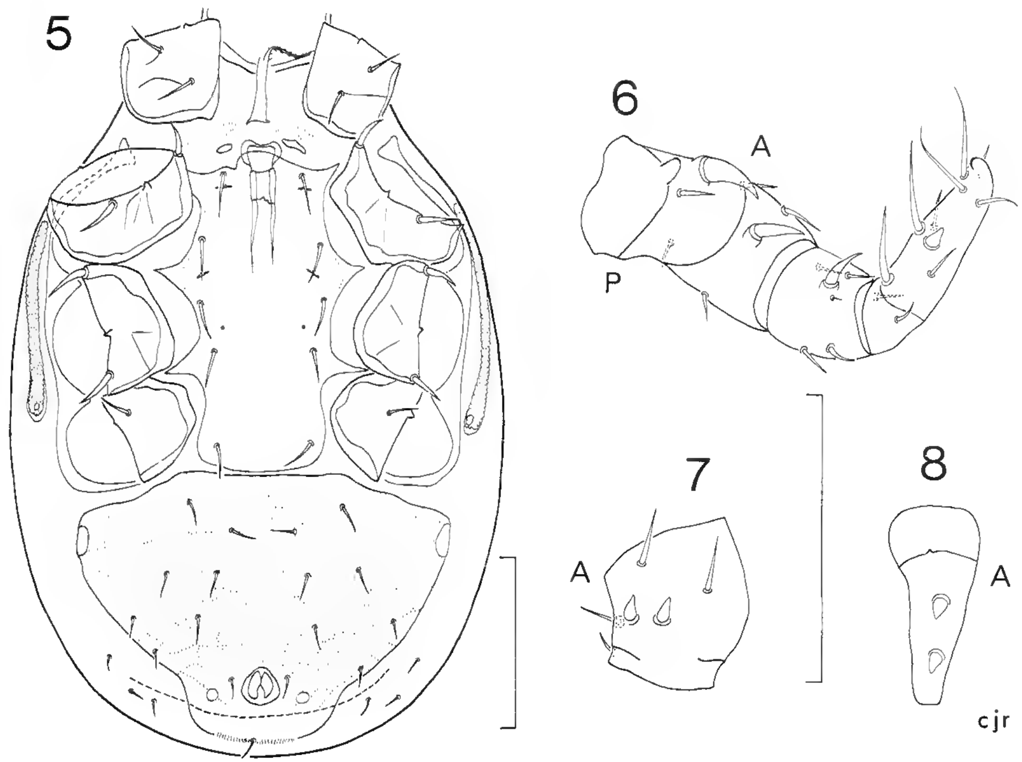


Fig. 4: *Proctolaelaps spencerae* sp. nov. Venter ♀ (with variant sternal and anal shields).



Figs 5-8: *Proctolaelaps spencerae* sp. nov., ♂. 5: Venter. 6: Femur-tarsus IV (ventral and lateral setation). 7: Femur II (ventral and lateral setation). 8: Tarsus II (modified ventral setation).

Leg setation holotrichous, with one exception: unideficient on femur I (one *pv*). All setae as in *Hattena panopla* Domrow below, except that they are simple. No spine on anterodorsal margin of coxa II. Pulvilli simple.

Male (Figs 2, 5-8): Capitulum as in ♀, except as follows. Movable digit of chelicerae with elongate, retrorse and apically sinuous spermatodactyl.

Idiosoma 420 μm long, 290 μm wide. Dorsum as in ♀, except that shield entirely covers dorsal cuticle.

Venter undistinguished and as in ♀, except as follows. Sternogenital shield virtually textureless; ventrianal shield reticulate, with seven pairs of usurped ventral setae and incorporating metapodal shields. Ventral cuticle with about three pairs of setae. Peritremes shorter, confined to venter.

Legs inconveniently folded, but seen to be as in ♀, setation modified as follows (cf. *Lasioseius corticeus* Lindquist, 1971). Leg II: femur with two basal *v* spur-like; tarsus with $av_{2\text{-}3}$ spur-like. Leg IV (and to much lesser extent III): trochanter-femur with *al* heavily spinose (also small rounded process on distal margin of basifemur); genu-tibia with *av* spinose; tarsus with $av_{2\text{-}3}$ blade-like and pv_2 spur-like.

Host and Localities

On honey possum, *Tarsipes spencerae* Gray (Marsupialia: Tarsipedidae) (WAM 6426), Ferdacuttup, W.A., 20.XI.1969, T. & R. Goldfinsh (holotype ♀, allotype ♂, 51 paratype ♀♀). In WAM (including holotype and allotype), FMNH, QIMR, CU.

On *T. spencerae* (WAM M4685), Green Range, Albany, W.A., 25.VIII.1961, T.C. Scott (143 paratype ♀♀, 2 paratype ♂♂). In WAM, FMNH, QIMR, CU.

(Dr Lukoschus has since kindly mounted the balance of this material from spirit [five ♀♀ from Ferdacuttup, 406 ♀♀ from Green Range — these are not types]. None carries a formed [i.e. shelled] egg, suggesting [with the paucity of males and the absence of immatures] that their association with the honey possum is simply one of phoresy.)

AMEROSEIIDAE

This section is arranged after Evans (1963a) and Ishikawa (1972). Gravatt (1969), Allred (1970) and Baker & Delfinado (1976) listed species from New Zealand, New Guinea and Nepal.

Asperolaelaps was originally described as a neoparasitid genus (Womersley, 1956), but, in two paratype ♀♀ of *A. rotundus* Womersley in QIMR, the capitulum (palpi holotrichous), dorsal (to include all 10 pairs of setae originally shown by me as free in cuticle, one additional pair each in positions z_6 and J_5, and additional small [anterior] pair on penultimate pair of tubercles, thereby making up 29 pairs typical of *Neocypholaelaps* Vitzthum), sternal and anal shields, and leg setation (e.g. four unideficiencies noted on femora I-II and genu-tibia I in *Hattena* below [other segments holotrichous, except, apparently, unideficient femur IV 1-3/1-0]) are now seen to be ameroseiid, and the transfer and new generic synonymy is made.

Hattena was originally described as a laelapid *s.l.* genus (Domrow, 1963), but the capitulum, dorsal, sternal and anal shields, and leg setation (e.g. four unideficiencies noted on femora I-II and genu-tibia I below[3]) are now seen to be ameroseiid, and the transfer is made. It is near *Neocypholaelaps* (Evans, 1963a; Mo, 1969), but constant differences (fewer pairs of setae on dorsal shield, usurped ventral setae on anal shield of male etc.) support its present retention.

[3] In this respect, Evans' illustrations and tables (1963a) do not agree, and I have used his later, definitive account (1963b).

NEOCYPHOLAELAPS AFRICANUS EVANS, 1963a (emend.)

In size, the specimens below (dorsal shield 330-375 μm long, setae J_5 [formerly Z_5] 13-16 μm long) match the original specimens from African apid bees better than those from Queensland apids only provisionally assigned to the species (Evans, 1963a).

Host and Locality

On little red lory, *Charmosyna pulchella* Gray (Psittaciformes: Psittacidae), Opanabu, Nowata, P.N.G., 8.VII.1969, W.B. Hitchcock (8 ♀♀). In QIMR.

HATTENA PANOPLA DOMROW, 1966

This interesting species was previously known only from a single female taken from the nares of a brown honeyeater, *Gliciphila indistincta* (Vigors & Horsfield) (Meliphagidae) in coastal Queensland some 1,375 km SSE of the present locality. (Since writing this, I have seen Fain & Lukoschus' record [1979] from Western Australia.)

Female (Figs 9-10): Epistome a smooth shallow lobe not exceeding palpal trochanters.

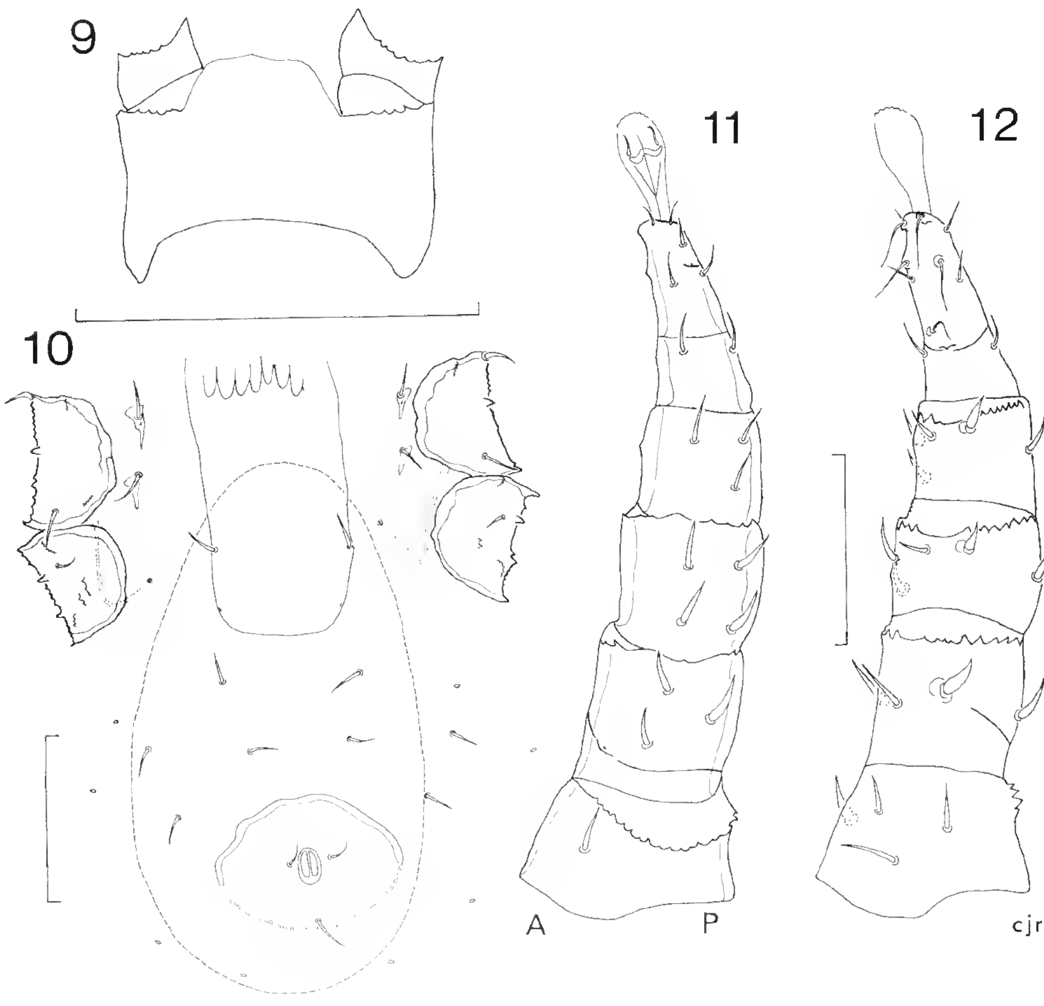
Metapodal shields almost linear as in ♂, clear only in older specimens. Insemination apparatus visible only as adductor canals. Egg obovate, 315 μm long, 175 μm wide (max.); shell textureless.

Leg setation confirmed as holotrichous (including femur III), with five exceptions: one additional seta (pl_2) on genu IV as in *Androlaelaps* Berlese etc., and unideficiencies on femur I (one *pv*), femur II (one *ad*) and genu-tibia I (presumably pd_3, pd_2 having moved somewhat basad to fill vacancy). All setae (including those on capitulum and idiosoma) simple, except for an occasional lateral barbule on the very strongest; none on femora-genua I-II unduly strengthened.

Male (Figs 11-15): Capitulum essentially as in ♀, but cornicles flared and diaphanous, and *d* setae on palpal femur-genu stronger. Chelicerae stouter than in ♀; fixed digit bidentate; movable digit shorter, with paler baso-external excrescence giving rise to retrorse, slenderly tapering spermatodactyl.

Idiosoma stouter than in ♀, 585 μm long, 495 μm wide. Dorsum essentially as in ♀, but shield much more extensive posteriorly, taking in row of four setae flanking posterior margin in ♀.

Tritosternum with short median (third) prong. Sternal, metasternal and genital shields fused, with distinct cornua laterally; anterior margin biconvex, divided by genital aperture; posterior margin horned, transverse and free of body surface (striate cuticle visible beneath, cf. ♂ of *Macronyssus leucippe* [Domrow], see Domrow [1977]); surface textureless (but with indications of muscle insertions on genital portion), bearing usual five pairs of setae (*mst* strengthened) and three pairs of pores (minute). Ventrianal shield subcircular, but with characteristic incision on anterior margin; surface marked by reticulations and muscle insertions, bearing anus in posterior portion, and one pair of setae anteriorly in addition to usual three setae (*pa* strongest) and pair of pores; cribrum linear. Metapodal shields weak, almost linear. Ventral cuticle with three pairs of setae and five pairs of pores (in addition to pair of pores on cuticle beneath portion of anal shield that is free of body surface posteriorly). Peritrematalia as in ♀.



Figs 9-12: *Hattena panopla* Domrow. 9: Basis capituli ♀ (dorsal). 10: Hysterosoma ♀ (ventral). 11: Trochanter-tarsus III ♂ (dorsal setation). 12: Trochanter-tarsus III ♂ (ventral and lateral setation).

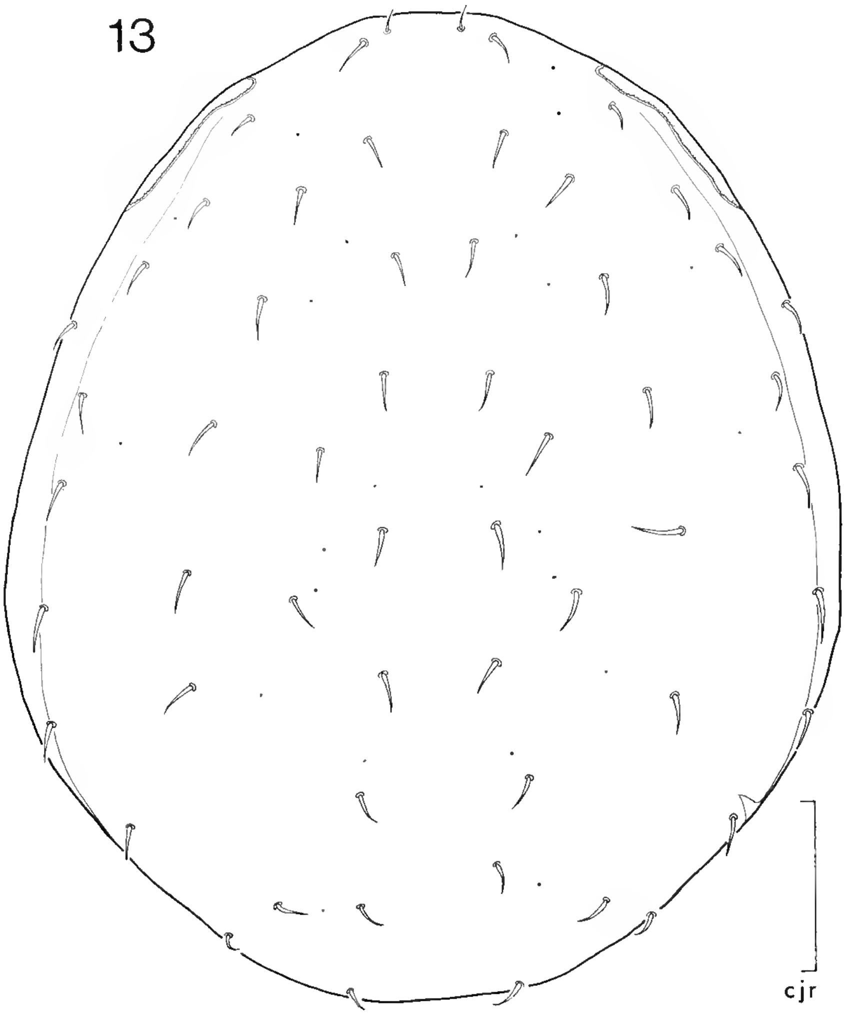


Fig. 13: *Hattena panopla* Domrow. Dorsum ♂.

Leg setation as in ♀, except femur III 1-3/2-1 (i.e. one additional *v*); trochanter II abnormally 1-0/3-2 on one side (i.e. one additional, and strong, *pl*). Legs II-III incrassate, with *pv* on coxae, two *pv* on femur II, and *pv* on genu-tibia II and femur-tibia III strengthened and set on small blunt tubercle; also with $av_{1\text{-}3}$ and $pv_{1\text{-}2}$ on tarsi associated with small acute tubercle, but normal.

Deutonymph (Fig. 16): Capitulum and legs as in ♀, except femur III 1-3/2-1 (i.e. one additional *v*, even on one side of one specimen where genu-tarsus are stunted and increasingly hypotrichous).

Idiosoma 475 μm long, calculated to be 380 μm wide. Dorsum essentially as in ♂, but shield with indications of posterolateral incisions seen in ♀ rather clearer and surface uniformly granulate, without distinct reticulations.

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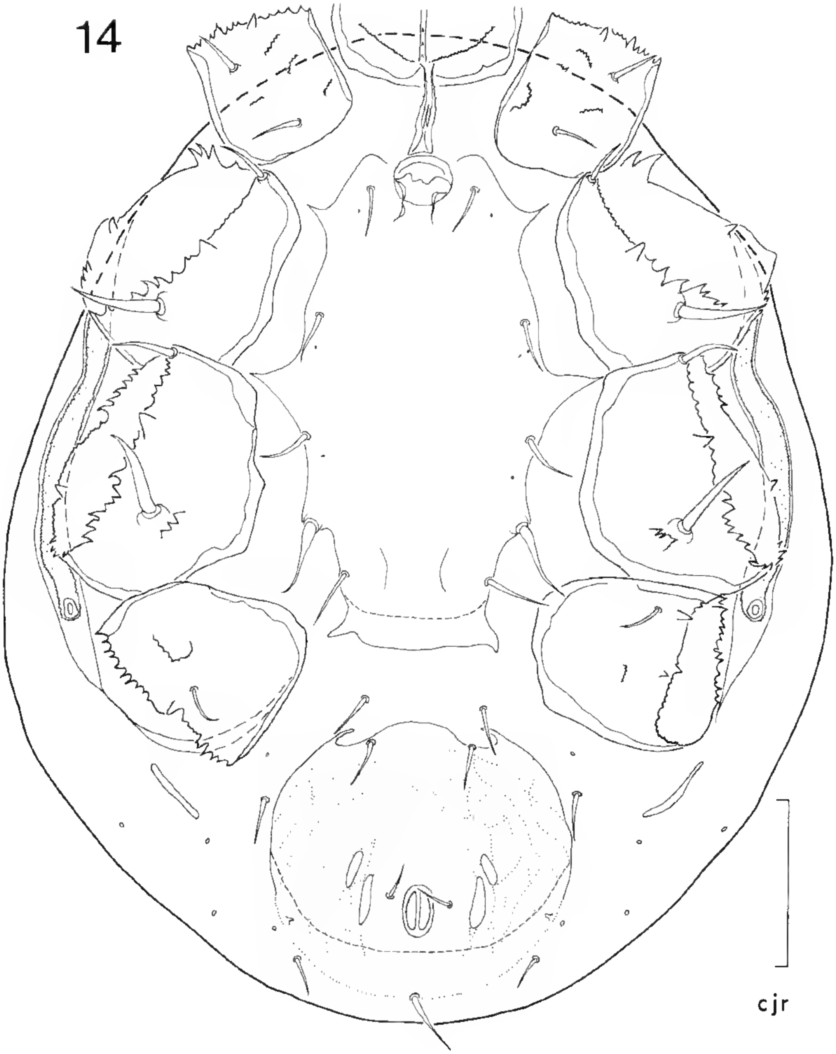

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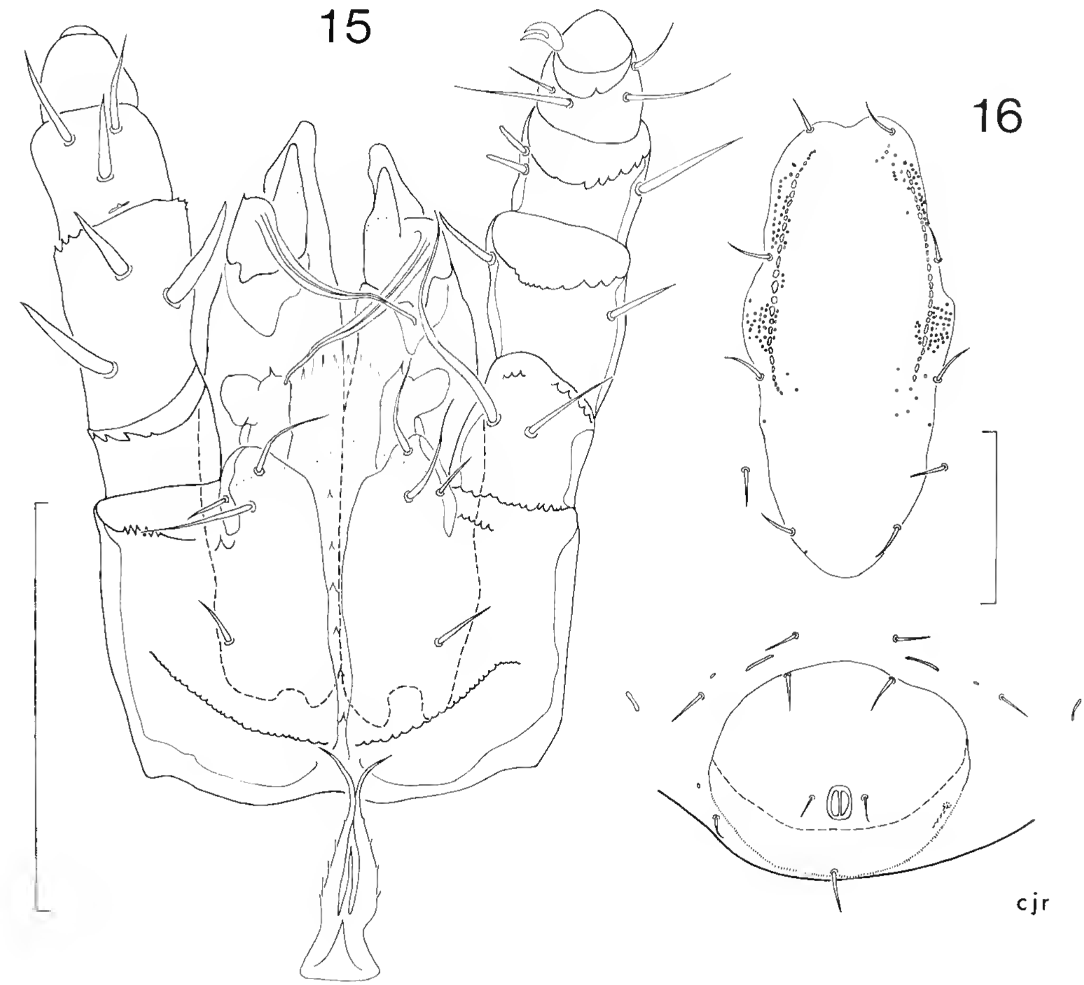
Fig. 14: *Hattena panopla* Domrow. Venter ♂.

Tritosternum as in ♀. Sternogenital shield biconvex anteriorly, somewhat expanded midlaterally (i.e. with indications of cornua between coxae II-III), and roundly tapered between coxae IV; surface with heavy longitudinal texture submarginally from setae st_1 to st_3, bearing $st_{1\text{-}3}$ and g, and four pairs of pores (minute); *mst* free in cuticle. Venter otherwise as in ♂, except that two shieldlets in cuticle have not fused with ventrianal shield (cuticle somewhat crinkled, and some pores probably not seen).

Hosts and Localities

Running over beak and in and out of nostrils of white-throated honeyeater, *Melithreptus albogularis* Gould (Passeriformes: Meliphagidae), Higginsfield, Bamaga, near Cape York, Q., III.1975, R. Domrow & J.S. Welch (1 ♀). In QM.

In same circumstances on dusky honeyeater, *Myzomela obscura* Gould (Meliphagidae), Higginsfield etc. (4 ♀♀, 1 ♂, 2 dn). In QM, QIMR.



Figs 15-16: *Hattena panopla* Domrow. **15:** Capitulum and tritosternum ♂ (ventral, but true right palp dorsal). **16:** Sternogenital and anal shields dn.

HATTENA COMETIS SP. NOV.

This species is near *H. erosa* Domrow, 1963, but, in the female, shows distinct differences in the length of the peritremes (reaching level of posterior margins of coxae I rather than II), and the reduced setation of the dorsal shield (notably z_6 absent) and legs (notably genua II-III as detailed below). Males are separable at a glance (setation of dorsal shield, armature of legs etc.).

The specific name is the Greek adjective κομητης (masc.), κομητις (fem.), wearing long hair.

Female (Figs 17-18): Capitulum as in *H. erosa*, including unideficient palpal trochanter; palpal femur, genu and probably tibia holotrichous (setae $al_{1\text{-}2}$ on genu spatulate). Epistome a simple lobe somewhat more rounded than in *H. panopla*, but still not exceeding palpal trochanters. Fixed digit of chelicerae with narrow hyaline lobe running length of external face.

Idiosoma 450 µm long, 350 µm wide (not gravid). Dorsum as in *H. erosa*, except as follows. Shield with reticulation polygonal in general, but tending to longitudinal posteromedially (cf. *H. panopla*); with fewer pairs of setae (19, taking 2 as average of 2.2, 1.3 and 1.3 setae in posterolateral angles); z_6 absent. Marginal cuticle with 18-20 pairs of short setae.

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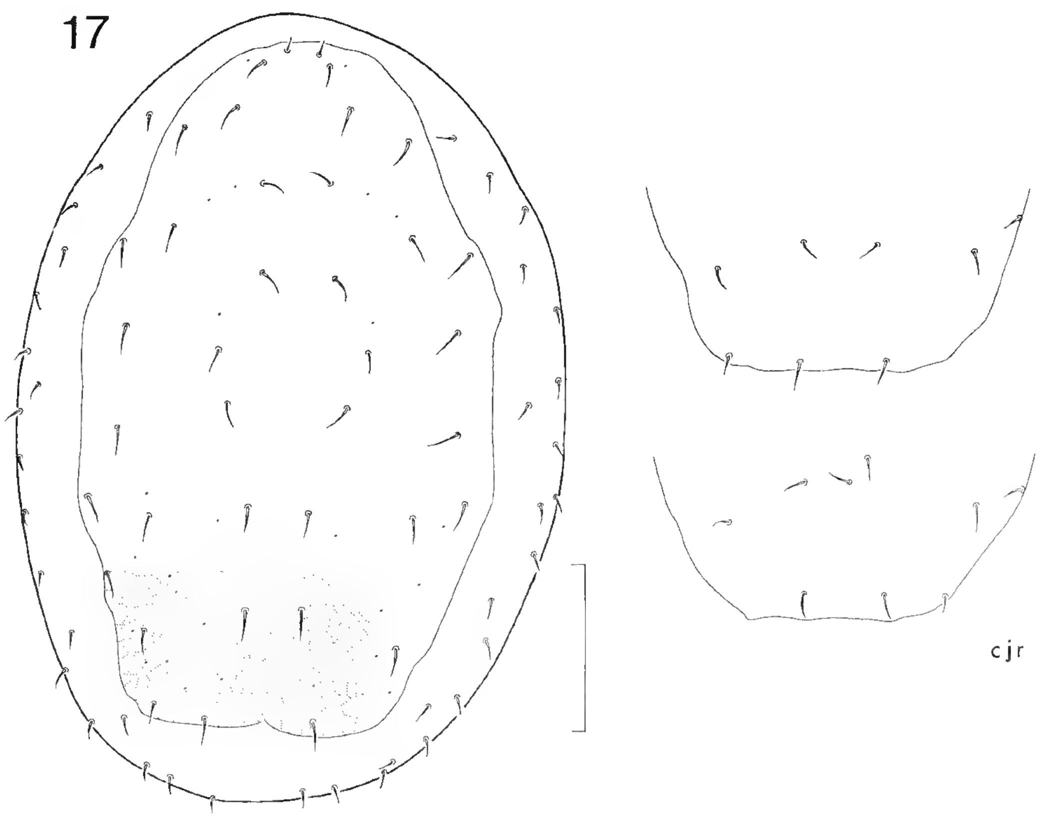

Fig. 17: *Hattena cometis* sp. nov. Dorsum ♀ (with variant terminal portions of dorsal shield).

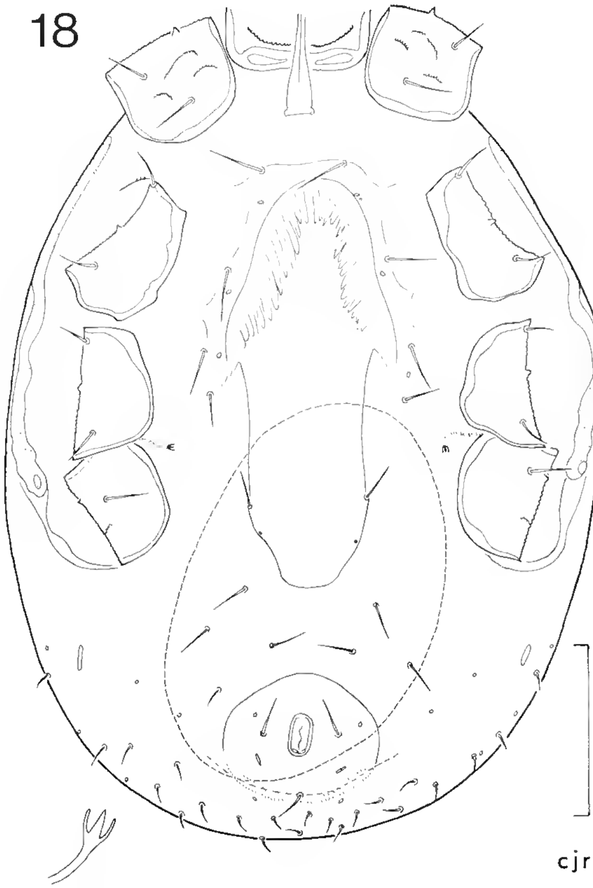

Fig. 18: *Hattena cometis* sp. nov. Venter ♀.

Venter as in *H. erosa*, except as follows. Sternal shield evident more by cessation of cuticular striae than as definite plate. Genital shield longer, taking in genital pores. Ventral cuticle with 14-15 pairs of setae of which first 1.2 are stronger. Peritremes extending forward to level of posterior margins of coxae I. Insemination apparatus as in *H. panopla*, but adductor canals shorter, cf. *N. novaehollandiae* Evans, 1963a. Egg as in *H. panopla*, but more ovate, 230 μm long, 150 μm wide.

Legs with holotrichous coxae, trochanters (I 1-1/3-0 on one side of one specimen), femora III-IV (better expressed 1-4/1-0 than 1-3/1-1), tibiae II-IV and tarsi II-IV (tarsus I not counted). Genu IV with seta pl_2 as in *H. panopla*, but also with *pv* (i.e. 2-5/2-2 compared with holotrichous 2-5/1-1). Femora I-II and genu-tibia I with same four unideficiencies as in *H. panopla* (variations — femur I: one specimen normal, another 2-5/3-1 [lacking pl_2] on one side, another 3-5/3-2, 3-5/3-4; femur II 2-4/2-1 [lacking one *pv*] on one side of two specimens; tibia I 1-5/3-2

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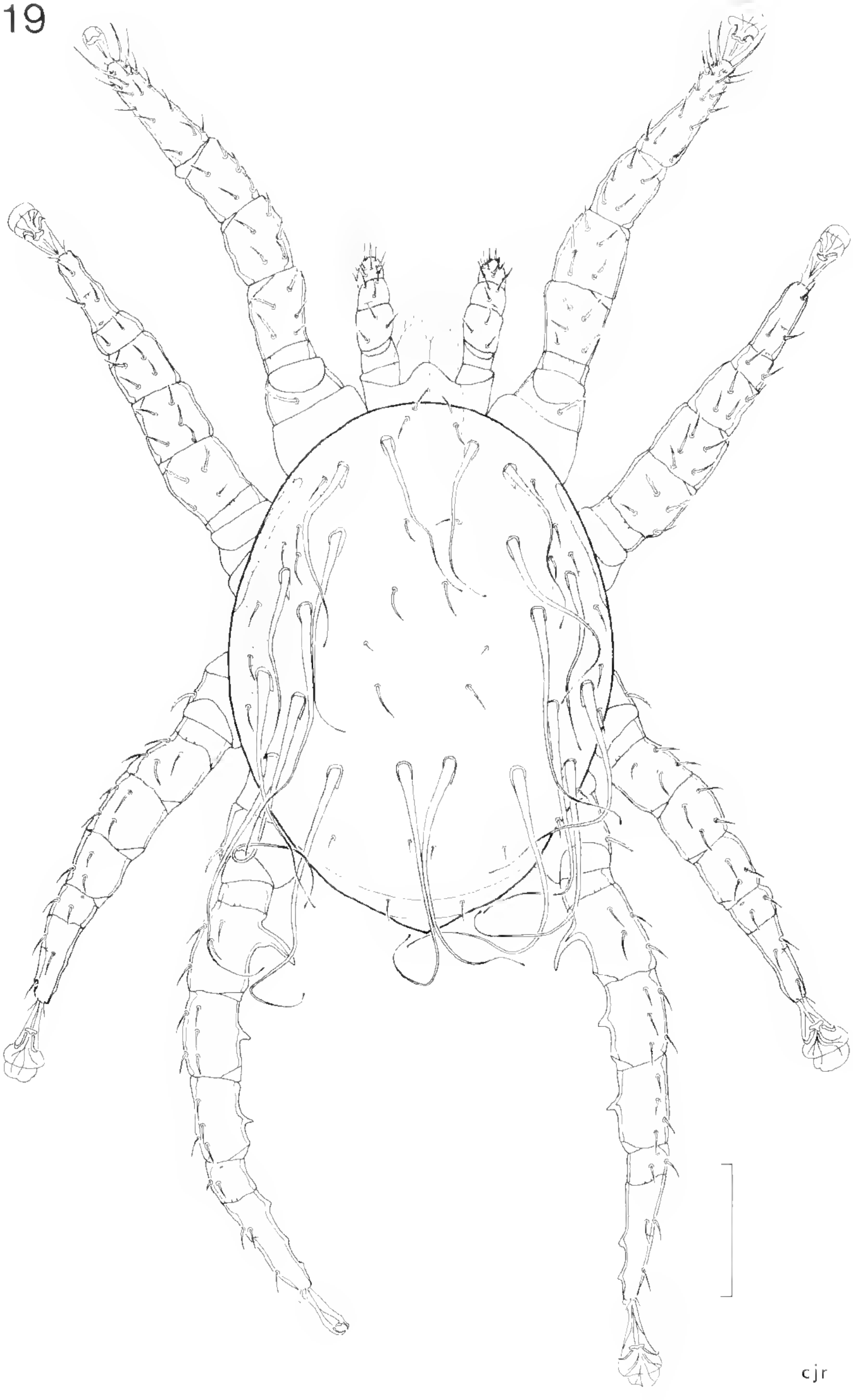

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Fig. 19: *Hattena cometis* sp. nov. Dorsum ♂.

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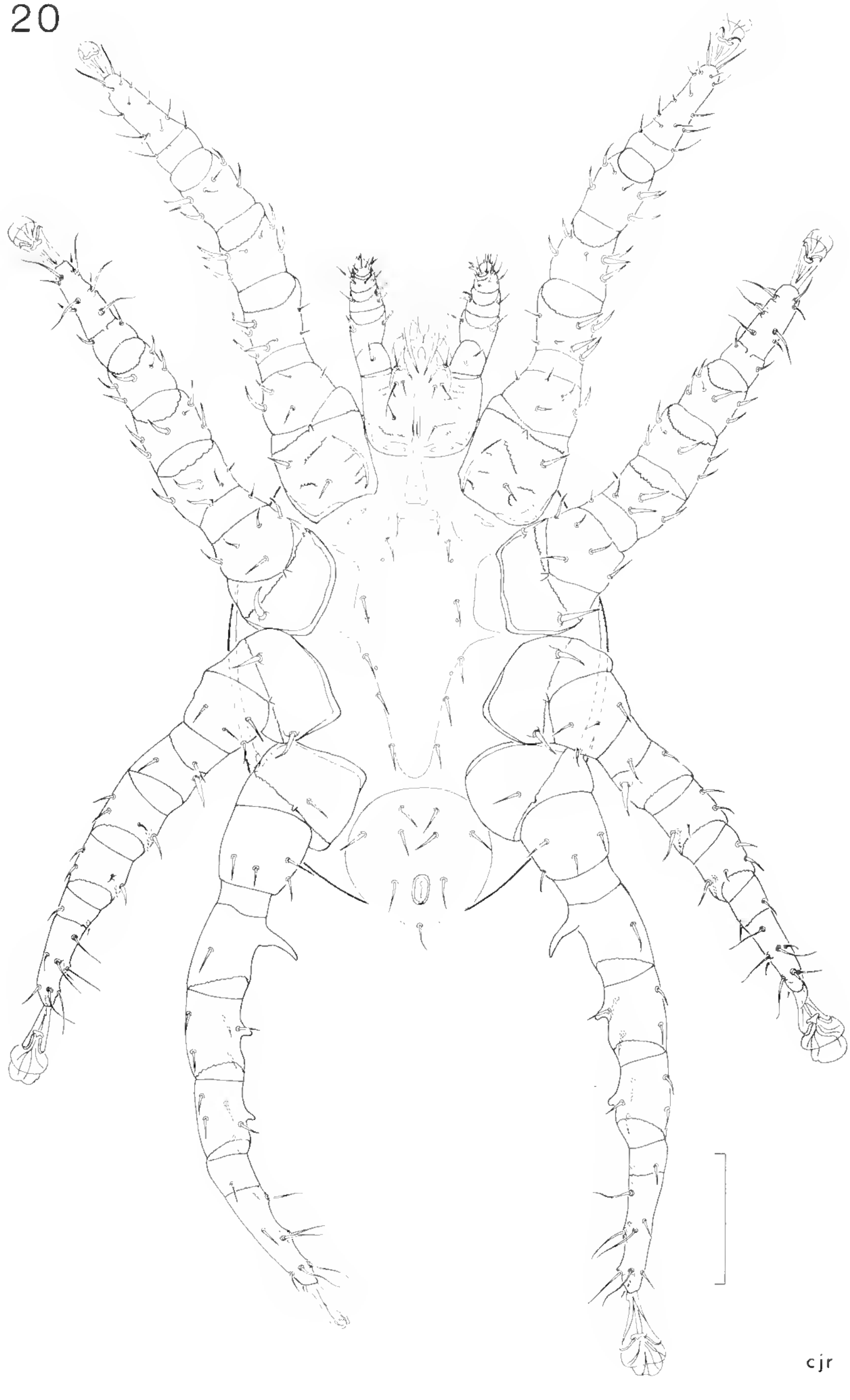

Fig. 20: *Hattena cometis* sp. nov. Venter ♂.

[lacking al_2] on one side of one specimen). Remaining two segments holotrichous, except as follows: genu II variable — 2-5/1-2 (lacking *av*) on both sides of one specimen, 2-5/1-2 (lacking *av*) on one side and 2-5/0-2 (lacking *av* and *pv*) on other side of another, and 2-5/0-2 (lacking *av* and *pv*) on both sides of another; genu III 2-4/1-1 (lacking *pv*). All setae as in *H. panopla.* No spine on anterodorsal margin of coxa II.

Male (Figs 19-20): Capitulum essentially as in ♀, except as follows. Setae *c* shorter, not reaching sides of basis. Hypostome with seta $h_2 > h_3$. Seta *al* on palpal femur spatulate. Chelicerae as in *H. panopla*, but details not clear.

Idiosoma 395 μm long, 115 μm wide. Dorsal shield not readily distinguishable humerally from reticulate cuticle, but surface otherwise granulate and marked by muscle insertions; setation as in ♀, at least medially, with 16 setae on one side and 18 on other, of which 10 pairs are hypertrophied, with characteristic insertions and spatulate tips.

Tritosternum bipartite as in ♀. Sternogenital shield granulate, but only weakly delineated and sharply tapered in posterior half; with usual five pairs of setae and three pairs of pores. Ventrianal shield bearing three pairs of setae in addition to setae *aa* and *pa*; cribrum linear. Ventral cuticle somewhat crinkled, details not clear.

Leg setation as in ♀, except as follows. Femora III 1-4/2-0, IV with seta *v* transformed into large spur. Genua II-III holotrichous, IV with *pv* transformed into small spur. Tibia IV with *pv* transformed into small spur. Tarsi II-IV with $av_{1\text{-}3}$ and $pv_{1\text{-}2}$ normal, but set on small tubercle, cf. *H. panopla.*

Hosts and Localities

Running over beak and in and out of nostrils of yellow honeyeater, *Meliphaga flava* (Gould) (Passeriformes: Meliphagidae), Bamaga, Q., III.1975, R. Domrow & J.S. Welch (holotype ♀, allotype ♂). In QM.

In same circumstances on graceful honeyeater, *M. gracilis* (Gould), Bamaga etc. (2 paratype ♀♀). In QIMR.

On eastern spinebill, *Acanthorhynchus tenuirostris* (Latham) (Meliphagidae), 1.6 km W of Mount Keira, N.S.W., 3.VI.1972, H. Battam (2 ♀♀, not types). In QIMR.

KLEEMANNIA PLUMOSA (OUDEMANS, 1902)

Hughes (1976) recorded this cosmopolitan species both in association with mites of stored food products and as a free-living predator. It is known from Western Australia (Domrow, 1974).

Host and Localities

On western chestnut native mouse, *Pseudomys nanus* (Gould) (Rodentia: Muridae) (3092), Port Warrender, W.A., 25.X.1976 (1 ♀). In WAM.

Free-living, Arramall Cave, Arrowsmith River, near Dongara, W.A., 3.XI.1973, J.W.J. Lowry (2 ♀♀). In QIMR.

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GEOGRAPHICAL VARIATION IN THE AUSTRALIAN ROCK PIGEONS

F.H.J. CROME*

and

R.E. JOHNSTONE†

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ABSTRACT

Specimens of White-quilled and Chestnut-quilled Rock Pigeons from forty and eight localities respectively were measured and scored for colour and extent of the wing patch. There was clinal variation in most characters in White-quilled Rock Pigeons: large dark birds in the west Kimberley to small red birds further east. The extent of the wing patch showed no such variation but a sharp transition from presence of a large patch to virtual absence. The populations are grouped in three taxa — *Petrophassa rufipennis, P. albipennis albipennis* and *P. a. boothi.*

INTRODUCTION

The Australian White-quilled and Chestnut-quilled Rock Pigeons (*Petrophassa* sens. strict.) are restricted to sandstone escarpments from the Kimberley to Arnhem Land. The first specimens of White-quilled Rock Pigeons were obtained by Lort Stokes in 'north western Australia' and named *P. albipennis* by Gould before the Zoological Society on 8 December 1840 (published 1841). In 1898 Collett described *P. rufipennis* from specimens collected by Knut Dahl in 1895 (Dahl, 1895; Whittell, 1954). Mathews (1912) designated Wyndham as the type locality of Gould's *albipennis* and erected *P. albipennis alisteri* for a form from Napier Broome Bay on the basis of its being 'dark uniform brown above, altogether lacking the rufous brown of typical birds'.

* Division of Wildlife Research, C.S.I.R.O., P.O. Box 84, Lyneham A.C.T. 2602.

† Western Australian Museum, Francis Street, Perth W.A. 6000.

Another subspecific name — *boothi* — was given to specimens of White-quilled Rock Pigeons from the Victoria River that lacked the wing patch to varying degrees (Goodwin, 1969). In the 1975 Checklist only one species of Rock Pigeon was recognised and treated as a polytypic species with three subspecies *P. albipennis albipennis*, *P. a. rufipennis* and *P. a. boothi*; *alisteri* was suppressed under the nominate *albipennis*.

As a result of extensive surveys in the Kimberley and Northern Territory by the Western Australian Museum and C.S.I.R.O. enough material is now available for a more detailed analysis of geographic variation in the Australian Rock Pigeons.

MATERIALS AND METHODS

Specimens of White-quilled Rock Pigeons from forty localities and Chestnut-quilled Rock Pigeons from eight localities, held in the collections of the Western Australian Museum, British Museum (Natural History), American Museum of Natural History and the Australian National Wildlife Collection were examined. Localities with fewer than three specimens were, unless more than 100 km away from, or obviously different in colour from, the nearest group, combined with nearby localities for statistical purposes. The original localities were thus reduced to sixteen (White-quilled) and four (Chestnut-quilled) groups, five localities remaining ungrouped and not subject to statistical analysis (Table 1 and Fig. 1).

Each specimen was measured as follows:

1 length of the culmen from the tip to its insertion in skull
2 length of the chord of the flattened wing
3 length of the tarsus
4 weight (from collector's labels)

Specimens of White-quilled Rock Pigeons were scored for colour of the back and belly and the size of the wing patch as follows:

Colour

Back

The mantle and rump vary from red-brown to a dark brownish black. The individual feathers are tricoloured with a greyish or pale brownish central area, a coloured area around this (which was scored for back colour), and a pale fringe. The overall colour of the back was scored on a scale of 1 (blackest) to 6 (reddest) by comparison with a standard series of birds chosen to represent the full range of variation. The series used is given in Table 2.

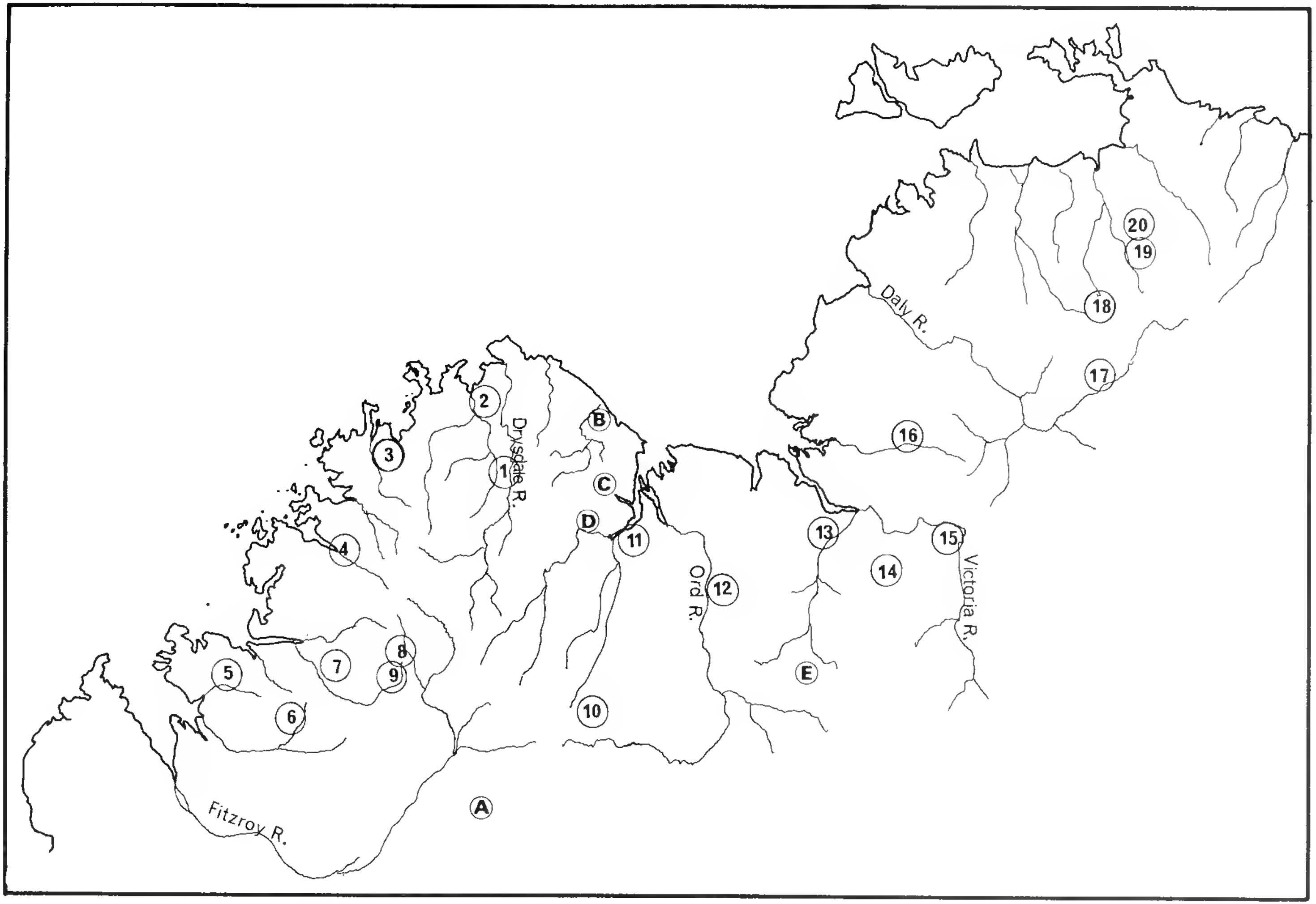

Fig. 1: Localities from which Rock Pigeons were examined. Numbers refer to groups in Table 1.

TABLE 1

Localities from which Rock Pigeons were examined

Localities		Co-ordinates		Groups
White-quilled				
Theda Station		14°48'S	126°30'E	1 Theda
Drysdale River		14°14'	127°00'	
Kalumburu		14°17'	126°38'	2 Kalumburu
Mitchell Plateau		14°40'	125°44'	3 Mitchell Plateau
Mitchell Falls		14°52'	125°50'	
Wollaston Island		14°31'	124°27'	
Prince Regent River (1)		15°07'	125°33'	4 Prince Regent
(2)		15°34'	125°25'	
(3)		15°47'	125°20'	
Wotjulum		16°11'	123°40'	5 Yampi Peninsula
Kimbolton Spring		16°38'	123°43'	
Oobagooma		16°46'	123°58'	
Napier Downs		17°17'	124°55'	6 Napier Downs
Mt Bell		17°10'	125°19'	7 King Leopold Range
Mt Vincent		17°09'	125°19'	
Mt Hart		17°08'	125°14'	
Beverley Springs		16°39'	125°30'	8 Joint Hill
Joint Hill		16°27'	125°56'	
Mt Barnett		16°43'	125°56'	9 Mt Barnett
Tableland Station		17°20'	127°05'	10 Durack Range
Teronis Gorge		17°19'	127°18'	
Mt King		17°19'	127°25'	
Mt Bedford		17°27'	127°20'	
Bedford Downs		17°26'	127°37'	
Fossil Downs		17°45'	126°08'	A Not grouped
Chamberlain River		16°01'	127°56'	11 Wyndham
Moochalabra Dam		15°38'	128°08'	
Parry Creek		15°30'	128°15'	
Berkeley River		14°30'	127°35'	B Not grouped
Forrest River	*ca.*	15°10'	127°50'	C Not grouped
Durack River	*ca.*	15°30-35'	127°30-128°	D Not grouped
Kununurra		15°39'	128°42'	12 Kununurra
Ord River Main Dam		16°00'	128°47'	
Spencer Range		15°38'	129°40'	13 Spencer Range
Jasper Gorge		16°03'	130°42'	14 Jasper Gorge
Bridge over Victoria River		15°36'	131°06'	15 V.R.D.
Waterloo Station		16°55'	129°35'	E Not grouped
Dee River		14°39'	130°56'	16 Dee River

TABLE 1 (continued)

Localities	Co-ordinates	Groups
Chestnut-Quilled		
Katherine Gorge	14°20' 132°25'	17 Katherine Gorge
UDP Falls	13°26' 132°25'	
El Sherana	13°31' 132°31'	18 UDP Falls
Koolpin Creek	13°29' 132°36'	
Nourlangie	12°51' 132°46'	
Sawtooth Gorge	12°54' 132°57'	19 Nourlangie
Noranda	12°53' 132°48'	
Mt Brockman	12°44' 132°55'	20 Mt Brockman

TABLE 2

Colour standards used in scoring back and belly in White-quilled Rock Pigeons

Score	Reg. no. of specimen	Colour of feathers*	
Back		Main coloured area	Fringe
1	ANWC 13662	Blackish-fuscous	Drab to clay
2	ANWC 12482	Umber-fuscous	Drab to clay
3	ANWC 12470	Blackish burnt umber	Drab
4	ANWC 12497	Raw umber	Clay
5	ANWC 12135	Dark cinnamon-brown	Cinnamon
6	ANWC 12907	Reddish antique brown	Cinnamon
Belly		General colour	
1	ANWC 14698	Dusky brown	
2	ANWC 12468	Dark greyish brown	
3	ANWC 12500	Dark fuscous	
4	ANWC 12907	Fuscous	

* The colours are the nearest match in Smithe (1974) and are approximate matches only.

Belly

The darkness of the belly was scored on a scale of 1 (darkest) to 4 (lightest), see Table 2.

These scores were converted to standard deviates (Table XX, Fisher & Yates, 1970) prior to calculation of means and standard deviations.

Wing patch

The specimens in the ANWC had been prepared with one wing detached and spread. The total length of, and the length of the white area on, each primary was measured. The purity of the white area was then scored as being pure white or with a few brown flecks only (A), or with brown flecks occupying at least 50% of the total white area (B). For each specimen two indices of the size of the white patch were calculated as follows:

$$I_1 = 100 \left(\sum_{i=1}^{10} W_{Ai} / \sum_{i=1}^{10} L_i \right)$$

$$I_2 = 100 \left(\sum_{i=1}^{10} W_{Bi} / \sum_{i=1}^{10} L_i \right)$$

where I = index

W_{Ai} = length of pure white area on a primary

W_{Bi} = length of brown/white area on a primary

L_i = length of primary

Where specimens had broken or growing primaries, as long as there were not more than two feathers unmeasureable, the means for the population to which the specimen belonged were used as replacements for these missing values (e.g. specimen ANWC 19242 from Dee River was growing primary 2. The value of 100 mm was used as the length of this feather, this being the mean length of primary 2 in the Dee River population). If within the one sample 25% or more of the specimens had the same primary broken they were not used in the analysis.

RESULTS

Measurements of size, colour and wing patch are given in the appendix and in Fig. 2.

Variation in size

Chestnut-quilled

There are no significant differences in the length of the culmen, wing and tarsus or the weight between the four groups.

White-quilled

Culmen

The length of the culmen decreases from the north-western and central Kimberley to the V.R.D. The population with the largest average culmen

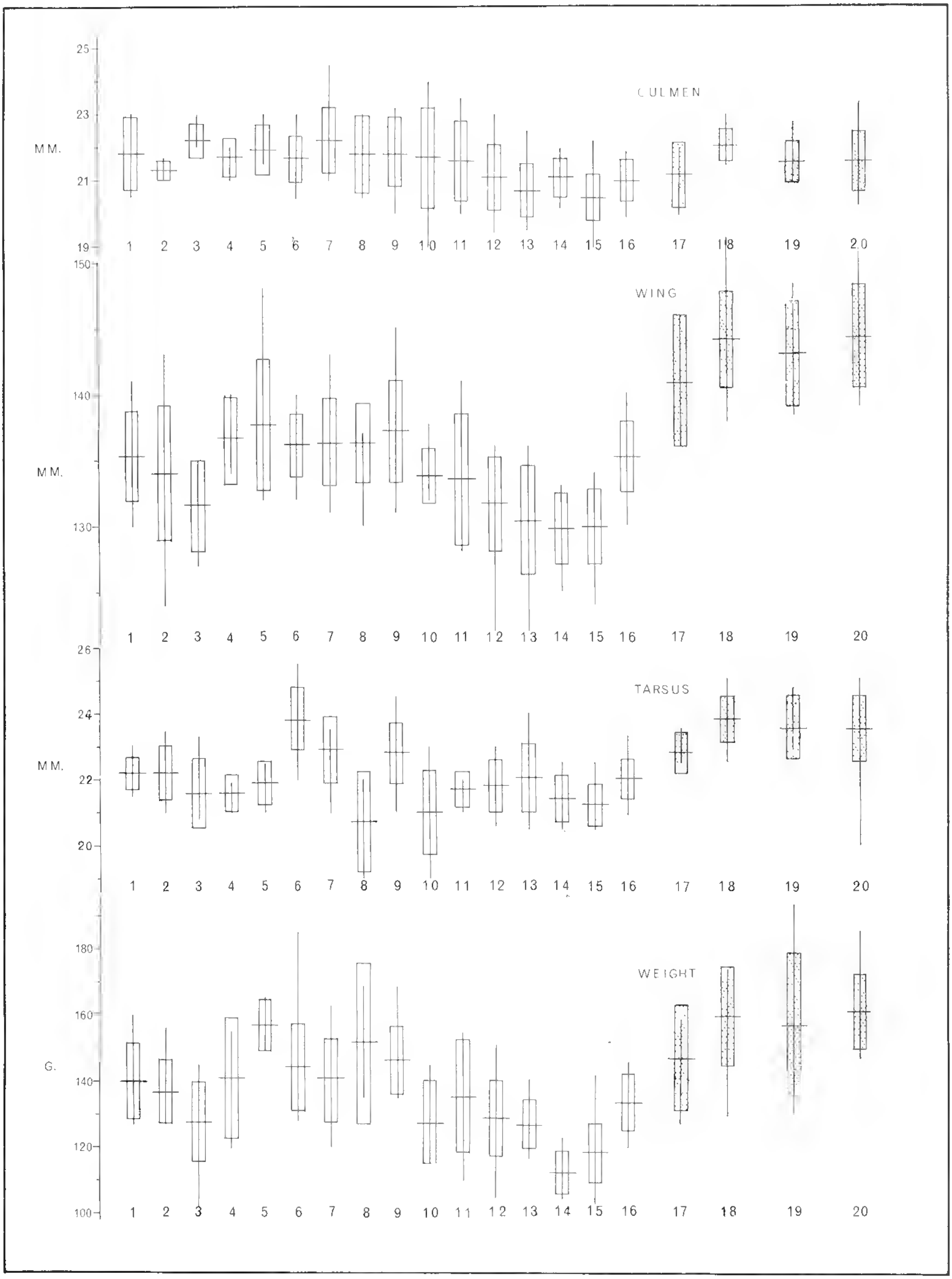

Fig. 2: Measurements (means, ranges and standard deviations) of Rock Pigeons. Numbers refer to groups in Table 1. Open figures — White-quilled Rock Pigeons, shaded figures — Chestnut-quilled Rock Pigeons.

is from King Leopold Range, that with the smallest from the V.R.D. The trend is a shortening from west to east.

Wing

There is again a clinal decrease of wing length from west to east but it is more complex than that of culmen length. Wing length is greatest in south-west Kimberley (Yampi Peninsula to Mt Barnett) then decreases through Durack Range, Wyndham and Kununurra to the V.R.D. Birds from the Dee River, north of the V.R.D., however have longer wings than the V.R.D./Spencer Range populations, and the length is not significantly different from that of the south-west Kimberley birds. Populations in north Kimberley, particularly the eight birds from Mitchell Plateau have shorter wings than the south-western birds.

Tarsus

The trends in tarsus length are not as marked as those in wing length, tarsus, like bill, not being as sharply correlated with size within similar populations as wing length. Joint Hill and Durack Range birds have the shortest and Napier Downs the longest tarsi.

Weight

The changes in weight show a pattern, as one would expect, similar to that of wing length with a diminution (clinal) from the west Kimberley to the V.R.D., and with birds from the Dee River being heavier than those from the V.R.D., while those from the north Kimberley are lighter than those from the south-west Kimberley.

Variation in colour

Chestnut-quilled Rock Pigeons

There is no measurable variation in back and belly colour of the specimens.

White-quilled Rock Pigeons (Fig. 3)

Birds from the north Kimberley (Theda, Kalumburu, Mitchell Plateau) are darkest of all, being blackish brown above and below. The colour lightens in the Prince Regent area and from Yampi Peninsula to King Leopold Range. From Mt Hart the trend of lightening and reddening continues eastward but there are anomalous breaks in an otherwise smooth cline. Birds from Joint Hill and Mt Barnett are darker than those from King Leopold Range to the west. Spencer Range and Dee River birds are also darker than the populations to the east and south of them (Wyndham to V.R.D.). The reddest birds of all are from Jasper Gorge. The ungrouped birds support the general picture. The Fossil Downs bird is like those from Durack Range, and that from Waterloo Station like Jasper Gorge and V.R.D. birds. The Forrest

River and Durack River birds are like those from Wyndham. The two birds from Berkeley River (AMNH 615853 and 615852) are darker and greyer than Wyndham birds and more like those from south-west Kimberley (King Leopold Range).

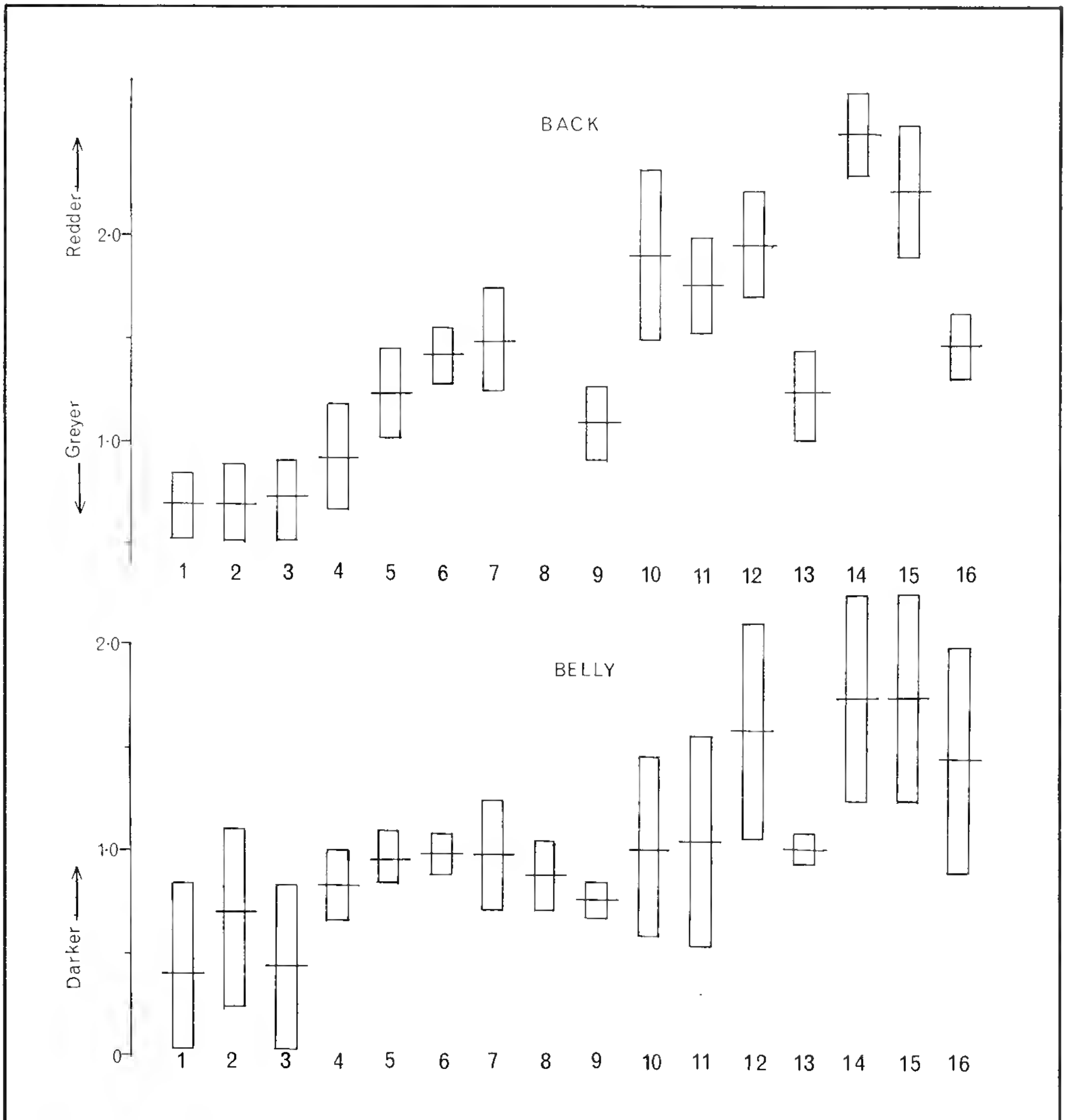

Fig. 3: Scores (mean and standard deviations) for colours of White-quilled Rock Pigeons. Numbers refer to groups in Table 1.

Variation in the wing patch of White-quilled Rock Pigeons (Fig. 4)

Birds from the V.R.D., Jasper Gorge and the one from Waterloo have no wing patch or it is extremely reduced. Only a few V.R.D. birds had a score

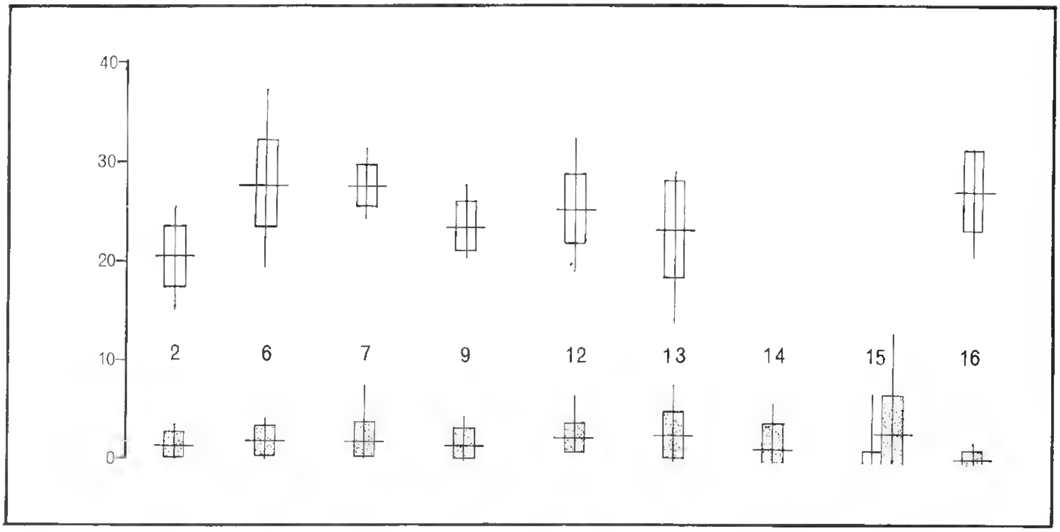

Fig. 4: Size (mean and standard deviation) of the wing patch of White-quilled Rock Pigeons. Open figures — Index I_1, shaded figures — Index I_2.

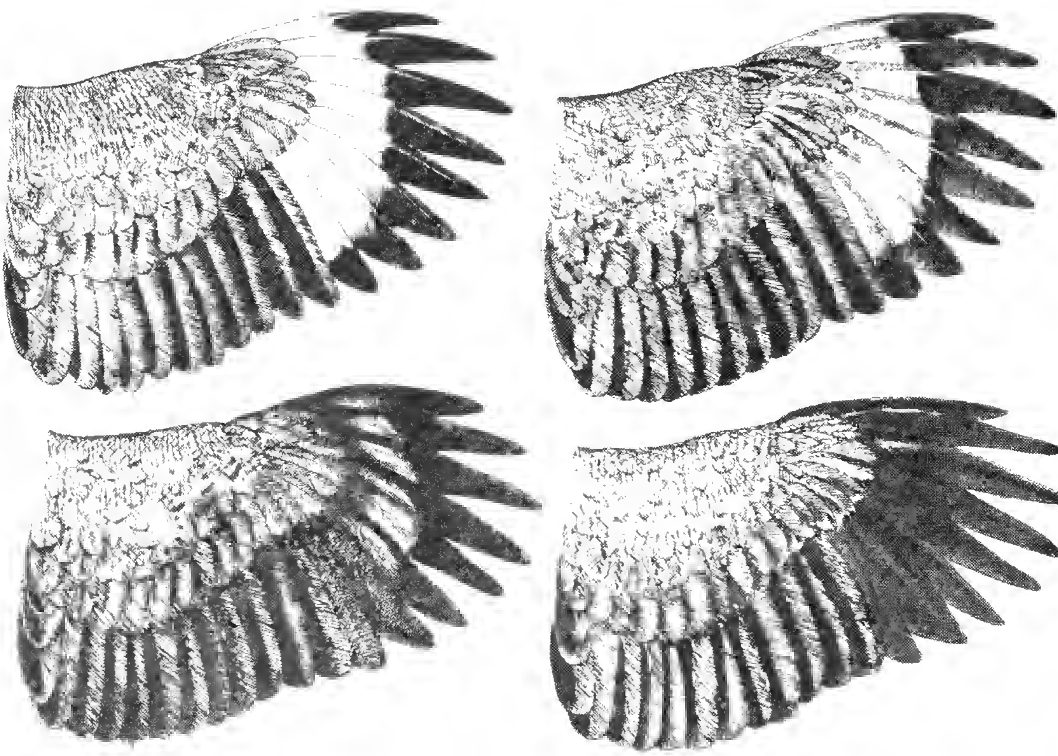

Fig. 5: Wings of selected White-quilled Rock Pigeons showing variation in the white patch. Top left ANWC 19236 Dee River; top right — ANWC 12920 Spencer Range; bottom right — ANWC 12929 Jasper Gorge; bottom left — ANWC 13675 Victoria River.

for Index 1. Eight of the twenty-one V.R.D. birds, six of the ten Jasper Gorge birds and the single Waterloo bird had no white whatsoever in the wing. Amongst the other populations there is a vague tendency for the white patch to diminish from west to east. The smallest average wing patches are on Kalumburu birds and the largest on Dee River birds.

In some birds from the V.R.D. a speckled white patch is obvious and in some birds with large white patches there is some encroachment of brown (Fig. 5); nonetheless the break between a large wing patch and none or a reduced patch is sharp.

DISCUSSION

The trend of variation in White-quilled Rock Pigeons is from large dark birds in north and west Kimberley to small red birds in east Kimberley and Northern Territory. This trend is however made more complex by the presence of large dark populations at the Spencer Range and the Dee River east of the small red population at Kununurra and west and north of the V.R.D. group. This pattern could be associated with differences in rainfall or rock colour (camouflage), the darkest birds coming from wet north-west coastal Kimberley and the reddest from the more inland drier parts (Gloger's rule) or dark birds living on darker sandstone than red birds. We have no quantifiable information to test associations with rock colour but a regression of average colour score on rainfall shows a highly significant relation (the best fit to the data was a power curve: colour = 25976.7 $(\text{rainfall})^{-1.454}$, $r = .853$ ($df = 14$), $t = 5.686$ ($df = 14$) ($P < .001$).

The populations in the V.R.D./Jasper Gorge area to which the name *boothi* has been applied appear in all respects, except wing patch, to be the end of this cline in colour and size. The break between V.R.D./Jasper Gorge and Spencer Range populations in this character is of course abrupt but the character is obviously labile since many V.R.D./Jasper Gorge birds have some traces of white. The V.R.D./Jasper Gorge populations are probably recent isolates. They are separated from the Spencer Range by the unsuitable habitat of the Whirlwind Plains, and a survey in 1976 found no suitable habitat between the V.R.D. and the Dee River population. Further west they are separated from the Kununurra and northern Durack Range populations by the flood plain of the Ord River. In the south-west, however, there could be continuous habitat connecting the Waterloo and Mt Bedford populations. If so there could be a cline in the size of the wing patch through this region. If not the V.R.D./Jasper Gorge populations would be completely isolated and could be unequivocally given subspecific status. Until such time as this information is available we prefer to be conservative and only tentatively retain the name *boothi* for them.

The clinal variation in colour and size of White-quilled Rock Pigeons is the reverse to what one would expect if a geographical connection with Chestnut-quilled Rock Pigeons existed. Although the large brown birds of the Dee River probably extend into the Flora River headwaters there is no suggestion of their being like Chestnut-quilled Rock Pigeons. The two are, of course, closely related. In fact, close examination of the wing patch showed that some individuals from Kununurra, Jasper Gorge and V.R.D. had a slight chestnut suffusion to the subdistal areas of some primaries (19 birds) and primary coverts (28 birds). However the following characters consistently distinguish between White and Chestnut-quilled Rock Pigeons and appear fixed in both forms:

1 The chin and centre of the throat is white in Chestnut-quilled Rock Pigeons and spotted black and white in White-quilled Rock Pigeons (feathers black with white centres).

2 The head, neck, mantle and upper breast in Chestnut-quilled Rock Pigeons is mottled with sagittate silvery-grey marks (feather centres) while this area in White-quilled Rock Pigeons is more or less concolorous or slightly scalloped grey and brown.

Nomenclature

From the foregoing we consider the populations of Australian Rock Pigeons to consist of two species — the Chestnut-quilled Rock Pigeon and White-quilled Rock Pigeon, the latter with two subspecies. The first subspecies shows clinal variation in size and back colour and extends throughout Kimberley from Oobagooma to Kununurra and into the Northern Territory north of the flood plain of the Baines River and into the ranges of the Fitzmaurice River system east, probably, to the headwaters of the Flora River. Two names have been applied to birds from this population — *albipennis* Gould and *alisteri* Mathews. *Alisteri* must be sunk but there is confusion over the type locality of *albipennis.*

Gould (1841) described the White-quilled Rock Pigeon from a male and female obtained from the 'most rugged and sterile districts of the north-west coast of Australia' by officers of H.M.S. *Beagle* and now in the Academy of Natural Sciences Philadelphia. Mathews (1912) restricted the type locality to Wyndham, and described a new race, *P. a. alisteri* from Napier Broome Bay. Whittell (1954) and Parker (1968) believed that the cotypes of *albipennis* came from the vicinity of King Sound. Meyer de Schauensee (1957) simply gives the type locality as north-west Australia.

The *Beagle*, under the command of John Lort Stokes, made two voyages to northern Australia, the first in 1838 to the King Sound region, Western Australia, and the second in 1839 to the Victoria River in the Northern Territory. White-quilled Rock Pigeons were collected in King Sound, as

Stokes noted in his diary: 'Some rather small pigeons of a dark colour marked with a white patch on the wings, were seen, and some specimens shot. They made a whirring sound in flight, like a partridge, and appeared to haunt the rocks, a habit which all subsequent observation confirmed.'

Nine new birds were collected in the King Sound area in 1838 and were described by Gould in 1839; these included White-breasted Whistler, Silver-crowned Friarbird, Yellow-tinted Honeyeater, Red-headed Honeyeater and Black-ringed Finch. Would Gould have waited until 1841 to describe a new genus of pigeon if specimens were available two years earlier?

In 1839 the *Beagle* sailed up the east coast of Australia to survey the Northern Territory coast west to the Victoria River. On the return journey down the Victoria River on 27 November 1839 Stokes shot some pigeons of a dark brown colour with a white patch on the extremity of the wing similar to the birds he had seen in King Sound and 'which always inhabited rocky districts and making a whirring sound, like a partridge on the wing'. Whittell (1954: 104) wrongly supposed that these birds were specimens of *Petrophassa rufipennis.*

Gould described his specimens as having the crown of the head and neck greyish brown, margined with sandy brown, all the upper surface, chest and tail rufous brown, the centre of each feather inclining to grey (Gould, 1843; pl. 71). Birds from the Spencer Range and the Dee River near the mouth of the Victoria River match this description better than the blackish brown King Sound birds. We have compared three plates of Gould (one of 1843 and two of 1848) with specimens but can find no good match. The most dissimilar are Kalumburu/Prince Regent birds. Dee River birds are the closest but still lack the rich brown portrayed. Dr F.B. Gill of the Academy of Natural Sciences Philadelphia kindly compared the cotypes with specimens from Lake Argyle (Ord River) and the Drysdale River, sent to him. He wrote that they were similar to A14046 (Drysdale River) but 'they are badly faded, paler and more brownish, lacking the intense charcoal coloration of your specimens. However they also lack the bright rusty colour of the eastern race.' Birds from the Dee River and Spencer Range are slightly browner than Drysdale specimens.

We conclude therefore that the most likely source of the types was the mouth of the Victoria River.

The second subspecies is a presumed isolate extending from the Stokes Range to Waterloo Station in the Northern Territory, south-east of the Baines River floodplain but with an unknown range to the south-east and south-west and characterised by no or a reduced wing patch. It was described as *P. albipennis boothi* by Goodwin (1969).

The arrangement we therefore propose is as follows:

Petrophassa rufipennis Collett

Type locality Alligator River, N.T.

Petrophassa albipennis Gould

Petrophassa albipennis albipennis Gould

Type locality presumably mouth of Victoria River, N.T. (syn. *P. a. alisteri* Mathews)

Petrophassa albipennis boothi Goodwin

Type locality Stokes Range, N.T.

ACKNOWLEDGEMENTS

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APPENDIX

Measurements of Rock Pigeons from localities in Kimberley and Northern Territory

Locality	Culmen (mm)				Wing (mm)				Tarsus (mm)				Weight (g)			
	x	S	Range	N	x	S	Range	N	x	S	Range	N	x	S	Range	N
White-quilled																
1 Theda	21.9	1.09	20.5-23.0	8	135	3.5	130-141	8	22.2	0.51	21.5-23.0	8	140	11.7	127-160	7
2 Kalumburu	21.3	0.30	20.9-21.7	10	134	5.1	124-143	11	22.2	0.82	21.0-23.5	12	137	9.9	127-156	11
3 Mitchell Plateau	22.2	0.45	22.0-23.0	5	132	3.4	127-135	5	21.6	1.04	20.8-23.3	5	127	12.4	112-145	5
4 Prince Regent	21.7	0.58	21.0-22.0	. 3	137	3.1	134-140	3	21.6	0.55	21.0-21.9	3	141	18.5	120-155	3
5 Yampi Peninsula	21.9	0.74	21.5-23.0	5	138	5.0	132-148	5	21.9	0.67	21.0-22.5	4	157	7.6	150-165	3
6 Napier Downs	21.7	0.72	20.5-23.0	15	136	2.3	132-140	15	23.8	0.99	22.0-25.5	16	144	13.3	128-185	16
7 King Leopold Range	22.2	0.99	21.0-24.5	24	136	3.3	131-143	23	22.9	0.98	21.0-23.5	24	140	12.8	120-163	22
8 Joint Hill	21.8	1.19	20.5-23.0	4	136	2.9	130-137	4	20.7	1.53	19.0-22.0	3	152	24.0	135-169	2
9 Mt Barnett	21.8	0.98	20.0-23.2	18	137	3.9	131-145	18	22.8	0.94	21.0-24.5	18	146	10.1	135-169	18
10 Durack Range	21.7	1.56	19.0-24.0	9	134	2.1	132-137	9	21.0	1.24	19.0-23.0	9	127	12.6	115-145	8
11 Wyndham	21.6	1.20	20.0-23.5	6	134	5.0	128-141	6	21.7	0.52	21.0-22.0	6	136	16.9	110-155	5
12 Kununurra	21.1	0.97	19.5-23.0	23	132	3.6	122-136	25	21.8	0.79	20.6-23.0	24	129	11.5	105-151	22
13 Spencer Range	20.7	0.87	19.5-22.5	13	130	4.2	122-136	14	22.0	1.07	20.5-24.0	14	127	7.2	117-141	14
14 Jasper Gorge	21.1	0.56	20.3-22.0	10	130	2.8	125-133	10	21.4	0.69	20.5-22.5	10	113	6.8	105-123	10
15 Victoria River District	20.5	0.78	19.0-22.2	21	130	2.8	124-134	21	21.2	0.62	20.5-22.5	20	119	9.2	103-142	20
16 Dee River	21.0	0.62	19.9-21.9	13	135	2.9	130-140	14	22.0	0.64	20.9-23.3	14	134	8.6	120-146	14
Chestnut-quilled																
17 Katherine Gorge	21.2	1.06	20.0-22.0	3	141	5.0	136-146	3	22.8	0.58	22.5-23.5	3	148	16.1	136-166	3
18 UDP Falls	22.0	0.55	21.4-23.0	12	144	4.3	137-154	14	23.7	0.70	22.5-25.0	14	160	14.0	130-174	14
19 Nourlangie	21.6	0.85	20.5-23.0	11	143	4.2	136-149	11	23.5	0.77	22.5-24.5	11	159	18.3	130-194	11
20 Mt Brockman	21.6	0.89	20.3-23.4	28	144	3.6	139-151	29	23.5	1.09	20.0-25.0	26	161	11.4	137-186	29

(Localities combined as in Table 1)

APPENDIX

Body colour and size of the wing patch of White-quilled Rock Pigeons

Locality	Back Colour				Belly Colour				Wing Patch							
									Index I_1				Index I_2			
	x^1	S^1	Range[2]	N	x^1	S^1	Range[2]	N	x	S	Range	N	x	S	Range	N
1 Theda	0.69	0.16	2-3	8	0.40	0.44	1-3	8								
2 Kalumburu	0.69	0.18	2-3	11	0.68	0.45	1-3	11	20.44	3.04	14.93-26.25	11	1.46	1.23	0-3.37	11
3 Mitchell Plateau	0.72	0.20	2-3	5	0.44	0.40	1-2	5								
4 Prince Regent	0.92	0.25	2-3	3	0.83	0.17	2-3	3								
5 Yampi Peninsula	1.23	0.22	3-4	5	0.97	0.13	2-3	5								
6 Napier Downs	1.42	0.14	3-4	16	0.99	0.10	2-3	16	27.73	4.38	19.62-37.29	16	1.86	1.58	0-4.02	16
7 King Leopold Range	1.49	0.24	2-5	24	0.99	0.27	2-4	24	27.66	2.05	24.70-31.11	12	1.89	2.22	0-7.42	12
8 Joint Hill	1.07	0	3	4	0.88	0.17	2-3	4								
9 Mt Barnett	1.09	0.17	2-4	18	0.76	0.10	2-3	18	23.71	2.42	20.41-27.79	16	1.78	1.72	0-4.31	16
10 Durack Range	1.90	0.41	4-6	9	1.01	0.42	2-4	9								
11 Wyndham	1.76	0.23	4-5	6	1.05	0.51	2-4	6								
12 Kununurra	1.95	0.26	4-6	23	1.59	0.54	3-4	23	25.40	3.64	19.20-32.45	15	2.62	1.54	1.46-6.74	15
13 Spencer Range	1.24	0.21	3-4	14	1.01	0.08	2-3	14	23.40	4.89	14.01-29.20	13	2.82	2.44	0-7.82	13
14 Jasper Gorge	2.48	0.20	5-6	10	1.75	0.49	3-4	10	0	0	0	10	1.55	2.35	0-6.04	10
15 Victoria River District	2.21	0.32	5-6	21	1.72	0.50	3-4	21	0.33	1.53	0-6.99	21	3.04	3.95	0-12.97	21
16 Dee River	1.47	0.17	3-5	14	1.45	0.55	2-4	14	27.62	4.08	20.77-32.60	9	0.45	0.70	0-2.02	9

(Localities combined as in Table 1)

[1] Calculated after conversion of scores to normal deviates.

[2] Actual scores.

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Rec. West. Aust. Mus., 1979, 8 (1)

FIVE NEW LIZARDS FROM WESTERN AUSTRALIA

G.M. STORR*

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ABSTRACT

A gecko *Diplodactylus rankini*, a pygopodid *Aprasia rostrata fusca* and three skinks *Ctenotus colletti rufescens, Lerista christinae* and *Notoscincus butleri* are described as new.

INTRODUCTION

The entire type series of three of these taxa were collected during fieldwork in the Exmouth Gulf region, carried out for the Western Australian Museum by Messrs T.M.S. Hanlon, D. Knowles, G. Barron and G. Harold and financed by grants from Mr and Mrs W.H. Butler.

GEKKONIDAE

DIPLODACTYLUS RANKINI SP. NOV.

Holotype

R61474 in Western Australian Museum, collected on 7 December 1978 by Messrs G. Harold and G. Barron at mouth of Yardie Creek, Western Australia, in 22°20′S, 113°48′E.

Diagnosis

A member of the *D. strophurus* group (Kluge, 1967: 1031) generally intermediate between *D. spinigerus* and *D. strophurus*. Distinguishable from *spinigerus* by absence of spines and of black vertebral stripe, and from

* Department of Ornithology and Herpetology, Western Australian Museum, Francis Street, Perth 6000.

strophurus by restriction of dorsal tubercles to a dorsolateral series (rather than scattered over entire width of back) and absence of narrow, partly concealed bands of yellowish skin on tail.

Distribution

Upper west coast of Western Australia. Active at night in trees and shrubs on white coastal dunes.

Plate 1: Holotype of *Diplodactylus rankini* photographed in life by G. Harold.

Description

Snout-vent length (mm): 47-63 (N 11, mean 56.1). Length of tail (% SVL): 61-67 (N 7, mean 64.0).

Rostral pentagonal, 2.2-3.3 (2.7) times as wide as high; median groove extending down 20-100% of scale. Nostril surrounded by first labial, rostral, two supranasals and one or two postnasals. Anterior supranasals much the larger and separated by 1-3 (2.1) scales; posterior separated by 4-6 (5.1) scales. Interorbitals 20-27 (23.5). No supraciliary (or other) spines. Upper labials 8-10 (N 11, mean 9.0) back to level of eye. Dorsal scales moderately large, juxtaposed and homogeneous except for a sparse dorsolateral series of slightly larger and higher scales. Dorsolateral tubercles on tail more regularly located and a little higher than those on back, each tubercle on same whorl as its opposite number and separated from it by 3 scales which are a little higher than other non-tubercular supracaudals (in *D. spinigerus* the dorsolateral spines are separated by 4-6 granules which are not differentiated from other supracaudal granules). On each side of five specimens 4-6 (5.0) preanal pores and 3 large cloacal spurs; no pores or spurs in other specimens (presumably female). Under fourth toe 4 or 5 (mostly 4) large transverse lamellae, followed proximally by 1-3 (mostly 2) rows of two circular scales.

Upper parts pale grey, becoming darker on snout and lips. Under parts greyish white.

Remarks

Named in memory of Peter Rankin, whose death in New Caledonia in January 1979 tragically cut short what promised to be a brilliant career in systematic herpetology.

Paratypes

North-west Division (W.A.): mouth of Yardie Creek (61171-3, 61482); Ningaloo (61407-10); Point Cloates (15220); Coral Bay (31940).

PYGOPODIDAE

APRASIA ROSTRATA FUSCA SUBSP. NOV.

Holotype

R61077 in Western Australian Museum, collected on 14 December 1978 by Messrs T.M.S. Hanlon and D. Knowles at 3 km NW of Bullara, W.A., in 22°40′S, 114°02′E.

Diagnosis

A narrow-headed long-snouted member of the *A. repens* superspecies, distinguishable from *A. rostrata rostrata* by its much darker coloration (especially of lateral and ventral surfaces), from *A. haroldi* by 5 (rather than 4) upper labials, and from *A. repens* by 14 (rather than 12) rows of midbody scales.

Distribution

The Exmouth Gulf region of Western Australia, in both the white dunes along the coast and red dunes further inland.

Description

Snout-vent length (mm): 75-107 (N 4, mean 89).

Scutellation as in *A. r. rostrata,* as exemplified by the paratype (the holotype of *A. rostrata,* figured by Kluge (1974:64), is freakish.)

Head pale brown, variegated with black or dark brown. Back brownish white with 4 black or blackish brown lines (passing through centres of paravertebral and laterodorsal scales), the central pair finer and less continuous than the outer. Scales on sides of body whitish, broadly edged and centrally streaked with black or blackish brown, so that flanks could be described as blackish with whitish elliptic spots. Tail dorsally and laterally pale buffy yellow with about 10 dark brown lines, each passing through centres of scales. Under head and body brownish white, densely flecked with dark brown. Under tail pale yellow. Regenerated tail pale buffy yellow clouded with dark brown.

Paratypes

North-west Division (W.A.): mouth of Yardie Creek (61454); 3 km NW of Bullara (61078-9).

SCINCIDAE

CTENOTUS COLLETTI RUFESCENS SUBSP. NOV.

Holotype

R61152 in Western Australian Museum, collected by Messrs T.M.S. Hanlon & D. Knowles on 13 December 1978 at 3 km E of Giralia, Western Australia, in 22°41′S, 114°23′E.

Diagnosis

Differing from *C. c. colletti* and *C. c. nasutus* by its longer appendages, the upper lateral zone splitting into two dark stripes on temples, and the foreback suffused in life with red. It agrees with *C. c. colletti* in dorsal pattern but, like *C. c. nasutus,* it has contiguous prefrontals and fewer midbody scale rows.

Distribution

Red sand-ridges in the vicinity of Exmouth Gulf, Western Australia.

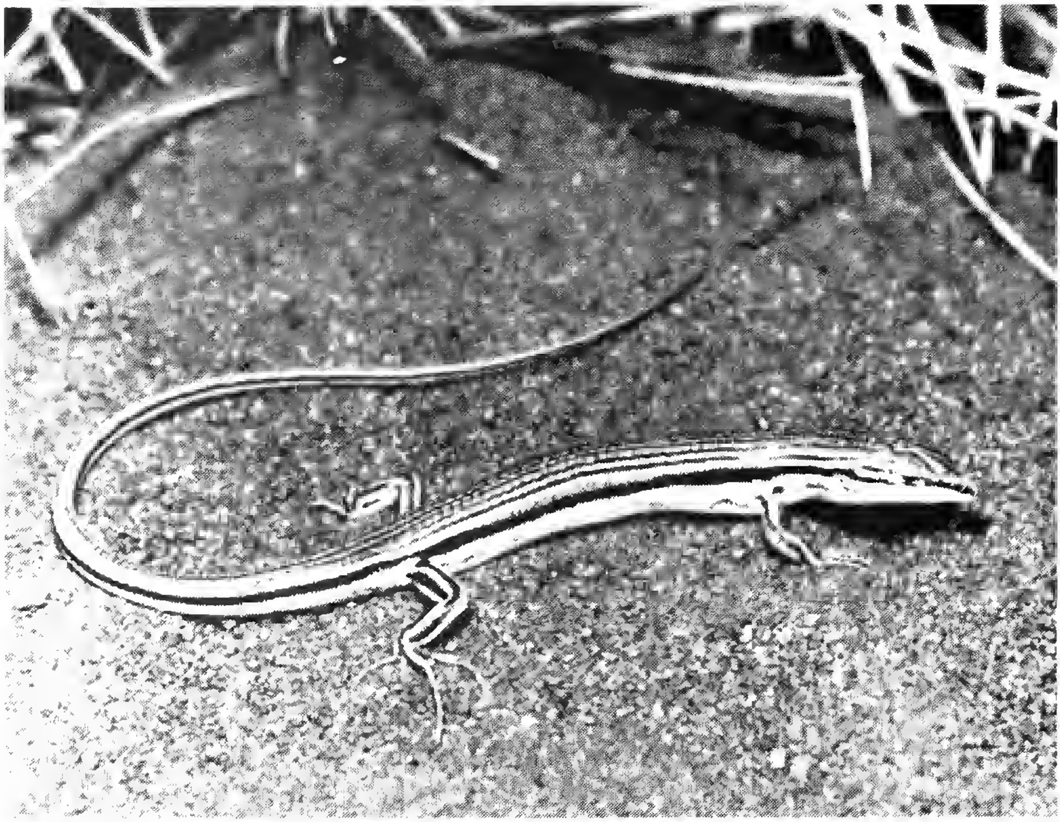

Plate 2: Holotype of *Ctenotus colletti rufescens* photographed in life by T.M.S. Hanlon.

Description

Snout-vent length (mm): 29-43. Length of appendages (% SVL): foreleg 28-30, hindleg 46-50, tail 239-244.

Nasals in contact or very narrowly separated. Prefrontals in contact. Supraoculars 4, first 3 in contact with frontal, first very wide. Supraciliaries 6 (5 on one side of one specimen). Palpebrals (*recte* upper ciliaries) 8-10. Presuboculars 2. Upper labials 7 (8 on one side of one specimen). Ear lobules 1-3 (mostly 2, first very large and very obtuse). Nuchals 3-5. Midbody scale rows 23-24. Lamellae under fourth toe 23-26, each with a fine, very weak keel (keels weakest or absent on proximal lamellae).

In spirits dorsally pale brown with 7 narrow dark brown or blackish stripes, the outermost (laterodorsal) and central (vertebral) being widest and darkest and extending well on to tail, the other pair on each side fusing just behind hindleg and fading soon after. Dark brown spots and streaks on head, the most prominent a median streak from back of frontal to centre of frontonasal.

Whitish dorsolateral stripe narrow. Upper lateral zone blackish brown, extending back nearly to tip of tail (on which it becomes paler and narrower), and splitting on temples into two stripes which fuse in front of orbit to form a single loreal stripe which joins its opposite number on tip of snout. White midlateral stripe wide. Narrow brown ventrolateral stripe passing forward (after wide break at ear aperture) through centre of upper labials. Three brown longitudinal stripes on upper surface of limbs, widest and darkest on hindlegs.

Paratypes

North-west Division (W.A.): Vlaming Head (60950); 3 km E of Giralia (60994).

LERISTA CHRISTINAE SP. NOV.

Holotype

R59022 in Western Australian Museum, collected by Miss Christine Davidge in November 1977 in heath 22 km S of Badgingarra, Western Australia, in 30°33′S, 115°26′E.

Diagnosis

A slender *Lerista* with digits 4 + 4 and eyelid immovable. Similar in scutellation to *L. elegans* but much more boldly patterned (back and sides whitish with 6 black longitudinal stripes).

Distribution

Only known from a sandplain 160 km NNW of Perth.

Description (based on holotype, the only available specimen)

Snout-vent length (mm): 34.5. Length of appendages (% SVL): foreleg 18, hindleg 32, tail 130, snout to foreleg 35.

Nasals in contact. Prefrontals widely separated. Frontoparietals in long contact, smaller than interparietal. Supraoculars 3, first two in contact with frontal. Supraciliaries 4, first three subequal, last much the smallest. Temporals 3, upper secondary much the largest, lower secondary much the smallest. Upper labials 6. Midbody scale rows 16. Lamellae under longest toe (third) 16/17.

Ground colour of head pale olive grey, of back very pale olive grey (almost white), and of tail very pale brownish grey. On each side a moderately wide

Plate 3: Photograph of holotype of *Lerista christinae*.

black paravertebral stripe from nape to base of tail, extending to head and middle of tail in a series of short ill-defined blackish brown dashes. Wide black upper lateral stripe from eye to base of tail, continuing forward as a narrowing stripe through lores to side of rostral, and back as an irregular series of blackish brown dots to middle of tail. Broad white midlateral stripe from upper lips to base of tail. Narrow black lower lateral stripe from a little in front of foreleg to a little behind hindleg. Limbs pale greyish brown, variegated with blackish brown. Under toes greyish brown; rest of under parts white, becoming buffy under tail.

NOTOSCINCUS BUTLERI SP. NOV.

Holotype

R61518 in Western Australian Museum, collected by Mr W.H. Butler on 10 January 1979 at 30 km SSW of Dampier, Western Australia, in 20°55′S, 116°39′E.

Diagnosis

A relatively large and stout *Notoscincus* whose colour pattern consists almost wholly of bold, dark and pale longitudinal stripes. Further differing from both subspecies of *N. ornatus* by more numerous midbody scale rows and absence of olive tone to dorsum.

Distribution

Only known from a single locality in the Pilbara region, north-western Western Australia.

Description (excluding characters listed for genus by Storr, 1974)

Snout-vent length (mm): 34-42 (N 9, mean 37.0). Length of appendages (% SVL): foreleg 24-29 (mean 26.9), hindleg 39-44 (41.7), tail 170-181 (N 3, mean 176).

Nasals moderately to narrowly separated. Prefrontals in medium to long contact. Supraciliaries 6. Nuchals 1-4 (2.9). Ear lobules 2-4 (small, first largest, usually extremely obtuse). Midbody scale rows 28-32 (29.8). Lamellae under longest toe 22-24 (23.0), divided.

Dorsal and lateral ground colour dark brown. Back and sides with 8 subequally wide pale stripes: on each side a pale brown paravertebral and

Plate 4: Photograph of holotype of *Notoscincus butleri*.

dorsolateral and a whitish midlateral and ventrolateral; midlateral extending forwards over lips to just beyond orbit and backwards nearly to tip of tail. Dark vertebral stripe usually represented on tail by a series of large spots, and laterodorsal usually by small spots. Limbs whitish with dark brown markings taking form of vague longitudinal streaks or series of spots.

Remarks

Named after its discoverer, W.H. Butler, M.B.E., Honorary Associate and generous benefactor of the Western Australian Museum. The type series was collected under an old Wedge-tailed Eagle's nest that had fallen from a bloodwood. The litter under adjacent bloodwoods was unsuccessfully searched for more examples of this skink (W.H. Butler, pers. comm.).

Paratypes

North-west Division (W.A.): 30 km SSW of Dampier (61510-7).

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CTENOTUS GREERI, A NEW SCINCID LIZARD FROM WESTERN AUSTRALIA

G.M. STORR*

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INTRODUCTION

In October 1975 Dr A.E. Greer of the Australian Museum collected seven specimens of a strange *Ctenotus* on the Warburton-Rawlinna track through the Great Victoria Desert. He kindly sent them to me for description, but I was unable to convince myself that they were not a peripheral variant of *C. leonhardii.*

In March 1979 the Biological Survey of the Western Australian Museum collected eight specimens of a skink that was very like Dr Greer's and almost certainly conspecific with it. However the Biological Survey obtained at the same locality a series of *C. leonhardii* (and of *C. uber*), which proved the distinctness of the strange skink. I name this skink after Dr Greer in recognition of his many contributions to the classification of the Scincidae.

CTENOTUS GREERI SP. NOV.

Holotype

R65980 in Western Australian Museum, collected by the Biological Survey of the Western Australian Museum on 22 March 1979 at 9 km S of Mt Linden, W.A., in 29°24′S, 122°20′E.

Diagnosis

A member of the *Ctenotus leonhardii* species group, very like *C. leonhardii* but with fewer midbody scale rows, wider vertebral stripe and a dorsolateral

* Department of Ornithology and Herpetology, Western Australian Museum, Francis Street, Perth, W.A. 6000.

series of white dots or short dashes. Distinguishable from *C. uber* by well-developed midlateral and vertebral stripes.

Distribution

Known from two widely separated localities in the arid south-eastern interior of Western Australia.

Description

Snout-vent length (mm): 43-51 (N 8, mean 48.0). Length of appendanges (% SVL): foreleg 27-30 (N 6, mean 28.8), hindleg 46-53 (N 7, mean 49.4), tail 184-228 (N 5, mean 204.0).

Nasals in short contact or narrowly separated. Prefrontals usually narrowly separated (in contact in two specimens). Supraoculars 4, first three in contact with frontal. Supraciliaries usually 7, occasionally 8. 'Palpebrals' (upper ciliaries) 10-12 (N 6, mean 11.0). Second loreal 1.3-1.8 times as wide as high (N 7, mean 1.51). Presuboculars 2. Upper labials 8. Ear lobules 5-7 (N 6, mean 5.7,

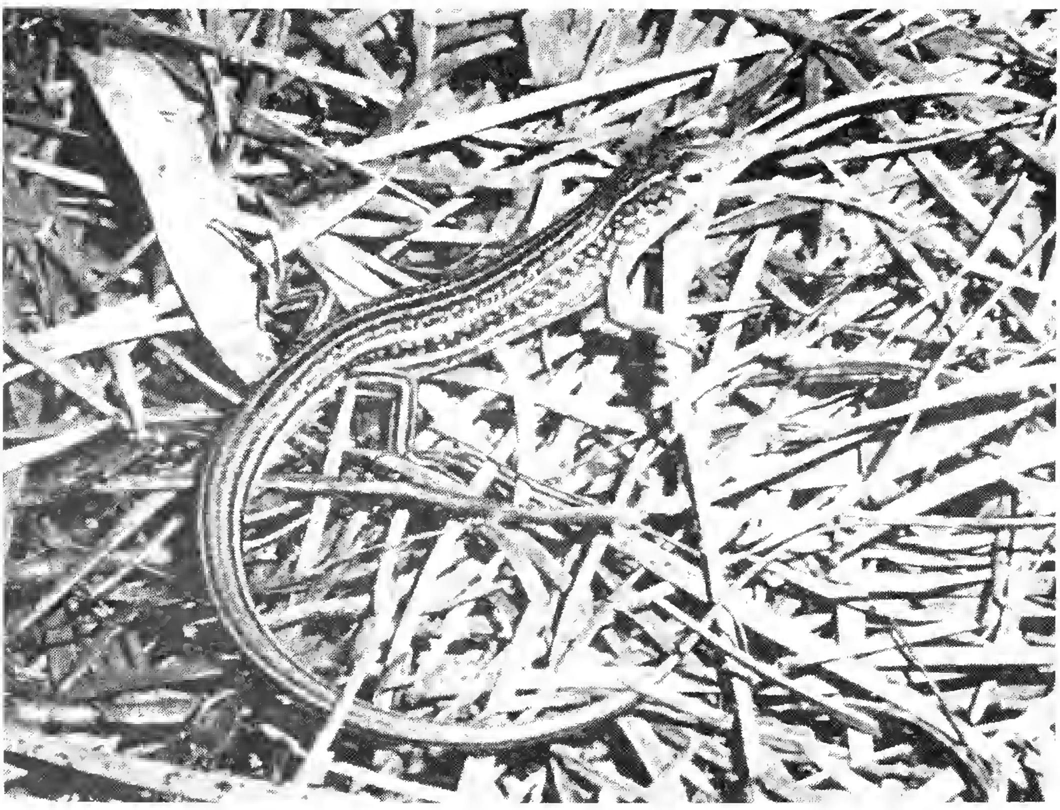

Plate 1: A paratype of *Ctenotus greeri* from Mt. Linden, photographed in life by G. Harold.

obtuse or subacute, third usually largest). Nuchals 2-4 (N 7, mean 3.3). Midbody scale rows 24 or 26 (N 7, mean 25.2). Lamellae under fourth toe 23-27 (N 6, mean 24.5), each with a narrow callus or obtuse keel.

Ground colour of back and sides very dark brown, becoming paler and more reddish on head and neck and much paler on tail. Wide blackish brown vertebral stripe from nape to base of tail, edged by white paravertebral line (which on tail becomes buffy and broader and soon merges with its opposite number). A dorsal series of white dots or short dashes between paravertebral and dorsolateral lines. White dorsolateral line from above temples to tail, on which it becomes buffy and broader. Upper lateral zone enclosing a series of white dots. Narrow white midlateral stripe well developed posteriorly but breaking up into a series of short dashes between foreleg and ear aperture. Limbs longitudinally striped with dark brown.

Geographic variation

The above description is based on the Mt Linden series. Dr Greer's specimens from Cooper Creek differ in having more midbody scale rows (26 or 28, N 7, mean 26.6), fewer nuchals (1-4, N 7, mean 2.2), fewer ear lobules (4-6, N 7, mean 5.0), paler ground colour, brownish white paravertebral line and laterodorsal dashes, and midlateral stripe anteriorly wavy and not breaking up into short dashes. The Cooper Creek specimens are larger (61-65, N 7, mean 62.2), but they could be older judging from their sharper ear lobules. Possibly due to their age the Cooper Creek specimens have relatively longer tails (218-240, N 6, mean 225) and shorter limbs (foreleg 24-26, N 7, mean 25.2; hindleg 46-49, N 7, mean 47.4).

Remarks

Dr R. How of the Biological Survey tells me that the Mt Linden series was obtained on red loamy sand vegetated with mulga, mallee and spinifex. The Cooper Creek specimens inhabited the ecotone between the watercourse flats and the surrounding spinifex and shrubbery; Dr Greer also collected *Amphibolurus isolepis*, *A. scutulatus*, *Ctenotus helenae*, *C. schomburgkii* and *Menetia greyii* at this locality.

For descriptions of the closely related *Ctenotus leonhardii* and *C. uber* see Storr (1969).

Paratypes

Eastern Division: 9 km S of Mt Linden (WAM R65904, 65907-8, 65939-40, 65965, 65992); Cooper Creek (27°20′S, 126°21′E) (AM R49624-5, 49723, 70215-8).

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THE CONVICT-BUILT 'FENCE' IN THE CANNING RIVER

D. HUTCHISON*
and
DIANNE DAVIDSON†

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ABSTRACT

A long row of piles in sections of the Canning River has long been known as the 'Convict Fence'. In 1974 the Canning Town Council applied to the Interim Committee for the National Estate for a grant to conserve the 'fence' or part of it. The Interim Committee made a grant to the Western Australian Museum to investigate the proposal. This paper is the result of research into conflicting claims about the origins of the 'fence'. That part of it was built by convicts in 1866 is demonstrated. However, owing to considerable reconstruction since, it is impossible to identify parts of the convict-built section which may survive.

INTRODUCTION

In 1973 the Canning Town Council proposed to increase the recreational use of the Shelley Basin, part of the Canning River. The Council commissioned the engineering firm of Halpern and Glick to report on dredging and reclamation work which might be necessary to improve the environmental and recreational qualities of the Basin. A feature of the Basin is a long chain of piles, long known as the 'Convict-built Fence'. The Canning Districts Historical Society had recommended in 1972 the retention and restoration of part of the 'fence', 'the middle section off both sides of Mum's Point', because of the historical significance of the structure. The Society also asked the Town Council if it would 'provide labour to assist, under the direction

* Senior Curator of History, Western Australian Museum, Francis Street, Perth W.A. 6000

† Temporary Graduate Assistant, Western Australian Museum

of the Canning Districts Historical Society or a Western Australian Museum representative, in the excavation and restoration of the remains of the "Fig Trees" convict camp on Mum's Point'. The National Trust of Australia (W.A. Branch) had also recommended retention of the fence on two grounds: its historical significance and its possible role in the ecology of the river. It had been claimed that the rotting piles provided havens for young fish.

In 1974 the Canning Town Council applied to the Interim Committee for the National Estate for a grant to conserve the 'fence' or part of it. Because there was opposition to the claim that the 'fence' was built by convicts, and because of doubts about the practicability of conserving the piles, the Interim Committee of the National Estate, on the recommendation of the Western Australian State Policy Group on the National Estate, made a grant of $5,000 to the Western Australian Museum. The grant was 'to assist with study of the means of restoration and preservation of a portion of the Canning River "Convict Fence", built during the 1860s, with a view to long-term re-erection of the old convict camp and establishing it as a local convict museum'.

Hutchison reviewed the evidence for the claim that the 'fence' was built by convicts in the 1860s or 1870s, including the booklet published by the Canning District Historical Society, Occasional Paper No. 1, n.d. He reported that, although there was prima facie case for preservation of the 'fence', further research was necessary, Davidson (formerly Sholl) was appointed as temporary graduate assistant in the History Department of the Western Australian Museum to conduct this research. Her appointment was funded by the I.C.N.E. grant. The reports by Hutchison and Sholl were distributed to interested parties and were also published as a booklet by the Riverton Library (Sholl & Hutchison, 1977).

THE CASE FOR PRESERVATION OF THE 'FENCE'

The case for preservation of the 'fence' was based primarily on the researches of members of the Canning Districts Historical Society into the history of the Mason and Bird Timber Company. This was an enterprise which played a major role in the early settlement of the Canning Districts. Mason, who started his business in 1862, transported logs from his saw mill to Mason's Landing on the Canning River. Shallow-draught barges carried the timber down river. They were poled through the shallows to the deeper water near Salter's Point, there to be taken in tow by a steamer for transport to Fremantle. In summer time even the shallow-draught barges often grounded in the shallows and Mason found it difficult to meet export contracts. He conceived the idea of employing convict labour to dredge a channel in the shallow section between Mason's Landing and the deeper water downstream.

The Governor approved the plan and capital was obtained by Mason entering into partnership with Francis Bird. It appeared that the channel was dredged in 1872, but this was not substantiated fully by research. Davidson's research shows that a section of the 'fence' was first erected in 1866.

It was claimed that the 'fence' was needed to hold back mud thrown up by the channel-diggers. The term 'fence' was really a misnomer, 'barrier'[1] being more appropriate. If the structure or a section of it is retained it is hoped that the term 'barrier' will be used in future. The 'fence' was reported to have been constructed of jarrah poles backed by casuarina logs and boughs felled on the nearby banks. The tops of the piles were linked by a 10 cm x 10 cm planking, but no trace of the planking remains. Insufficient evidence was produced for these claims, and no accounts of the methods of construction were reported.

Halpern and Glick (1975) were sceptical of these claims and commented:

> The report goes on to say that the prisoners were required to form a channel along-side the fence by digging mud up in buckets and throwing it over the fence. If this report is correct the fence is a memorial to one of the grosser acts of inhumanity of pioneer days.
>
> An attempt by a member of the Consultant's staff (an English migrant) to move mud with a bucket proved that even with the inducement of an overseer's whip his daily output would have been negligible. Working conditions would have been intolerable since there is 3 ft of water over most of the mud even at low tide and the bottom is too soft to walk on.
>
> A merchant as astute as Mr Mason could easily have found out that a dredge called a 'mud mill' was powered by men walking a treadmill in Holland in the 16th Century and that similar bucket dredges driven by man-power (and later by horses) were in use throughout Europe until men and horses were replaced by the steam engine. He would not have wasted rations on convicts dabbling in the mire. It seems much more likely that the posts were driven to support a walk-way for men pulling tow ropes or to provide purchase for the barge hands to pole the boat along. Punt poles would obviously not work in the mud. An old photograph shows a plank walk-way fixed to the top of the posts.
>
> The prisoners did excavate a channel through sand at the northern end of Mum's Point. The channel was filled by the 1965 reclamation but the trees which grew on the spoil banks on either side are still there.
>
> It is reported that the dredge the 'Black Swan' arrived in the basin about the same time as the 'Convict Fence' was built but there is no evidence that it did any useful work. The wreck of barge is still against the fence.

Hutchison (Sholl & Hutchison, 1977) claimed that 'the suggestion that men with tow ropes walked along this walk-way is less convincing than the

[1] However, the use of the term 'fence' during the construction of it may justify the retention of this name.

use of the barrier to provide purchase for poling the barges'. It is doubtful if the 10 cm x 10 cm planking, given the span between piles, would have provided a firm enough platform for men to walk along towing barges. Hutchison also averred that 'historical archaeological research could verify whether casuarina logs and boughs were laid behind the piles. He suggested that the barrier may have been built to encourage scouring of a channel by winter flow. The use of the 'fence' to encourage scouring was in fact suggested by Mason, as will be shown. It was at least partially successful for this purpose.

It had been reported that there were plans in the Public Works Department showing that the barrier had been erected by that Department in 1897. Although the various claims and counter-claims had not been verified by research to that date, Hutchison suggested that the historical significance of the 'fence' rested on several factors:

1 It was part of a major enterprise in the early period of Canning Districts settlement,

2 It appeared to be a unique civil engineering structure from the colonial period,

3 The association of the fence with the convict period, and

4 It was a visual reminder of the importance of river barge transport in the nineteenth century.

Davidson was therefore commissioned to try to determine:

1 Whether the so-called 'fence' or 'barrier' in the Canning River was in fact erected by convict labour and, if so, when.

2 Whether the existing piles were erected by the Public Works Department at a later date, and, if so, whether any of the existing piles were part of any original convict-built structure.

3 Whether, if the convicts were employed on the original structure, sites of convict encampments could be identified.

Supplementary to these main enquiries Davidson was also asked to determine whether information could be discovered about the material and methods used in the construction of the 'fence'.

ORIGIN OF THE 'FENCE'

The history of the Canning River barrier is very closely linked with the development of the Canning Districts. The early 1860s saw the establishment of a timber industry on the banks of the Canning, and this development led to special attention being given to the navigability of the river. Between

Salter's Point and Mason's Landing the river was very shallow, especially in summer; barges carrying timber for export frequently got stuck on the sand banks and failed to connect with the steam tugs which were waiting to take them in tow at Mt Henry where the water was deeper.

In December 1863 George Randell, owner of a steamboat service which provided transport between Perth and Fremantle, wrote to the Colonial Secretary complaining about the condition of the Canning, and persuaded the Government to send out a party of convicts to excavate some of the sand and mud which had collected in the river (CSLS 19/1/1864: 1350). However, after a little more than a year sand and mud banks were interfering with river traffic once more. In March and April 1865 letters appeared in the *Inquirer* newspaper from George Randell and Benjamin Mason, proprietor of the recently established Mason Timber Company on the Canning. These letters set out in detail the trading problems which timber dealers faced because of shipping difficulties caused by the condition of the river, and requested the Government to take immediate steps to ensure that the Canning remained navigable throughout the year (*Inquirer* 15/3/1865, letter from B. Mason; 5/4/1865, letter from G. Randell). In August 1865 Mason followed this up with a letter to the Colonial Secretary repeating their request for Government action. F.P. Barlee, the Colonial Secretary, replied on 21 September 1865:

> With reference to your letter of the 30th ultimo in regard to improving the navigation of the Canning River, I am directed to inform you that it is not intended, in the first instance, that the Government shall do more than perform the work mentioned hereafter, such work to be commenced about the middle of next month, viz.
>
> To stop the upper mouths of the Channel round the several small Islands, and throw all the water into the main Channel, whereby the current in winter would be strengthened, and the Channel in summer would to a certain extent be deepened.
>
> To clear a sufficient width for summer traffic by means of scoop or otherwise, and to cut the oyster beds deeper and wider; and
>
> To clear the River of snags and branches as far as Hester's Rapids, to which point there is an abundance of water.
>
> (CSLS 21/9/1865: 426)

Apparently these interim measures were not satisfactory. By late 1866 silt had accumulated in the river again to such an extent that navigation was completely stopped. This time the Government was evidently prepared to do some construction work in the river as well as having the channel dug out yet again. Unfortunately a crucial letter from Benjamin Mason and George Randell, which apparently contained detailed suggestions about the nature of the construction work which they felt needed to be undertaken, is missing from the Colonial Secretary's letterbook, although its receipt on 15 September 1866 was noted in the Correspondence Register. (CSOCR, 1866)

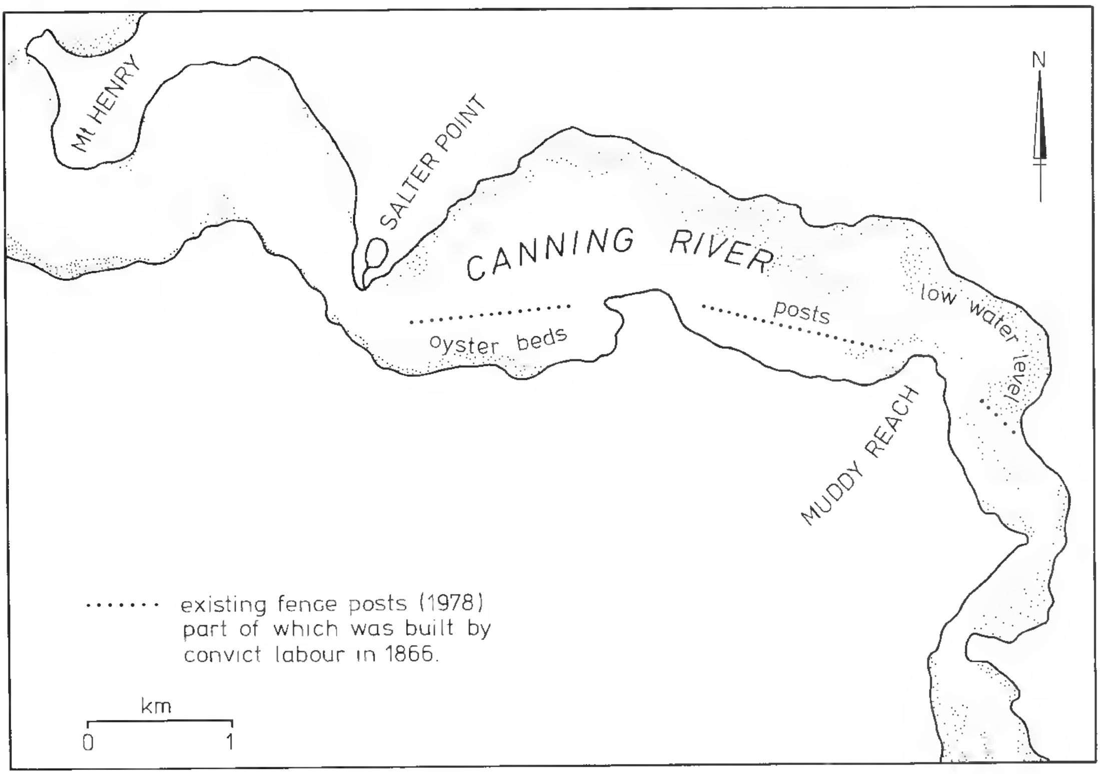
The letter is important because the suggestions outlined in it by Mason and Randell were approved by the Governor and the Clerk of Works of the Convict Department was instructed to proceed with the work. In the absence of this letter no clear details of the work are available other than that a convict party was sent to the Canning River and ordered to start preparing stakes and wattling. (CR 1867, C. 2: 197, 199, 219, 227, 248)

However, some idea of the nature and location of the work performed by this convict party can be gained from later correspondence between the Colonial Secretary, Benjamin Mason and George Randell. On 26 August 1869 Mason and Randell wrote to the Colonial Secretary referring to the work carried out in 1866:

> Sir:
>
> We the undersigned respectfully beg again through you to draw the attention of His Excellency the Governor to the State of the Canning River, so that some steps may be taken to facilitate the transit of Timber and other produce from the various stations South-East of Perth, the Sound road, and the Timber Stations in the darling range north of the Canning River.
>
> We are glad to observe the works executed thro the oyster beds and sand flat as far as they have gone answered expectations formed concerning them, and that the stakes driven in Muddy Reach have stood much better than could have been anticipated; but we now beg to call attention to sundry repairs which require to be effected in the wattling and the banks of the canals formed through the oyster beds and to the urgent necessity of wattling the lines marked out by stakes in Muddy Reach so as to confine the current of the river in narrower limits and also the necessity of deepening the Channel thus marked out in the shallower part of Muddy Reach.
>
> We earnestly trust you will urge upon his Excel^{cy} the Governor the great importance of the beforementioned works; from the fact that there are large orders for timber the greater portion of which will require to be brought by this route and should this fail or delays occur through these improvements not being effected, these contracts or a large portion of them at least cannot be complied with except at a loss.
>
> We therefore beg to request His Excellency the Governor will be pleased to direct the convict party may be at once placed at these works.
>
> We will be willing to render such assistance as may be in our power, such as the use of a boat for the conveyance of Stakes, Wattling etc. or the Steamer to agitate the Channel in Muddy Reach thus enabling the current confined as it will be by the Stakes and Wattling to carry the soil so disturbed into deeper water below.
>
> Should it be necessary to let the work by Contract we will be prepared to give all the assistance in our power.
>
> The work to be done in Muddy Reach will be about one mile of Wattling, repairing the Staking and strengthening at various places, and to continue it

> from its highest point to a point of the River known as Watts Point dredge this distance also and repair sundry beaches in the banks of the Canal and deepening lower portion of oyster beds.
>
> Hoping a favourable notice and reply.
>
> P.S. In the event of the government not being able to supply a convict party for the above work, we beg to annex an offer for its performance.
>
> (CSO 1869, Public Works)

It is clear from this letter that the convict party had erected stakes in the stretch from Muddy Reach to the oyster beds at least, and that the oyster beds section had also been wattled (see Map 1). (The location of Muddy Reach and the oyster beds was pointed out by Mr Charlie McIntosh, an 84-year-old resident of the Canning Districts.)



MAP 1

It can therefore be confidently stated that at least part of the 'fence' in the Canning River was originally built by convict labour in late 1866. However, the original structure, the precise dimensions of which are in any case not ascertainable, has undergone a great deal of repair and extension since it was first erected. As early as 1869 Benjamin Mason and George Randell were complaining about the state of navigation on the Canning, and pointing out that the existing fence had fallen into disrepair and needed attention. This time the Government decided against using convict labour to perform the work necessary, and called instead for tenders (*Government Gazette*, 31/8/1869). The successful contractors were Mason and Randell, who described the work they expected to carry out:

> Sir:
>
> We the undersigned would be willing to perform the following works for the improvement of the Canning River.
>
> Viz.
>
> To complete the Staking and Wattling already commenced in Muddy Reach from the land on the north side of the river, to the point shown us by the Clerk of Works, about one mile in length to agitate the mud to form a channel along the same to a depth of one foot by means of the steamer.
>
> To repair the breaches in the banks of canal at the oyster beds, and continue the staking and wattling down to Watts Point for the Sum of Two Hundred Fifty Pounds.
>
> (CSO, 1869, Public Works)

At least one other settler, Wallace Bickley, had found the 'fence' to be a mixed blessing. He wrote to the Colonial Secretary on 27 August 1869 (CSO 27/8/1869: 643):

> I have pointed out over and over again that the very method adopted and adhered to so pertinaceously [*sic*] by Mr Mason to improve the navigation cannot possibly have any other effect than that of impeding it, and even before the first stake was cut to wattle the Flats channel, I stated to Governor Hampton that the inevitable result of forcing the water and silt into one confined channel would be the formation of silt banks in those parts heretofore free.
>
> That this has been the result cannot be denied — year after year . . . Mischievous meddling has occurred, labor has been thrown away and money expended in the endeavour to remedy a blunder which no man with the slightest pretence to engineering skill would ever have perpetrated . . . I now beg most respectfully to protest against any continuation of the system which has already nearly destroyed the navigation of the river . . .

Barlee, the Colonial Secretary, inspected the works on September 9 and reported (CSO 9/9/1869: 643):

> We heard all Mr Bickley's objections and propositions, that work requires to be done is apparent from the fact that it was with the utmost difficulty we forced our way by steam power up the river in an empty flat bottomed steamer drawing only 12 inehes water . . .
>
> Mr Bickley did not seem to be fully aware of the extent of work already done. To carry out his plan (which, had no work been done, would be well worth consideration) would involve the undoing all hitherto done, and considerable outlay. This, looking at the fact that what is wanted is immediate possible

> transit up and down the river, did not meet any support, and it was thought better to continue the work in progress, which to a certain extent, has had a satisfactory result . . . It was arranged (subject, of course, to approval) that one half the portion [of stakes along 'Muddy Reach'] should be wattled, and the remaining portion not wattled, and that thus, some reliable information would be gained.
>
> The only contractors (Messrs Randell and Mason) whose tender is recommended, understood fully the alteration suggested, and bind themselves to wattle the portion not wattled at any time they may be called upon to do so.

Apparently by the end of 1872 more repairs were required, as floods had seriously damaged the wattling in the fence at Muddy Reach. In October of that year Mason, Bird & Co. wrote to the Colonial Secretary asking that convicts be sent to carry out this work, and in response to this request the Clerk of Works was despatched to report on the state of the fence and on navigation in the river generally (CSO 1872, Public Works). On his recommendation a party of convicts was despatched to the Canning on 10 December 1872 with the following instructions:

> Memo for guidance of the Warder in charge of the party on the Canning River.
>
> You will commence to deepen and widen the canals above Muddy Reach so as to open the passage for traffic as soon as possible.
>
> Also open the passage through the sand bank at the head of Muddy Reach.
>
> When these are opened you will cut stakes and wattle to repair the several gaps in the wattle fencing.
>
> After which you will alter the direction of the fencing at the head of Muddy Reach as will be pointed out to you, and extend the fencing at the lower end of the Muddy Reach giving more room to enter the channel.
>
> (CR 10/12/1872: C 9)

Yet another repair job on the 'fence' was found to be necessary in 1887-88, when a petition was forwarded to the Chairman of the Canning Roads Board by fifteen Canning settlers (the names of Benjamin Mason, his partner Francis Bird or George Randell do not appear on this petition). The Canning Roads Board duly arranged for this work to be carried out; sections of the 'fence' in Muddy Reach were again replaced and extra stakes were added and fastened with wire along the whole structure. This operation required 120 cart loads of wattling and 1,200 new stakes, so clearly the work was fairly extensive (CSO File 4019/87).

Finally, in 1892, the Public Works Department decided to carry out major dredging and structural work in the Canning River. The entire old channel was redredged and extended, and piles with spearwood wattling in between were erected to hold back the dredged river spoil. (Public Works Department Plans No. 3852 and 2653 show the extent of the new work as well as the position of the old piles in the river. See also Printed Papers, Reports, etc. of the Parliament, 1893-1897 Public Works Department Annual Statements of Work carried out.)

According to Public Works Department Plan No. 3852 the piles which were already in the river were to be incorporated into the new structure except for 'all old work in the way of new work' — unfortunately no more specific information is provided.

It seems clear that the old convict-built 'fence' in the Canning River does form part of the existing structure. Unfortunately it is not possible to identify precisely which sections of the present barrier were constructed by convicts in 1866 and which were added during the repairs of 1869 and 1887-88 when convict labour was not used; nor is it possible to discover just how much of the earlier structure was incorporated into the Public Works Department project of 1892-97.

METHODS OF CONSTRUCTION

There is virtually no direct information available about methods of construction employed in the erection of the posts, nor about materials used in the construction. Both the stakes and wattling seem to have been cut locally and taken out by boat to the point where they were to be installed, as indicated in the letter written by Mason and Randell to the Colonial Secretary in 1869 (see above).

Some information is available, however, on the nature of the work done by convicts to deepen the channel of the river. Documents contained in the Convict Records lodged with the State Archives indicate that convicts were required to stand waist-deep in water digging up the mud with spades and pitching it over to the shore side of the 'fence'. The following memorandum, for example, was forwarded by the Clerk of Works Office to the Warder in Charge of the Canning River convict party:

> 15th December 1873
>
> Warder Feltham, Canning River Party.
>
> Memorandum.
>
> In reference to the work to be done in clearing out the canals, repairing the wattle fencing, and deepening the various channels on the Canning River, the following instructions are forwarded for Warder Feltham's guidance.
>
> The entrance to the first canal from Mason's landing requires deepening, the silt in all cases to be put on the shore side of the fencing, and not left on the canal side; if possible, after the deepening has been done, the fence is to be carried on from the bed of shells on the right side ascending the river to the tuft of rushes near the entrance to the Blind Creek. Also remove all the

hummocks in the passage down the stream, and all the snags wherever they in any way impede the navigation, particularly at the spot where the boats were struck on Friday last. Also, deepen down to where the old flat is sunk, and renew the cross wattling near this spot, some of the fencing is also gone here and requires renewing. Deepen the sand bank between the two lines of fencing — in a work of this nature a great deal must be left to the discretion of the Officer in Charge; the Clerk of Works has full confidence in Warder Feltham employing his men to the best advantage.

The Clerk of Works has recommended that the men be allowed the extras usual for men working in the water, and a ration of tobacco, but not the same as the rations allowed on the dredge which is made special on account of the filthy nature of the stuff the dredge party is employed in removing.

(CR 1873, C 9: 973)

The arduous nature of the work involved was clearly recognized by Government officials. Even though tasks of this kind were allotted only to reconvicted prisoners who were generally treated with considerable severity, the Superintendent of Fremantle Prison, H.M. Lefroy, was moved to write to the Comptroller General requesting special treatment for the convicts employed on one of the earlier channel clearing assignments:

29.2.1864

Sir, I have the honor to submit that the party of Eight Reconvicted Prisoners Employed under Warder Corp in deepening the centre of the Channel of the Canning River be allowed a Ration of Tobacco each without deduction of any of their food on account of the same.

These men are working in the water the entire day frequently up to their Waist and from the nature of their work digging the mud up with spades their whole bodies must be wet the whole working day. This sort of work requires the support of a large quantity of food which is practically proved by these men having declined to take Tobacco on the regulated condition of a reduction of Bread being made on account of it. At the same time I think the constant immersion of the body in water creates a necessity for the support of a more stimulating ration than the ordinary Prison Ration and therefore that in such a case Reconvicted Prisoners should be allowed the ration of tobacco which is ordinarily allowed to Probation Prisoners.

(CR 1864, C 8: 397)

By the 1890s the lot of prisoners employed on channel clearing work had obviously improved. For the 1892-97 project the Public Works Department used a dredge, the *Black Swan* to deepen the channel. The work was still performed by prison labour, but evidently conditions were not nearly as primitive as they had been twenty or thirty years earlier. (PP 1896, No. 25)

CONVICT ENCAMPMENT SITES

There seems to be almost no evidence available to assist in identifying sites of convict camps, nor is any information to be found on the kinds of shelter used. The only reference to camp sites which could be located in the Convict Records relates to the 1872-73 repair job on the fence and mentions that 'This party will be encamped on the Perth side of the Canning at the head of a place called Muddy Reach near W. Thomas Saw's and distant from Perth about eight miles.' (CR 1873, C 42: 217)

This information seems rather puzzling, since Mr McIntosh's identification of Muddy Reach locates it on the other side of the river; although it is possible, of course, that the whole area was known in this early period as Muddy Reach. The reference to W. Thomas Saw seemed promising, but unfortunately the Lands and Surveys Department records held by the State Archives contain no reference to land owned by anyone of this name on the banks of the Canning.

CONCLUSION

On the evidence currently available there appears to be little justification for regarding the entire 'fence' or barrier in the Canning River as a genuine relic of the convict era, in view of the extensive repairs and additions made to it since it was originally erected in 1866. It is possible that there may still exist some sections of the work carried out by convicts. The barrier constitutes an important part of the history of the Canning Districts, however, since its erection and maintenance were obviously matters of great and continuing interest and concern to the settlers on the Canning throughout the last half of the nineteenth century.

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Convict Records (CR in text] :

Vol. C 2: Letterbook — Comptroller-General to various officials, 2 June 1866-24 February 1867 (Battye Library Accession no. 1156)

Vol. C 8: Letterbook — Superintendent of Fremantle Prison to Comptroller-General, 3 October 1861-9 July 1865 (Battye Library Accession no. 1156)

Vol. C 9: Clerk of Works Letterbook 17 November 1871-30 June 1874 (Battye Library Accession no. 1156)

Vol. C 42: Comptroller-General to various officials, 11 March 1872-27 November 1873 (Battye Library Accession no. 1156)

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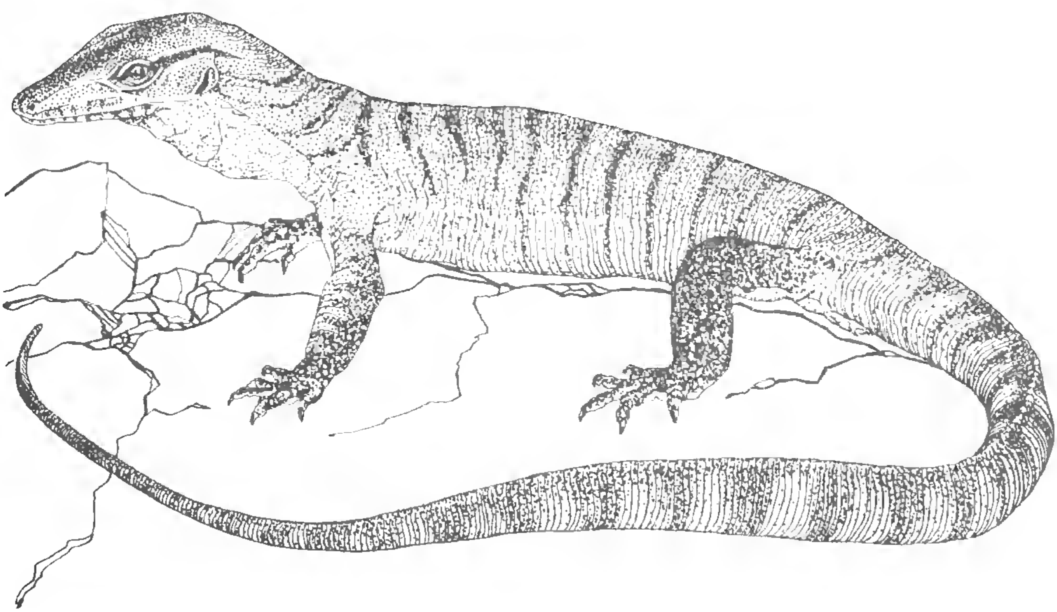

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TAPHOZOUS HILLI SP. NOV. (CHIROPTERA: EMBALLONURIDAE), A NEW SHEATH-TAILED BAT FROM WESTERN AUSTRALIA AND NORTHERN TERRITORY

D.J. KITCHENER*

ABSTRACT

A new species of sheath-tailed bat is described from the Murchison, Pilbara and Gibson Desert regions of Western Australia, and from the vicinity of Tennant Creek, Northern Territory. It is distinguishable from other Australian species of the genus *Taphozous* on the basis of cranial and dental morphology.

INTRODUCTION

Troughton (1925) placed the Australian emballonurids in the genera *Taphozous* and *Saccolaimus.* This was primarily on the basis that *Taphozous* had well developed radio-metacarpal pouches, incomplete antero-internal sides to auditory bullae, outline of the mandible markedly concave beneath premolars, and upper anterior premolars small and not acutely cusped; *Saccolaimus* had no wing pouches, or rudimentary ones, complete auditory bullae, outline of mandible convex beneath premolars, and upper anterior premolars large and acutely cusped. At that time Troughton recognised the following five species of emballonurids in Australia: *Taphozous georgianus* Thomas, 1915; *T. australis* Gould, 1854; *Saccolaimus flaviventris* (Peters, 1867); *S. mixtus* Troughton, 1925 and *S. nudicluniatus* (De Vis, 1905). Tate (1952) reviewed this classification and relegated *Saccolaimus* to a subgenus of *Taphozous*, while still recognising the same species as Troughton. In addition he described another species, *Taphozous troughtoni.* However, Tate examined the female holotype of *T. georgianus* but could find no distinctly differing measurement; he therefore questioned whether *T. georgianus* differed in any substantial way from *T. australis.* Johnson (1964) also considered the possibility that *T. australis* and *T. georgianus* were merely geographic races of one species. McKean and Price (1967) examined this suggestion and concluded that *T. australis* could be distinguished from *T. georgianus* by the presence of a gular pouch in males and a naked area and

* Western Australian Museum, Francis Street, Perth, Western Australia 6000

rudimentary edge on the gular region of females. Hill (in litt.) also confirms these and certain other differences in cranial features between *T. georgianus* and *T. australis* recognised earlier by Troughton (1925). McKean and Price considered that while *T. georgianus* had a wide tropical distribution, *T. australis* was restricted to New Guinea and north coastal Queensland; they also tentatively decided that *T. troughtoni* should be retained as a race of *T. georgianus.* Ride (1970) recognised the same five species of *Taphozous* as Troughton (1925) and Tate (1952), with the exception that he followed McKean and Price in not recongising *T. troughtoni* as a full species. Recently J.L. McKean and G.R. Friend have prepared a description, as yet unpublished, of a new species of *Taphozous* from the Northern Territory.

Of the species of *Taphozous* (*sensu stricto*), only *T. georgianus* has been recorded in Western Australia where gular pouches are sometimes reported in males of the species (Ride, 1970). Previously, I had examined specimens of this subgenus in Western Australia as a prelude to the reproductive studies reported in Kitchener (1973, 1976). There were some skull differences between the most southern of the Western Australian populations at Tallering Peak and Murgoo, and those from the Pilbara and Kimberley regions of the State. I concluded that these skull differences represented geographic variation within *T. georgianus* and could find no consistent differences in external measurements. Recently while removing skulls from *Taphozous* I discovered a northern specimen with southern skull characteristics; this came from the same locality (Tambrey Homestead) as specimens with skull characteristics typical of the Pilbara and Kimberley populations. This discovery indicated the need for a re-examination of specimens belonging to the subgenus *Taphozous* in the collections of the Western Australian Museum.

The subsequent recognition of two forms of *Taphozous* (*sensu stricto*) in Western Australia led me to compare them with paratypes of *T. australis*, the holotype of *T. georgianus*, topotypic specimens of *T. troughtoni* and the extensive collection of Asian *Taphozous* in the British Museum (Natural History). In addition J.L. McKean and G.R. Friend loaned me a specimen of their recently discovered *Taphozous* sp.

DESCRIPTION OF MATERIAL

Taphozous hilli sp. nov.
(Fig. 1a-c; Table 1)

Holotype

Western Australian Museum Collection (WAM). Reg. No. M18260, adult female in alcohol with skull removed, collected at 1630 hrs by A. Baynes and C.G. Dawe (by mist-netting) on 7 August 1979.

Type locality

4.8 km 180° from Mt Bruce (22°39'03''S, 118°08'30''E), Hamersley Range National Park (No. A30082), disturbed from roof of test adit at Marandoo minesite.

Paratypes

Eleven females and 10 males — all WAM specimens; listed in Specimens Examined.

Diagnosis

External and cranial characters typical of the subgenus *Taphozous*. Approximately same body proportions as *Taphozous georgianus*. Distinguishable from other Australian species of subgenus by rounded anterior rim of mesopterygoid fossa, angular basisphenoid pits, slender and short upper canines, and less steeply excavated frontal depression between orbits of eyes (Fig. 1a-c).

Description

Body and skull measurements for *Taphozous hilli* are presented in Table 1 with comparable measurements for *T. georgianus* (the species most likely to be confused with *T. hilli*). Comparison is also made with *T. australis*, *T. troughtoni* and the species recently identified by McKean and Friend and referred to here as *Taphozous* sp.

Skull: in *T. hilli* frontal depression less steeply excavated and shallower than in other species; little or no sagittal crest, lambdoidal ridge not as well developed, flattening at its apex to a more rounded crest; postorbital width greater, with exception of *T. australis*; rostrum narrower anteriorly; mastoid region less inflated laterally, producing narrower appearance to back of skull; anterior rim of mesopterygoid fossa very rounded compared to the V shape in other species (sharpest in *T. troughtoni*); basisphenoid pits more angular and relatively long, most rounded in *Taphozous* sp.; lower anterior orbital rim flattened; pterygoid groove, which tends to be constricted posteriorly is (except in *Taphozous* sp.) more pronounced; tympanic bullae incomplete and similar in shape to other species; zygomata slender and constricted posteriorly. Outline of dentary beneath premolars markedly concave to about the same degree as in other species, unlike *Taphozous* sp. with only slightly concave outline.

Dentition: *T. hilli* canines shorter and more slender, with small anterobasal cusp about one-third length of tooth; anterior upper premolar weaker; posterior premolar with small anterobasal cusp and reduced cingulum; molars similar in shape to those of other species.

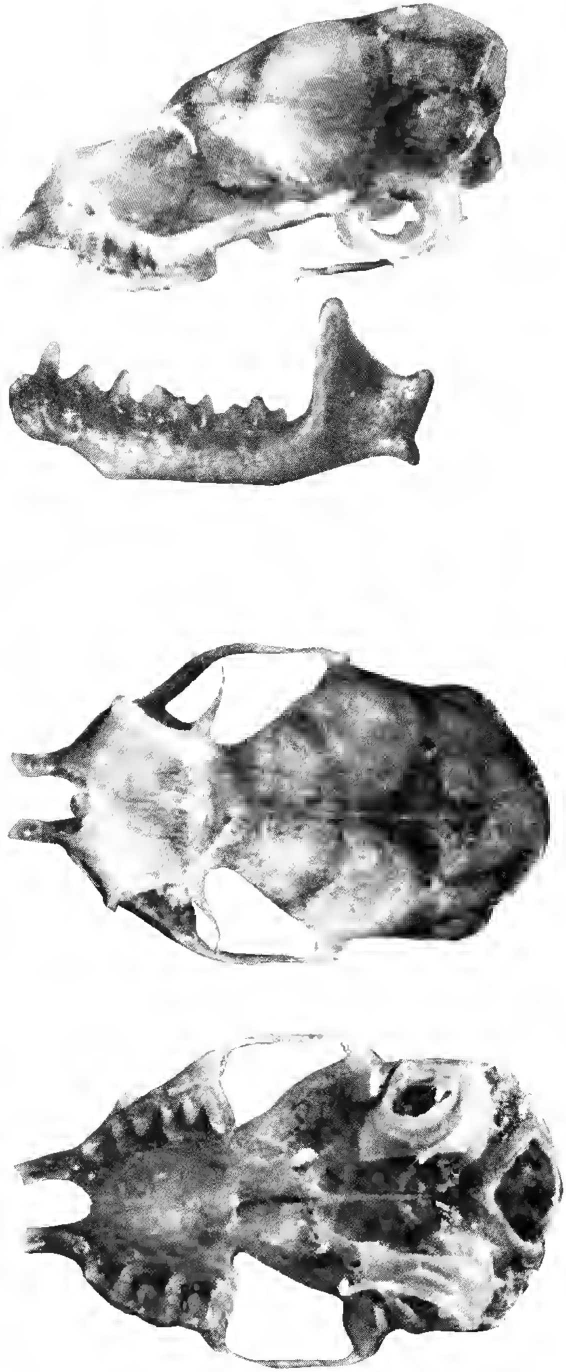

Fig. 1: Skull and dentary of the holotype of *Taphozous hilli* from (a) lateral (b) dorsal and (c) ventral views. X3.

Table 1. Measurements in mm (mean, standard deviation, and range) of *Taphozous hilli* from holotype and paratype specimens (10♂♂, 12♀♀) and of *T. georgianus* (10♂♂, 10♀♀). (all taken from alcohol stores specimens). N = number of measurements. Measurements of the holotype of *T. hilli* are also listed separately.

	T. hilli					*T. georgianus*			
	Holotype	Holotype and Paratypes							
(a) Skull/Dental	M18260	mean	S.D.	range	N	mean	S.D.	range	N
Greatest length (including canine)	22.1	21.4	0.37	20.7- 22.2	22	23.1	0.49	22.1- 24.1	20
Anteorbital width	8.6	8.7	0.25	8.2- 9.1	22	9.0	0.32	8.5 9.7	20
Least interorbital width	6.1	6.1	0.21	5.7- 6.4	22	6.3	0.33	5.7- 6.8	20
Post orbital width	4.9	4.9	0.22	4.5- 5.4	22	4.3	0.18	3.8- 4.6	20
Zygomatic width	13.0	12.8	0.22	12.3- 13.2	22	13.2	0.28	12.9- 13.9	20
Mastoid width	10.6	10.6	0.15	10.4- 10.8	22	10.9	0.19	10.6- 11.4	20
Rostrum length	7.6	7.4	0.21	6.9- 7.7	22	8.3	0.20	7.9- 8.6	20
Braincase length	13.2	12.8	0.32	12.3- 13.4	22	13.1	0.27	12.7- 13.6	20
Braincase width	10.4	10.1	0.23	9.5- 10.5	22	9.8	0.21	9.4- 10.2	20
Basial pit length	4.6	4.5	0.16	4.2- 4.9	22	4.3	0.17	3.9- 4.6	20
Palatal length	5.8	5.5	0.11	5.4- 5.8	22	6.7	0.19	6.4- 7.1	20
Basicranial length	10.0	9.7	0.23	9.4- 10.4	22	10.2	0.22	9.8- 10.6	20
Bulla length	5.4	5.1	0.14	4.9- 5.4	22	4.9	0.16	4.5 5.3	20
C^1 height	2.2	2.4	0.13	2.2- 2.6	22	2.9	0.25	2.4- 3.2	20
C^1 - C^1 breadth	3.5	3.4	0.12	3.2- 3.6	22	4.1	0.10	3.9- 4.3	20
C^1 - M^3 length	8.9	8.6	0.14	8.3- 8.9	22	9.7	0.19	9.4- 10.0	20
M^1 - M^3 length	4.9	4.9	0.11	4.6- 5.0	22	9.1	0.24	5.0 - 5.5	20
M^3 - M^3 breadth	9.1	9.0	0.21	8.6- 9.3	22	9.1	0.24	8.7- 9.6	20
M^1 length	2.2	2.2	0.05	2.1- 2.3	22	2.4	0.05	2.4- 2.5	20
M^1 width	2.2	2.2	0.05	2.2- 2.3	22	2.4	0.07	2.3- 2.5	20
Lower tooth row length	11.0	10.7	0.22	10.5- 11.0	22	11.7	0.19	11.4- 12.1	20
(b) Body									
Total length	106.3	101.2	4.62	88.8-109.2	21	103.5	4.10	95.8-112.7	20
Tail length	30.4	30.4	2.33	26.3- 34.4	16	30.5	1.38	28.7- 34.1	20
Ear length	21.4	20.2	1.05	18.4- 21.6	21	20.7	0.89	19.2- 22.1	20
Tragus length	6.2	5.9	0.35	5.2- 6.4	21	5.6	0.36	5.1- 6.1	20
Radius length	69.5	67.9	1.83	63.7- 71.3	20	67.3	1.73	64.3- 70.5	20
Tibia length	27.5	27.1	0.64	25.5- 28.5	21	27.5	1.02	26.2- 29.7	20
Foot length	12.0	12.3	0.35	11.4- 12.9	21	11.7	0.28	11.4- 12.3	20
Weight (gm)	22.0	22.0	2.16	20.0- 25.0	4	23.4	2.72	17.0- 26.5	10

External morphology: in *T. hilli* the general body shape, including wings and ears, is very similar to *T. georgianus* (Table 1) but with a gular pouch present in males.

Pelage and skin colour: described following Ridgway's (1912) colour code, from specimen M18258 while it was alive. There is no marked colour patterning in *T. hilli.* Predominant pelage colour on dorsal surface is Clove Brown on head to sternal region and Clay Color on rump region. These colours are from tips of hairs, the basal two-thirds of are Light Buff — although short hairs of rump and uropatagium to the point where the tail passes dorsally through its sheath are all Clay Color. Hairs on ventral surface are Light Buff tipped with Olive Brown from head to chest and Cartridge Buff tipped with Clay

Color posteriorly; uropatagium furred lightly and only in anal region; propatagium very sparsely covered with Clay Color hairs; plagiopatagium lightly furred with Cartridge Buff hairs along edge of upper arm and forearm, although there is a patch of about 4.0 x 4.5 mm of short dense Clay Color hairs at entrance of radio-metacarpal pouch; there are a few Clay Color hairs scattered on ventral surface of this pouch. Skin of patagium is Dusky Drab while that of rhinarium and lips is Light Seal Brown.

Remarks

Taphozous hilli has a wide distribution in the arid and semi-arid regions of Western Australia but does not appear to penetrate into the Kimberley or sandy deserts. It has been collected from the same site (adit near Mt Bruce, 22°39'03"S, 118°08'20"E) and at the same time as *T. georgianus*; the two species have also been collected on three other occasions from the same locations. As these two species are of similar size, it is of interest to know how they partition available resources; differences in size of their teeth indicate that their food niches may be different.

Taphozous hilli (and *T. georgianus*) has probably expanded its distribution in modern times with the onset of extensive mining in Western Australia; it is frequently collected from adits and mines and seems to utilise such sites soon after they are abandoned by man.

The broad reproductive cycles of *T. hilli* (as "*T. georgianus*") have been described by Kitchener (1976). Briefly, females give birth to young over a five month period between late November and late April. During mid-autumn and winter they are reproductively quiescent but not inactive. Males have active spermatogenesis throughout the year. Although the specimens used by Kitchener (1976) were all *T. hilli*, an earlier study on the reproduction of "*T. georgianus*"(Kitchener, 1973) included specimens of *T. hilli* and will need to be repeated.

SPECIMENS EXAMINED

Taphozous hilli. Paratypes

All WAM specimens, all adults preserved in alcohol and with skulls removed, unless stated otherwise.

Marandoo Mine (22°39'03"S, 118°08'30"E), M18258 (♀), mounted skin with body in alcohol and skull removed, mist netted, entrance of test adit, A. Baynes, 7 August 1979; Peak Hill (25°36'00"S, 118°49'00"E), M10717 (♀), T. Campbell, 19 June 1966; Peak Hill

Goldmine (25°38'00"S, 118°43'30"E), M12212 (♀) and M12213 (♂), J. Dahlberg, 4 September 1974; Wilgie Mia (26°56'05"S, 117°42'00"E), cave, M5963 (♂), A.M. Douglas, 28 February 1963, M10625 (♂) and M10626 (♀), M. Thomas, 29 August 1973; Gahnda Rockhole (26°36'00"S, 125°52'00"E), M5242/001 (♀), W.H. Butler, 21 August 1962; Manunda Rockhole (26°50'50"S, 125°39'30"E), M4626 (♂), W.H. Butler, 30 August 1961; Muggan Rockhole (27°01'00"S, 125°20'00"E), M5241/001 (♂) and M5241/002 (♀), W.H. Butler, August 1962; near Murgoo Homestead (27°28'40"S, 116°22'10"E), M10245 (♂), A.M. and M.J. Douglas, 3 June 1973; Tallering Peak mine adit (28°06'10"S, 115°38'00"E), M10191 (♀), E. Ride, 1500 hrs, 14 May 1973, M10938/001 (♀), M10940 (♀), M11031 (♂) and M12714 (♂), M.J. and A.M. Douglas, 15 December 1973 and 13 January 1974, M13727 (♂), M. Jackson, 31 August 1975; near Tallering Homestead (28°15'00"S, 115°51'00"E), M10676 (♀) and M10685 (♂), A.M. and M.J. Douglas, 12 August 1973; Yalgoo (28°18'45"S, 116°38'30"E), M10120 (♀) breakaway cave, A.M. and M.J. Douglas, 1050 hrs, 21 April 1973.

Taphozous hilli. Other Specimens

(identified from external morphology and from dentition, but skulls not removed from many specimens. All WAM specimens.)

Northern Territory: 16 km W Tennant Creek; M5841-47 (5♂♂, 2♀♀); Peko Mine, near Tennant Creek, M6283-88 (2♂♂, 4♀♀).

Western Australia: Shay Gap, M18255 (♂); Tambrey Homestead, M4747 (♀); Marandoo, M18259, M18261-65, (3♂♂, 3♀♀); Ophthalmia Range, M18041 (♀); 40 km SE Juna Downs Homestead, M18252, M18253/001 and /002 (1♂, 2♀♀); Paraburdoo, M14937 (♀); Browne Range, M14642 (♀); Todd Range, M14640 (♀); Peak Hill, M10716, M10718, M12212-13 (1♂, 3♀♀); Mileura Homestead, M4303 (♀); Gahnda Rockhole, M5242/002 (♀); Manunda, M4601 (unsexed); Wilgie Mia, M3803-08, M4639, M4747, M4990, M5255-56, M5557, M5796, M8187, M9622, M10624, M10627, M10148-51 (14♂♂, 5♀♀, 2 unsexed); Murgoo M9653, M10239-46, Tallering (5♂♂, 4♀♀); Tallering Peak, M10191-92, M10673-75, M10677-88, M10693-98, M10939A, M10941, M11030, M11032, M12459, M12713-20 (16♂♂, 19♀♀, 1J); 5 km NW Yalgoo, M10115-17, M10118, M10119, M10122, M10125-26, M10128, M10130 (4♂♂, 6♀♀).

Taphozous georgianus.

British Museum Catalogue No. 44.2.27. 59, holotype, female collected at King George Sound by Dr Richardson, alcohol specimen — skull removed. M3270 (♂) Bamboo Creek; M4325 (♀) Ullawarra Station; M4342 (♂) Tambrey Homestead; M7459 (♂) near Whim Creek; M7461 (♀) Tambrey Homestead; M7476 (♂), 9.6 km ENE Yardie Homestead; M9611 (♂), 27 km NNW Argyle Downs Homestead; M9612 (♂) Ord River Basin; M10454 (♂), Boongaree Island; M11038 (♀), Mosquito Creek; M11044 (♀), 34.3 km E Nullagine, M11056 (♂), 10.6 km ESE Nullagine; M11063-64 (♀♀), 29.5 km S Yarrie Homestead; M11465 (♂) 23.3 km N Argyle Downs Homestead; M14384 (♀) 0.8 km ESE Durba Spring; M15240-41 (♂, ♀), near Nullagine; M15415 (♂), Bigge Island.

Taphozous australis

British Museum Catalogue Nos 55.11.7.10-11, paratypes (labelled cotypes). Albany Island, Cape York, Queensland, alcohol specimens — skulls removed.

Taphozous troughtoni

British Museum Catalogue No. 653437, Native Bee Mine, Mt Isa, Queensland (near type locality), female alcohol specimen — skull removed.

Taphozous sp.

CSIRO Wildlife Research Collection, Catalogue No. CM4800, male, collected at 'Kapalga', between South and West Alligator Rivers, Northern Territory, by G. Friend on 20 September 1978, skin and skull.

ACKNOWLEDGEMENTS

Taphozous hilli is named after John Edwards Hill, Mammal Section, British Museum (Natural History), in recognition of his assistance to Australian chiropteran taxonomists over many years. The assistance he rendered me with the description of *T. hilli* while I was at the British Museum is gratefully acknowledged. G. Barron and J. Henry, Western Australian Museum, did much of the preparatory work for this paper and the former, with C. Bryce, Western Australian Museum, took the photographs for Fig. 1. I also thank J.L. McKean and G.R. Friend, CSIRO, for allowing me to peruse a draft of their manuscript describing a new Australian *Taphozous* species and for loan of a specimen.

T.F. Houston and G.M. Storr, Western Australian Museum, kindly criticised the manuscript.

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A REVIEW OF THE DAMSELFISH GENUS *STEGASTES* FROM THE EASTERN PACIFIC WITH THE DESCRIPTION OF A NEW SPECIES

GERALD R. ALLEN*

&

LOREN P. WOODS†

ABSTRACT

The pomacentrid genus *Stegastes* is represented by seven species in the tropical eastern Pacific: *flavilatus*, *leucorus*, *acapulcoensis*, *rectifraenum*, *arcifrons*, *redemptus*, and a new species *baldwini*. *Stegastes flavilatus* and *S. acapulcoensis* are relatively widespread along the coast of Central America and northern South America; *S. rectifraenum* is confined almost exclusively to the Gulf of California, but it has also been collected as far north as Magdalena Bay on the west coast of Baja California. The remaining species appear to be mainly inhabitants of islands situated well offshore, although *S. leucorus* and *S. redemptus* have been reported near the mainland. *Stegastes arcifrons* is a common inhabitant of the Galapagos Archipelago and also occurs on neighbouring islands such as Malpelo and Coco. *Stegastes leucorus* is divisable into two subspecies. The nominal form, *S. leucorus leucorus*, is confined primarily to the Revillagigedo Islands with additional records from Mexico; *S. leucorus beebei* is known from the Galapagos, Malpelo, and a single record from the Perlas Islands, Gulf of Panama. *Stegastes redemptus* occurs at the Revillagigedo Islands, Guadalupe Island, and Cape San Lucas, Baja California. *Stegastes baldwini* sp. nov. is known only from Clipperton Island, where numerous examples were collected in 1956. It is closely allied to *S. leucorus*, differing chiefly in colour pattern and numbers of soft dorsal rays and gill rakers.

INTRODUCTION

The family Pomacentridae is composed of approximately 300 species which are primarily inhabitants of tropical and subtropical reefs. Until recently most species have been assigned to relatively few genera of which *Abudefduf* Forsskal, *Chromis* Cuvier, and *Pomacentrus* Lacépède are by far the largest. However, a recent study by the senior author (Allen, 1975) stressed the critical need for revision at the generic level. Previous authors have vacillated

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* Western Australian Museum, Francis Street, Perth, Western Australia 6000.

† Formerly Field Museum of Natural History, Chicago, Illinois, U.S.A. (Deceased)

between the use of *Eupomacentrus* Bleeker and *Pomacentrus* for certain species which possess serrae on the margin of the suborbital and preopercle. A revision of these fishes by Dr A.R. Emery and the senior author (1980) substantiates the validity of both genera. However, we have found that *Stegastes* Jenyns (1842) holds priority over *Eupomacentrus* Bleeker (1977), and therefore the former is used here. Emery and Allen (1980) provide details of this nomenclatural change. *Stegastes* contains approximately 30 species which are distributed in all tropical seas; *Pomacentrus* includes about twice as many species, but is confined to the Indo-Pacific. The salient features of *Stegastes* include distinct serrae on the preopercle and suborbital, uniserial teeth on the jaws which are relatively elongated with flattened tips, a relatively broad preorbital which is largely devoid of scales, a scaly suborbital, the snout scaled to about the level of the nostrils, and the greatest body depth of adults usually between 1.9 and 2.1 in the standard length.

The last comprehensive review of the eastern Pacific members of the genus was that of Jordan and Evermann (1898). They recognised only three species: *leucorus*, *rectifraenum*, and *flavilatus*. The present study reveals there are seven species inhabiting this region, including *Stegastes baldwini* which is described herein. Not surprisingly, the eastern Pacific species appear to be most closely allied with regard to overall morphology to those from the tropical western Atlantic. However, only one, *S. flavilatus*, exhibits a close affinity to a Caribbean species (*S. variabilis*).

The distribution of eastern Pacific *Stegastes* is shown in Figs 1 and 2. These fishes generally inhabit shallow rocky areas, usually at depths less than 10 m. The diet consists primarily of algae.

We have collected specimens in the field at the Galapagos Archipealgo, Perlas Archipelago, and the near shore islands in the Gulf of Panama. In addition we have examined all the eastern Pacific pomacentrid holdings at the following institutions (abbreviations indicated are used in the subsequent text): Academy of Natural Sciences, Philadelphia (ANSP); American Museum of Natural History, New York (AMNH); British Museum (Natural History), London (BMNH); California Academy of Sciences, San Francisco (CAS); Field Museum of Natural History, Chicago (FMNH); Natur-Museum Senckenberg, Frankfurt (SMF); Stanford University (SU, specimens presently deposited at CAS); National Museum of Natural History, Washington, D.C. (USNM); and the Western Australian Museum, Perth (WAM). In addition, selected specimens were examined from the University of California at Los Angeles (UCLA) and Scripps Institute of Oceanography, California (SIO).

All lengths given in the subsequent text refer to the standard length which is measured from the snout tip to the base of the middle caudal rays. Caudal preduncle length is the horizontal distance between the bases of the last dorsal ray and middle caudal rays. Preorbital width is the greatest width measured from just above the rear corner of the mouth to the lower edge of the orbit. A summary of counts for the dorsal, anal, and pectoral fin rays, tubed lateral-line scales, and gill rakers on the first arch is presented in Table 1.

Table 1: Fin ray, lateral-line scale, and gill raker counts for species of *Stegastes* from the eastern Pacific.

Species	soft dorsal rays 14	15	16	soft anal rays 12	13	14	pectoral rays 19	20	21	22	23	24	LL scales with tubes 19	20	21	22	lower limb gill rakers 10	11	12	13	14	15
flavilatus	15	1		16						5	10	1		16				8	2			
leucorus leucorus	1	4	16	1	18	2		3	17	1			2	17	2	1			15			
leucorus beebei	5	21	1		26	1		14	44				2	24			5	15	2			
baldwini		10	1		11				9	2				10	1				6	5		
acapulcoensis		10	1		11			1	16	64	5			11				2	3	5		
rectifraenum		12	4	1	14	2	12	55	2				2	16				2	12			
arcifrons		9	2	1	10		1	12					1	12					7	5	1	
redemptus	1	18			19		1	17	1				1	17	1				1	7	10	1

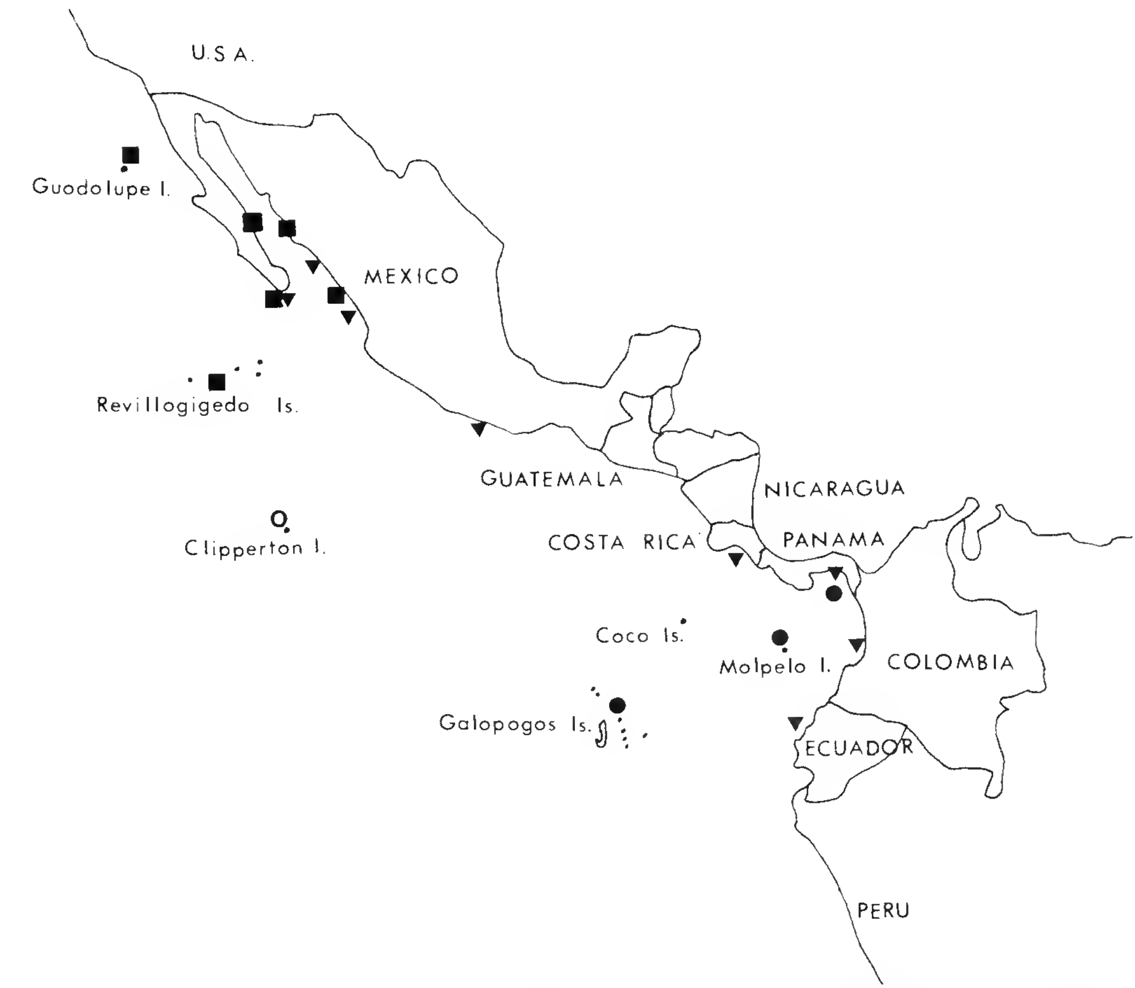

Fig. 1: Distribution of certain species of eastern Pacific *Stegastes*: *S. leucorus leucorus* (squares); *S. leucorus beebei* (solid circles); *S. baldwini* (hollow circles); *S. flavilatus* (triangles).

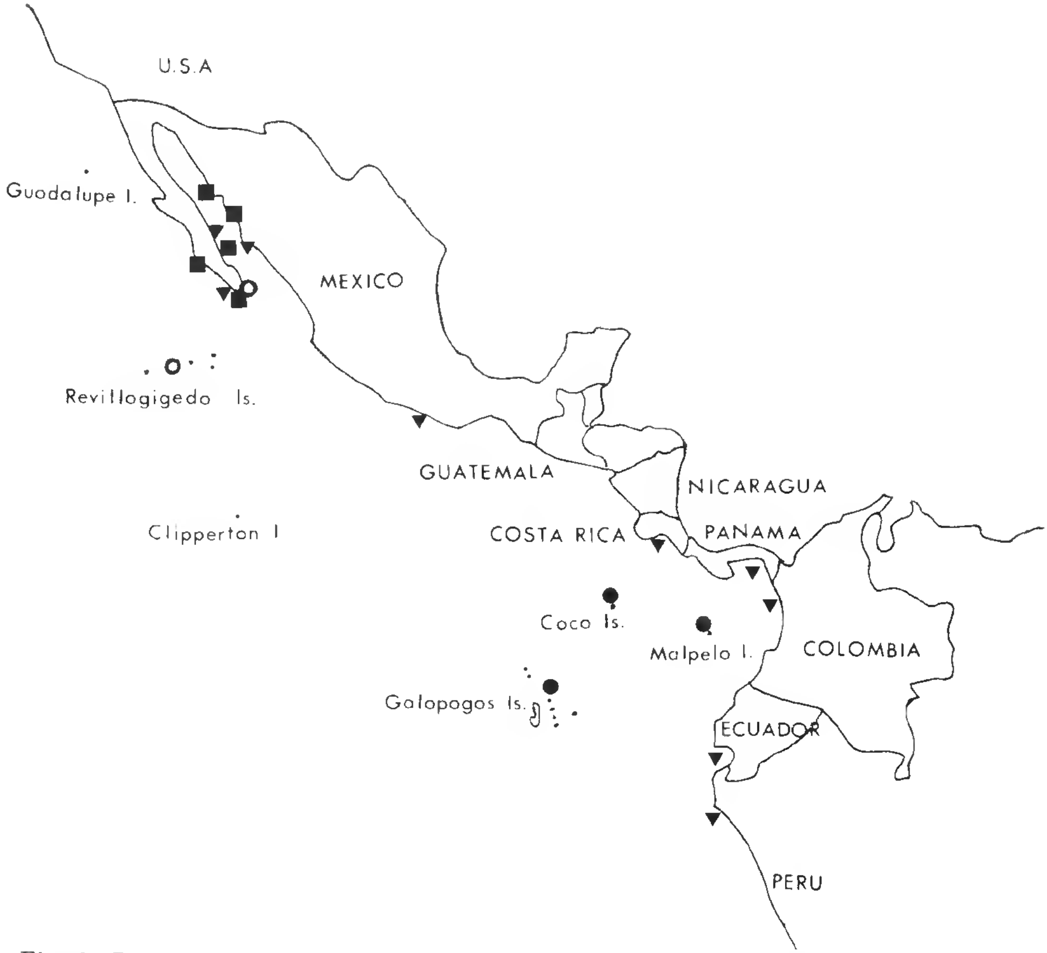

Fig. 2: Distribution of certain species of eastern Pacific *Stegastes*: *S. rectifraenum* (squares); *S. arcifrons* (solid circles); *S. redemptus* (hollow circles); *S. acapulcoensis* (triangles).

KEY TO *STEGASTES* OF THE EASTERN PACIFIC

1a Soft dorsal rays usually 14; soft anal rays usually 12; supplementary scale usually present on opercle (Figs 4a, b) (Cape San Lucas to Bahia de Santa Elena, Ecuador) . . . . *flavilatus* (Gill)

1b Soft dorsal rays usually 15 or 16; soft anal rays usually 13; supplementary scale on opercle absent (Fig. 4c) 2

2a Pectoral fins dark with well contrasted pale (yellow or white) margin (Fig. 8) or if pale margin not apparent prominent pale band present across caudal peduncle; caudal fin dark;

opercular margin black on upper portion, strongly contrasted with surrounding area 3

2b Pectoral fins without pale margin; prominent pale band across caudal peduncle absent (peduncle sometimes pale, but not in form of contrasted band); caudal fin dark or pale; opercular membrane not strongly contrasted with surrounding area 5

3a Soft dorsal rays usually 16; gill rakers on lower limb of first arch usually 12 (Guadalupe I., Revillagigedo Is, Gulf of California to Mazatlan) . . . . *leucorus leucorus* (Gilbert)

3b Soft dorsal rays usually 15; gill rakers on lower limb of first arch usually 10 to 12 4

4a Gill rakers on lower limb of first arch usually 10 or 11; lips dusky, not strongly contrasted with surrounding area; prominent pale band across caudal peduncle usually not apparent or if present poorly defined (Galapagos Is, Malpelo I., Perlas Is) . . . . *leucorus beebei* Nichols

4b Gill rakers on lower limb of first arch usually 12; lips pale (pinkish) strongly contrasted with surrounding area; prominent pale band across caudal peduncle (Clipperton I.) . . . . *baldwini* n. sp.

5a Pectoral rays 21 to 23 (usually 22) (Gulf of California to northern Peru) . . . . *acapulcoensis* (Fowler)

5b Pectoral rays usually 19 or 20 6

6a Caudal peduncle about same shade as rest of body; caudal fin dusky in specimens over 50 mm, 11 scales between 13th lateral-line scale and anal opening (Gulf of California and Baja California) . . . . *rectifraenum* (Gill)

6b Caudal peduncle lighter than rest of body; caudal fin pale to dusky; 10 scales between 13th lateral-line scale and anal opening 7

7a Upper profile of head very steep, not symmetrical with ventral profile (Fig. 11); lips pale, much lighter than surrounding area; gill rakers on lower limb of first arch usually 12 or 13 Galapagos Is, Coco Is, Mapelo I.) . . . . *arcifrons* (Heller and Snodgrass)

7b Upper profile of head less steep, approximately symmetrical with ventral profile (Fig. 12), lips more or less dusky (at least upper), not strongly contrasted with surrounding area; gill rakers on lower limb of first arch usually 13 or 14 (Revillagigedo Is, Baja California . . . *redemptus* (Heller and Snodgrass)

SYSTEMATICS

Stegastes flavilatus
(Fig. 3)

Pomacentrus flavilatus Gill, 1863. *Proc. Acad. Nat. Sci. Philad.*, 1862: 148 (type locality: Cape San Lucas, Lower California).

Pomacentrus gilli Gilbert and Starks, 1904. *Mem. Calif. Acad. Sci.* 4: 141, Pl. 22, Fig. 44 (type locality: Panama).

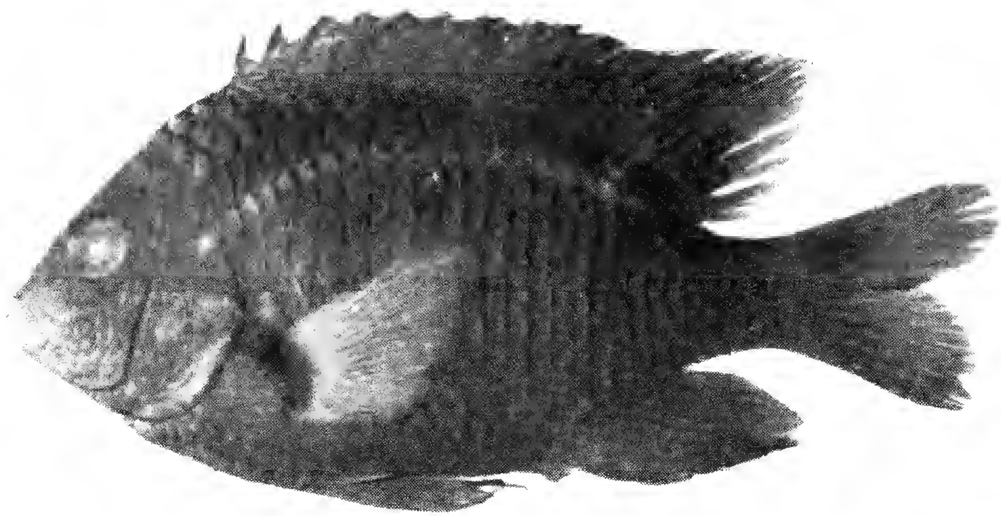

Fig. 3: *Stegastes flavilatus*, 95 mm, Perlas Archipelago (WAM P25511-004).

Diagnosis

(Proportions based on 15 specimens, 75-104 mm) Dorsal rays XII,14 (rarely 15); anal rays II,12; pectoral rays 22 or 23 (rarely 24); scales in lateral line bearing tubes 20; vertical scale rows from upper edge of gill opening to base of caudal fin 27 (rarely 26), between lateral line and origin of dorsal fin 3½; between 13th lateral-line scale and anal opening 10; gill rakers on lower limb of first branchial arch 11 (rarely 12).

Depth of body 1.8 to 2.0, head length 2.7 to 3.0, both in standard length; snout length 2.7 to 3.1, eye diameter 3.3 to 3.6, interorbital width 3.7 to 4.0, preorbital width 5.6 to 6.2, depth of caudal peduncle 2.3 to 2.5, length of caudal peduncle 2.8 to 3.2, of pectoral fin 1.1 to 1.2, of pelvic fin 1.1 to 1.2, of caudal fin 1.0 to 1.1, all in head length.

Colour in alcohol: (juvenile specimens up to approximately 55 mm) top of head and body blue to dark brown; sides abruptly yellow or light tan; lower lip and lateral portion of upper lip and jaw, preorbital, suborbital, cheeks, and opercles pale or yellow with blue or brown spots, largest and most conspicuous on opercles; a large ocellated dark spot present at base of anterior soft dorsal rays, about one-third on rays and two-thirds on body; an ocellated spot, smaller than pupil, dorsally on caudal peduncle; spinous dorsal and anterior soft rays dark, remainder of fin pale or slightly dusky; caudal yellowish or faintly dusky, outer edges with distinct narrow dark line; small blue spots on basal one-third of middle caudal rays; most of anal fin yellow with fine dark line on outer edge and sometimes a blue spot at base of last two or three rays; pelvic fins with dark spine and outer ray, inner rays yellow or light tan; pectoral fins pale, a small black spot on dorsal edge of base of upper ray only, inner face of pectoral pale. The largest juveniles have dark edges on the scales along the middle of the sides, which is a characteristic adult feature. Some specimens up to 75 mm still retain the juvenile colouration. In the southern portion of its range at Costa Rica and Panama, the transition from pale juvenile to dark adult appears to take place at a much smaller size; the dorsal spot is sometimes lost under 40 mm and the caudal spot disappears before a standard length of 45 mm is attained. One specimen, 45 mm, had lost both spots and many specimens between 40-45 mm were relatively dark on the lower sides showing no trace of the bicoloured juvenile pattern described above. Adults (specimens larger than about 70 mm): head and body dark brown; scales of suborbital and cheek with pale centres; lower lip pale, upper lip dusky; opercular membrane dark or dark edged; scales of lower sides and caudal peduncle with short lengthwise light streaks; body scales dark edged with lighter reddish-brown centres giving appearance of alternating narrow light and dark vertical bands on sides; breast light tan; dorsal fin mostly dark, black along outer margin; posterior soft dorsal rays pale on distal half; caudal fin dusky, darker basally, sometimes pale yellowish or tan distally; anal fin dark except tips of posterior rays pale or slightly dusky; pelvic spine and outer ray entirely dark, inner rays dusky on basal portion, pale distally with pale membranes between rays; pectoral fin pale, a large dark blotch covering fin base, more intense dorsally; outer face of pectoral axil very dark on upper two-thirds, pale ventrally.

Colour in life (from 35 mm transparencies taken at the Perlas Archipelago in 2-4 m depth): juveniles — top of head, spinous dorsal fin and upper back bright blue, remainder of sides abruptly yellow; most of body scales with dusky margin; prominent light blue edged black ocellus at base of first few soft dorsal rays and smaller ocellated spot on top of caudal peduncle; light blue spot at base of posterior anal rays and similar, but smaller spots on side of head, middle of anal fin and at base of caudal fin; iris golden except light blue stripe across dorsal portion; caudal, anal, and pelvic fins yellow; pectoral fin transparent, but slightly yellowish. Subadults mostly blue except breast, abdomen, and lower half of head tan; body scales with prominent dark margins; dorsal ocellus absent or represented by a diffuse black spot; peduncular spot present or absent; most of soft dorsal, caudal, and anal fins dusky yellow; pelvic fins brighter yellow. Adults — most of head and body golden brown, lighter on breast, abdomen, and lower half of head; body scales with prominent dark margin; most of dorsal and anal fin dusky brown except outer portion of posterior rays yellowish; caudal fin dusky brown basally, yellowish on outer portion; pelvic fins yellow, but with some duskiness; pectoral fins transparent and slightly yellowish with dark brown blotch at base.

Range

Widespread on the Pacific coast of Central America from Cape San Lucas and the lower Gulf of California (Isla Venados) to Bahia de Santa Elena, Ecuador.

Remarks

This species is apparently derived from the same ancestral stock as *S. variabilis* (Castelnau) of the tropical western Atlantic. The two species have nearly identical juvenile colour patterns and possess a supplementary scale on the operculum (**Fig. 4**). The latter feature is unique among Atlantic and eastern Pacific members of *Stegastes*.

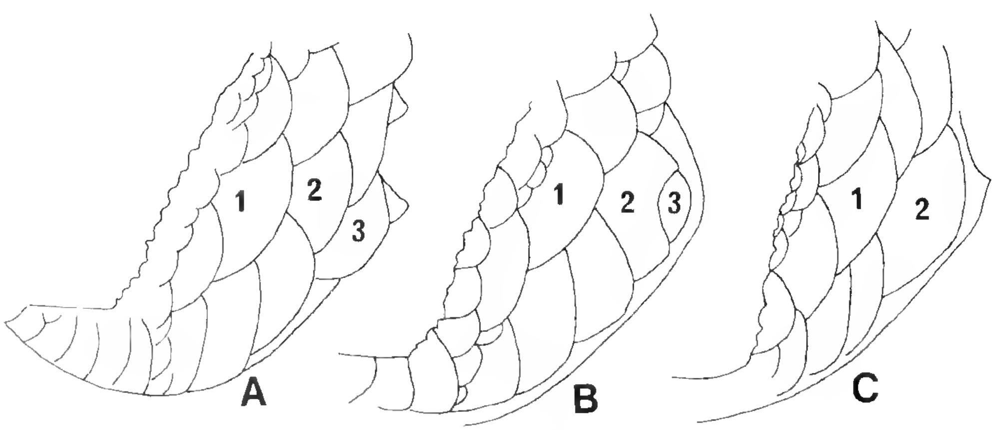

Fig. 4: Diagrammatic representation of opercular scalation in A and B) *S. flavilatus*-*S. variabilis*, C) other species of eastern Pacific and western Atlantic *Stegastes* (adapted from Emery and Burgess, 1974).

Material examined

Holotype of *Pomacentrus gilli*, SU 6803, 105 mm, Panama; paratype of *P. gilli*, 101 mm, Panama. In addition, 150 specimens, 18-93 mm, from Isla Venados (Gulf of California), Mazatlán, Acapulco, Costa Rica (Gulf of Nicoya), Panama, Colombia (Gorgona Island), and Ecuador (Bahia de Santa Elena) studied at CAS, FMNH, USNM and WAM.

Stegastes leucorus leucorus
(Fig. 5)

Pomacentrus leucorus Gilbert, 1891. *Proc. U.S. natn. Mus.*, 14: 554 (type locality: Socorro Island, Revillagigedo Islands).

Pomacentrus elaimelas Fowler, 1944. *Monogr. Acad. nat. Sci. Philad.* no. 6: 381, Figs 225-227 (type locality: Mazatlán, Mexico).

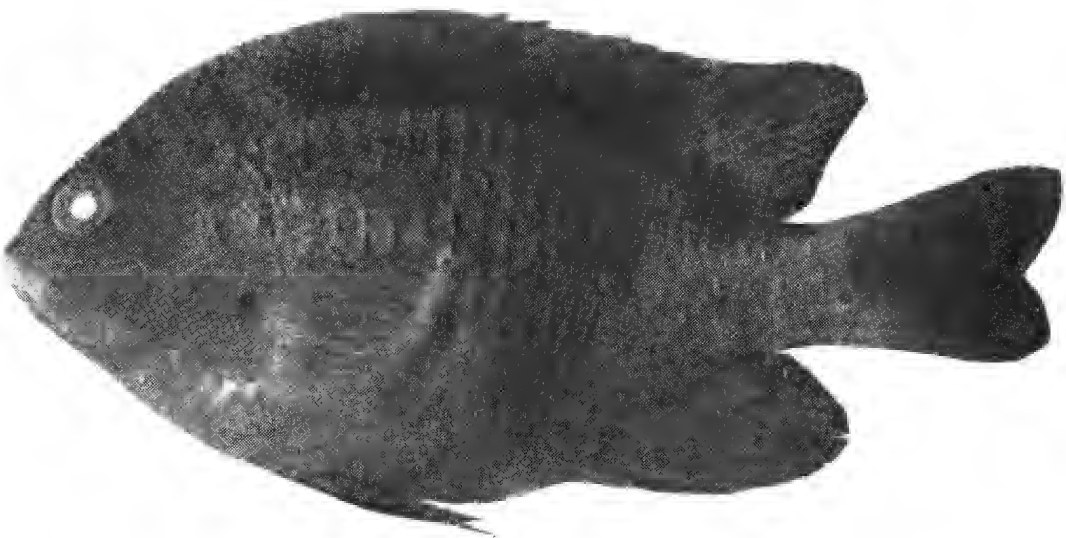

Fig. 5: *Stegastes leucorus leucorus*, 91 mm, Revillagigedo Islands (FMNH 61887).

Diagnosis

(Proportions based on 14 specimens, 67-111 mm) Dorsal fin rays XII,16 (occasionally 14 or 15); anal rays II,13 (rarely 12 or 14); pectoral rays 21 (rarely 20 or 22); scales in lateral line bearing tubes 20 (rarely 19, 21 or 22); vertical scale rows from upper edge of gill opening to base of caudal fin 26-27, between lateral line and origin of dorsal fin 3½, between 13th lateral-line scale and anal opening 10; gill rakers on lower limb of first branchial arch 12.

Depth of body 1.8 to 2.0, head length 3.0 to 3.3, both in standard length; snout length 2.9 to 3.6, eye diameter 3.0 to 3.6, interorbital width 3.0 to 4.0, preorbital width 6.0 to 7.2, depth of caudal peduncle 1.9 to 2.3, length of caudal peduncle 2.5 to 3.0, of pectoral fin 1.1 to 1.2, of pelvic fin 0.9 to 1.2, of caudal fin 0.9 to 1.2, all in head length.

Colour in alcohol: juveniles — similar to young *S. leucorus beebei.* Adults — head and body dark brown; scales of body with narrow dark margins; hind margin of upper part of operculum jet black; fins dark brown to blackish; spinous dorsal with narrow black distal margin; pectoral fins with highly contrasted white band on posterior margin (see **Fig. 8**).

Colour in life: juvenile (41 mm, from 35 mm transparency taken by Mr Alex Kerstitch at Isla San Jose, Baja California) — overall dark purplish-brown grading to yellow-brown on forehead, anterior part of back, and spinous dorsal fin; a black spot, about eye size at base of anterior soft dorsal rays; a much smaller black spot on dorsal edge of caudal peduncle; margins of body scales dark brown or blackish; caudal peduncle white, at least posteriorly; soft dorsal fin purple-brown basally, translucent distally, caudal fin translucent; anal and pelvic fins dark purple-brown; pectoral fins translucent.

Range

Known in the literature primarily from the Revillagigedo Islands, but single specimens are also reported from Guadalupe Islands and Mazatlán, Mexico. Mr Alex Kerstitch reports (personal communication) that it is relatively common at certain localities in the vicinity of Cabo San Lucas, Baja California extending northward in the Gulf of California to Isla Carmen (approximately 26°N), Baja California and Isla San Ignacio Farallon off Topolobampo, Sinaloa (mainland Mexico).

Remarks

The two subspecies of *S. leucorus* are separable on the basis of colour pattern (Table 2) and slight modal differences in soft dorsal ray and gill raker counts (Table 1). Adult males of *S. leucorus leucorus* and *S. leucorus beebei* have a dense covering of tiny papillae on the outer half of the pectoral fin. The smallest specimens we have examined which exhibit this feature are 86 mm and 89 mm respectively for the two subspecies. The papillae are lacking on our numerous examples of the closely related *S. baldwini*, the largest specimen of which is 90 mm.

Material examined

Syntypes, USNM 48248-49, three specimens, 79-106 mm, Socorro Island, Revillagigedo Islands; syntypes, SU 329, three specimens, 98-100 mm, Socorro Island; syntypes, BMNH 1901.6.28.202-211, 13 specimens, 65-111 mm, Socorro Island; type of *Pomacentrus elaimelas*, ANSP 70261, 112 mm, Mazatlán, Mexico. In addition, 29 specimens, 45-99 mm, from the Revillagigedo Islands, and a single specimen from Guadalupe Island, 135 mm, studied at CAS, FMNH, SIO, UCLA, and USNM.

Table 2: Comparison of colour patterns of species in the '*leucorus*' complex.

	baldwini	*leucorus leucorus*	*leucorus beebei*
General ground colour	yellowish brown, darker in small, lighter in large specimens.	dark brown, some lighter specimens tan or pale greyish brown, not yellowish or reddish.	tan to reddish brown, small specimens (under 50 mm) with back light orange to carmine.
Lips	pale or yellow	dusky	dusky
Pectorals	black with tips of *lower* rays only hyaline.	black with broad yellow or white bar across distal edge, upper rays included.	black with broad white bar across distal edge, upper rays included.
Spiny dorsal	narrow black margin; yellow or pale submarginal band.	broad black margin, no submarginal pale areas or very narrow pale areas but, these not forming band.	broad black margin, submarginal area lighter but dusky, only indistinct band evident.
Soft dorsal	tip of posterior rays pale; no black spot at any size.	all rays black to tips; small specimens (under 50 mm) with large black spot on base of anterior dorsal rays.	all rays completely black; young with large black spot on base of anterior rays.
Caudal fin	black from base of rays to tip; upper rays pale or yellow in small specimens.	dusky, small specimens dusky on median portion, basal and distal portions pale.	dusky, pale basally in large and small specimens.
Caudal peduncle	prominent white band encircling entire caudal peduncle.	posterior half to one-third pale in small specimens, dark as adjacent body in large.	posterior half to one-third pale in young, usually one-third pale in large, but poorly contrasted in preserved specimens.

Stegastes leucorus beebei
(Fig. 6)

Eupomacentrus beebei Nichols, 1924, *Zoologica*, 5: 64 (type locality: Galapagos Is).

Fig. 6: *Stegastes leucorus beebei*, 94 mm, Galapagos Archipelago (WAM P25574-001).

Diagnosis

(Proportions based on 14 specimens, 74-108 mm) Dorsal fin rays XII,15 (occasionally 14, rarely 16); anal rays II,13 (rarely 14); pectoral rays 20 or 21; scales in lateral line bearing tubes 20 (rarely 19); vertical scale rows from upper edge of gill opening to base of caudal fin 26-27, between lateral line and origin of dorsal fin 3½, between 13th lateral-line scale and anal opening 10; gill rakers on lower limb of first branchial arch 10-11 (rarely 12).

Depth of body 1.9 to 2.0, head length 3.0 to 3.3, both in standard length; snout length 3.0 to 3.4, eye diameter 3.3 to 3.7, interorbital width 3.1 to 4.0, preorbital width 6.3 to 8.0, depth of caudal peduncle 1.9 to 2.2, length of caudal peduncle 2.5 to 3.0, of pectoral fin 1.1 to 1.2, of pelvic fin 0.9 to 1.1, of caudal fin 1.0 to 1.2, all in head length.

Colour in alcohol: juveniles overall reddish-brown with prominent ocellus at base of anterior soft dorsal rays and small dark spot on upper edge of caudal peduncle; upper edge of opercular membrane black; scale margins on body dusky; most of dorsal fin brown except outer portion of soft rays pale; posterior portion of caudal peduncle turning pale, grading into yellowish caudal fin; anal fin mostly dark brown, nearly black, except outer portion of posterior rays pale; pelvic fins dark brown to black; pectoral fins pale but turning dark with increased size; narrow dark brown bar across pectoral base and axil light brown. Adults — similar to juveniles except darker brown and all fins dark brown to blackish without ocellus; pectoral fins with prominent pale band across posterior margin (see Fig. 8) and small dark spot at base of uppermost rays.

In many specimens, particularly those under approximately 50-60 mm, there is a hint of faint pale band across the caudal peduncle, similar to that found in *S. baldwini*, but not nearly as strongly contrasted.

Colour in life (from Hobson, 1975, Fig. 2): head and body overall reddish-brown, grading to dark brown posteriorly; strong suffusion of red on antero-dorsal portion of body and spinous dorsal fin; bright red patch on top of eye; margins of body scales dark brown; broad pale brown band at base of caudal fin; opercular membrane black; fins dark brown to blackish; pectorals with yellowish band across outer margin; blue stripe across superior portion of iris.

Range

Previously known only from the Galapagos Archipelago, but also recorded from the Perlas Islands, Gulf of Panama on the basis of a single specimen (UCLA W53-208). In addition, McCosker and Rosenblatt (1975) recorded it from Malpelo Island, off Colombia.

Material examined

Holotype, AMNH 8270, 14 mm, Galapagos Archipelago. In addition, 553 specimens, 12-113 mm, from the Galapagos Archipelago and a single specimen, 102 mm from Panama were studied at FMNH, SMF, UCLA, and USNM.

Stegastes baldwini sp. nov.
(Fig. 7)

Holotype

USNM 114944, 87 mm, Clipperton Island, about 0-1.5 km north of Wreck on east side of island, 23 October 1956, Baldwin, Limbaugh, and Hohnhaus.

Paratypes

USNM 114945, 38 specimens, 29-88 mm, same data as holotype; FMNH 61882, 54 specimens, 22-82 mm, Clipperton Island, two areas (1) 400 m west of Wreck, (2) 800 m west of Wreck, 20 October 1956, Baldwin, Limbaugh, and Hohnhaus; BMNH 1957.1.21.1-10, 10 specimens, 38-90 mm, Clipperton Island, just north of Wreck on east side of island, 24 October 1956, Baldwin, Limbaugh, and Hohnhaus; ANSP 75182, 181 specimens, 26-88 mm, Clipperton Island, east side, 1.6 km north of Wreck, near single coconut tree, 25 October 1956, Baldwin, Limbaugh and Hohnhaus; WAM P25547-001, 10 specimens, 48-85 mm formerly part of ANSP 75182; CAS 20715, 137 specimens, 21-80 mm, Clipperton Island, on south shore near large rock, 28 October 1956, Baldwin, Limbaugh and Hohnhaus; SU W56-241 (now deposited at CAS), 93 specimens, 21-73 mm, Clipperton Island, near grove of trees and old barracks on west shore, 29 October 1956, Baldwin, Limbaugh and Hohnhaus.

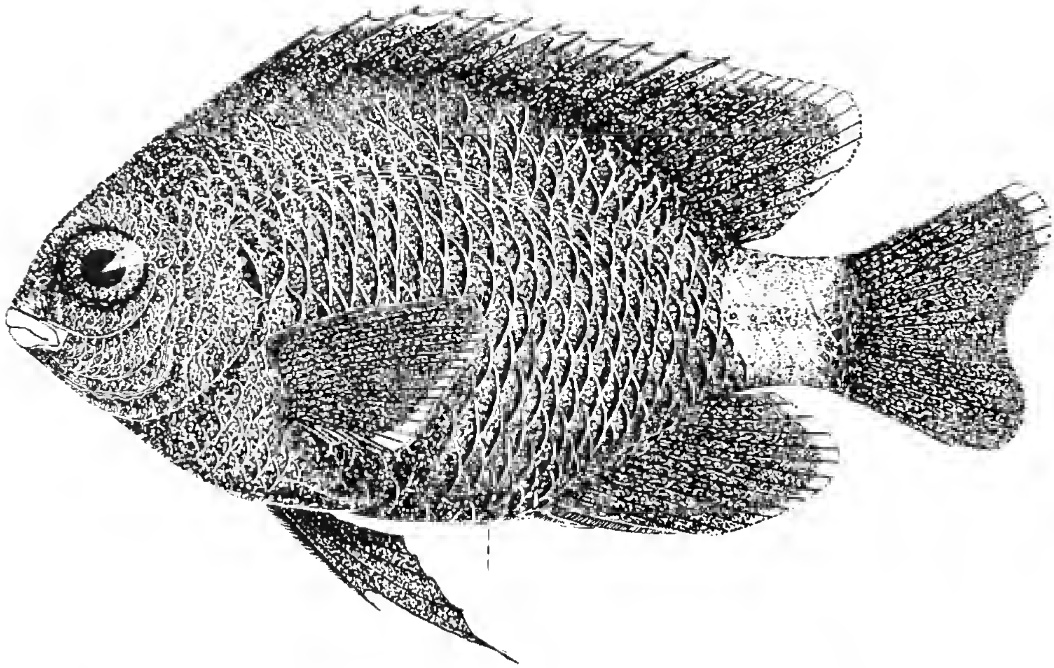

Fig. 7: *Stegastes baldwini*, paratype, 77 mm, Clipperton Island (FMNH 61882).

Description

(Counts and proportions of type are given first with range for paratypes noted in parentheses. Paratypes measured range in size 69-90 mm, counts based on these plus many additional specimens — see Table 1.)

Dorsal fin rays XII,15 (XII,15, rarely XII,16); anal rays II,13 (II,13); pectoral rays 21 (21, rarely 22); scales in lateral line bearing tubes 20 (20, rarely 21), vertical scale rows from upper edge of gill opening to base of caudal fin 27 (27, rarely 26), between lateral line and origin of dorsal fin 3½ (3½, rarely 3), between 13th lateral-line scale and anal opening 10 (10); gill rakers on lower limb of first arch 12 (12 or 13).

Depth of body 1.9 (1.8-2.1), head length 3.1 (2.9-3.2), both in standard length; snout length 3.1 (3.1-3.7), eye diameter 3.7 (3.3-3.8), interorbital width 3.3 (3.2-3.8), preorbital width 7.4 (7.1-7.7), depth of caudal peduncle

2.0 (2.0-2.1), length of caudal peduncle 2.5 (2.5-3.0), of pectoral fin 1.2 (1.1-1.3), of pelvic fin 1.0 (0.9-1.0), of caudal fin 1.1 (1.0-1.1), all in head length.

Body deep, strongly compressed, dorsal profile rising steeply to origin of dorsal fin; dorsal profile smoothly convex from interorbital to origin of dorsal, slightly concave snout (straight in small specimens under 45 mm), snout angular, neither exceptionally broad nor pointed; mouth horizontal, posterior tip of upper jaw reaching to vertical with anterior margin of pupil, lips thick, smooth; fleshy flange on maxillary very thick and well developed distally.

Teeth in both jaws uniserial, narrow, close-set to form cutting edge, tips compressed, rounded, truncate or slighly emarginate. Lower pharyngeal bone with tooth patch broadly trinagular, teeth arranged in five rows, at apex only one enlarged tooth, behind this the second row contains only two teeth, the third row continuous along sides to wings, fourth row incomplete with only 10 teeth, median ones conical and obtuse, posterior row with teeth slender and elongate except five median teeth have enlarged bases.

Head scaled except for snout anterior to nostrils, preorbital and tip of lower jaw; suborbital scaled to below middle of pupils in small specimens (up to 45 mm), to corner of mouth in larger (50-65 mm) and to anterior margin of pupil in largest specimens (75-90 mm); suborbital scales in a single row in small specimens, a double row in large with scales near rim of orbit much smaller; margin of suborbital entire in young becoming progressively finely serrate anteriorly with increased size, largest specimens serrate to corner of mouth; scales in three regular rows across widest part of cheek, smaller scales surrounding these not reaching to margin of preopercle so preopercle has broad naked margin on horizontal limb but very narrow naked margin on vertical limb; vertical limb margin of preopercle usually straight, angle not produced, serrae very fine.

Gill rakers short, slender, the anterior ones broad and fleshy; longest rakers near angle, their length less than half the diameter of pupil; two rows of very short fleshy papillae on inner face of gill rakers.

Dorsal fin originates above third lateral-line scale; dorsal spines gradually increasing in length posteriorly, length of last spine a little more than half the length of head. Membranes between spines longer than anterior spine forming a short tab at least on first few membranes; margin of soft dorsal fin broadly angular, its base equal in length to both spiny and soft portions of anal fin.

Anal fin originates on vertical below insertion of 11th dorsal spine; anal fin margin broadly rounded; first anal spine more than one-third length of second, second anal spine longer and stronger than any dorsal spines, about 1.6 in head.

Upper caudal lobe slightly angular, lower lobe rounded, caudal fin with broad shallow notch, the middle caudal rays about two-thirds length of longest rays of upper lobe.

Pelvic fins inserted vertically below insertion of third dorsal spine, outer pelvic rays filamentous but not greatly produced; pelvic spine more slender but only a little shorter than second anal spine.

Pectoral fin angular, its posterior margin convex; simple rays on lower margin of fin free about one-third to half their length except inner one (third from bottom) free only at tip; scale just above pectoral axil enlarged, the vertical width of its exposed portion not quite as long as the width of pectoral base.

Colour in alcohol: juveniles (20-25 mm) — uniformly dark bodied with only the posterior half of the caudal peduncle pale; caudal and pectoral fins pale, pectoral with a large dark blotch covering its entire base; distal half to two-thirds of soft dorsal pale; gill membrane between opercular spines and margin of spiny dorsal membranes dark; submarginal band on dorsal fin very faint; lips and chin dusky, but paler than rest of head. One specimen, 22 mm, had short blue lines from the snout to the interorbital; another 20.8 mm possessed a broad, pale lengthwise band (probably yellow in life) running from just above pectoral to base of caudal fin and lacked the black blotch on the pectoral base. Juveniles (30-40 mm) — very dark bodied though some show a trace of yellow on the scales; caudal fin dark on basal portion and lower lobe, but superior portion of upper lobe pale; pectoral fin with basal two-thirds to three-quarters dark, margin hyaline; lips pale, but smallest specimens in this size group have lips dusky laterally; pale submarginal band on dorsal distinct; caudal peduncle with only posterior half pale in specimens to 35 mm, but as 40 mm is approached a larger area is pale; chalky appearance of caudal peduncle not evident on most specimens in this size group. Adults and subadults — body colour generally brown, smaller specimens darker; largest specimens with more yellow on snout, sides and breast; top of head darker brown than rest of body; lips yellow or pale; sometimes slightly dusky near corners of mouth and with preorbital area yellow; chin pale, cheeks brown, posterior row of opercular scales yellow; branchiostegal membranes yellow, opercular membrane intense black in notch between opercular spines; body scales below lateral-line with narrow dark brown margin, the base of each scale yellow so body appears to have a series of diagonal transverse dark lines alternating with yellow; caudal peduncle chalky white, this colour ending abruptly at base of caudal rays; some specimens with middle row of scales on caudal peduncle yellow, forming yellow streak running forward and gradually fading into dark part of body (this band often continues to opercle in very small specimens [20 mm]); a faint dark spot on body just below base of last dorsal rays; dorsal fin dark on base, a pale or yellow submarginal band and narrow black marginal line on both spiny and anterior soft rays; posterior dorsal rays pale distally; caudal fin usually entirely black but some large specimens with upper rays pale or yellowish; anal fin black; pelvic fins black; pectoral fins black with narrow pale bar across tips of all rays in young, but in individuals larger than 55 mm, upper rays black tipped (with further increase in size pectorals become entirely black); small faint black spot on base of upper pectoral rays; axil of pectoral yellow.

Range

This species is known only from Clipperton Island. It is abundant in shallow (approximately one metre or less) water over the bottom of coral, limestone rocks and sand.

Remarks

Stegastes baldwini is obviously a close relative of *S. leucorus*. The two species are separable primarily on the basis of colour pattern differences. This evaluation may appear to be inconsistent with our division of *S. leucorus* into two subspecies on the basis of similar differences. However, it is our opinion that the pattern differences (Table 2 and **Fig.** 8) are of sufficient magnitude to justify full species recognition for *S. baldwini*. In addition, males of *S. baldwini* lack papillae on the outer pectoral fin, a feature found in both subspecies of *S. leucorus* (see remarks section for *S. leucorus leucorus*).

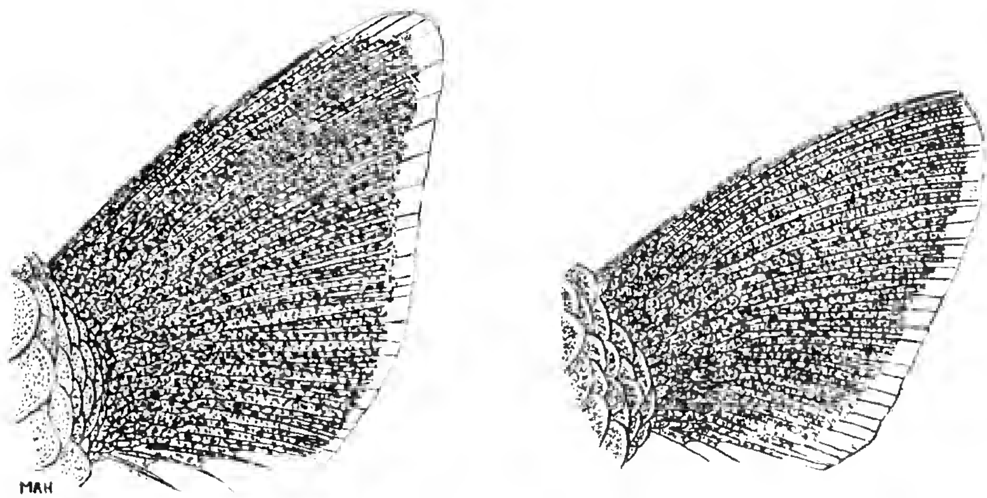

Fig. 8: Comparison of pectoral fin colouration in A) *S. leucorus beebei* and *S. leucorus leucorus*, B) *S. baldwini* (subadults).

The holotype is a male. Among the many specimens examined, only two females (67 and 87 mm) were found with eggs which were very small and certainly not ripe. No difference in colour pattern or shape was noticed between males and females. *Stegastes baldwini* also differs from *S. leucorus beebei* in number of gill rakers on the first arch (usually 12 on the lower limb for *baldwini* vs. 10-11 for *beebei*), and from the Revillagigedo population of *leucorus leucorus*, in number of soft dorsal rays (usually 15 for *baldwini* vs. 16 for *leucorus leucorus*).

Named for Mr Wayne Baldwin, one of the collectors of the excellent series of specimens which formed the basis of the above description.

Stegastes acapulcoensis
(Fig. 9)

Pomacentrus (Omopomacentrus) acapulcoensis Fowler, 1944. *Monogr. Acad. nat. Sci. Philad.*, no. 6: 363, Figs 222, 223 (type locality: Acapulco, Mexico).

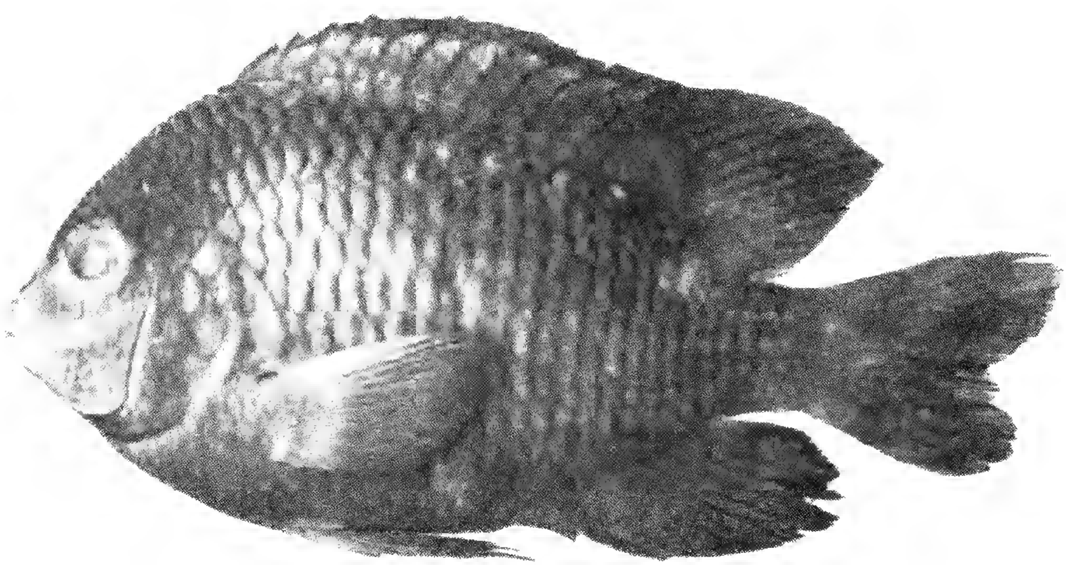

Fig. 9: *Stegastes acapulcoensis*, 102 mm, Perlas Archipelago (WAM P25511-005).

Diagnosis

(Proportions based on 20 specimens, 71-140 mm) Dorsal fin rays XII,15 (rarely 16), anal rays II,13; pectoral rays usually 21 or 22 (rarely 20; Panama, Ecuador, and Peru occasionally 23, see Table 3); scales in lateral line bearing tubes 20; vertical scale rows from upper edge of gill opening to base of caudal fin 26-27; between lateral line and origin of dorsal fin 3-3½; between 13th lateral-line scale and anal opening 10; gill rakers on lower limb of first branchial arch 11 to 13.

Depth of body 1.8 to 2.0, head length 2.9 to 3.2, snout length 2.5 to 3.0, eye diameter 3.4 to 4.0, interorbital width 2.9 to 3.7, preorbital width 3.8 to 5.7, depth of caudal peduncle 2.0 to 2.1, length of caudal peduncle 2.4 to 3.2, of pectoral fin 1.0 to 1.2, of pelvic fin 1.0 to 1.1, of caudal fin 1.0 to 1.2, all in head length.

Colour in alcohol: juveniles (under 60 mm) — general body colour reddish-brown, each scale of head, back, and sides, including scaly sheaths of dorsal and anal fins with a light or blue spot; a pair of blue lines from tip of snout, over eye to sides of spiny dorsal; a short blue bar on preorbital; large black spot on last spine and first three dorsal rays outlined by scales with blue centres, two-thirds of spot on base of rays and one-third of spot on body; a small ocellated spot on upper edge of caudal peduncle; dorsal spot present on specimens under 50 mm, fades and disappears between 50 and 60 mm; trace of caudal peduncle spot persists in specimens even as large as 75 mm. Adults and subadults (in excess of 60 mm) — light greyish to dark reddish-brown; scales with dark brown margin, scale centres paler, these forming light and dark oblique lines across body; light and dark area about equal in smaller specimens (up to 75 mm), lighter lines broader in largest (over 100 mm), head darker than body; lips usually dusky but lower lip pale on large specimens from Panama and Ecuador; vertical fins dark, exposed portion of dorsal membrane dark with small white fleshy tab just behind tip of each spine; caudal, anal, and pelvic fins dark; pectorals pale in specimens up to 75 mm, dusky distally in specimens 90-100 mm, dark distally and pale basally in largest specimens; distinct dark spot on base of upper pectoral ray, inner face of pectoral not darker than adjacent body colour.

Colour in life (from 35 mm transparencies taken by the senior author at the Perlas Archipelago in 2-4 metres depth): juveniles — generally bright blue with prominent ocellus at base of soft dorsal fin and ocellated black spot on dorsal edge of caudal peduncle; scale margins blackish; head dark grey or blackish with pair of bright blue lines from tip of snout, over eye to sides of spinous dorsal fin; blue spot on preorbital and others scattered on cheek and opercles; pectoral fins transparent; remainder of fins grey or dusky with sheath scales mostly blue; spinous dorsal and anterior edge of anal and pelvic fins with narrow margin of light blue. Adults — mostly brown, lighter on head and anterior portion of body; most of scales with blackish margins; fins dark brown to smoky grey; small black spot on upper pectoral base and uppermost two-thirds pectoral rays white on basal half; outer face of pectoral axil with prominent white band across base of rays.

Range

Widespread along the Pacific coast of Central and South America from Mexico (Baja California and Sinaloa Province) to Lobos de Afuera, Peru. Mr Alex Kerstitch reports (personal communication) that it is also locally common at Cabo San Lucas, Baja California and occurs in the Gulf of California at Isla Carmen off the Baja side (approximately 26°N) and at Isla San Ignacio Farallon off Topolobampo, Sinaloa (mainland Mexico). Over a large part of the range this species is sympatric with *S. flavilatus.*

Remarks

Fowler (1944) placed *S. acapulcoensis* in a new subgenus, *Omopamacentrus,* on the basis of an enlarged scale over the pectoral base, numerous small axillary scales on the occiput, interorbital, post ocular, and anterior opercular regions, and the dark colouration of the body and vertical fins. We have examined Fowler's type specimens and find all these characters within the range exhibited by other eastern Pacific *Stegastes.* The enlarged pectoral scale tends to be of greater size and hence most conspicuous in very large adults. It has been exaggerated in Fowler's drawing (Fig. 222).

Material examined

Holotype and paratype, ANSP 70281-70282, 158 and 137 mm, Acapulco, Mexico. In addition, 301 specimens, 12-117 mm, from Mexico (Acapulco), Costa Rica (Gulf of Nicoya), Panama (Gulf of Panama), Colombia (Bahia Utria), Ecuador (Gulf of Guayaquil), and Peru (Lobos de Afuera) studied at AMNH, FMNH, USNM, and WAM.

Stegastes rectifraenum
(Fig. 10)

Pomacentrus rectifraenum Gill, 1862. *Proc. Acad. nat. Sci. Philad.* 1862. 148 (type locality: Cape San Lucas, Baja California).

Pomacentrus analigutta Günther, 1862. *Cat. Fishes Brit. Mus.* 4: 27 (type locality: Cape San Lucas).

Diagnosis

(Proportions based on 13 specimens, 78-88 mm) Dorsal fin rays XII,15 (rarely 16); anal rays II,13 (rarely 12 or 14); pectoral rays usually 20 (occasionally 19 or 21); scales in lateral line bearing tubes 20 (rarely 19); vertical scale rows from upper edge of gill opening to caudal fin base 26-27, between lateral line and origin of dorsal fin 3½, between 13th lateral-line scale and anal opening 11 (rarely 10½); gill rakers on lower limb of first branchial arch 12 (rarely 11).

Depth of body 1.9 to 2.1, head length 2.9 to 3.2, both in standard length; snout length 2.7 to 3.0, eye diameter 3.4 to 3.6, interorbital width 3.5 to 3.9, preorbital width 5.4 to 6.5, depth of caudal peduncle 2.0 to 2.2, length of caudal peduncle 2.7 to 3.2, of pectoral fin 1.1 to 1.2, of pelvic fin 1.0 to 1.1, of caudal fin 1.0 to 1.2, all in head length.

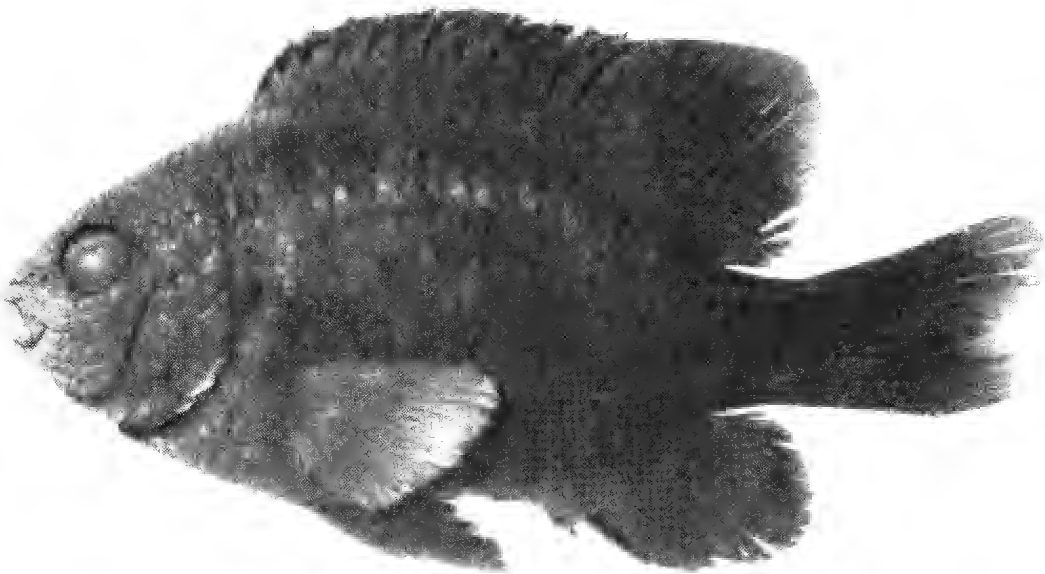

Fig. 10: *Stegastes rectifraenum*, 86 mm, Gulf of California (WAM P25544-001).

Colour in alcohol: juveniles (under 60 mm) — many specimens overall dark, but others showing markings as follows: scales of head and body with basal portion blue, most distinct on back and base of anal fin; distinct blue lines from snout to origin of dorsal fin and from eye along base of dorsal fin; a large dark ocellus on base of last dorsal spines and first soft rays; a small saddle-shaped ocellus on caudal peduncle just behind last dorsal ray, becoming very faint and disappearing in specimens between 40-50 mm, occasionally persisting as a faint remnant to 60 mm; spot on base of upper pectoral rays very distinct, often with narrow extension ventrally across base of most rays. Adults and subadults — overall dark reddish-brown to dark greyish-brown; scales with narrow dark margin or slightly lighter basal portion forming faint transverse lines on sides (sometimes absent); lips dusky, except pale on middle portion of lower lip; some specimens with narrow blue lines on head or each scale of head with faint blue or white marking; opercular membrane dark at notch, pale below; vertical fins dark except tips of dorsal and caudal rays; membrane of spiny dorsal with broad dark band on distal portion, a paler area below this, along edge of scales covering dorsal; pelvic fins dark, the membranes darker than the rays;

pectoral fin pale, a diffuse dark spot on base of uppermost one or two rays; inner face of pectoral not darker than body colour, but basal spot usually distinct on upper rays; largest specimen with median pectoral rays dusky.

Colour in life (based on 35 mm transparencies taken in the Gulf of California by Mr Dave Powell): juveniles — scales of head, body, and base of fins with blue centres and black margins giving overall bright blue appearance; black spot (remnant of ocellus) about size of eye at base of anterior soft dorsal rays; small blue-rimmed black ocellus on dorsal edge of caudal peduncle; a pair of bright blue lines from snout to origin of dorsal fin; similar lines on preorbital, suborbital, and cheek; small blue spot at base of posteriormost anal rays; pectoral fins yellowish; rest of fins smoky grey; margin of spinous dorsal and anterior edge of anal and pelvic fins with narrow margin of light blue. Adults — head, anterior portion of body, and most of spinous dorsal fins pale reddish-brown; blue stripes on snout and forehead, and bright blue scale centres sometimes persisting in adults; posterior portion of body and all fins except pectorals dark charcoal-grey to blackish; scales of body with dark margins giving overall appearance of alternating light and dark lines, particularly evident on lighter anterior portion of body; pectoral fins yellowish.

Range

Magdalena Bay on the west coast of Baja California and the entire coast of the Gulf of California, including islands; not known south of the state of Sonora on the Mexican mainland. The many literature and museum records of this species from locations south of the Gulf of California are mostly attributable to *S. acapulcoensis.*

Remarks

The description of *Pomacentrus analigutta* was apparently never published although the authorship is credited to Günther on the basis of its inclusion in a key which appears in his Catalog of Fishes in the British Museum (1862). It is likely that Gill intended to describe the species as Günther stated that the key was communicated to him by Gill. There are 13 specimens, 13-36 mm, at the USNM (register no. 3674) which are labelled as the types of *analigutta.* These are synonymous with *S. rectifraenum.*

The number of pectoral rays is a reliable character for separating *rectifraenum* from *acapulcoensis*, species which are often confused. The pectoral counts are compared in Table 3.

Material examined

Syntypes, USNM 3670, 4 specimens, 41-64 mm, Cape San Lucas. In addition, 225 specimens, 13-87 mm from the Gulf of California and Magdalena Bay were studied at AMNH, CAS, FMNH, USNM, and WAM.

Table 3: Comparison of number of pectoral rays in *Stegastes rectifraenum* and *S. acapulcoensis* by region.

		No. spec.	Pectoral rays				
			19	20	21	22	23
S. rectifraenum	Baja Calif.-W. Coast and Cape San Lucas	18	3	14	1		
	Baja Calif.-E. Coast and Gulf Islands	26	5	21			
	Mainland Sonora Mexico	24	4	20	1		
S. acapulcoensis	Mazatlán and Tres Marias Islands	22		1	5	16	
	Acapulco	27			7	20	
	Costa Rica	2				2	
	Panama	17			1	14	2
	Ecuador	13			3	9	1
	Peru	3				1	2
	Galapagos	2				2	

Stegastes arcifrons
(Fig. 11)

Pomacentrus arcifrons Heller and Snodgrass, 1903. *Proc. Wash. Acad. Sci.* 5: 202, Pl. 7 (type locality: Barrington Island, Galapagos Archipelago).

Diagnosis

(Proportions based on 20 specimens, 89-119 mm) Dorsal fin rays XII,15 (rarely 16); anal rays II,13 (rarely 12); pectoral rays 20 (rarely 19); scales in lateral line bearing tubes 20 (rarely 19); vertical scale rows from upper edge of gill opening to caudal fin base 26-27, between lateral line and origin of dorsal fin 3-3½, between 13th lateral-line scale and anal opening 10; gill rakers on lower limb of first branchial arch 12 or 13 (rarely 14).

Depth of body 1.8 to 2.1, head length 2.9 to 3.4, both in standard length; snout length 2.7 to 3.0, eye diameter 3.4 to 3.9, interorbital width 3.1 to 3.8, preorbital width 4.4 to 5.8, depth of caudal peduncle 2.0 to 2.1, length of caudal peduncle 2.4 to 2.9, of pectoral fin 1.1 to 1.3, of pelvic fin 0.9 to 1.2, of caudal fin 0.9 to 1.2, all in head length.

Colour in alcohol: juveniles (under 60 mm) — primarily reddish-brown with the caudal peduncle and adjacent body region more or less abruptly light yellow. The fins are similar to the body in colour except the pectorals, soft dorsal, caudal, and posterior anal rays are pale. There is a pale rimmed black ocellus at the base of the soft dorsal junction. Adults and subadults — head and back dark reddish-brown, sides with oblique streaks following edges of scale rows antero-ventrally, scale bases yellowish; caudal peduncle and caudal fin pale yellow in small specimens, dusky to completely dark in large specimens; breast and abdomen tan to reddish-brown; anal opening pale, lips pale; opercular membrane dusky dorsally; anal, pelvics, and dorsal margin of caudal fin dark; membranes between middle caudal rays with dark streaks; pectoral fins pale, a small black spot on base of upper ray only and extending along dorsal margin of ray; inner face of pectoral base dark with very distinct narrow light streak across base of rays, basal portion of rays on inner side dusky, highlighting light streak.

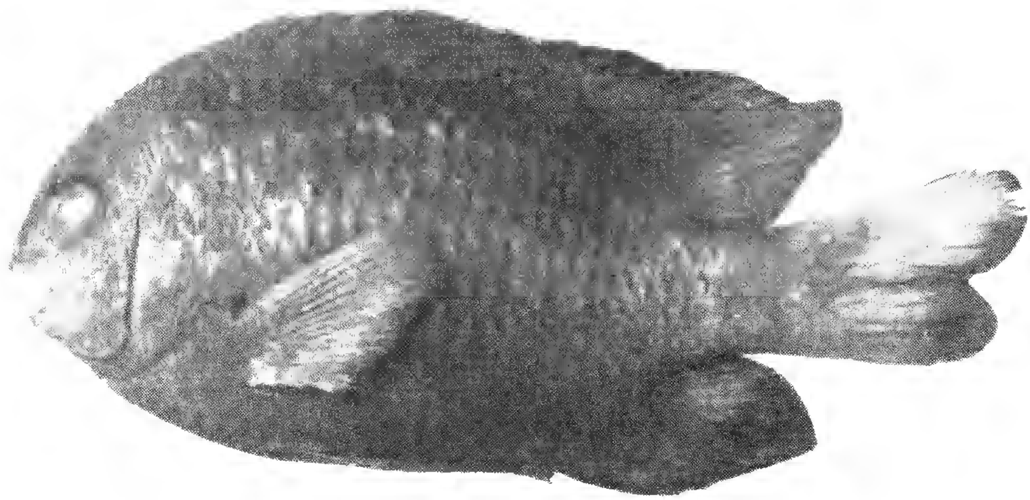

Fig. 11: *Stegastes arcifrons*, 102 mm, Galapagos Archipelago (WAM P25575-001).

Range

Known only from the Galapagos Archipelago, Malpelo Island (Fowler, 1938; McCosker and Rosenblatt, 1975), and Coco Island.

Remarks

Slight differences in body depth and head length were noted between specimens from the Galapagos and Coco Island. Individuals from the latter locality generally have a slightly longer head (2.89-3.17 in SL vs. 3.04-3.37) and are slightly deeper bodied (1.80-1.99 in SL vs. 1.82-2.10) than Galapagos specimens. There do not appear to be any differences in colour or meristic values between the two populations. It is doubtful that even racial differences can be shown between the two populations which are separated by approximately 700 km.

Material examined

Holotype, SU 6356, 113 mm, Barrington Island, Galapagos Archipelago; paratypes, SU 6536, 3 specimens, 70-104 mm, Albemarle Island, Galapagos; paratypes, BMNH 1901.6.28.212-21, 17 specimens, 53-122 mm, Duncan Island, Galapagos. In addition, 370 specimens, 27-124 mm, from the Galapagos studied at CAS, FMNH, and USNM. Also six specimens, 66-92 mm, from Coco Island, Costa Rica.

Stegastes redemptus
(Fig. 12)

Pomacentrus redemptus Heller and Snodgrass, 1903. *Proc. Wash. Acad. Sci.*, 5: 200, Pl. 6 (type locality: Clarion Island, Revillagigedo Islands).

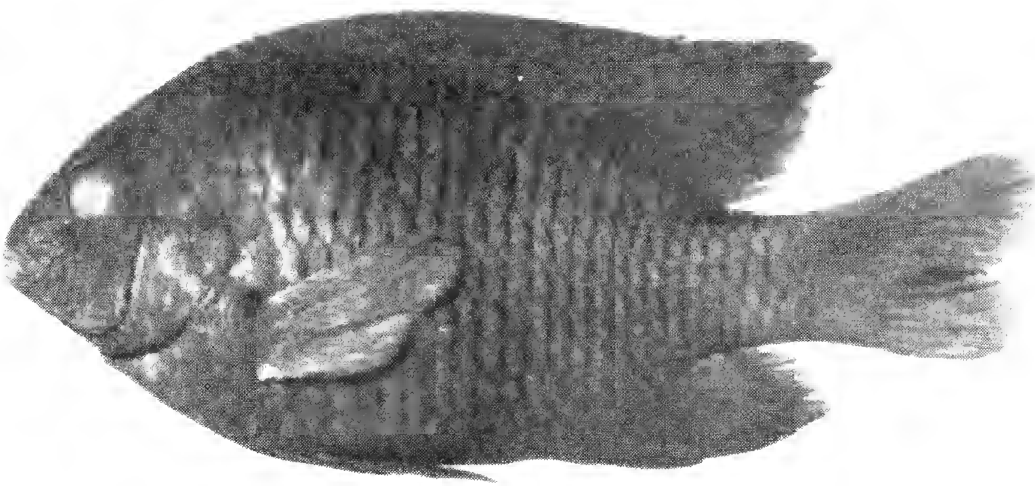

Fig. 12: *Stegastes redemptus*, 103 mm, Revillagigedo Islands (FMNH 61888).

Diagnosis

(Proportions based on 18 specimens, 80-107 mm) Dorsal fin rays XII,15 (rarely 14); anal rays II,13; pectoral rays 20 (rarely 19 or 21); scales in lateral line bearing tubes 20 (rarely 19 or 21); vertical scale rows from upper edge of gill opening to caudal fin base 26 (rarely 27), between lateral line and origin of dorsal fin 3½, between 13th lateral-line scale and anal opening

10; gill rakers on lower limb of first branchial arch 13-14 (rarely 12 or 15).
(rarely 12 or 15).

Depth of body 1.9 to 2.0, head length 3.0 to 3.5, both in standard length; snout length 2.7 to 3.0, eye diameter 3.0 to 3.6, interorbital width 3.1 to 3.8, preorbital width 5.1 to 5.8, depth of caudal peduncle 1.8 to 2.0, length of caudal peduncle 2.4 to 3.1, of pectoral fin 1.0 to 1.2, of pelvic fin 0.8 to 1.1, of caudal fin 0.9 to 1.1, all in head length.

Colour in alcohol: juveniles (under 60 mm) — slightly paler than adults; a black spot, about equal to eye size, at base of anteriormost soft doral rays; much smaller black spot on dorsal edge of caudal peduncle. These markings gradually fade with growth and are no longer apparent after a length of approximately 60-65 mm is attained. Adults and subadults — reddish-brown on head, nape and upper sides above lateral line; tip of snout darker than rest of head, lips dusky; sides below lateral line with dark oblique streaks following scale rows formed by dark margins along scales; centres of scales lighter brown, yellowish or even reddish in freshly preserved specimens; spiny dorsal membranes dark along distal edge, tips of soft rays forming dorsal margin dark; posterior half of soft dorsal with membranes dark, rays pale; caudal fin pale, outer edges with a very narrow dark line; membranes of caudal, soft dorsal, and anal fins dusky; anal fin coloured as adjacent body on basal scaly portion, rays pale, membranes dark; pelvic fins dark, membranes darker than rays; pectoral fins pale, a small black spot on base of upper ray extending along outer edge of upper pectoral ray; inner face of pectoral base dark overall with distinct pale streak across basal portion of rays.

Colour in life: juvenile (30 mm collected by Mr Alex Kerstitch at Cabo San Lucas) — overall bright yellow with some duskiness on upper back; a prominent dark spot at base of anterior soft dorsal rays; a smaller dark spot on upper edge of caudal peduncle. Another juvenile, 40 mm, was maintained in captivity for four months by Mr Kerstitch. During this period the fish grew to 60 mm and assumed an overall dusky colour with only a hint of the dorsal spot remaining. Adult (from 35 mm transparency taken by Mr Dave Powell at Socorro Island in six metres depth, total length of fish approximately 130 mm) — head and anterior portion of body light brown, middle portion of body gradually becoming darker brown and posterior one-fourth whitish; most of body scales with prominent blackish margins giving overall reticulated appearance; large diffuse bluish patch on upper back and posterior portion of spiny dorsal fin in transitional region between light and dark parts of body; remainder of spinous dorsal charcoal coloured with narrow black margin; soft dorsal and anal fins mostly whitish with pale yellow on outer portion; caudal fin pale yellow; pelvic fins dark brown; pectoral fins transparent, but slightly yellowish.

Range

Previously known only from Revillagigedo Island, but Mr Alex Kerstitch (personal communication) recently collected two juveniles, 30-40 mm SL, at Bahia Santa Maria, Cabo San Lucas, Baja California.

Remarks

This species appears to be most closely related to *S. arcifrons*, but differs significantly with regard to head shape and modal number of gill rakers on the lower limb of the first branchial arch (Table 1). The forehead profile of *S. arcifrons* is blunter or steeper than that of *S. redemptus* (compare Figs 11 and 12). In addition, there are consistent colour pattern differences. The lips of *S. redemptus*, particularly the upper, are not significantly paler than the surrounding area as they are in *S. arcifrons*. Also the outer portion of the longest dorsal rays tend to be dusky in *S. redemptus* and noticeably pale in *S. arcifrons*. Finally, there is a significant difference in the colouration of juveniles: those of *S. arcifrons* lack the small dark spot on the dorsal surface of the caudal peduncle which is characteristic for *S. redemptus*.

Material examined

Holotype, SU 6358, 108 mm, Clarion Island, Revillagigedo Islands, Mexico. Numerous additional specimens at CAS, FMNH, UCLA, and USNM, all from the Revillagigedo Islands, 38-112 mm.

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STEGASTES; A SENIOR SYNONYM FOR THE DAMSELFISH GENUS *EUPOMACENTRUS*; OSTEOLOGICAL AND OTHER EVIDENCE, WITH COMMENTS ON OTHER GENERA

ALAN R. EMERY*

&

GERALD R. ALLEN†

ABSTRACT

Caribbean and Indo-Pacific damselfishes that are presently placed in the genus *Eupomacentrus* share diagnostic generic characters with Eastern Atlantic species of *Stegastes*. *Eupomacentrus* Bleeker, 1877 is therefore considered to be a junior synonym of *Stegastes* Jenyns, 1842. *Stegastes* is clearly separable from *Pomacentrus*, its most similar relative, on the basis of external morphology and osteology.

INTRODUCTION

The damselfishes (Pisces: Pomacentridae) have had a long history of confused generic limits, beginning with Linnaeus (1758) who placed *Abudefduf saxatilis* in the genus *Chaetodon*, and continuing to the last decades when taxonomists (e.g. Rivas, 1960) placed members of the genus *Eupomacentrus* (*sensu* Bleeker, 1877) into the genus *Pomacentrus* (originally described by Lacépède, 1892). In the course of investigations of type specimens of many pomacentrid fishes, we examined the holotype of *Stegastes imbricatus* Jenyns, 1842. This paper defends the position that the genera *Stegastes* and *Eupomacentrus* are synonymous.

MATERIALS AND METHODS

Osteological information was gathered from radiographs and specimens cleared and stained using trypsin and alizarin red. Skeletal drawings were made from a camera lucida image. A total of 250 specimens representing

* Royal Ontario Museum, 100 Queen's Park, Toronto, Ontario, Canada.

† Western Australian Museum, Francis Street, Perth, Western Australia 6000.

94 species and 21 pomacentrid genera from the collections of the following institutions was examined: Academy of Natural Sciences (Philadelphia), Bernice P. Bishop Museum (Hawaii), British Museum of Natural History (London), California Academy of Sciences (San Francisco), Department of Agriculture Stock and Fisheries (Papua-New Guinea), Field Museum of Natural History (Chicago), Florida State Museum (Gainsville), J.L.B. Smith Institute of Ichthyology (Grahamstown, South Africa), Museum National d'Histoire Naturelle (Paris), Rosenteil School of Marine and Atmospheric Science (Miami), Royal Ontario Museum (Toronto), Smithsonian Oceanographic Sorting Centre (Washington, D.C.), National Museum of Natural History (Washington, D.C.) and Western Australian Museum (Perth).

We have also examined the holotype (BMNH 1917.7.14.45), 58.5 mm SL, of *Stegastes imbricatus* collected off Quail Island, Porto Praya, Cape Verde Islands by Charles Darwin aboard *Beagle*. In addition, we have studied numerous examples representing all known species of *Stegastes* (*sensu novum*). We are presently preparing a revision of this genus which contains approximately 35 species distributed mainly in the tropical eastern and western Atlantic, eastern Pacific and Indo-West Pacific faunal provinces.

Definition of *Eupomacentrus* Bleeker

Bleeker's original description of *Eupomacentrus* in 1877, based on the species *Chaetodon lividus* Bloch & Schneider, 1801, noted the following distinguishing features:

1 Maxillary teeth uniserial and truncate.
2 Scaled rostrum.
3 Suborbital bones and preoperculum serrated (only anterior three suborbital bones have serrae in type species).
4 Suboperculum edentate.
5 A single spine at the angle of the operculum.
6 Dorsal spines XII, rays 14 to 17.
7 Anal rays 12 to 14.

In the same publication, Bleeker stated that *Pomacentrus punctatus* and *P. albifasciatus* from the Pacific, and *P. fuscus* and *P. variabilis* from the Caribbean were referable to the new genus. He further remarked that the species *Pomacentrus pictus* which ' . . . M. de Castelnau supposed could well be a variety of *Pomacentrus variabilis* appears to me more likely [to be] a species of *Glyphisodon*, in the subgenus *Stegastes*.' (:73 — translation). Bleeker, therefore, inferred a close relationship between *Stegastes* and *Eupomacentrus*.

Definition of *Stegastes* Jenyns

Jenyns (1824) described *Stegastes* based on the species *S. imbricatus* and included the following characters which correspond to those Bleeker later used to define the genus *Eupomacentrus*:

1 Maxillary teeth all uniserial.
2 Rostrum scaled.
3 Suborbital bones and preoperculum denticulated.
4 Suboperculum denticulated.
5 Opercle unarmed (Jenyns noted in his description of *imbricatus* that '. . . The opercle terminates posteriorly in a very obtuse angle, and shows some indication of two very minute flattened points which however do not project beyond the membrane').
6 Dorsal spines XII, rays 16.
7 Anal rays 12.

In his comments on the holotype of *S. imbricatus*, Jenyns stated that his new genus *Stegastes* was unlike *Pomacentrus* in having very scaly fins. It is true that *Stegastes* does have scaled fins, but this feature is also found in *Pomacentrus*. He also stated '. . . this genus further shows itself an affinity to *Glyphisodon*, in the filamentous prolongation of the first soft rays in the ventrals. This character is not, I believe, found in *Pomacentrus*.' However, in contrast to Jenyns' statement, species of *Pomacentrus* often possess ventral fins which are prolonged into a filament. Therefore, in view of the prevailing taxonomy of pomacentrids Jenyns was not justified in splitting *Stegastes* from *Pomacentrus*, at least not on the basis of the characters he presented. Thus, his recognition of this discrete generic unit was really 'accidental'.

Although the original definitions of *Eupomacentrus* and *Stegastes* include the presence of only 12 dorsal spines, a number of Indo-Pacific species have subsequently been assigned to this group which have 13 spines and one species, *S. gascoynei*, has 14 dorsal spines (Allen, 1975, chapter on *Eupomacentrus*).

Glyphisodon was described by Lacépède (1802, type species = *G. moucharra*) and since then numerous species have been referred to this genus (e.g. Cuvier & Valenciennes, 1830). Recently, the name has been recognised as a junior synonym of *Abudefduf* (Forsskål, 1775). It would appear that Jordan & Seal (1906), in their review of the fishes of Samoa, were among the first to adopt *Abudefduf* as a general synonym for Lacépède's name. The replacement of *Glyphisodon* by *Abudefduf* was first resisted not only on taxonomic grounds, but on etymological principles. Ogilby (1913), for instance, stated '. . . I am unable to accept Forsskål's *Abudefduf*, both because of its manifest barbarity, and . . . [because Forsskål] employed it as a stop-gap measure until he should decide on a more suitable name.' Still, *Abudefduf* has been widely accepted by recent workers (Allen, 1975). Both

Jenyns (1842) and Bleeker (1877) suggested a close relationship between *Glyphisodon* (= *Abudefduf*) and *Stegastes*. *Abudefduf* as currently recognised is, however, easily separated and very distinct from *Stegastes*. In contrast to *Stegastes*, *Abudefduf* has: no serrations on the suborbitals, preopercle or subopercle; notched teeth in the upper jaw, and a colour pattern usually composed of dark vertical bars on a paler background.

The genus most easily confused with *Eupomacentrus-Stegastes* is *Pomacentrus* Lacépède. Bleeker (1877) gave an accurate definition of the latter genus which is generally followed by current taxonomists. Using his definition *Pomacentrus* is restricted to those species having two rows of teeth in the upper jaw (the second a row of small, inner buttress teeth), a notch in the suborbital series, and 13 to 14 dorsal spines. Thus, the two can be separated with no overlap.

Bleeker's suggestion that '*Pomacentrus pictus*' belonged in Jenyns' genus *Stegastes* is surprising. This Brazilian species and its Caribbean geminate *Stegastes partitus* are essentially equivalent to Bleeker's description of *Eupomacentrus*. Had Bleeker examined Jenyns' specimens, he would have been unlikely to have created the genus *Eupomacentrus*. The only readily recognisable difference (one not mentioned by Bleeker) between the *partitus-pictus* pair and other species of *Stegastes* is the presence of three instead of four rows of cheek scales respectively. It is our opinion that both *partitus* and *pictus* belong in the genus *Stegastes*.

Osteology

In the course of osteological investigations of damselfishes, differences in the number and arrangement of predorsal bones were observed. The most common number of predorsal bones in damselfishes is three, although one or two predorsals also occur. A single predorsal bone (as occurs in *Pristotis* and *Teixeirichthys*) may be the result of a fusion of all three elements, or may represent the enlargement of a single bone following loss of the other two (Fig. 1B). The number of predorsal bones is usually consistent within a damselfish genus, although three exceptions have been noted to date: *Neopomacentrus* normally has three predorsal bones, but the single specimen examined of *N. cyanomos* had only two: *Amphriprion* is quite variable with specimens of *A. ocellaris* having either three or two predorsal bones (the characteristic of having two predorsal bones therefore is not unique to *Premnas* in the Amphiprioninae as Allen, 1972, suggested); *Pomacentrus* includes species that have two predorsal bones.

The pattern of interpenetration of the predorsal bones between the neural spines of anterior vertebrae is quite consistent within a genus. Where three predorsal bones are present, the penetration of the first bone is into the

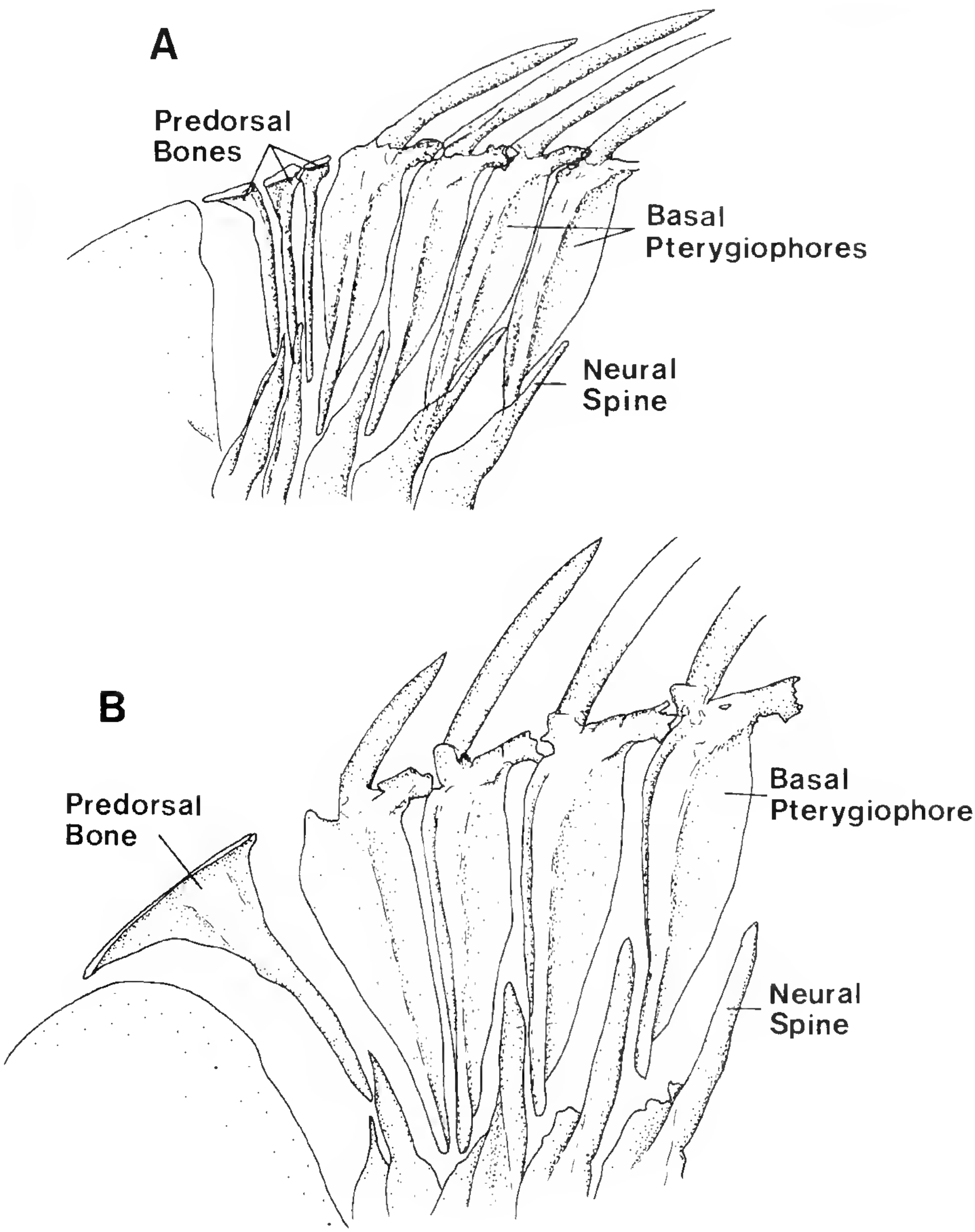

Fig. 1: The predorsal bone and pterygiophore interpenetration of the interspaces formed by the vertebral neural spines in two species of damselfishes (A — *Stegastes variabilis*; Caribbean. B — *Pristotis jerdoni*; Indo-west Pacific). Predorsal bones in A penetrate the first three spaces (coded 1,1,1); in B the single predorsal bone penetrates the second space only (coded 0,1,0). Pterygiophores in A penetrate spaces singly, beginning with the third space (coded 0,0,1,1,1 . . .); in B two pterygiophores penetrate the third space, but penetrate singly thereafter (coded 0,0,2,1,1 . . .).

space between the cranium and first neural spine, the second bone penetrates between the first and second neural spine, and the third penetrates between the second and third neural spine. The arrangements of the interpenetration can be expressed as 1,1,1; or 1,2,0; or 0,2,1. We know of no other combinations. When there are two predorsal bones they seem consistently to penetrate the first two interspaces (1,1,0). Where there is a single predorsal bone (*Pristotis*, *Texeirichthys*) the pattern is 0,1,0 (**Fig. 1B**).

Pterygiophores also interpenetrate the spaces between neural spines, but beginning at the third interspace. Only two pterygiophore patterns have been found in pomacentrids: 0,0,2,1,1,1 . . . 0,0,1,2,1,1 . . . (**Fig. 1A, B**). The pattern in *Stegastes* and *Abudefduf* is: predorsal bones 1,1,1; pterygiophores 0,0,2,1,1 . . . (Table 1). A total of 13 genera were found to have a pterygiophore interpenetration of 0,0,2,1,1,1 . . . , while eight genera have a pattern of 0,0,1,2,1,1 . . . The combination of predorsal and pterygiophore patterns for various pomacentrid genera are listed in Table 1.

Table 1: Summary of the predorsal bone number and predorsal bone and pterygiophore interpenetration with the interspaces formed by vertebral neural spines for various pomacentrid genera (see text and figures for the explanation of the code used).

Pterygiophore	0,0,1,2,1,1 ...	0,0,2,1,1,1 ...					Number of species examined
Predorsal Bones	1,1,1	1,1,1	1,2,0	0,2,1	1,1,0	0,1,0	
Genus							* = monotypic
Amphiprion		x			x		4
Neopomacentrus		x			x		4
Dischistodus		x					3
Paraglyphidodon		x					2
Pomacentrus		x	x		x		28
Amblyglyphidodon		x					1
Hemiglyphidodon		x					1*
Cheiloprion			x				1*
Chrysiptera				x			4
Acanthochromis					x		1*
Premnas					x		1*
Teixeirichthys						x	1*
Pristotis						x	1*
Stegastes	x						17
Chromis	x						10
Plectroglyphidodon	x						3
Abudefduf	x						2
Mecaenichthys	x						1*
Dascyllus	x						4
Lepidozygus	x						1*
Microspathodon	x						1

SUMMARY

We conclude that the status of the above mentioned genera is as follows:

Abudefduf Forsskål, 1775 (valid)
Glyphisodon Lacépède, 1802 (= *Abudefduf*)
Stegastes Jenyns, 1842 (valid)
Pomacentrus Lacépède, 1802 (valid)
Eupomacentrus Bleeker, 1877 (= *Stegastes*)

The gender of *Stegastes* and of *Eupomacentrus* are both masculine, thus no change is required in the endings of trivials of the binomen when species formerly placed in *Eupomacentrus* are referred to *Stegastes*.

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We give special thanks to the following people who have made substantial contributions in criticising early drafts of the manuscript: Dr R. Winterbottom, Dr E.J. Crossman (both of the Royal Ontario Museum, Toronto), and Dr J.E. Randall (Bernice P. Bishop Museum, Hawaii). Mrs C.J. Allen prepared the final typescript.

Because the pomacentrids represent a large and diverse group of tropical and subtropical species with many easily investigated ecological and behavioural characteristics, they have been popular subjects for investigation by non-systematists. We appreciate the many suggestions we have received from these scientists and have weighed them carefully in coming to the decision suggested here.

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SOME LAELAPINE PARASITES OF AUSTRALASIAN MAMMALS (ACARI: DERMANYSSIDAE)

R. DOMROW*

ABSTRACT

Twenty-one species in six genera of laelapine mites, mostly from the Kimberley, Western Australia, are listed: *Mesolaelaps* (two species), *Haemolaelaps* (five), *Androlaelaps* (one), *Laelaps* (10, including four new ones from murine rodents: *L. elegans* from *Pseudomys* spp., *L. synnomus* from *Zyzomys argurus*, *L. parameces* from *Conilurus penicillatus* and *L. angiodes* from *Z. woodwardi*), *Neolaelaps* (one) and *Trichosurolaelaps* (two).

INTRODUCTION

This contribution to our knowledge of Western Australian ectoparasites collected by Dr F.S. Lukoschus, Catholic University, Nijmegen, treats the various laelapine mites from mammals (for completeness' sake, I have incorporated data from a few other slides, mostly with Western Australian Museum labels). Current papers on the group in Australia are more concerned with the fauna of the eastern states (Domrow 1973, 1977, 1979).

The term "holotrichous" refers to the setal condition in typical free-living dermanyssids (Evans & Till 1965, Evans 1969). Hosts are given after Ride (1970). Numbers in the 2-3000s are Dr Lukoschus' field numbers for the hosts. Depositories for mites are abbreviated: WAM Western Australian Museum, Perth; FMNH Field Museum of Natural History, Chicago; QIMR Queensland Institute of Medical Research, Brisbane; CU Catholic University, Nijmegen; ANIC Australian National Insect Collection, CSIRO, Canberra; MNK Museum für Naturkunde an der Humboldt-Universität, Berlin; RMNH Rijksmuseum van Natuurlijke Historie, Leiden; ZMH Zoologisches Institut und Zoologisches Museum der Universität, Hamburg.

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* Queensland Institute of Medical Research, Bramston Tce, Herston, Brisbane, Queensland 4006, Australia.

DESCRIPTION OF MATERIAL

Mesolaelaps australiensis (Hirst, 1926)

This species is widespread throughout Australia and adjacent territories (Domrow 1979). *Notomys alexis* and *Pseudomys nanus* are added to its equally wide range of hosts.

Hosts and Localities

On brindled bandicoot, *Isoodon macrourus* (Gould) (Marsupialia: Peramelidae) (3150), Port Warrender, W.A., 31.X.1976 (7 ♀♀). In WAM, FMNH, QIMR, CU.

On Tunney's rat, *Rattus tunneyi* (Thomas) (Rodentia: Muridae) (2679), Mount Hart, W.A., 10.IX.1976 (8 ♀♀). On *R. tunneyi* (3140), Port Warrender, 30.X.1976 (3 ♀♀, 1 ♂). In WAM, FMNH, QIMR, CU.

On spinifex hopping mouse, *Notomys alexis* Thomas (Muridae) (M12964), Wanjarri Nature Reserve, W.A., 8.I.1975, P. Lambert (1 ♀). In WAM.

On western chestnut native mouse, *Pseudomys nanus* (Gould) (Muridae) (3030), Mitchell Plateau, W.A., 20.X.1976 (1 ♀). In WAM.

On scale-tailed rat, *Melomys* sp. (Muridae) (3140, 3141), Port Warrender, 30.X.1976 (3 ♀♀). In WAM, FMNH, QIMR.

Mesolaelaps antipodianus (Hirst, 1926)

This species is common on bandicoots in east and south-east Australia, including Tasmania (Domrow 1963, 1977), but was previously unknown from *Isoodon auratus* and Western Australia. The specimen from *Antechinus macdonnellensis* is best regarded as a straggler. The dorsal shield of this species has not previously been described.

Female (**Fig. 1**): Dorsal shield 900-915 μm long, 670-690 μm wide; as characteristic (broadly drop-shaped, with truncate termen) as that of *M. sminthopsis* (Womersley) (see Domrow 1977); surface granulate, with very weak reticulate striae marginally from vertex to posterolateral angles; holotrichous (with 22 pairs of setae on podonotal portion, 17 on opisthonotal; J_4 widely set and J_5 displaced to termen, thereby leaving large quadrate expanse between their bases bare), lacking only one pair of pores (that behind j_4) of 22 pairs figured by Evans & Till (1965) for *Laelaps* Koch.

Hosts and Localities

On golden bandicoot, *Isoodon auratus* (Ramsay) (Marsupialia: Peramelidae) (M7181), Barrow Island, W.A., 29.V.1964, W.H. Butler (9 ♀♀). In WAM, FMNH, QIMR, CU.

On red-eared marsupial mouse, *Antechinus macdonnellensis* (Spencer) (Marsupialia: Dasyuridae) (M8938), Warburton Range, W.A., 6.VIII.1967, A.M. Douglas (1 ♀). In WAM.

Fig. 1: *Mesolaelaps antipodianus* (Hirst). Dorsal shield ♀. (All scales = 100 μm.)

***Haemolaelaps casalis* (Berlese, 1887a)**

This widespread associate of vertebrates and their nests is known from the south-west Pacific and south-east Australia, but not from Western Australia (Womersley 1956, Wilson 1967, Domrow 1973). The question of its synonymy with *H. fenilis* (Mégnin) remains unresolved (Strandtmann 1963, Evans & Till 1966).

Host and Locality

On common rock rat, *Zyzomys argurus* (Thomas) (Rodentia: Muridae) (3117), Port Warrender, W.A., 29.X.1976 (1 ♀). In WAM.

Haemolaelaps marsupialis (Berlese, 1910)

This species is common on bandicoots in eastern Australia, including Tasmania (Keegan 1956, Domrow 1963), but was previously unknown from *Isoodon auratus* and Western Australia.

Host and Locality

On golden bandicoot, *Isoodon auratus* (Ramsay) (Marsupialia: Peramelidae) (M7181), Barrow Island, W.A., 29.V.1964, H.W. Butler (2 ♀♀). In WAM.

Haemolaelaps domrowi Womersley, 1958

This species is common on bandicoots in New Guinea and eastern Australia, including Tasmania (Domrow 1961, 1979), but was not previously known from Western Australia. The deutonymph was previously unknown. The specimens from *Rattus tunneyi* are best regarded as stragglers.

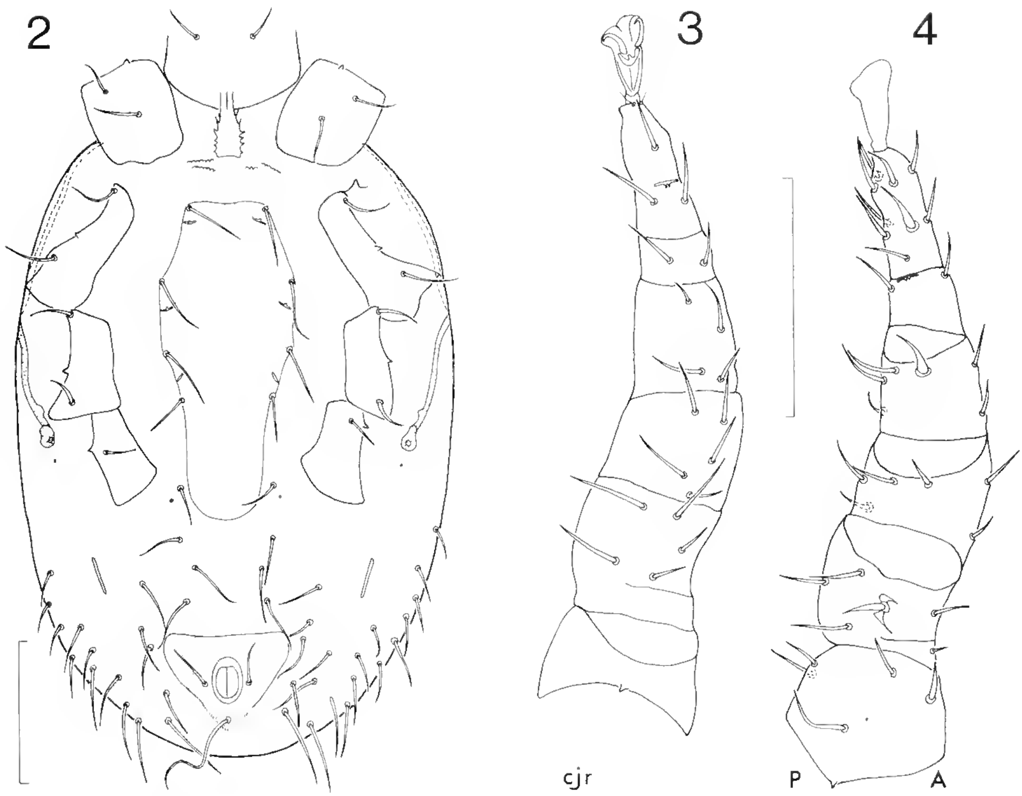
Femur II, even among the same series, may show seta *av* associated with a low, bilobed prominence. Correlated with this, seta *av* on genu-tibia II and av_2 on tarsus II may be flared basally.

Deutonymph (**Figs 2-4**): Freshly moulted and pale, but capitulum essentially as in ♀.

Dorsal shield 445-470 μm long, laterial margins not especially clear, but certainly incised between podonotal and opisthonotal portions. Dorsum otherwise as in ♀.

Some presternal striae spinulose. Sternogenital shield 215-225 μm long, 90-95 μm wide at level of second pair of sternal setae (st_2); posterior margin broadly ligulate; surface with a few reticulate striae anterolaterally; with usual four pairs of setae and three pairs of pores; genital setae *(g)* and pores free in adjacent cuticle. Anal shield 60-65 μm long, *ca* 80 μm wide. Ventral cuticle with about 20 pairs of setae of increasing length posteriorly. Venter otherwise as in ♀, except that poststigmatic pores are free in cuticle.

Leg setation holotrichous, predicting that of ♀ noted above [but note that Till (1963) found genu IV in Ethiopian species of *Androlaelaps* Berlese—taken to include *Haemolaelaps* Berlese—to bear one additional seta (pl_2), *i.e.* 2-5/1-2].



Figs 2-4: *Haemolaelaps domrowi* Womersley. 2, Idiosoma dn (ventral). 3-4, Leg II dn (dorsal, and ventral and lateral).

Hosts and Locality

On brindled bandicoot, *Isoodon macrourus* (Gould) (Marsupialia: Peramelidae) (3150), Port Warrender, W.A., 31.X.1976 (12 ♀♀, 4 ♂♂, 1 dn, 1 pn). In WAM, FMNH, QIMR, CU.

On Tunney's rat, *Rattus tunneyi* (Thomas) (Rodentia: Muridae) (3112, 3140), Port Warrender, 29, 30.X.1976 (5 ♀♀, 1 ♂, 1 dn, 1 pn). In WAM, FMNH, QIMR, CU.

Haemolaelaps hattenae Domrow, 1963

The only known records of this species are from rat kangaroos: *Aepyprymnus rufescens* in Queensland and *Bettongia gaimardi* (Desmarest) in Tasmania (Domrow 1963, 1972a).

Hosts and Localities

On rufous rat kangaroo, *Aepyprymnus rufescens* (Gray) (Marsupialia: Macropodidae), Tooloom, N.S.W., 14.XI.1961, J.H. Calaby (2 ♀♀). In QIMR.

On brush-tailed rat kangaroo, *Bettongia penicillata* (Gray) (Macropodidae), Manjimup, W.A., 19.XII.1977, G. de Chaneet (1 ♀). In QIMR.

Haemolaelaps quartus Domrow, 1961

The only known records of this species are from the rat kangaroo *Aepyprymnus rufescens* in S.E. Queensland and adjacent New South Wales (Domrow 1963, 1972a).

Hosts and Localities

On rufous rat kangaroo, *Aepyprymnus rufescens* (Gray) (Marsupialia: Macropodidae), Byfield, Q., 28.I.1964, R.K. Norton (1 ♀). On *A. rufescens,* Inkerman, 11 km S of Home Hill, Q., 16.VIII.1972, P. Ferris (4 ♀♀). In QIMR.

On brush-tailed rat kangaroo, *Bettongia penicillata* (Gray) (Macropodidae), Manjimup, W.A., 19.XII.1977, G. de Chaneet (1 ♀). In QIMR.

Androlaelaps hermaphroditus (Berlese, 1887b)

This associate of vertebrates and their nests is widespread in the south-west Pacific and east Australia, but was previously unknown from Western Australia (Womersley 1956, Wilson 1967, Domrow 1977).

Host and Locality

On common rock rat, *Zyzomys argurus* (Thomas) (Rodentia: Muridae) (3059), Mitchell Plateau, W.A., 22.X.1976 (1 dn). In WAM.

Laelaps nuttalli Hirst 1915

This cosmopolitan species is widespread on many species of *Rattus*—including *R. tunneyi*—and *Melomys* in Australasia, but was previously unknown from Western Australia (Allred 1969, Marshall 1976, Ramsay 1977, Ramsay & Paterson 1977, Domrow 1979).

Hosts and Localities

On Tunney's rat, *Rattus tunneyi* (Thomas) (Rodentia: Muridae) (2679), Mount Hart, W.A., 10.IX.1976 (4 ♀♀). On *R. tunneyi* (3099, 3101, 3112), Mitchell Plateau, W.A., 28, 29.X.1976 (14 ♀♀, 20 ♂♂, 22 dn, 3 pn). On *R. tunneyi* (3116, 3140), Port Warrender, W.A., 29, 30.X.1976 (1 ♀, 2 ♂♂). In WAM, FMNH, QIMR, CU.

On scale-tailed rat, *Melomys* sp. (Muridae) (3140, 3141), Port Warrender, 30.X.1976 (33 ♀♀, 14 ♂♂, 4 pn). In WAM, FMNH, QIMR, CU.

Laelaps assimilis Womersley, 1956

This species is common on *Rattus fuscipes* and *R. lutreolus* (Gray) throughout their ranges (Domrow 1977). The following specimens are included for historical reasons.

Host and Locality

On southern bush rat, *Rattus fuscipes* (Waterhouse) (Rodentia: Muridae) (20359), Australia, 1869, S. de Hambourg (1 ♀, 1 dn). In RMNH.

Laelaps elegans sp. nov.

L. nuttalli Domrow, 1979 *partim* (1 ♀ from *Pseudomys gracilicaudatus)*.

The original female I studied keyed out to *L. nuttalli* in Domrow (1965) and Allred (1969), despite small differences *(e.g.* seta *av* on coxa I basally expanded; outline of genitoventral shield extended posteriorly well beyond concave stria between third pair of usurped ventral setae, truncate rather than softly curved; anterior margin of anal shield concave). However, the long series now listed quickly showed that these differences in the female, subtle though they be, were not only constant, but also supported by a striking difference in the male: in the new species, the holoventral shield is so narrow behind coxae IV as to leave the metapodal shields well clear in the cuticle (fused into holoventral shield in *L. nuttalli*).

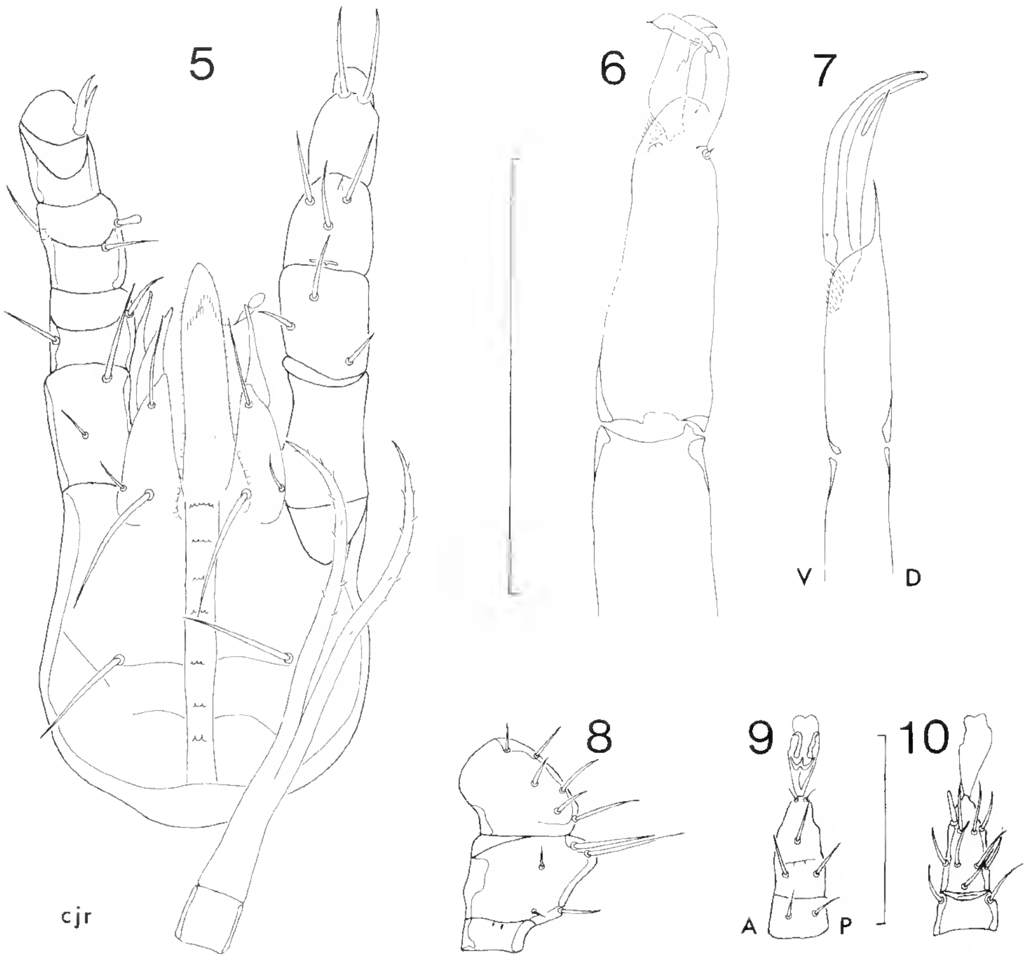
The normal hosts of the new species seem to be species of *Pseudomys* (the four specimens from *Rattus tunneyi* and *Zyzomys argurus* are best regarded as stragglers). *L. nuttalli* is common in Australia on certain species of *Rattus*.

The new specific name is the Latin adjective *elegans* (fine, neat), and refers to seta *av* on coxa I.

A full description of the first new species will allow a briefer, comparative treatment of the other three.

Female (**Figs 5-6, 8-14**): Epistome a broad, hyaline, inverted U reaching to level of apices of palpal femora. Basis capituli longer than wide; setae *c* reaching beyond opposite edge of deutosternum (which bears seven short rows of denticles). Hypostome with setae $h_3 > h_1 > h_2$. Internal malae a ciliated median triangle flanked on either side by lobate process, *cf. Haemolaelaps ulysses* Domrow, 1961. Cornicles of normal length, but slender and weakly sclerotised. Salivary stylets present. Labrum hastate, spiculate marginally, grooved medially, Palpi holotrichous (trochanter-tibia 2.5.6.14, including two dorsodistal rods on tibia; tarsus with usual few slender ventral setae and cluster of terminal rods); claw bifid. Chelicerae 135-145 µm long overall, with digits occupying 20% of total length; shaft bearing usual setule, two pores and small corona; fixed digit edentate, with pilus dentilis strongly inflated, apically spined, projecting outwardly between two external teeth on movable digit; latter also with one subterminal tooth on margin in addition to sharp tip.

Dorsal shield 450-505 μm long, 280-305 μm wide; ovate, evenly rounded in posterior third, with very narrow strip on margin pale; surface with reticulate striae; holotrichous (with 22 pairs of setae on podonotal portion, 17 on opisthonotal), with usual 22 pairs of pores [lyriform outside setae z_1 and Z_5, others ranging from punctate to small crateriform; none with surrounding "window," *i.e.* obvious area of thinned cuticle, as in *L. hapaloti* Hirst, see Domrow (1973)]. Dorsal cuticle with about 13 pairs of setae of increasing length posteriorly.



Figs 5-10: *Laelaps elegans* sp. nov. 5, Capitulum and tritosternum ♀ (ventral, with true left palp dorsal). 6-7, Chelicerae ♀ and ♂ (dorsoexternal). 8, Femur-genu I ♀ (dorsal). 9-10, Tarsus II ♀ (dorsal, and ventral and lateral).

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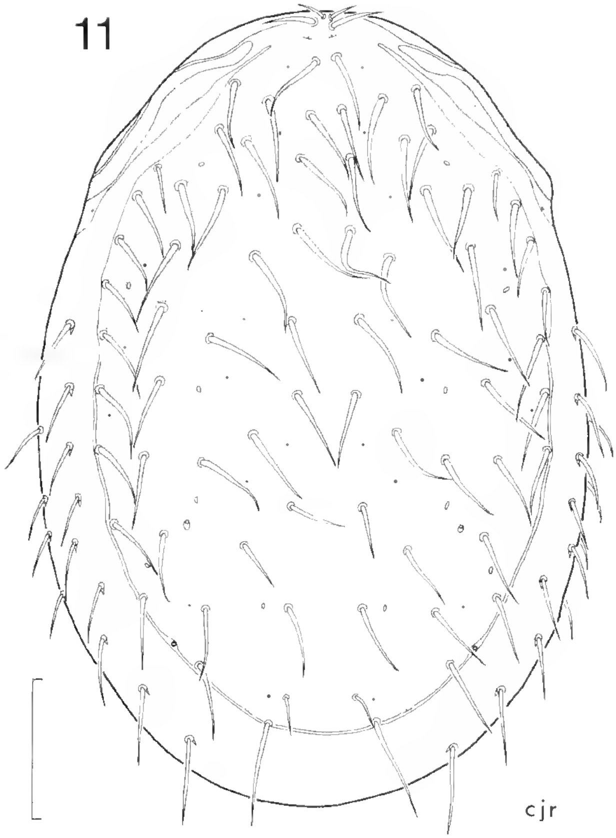
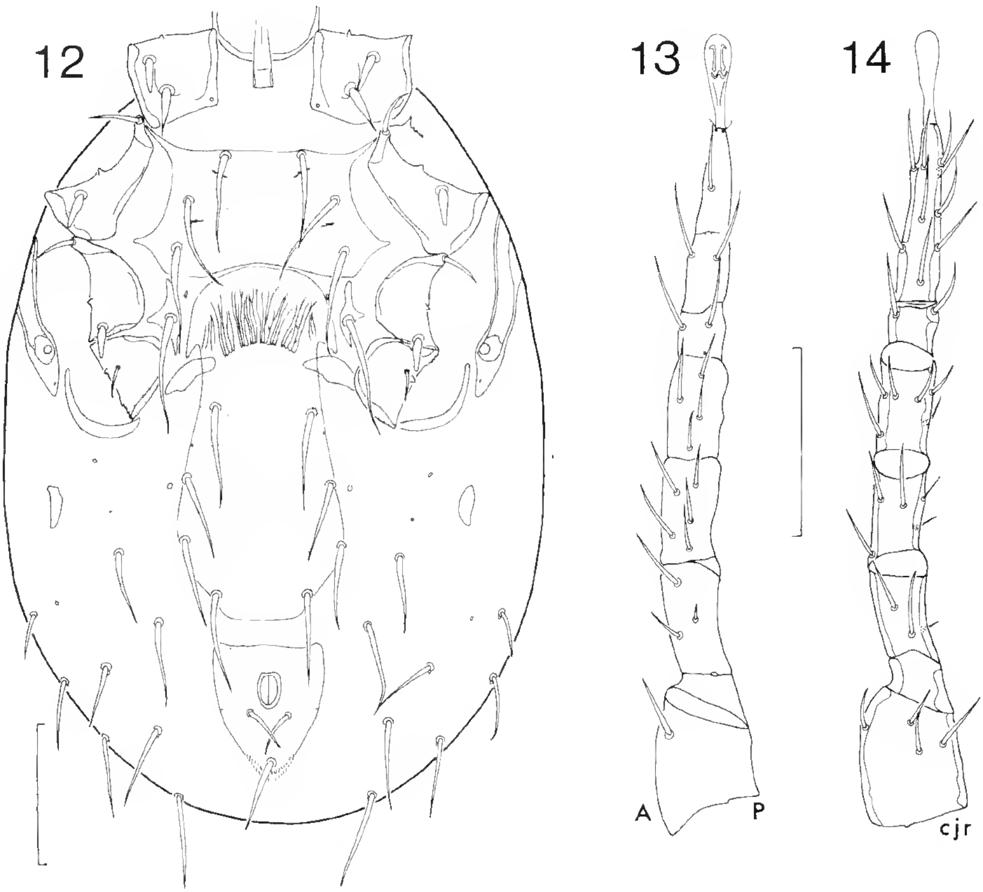


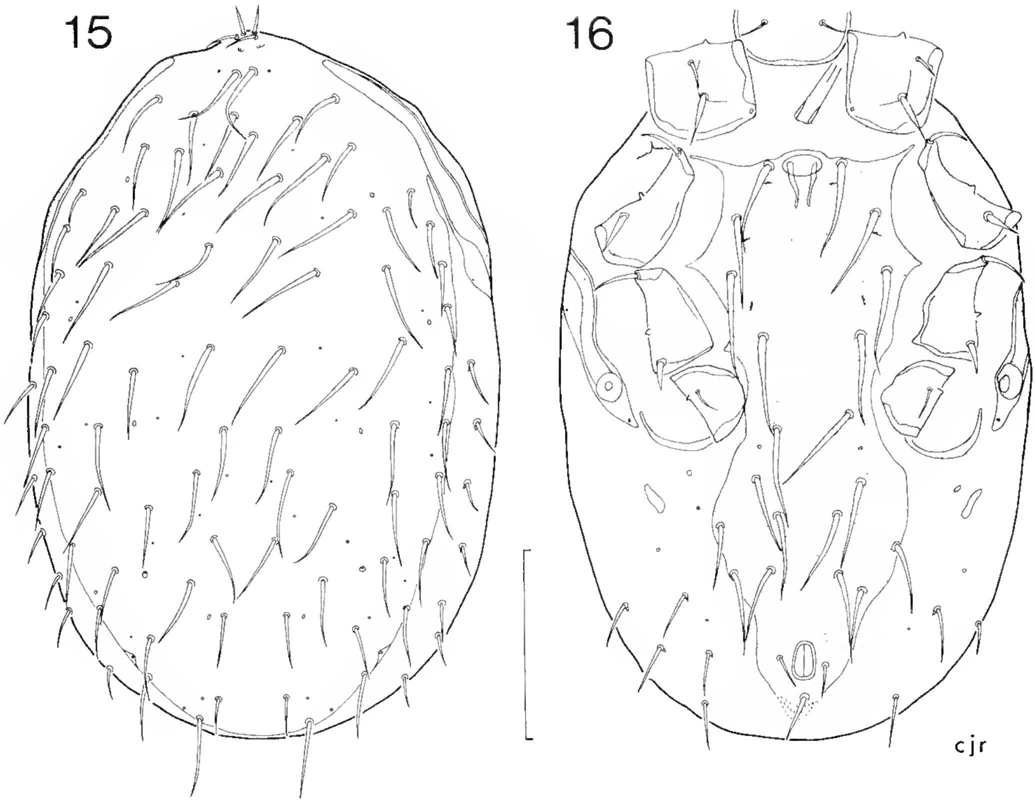
Fig. 11: *Laelaps elegans* sp. nov. Idiosoma ♀ (dorsal, seta S_3 absent on right-hand side).

Tritosternum with base unarmed; laciniae slender, lightly ciliated. Presternal area with transverse striae. Sternal shield shorter in midline (70-75 μm) than wide at level of second pair of sternal setae *(st_2)* (120-130 μm); anterior margin straight, posterior margin slightly concave; surface with reticulate striae; with usual three pairs of sternal setae *($st_{1\text{-}3}$)* and two pairs of sternal pores. Metasternal setae *(mst)* set on metasternal shields whose posterior points project freely from cuticle, metasternal pores free in cuticle. Genitoventral shield elongate, only slightly expanded behind coxae IV, much longer behind genital setae *(g)* (140-150 μm) than maximum width (110-120 μm); posterior margin distinctly drawn out behind third pair of usurped ventral setae *(v_3)*, truncate; surface with transverse striae; with usual four pairs of setae *(g, $v_{1\text{-}3}$)* and pair of genital pores; operculum rayed, supported by genital apodemes between coxae IV, reaching forward in even curve to posterior margin of sternal shield. Anal shield longer in midline (85-95 μm, including cribrum) than maximum width (70-75 μm); anterior margin slightly concave; surface with reticulate striae marginally; with usual pair of adanal setae *(aa)*, postanal seta *(pa)* and pair of anal pores (*aa* barely reaching insertions of stronger *pa*). Metapodal shields present. Ventral cuticle with some paired plaquettes and pores, and about eight pairs of setae of increasing length posteriorly. Peritremes reaching forward almost to level of anterior margins of coxae I; peritrematic shields fused vertically to dorsal shield, but free posteriorly of crescentic expodal shields IV.

Leg setation holotrichous, with one exception: genu IV with one additional seta *(pl_2), i.e.* 2-5/1-2 as often in *Laelaps, e.g. L. echidninus* Berlese. Coxae with a few short striae; I with *av* somewhat swollen basally, attenuate distally; I-III with *pv* strengthened and blunt, *i.e.* spur-like (II also with small spinose process on anterodorsal margin). Femora I-II with both ad_1 and pd_1 elongate. Genua I with pd_3 and II with pd_2 elongate. Tarsi II-III with al_1 spur-like, but not to extent of *pv* on coxae I-III. Tarsus I with dorsodistal sensory islet.



Figs 12-14: *Laelaps elegans* sp. nov. 12, Idiosoma ♀ (ventral). 13-14, Leg IV ♀ (dorsal, and ventral and lateral).



Figs 15-16: *Laelaps elegans* sp. nov. Idiosoma ♂ (dorsal and ventral).

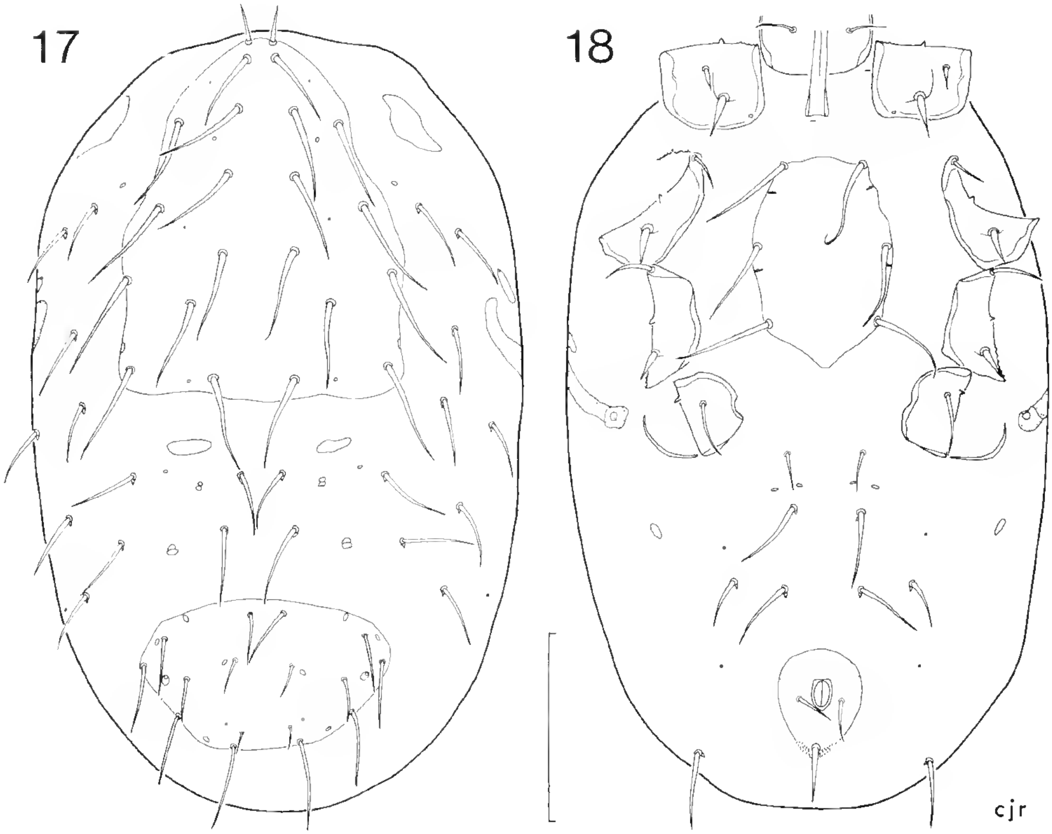
Male **(Figs 7, 15-16):** Capitulum as in ♀, except for secondary sexual characters of chelicerae. Fixed digit obsolescent. Spermatodactyl occupying 45% of total length (105-115 µm overall), almost obliterating movable digit.

Dorsal shield with reticulate striae as in ♀, 345-400 µm long, 210-235 µm wide. Dorsal cuticle with about six pairs of subequal setae.

Venter as in ♀, except as follows. Holoventral shield 290-330 µm long, with ventral portion only slightly expanded behind coxae IV (95-115 µm wide), bearing usual five pairs (at times 5/4) of ventral setae, but leaving metapodal shields quite free in cuticle. Ventral cuticle with about four pairs of subequal setae. Peritrematic shields fused humerally to dorsal shield.

Legs as in ♀, except as follows. Coxae I with *pv* almost setiform, sharp-tipped, II-III with *pv* sharp-tipped. Genu II with pd_2 hardly elongate. Tarsi II-III with al_1 sharp-tipped.

Protonymph **(Figs 17-18):** Capitulum as in ♀, except as follows. Palpi holotrichous (trochanter-tibia 1.4.5.12, including two dorsodistal rods). Chelicerae 85-105 µm long.



Figs 17-18: *Laelaps elegans* sp. nov. Idiosoma pn (dorsal and ventral).

Podonotal shield 170-200 μm long, 135-155 μm wide (larger specimens presumably prefemale); sinuous laterally, shallowly trilobate posteriorly; surface with reticulate striae; holotrichous (with 11 pairs of setae), with five pairs of obvious pores. Opisthonotal shield 70-80 μm long, 110-130 μm wide; slightly rounded anteriorly, three-sided posteriorly; surface with reticulate striae; holotrichous (with eight pairs of setae), with six pairs of distinct pores. Three pairs of mesonotal shieldlets present. Dorsal cuticle holotrichous (with five pairs of podonotal setae and six opisthonotal), with some paired plaquettes and pores.

Venter as in ♀, except as follows. Sternal shield 95-110 μm long, 65-80 μm wide; slightly convex laterally, angulate posteriorly; surface with reticulate striae; with usual three pairs of setae and two pairs of pores. Anal shield 50-60 μm long, 35-45 μm wide; with minimal striae. Ventral cuticle with five pairs of setae, anteriormost pair shortest. Peritremes abbreviated, falling short of anterior margins of coxae III, with peritrematic shields in two fragments on dorsum (these representing two dorsal expansions of entire shields in ♀ in **Fig. 11**).

Leg setation holotrichous, with one exception: genu IV with one additional seta *(pl_1), i.e.* 1-4/0-1. Setae as in ♂ (including *pv* on coxae I-III, ad_1 and pd_1 on femora I-II, pd_2 on genua I-II, and al_1 on tarsi II-III).

Hosts and Localities

On western chestnut native mouse, *Pseudomys nanus* (Gould) (Rodentia: Muridae) (3004, 3007, 3014, 3029, 3030, 3039, 3040, 3045, 3048, 3050, 3051, 3054, 3062, 3065, 3091, 3092, 3093, –), Mitchell Plateau, W.A., –, 18-25.X.1976 (holotype ♀, allotype ♂, 83 paratype ♀♀, 73 paratype ♂♂, 131 morphotype pn). In WAM (including holotype 79/1434, and allotype 79/1435), FMNH, QIMR, CU.

On Forrest's native mouse, *Pseudomys forresti* (Thomas) (3063), Mitchell Plateau, 22.X.1976 (3 ♀♀, 1 pn, not types). In WAM, FMNH, QIMR, CU.

On eastern chestnut native mouse, *Pseudomys gracilicaudatus* (Gould), 98 km NW of Bundaberg (24°31′S, 151°28′E), Q., 10.I.1975, A.C. & J.F. Robinson (1 ♀, not a type). In ANIC.

On Tunney's rat, *Rattus tunneyi* (Thomas) (Muridae) (3140), Port Warrender, W.A., 30.X.1976 (1 ♂, not a type). In WAM.

On common rock rat, *Zyzomys argurus* (Thomas) (Muridae) (2809), Brooking Springs, W.A., 29.IX.1976 (1 ♂, not a type). On *Z. argurus* (3037), Mitchell Plateau, 20.X.1976 (2 ♀♀, not types). In WAM, FMNH, QIMR.

Laelaps synnomus **sp. nov.**

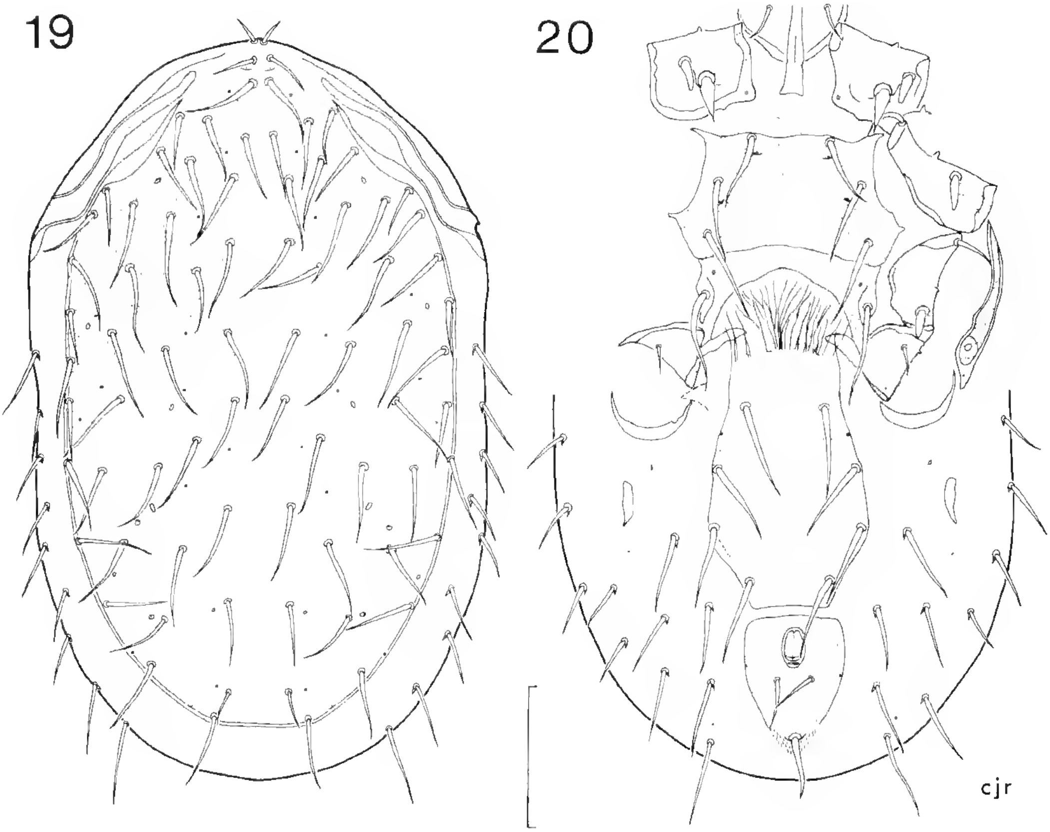
Accepting that both setae on coxa I are spur-like, the new species keys out near *L. wasselli* Domrow both in Domrow (1965) and Allred (1969). Apart from its much smaller size (dorsal shield 460-505 μm long in *L. synnomus*, 735-755 μm in *L. wasselli*), the new species is further separable from *L. wasselli* by the extended posterior margin and narrower proportions of the genitoventral shield (ratio L/B 1.15 *v.* 1.00).

The normal host seems to be *Zyzomys argurus*. The two specimens from *Rattus tunneyi* are best regarded as stragglers. *L. wasselli* is restricted to *Hydromys chrysogaster* Geoffroy (Muridae).

The new specific name is the Greek adjective συννομος (feeding together, gregarious), and refers to the presence on *Zyzomys* of other species of *Laelaps*.

Female **(Figs 19-20):** Chelicerae 130-135 μm long, with digits occupying 20% of length; movable digit with only two external teeth in addition to sharp tip. Capitulum otherwise as in *L. elegans*.

Dorsal shield 460-505 μm long, 250-305 μm wide (smallest specimens pale and freshly moulted); not so roundly ovate as in *L. elegans*. Dorsum otherwise as in *L. elegans*, except that cuticle bears only about nine pairs of setae.



Figs 19-20: *Laelaps synnomus* sp. nov. Idiosoma ♀ (dorsal and ventral).

Sternal shield 75-80 μm long, 125-135 μm wide. Genital shield 125-140 μm long, 105-125 μm wide. Anal shield 85-95 μm long, 65-85 μm wide; anterior margin ever so slightly convex medially. Venter otherwise as in *L. elegans,* except that cuticle bears about 10 pairs of setae.

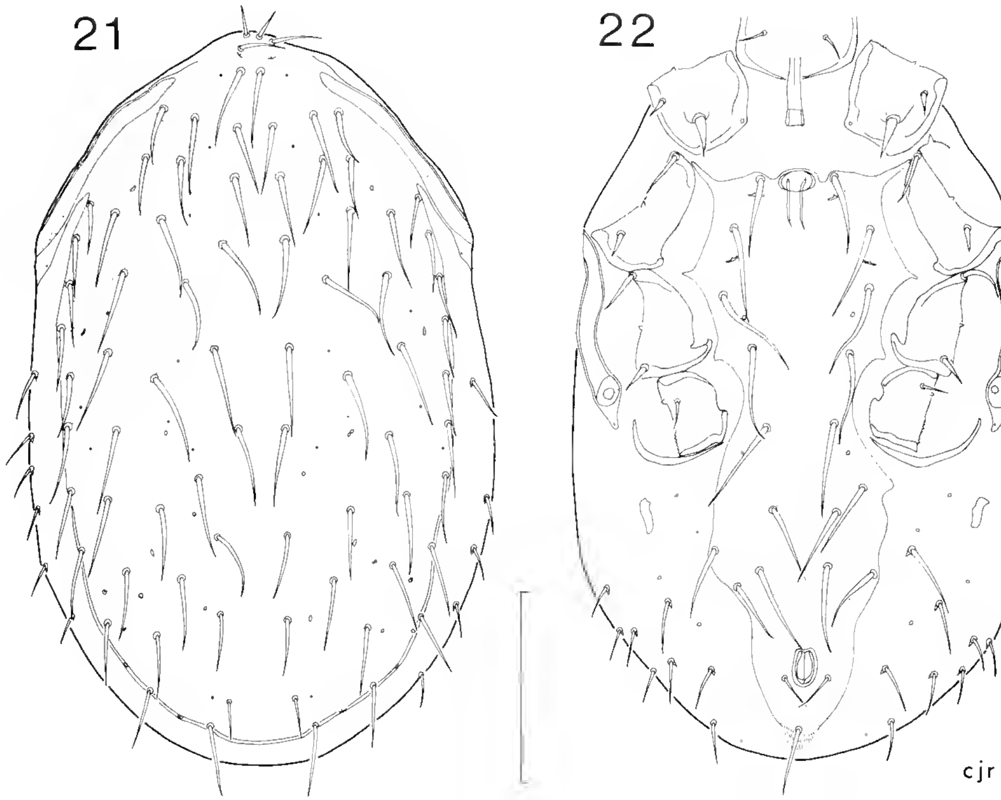
Leg setation as in *L. elegans,* except as follows. Coxa I with *av* a spur in shape of arrow-head, with short terminal filament that is almost invariably snapped off (as is case in *L. wasselli*). Tarsi II-III with al_1 strengthened, but still sharp-tipped.

Male **(Figs 21-22):** Chelicerae 105-110 μm long, with spermatodactyl occupying 45% of length. Capitulum otherwise as in *L. elegans.*

Dorsal shield 360-375 μm long, 200-210 μm wide. Dorsum otherwise as in *L. elegans.*

Holoventral shield 305-320 μm long, 95-105 μm wide; ventral portion normally with five pairs of setae. Venter otherwise as in *L. elegans,* except that cuticle bears about eight pairs of setae.

Leg setation as in ♀, except that *pv* on coxae I-III is sharp-tipped.



Figs 21-22: *Laelaps synnomus* sp. nov. Idiosoma ♂ (dorsal and ventral, former with seta J_2 absent on right-hand side, latter with setae on ventral portion of holoventral shield irregular on both sides, *i.e.* one absent on left-hand side and one free in adjacent cuticle on right-hand side).

Protonymph **(Figs 23-24):** Capitulum holotrichous; otherwise as in ♀. Chelicerae 80-90 µm long.

Podonotal shield 170-190 µm long, 145-155 µm wide. Opisthonotal shield 75-90 µm long, 115-130 µm wide; anterior margin more strongly arched than in *L. elegans.* Dorsum otherwise as in *L. elegans.*

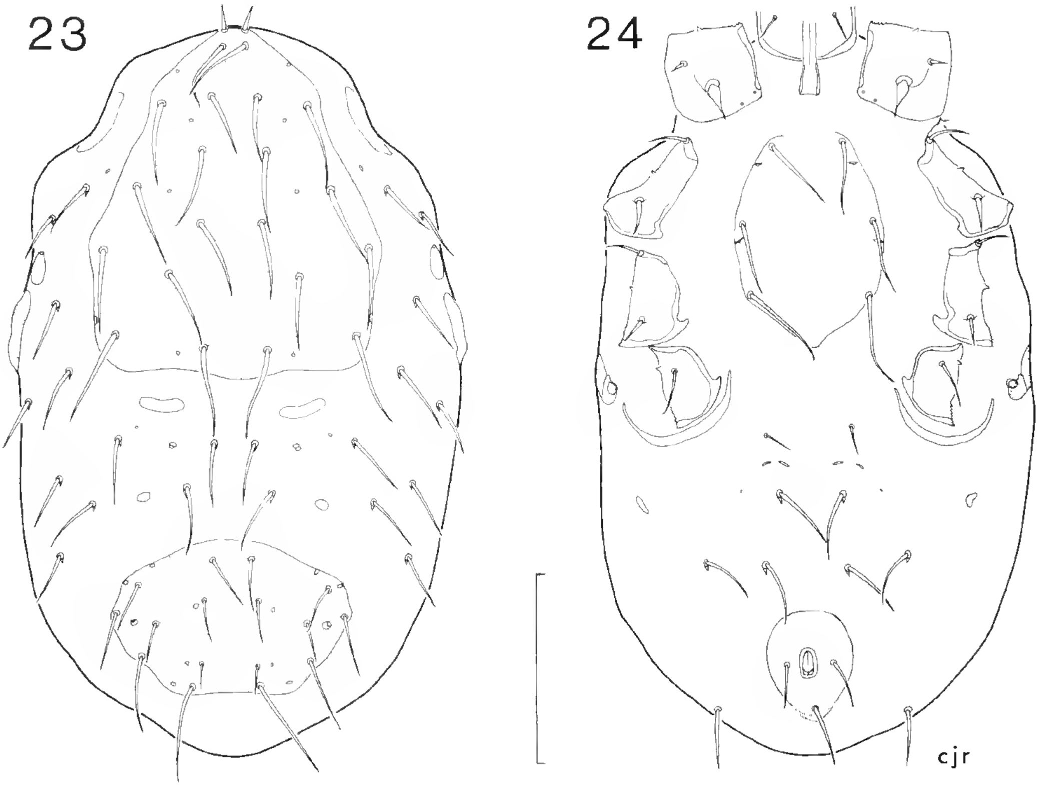
Sternal shield 100-115 µm long, 75-85 µm wide. Anal shield 55-65 µm long, 40-45 µm wide. Venter otherwise as in *L. elegans.*

Legs holotrichous, with one exception: genu IV 1-4/0-1; otherwise as in ♂.

Hosts and Localities

On common rock rat, *Zyzomys argurus* (Thomas) (Rodentia: Muridae) (3100, 3105, 3119, 3122, 3138, 3146, 3155, 3156), Port Warrender, W.A., 28-31.X.1976 (holotype ♀, allotype ♂, 8 paratype ♀♀, 4 paratype ♂♂, 4 morphotype pn). On *Z. argurus* (2655), Napier Downs, W.A., 2.IX.1976 (1 ♀, not a type). On *Z. argurus* (2697, 2703, 2710), Mount Hart, W.A., 12, 14.IX.1976 (3 ♀♀, 1 pn, not types). On *Z. argurus* (3060), Mitchell Plateau, W.A., 22.X.1976 (1 ♀, not a type). In WAM (including holotype 79/1505, and allotype 79/1508), FMNH, QIMR, CU.

On Tunney's rat, *Rattus tunneyi* (Thomas) (Muridae) (3114, 3127), Port Warrender, 29-30.X.1976 (1 ♀, 1 pn, not types). In WAM, FMNH.



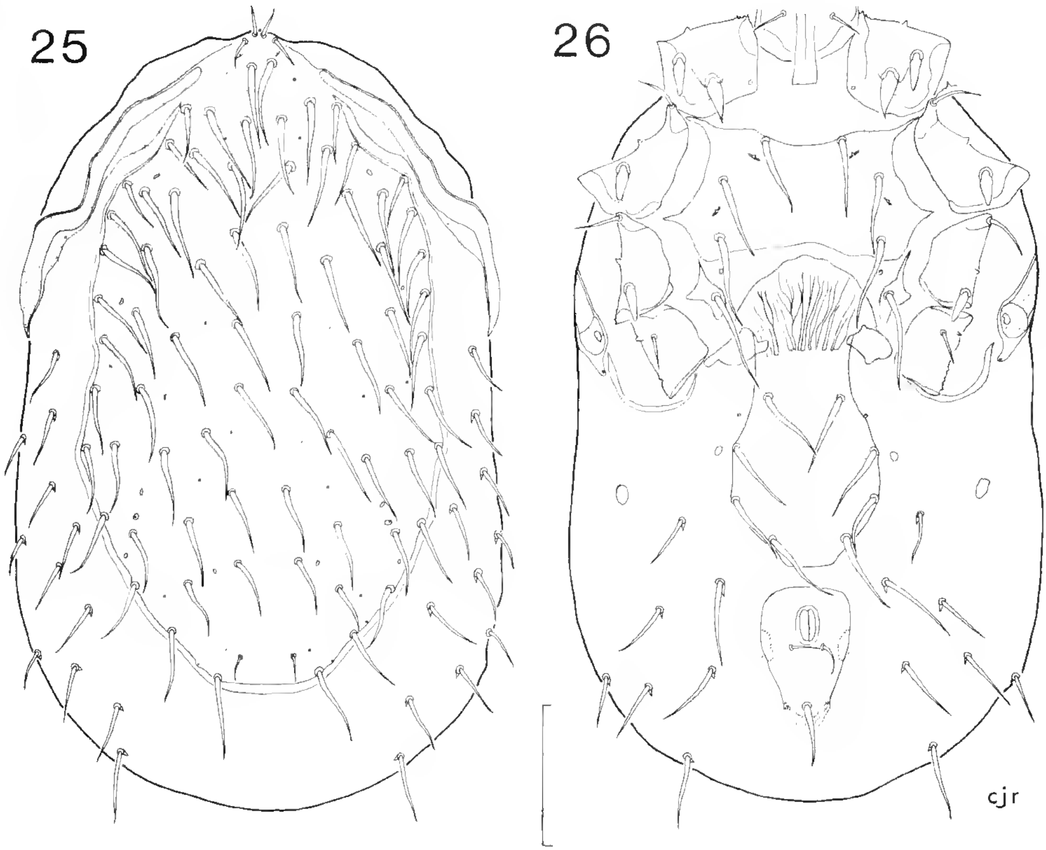
Figs 23-24: *Laelaps synnomus* sp. nov. Idiosoma pn (dorsal and ventral).

Laelaps parameces sp. nov.

This new species also keys out near *L. wasselli,* but is at once separable by the differing outlines of all four major idiosomatal shields [the dorsal shield of *L. wasselli* was figured by Domrow (1963)]. Thus, the dorsal shield of the new species is tapered and truncate at the termen, the sternal excavated anteriorly, the genital extended posteriorly and the anal elongated.

The new specific name is the Greek adjective παραμηκης (of a longish shape), and refers to the dorsal shield.

Female (**Figs 25-26**): Chelicerae 135-140 μm long, with digits occupying 22% of length; otherwise as in *L. synnomus*. Capitulum otherwise as in *L. elegans*, except that labrum is more slender, *i.e.* evenly tapering.



Figs 25-26: *Laelaps parameces* sp. nov. Idiosoma ♀ (dorsal and ventral).

Dorsal shield 445-480 μm long, 235-255 μm wide; shaped somewhat differently from that of *L. elegans*, *i.e.* parallel-sided, tapering to truncate termen, with paler marginal strip more pronounced (*cf. Laelaps* sp. nov. Domrow, in preparation, from *Pogonomys* spp. in Papua New Guinea). Dorsum otherwise as in *L. elegans*, except that some smaller pores on dorsal shield appear to be lacking.

Sternal shield 70-75 μm long, 135-140 μm wide; anterior margin shallowly excavated between st_1. Genital shield 115-125 μm long, 95-105 μm wide. Anal shield 100-110 μm long, 60-65 μm wide, more elongate than in *L. elegans;* anterior margin weakly convex; *aa* falling well short of *pa*. Venter otherwise as in *L. elegans*.

Leg setation as in *L. synnomus*.

Male (**Figs 27-28**): Chelicerae 110 μm long, with spermatodactyl occupying 40% of length. Capitulum otherwise as in *L. elegans*.

Dorsal shield 360-375 μm long, 180-185 μm wide. Dorsum otherwise as in ♀, except that pale marginal strip on dorsal shield is less distinct and cuticle bears only about six pairs of setae.

Holoventral shield 315-335 μm long, 85-90 μm wide. Venter otherwise as in ♀, except that cuticle bears only about six pairs of setae.

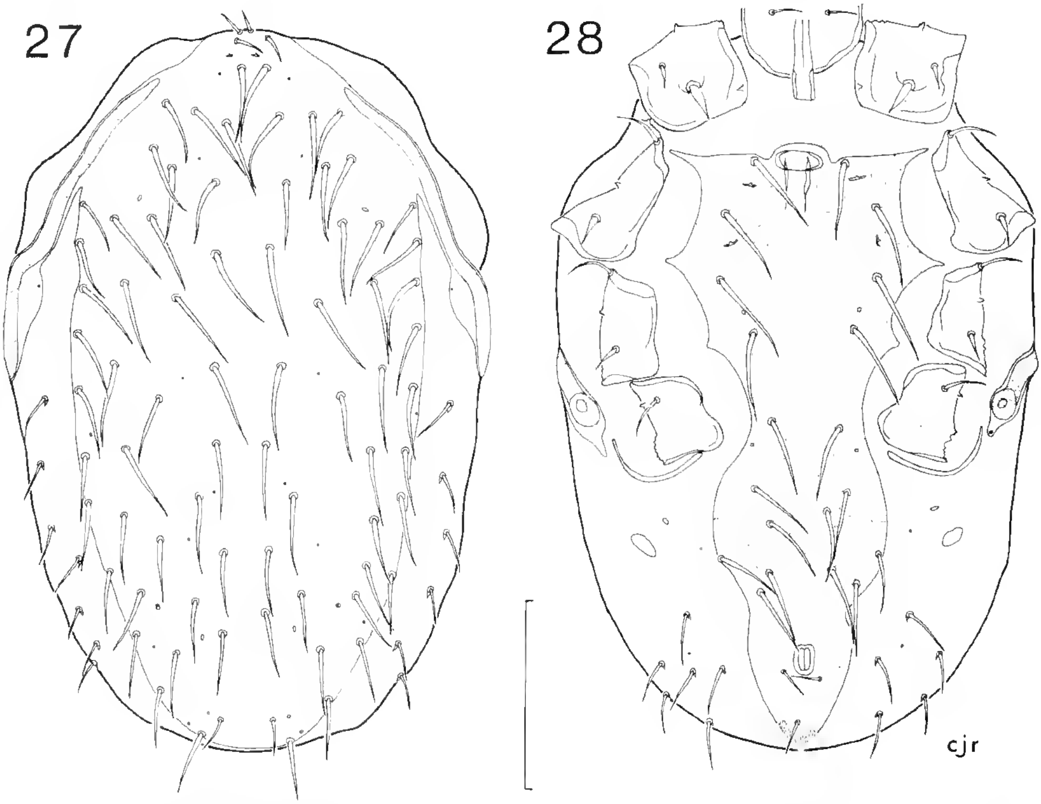
Leg setation as in ♀, except that *pv* on coxae I-III is slightly attenuate distally.

Protonymph (**Figs 29-30**): Capitulum holotrichous; otherwise as in ♀. Chelicerae 85-105 μm long.

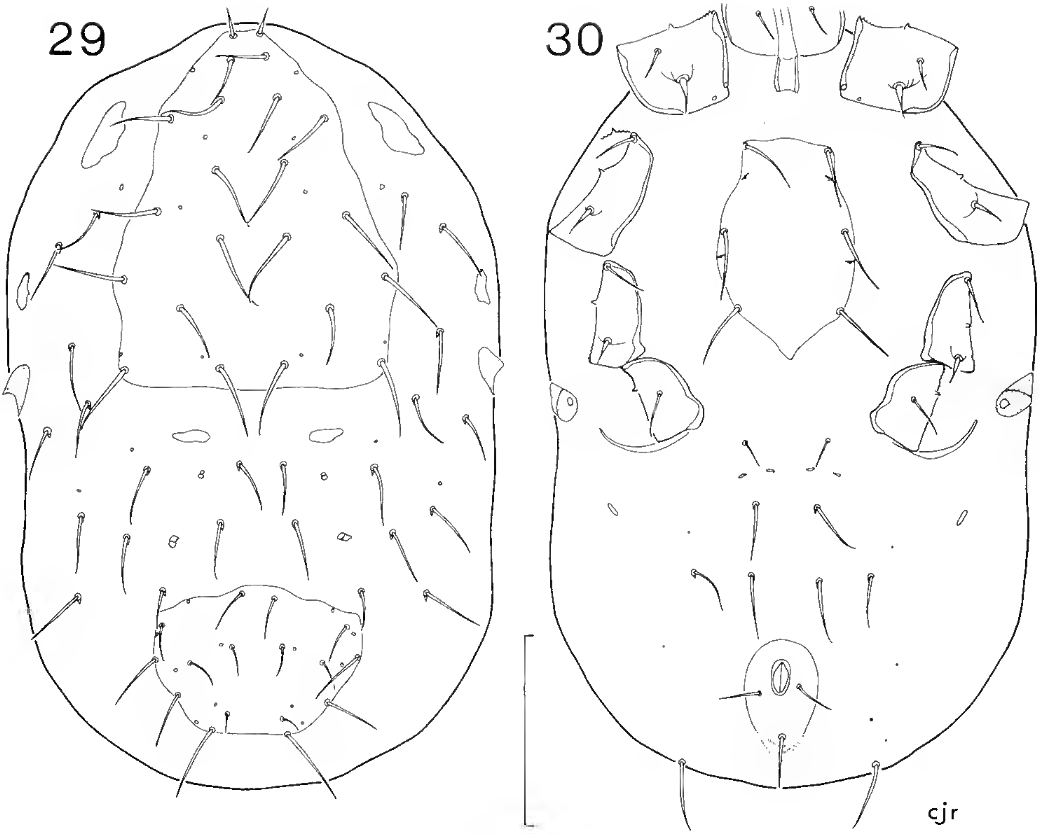
Podonotal shield 165-195 μm long, 150-155 μm wide. Opisthonotal shield 70-85 μm long, 95-115 μm wide. Dorsum otherwise as in *L. elegans*.

Sternal shield 110-120 μm long, 70-75 μm wide. Anal shield 60-70 μm long, 40 μm wide. Peritremes very short, barely reaching level of insertions of *pv* on coxae III. Venter otherwise as in *L. elegans*.

Legs holotrichous, with one exception: genu IV 1-4/0-1; otherwise as in ♂, except that *pv* on coxae I-III is even more attenuate distally.



Figs 27-28: *Laelaps parameces* sp. nov. Idiosoma ♂ (dorsal and ventral, former with seta px_2 displaced on right-hand side).



Figs 29-30: *Laelaps parameces* sp. nov. Idiosoma pn (dorsal and ventral).

Host and Locality

On brush-tailed tree rat, *Conilurus penicillatus* (Gould) (Muridae) (3098, 3110, 3111, 3115, 3123, 3159), Port Warrender, W.A., 28, 29, 31.X.1976 (holotype ♀, allotype ♂, 28 paratype ♀♀, 4 paratype ♂♂, 7 morphotype pn). In WAM (including holotype 79/1511, and allotype 79/1512), FMNH QUMR, CU.

Laelaps angiodes **sp. nov.**

Although *L. angiodes* also keys out near *L. wasselli,* it more resembles the novelty just described *(L. parameces)* in the proportions of the four major idiosomatal shields. These effects, however, are exaggerated in *L. angiodes,* especially the tapering of the dorsal, and the excavation of the sternal, shields.

The normal host seems to be *Zyzomys woodwardi.* The four specimens from *Rattus tunneyi, Z. argurus* and *Conilurus penicillatus* are best regarded as stragglers.

The new specific name is the Greek adjective αγγειωδης (like a vessel, hollow), and refers to the anterior margin of the sternal shield.

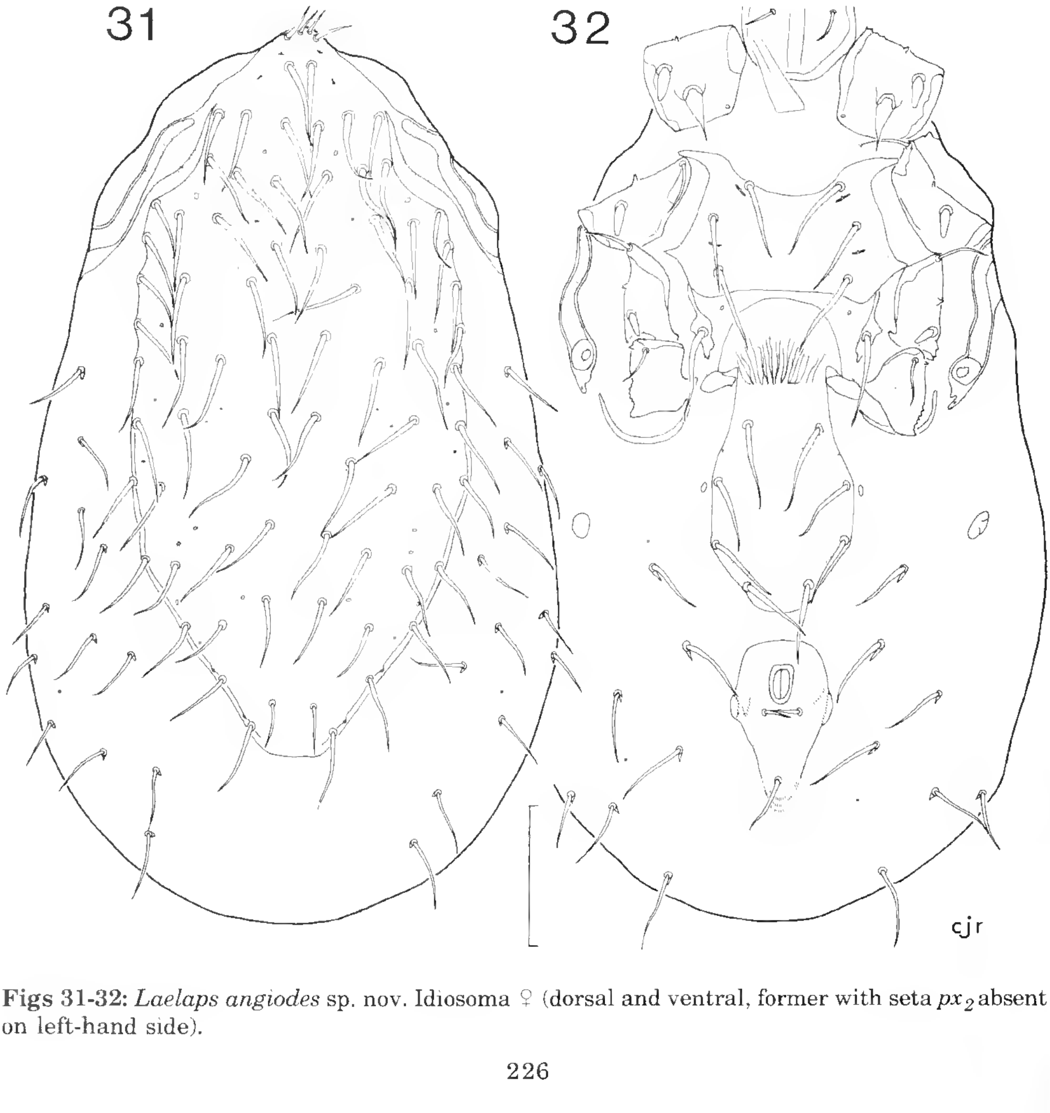
Female (**Figs 31-32**): Chelicerae 135-150 μm long, with digits occupying 22% of length; otherwise as in *L. synnomus*. Capitulum otherwise as in *L. parameces*.

Dorsal shield 475-510 μm long, 230-255 μm wide; elongation, posterior tapering and truncation more exaggerated than in *L. parameces*. Dorsum otherwise as in *L. parameces*.

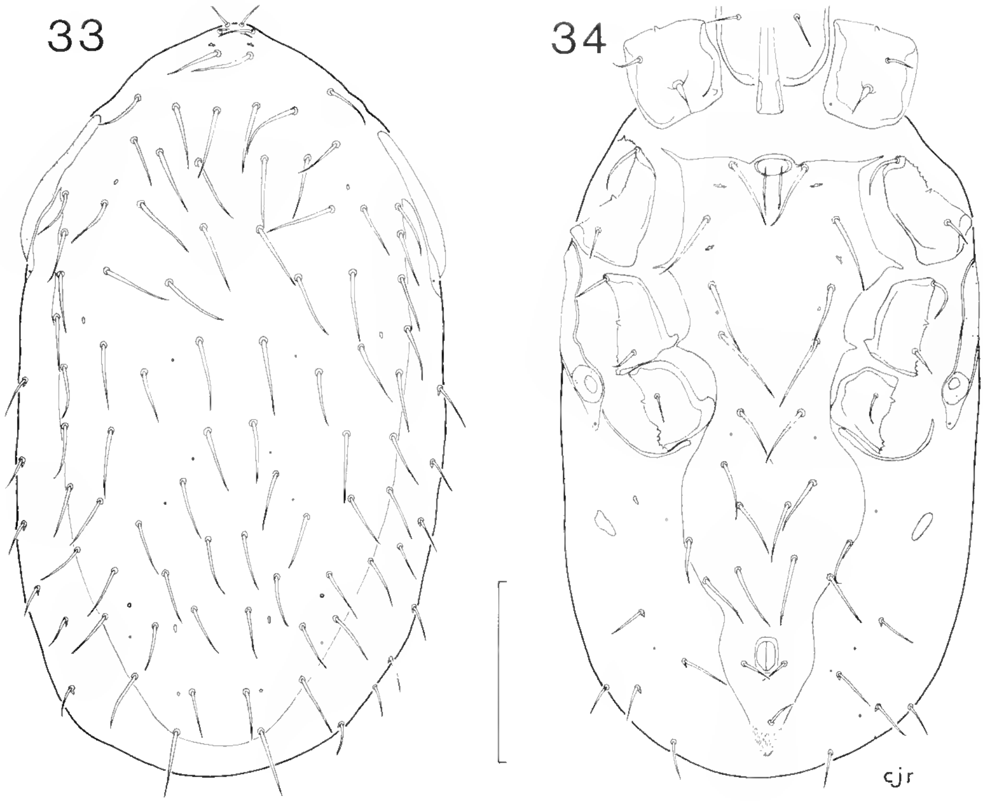
Sternal shield 60-70 μm long, 130-135 μm wide, as in *L. parameces*, except that anterior margin is more strongly excavated. Genital shield 125-135 μm long, 95-105 μm wide. Anal shield 115-125 μm long, 60-65 μm wide, a little more modified than in *L. parameces*. Venter otherwise as in *L. parameces*.

31

32



Figs 31-32: *Laelaps angiodes* sp. nov. Idiosoma ♀ (dorsal and ventral, former with seta px_2 absent on left-hand side).



Figs 33-34: *Laelaps angiodes* sp. nov. Idiosoma ♂ (dorsal and ventral).

Leg setation as in *L. parameces,* except that *pv* on coxae I-III is rather more parallel-sided.

Male **(Figs 33-34):** Chelicerae 115 μm long, with spermatodactyl occupying 37% of length. Capitulum otherwise as in *L. elegans.*

Dorsal shield 240 μm long, 195 μm wide. Dorsum otherwise as in *L. parameces.*

Holoventral shield 335 μm long, 95 μm wide. Venter otherwise as in *L. parameces.*

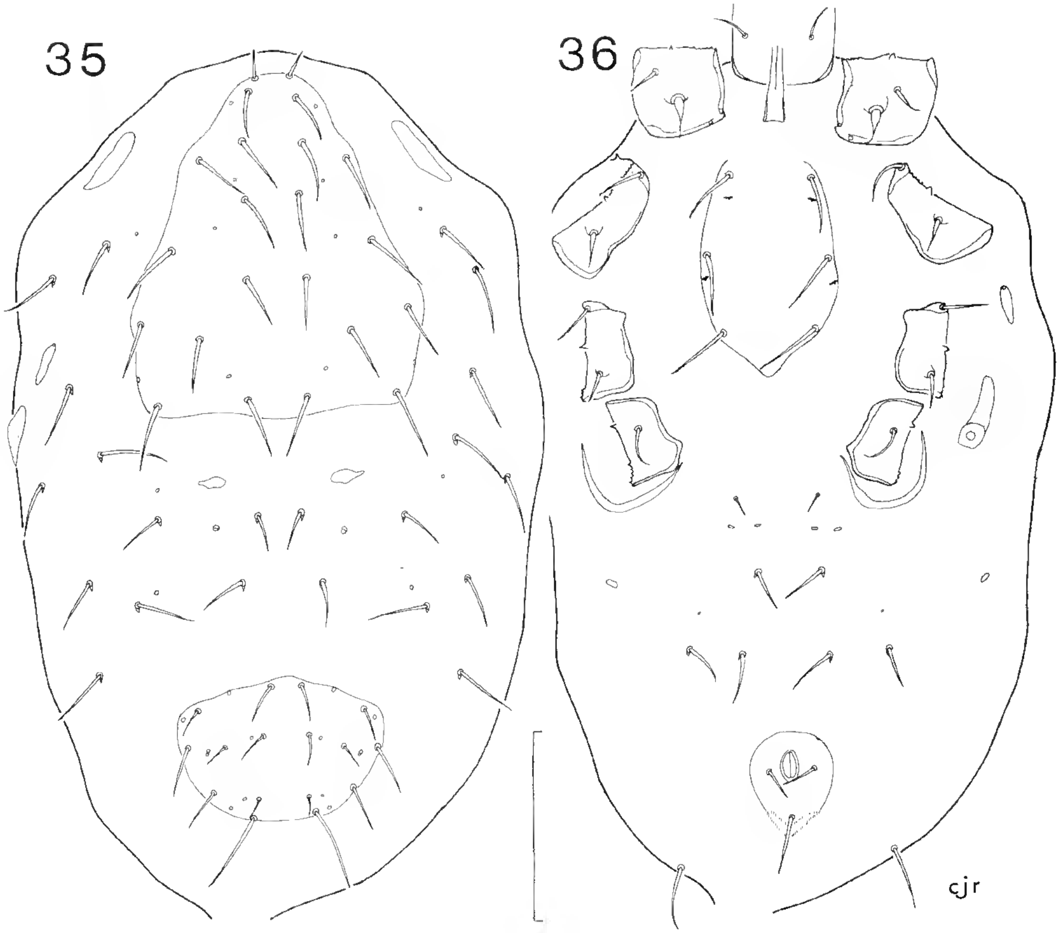
Leg setation as in ♀, except that *pv* on coxae I-III is virtually setiform.

Protonymph **(Figs 35-36):** Capitulum holotrichous; otherwise as in ♀. Chelicerae 90-105 μm long.

Podonotal shield 170-185 μm long, 140-150 μm wide. Opisthonotal shield 70-80 μm long, 95-105 μm wide. Dorsum otherwise as in *L. elegans.*

Sternal shield *ca* 120 μm long, 65-80 μm wide. Anal shield 55-60 μm long, 35-40 μm wide. Venter otherwise as in *L. parameces.*

Legs holotrichous, with one exception: genu IV 1-4/0-1; otherwise as in ♂.



Figs 35-36: *Laelaps angiodes* sp. nov. Idiosoma pn (dorsal and ventral).

Hosts and Localities

On Woodward's rock rat, *Zyzomys woodwardi* (Thomas) (Rodentia: Muridae) (3120, 3142, 3144), Port Warrender, W.A., 29-30.X.1976 (holotype ♀, allotype ♂, 39 paratype ♀♀, 9 morphotype pn). In WAM (including holotype 79/1521, and allotype 79/1522), FMNH, QIMR, CU.

On Tunney's rat, *Rattus tunneyi* (Thomas) (Muridae) (3116), Port Warrender, 29.X.1976 (1 ♂, 1 pn, not types). In WAM.

On common rock rat, *Zyzomys argurus* (Thomas) (3037), Mitchell Plateau, W.A., 20.X.1976 (1 pn, not a type). In WAM.

On brush-tailed tree rat *Conilurus penicillatus* (Gould) (Muridae) (3111), Port Warrender, 29.X.1976 (1 ♀, not a type). In WAM.

Laelaps aella Domrow, 1973

This species was previously known from two closely related species of *Pseudomys* in Queensland, the Northern Territory and Western Australia: *P. gracilicaudatus* and *P. nanus* (Domrow 1979). The specimen from *Macroglossus lagochilus* is clearly a straggler.

Hosts and Locality

On western chestnut native mouse, *Pseudomys nanus* (Gould) (Rodentia: Muridae) (3004, 3007, 3025, 3045, 3046, 3048, 3055, 3062, 3064, 3091), Mitchell Plateau, W.A., 18, 19, 20, 21, 22, 25.X.1976 (18 ♀♀). In WAM, FMNH, QIMR, CU.

On Forrest's native mouse, *Pseudomys forresti* (Thomas) (3063), Mitchell Plateau, 22.X.1976 (1 ♀). In WAM.

On native mouse, *Pseudomys* sp. (3038, 3093), Mitchell Plateau, 20, 25.X.1976 (8 ♀♀). In WAM, FMNH.

On northern blossom bat, *Macroglossus lagochilus* Matschie (Chiroptera: Pteropodidae) (3020), Mitchell Plateau, 19.X.1976 (1 ♀). In WAM.

Laelaps rothschildi Hirst, 1914

This species, though common on many species of *Melomys* and *Uromys* in New Guinea and north-east Australia (Domrow 1977, 1979), was previously unknown from Western Australia.

Host and Locality

On scale-tailed rat, *Melomys* sp. (Rodentia: Muridae) (3141, 3151), Port Warrender, W.A., 30, 31.X.1976 (28 ♀♀). In WAM, FMNH, QIMR, CU.

Laelaps pammorphus Domrow, 1973

This species was previously known from two species of *Zyzomys* in Queensland, the Northern Territory and Western Australia: *Z. argurus* and *Z. woodwardi* (Domrow 1979). The specimens from rodents other than *Zyzomys* are best regarded as stragglers; those from bats certainly are.

Hosts and Localities

On common rock rat, *Zyzomys argurus* (Thomas) (Rodentia: Muridae) (2632, 2637, 2638, 2639, 2640, 2641, 2643, 2644, 2645, 2647, 2653, 2654, 2655, 2662, 2665, 2669), Napier Downs, W.A., 30, 31.VIII, 1, 2, 3, 4.IX.1976 (68 ♀♀, 21 ♂♂). On *Z. argurus* (2693, 2694, 2697, 2698, 2701, 2710, 2712), Mount Hart, W.A., 11, 12, 14.IX.1976 (12 ♀♀, 1 ♂). On *Z. argurus* (2721, 2726, 2733, 2734, 2736, 2737, 2738, 2792, 2793, 2794), Beverley Springs, W.A., 18, 19, 22.IX.1976 (43 ♀♀, 14 ♂♂). On *Z. argurus* (2802, 2803, 2804, 2810, 2812, 2814, 2816, 2817, 2818, 2834, 2837, 2851, 2852, 2854, 2857, 2864, 2885, 2912), Brooking Springs, W.A., 28, 29, 30.IX, 2, 4.X.1976 (83 ♀♀, 48 ♂♂). On *Z. argurus* (3015, 3037, 3052, 3053, 3060, 3083, 3084, 3087), Mitchell Plateau, W.A., 19, 20, 21, 22, 24.X.1976 (35 ♀♀, 9 ♂♂). On *Z. argurus* (3100, 3104, 3105, 3108, 3119, 3122, 3124, 3138, 3143, 3144, 3146, 3147, 3154, 3155, 3156, 3164, 3165), Port Warrender, W.A., 28, 29, 30, 31.X, 2.XI. 1976 (67 ♀♀, 18 ♂♂). In WAM, FMNH, QIMR, CU.

On Woodward's rock rat, *Zyzomys woodwardi* (Thomas) (3144), Port Warrender, 30.X.1976 (1 ♀). In WAM.

On Tunney's rat, *Rattus tunneyi* (Thomas) (Muridae) (3114), Port Warrender, 29.X.1976 (1 ♂). In WAM.

On brush-tailed tree rat, *Conilurus penicillatus* (Gould) (Muridae) (3149), Port Warrender, 31.X.1976 (1 ♀). In WAM.

On western chestnut native mouse, *Pseudomys nanus* (Gould) (Muridae) (3054), Mitchell Plateau, 21.X.1976 (1 ♀). In WAM.

On native mouse, *Pseudomys* sp. (3038), Mitchell Plateau, 20.X.1976 (2 ♀♀). In WAM, FMNH.

On scale-tailed rat, *Melomys* sp. (Muridae) (3141), Port Warrender, 30.X.1976 (2 ♀♀). In WAM.

On house mouse, *Mus musculus* Linnaeus (Muridae) (2808, 2841), Brooking Springs, 28, 29.IX.1976 (1 ♀, 1 ♂). In WAM.

On northern mastiff bat, *Tadarida jobensis* (Miller) (Chiroptera: Molossidae) (2727), Beverley Springs, 18.IX.1976 (1 ♀). In WAM.

On little bat, *Eptesicus pumilus* (Gray) (Chiroptera: Vespertilionidae) (2739), Beverley Springs, 19.IX.1976 (1 ♀). In WAM.

On black flying fox, *Pteropus alecto* Temminck (Chiroptera: Pteropodidae) (2805, –), Brooking Springs, 28, 29.IX.1976 (3 ♀♀, 2 ♂♂). In WAM, FMNH, QIMR, CU.

On northern blossom bat, *Macroglossus lagochilus* Matschie (Pteropodidae) (3013), Mitchell Plateau, 19.X.1976 (1 ♀, 1 ♂). In WAM.

Laelaps hapaloti Hirst, 1931

This species, though common on the genus *Notomys* in the drier parts of Queensland, Victoria, South Australia and Central Australia (Domrow 1973), was previously unknown from Western Australia. The deutonymph is newly described. It is a disappointment that the first mite I have seen from the rare *Notoryctes typhlops* is only a straggler.

Adult: Dorsal shield showing following individual variation, *cf.* Domrow (1963, 1973): from *N. alexis,* ♀ normal; one ♂ with z_6 absent on one side, other ♂ with z_6 and S_5 absent on one (same) side; from *Notomys* sp., ♀ with z_6 absent on one side; from *Notorcycte*s, ♀ with z_6 absent on one side, and z_6 and s_4 on other.

Deutonymph (**Figs 37-38**): Capitulum, as far as can be seen, as in ♀.

37

Fig. 37: *Laelaps hapaloti* Hirst. Idiosoma dn (dorsal).

Dorsal shield calculated to be 790 µm long, 415 µm wide; parallel-sided (unincised), but tapered to short, transverse termen; surface with reticulate striae; hypotrichous (with 22 pairs of setae on podonotal portion, $s_{1\text{-}2}$ and $r_{2\text{-}4}$ actually free in adjacent cuticle; 15 on opisthonotal, $px_{2\text{-}3}$ lacking), with at least some of 22 pairs of pores commonly seen in *Laelaps*, but, while two pairs in front of $S_{4\text{-}5}$ are distinct, it cannot be seen in this pale, freshly moulted specimen whether they are accompanied by "windows." Dorsal cuticle with many pairs of short setae.

38

Fig. 38: *Laelaps hapaloti* Hirst. Idiosoma dn (ventral).

Presternal area striate. Sternogenital shield elongate, 390 µm long, 135 µm wide; sides subparallel, irregular posteriorly; surface with reticulate striae; with usual four pairs of setae and three pairs of pores; genital setae and pores free in adjacent cuticle. Anal shield 90 µm wide (length unavailable because cribrum turns onto dorsum). Ventral cuticle with many pairs of setae, longer midventrally and posteriorly. Venter otherwise as in ♀, except that post-stigmatic pores are free in cuticle.

Legs as in ♀, except that al_1 on tarsi II-III is sharp-tipped.

Hosts and Localities

On spinifex hopping mouse, *Notomys alexis* Thomas (Rodentia: Muridae) (M12964), Wanjarri Nature Reserve, W.A., 8.I.1975, P. Lambert (1 ♀, 2 ♂♂, 1 dn). In WAM.

On Mitchell's hopping mouse, *Notomys mitchellii* (M8155), Lake Biddy, W.A., 18.IV.1969, M. Hartley (1 ♀). In WAM.

On marsupial mole, *Notoryctes typhlops* (Stirling) (Marsupialia: Notoryctidae) (M7711), Warburton Range, W.A., 1968, T. Carr (1 ♀). In WAM.

Neolaelaps spinosus **(Berlese, 1910)**

This species is widespread on bats of the genus *Pteropus* (Pteropodidae) in S.E. Asia and Australasia (Domrow 1961, 1973, Wilson 1967, Prasad 1974). The specimen is clearly a straggler, *cf.* Bhattacharyya (1971).

Host and Locality

On grassland scale-tailed rat, *Melomys littoralis* Lönnberg (Muridae), Capsize Creek, 80 km S of Moreton Telegraph Office, Cape York Peninsula, Q., 19.VII.1964, K. Keith (1 ♀). In QIMR.

Trichosurolaelaps emanuelae **Domrow, 1958**

These specimens, from the original host genus, are included for historical reasons. See also Domrow (1977).

Host and Locality

On spiny bandicoot, *Echymipera* sp. (Marsupialia: Peramelidae) (13056), Stephansort (= Bogadjim), ex-German New Guinea, 25.V.1904, P. Preuss (1 ♀, 1 ♂). In MNK.

Trichosurolaelaps marra **Domrow, 1972b**

These specimens, from one of the original hosts, are included for historical reasons. See also Domrow (1977). Immatures were previously unknown.

Deutonymph: Capitulum as in ♀, with fully developed chelicerae.

Dorsal shield 435 μm long, 230 μm wide, not incised laterally between podonotal and opisthonotal portions; texture not wholly clear, but with some reticulate striae vertically, humerally and posterolaterally; setation as in ♀, but s_1, $r_{2\text{-}5}$ and s_6 free in adjacent cuticle. Dorsal cuticle with about 16 pairs of setae, all bladed, except one longer pair subposteriorly.

Sternogenital complex as in *T. crassipes* Womersley, see Domrow (1979); measurements unavailable because of fracture. Venter otherwise as in ♀, except as follows. Ventral cuticle with about 10 pairs of slightly bladed setae. Peritremes as in ♂.

Legs predicting those of ♀.

Protonymph: Capitulum with palpal trochanter-genu holotrichous (*i.e.* 1.4.5, *cf.* hypotrichous 2.4.5 in dn).

Dorsum as in *T. crassipes*, granted setae on opisthonotal cuticle are 6.5 in one specimen and 5.5 in other (*cf.* holotrichous 6.6). Podonotal shield 250 µm long, 200 µm wide. Opisthonotal shield *ca* 125 µm long, 60 µm wide.

Venter as in *T. crassipes.*

Leg setation as in *T. crassipes.*

Host and Locality

On sugar glider, *Petaurus breviceps* Waterhouse (Marsupialia: Petauridae) (T663), Australia, 29.XI.1913, Vosseler (1 ♂, 1 dn, 2 pn). In ZMH, QIMR.

ACKNOWLEDGEMENTS

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THE MONITOR LIZARDS (GENUS *VARANUS* MERREM, 1820) OF WESTERN AUSTRALIA

G.M. STORR*

ABSTRACT

The 19 species and subspecies of *Varanus* inhabiting Western Australia are defined and keyed: *V. acanthurus* Boulenger, *V. brevicauda* Boulenger, *V. caudolineatus* Boulenger, *V. eremius* Lucas & Frost, *V. giganteus* (Gray), *V. gilleni* Lucas & Frost, *V. glauerti* Mertens, *V. glebopalma* Mitchell, *V. gouldii* (Gray), *V. kingorum* nov., *V. mertensi* Glauert, *V. mitchelli* Mertens, *V. panoptes panoptes* nov., *V. panoptes rubidus* nov., *V. pilbarensis* nov., *V. rosenbergi* Mertens, *V. storri ocreatus* nov., *V. timorensis scalaris* Mertens and *V. tristis tristis* (Schlegel).

INTRODUCTION

Thanks largely to the efforts of the late Professor Robert Mertens the alpha taxonomy of Australian varanids is soundly based. However, Mertens' subgeneric classification of *Varanus* is not standing up so well to the scrutiny of modern investigators. For example, *Varanus mitchelli,* placed by Mertens (1953) in the subgenus *Varanus,* has the same karyotype and lactate dehydrogenase isozyme as members of the subgenus *Odatria* (Holmes, King & King, 1975). It seems that the laterally compressed tail of *V. mitchelli* is not homologous with that of the large monitors. In the latter it probably serves as a weapon of defence; in *V. mitchelli* it is doubtless an adaptation for swimming.

Because it is still uncertain how best to divide *Varanus* into subgenera and species-groups, I herein deal with the western taxa in alphabetic order. This revision is based on material in the Western Australian Museum and the collection of the British Joint Services Expedition to Central Australia (specimen numbers prefixed with JSE).

I am grateful to Mrs Ariadna Neumann for her painstaking translation of much of Professor Mertens' work.

*Western Australian Museum, Francis Street, Perth, Western Australia 6000.

KEY

1. Tail (except base) markedly laterally compressed with a low two-keeled crest; lateral caudals small, weakly keeled, not spinose or mucronate; length of head plus body up to 70 cm—"subgenus *Varanus*" 2

   Tail not or slightly laterally compressed, usually without a two-keeled crest; lateral caudals moderately large, weakly to strongly keeled, with or without a spine or mucron; length of head plus body up to 36 cm—"subgenus *Odatria*" 8

2. Tail extremely compressed; nostril small, located on swollen canthus rostralis (i.e. laterodorsal or dorsolateral in position); dorsally olive with scattered very small, black-edged, whitish spots on back and limbs ... ... *V. mertensi*

   Tail strongly compressed; nostril moderately large, located below weak to moderately strong canthus rostralis (i.e. lateral in position); dorsal coloration not as above 3

3. Canthus rostralis very strong; nostril about twice as far from orbit as tip of snout; anterior part of head strongly concave in plan (so that snout is narrow with sides almost parallel); a fine dark reticulum underneath; midbody scale rows 265-287 ... ... *V. giganteus*

   Canthus rostralis weak to moderately strong; nostril not much further from orbit than tip of snout; side of head not strongly concave in plan; underneath spotted, banded or coarsely reticulated; midbody scale rows 103-242 4

4. Throat, breast, belly and under legs and tail *narrowly* cross-banded with grey; length of head plus body up to 25 cm; midbody scale rows 103-130 ... ... *V. mitchelli*

Ventrally spotted, reticulated or *widely* cross-banded; length of head plus body up to 66 cm; midbody scale rows 132-242 5

5. Dorsal pattern consisting of transverse rows of large dark spots alternating with rows of small pale spots; small dark spots on venter aligned with large dark spots on back 6

   No large dark spots on back; venter immaculate, banded or spotted (spots not aligned transversely) 7

6. Dorsal ground colour brown; tail entirely banded ... ... *V. panoptes panoptes*

   Dorsal ground colour reddish; end of tail pale, unbanded ... ... *V. panoptes rubidus*

7. End of tail yellow; neck not banded; venter in adults spotted with dark brown ... ... *V. gouldii*

   End of tail banded or uniformly dark; 3 or 4 black cross-bands on neck curving down and forwards on sides; venter coarsely reticulated or cross-banded with grey ... ... *V. rosenbergi*

8. Tail distally with dark longitudinal stripes or lines 9

   Tail without dark longitudinal stripes or lines (i.e. pattern, if any, entirely transverse) 11

9. Scales on top of head obtusely keeled; tail with a low two-keeled crest; nails long, slender and slightly curved; throat streaked with grey ... ... *V. eremius*

   Head scales smooth; tail without a two-keeled crest; nails short, thick and strongly curved; throat freckled with brown 10

10. Head, neck and back spotted with dark brown ... ... *V. caudolineatus*

    Head streaked and back narrowly cross-banded with dark brown ... ... *V. gilleni*

11. All but base of tail encircled by bold black and white bands ... ... *V. glauerti*

    Tail not so 12

12. Distal two-fifths of tail whitish, unbanded ... ... *V. glebopalma*

Tail not so 13

13. Caudal scales strongly spinose 14

Caudal scales not strongly spinose 15

14. Neck with longitudinal stripes; back with pale spots; midbody scale rows 88-112; length of head plus body up to 24 cm ... ... *V. acanthurus*

Neck not striped; back without pale spots; midbody scale rows 70-84; length of head plus body up to 13 cm ... ... *V. storri ocreatus*

15. Coloration predominantly black, brown and grey; dorsal pattern (if any) consisting of large pale spots; length of head plus body up to 28 cm 16

Coloration predominantly reddish brown; dorsal pattern consisting of small dark spots; length of head plus body up to 17 cm 17

16. Ventrolaterally on tail a squarish or circular cluster of black or black-and-white spinose scales much larger than adjacent scales and well separated from cloaca by small scales; supraorbitals much smaller than interorbitals and sharply differentiated from them; midbody scale rows 119-152 ... ... *V. tristis tristis*

Lateroventrally on tail in males several rows of small narrow white pointed or spinose scales immediately behind cloaca; supraorbitals much smaller than interorbitals and gradually merging with them; midbody scale rows 98-124 ... ... *V. timorensis scalaris*

17. Scales on top of head very weakly keeled; length of head plus body up to 12 cm; tail less than 1.2 times as long as head plus body; lamellae under fourth toe 12-16 ... ... *V. brevicauda*

Head scales smooth; length of head plus body up to 17 cm; tail more than 1.7 times as long as head plus body; lamellae under fourth toe 19-25 18

18. Four to six curving rows of narrow pale spinose scales on each side of tail immediately behind

cloaca; dorsal and lateral caudal scales weakly keeled ... ... *V. pilbarensis*

No cluster of spinose scales behind cloaca; dorsal and lateral caudals sharply keeled ... ... *V. kingorum*

SPECIES AND SUBSPECIES

Varanus acanthurus

(Plate 1; Fig. 1)

Varanus acanthurus Boulenger, 1885, Catalogue of the lizards in the British Museum (Natural History) **2:** 324. "N.W. Australia."

Varanus acanthurus brachyurus Sternfeld, 1919, Senckenbergiana **1:** 78. Hermannsburg, N.T.

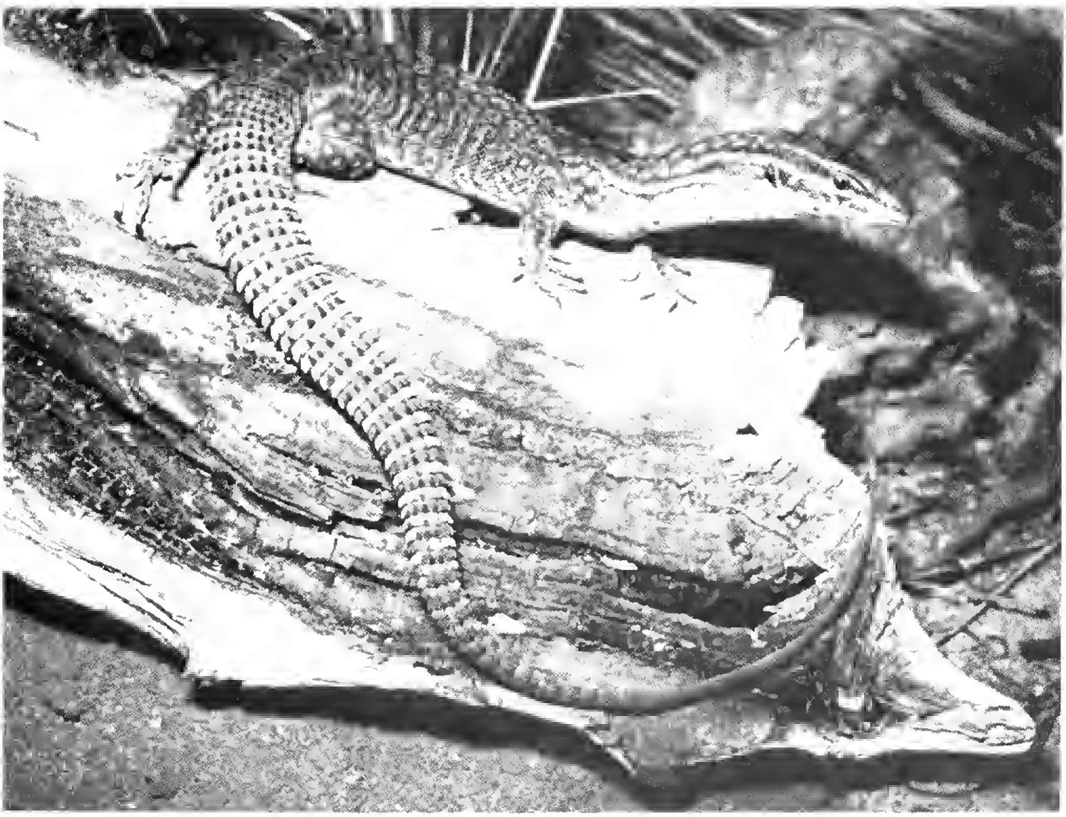

Plate 1: A *Varanus acanthurus* from Nullagine. Photographed by R.E. Johnstone.

Diagnosis

A medium-sized monitor (up to 63 cm long) with strongly spinose tail. Distinguishable from both subspecies of *V. storri* by more numerous midbody scale rows and transverse rows of ventrals, greater size and stronger colour pattern (usually including pale stripes on neck, pale spots on back and pale rings on tail).

Distribution

Tropical Western Australia, south to beyond North West Cape (Yardie Creek), the Hamersley Range, the vicinity of Lake Disappointment (Durba Springs) and the Gibson Desert (64 km N of Windy Corner); also offshore from Sir Graham Moore I. south-west to South Muiron I. Also the Northern Territory (from Katherine south to the Kintore and Macdonnell Ranges) and north-west Queensland.

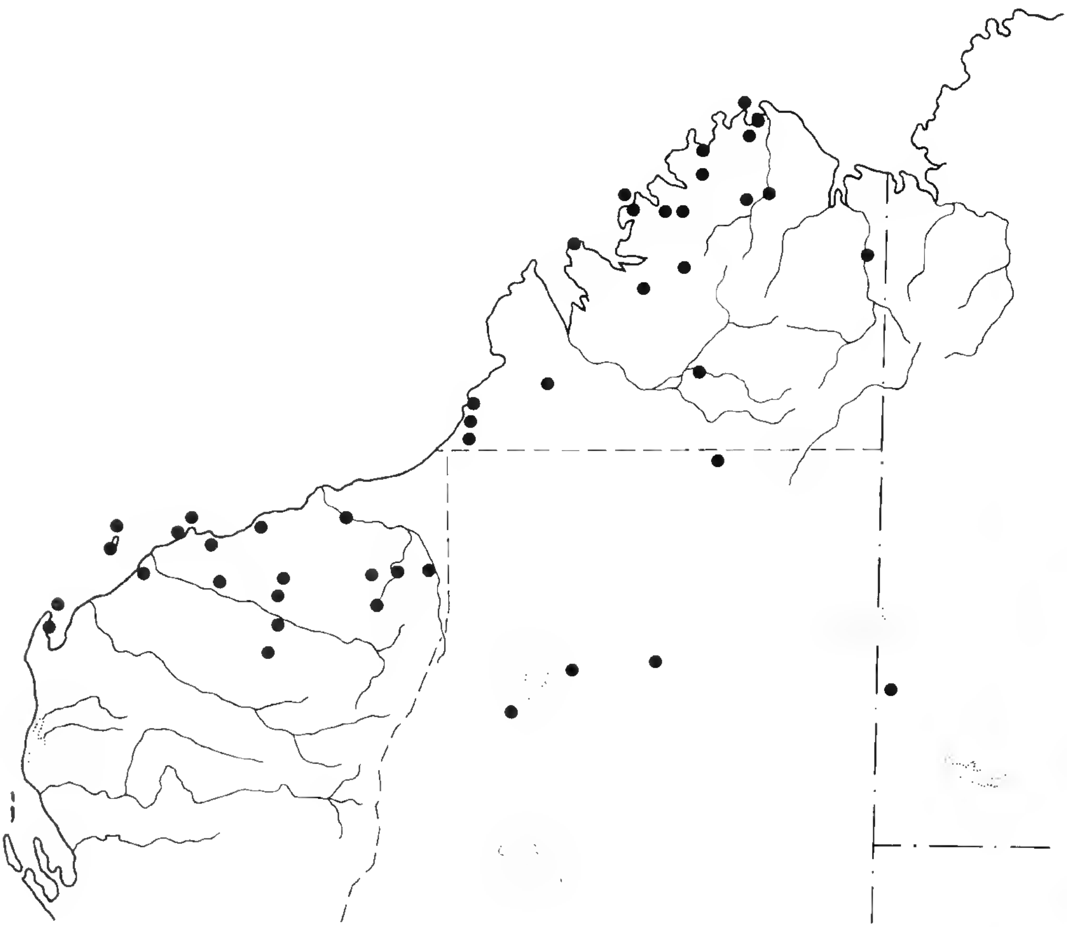

Fig. 1: Map of northern Western Australia showing location of specimens of *Varanus acanthurus*.

Description

Snout-vent length (mm): 65-237 (N 111, mean 150.6). Length of appendages (% SVL): foreleg 23-30 (N 96, mean 27.1), hindleg 30-45 (N 99, mean 36.3), tail 136-228 (N 86, mean 176.7). Midbody scale rows 88-112 (N 89, mean 98.8). Lamellae under fourth toe 15-23 (N 97, mean 18.5).

Head scales small, smooth; interorbitals largest, supraorbitals smallest and moderately well differentiated. Canthus rostralis weak. Nostril lateral, a little nearer to tip of snout than orbit. Nails moderately long and slender, strongly curved.

Upper surfaces strongly patterned with dark and pale markings; former varying from black through blackish brown to dark reddish brown; latter from mid reddish brown through pale reddish brown and pale brown to brownish or yellowish white. Dark markings on head tending to be elongate spots or short stripes; on nape longitudinal stripes alternating with whitish stripes or rows of spots; on back a fine or coarse reticulum enclosing large to moderately large pale spots, usually with a dark central dot; and on tail indistinct cross-bands (1-2 scales wide) alternating with pale cross-bands (one scale wide); but, as described under geographic variation, pale markings may be greatly reduced in north. Upper surface of limbs dark with pale spots. Facial pattern consisting mainly of a dark loreotemporal stripe bordered above and below by a more or less distinct pale line. Sides of body patterned like back or with alternating dark and pale vertical stripes. Underneath brownish white (under tail dark grey in north), spotted with brown on throat, venter, hindlegs (rarely forelegs) and base of tail; spots largest on side of throat and tending to coalesce into short oblique stripes; spots on abdomen occupying whole of scale.

Geographic variation

Apart from slightly peculiar populations on some islands (e.g. Barrow and South Muiron), geographic variation is clinal and generally overshadowed by the wide range of individual variation.

From north to south coloration becomes on average paler and redder. Overall pallor increases southwards despite the fact that the pale elements of the pattern are actually becoming darker, i.e. changing from predominantly brownish white in the north to predominantly reddish in the south. In the north, especially in subhumid north-west Kimberley, the blackish reticulum is so thick as to leave on the back only small rosettes of pale pigment, and on the tail the blackish pigment is often relieved only by the pale spines on some of the proximal caudals. Southwards the reticulum becomes dark reddish brown and finer, the enclosed ocelli larger, and the pale caudal rings more numerous and complete.

As can be seen in the following table, relative length of tail and hindleg and number of lamellae under fourth toe decrease from north to south.

latitude		14-17°S	17-20°S	20-24°S
	N	35	19	45
hindleg	range	34-45	34-44	30-40
	mean	37.8	36.8	34.8
	N	29	17	40
tail	range	158-228	156-219	136-187
	mean	194.4	181.0	163.3
	N	34	18	45
lamellae	range	18-23	17-22	15-20
	mean	19.8	18.4	17.5

Remarks

Distribution and variation seem too continuous in this species to permit its division into northern and southern subspecies.

Until the taxonomic status of *insulanicus* Mertens of Groote Eylandt is clarified I refer to *V. acanthurus* binomially.

Material

Kimberley Division (W.A.): Sir Graham Moore I. (44057); Pago (953*a-b*); Kalumburu (28034, 58773, 59024); Port Warrender (56366); Surveyors Pool, Mitchell Plateau (14°40′S, 125°44′E) (43134); Mitchell Plateau (14°52′S, 125°50′E) (43165, 43201, 43320); Drysdale River National Park in 15°16′S, 126°43′E (50690); Old Doongan (50988); Augustus I. (41301, 42965); Kunmunya (40475); Prince Regent River Reserve in 15°28′S, 125°29′E (46688, 46991-3, 47275) and 15°28′S, 125°40′E (46972); Lake Argyle (58769-71, 59976); Wotjulum (11203-4, 11825-32, 12334-5); Beverley Springs (13665); Mt Hart (24067-8, 24080-2, 24736); Fossil Downs (21222); near McHugh Bore, Dampier Downs (54151, 54160-1); Lagrange (46435, 58772, 58774); Frazier Downs (40674); Mt Phire (28019-20); Mannerie Swamp, Nita (59977).

North-west Division (W.A.): Mulyie (58992); Mundabullangana (14903-5, 29061); Legendre I., Dampier Archipelago (14363); West Lewis I., Dampier Archipelago (37339-40); Hermite I., Montebello Is (37442); Lowendall I.

(12897); Barrow I. (56703, 58764-8); Roebourne (12130); Braeside (14590); Meentheena (46175); Mt Edgar (14902, 14906); Mardie (22936); Mt Herbert (20003-4, 58949-50); South Muiron I. (37245); Exmouth (31414); Yardie Creek (28021-2, 51026, 53325); Woodstock (13803, 31210, 58775, 59025); White Springs (36592); Nullagine and 5 km E (37982, 51714); Wittenoom Gorge (29121); Marandoo (52711).

Eastern Division (W.A.): S of Lake Betty (19°35′S, 126°22′E) (51215); 64 km N of Windy Corner (26927); 33 km E of Well 24, Canning Stock Route (27018); Durba Springs (51944).

Northern Territory: Katherine (26345); 32 km N of Larrimah (23802) and 16 km N (23803); between Wave Hill and Inverway (13718); 23 km N of Wauchope (24295); 36 km W of Alice Springs (20824); Mt Leisler (45205).

Queensland: 45 km NE of Mt Isa (55451).

Varanus brevicauda

(Plate 2; Fig. 2)

Varanus brevicauda Boulenger, 1898, Proc. zool. Soc. Lond. 1898: 920. Sherlock River, W.A.

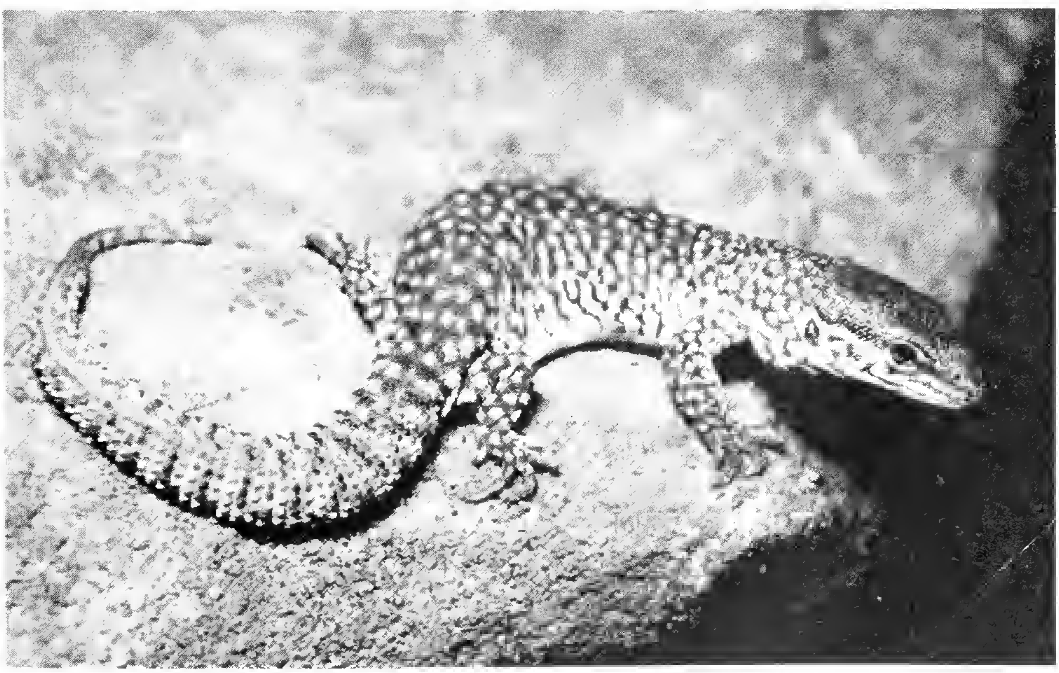

Plate 2: A *Varanus brevicauda* from Marandoo. Photographed by R.E. Johnstone.

Diagnosis

A very small monitor (up to 23 cm long) with short snout, limbs, toes and tail; tail basally constricted and depressed, distally circular in section; dorsal and lateral caudal scales strongly keeled but not spinose or mucronate.

Distribution

Arid and semiarid north-western Western Australia from King Sound south to the Carnarvon and Wiluna districts. Also Northern Territory (Tanami Desert).

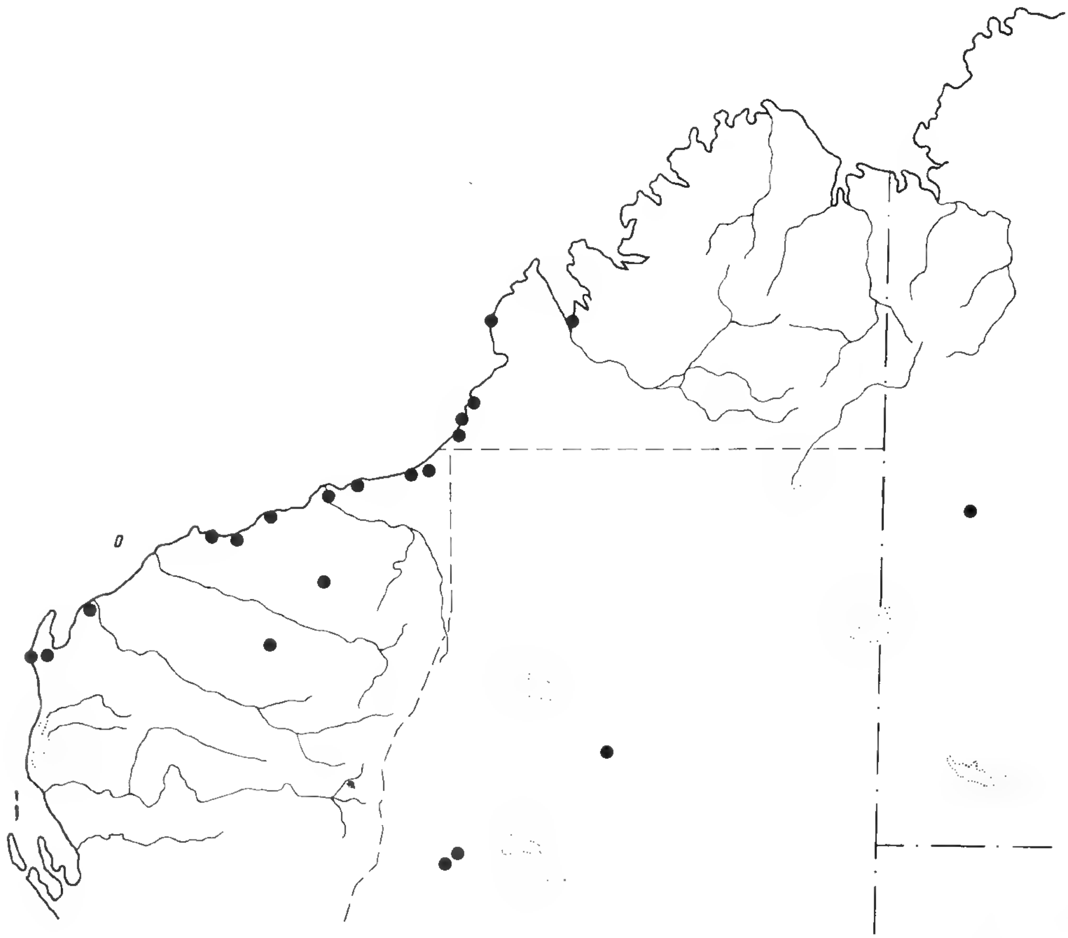

Fig. 2: Map of northern Western Australia showing location of specimens of *Varanus brevicauda*, including those listed in Pianka (1970*a*).

Description

Snout-vent length (mm): 39-118 (N 21, mean 86.9). Length of appendages (% SVL): foreleg 17-24 (N 18, mean 21.6), hindleg 19-29 (N 17, mean 24.9), tail

87-116 (N 20, mean 97.7). Midbody scale rows 74-92 (N 16, mean 82.8). Lamellae under fourth toe 12-16 (N 16, mean 14.0).

Head scales small, very weakly keeled; supraorbitals much smaller than interorbitals but not sharply differentiated from them. Canthus rostralis weak. Nostril lateral, a little nearer to tip of snout than orbit. Cluster of spines at each side of base of tail slightly behind cloaca. Nails moderately short, slender and curved.

Dorsal and lateral surfaces pale to dark reddish brown. Back and tail spotted or flecked with dark brown, and occasionally flecked with brownish white; dark markings sometimes forming a reticulum on back and narrow vertical bars on flanks. Occasionally an indistinct dark loreotemporal streak and a pale narrow stripe from bottom of ear aperture to top of foreleg. Underneath brownish or reddish white, throat occasionally and venter rarely with small greyish brown spots.

Remarks

For notes on its distribution, habitat preferences, reproduction and diet, see Pianka (1970*a*).

Material

Kimberley Division (W.A.): 32 km S of Derby (20350); Coulomb Point (40273-4, 44329); Lagrange (28029); Anna Plains (46168).

North-west Division (W.A.): 34 km W of Sandfire Flat Roadhouse (51301); Wallal (1023-5, 45806-7); 16 km ENE of Pardoo (60433); De Grey (2124); Mundabullangana (14915); Roebourne (29118, 41058); Abydos (12622); 16 km SE of Urala (29768); Ningaloo (16876) and 29 km E (16884); Marandoo (54347).

Eastern Division (W.A.): 24 km E of Mt Madley (24°30′S, 124°15′E) (40616).

Varanus caudolineatus

(Plate 3; Fig. 3)

Varanus caudolineatus Boulenger, 1885, Catalogue of the lizards in the British Museum (Natural History) **2:** 324. Champion Bay, W.A.

Diagnosis

A small arboreal monitor (up to 32 cm long) with tail circular in section and longitudinally striped. Very similar to *V. gilleni* but head and back spotted rather than streaked and cross-banded. Distinguishable from *V. eremius* by smooth (rather than keeled) head scales.

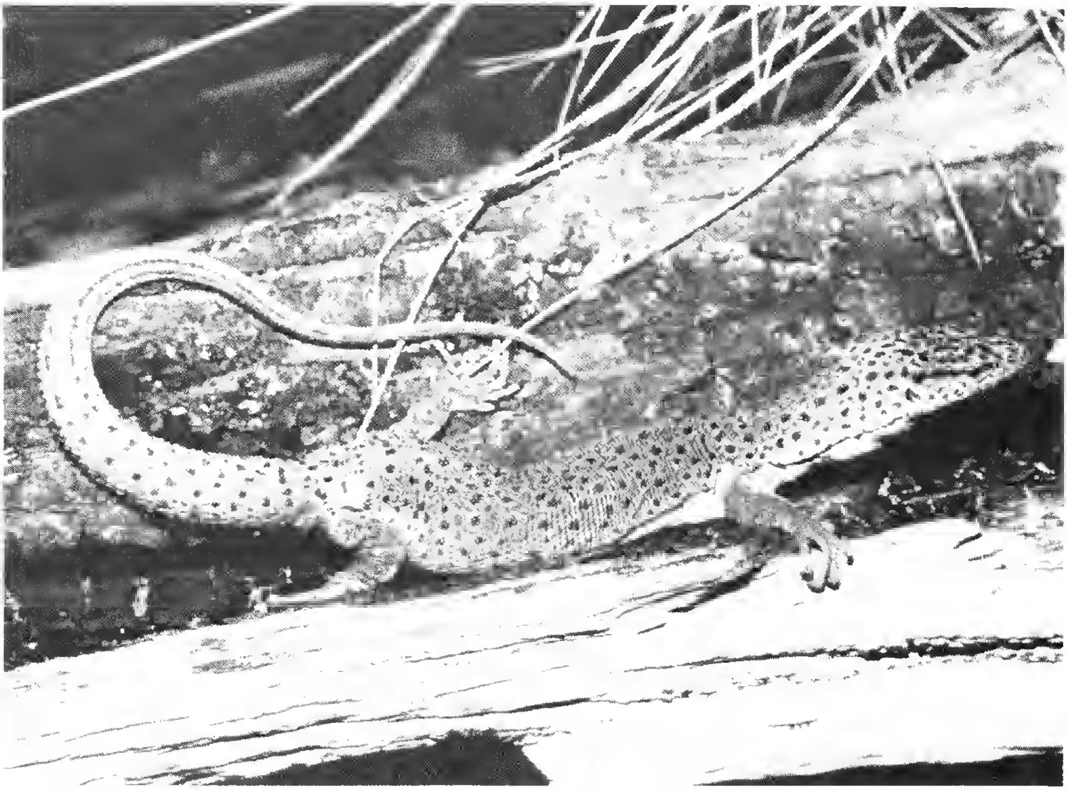

Plate 3: A *Varanus caudolineatus* from Wilroy. Photographed by R.E. Johnstone.

Distribution

Western half of arid and semiarid zones of Western Australia from the southern Pilbara and far south of Great Sandy Desert south to the northern Wheat Belt and Eastern Goldfields.

Description

Snout-vent length (mm): 57-132 (N 110, mean 93.8). Length of appendages (% SVL): foreleg 19-29 (N 84, mean 25.1), hindleg 29-39 (N 76, mean 33.4), tail 109-149 (N 82, mean 127.7). Midbody scale rows 80-109 (N 71, mean 92.0). Lamellae under fourth toe 16-25 (N 78, mean 20.0).

Head scales small, smooth; supraorbitals smallest, not sharply differentiated from interorbitals. No canthus rostralis. Nostril lateral, a little nearer to orbit than tip of snout. Dorsal and lateral caudal scales strongly keeled but not spinose or mucronate. Nails short, thick and strongly curved.

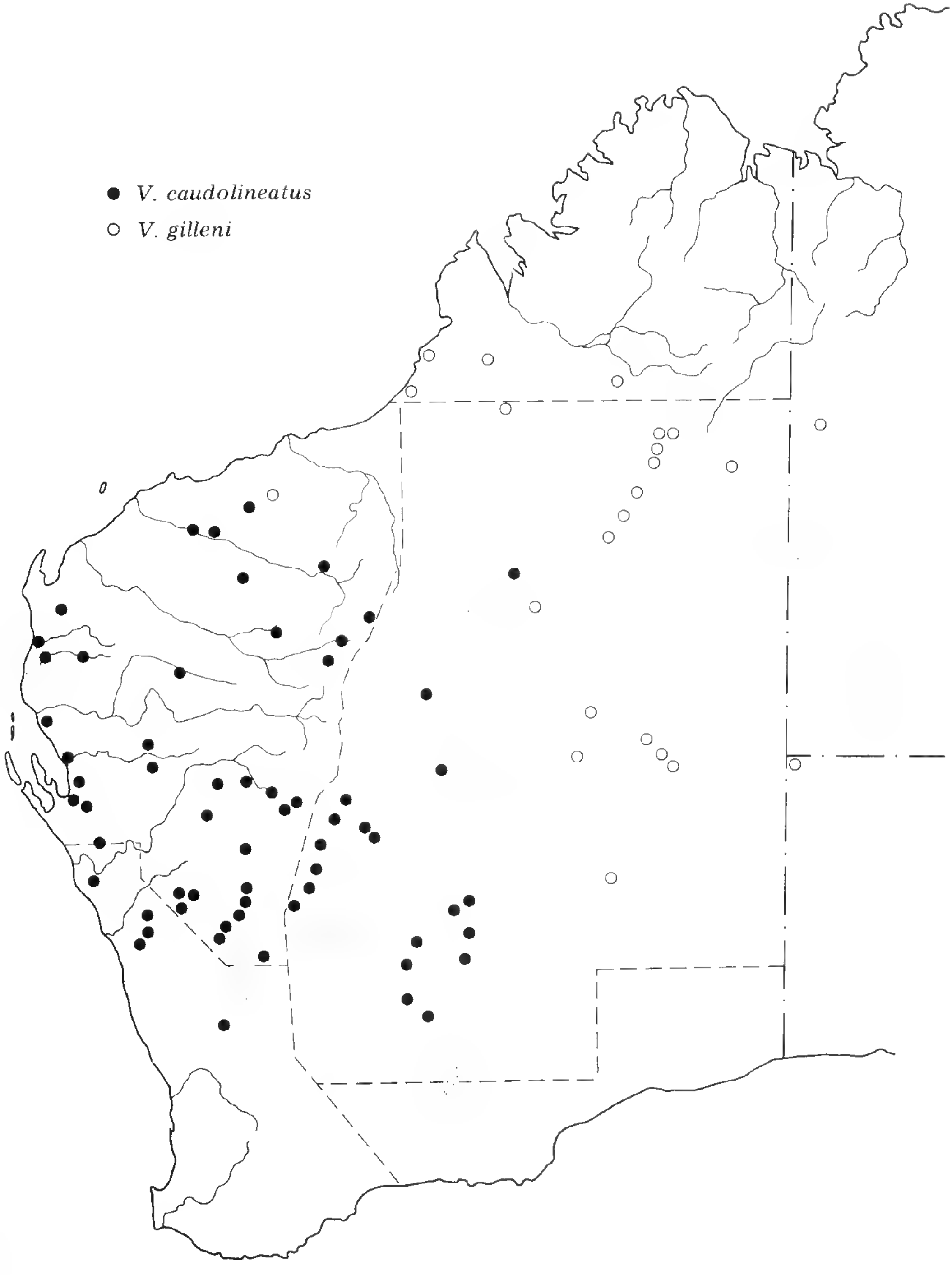

Fig. 3: Map of Western Australia showing location of specimens of *Varanus caudolineatus* and *V. gilleni*, including those listed in Pianka (1969).

Dorsal ground coloration usually reddish brown, brightest and palest on tail; often greyish brown, sometimes tinged on back with red and on tail with yellowish brown. Head, neck, back and base of tail sparsely or densely covered with small dark reddish brown or blackish brown spots; spots on back commonly surrounded by a circular area slightly paler than ground colour (each of these paler areas enclosed by a barely discernible, fine, dark ring). Distal 65-75% of tail with 4 or 5 longitudinal dark reddish brown or blackish brown stripes (a dorsolateral, midlateral and commonly a vertebral). Dark streak from eye reaching backwards and slightly upwards to above ear aperture. Underneath greyish white, brownish white or buffy white, freckled with brown on chin and throat and occasionally on venter and under legs and base of tail.

Geographic variation

Specimens from north of the Ashburton are larger (SVL 85-132, N 10, mean 115.0; *vs* 57-115, 100, 91.7) and have more numerous midbody scale rows (91-109, N 10, mean 99.3; *vs* 80-107, 61, 90.8) and a tendency for dark spots on base of tail to align transversely. In each of these characters the northernmost population of *V. caudolineatus* shows an approach to its close relative and near neighbour *V. gilleni.*

Remarks

For notes on its distribution, habitat preferences, diet and reproduction, see Pianka (1969).

Material

North-west Division (W.A.): near Kangiangi (20241); Tambrey (4288); Marandoo (54230, 56834); 27 km E of Marillana (14917); Marrilla (5048); Jiggalong (13362, 26068-70); Warroora (8167-8); 3 km SE of Turee Creek (25149); Mundiwindi (12278); 30 km SE of Bulloo Downs (47793); Mt Augustus (52893-6); Minilya (10611); Callagiddy (34563-4, 39765); Coordewandy (28394, 28955-6); Wooramel (54595); Woodleigh (44529, 49943, 57377-8); Byro (47347); Belele (7378-9); Mileura (15785-9, 47630); Overlander Roadhouse, Shark Bay turnoff (13137, 13711); 15 km E of Hamelin Pool (54594); 20 km ENE of Meadow (26°39'S, 114°48'E) (59607); Murchison Downs (4934); Quinns, via Nannine (10812); Kalli (41793); 34 km SSE of Nerren Nerren (27°19'S, 114°51'E) (59620); 11 km S of Cue (14918); Marloo (3818); Yalgoo (22870); Gullewa (4732-3); 16 km S of Mt Magnet (48152) and 32 km S (29111); 5 km NW of Kirkalocka (48151); Fields Find (22652); Warriedar (1191) and 5 km S (51157); 64 km N of Beacon (34685).

Eastern Division (W.A.): Well 29, Canning Stock Route (3903); The Weld Spring (28028); 32 km NE of Yelma (21100); 24 km SW of Wiluna (21137) and 70 km SW (21138-9); Albion Downs (19789-90, 28290, 30967-9); Kathleen Valley (12407, 19771, 27231); 35 km N of Sandstone (21149); Cosmo Newberry (13857, 19600); Sandstone (47374) and 51 km SW (21150); Youanmi (39043, 60130) and 11 km SW (21178-81); Laverton (3415-6, 3423, 23908-10); Mt Margaret (17681); Linden (46621); 60 km S of Leonora (51092); 14 km S of Menzies (31681); Yarri (46618); Ora Banda (51189).

South-west Division (W.A.): Ajana (22995, 25883); Wilroy Reserve, 19 km S of Mullewa (49992-3); 35 km NE of Mingenew (31381-5).

Varanus eremius

(Fig. 4)

Varanus eremius Lucas & Frost, 1895, Proc. R. Soc. Vict. (new ser.) **7**: 267. Central Australia [= Idracowra and Charlotte Waters, N.T.].

Diagnosis

A moderately small ground monitor (up to 46 cm long) with tail triangular in section and longitudinally striped. Distinguishable from *V. caudolineatus* and *V. gilleni* by keeled head scales, dark streaks on throat and long slender nails.

Distribution

Arid and semiarid zones of Western Australia from the Pilbara and Great Sandy and Tanami Deserts south to the far north of the Wheat Belt and to the Great Victoria Desert. Also southern Northern Territory and north-western South Australia.

Description

Snout-vent length (mm): 57-164 (N 36, mean 127.7). Length of appendages (% SVL): foreleg 22-30 (N 35, mean 25.9), hindleg 36-44 (N 35, mean 39.7), tail 155-209 (N 32, mean 183.6). Midbody scale rows 87-110 (N 26, mean 97.1). Lamellae under fourth toe 19-28 (N 33, mean 23.7).

Head scales small, obtusely keeled; interorbitals largest, supraorbitals much smaller than interorbitals but not sharply differentiated from them. Canthus rostralis weak to moderately strong. Nostril very large, midway between orbit and tip of snout or slightly nearer to orbit. Face concave ("hollow-cheeked") between canthus rostralis and loreal crease, below which it is convex ("swollen"). Tail with a two-keeled crest. Dorsal and lateral caudal scales with a high keel tipped with a small mucron. Nails very long and slender, only slightly curved.

Dorsally reddish brown or greyish brown, rarely yellowish brown. Head with or without short longitudinal or oblique blackish brown streaks. Neck, back, limbs and base of tail usually covered with small blackish brown spots and frequently also pale brown spots (usually dark-edged) or pale flecks. Tail with 4 blackish brown longitudinal stripes (dorsolateral and midlateral). Dark streak from lores through top of orbit to above ear aperture. Whitish line from lips to arm, bordered above by a dark streak. Ventrolateral surfaces of body grey, occasionally bisected by a whitish stripe. Underneath whitish; pinkish under tail. Chin, throat and under neck finely or coarsely marked with grey: a median streak and usually two oblique lateral streaks on throat, all confluent on chin (thus forming an arrowhead); lateral streaks extending back (parallel to median streak) discontinuously to under hindneck, which may be broadly grey.

Remarks

For notes on its distribution, habitat preferences, behaviour, diet and breeding season, see Pianka (1968).

Material

North-west Division (W.A.): 5 km E of Roebourne (17081); Tambrey (20083-4); White Springs (109 km N of Wittenoom) (36593); Boologooro (28015, 60406-8); Callagiddy (40677); 16 km S of Gascoyne Junction (56859); Peron HS (55167); 14 km ENE of Meadow (59621).

Eastern Division (W.A.): 48 km W of Balgo Hill (40873); Well 38, Canning Stock Route (45261); 58 km E of Jupiter Well (45126); Well 26, C.S.R. (39144); Well 12, C.S.R. (42307); 145 km N of Carnegie (40603, 40614); Well 7, C.S.R. (28023); SE Carnarvon Range (40749); Warburton Range (14658, 22001, 22020) and 93 km E (34145); Wanjarri (27230, 40529); Maloora Rock-hole (14916).

South-west Division (W.A.): Lockwood Spring, Kalbarri National Park (37570-1); 29 km N of Ajana (33597); Janja Thicket, Kalbarri N.P. (37637); 44 km NE of Yuna (56971); East Yuna Reserve, 30 km ESE of Yuna (48117); 32 km E of Mullewa (11353).

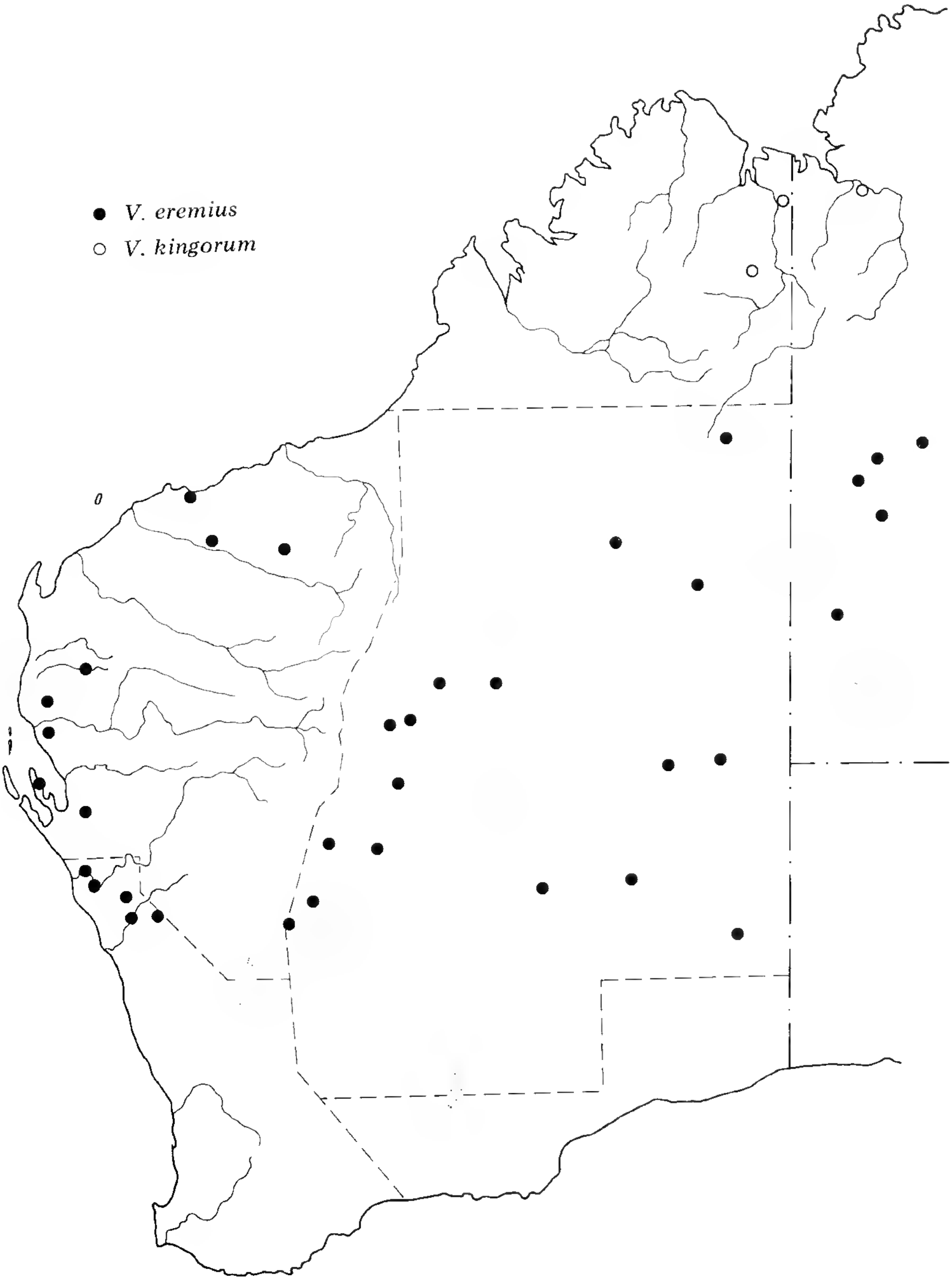

Fig. 4: Map of Western Australia and adjacent part of Northern Territory showing location of specimens of *Varanus eremius* (including those listed in Pianka, 1968) and *V. kingorum*.

Varanus giganteus

(Fig. 5)

Hydrosaurus giganteus Gray, 1845, Catalogue of the specimens of lizards in the collection of the British Museum, p.13. North coast of New Holland [= Barrow I., W.A.*].

Diagnosis

A very large ground monitor (up to 2 m long) with tail strongly compressed, back with transverse rows of large pale spots, and under surface with a dark reticulum. Further distinguishable from *V. gouldii, V. panoptes* and *V. rosenbergi* by the narrow parallel-sided snout, nostril about twice as far from orbit as snout, and more numerous midbody scale rows and subdigital lamellae.

Distribution

Rocky country in the arid zone of Western Australia from the Pilbara south to Yalgoo and the Menzies district and east to the Gibson and Great Victoria Deserts. Also southern Northern Territory, far western Queensland and northern South Australia.

Description

Snout-vent length (mm): 158-700 (N 11, mean 374.2). Length of appendages (% SVL): foreleg 29-35 (N 9, mean 32.2), hindleg 39-50 (N 9, mean 43.9), tail 147-192 (N 9, mean 166.6). Midbody scale rows 265-287 (N 4, mean 279.7). Lamellae under fourth toe 33-36 (N 4, mean 34.7).

Head scales smooth, very small; interorbitals largest, supraorbitals smallest and well differentiated. Canthus rostralis strong. Supraciliary ridge very strong and jutting out over eye. Nostril lateral, much nearer to tip of snout than orbit. Face sunken between canthus rostralis and strong loreal crease. Tail proximally subcircular in section, distally strongly compressed with low two-keeled crest. Lateral caudal scales very small with low weak keels not spinose or mucronate.

Dorsally dark brown to black, finely stippled in adults with yellow. Head with small irregular whitish or yellowish spots (creamy white in juveniles). Back, limbs and tail with transverse rows of brownish yellow spots (creamy

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*Stokes (1846: 210) wrote of "two iguanas, measuring seven feet in length" that were killed on Barrow Island in September 1840.

white in juveniles). Spots on back largest, usually black-centred and black-edged. Spots on neck posteriorly circular and yellowish but not black-centred; anteriorly greyish, elongate and coalescing into wavy-edged stripes extending forwards and downwards on side of neck and merging with reticulum of under surface. Spots on tail circular and black-centred at base, but becoming smaller and longitudinally elongate distally. Side of head whitish, reticulated or vertically barred with dark grey or greyish brown. Underneath whitish,

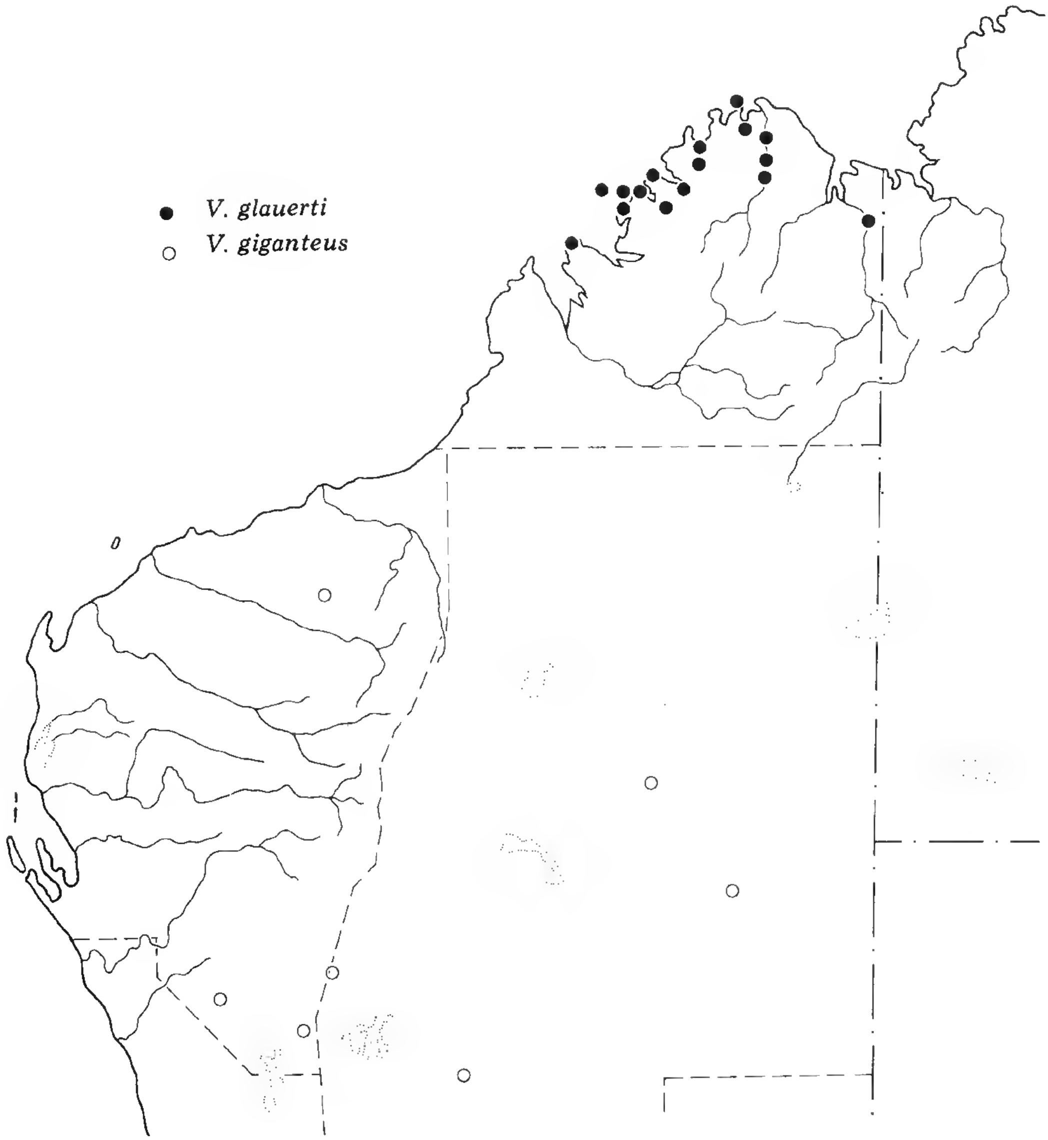

Fig. 5: Map of northern Western Australia showing location of specimens of *Varanus giganteus* and *V. glauerti*.

reticulated with black, dark grey or dark brownish grey; reticulum fine anteriorly and usually reduced on chin (and lips) to transverse bars; reticulum thicker on venter, which could be better described as dark grey with alternating transverse rows of large and small whitish spots that tend to merge with each other (when spots completely confluent the abdomen is, in effect, whitish with hollow grey transverse bands, like those of *V. rosenbergi*). Pattern under hindlegs similar to that of abdomen, but whitish spots aligned and confluent longitudinally.

Material

North-west Division (W.A.): Barrow I. (28005); Woodstock (13454, 52114, 60128); near Exmouth (31441); Tantabiddi Well, Yardie Creek (28004); Yalgoo (12923); Mt Wardiacco (60 km NE of Paynes Find) (13708); locality unknown (12637).

Eastern Division (W.A.): Charles Knob (53596); 5 km ESE of Miss Gibson Hill (48729); Anketell (756); 10 km ENE of Comet Vale (65660).

Varanus gilleni

(Plate 4; Fig. 3)

Varanus gilleni Lucas & Frost, 1895, Proc. R. Soc. Vict. (new ser.) **7**: 266. Central Australia [= between Glen Edith and Deering Creek, and Charlotte Waters, N.T.]

Diagnosis

A small arboreal monitor (up to 38 cm long) with tail circular in section and longitudinally striped. Very similar to *V. caudolineatus,* but head streaked and back banded rather than spotted. Distinguishable from *V. eremius* by smooth (rather than keeled) head scales.

Distribution

Northern and eastern arid zones of Western Australia, from the far south of the Kimberley south and south-east through the Great Sandy, Gibson and Great Victoria Deserts to the vicinity of Neale Junction. Also one record from the Pilbara: specimen from Pilgangoora Well in South Australian Museum, examined by Pianka (1969). Also in southern Northern Territory and northern South Australia.

Plate 4: A *Varanus gilleni*. Photographed by G. Harold.

Description

Snout-vent length (mm): 58-159 (N 47, mean 111.6). Length of appendages (% SVL): foreleg 21-31 (N 42, mean 24.8), hindleg 26-38 (N 41, mean 31.5), tail 111-166 (N 40, mean 135.0). Midbody scale rows 95-120 (N 36, mean 107.7). Lamellae under fourth toe 18-25 (N 37, mean 21.7).

Head scales small, smooth; supraorbitals smallest, not sharply differentiated from interorbitals. No canthus rostralis. Nostril dorsolateral, a little nearer to orbit than tip of snout. Nails short, thick and strongly curved.

Dorsally reddish brown, greyish brown with a slight reddish tinge or (rarely) yellowish brown; marked with blackish brown or dark reddish brown as follows: streaks on head and foreneck (transverse on snout, reticulate on crown, and longitudinal on neck), narrow cross-bands on body and proximal 30-40% of tail, and 5 more or less continuous longitudinal lines on distal 50-60% of tail (vertebral, laterodorsal and midlateral); commonly small dark spots between dorsal bands, usually arranged in single transverse rows; dorsal bands occasionally flecked with white, legs spotted or finely banded with dark reddish brown or unmarked. Temporal streak from eye to above ear aperture, occasionally continuous with outermost of longitudinal streaks on neck. Underneath whitish, freckled with reddish brown on throat and commonly also on venter.

Geographic variation

Northern specimens have longer appendages than southern. North of 22°S relative length of tail ranges from 128 to 166 (N 15, mean 145.3; *vs* 111-145, 25, 128.8), foreleg 24-31 (N 15, mean 25.9; *vs* 21-27, 27, 24.2) and hindleg 29-38 (N 14, mean 32.6; *vs* 26-35, 27, 31.0). Number of midbody scale rows and subdigital lamellae also decrease slightly from north to south, e.g. lamellae north of 22°S range from 20 to 25 (N 15, mean 22.9; *vs* 18-24, 22, 20.9).

Remarks

For notes on its distribution, habitat preferences, diet and reproduction, see Pianka (1969).

Material

Kimberley Division (W.A.): no locality but presumably south-west Kimberley (26714); Injudinah Creek, Lagrange (28027, 60135); Anna Plains (46165-7); Edgar Ranges Reserve in 18°49′S, 123°17′E (54125) and in 18°55′S, 123°15′E (54073); 32 km SW of Christmas Creek HS (46123).

Eastern Division (W.A.): McLarty Hills (57302-4); Well 49, Canning Stock Route (3995); Mt Romilly (40887); Point Massie (47674); 30 km NNE of Stretch Range (57047); Well 43, C.S.R. (8715); Well 40, C.S.R. (45262); Well 37, C.S.R. (3970); 96 km E of Well 24, C.S.R. (47674); 14 km NW of Mt Beadell (28814) and 77 km SW (28864); 45 km NW of Warburton Range (14657) and 8 km NNW (15179); Warburton Range (14653-6, 19598-9, 20608, 22021-2, 22211-2) and 10 km SE (21000-1) and 32 km SE (15706-8).

Northern Territory: near Alice Springs (45768-9, 53787-9) and 50 km SSE (24437).

Varanus glauerti

(Plate 5; Fig. 5)

Varanus (Odatria) timorensis glauerti Mertens, 1957, West. Aust. Nat. **5:** 183. Wotjulum, W.A. [16°11′S, 123°37′E].

Diagnosis

A smooth, slender, flat-headed, long-tailed, long-limbed, medium-sized rock monitor (up to 79 cm long) with tail slightly compressed; coloration distinctive (head, neck and usually foreback dark and unpatterned; back blackish with transverse rows of blue-grey ocelli; and tail boldly banded with black and white).

Distribution

North Kimberley, south to Yampi Sound and the Kununurra district; also offshore from Sir Graham Moore I. south-west to Byam Martin I.

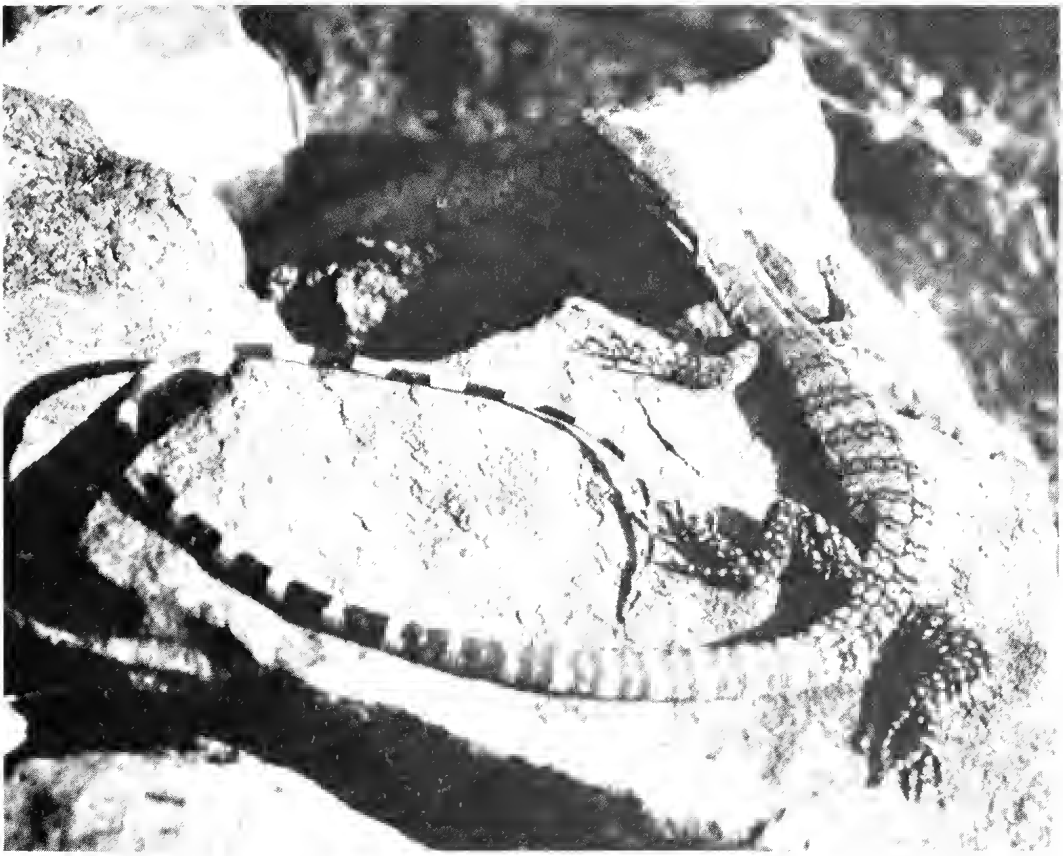

Plate 5: A *Varanus glauerti* from the Carson Escarpment. Photographed by R.E. Johnstone.

Description

Snout-vent length (mm): 70-227 (N 34, mean 183.7). Length of appendages (% SVL): foreleg 26-33 (N 29, mean 29.9), hindleg 35-44 (N 27, mean 40.3), tail 183-268 (N 23, mean 231.1). Midbody scale rows 122-151 (N 23, mean 140.1). Lamellae under fourth toe 22-29 (N 29, mean 25.2).

Head scales small, smooth; interorbitals largest, supraorbitals smallest. No canthus rostralis. Nostril lateral or dorsolateral, a little nearer to tip of snout than orbit. Tail slightly depressed proximally, elliptic in section distally. Dorsal and lateral caudal scales proximally smooth; distally with very low keels, not spinose or mucronate. In males 2 or 3 vertical rows of enlarged raised scales ventrolaterally at base of tail, well separated from cloaca by small scales. Subdigital lamellae bearing 1-3 (mostly 2) blackish brown, round, flat tubercles; similar tubercles on palmars and plantars (increasing in size toward heel). Nails short, thick, well-curved.

Scales on top of head greyish white with a black centre. Neck, foreback (usually) and upper surface of forelegs dark grey or bluish grey, without pattern (except in occasional specimens with faint ocelli on foreback). Rest of back, upper surface of hindleg and base of tail with a complete or broken black or dark greyish brown reticulum, enclosing smoky blue-grey or greyish white ocelli, each with a central dark spot or cluster of dots. Tail proximally speckled more or less regularly with black and white, pattern becoming more regular distally until it consists of alternating black and white bands encircling tail. Side of head grey except for blackish streak from lores to temples, posteriorly bordered below by a whitish streak (yellow in life), below which a blackish streak extends from postocular upper labials to ear aperture. On side of body dark reticulum tending to form vertical stripes much narrower than grey interspaces. Underneath whitish, abdomen (especially sides) and hindlegs sometimes indistinctly banded with bluish grey.

Material

Kimberley Division (W.A.): Sir Graham Moore I. (44076); Kalumburu (13790); 20 km SSE of Barton Plains Outcamp (57144); South-west Osborne I. (44122); Crystal Creek (43044); Port Warrender (43325); Mitchell Plateau in 14°41'S, 125°52'E (56234); Surveyors Pool, Mitchell Plateau (14°40'S, 125°44'E) (43140); Drysdale River National Park in 14°40'S, 127°00'E (50773-4), in 14°44'S, 126°56'E (50603), in 14°46'S, 127°05'E (50571), in 15°02'S, 126°49'E (50887), in 15°03'S, 126°45'E (50532); Careening Bay (44016); Uwins I. (44137); Champagny I. (41505); Byam Martin I. (44149); Augustus I. (40448, 41302-4); Kuri Bay (41510); St Andrew I. (44139); Prince Regent River Reserve in 15°07'S, 125°33'E (46872), in 15°20'S, 124°56'E (46811-3, 46835), in 15°32'S, 125°14'E (46858); Wotjulum (11207, 12337 holotype); Carlton Reach Bore (13470).

Varanus glebopalma

(Fig. 6)

Varanus (Odatria) glebopalma Mitchell, 1955, Rec. S. Aust. Mus. **11:** 389. Lake Hubert, N.T.

Diagnosis

A moderately large, dark, rock monitor (up to 102 cm long) with tail not strongly compressed; subdigital, palmar and plantar tubercles large and black; upper surfaces usually dark with little pattern. Distinguishable from *V. glauerti* by having distal two-fifths of tail unbanded whitish (rather than most of tail boldly banded with black and white).

Distribution

Sandstone hills, plateaux and islands of north-west Kimberley from Kalumburu south-west to Yampi Sound (including Koolan I.); with an apparently isolated population at Mt Anderson (lower Fitzroy). Also far north of Northern Territory.

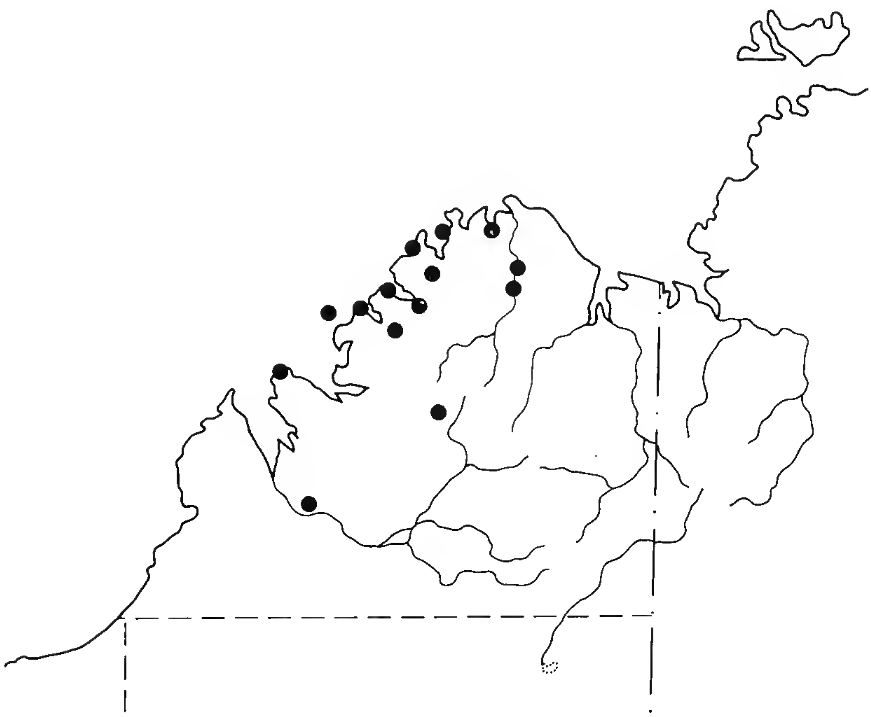

Fig. 6: Map of Kimberley Division showing location of specimens of *Varanus glebopalma*.

Description

Snout-vent length (mm): 158-355 (N 30, mean 261.5). Length of appendages (% SVL): foreleg 26-33 (N 27, mean 28.6), hindleg 38-47 (N 27, mean 42.0), tail

179-246 (N 19, mean 209.6). Midbody scale rows 132-157 (N 14, mean 146.9). Lamellae under fourth toe 19-23 (N 24, mean 20.8).

Head scales small, very smooth; interorbitals largest, supraorbitals much the smallest but not sharply differentiated. Canthus rostralis weak to moderately strong. Supraciliary ridge very strong and jutting out over eye. Nostril lateral to dorsolateral, about midway between tip of snout and orbit. "Cheeks hollow," i.e. face sunken between canthus rostralis and loreal crease. Tail slightly depressed proximally; moderately compressed distally, without a crest. Dorsal and lateral caudal scales fairly small, with a low, weakly mucronate keel. Subdigital lamellae with two low blackish brown tubercles; similar tubercles on palms and soles, small distally, large proximally. Nails short, thick and strongly curved.

Dorsally blackish grey, brownish grey or olive grey, except for brownish white or pale yellowish brown distal two-fifths of tail; scales of head, neck and back black-centred; toes and sometimes legs dotted white. In palest specimens some dorsal and lateral pattern discernible, e.g. (1) blackish grey cross-bands on back as wide as olive grey interspaces; (2) neck and back grey with a vague black reticulum, and rump with narrow black cross-bands separating rows of grey, black-centred ocelli; (3) head to base of tail pale olive grey with black variegations on head, black flecks on neck and foreback, a vague black reticulum on hindback, and black transverse bars on base of tail; and (4) side of head pale (especially lips and supraciliary ridge), vertically barred with black and brown. Underneath mostly brownish white, chin coarsely barred and throat and breast coarsely reticulated with dark grey; abdomen, legs and base of tail often clouded with grey; palms and soles dark.

Material

Kimberley Division (W.A.): Kalumburu (28036-7); South-west Osborne I. (44121); Katers I. (41487); Surveyors Pool, Mitchell Plateau (14°40′S, 125°44′E) (43121); Drysdale River National Park in 14°44′S, 126°56′E (50599), in 15°01′S, 126°39′E (50450-1) and 15°03′S, 126°45′E (50545-7); Uwins I. (44134-5); Boongaree I. (44106); Byam Martin I. (44148); Prince Regent River Reserve in 15°07′S, 125°33′E (46874), in 15°19′S, 125°35′E (47032), in 15°28′S, 125°29′E (47036-7), in 15°32′S, 125°14′E (46843-5) and in 15°32′S, 125°19′E (47034); Koolan I. (29586); Manning Creek (16°34′S, 126°56′E) (32242); Wotjulum (11841); Mt Anderson (32086).

Northern Territory: Oenpelli (32214-5); Katherine (19905).

Varanus gouldii

(Plates 6 & 7; Fig. 7)

Hydrosaurus gouldii Gray, 1838, Ann. nat. Hist. **1:** 394. Australia.
Varanus (Varanus) gouldii flavirufus Mertens, 1958, Senckenb. biol. **39:** 250. Bat Caves, S of Alice Springs, N.T.

Diagnosis

A large ground monitor (up to 160 cm long) with strongly compressed tail. Distinguishable from *V. p. panoptes* and *V. rosenbergi* by yellowish end of tail, from *V. p. rubidus* by absence of dark spots on back, and from *V. giganteus* by pale-edged dark temporal stripe and spotted rather than reticulated lower surfaces.

Distribution

Greater part of Western Australia, but not hilly interior of Kimberley (stronghold of *V. p. panoptes*) or far south (stronghold of *V. rosenbergi*). Also eastern Australia.

Description

Snout-vent length (mm): 67-655 (N 147, mean 241.2). Length of appendages (% SVL): foreleg 24-32 (N 108, mean 28.5), hindleg 36-46 (N 105, mean 41.7), tail 133-185 (N 124, mean 158.8). Midbody scale rows 132-189 (N 67, mean 167.3). Lamellae under fourth toe 20-33 (N 94, mean 27.3).

Head scales smooth, very small; interorbitals only a little larger than supraorbitals. Canthus rostralis weak to moderately strong. Nostril lateral, a little nearer to tip of snout than orbit. Loreal crease weak or absent. Tail basally subcircular; distally strongly compressed with a slight two-keeled crest. Dorsal and lateral caudal scales small, with low keels not spinose or mucronate. Nails long, slender and moderately curved.

Southern coloration. Head and neck blackish brown or dark olive brown, peppered with yellowish brown. Back with alternating dark and pale transverse zones: dark zones black and dotted, vermiculated or spotted with yellow; pale zones packed with small, more or less distinct, dark-edged yellowish spots. Tail proximally and centrally blackish brown, narrowly banded with yellowish brown or brownish white; tail distally unbanded yellowish white or brownish white. Broad black stripe from anterior tip of orbit backwards and slightly upwards to above ear aperture, edged above and below with creamy white (margins coinciding with free edges of eyelids). Blackish brown stripe along upper lip, edged above and below with creamy white, reappearing indistinctly on side of neck. Ear aperture margined with creamy white. Underneath whitish, marked with a grey arrowhead (rarely a chevron) on chin, grey streaks or clouding on throat, and small grey, brown or black spots on venter. Juveniles more strongly spotted above and less strongly spotted below than adults: dorsally brown to blackish brown with transverse rows of yellowish or brownish white spots (largest medially) on back; tip of tail often dark brown; ventrally often immaculate.

North-western coloration. Head and neck reddish brown. Back with alternating dark and pale zones: dark zones black, blackish brown or very dark reddish brown, with pale vermiculations or small spots; pale zones packed with reddish brown or yellowish brown, more or less distinct, dark-centred spots; occasionally dorsal pattern very vague, there being (as in Kimberley) little evidence of zoning. Underneath as in south, but chin and throat sometimes spotted (as in Kimberley) rather than marked with arrowhead.

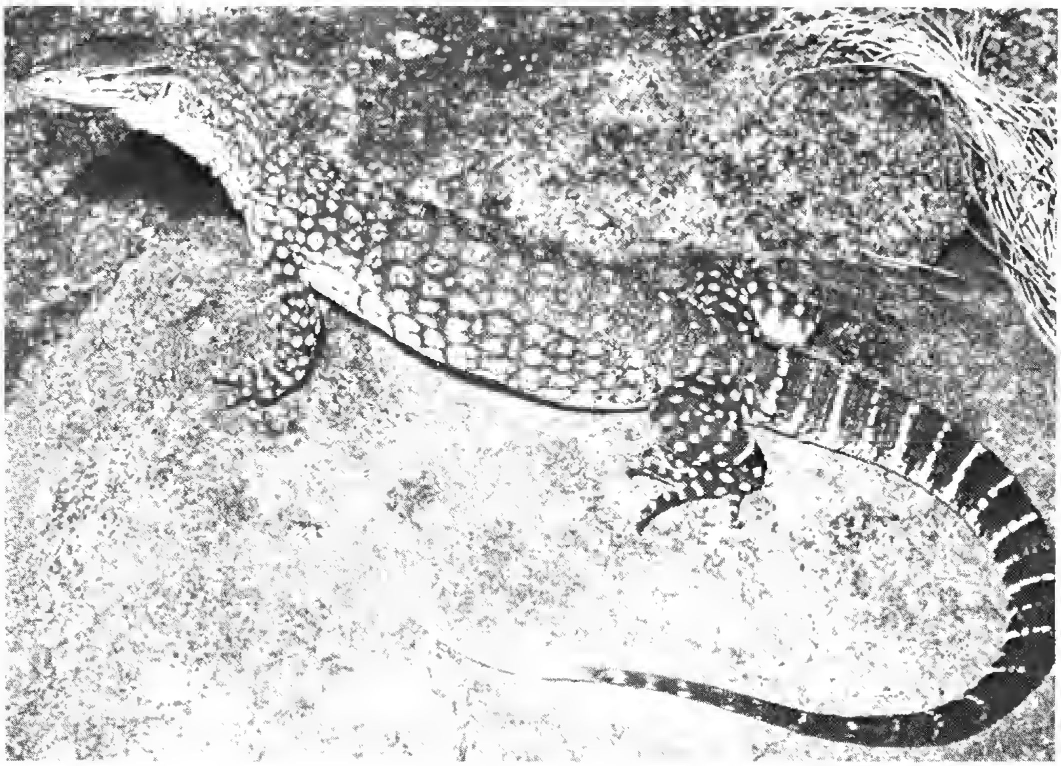

Plate 6: A southern variant of *Varanus gouldii* from Mt Dale. Photographed by G. Harold.

Desert coloration: Generally similar to north-western but brighter. Dorsal dark zones tending to be black bars in juveniles and black reticula in adults (enclosing reddish, dark-centred blotches). Dorsal pale zones usually unspotted reddish brown, with or without yellow or pale reddish brown vermiculations or flecks. Dark caudal bands tending to be split into two and not much wider than pale bands. Tail distally yellow.

Kimberley coloration: Generally darker and less patterned than in north-west and desert. Reddish brown above, heavily flecked with black. Dull pale spots on back fairly large and sparse. Tail distally pale. Heavily spotted with blackish brown from snout to abdomen, i.e. no arrowhead mark on chin.

Plate 7: A desert variant of *Varanus gouldii* from Yamarna. Photographed by R.E. Johnstone.

Geographic variation

In proportions and meristics there is little variation. The tail is relatively a little longer in the Kimberley and North-west Divisions than elsewhere (143-185, N 29, mean 165.0; *vs* 133-180, 95, 157.1). Midbody scale rows are a little more numerous in the Eastern Division than elsewhere (159-189, N 14, mean 174.7; *vs* 132-182, 53, 165.3).

In coloration there is a good deal of geographic variation; but, except in the Kimberley, the colour variants intergrade with each other. The southern variant extends north to about the mulga-eucalypt line. Specimens from

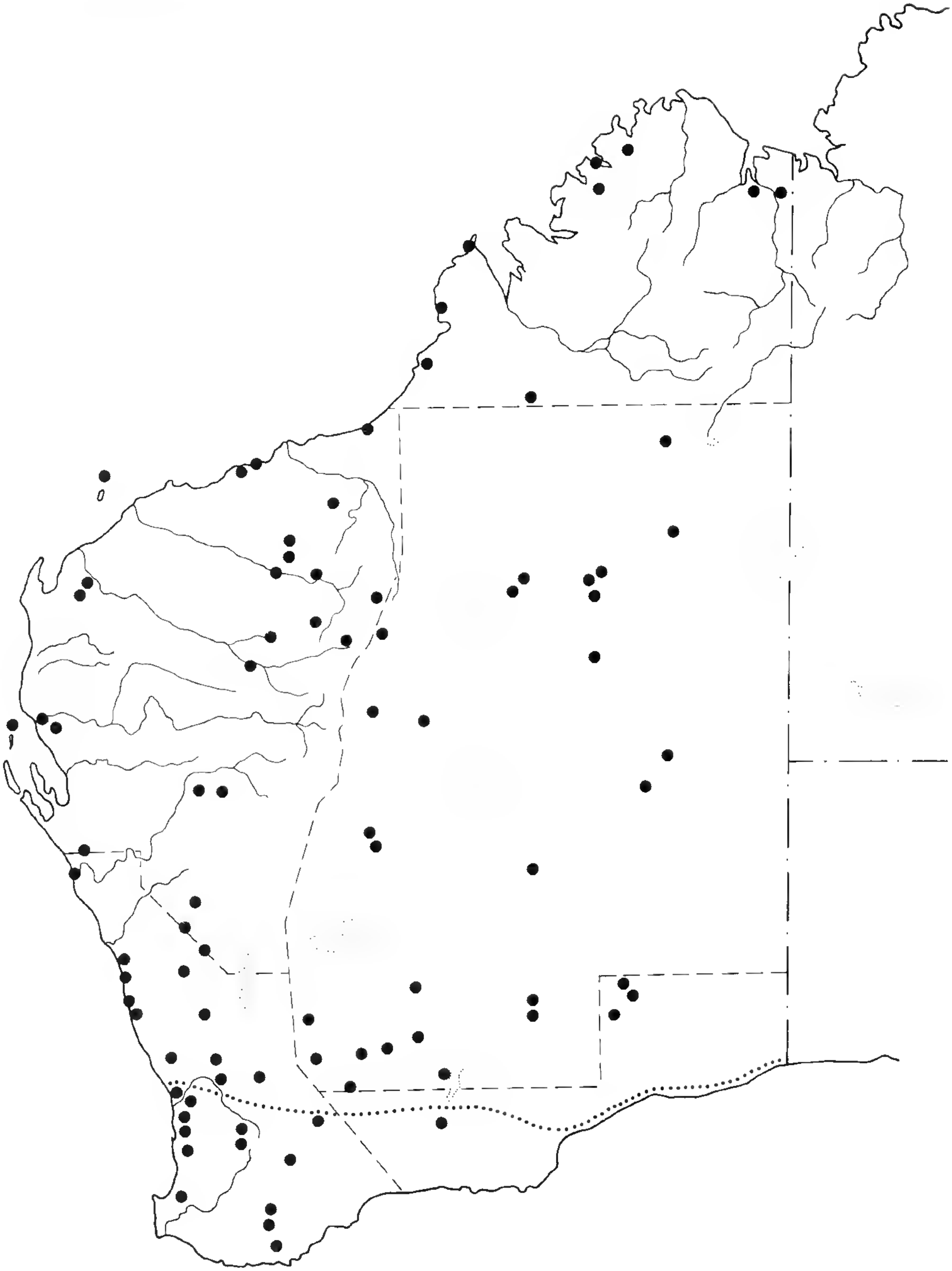

Fig. 7: Map of Western Australia showing location of specimens of *Varanus gouldii*. Dotted line indicates northern limit of *V. rosenbergi*.

Bernier I., Nerren Nerren, Cundeelee and the Nullarbor Plain are predominantly southern in coloration but the head is becoming reddish.

The desert variant *("flavirufus")* occurs in the deserts of Western Australia, the Northern Territory (north at least to Tennant Creek) and northern South Australia. In Western Australia it reaches the sandy coastal plains between southern Dampier Land and Exmouth Gulf. Where the eastern deserts contact the western plateaux (as at the Carnarvon Range) coloration is intermediate between the desert and north-western variants.

On Dampier Land (the peninsula south-west of King Sound, west Kimberley) the desert variant extends north to at least 24 km beyond Broome, and the Kimberley variant is found southwards at least as far as Martins Well, where it is unaffected by the proximity of the desert variant. Thus while it does not seem possible to recognise *flavirufus,* a Kimberley subspecies may prove separable.

Remarks

For notes on the biology of the desert population see Pianka (1970 *b*).

Material

Kimberley Division (W.A.): Mitchell Plateau in 14°52'S, 125°44'E (43477); presumably Wyndham (24811); Parry Creek (28007); Kimberley Research Station, N of Kununurra (11249); Boongaree I. (44138); Prince Regent River Reserve (46864); Martins Well (16°34'S, 122°57'E) (58541); 24 km N of Broome (31207); 8 km NE of Lagrange turnoff (58531); 42 km ENE of McLarty Hills (46517).

North-west Division (W.A.): Wallal (56149); Monte Bello Is (24744); mouth of Turner River (14882); 20 km ENE of Mundabullangana (17079) and 25 km E (14883); Bamboo Creek (33421); Woodstock (13081, 13379 and presumably 13078-9); northern part of Chichester Range (31146); Koordarrie (12636); Yanrey (14885); 32 km ESE of Wittenoom (14666) and 129 km ESE (29149); 48 km W of Talawana (39141); Newman (30918); 3 km SE of Turee Creek (25148); New Mundiwindi (14886); Mt Vernon (17695); presumably Carnarvon (21942); Bernier I. (13260, 13527 and possibly 51616, 60281-2); Callagiddy (39769); Nookawarra (15783-4); Mileura (15782); 18 km S of Nerren Nerren (18602) and 27 km S (18603); Yalgoo (4949).

Eastern Division (W.A.): Well 49 or 50, Canning Stock Route (3999); 48 km NW of Wilson Cliffs (*ca* 21°45'S, 126°45'E) (57049); 7 km S of Gary Junction (26995); 7 km SE of Kidson Camp (26939); Well 26, C.S.R. (39142); Well 24, C.S.R. (27051); 19 km SE of Jiggalong (42297); 50 km N of Windy Corner (45231) and 35 km N (45252); 110 km N of Charles Knob (26918); Carnarvon

Range (51924); Imbin Rock-hole, 23 km NE of Earaheedy (28133); 19 km N of Warburton Range (53587); Warburton Range (14661, 21206 and presumably 22023); Winduldarra Rock-hole (26°31′S, 126°01′E) (48730); Albion Downs (30970-1); Kathleen Valley (12406); 2 km N of Yamarna (52125) and 10 km E (53584); 5 km S of Goongarrie (28884); Queen Victoria Spring (58701); Cundeelee (12997); Walyahmoning Rock (30°38′S, 118°45′E) (41191); Coolgardie (19147); Woolgangie (12722); 61 km E of Southern Cross (30689); 13 km W of Moorine Rock (17650); 64 km N of Norseman (31148); Split Rocks, 29 km N of Mt Holland (37813).

South-west Division (W.A.): Kalbarri (37639, 37725) and 7 km E (33512, 33537); Hawks Head Lookout, Kalbarri National Park (33849); Mellenbye (3965); Lochada (45696); Irwin River (8930); Cliff Head (13449); presumably Caron (60137-8); Green Head (47081, 47800); 12 km E of Jurien Bay (30506); 43 and 56 km N of Beacon (48383-4); 5 km S of Pithara (18582); 10 km N of Goomalling (14892); 32 km NNW of Gingin (30322); Kellerberrin (7191-2); Seabrook (3770); Gnangara (25984); Nollamara (12701); Dianella (24735); Mt Lawley (10437); North Perth (5519); City Beach (29397); Kings Park (10239, 14893, 28329, 31071); Nedlands (45741); Swanbourne (9732); Mosman Park (5815); Rivervale (7975); Cloverdale (14134, 23834); Kalamunda (17854); Lesmurdie (14908-13, 18583); East Cannington (13425); North Lake (21850); Byford (18480); Keysbrook (39084); 10 km E of Pingelly (13437); Hyden (25824); Yornaning (19751); Samson Dam, Waroona (14895); Yarloop (19230); 11 km SE Capel (67382); Tarin Rock Reserve (46317-8); 8 km W of Kukerin (52632); Woodanilling (16894); Woodlands, Tambellup (1869); Cranbrook (60260); Yellanup, via Narrikup (11436).

Eucla Division (W.A.): 112 km N of Rawlinna (34569) and 80 km NNE (41227); Seemore Downs (14900); 45 km S of Norseman (14899).

Northern Territory: Tennant Creek (34013); 19 km E of Mt Olga (34246); 32 km W of Victory Downs (24475); Kulgera (13792).

South Australia: Coward Springs (60145); 10 km NE of Port Pirie (45777).

Varanus kingorum **sp. nov.**

(Fig. 4)

Holotype

R60374 in Western Australian Museum, collected on 9 June 1978 by Dr Max King beneath rock slabs at 10 km WNW of Timber Creek, Northern Territory, in 15°37′S, 130°23′E.

Diagnosis

A small reddish dark-spotted rock monitor, differing from *V. caudolineatus, V. gilleni* and *V. eremius* in tail much longer and not longitudinally striped. Further distinguishable from *V. eremius* by smooth head scales and short, thicker and more strongly curved nails. Distinguishable from *V. storri* by much longer and smoother tail.

Distribution

East Kimberley (far northeast of Western Australia) and adjacent part of Northern Territory.

Description

Snout-vent length (mm): 67-114 (N 5, mean 98.4). Length of appendages (% SVL): foreleg 25-27 (N 5, mean 25.8), hindleg 33-37 (N 5, mean 35.4), tail 200-270 (N 4, mean 228.0). Midbody scale rows 97-108 (N 5, mean 105.0). Lamellae under fourth toe 17-22 (N 5, mean 19.2), each with two dark brown tubercles, the outer series larger.

Head scales small, smooth; interorbitals largest, supraorbitals smallest but not sharply differentiated. Canthus rostralis weak. Nostril dorsolateral, midway between snout and orbit. Loreal crease strong. Tail slightly depressed proximally, subtriangular in section centrally, and elliptic distally. Dorsal and lateral caudal scales large, with low moderately sharp keels ending in a small mucron. Plantar scales tuberculate. Nails short, moderately thick and strongly curved.

Dorsally and laterally dull reddish brown (brighter in adult males) with small blackish spots on face, temples, neck, back, flanks, legs and proximal three-quarters of tail (black markings forming a reticulum on back of smallest specimen). Underneath buffy white, dotted blackish brown on venter and lateral surfaces of throat.

Remarks

This species is named after Drs Max King and Dennis King in appreciation of their contributions to the phylogeny of the Varanidae. I am grateful to Mr G.F. Gow of the Northern Territory Museum for the loan and donation of specimens from east Kimberley.

Paratypes

Kimberley Division (W.A.): Kununurra (formerly NTM R6955, now WAM R63341); Turkey Creek (NTM R6954, 6681-2; last specimen now WAM R63340).

Varanus mertensi

(Fig. 8)

Varanus mertensi Glauert, 1951, West. Aust. Nat. **3**: 14. Moola Bulla, W.A. [18°12′S, 127°30′E].

Diagnosis

A large dark water monitor (up to 113 cm long), all but base of tail extremely strongly compressed, with a two-keeled crest. Further distinguishable from *V. mitchelli* by more numerous midbody scale rows and dorsal pattern of small black-edged pale spots, immaculate throat and usually immaculate under surface of tail (pale yellowish brown, sharply demarcated from dark brown of lateral surfaces).

Distribution

Kimberley Division, south to the May and Mary Rivers. Also far north of Northern Territory.

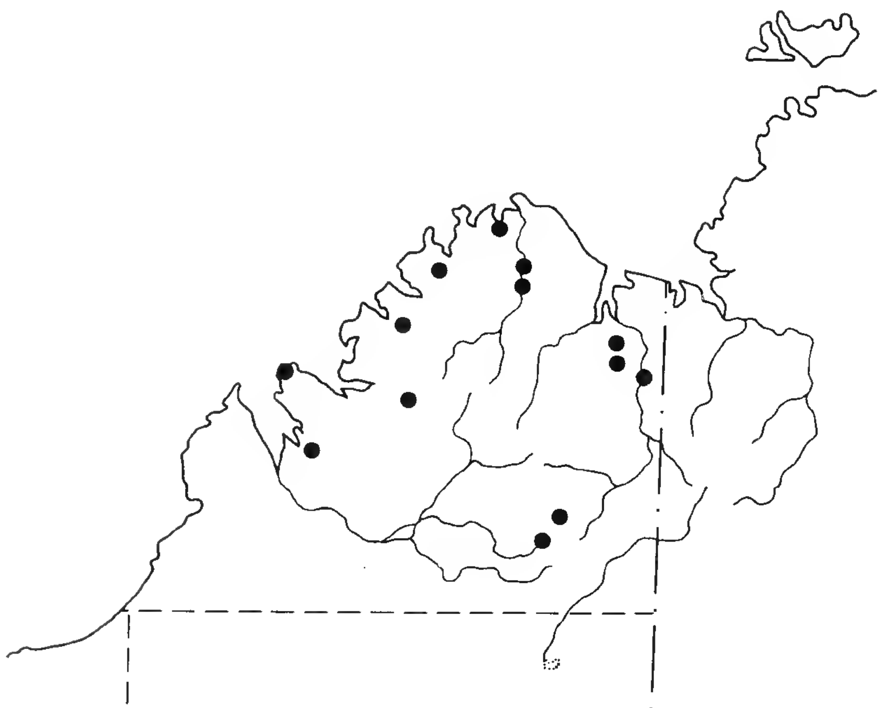

Fig. 8: Map of Kimberley Division showing location of specimens of *Varanus mertensi*.

Description

Snout-vent length (mm): 65-475 (N 33, mean 288.8). Length of appendages (% SVL): foreleg 24-30 (N 25, mean 26.3), hindleg 33-41 (N 26, mean 37.9), tail 136-183 (N 26, mean 153.2). Midbody scale rows 150-180 (N 16, mean 165.5). Lamellae under fourth toe 27-36 (N 25, mean 31.2).

Head scales smooth, small (but somewhat larger than in congeners); supraorbitals not well differentiated from interorbitals. No canthus rostralis. Nostril laterodorsal or dorsolateral, nearer to tip of snout than orbit. Nails black, moderately long and slender, slightly curved.

Head olive brown, centre of scales blackish brown. Back, sides of body, upper surfaces of limbs and base of tail medium to dark olive grey or olive brown, sparsely covered with very small, black-edged, greyish white or yellowish white spots; spots arranged in no pattern, except on base of tail where they tend to align transversely. Whitish ring around ear aperture, joined at top to whitish streak from orbit. Upper and lower lips barred with dark grey and brownish white. Sides of tail dull olive brown, occasionally tinged with reddish brown, and indistinctly flecked with buff and blackish brown. Under surfaces brownish white or yellowish white; abdomen, hindlegs and base of tail with irregular or broken bars, spots or a reticulum of grey or brownish grey.

Material

Kimberley Division (W.A.): Kalumburu (28030); Surveyors Pool, Mitchell Plateau (14°40′S, 125°44′E) (43120); Drysdale River National Park in 14°44′S, 126°56′E (50602), in 15°02′S, 126°49′E (50974), in 15°03′S, 126°45′E (50548); Prince Regent River Reserve in 15°34′S, 125°25′E (47039), in 15°38′S, 125°00′E (47035), in 15°49′S, 125°38′E (47018-9); Beverley Springs (51615); Wotjulum (11815, 11817, 11819-23, 12333); May River (28090); Soda Creek, near Wyndham (26781); Saw Range, 35 km WSW of Kununurra (60131); Ord Dam, Lake Argyle (60112-4); Moola Bulla (5819 holotype); Mary River at Great Northern Highway (46518); no locality (60124-5).

Northern Territory: Yirrkala (13526); Katherine (21933-4, 24938, 60126).

Varanus mitchelli

(Fig. 9)

Varanus (Varanus) mitchelli Mertens, 1958, Senckenb. biol. **39:** 256. 8 km W of Oenpelli, N.T.

Diagnosis

A smooth medium-sized aquatic monitor (up to 69 cm long), all but base of tail strongly compressed. Distinguishable from *V. mertensi* by lesser size, tail not so strongly compressed, fewer midbody scale rows (less than 130, *vs* more than 140), and darker coloration underneath, including heavily barred throat and dark under tail (both whitish in *mertensi*).

Distribution

Northern Kimberley, south to the King Leopold Ranges and Lake Argyle. Also north of Northern Territory.

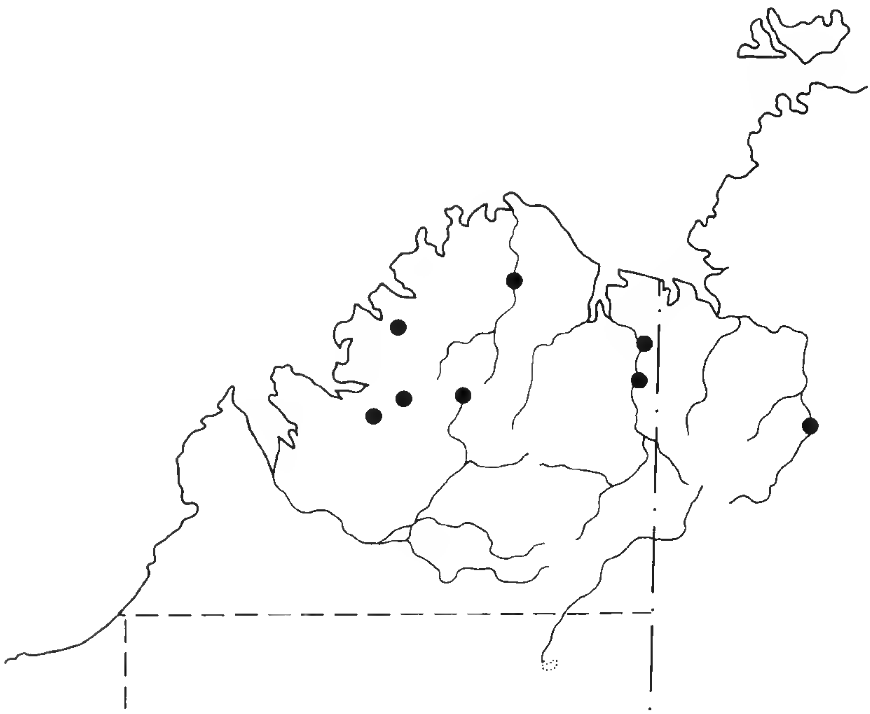

Fig. 9: Map of Kimberley Division showing location of specimens of *Varanus mitchelli*.

Description

Snout-vent length (mm): 113-247 (N 15, mean 181.2). Length of appendages (% SVL): foreleg 24-29 (N 15, mean 26.5), hindleg 33-41 (N 15, mean 36.9), tail 173-210 (N 13, mean 187.5). Midbody scale rows 103-130 (N 12, mean 111.9). Lamellae under fourth toe 27-31 (N 15, mean 29.3).

Head scales smooth (in fact polished), small (but somewhat larger than in congeners); supraorbitals smallest, not well differentiated from interorbitals. Canthus rostralis weak or absent. Nostril lateral to dorsolateral, about midway between tip of snout and orbit. Tail circular in section proximally, becoming strongly compressed distally with a low two-keeled crest. Dorsal and lateral caudal scales moderately small, with low keels (not spinose or mucronate). Nails long, slender, well-curved.

Dorsally dark grey, blackish grey or dark olive grey, variably marked with black and white. In Kimberley small dark spots on foreback and side of neck, and white dots invariably on limbs and hindback and often on neck and foreback. In Northern Territory markings on back tending to be indistinct pale black-centred ocelli alternating transversely with irregular black bands, and on legs small white spots. Throat, breast, belly, under legs and under base of tail whitish with narrow blackish grey or pale grey cross-bands, often broken medially on throat and breast. Under tail mostly dark greyish brown.

Material

Kimberley Division (W.A.): Drysdale River National Park in 15°03′S, 126°45′E (50544) and 15°16′S, 126°43′E (50678); Prince Regent River Reserve in 15°47′S, 125°20′E (46959); Hann River, 14 km SW of Gibb River HS (32309); Plain Creek (16°43′S, 125°23′E) (56459, 56462); Mt Hart HS (24060) and 15 km NW (56468); Kununurra (58848, 60110); Behn River, 3 km from its confluence with the Ord (60111).

Northern Territory: Oenpelli (32250); Katherine (26344); *ca* 50 km S of Victoria River Downs (60132, 60139).

Varanus panoptes panoptes subsp. nov.

(Fig. 10)

Holotype

R44792 in Western Australian Museum, collected on 9 January 1972 by Mr L.A. Smith at Lake Argyle, Western Australia, in 16°03′S, 128°47′E.

Diagnosis

A large ground monitor (up to 120 cm long) with strongly compressed tail. Generally similar to *V. gouldii* but differing in its strongly spotted dorsum (transverse rows of large dark spots alternating with rows of small pale spots), banded tail-tip, small dark ventral spots aligned with large dark spots of back and flanks, more numerous midbody scale rows, and smaller interorbital scales. Differing from *V. p. rubidus* mainly in its brown rather than reddish dorsal ground colour.

Distribution

Subhumid and semiarid zones of the Kimberley Division, south to Mt Anderson and Old Lissadell. Also far north of Northern Territory.

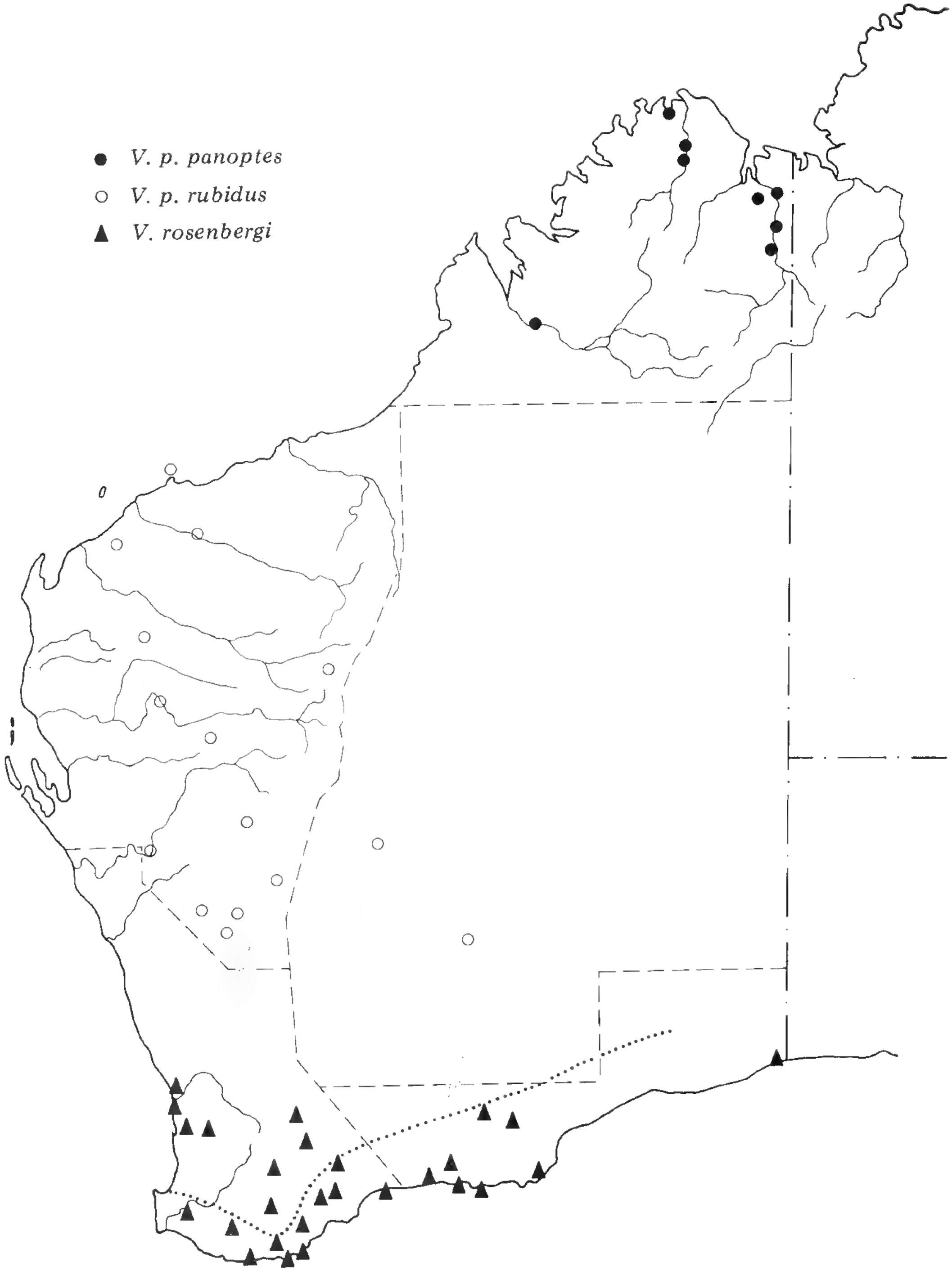

Fig. 10: Map of Western Australia showing location of specimens of *Varanus panoptes panoptes*, *V. panoptes rubidus* and *V. rosenbergi*. Dotted line indicates southern limit of *V. gouldii*.

Description

Snout-vent length (mm): 132-470 (N 18, mean 248.7). Length of appendages (% SVL): foreleg 28-33 (N 12, mean 29.4), hindleg 40-45 (N 11, mean 41.7), tail 142-175 (N 13, mean 157.5). Midbody scale rows 192-242 (N 13, mean 221.3). Lamellae under fourth toe 23-27 (N 13, mean 25.5).

Head scales small, smooth; interorbitals largest but not well differentiated from small adjacent supraorbitals; central supraorbitals slightly to considerably larger than outer. Canthus rostralis moderately strong. Nostril lateral, a little nearer to tip of snout than orbit. Tail subcircular basally; strongly compressed distally, with a low two-keeled crest. Dorsal and lateral caudal scales very small, weakly keeled or smooth. Nails moderately long, slender and curved.

Dorsally blackish brown, dark brown or dull reddish brown, darkest on head, palest on tail. Back and base of tail with alternating transverse rows of black or blackish brown spots and pale yellow or yellowish white spots; dark spots much larger and occasionally edged with pale greyish brown; pale spots small and edged with dark brown. Upper surface of legs densely covered with small yellowish white spots, with or without a black or dark brown edge. Proximal third of tail with vertical rows of dark brown or blackish spots alternating with vertical rows of yellow brown spots, the dark spots coalescing into continuous bands in middle of tail. Distal part of tail with alternating bands of dark brown and pale brown or brownish white. On side of head two wide white-edged black or blackish brown stripes, the upper through top of orbit, the lower along upper lip; both stripes extending backwards and slightly upwards almost to level of foreleg; below and parallel to these stripes 2-3 rows of moderately large longitudinally elongate dark spots on ventrolateral surface of neck. Side of body vermiculated and spotted with blackish or dark brown, the spots moderately large, vertically elongate and aligned with dark dorsal spots. Underneath whitish, except for small dark spots on hind throat and venter, latter aligning with dark dorsal and lateral spots. In old specimens dark dorsal spots tending to merge with ground colour, but pale spots on back and terminal bands on tail persistent.

Remarks

Named after Argus Panoptes, hundred-eyed guardian of Princess Io.

Paratypes

Kimberley Division (W.A.): Kalumburu (28033, 28035); Drysdale River National Park in 14°48′S, 126°57′E (50492) and 15°03′S, 126°45′E (50549);

Grotto Creek (26782); Kimberley Research Station, N of Kununurra (22368); Lake Argyle (44793-6, 60217-8); 3 km S of Old Lissadell (47717); Mt Anderson (28009, 28017, 32173).

Northern Territory: East Point, Darwin (23450).

Varanus panoptes rubidus subsp. nov.

(Plate 8; Fig. 10)

Holotype

R19132 in Western Australian Museum, collected on 6 March 1963 by Miss M. Helen Williams at Wilgie Mia, 60 km NNW of Cue, Western Australia, in 26°06′S, 117°42′E.

Diagnosis

A large ground monitor (up to 137 cm long) with strongly compressed tail. Generally similar to *V. gouldii* but differing in more numerous midbody scale rows, in having at all ages a strongly spotted dorsum (transverse rows of large dark spots alternating with rows of small pale spots), and in small dark spots of venter aligned with large dark spots of flanks and back (rather than distributed randomly). Differing from *V. p. panoptes* mainly in reddish rather than brown dorsal ground colour.

Distribution

Arid western plateaux of Western Australia from the southern Pilbara south to Fields Find and Mt Linden; also Dolphin I. (Dampier Archipelago).

Description

Snout-vent length (mm): 137-500 (N 17, mean 372.9). Length of appendages (% SVL): foreleg 28-33 (N 8, mean 29.9), hindleg 42-47 (N 6, mean 44.5), tail 150-189 (N 14, mean 170.0). Midbody scale rows 176-223 (only the Dolphin I. specimen has fewer than 195; N 11, mean 212.3). Lamellae under fourth toe 27-31 (N 11, mean 28.7). Head scales etc. as in *V. p. panoptes*.

Dorsally bright, pale to moderately dark reddish brown, darkest on head. Back and base of tail with alternating rows of blackish brown and reddish white spots: dark spots much the larger and tending to be elliptic (long axis transverse); pale spots edged with blackish brown or dark reddish brown. On proximal part of tail vertical rows of blackish or dark brown spots alternating with brownish yellow or brownish white spots, dark spots distally coalescing into more or less continuous bands. Distal part of tail with bands of dark or pale brown alternating with brownish white or yellowish white bands. Limbs, side of head and neck and venter as in *V. p. panoptes*. With age dark, as well as pale, dorsal spots persistent, but end of tail becoming completely yellowish (as in *V. gouldii*).

Plate 8: A *Varanus panoptes rubidus* from Mt Linden. Photographed by G. Harold.

Paratypes

North-west Division (W.A.): Dolphin I. (14331); Peedamulla (51614); 52 km W of Tambrey (14884); 11 km E of Wittenoom (26261); Ullawarra (13307); Yinnietharra (53508); 35 km N of Ilgararri Creek (51524); Errabiddy (53689); Billabalong (14890); New Forest (13975); 37 km E of Mt Magnet (14889); Nalbarra (13975*a*); 11 and 16 km S of Yalgoo (30912, 53507); Fields Find (12907).

Eastern Division (W.A.): Wanjarri (21233); near Mt Linden (65958-60).

Varanus pilbarensis sp. nov.
(Plate 9; Fig. 11)

Holotype

R39782 in Western Australian Museum, collected on 7 April 1971 by Mr J.C. Wombey in the Chichester Range, Western Australia, in 22°03′S, 118°48′E.

Diagnosis

A small reddish rock monitor (up to 47 cm long) with tail circular in section and comb-like clusters of pointed scales on each side of base of tail. Further distinguishable from *V. tristis* and *V. timorensis* by smoother tail, shorter toes and superior position of nostril.

Distribution

Pilbara region of north-western Western Australia.

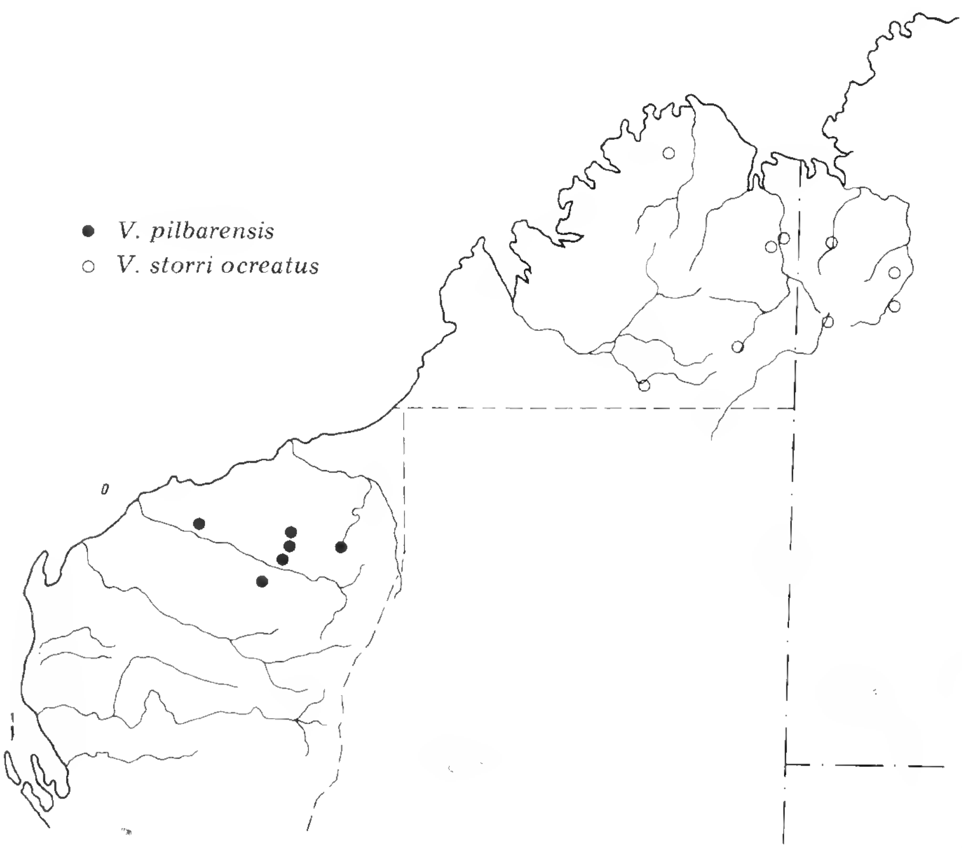

Fig. 11: Map of northern Western Australia and adjacent part of Northern Territory showing location of specimens of *Varanus pilbarensis* and *V. storri ocreatus*.

Description

Snout-vent length (mm): 110-169 (N 9, mean 140.0; a gravid female is 118). Length of appendages (% SVL): foreleg 30-34 (N 7, mean 31.6), hindleg 43-46 (N 6, mean 44.3), tail 175-205 (N 8, mean 192.0). Midbody scale rows 113-134 (N 7, mean 125.9). Lamellae under fourth toe 19-25 (N 9, mean 20.8), each usually with two moderately large, polished brown tubercles.

Head scales small, smooth; supraorbitals much smaller than interorbitals but not sharply differentiated from them. No canthus rostralis. Nostril laterodorsal, about midway between tip of snout and orbit. Tail slightly depressed proximally, circular in section centrally and elliptic distally. Keels of dorsal and lateral caudal scales low, with a small mucron. Lateroventrally 4-6 curving rows of long, narrow, pointed, white (occasionally reddish brown) scales immediately behind cloaca, scales increasing in size, elevation and spininess outwards from cloaca. Nails very short and thick, strongly curved.

Dorsally pale (occasionally moderately dark) reddish brown, tinged with olive on neck and back, palest on snout and tail. Head dotted or flecked with dark reddish brown. Neck flecked with dark reddish brown, flecks sometimes

Plate 9: A *Varanus pilbarensis* from Carawine Gorge. Photographed by R.E. Johnstone.

coalescing into narrow wavy cross-bands. Back and base of tail with small blackish brown or very dark reddish brown spots aligned in short variable transverse bars, between which are barely discernible greyish spots transversely confluent and aligned. Dark caudal rings distally grouped in couplets; towards end of tail members of each couplet usually merging to form wide dark reddish brown bands. Limbs with irregular pale grey or whitish spots, sometimes dark-edged or dark-centred. Side of head pale reddish brown, marked with reddish brown vertical bars on lips, oblique bars on temples, and occasionally a narrow streak from front of orbit backwards and upwards to above temples. Throat and venter greyish white, irregularly and indistinctly cross-banded or clouded with grey. Under limbs greyish white with an indistinct grey reticulum on hindlegs and occasionally also on forelegs.

Paratypes

North-west Division (W.A.): Black Hill Pool (21°19′S, 117°15′E) (20017); Abydos (10811); Woodstock (13082, 28011-2, 60432); Nullagine (39158); rim of Dales Gorge (14901).

Varanus rosenbergi

(Plate 10; Fig. 10)

Varanus gouldii rosenbergi Mertens, 1957, Zool. Anz. **159:** 17. Monigup Pass, Stirling Range, W.A.

Diagnosis

A large ground monitor (up to 103 cm long) with strongly compressed tail. Generally similar to *V. gouldii,* and differing mainly in coloration, especially black bands on neck and back, dark tail-tip and dark reticulation or banding of under surfaces.

Distribution

Far south of Western Australia, north to beyond Perth (Mussel Pool), nearly to Mt Cooke, Bendering, nearly to Norseman, nearly to Balladonia, and Eucla. Also southern South Australia.

Description

Snout-vent length (mm): 67-395 (N 46, mean 247.1). Length of appendages (% SVL): foreleg 25-30 (N 39, mean 28.7), hindleg 36-45 (N 39, mean 40.0), tail

132-179 (N 38, mean 156.3). Midbody scale rows 165-209 (N 22, mean 185.1). Lamellae under fourth toe 21-27 (N 31, mean 24.2).

Head scales small, smooth; interorbitals largest, supraorbitals smallest and not sharply differentiated. Canthus rostralis weak. Nostril lateral, nearer to snout than orbit. Tail proximally subcircular, distally strongly compressed. Dorsal and lateral caudal scales small, with low keels (not spinose or mucronate). Nails long, slender and moderately curved; uppermost scales surrounding their base usually small and dark.

Plate 10: A *Varanus rosenbergi* from the Stirling Range. Photographed by R.E. Johnstone.

Head black, with or without a peppering of yellowish white or greyish white. Ground colour of neck and back black (rarely bluish grey), peppered with sulphur yellow, greenish yellow, yellowish white or greyish white, dots on back and base of tail sometimes clustering to form small spots. Neck with 3 or 4 narrow black bands curving downwards and forwards on sides, the anteriormost parallel to temporal stripe. Back with *ca* 12 narrow black cross-bands, a little narrower or wider than interspaces. Tail proximally black, ringed with dull yellow; distally blackish brown, narrowly banded with yellowish brown (tip of tail sometimes uniformly dark). Legs and toes black with dots and small spots of brownish or yellowish white. Side of head blackish except for yellowish spots on upper lips and margins of temporal stripe. Underneath yellowish or whitish, usually with a black or grey reticulum from chin to abdomen and occasionally under legs; reticulum thickest on throat and under neck, finest on venter; longitudinal elements of reticulum commonly missing on chin, leaving cross-bars extending to lips; occasionally bars on chin broken medially; more rarely bars restricted to lips and replaced in middle of throat by a chevron; reticulum on venter sometimes faint, absent or replaced by hollow bands aligned with dorsal bands; dark caudal bands occasionally extending to lower surface, where hollow.

Geographic variation

The Kangaroo Island specimens differ from the Western Australian in their greater size (they are the only specimens with SVL greater than 369 mm), darker coloration (dorsally they are similar to the darkest western specimens, and they have considerable black flecking under neck and some on abdomen), and more numerous midbody scales (the only specimens with more than 199 rows).

Remarks

Hitherto *V. rosenbergi* has been treated as a subspecies of *V. gouldii;* but there is no hybridisation between these taxa, despite their considerable sympatry on the Swan Coastal Plain and in the southern Wheat Belt.

Material

South-west Division (W.A.): Mussel Pool (51559); North Fremantle (5381-8); Keysbrook (419); 21 km NNW of Bannister (36455) and 6 km NNW (19251); 8 km NE of Bendering (51102); 32 km N of Lake Grace (34543); Kuender (28148); Dumbleyung (12298); 23 km SE of Newdegate (21732) and 44 km SE (21733); Chinocup Reserve (41072-3); Hopetoun (18483-4); near Jerramungup (13043); Needilup (22534); Woodlands, Tambellup (1870); 11 km S of Nannup (60129); 20 km W of Rocky Gully (42964, 60348); Moir Pass (821); Bluff Knoll (58818); 15 km S of Mt Barker (58869); Kent River (44662); Two Peoples Bay (36349); 11 km SW of Albany (14896).

Eucla Division (W.A.): Eucla (18481); 6 km NE of Clear Streak Well, i.e. 68 km ESE of Norseman (58086); *ca* 70 km SSW of Balladonia Hotel (60375); Scaddan (9581); Young River (14898); Esperance (52112-3); Hellfire Bay, Cape LeGrand National Park (42528); 13 km SW of Israelite Bay (17626).

South Australia: Kangaroo I. (52115-7).

Varanus storri ocreatus subsp. nov.

(Plate 11; Fig. 11)

Holotype

R42717 in Western Australian Museum, collected on 11 October 1971 by Dr D.J. Kitchener at Argyle Downs airstrip, Western Australia, in 16°20′S, 128°46′E, now submerged by Lake Argyle.

Diagnosis

A small reddish monitor (up to 35 cm long) with strongly spinose tail. The species *V. storri* (Mertens, 1966) is very like *V. acanthurus* but is smaller (SVL up to 134 mm) and has fewer midbody scale rows (up to 91), fewer transverse rows of ventrals (up to 58) and much weaker colour pattern (e.g. the neck is never boldly striped). *V. storri* differs from *V. primordius* of far north of Northern Territory (Storr, 1968) in its more numerous midbody scale rows (70-91, *vs* 60-66), keels of dorsal and lateral caudals strongly spinose rather than merely mucronate, and prevailing reddish brown rather than olive grey coloration. *V. s. ocreatus* differs from *V. s. storri* mainly in the enlarged scales under distal part of hindleg; it also has a longer tail and limbs and fewer midbody scale rows and transverse rows of ventrals.

Distribution

Far north of Western Australia (i.e. Kimberley Division east of long. 126°E) and adjacent parts of Northern Territory.

Description

Snout-vent length (mm): 49-132 (N 10, mean 107.1). Length of appendages (% SVL): foreleg 26-32 (N 10, mean 27.8), hindleg 35-41 (N 9, mean 37.6), tail 157-187 (N 9, mean 168.6). Midbody scale rows 70-84 (N 10, mean 79.3). Transverse rows of ventrals 45-48 (N 10, 46.6).

Head scales small, smooth; supraorbitals smallest, not sharply differentiated. Nostril dorsolateral, i.e. located on swollen canthus rostralis. Tail basally slightly depressed; distally rounded triangular in section, with a two-keeled crest. Dorsal and lateral caudal scales forming perfect whorls with subcaudals. Scales under legs becoming juxtaposed and much enlarged towards foot. Subdigital lamellae bearing two dark (pale in juveniles), circular, flat tubercles; similar tubercles on plantars.

Dorsally reddish brown. Head usually flecked with blackish brown (dark pigment confined to tubercles). Dorsal and upper lateral surfaces of body and upper surfaces of limbs with a complete (rarely) or broken blackish brown reticulum, the enclosed spots sometimes paler than ground colour; reticulum occasionally reduced to flecks (coincident with keels of dorsals). Sides of head, body and limbs (anterior face only) usually spotted with blackish brown, spots on lips and temples tending to form irregular vertical bars. Occasionally a narrow brownish white midlateral stripe from ear aperture to level of foreleg, finely margined above and below with blackish brown. One specimen, much smaller than others, is devoid of dark pigment; it is pale reddish brown above and white below, the back covered with small white rosettes.

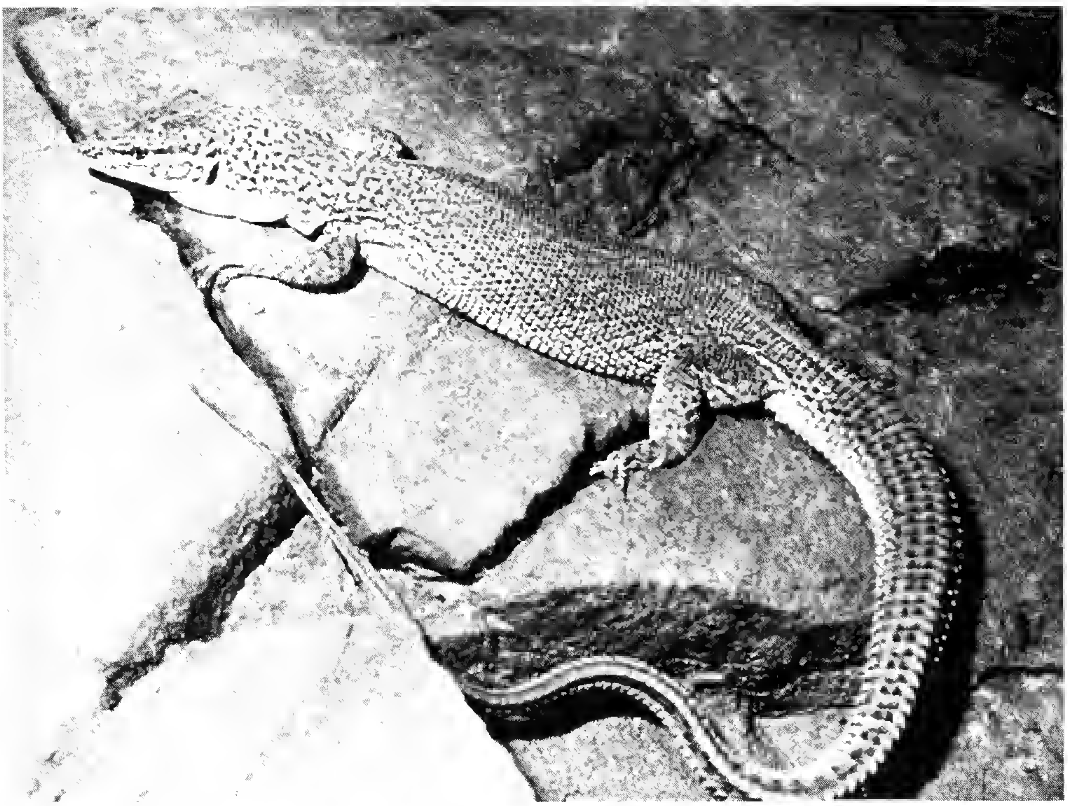

Plate 11: A *Varanus storri ocreatus* from Gordon Creek, N.T. Photographed by G. Barron.

Paratypes of V. s. ocreatus

Kimberley Division (W.A.): Old Theda (57244); 28 km SW of Argyle Downs (42764); 30 km SE of Halls Creek (60041); Bull Flat Bore, Christmas Creek Station (51266).

Northern Territory: Kildurk (40998); Gordon Creek, 48 and 49 km S of Victoria River Downs (60043-4); Wave Hill Police Station (60042); Inverway (13720).

Specimens of V. s. storri

Queensland: Charters Towers (55487) and 32 km ENE (57342) and 120 km S (53764-5).

Specimens of V. primordius

Northern Territory: Berry Springs (48820-1); 60 km S of Adelaide River (23779-80).

Varanus timorensis scalaris

(Fig. 12)

Varanus timorensis scalaris Mertens, 1941, Senckenbergiana **23:** 266. Beagle Bay, W.A.

Varanus (Odatria) timorensis similis Mertens, 1958, Senckenb. biol. **39:** 239. Groote Eylandt, N.T.

Diagnosis

A medium-sized arboreal monitor (up to 59 cm long) with uncompressed tail, caudal scales strongly keeled and mucronate, and in males several rows of

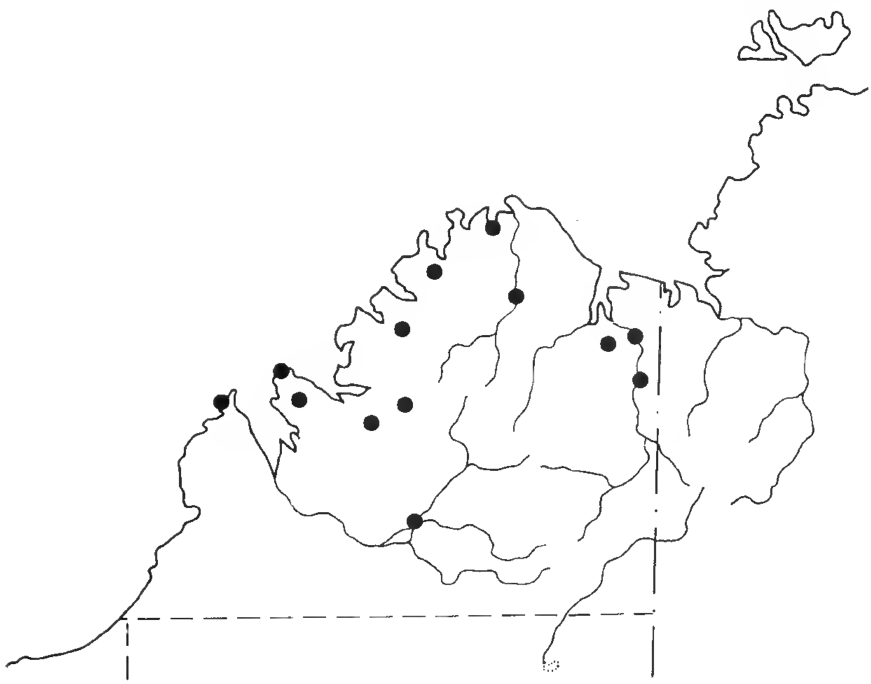

Fig. 12: Map of Kimberley Division showing location of specimens of *Varanus timorensis scalaris.*

small narrow spinose white scales on lateroventral surface of tail immediately behind cloaca. Further distinguishable from *V. tristis* by shorter snout and deeper head (giving it a seal-like profile), sides of head and neck and often top of head spotted, shorter appendages, fewer midbody scale rows, and supraorbitals not so well differentiated from interorbitals.

Distribution

Kimberley Division of Western Australia, south to northern Dampier Land, Fitzroy Crossing and Lake Argyle. Also north of Northern Territory, north Queensland, Torres Strait islands and New Guinea (Mertens, 1950).

Description

Snout-vent length (mm): 71-253 (N 69, mean 155.0). Length of appendages (% SVL): foreleg 22-29 (N 60, mean 25.9), hindleg 31-41 (N 54, mean 35.3), tail 132-166 (N 46, mean 155.0). Midbody scale rows 98-124 (N 53, mean 111.0). Lamellae under fourth toe 20-30 (N 59, mean 24.9), each with 2 or 3 tubercles.

Head scales small, smooth; interorbitals largest, supraorbitals much the smallest but not sharply differentiated. Canthus rostralis weak or absent. Nostril lateral, about midway between tip of snout and orbit. Usually a small but distinct dorsolateral fold on body. Tail proximally subcircular in section, centrally rounded triangular, distally elliptic. Dorsal and lateral caudal scales moderately small, with a low keel ending in a mucron. Lateroventrally immediately behind cloaca, 10-30 small narrow white scales in 3-5 longitudinal rows, raised and terminating in a small spine in males. Nails moderately short and thick, strongly curved.

Dorsally brownish grey to black, palest on head and tail, darkest on neck and back. Head usually spotted, stippled or vermiculated with blackish brown, and often vermiculated or flecked with pale grey or greyish white. Neck anteriorly with pale vermiculations or flecks, markings gradually changing posteriorly into spots like those of back. Back black with transverse rows of well-separated greyish-white black-centred spots; spots taking form of a thick ring, often broken on one or both sides, especially on flanks. Between dorsal spots often rows of greyish white dots or dashes. Occasionally pale dorsal spots so reduced that back is covered (as in holotype) with transverse bands of black alternating with bands of grey flecked with white. Tail (at least proximal half) ringed with brownish white or greyish white. Face dotted with dark brown (centre of scales). Lips vertically barred and side of neck spotted with greyish brown. Underneath whitish, usually with small greyish brown spots on throat (especially sides); clouded with greyish brown under legs and tail).

Remarks

When Mertens proposed *V. t. similis* for the Northern Territory and Queensland populations, he believed that the cross-banded dorsal pattern of the holotype of *V. t. scalaris* (see photograph, Mertens, 1942: 89, Fig. 32) was characteristic of the Western Australian populations. However this colour variant is uncommon (at least in immatures and young adults), and most Kimberley specimens are indistinguishable from those of the Northern Territory or the Thursday Island specimen photographed by Mertens (*ibid.*, Fig. 31).

I recognise *V. t. scalaris* for the Australian populations. According to Mertens they differ from the nominate race of Timor, Samao, Savu and Rotti in having spinose postanal scales. Furthermore they seem to differ in colour pattern; at any rate I cannot match Mertens' photograph (*ibid.*, Fig. 30) of a specimen from Kupang with any Australian specimen.

Material

Kimberley Division (W.A.): Napier Broome Bay (60487); Kalumburu (13566, 13580*a-b*, 13663, 28032, 60143, 60474); Mitchell Plateau at Surveyors Pool (58315) and in 14°52'S, 125°50'E (43180); Drysdale River National Park in 15°16'S, 126°43'E (50697-8) and 15°16'S, 127°12'E (50570); Prince Regent River Reserve in 15°47'S, 125°20'E (46931); *ca* 40km from Wyndham (26783); Ivanhoe (10278); Lake Argyle (42830-1, 42852-3, 60117-21, 60409); Wotjulum (11205, 11833-4); Martins Well (16°34'S, 122°51'E) (58528); Stewart River (16°36'S, 123°31'E) (51833); Kimbolton Spring (16°38'S, 123°43'E) (51203); Beverley Springs (11839, 13364); Mt Hart (24033, 24062-4, 24072, 24083); Fitzroy Crossing (47670); "Kimberley" (1738).

Northern Territory: Cape Don (26677); Yirrkala (13520 *a-d,* 13521 *a-c,* 13522 *a-e*); Oenpelli (32252-3); Darwin (26227, 34115); Edith River (47597); Katherine (13953, 13955, 16511-2, 19904, 23890, 29758); Kildurk (40999).

Varanus tristis tristis

(Plate 12; Fig. 13)

Odatria punctata Gray, 1832, Ann. nat. Hist. **1**: 394. "Shark's Bay" [= Swan River, W.A.]. Not *Varanus punctatus* Merrem [= *V. bengalensis* (Daudin)].

Monitor tristis Schlegel, 1839, Abbildungen neuer oder unvollständing bekannter Amphibien..., p.73. Swan River, W.A.

Varanus (Odatria) tristis centralis Mertens, 1957, West Aust. Nat. **5**: 185. Hermannsburg, N.T.

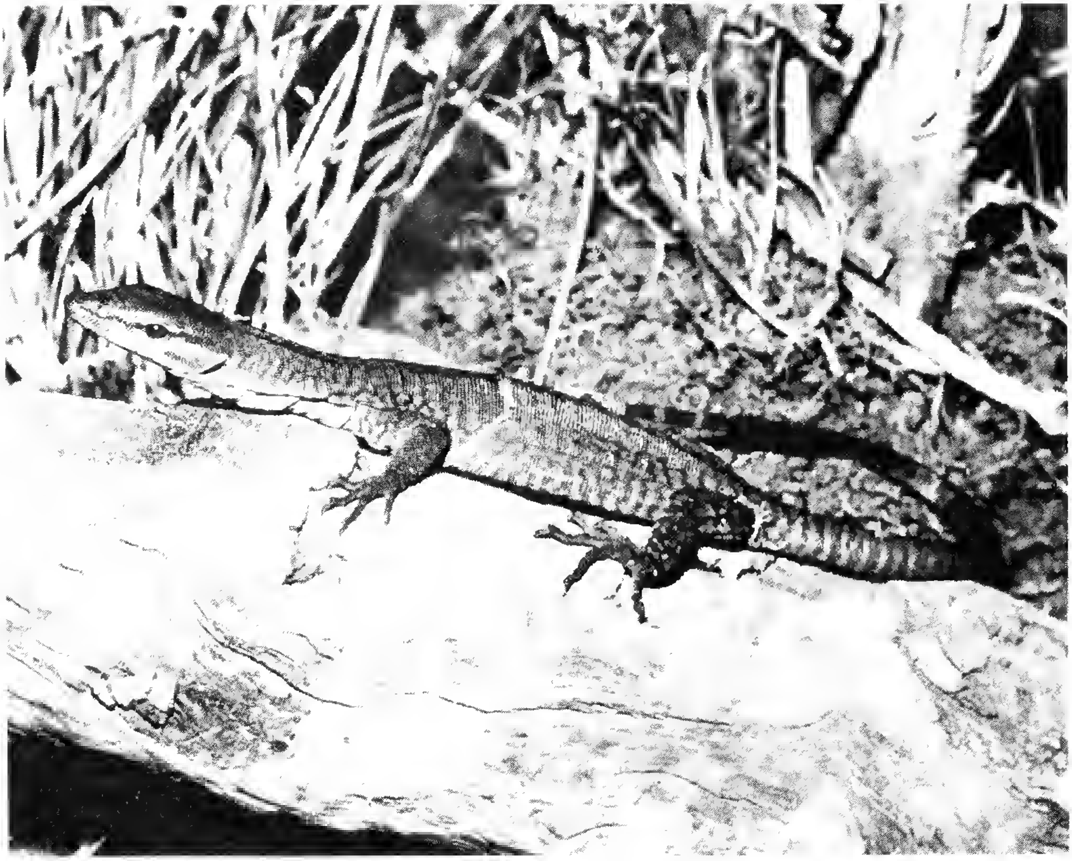

Plate 12: A *Varanus tristis* from Armadale. Photographed by R.E. Johnstone.

Diagnosis

A medium-sized arboreal monitor (up to 75 cm long) with tail not strongly compressed, caudal scales strongly keeled and mucronate, and a circular or squarish cluster of large black or black-and-white scales on each ventrolateral surface of base of tail (smaller and less spiny in females and young males). Further distinguishable from *V. timorensis* by longer snout, flatter unspotted head, pale caudal rings not extending for more than half-way down tail (and usually for much less), longer appendages, more numerous midbody scale rows, and supraorbital scales sharply differentiated from interorbitals.

Distribution

Throughout the State, except far south, i.e. south of Perth, Kelmscott, Wickepin, Narembeen, Kalgoorlie and the Great Victoria Desert. Also the Northern Territory and north-western South Australia.

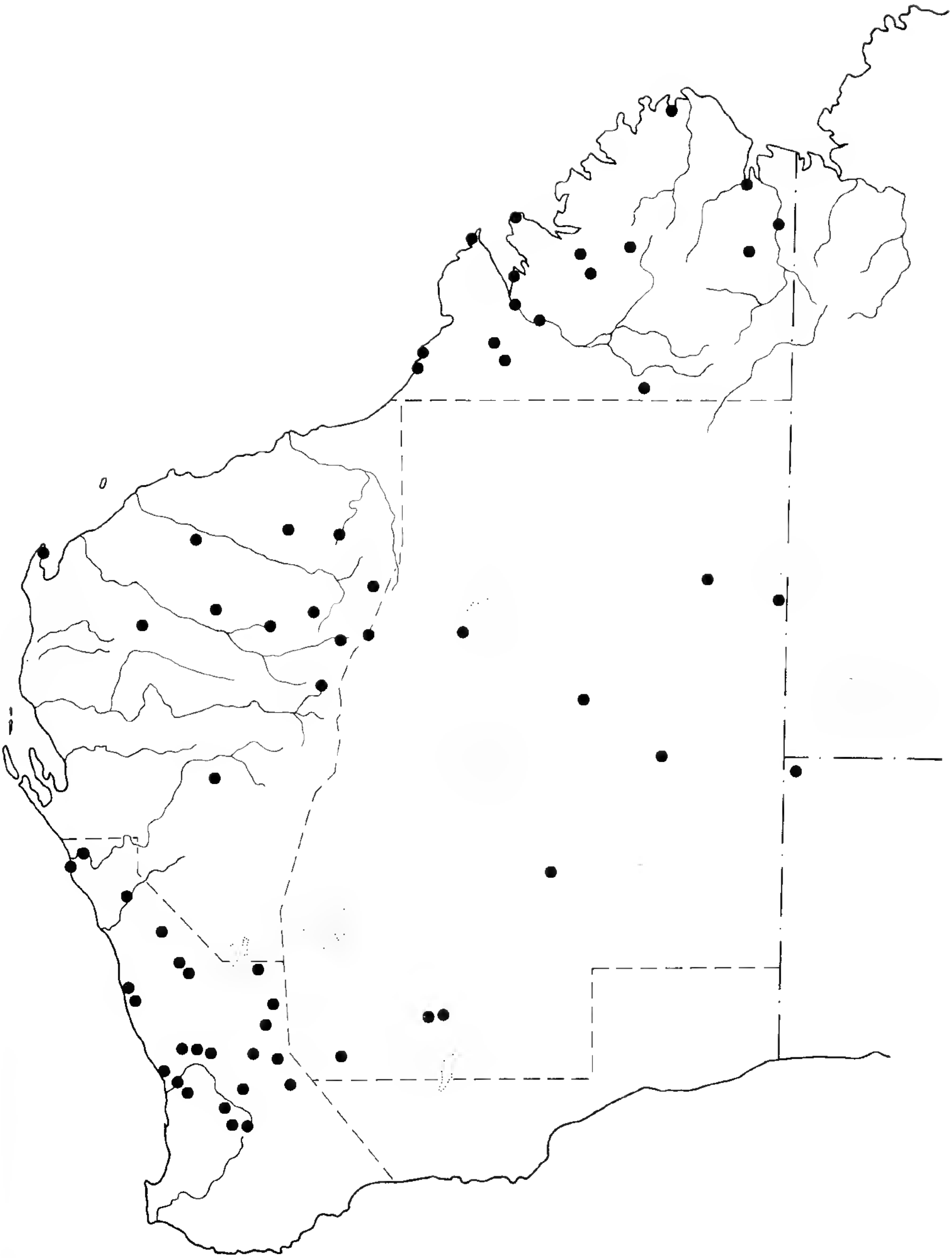

Fig. 13: Map of Western Australia showing location of specimens of *Varanus tristis tristis*.

Description

Snout-vent length (mm): 67-280 (N 110, mean 168.1). Length of appendages (% SVL): foreleg 26-33 (N 90, mean 28.6), hindleg 34-44 (N 88, mean 39.6), tail 151-226 (N 88, mean 187.9). Midbody scale rows 119-152 (N 53, mean 133.2). Lamellae under fourth toe 22-30 (N 77, mean 25.9); each with 2-4 (mostly 3) dark tubercles, the outermost largest.

Head scales small, smooth; interorbitals largest, supraorbitals smallest and sharply differentiated. Canthus rostralis weak or absent. Nostril lateral, about midway between tip of snout and orbit. Cheeks slightly hollow. Usually a small but distinct dorsolateral fold. Tail slightly depressed proximally, slightly compressed distally. Dorsal and lateral caudal scales moderately large, with a low sharp keel ending in a mucron or short spine. Nails moderately short and thick, strongly curved.

Juvenile coloration in south. Head and neck medium to dark brownish grey. Back dark grey with transverse rows of densely packed, longitudinally elongate, dark-centred pale spots, which are often laterally confluent and thus forming pale transverse bands, narrower or wider than dark interspaces. Tail medium to dark brownish grey, proximally ringed with pale grey. Underneath pale grey, spotted or clouded on throat with dark brownish grey or blackish grey, and narrowly cross-banded on venter and limbs with dark brownish grey (bands often wavy and sometimes broken medially).

Juvenile coloration in north (including the Pilbara and Central Australia). As in south, but head paler and tinged with olive brown, pale dorsal spots often extending on to neck, and venter usually spotted, rather than banded, with brownish grey.

Adult and subadult coloration in south. Head, neck, forelegs and most of tail black. Back in subadults covered by a moderately fine black reticulum, enclosing angular black-centred grey spots longer than wide; with age grey dorsal spots reducing to pale grey and dark grey flecks, finally disappearing and leaving back entirely black. Tail in subadults proximally ringed with greyish white flecks, which with age tend to disappear, leaving tail entirely black. Hindleg in subadults black, spotted with greyish white, proximal spots largest and black-centred; pale spots disappearing with age, leaving leg entirely black. Venter and under limbs in subadults greyish white or grey, flecked with dark grey, dark greyish brown or black (flecks sometimes roughly aligned transversely); with age becoming uniformly dark grey. Chin dark brown. Remaining under surfaces blackish.

Adult and subadult coloration in north. Northwards there is a general paling. In the North-west, south Kimberley, eastern deserts and Central

Australia, head, neck and most of tail usually blackish brown; grey of dorsal spots and caudal rings often replaced with reddish brown; under neck and tail medium to dark brownish grey; venter, under legs and under base of tail usually pale grey, mottled or spotted with grey (occasionally whitish, with or without sparse greyish spots). In the Kimberley proper (i.e. north of the Fitzroy) head still paler (olive brown); neck, as well as back, often covered with black-centred pale spots; whitish flecks sometimes predominating over blackish at base of tail; rings of pale caudal flecks usually extending to middle of tail; underneath greyish white, with or without sparse greyish brown spots.

Geographic variation

In the western part of its range (Western Australia, Northern Territory and South Australia) variation is slight and continuous. As we have seen, adult coloration becomes paler from south to north. There is also a slight increase in relative length of tail from south to north (e.g. 151-216 in South-west Division, N 41, mean 179.9; *vs* 174-226 in North-west and Kimberley Divisions, N 33, mean 197.3). In other respects all these western populations are much alike and clearly comprise a single taxon.

Our two specimens of *V. tristis* from Queensland, viz. a juvenile from 29 km W of Einasleigh (55896) and an adult from the Burra Range between Pentland and Hughendon (55897), are somewhat different in coloration and scutellation from all western specimens. I therefore tentatively recognise *V. tristis orientalis* Fry for the east Australian populations.

Remarks

For notes on its diet, seasonality of activity etc., see Pianka (1971).

Material

Kimberley Division (W.A.): Kalumburu (13567, 13791, 28018, 60140-2); Wyndham (13563); Wotjulum (11836-8); Lake Argyle (60116); 7 km NNE of Cape Borda (58529-30); Manning Creek (32340); Mt Hart (24061); 21 km N of Turkey Creek (58615); Mt Bell (32270); Derby (46173); 7 km SE of Willare Bridge (58675); Mt Anderson (28016); Injudinah Creek, Lagrange (28014); Frazier Downs (28013); Edgar Ranges Reserve in 18°21′S, 123°03′E (54005) and 18°55′S, 123°27′E (53935); Wattle Creek Spring (19°13′S, 126°07′E) (51282).

North-west Division (W.A.): Exmouth (31415); Millstream (20001); 5 km E of Mt Ulric (20000); Woodstock (13308); Nullagine (12308); Balfour Downs (39140); Neelaluna Claypan, 40 km S of Jiggalong (24015); Mt Newman

(13666, 26525); Paraburdoo (56140); Ullawarra (23919); Turee Creek (17691, 22750); Mundiwindi (12279); Kumarina (23984); Mileura (44959).

Eastern Division (W.A.): Pollock Hills (45234); 8 km W of Mt Tietkens, Buck Hills (45233); Durba Springs (23°45′S, 122°31′E) (51926); Charles Knob (25°04′S, 124°59′E) (53600); Warburton Range (22183); 16 km ESE of Point Sunday (53563); Kalgoorlie (10417) and 28 km E (4170); 29 km S of Yellowdine (37939).

South-west Division (W.A.): Wittecarra Gully, S of Kalbarri (18589); Lockwood Spring, 32 km ESE of Kalbarri (33471); East Yuna (4787); 16 km N of Morawa (12925); Bunjil (1736 *a-b*); Maya (4358); 51 km N of Beacon (48394); 11 km E of Green Head (48488); Mt Lesueur (49121); 3 km E of Wialki (24875); Mukinbudin (33400); 32 km S of New Norcia (60133-4); Bolgart (8992) and 13 km W (28010, 60431); Goomalling (22985); Merredin (8578); 32 km N of Kellerberrin (26469); Neerabup National Park (59347); Wyalunga Pool (12926); Gidgiegannup (19863, 40235); Wanneroo (48801); Millendon (8085); Sorrento (28393); Wembley Downs (22922); Floreat Park (24882); Midland (6921); Darlington (40702-3); Mt Helena (408); Quairading (1352); Wadderin Hill (2778); Lesmurdie (14914); Bickley (11756); Gosnells (34072); Kelmscott (51696); Brookton (28154); Pingelly (8564); Popanyinning (9659); 25 km E of Yornaning (51310); locality uncertain (3332, 60127, 60136).

Northern Territory: Yirrkala (13504, 13519); Katherine (16514, 24937); Willie Rock-hole (23°16′S, 129°45′E) (JSE 325-6); Owen Springs (20849); Hull River (JSE 148); Ruined Ramparts, Petermann Ranges (JSE 162); Chirnside Creek (20785); Shaw Creek (JSE 135).

South Australia: 18 km S of Mt Davies Camp (31708).

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THE PRIMARY TYPES OF ARACHNIDA, CHILOPODA, DIPLOPODA, INSECTA, ONYCHOPHORA AND PYCNOGONIDA IN THE WESTERN AUSTRALIAN MUSEUM

L.E. KOCH*

ABSTRACT

The primary type specimens of Arthropoda (excluding Crustacea) lodged in the Western Australian Museum are listed. The numbers of species or subspecies in the various groups are Arachnida (Scorpionida 10, Phalangida 2, Araneida 23, Acarina 6), Chilopoda 3, Diplopoda 10, Insecta (Thysanura 2, Odonata 10, Blattodea 41, Isoptera 4, Dermaptera 2, Embioptera 1, Hemiptera 7, Neuroptera 8, Coleoptera 48, Siphonaptera 1, Diptera 35, Trichoptera 3, Lepidoptera 8, Hymenoptera 53), Onychophora 1, Pycnogonida 7.

INTRODUCTION

This paper lists the primary type specimens of various groups of the Phylum Arthropoda, excluding the Crustacea, lodged in the Western Australian Museum. The list has been essentially compiled from the collection and includes all the types whose published descriptions have come to hand by the date of submission of the present paper. Primary types are here defined as the name-bearing specimens, i.e. holotypes, syntypes and lectotypes; there are no neotypes, and paratypes are excluded. Data from the type lists which I compiled for the published Annual Reports of the Western Australian Museum (1961-62 to 1968-69) have been incorporated.

The classes are listed alphabetically. The arachnid orders are in the sequence given in 'Classification of Insects', Brues, Melander and Carpenter, 1954. The insect orders are in the sequence given in 'The Insects of Australia', CSIRO, 1970. The order names of the Chilopoda and Diplopoda are those given in "Treatise on Invertebrate Paleontology" Part R, Arthropoda, 4(2), 1969, and are in the same sequence. The families, genera and species are arranged alphabetically within each order.

* Western Australian Museum, Francis Street, Perth, Western Australia, 6000.

For each species or subspecies, the information includes, wherever recorded, the sex of the type, the collector's name, date of collection or registration, and the locality of collection, for which I also include the latitude and longitude. Unfortunately, many of the old dates in the registers of the Western Australian Museum are not the dates of collection of the specimens but of their registration. Therefore in this list, wherever the date of collection is thought to be correct it is given preceded by 'col.', but wherever it is unknown the date of registration is given instead and is preceded by 'reg.'

The generic names are those with which the specific names were originally combined.

LIST OF TYPES

CLASS ARACHNIDA

ORDER SCORPIONIDA

Family Buthidae

Lychas jonesae Glauert, 1925, *J.R. Soc. West. Aust.* **11:** 110-111. Holotype, ♂, in alcohol, WAM 24-446. F. Jones; reg. 19.v.1924; Hampton Hill Station (Bulong), W.A.; 30°45′S, 121°46′E.

Lychas lappa Glauert, 1954, *N. Qd Nat.* **28:** 4-5. Holotype, ♀, in alcohol, WAM 64-62. W. Hosmer; reg. 24.i.1954; Lappa Junction [Siding], Qld; 17°22′S, 144°53′E.

Family Scorpionidae

Urodacus centralis Koch, 1977, *Rec. West. Aust. Mus.* **5:** 216-219. Holotype, ♂, in alcohol, WAM 73-775. W.H. Butler; col. 20.v.1973; Palm Valley, N.T.; 24°06′S, 132°43′E.

Urodacus elongatus Koch, 1977, *Rec. West. Aust. Mus.* **5:** 191-194. Holotype, ♂, in alcohol, WAM 68-490. J.C. Le Souef; col. x. 1967; Mt Remarkable, S.A.; 32°48′S, 138°10′E.

Urodacus giulianii Koch, 1977, *Rec. West. Aust. Mus.* **5:** 267-268. Holotype, ♀, in alcohol, WAM 69-2013. D.D. Giuliani; col. 7.vii.1969; Mt Davies Camp, 8 km NW of, S.A.; 26°09′S, 129°06′E.

Urodacus koolanensis Koch, 1977, *Rec. West. Aust. Mus.* **5:** 226-228. Holotype, ♂, in alcohol, WAM 68-487. O. Milton; col. 16.ix.1966; Koolan I., W.A.; 16°08′S, 123°45′E.

Urodacus lowei Koch, 1977, *Rec. West Aust. Mus.* **5:** 280-283. Holotype, ♂, in alcohol, WAM 69-620. W.R. Lowe; col. 2.ix.1967; Lawley River and Mitchell River area, within 16 km of, W.A.; 14°58′S, 126°02′E.

Urodacus megamastigus Koch, 1977, *Rec. West. Aust. Mus.* **5:** 229-231. Holotype, ♂, in alcohol, WAM 66-368. A. Snell; col. 8.iv.1963; Mundiwindi, W.A.; 23°50′S, 120°10′E.

Urodacus similis Koch, 1977, *Rec. West. Aust. Mus.* **5:** 284-286. Holotype, ♂, in alcohol, WAM 69-467. T. Moriarty; col. iii-iv.-1963; Kathleen Valley, W.A.; 27°23′S, 120°38′E.

Urodacus varians Glauert, 1963, *West. Aust. Nat.* **8:** 133-134. Holotype, ♂, in alcohol, WAM 62-1. O.H. Lipfert; col.iv.1930-x.1931; Canning Stock Route, from Wiluna to Billiluna, W.A.; 26°35′S, 120°14′E to 19°33′S, 127°40′E.

ORDER PHALANGIDA

Family Phalangodidae

Bindoona glauerti Roewer, 1929, *J.R. Soc. West. Aust.* **15:** 97-98. Holotype, in alcohol, WAM 27-672. L. Glauert; col. 14.v.1927; South Bindoon, W.A.; 29°59′S, 115°12′E.

Family Triaenonychidae

Dingupa glauerti Forster, 1952, *J.R. Soc. West. Aust.* **36:** 23-27. Holotype, ♂, in alcohol, WAM 36-2136. L. Glauert; col. iii.1936; Dingup, W.A.; 34°14′S, 116°12′E.

ORDER ARANEIDA

Family Araneidae

Aranea recherchensis Main, 1954, in The Archipelago of the Recherche. *Rep. Aust. geogr. Soc.* no. 1: 41-42. Holotype, ♀, in alcohol, WAM 55-4984. V.N. Serventy; col. 7.xi.1950; Figure-of-Eight I. (Recherche Archipelago), W.A.; 34°02′S, 121°37′E.

Family Ctenidae

Horioctenoides bidentatus Main, 1954, in The Archipelago of the Recherche. *Rep. Aust. geogr. Soc.* no. 1: 42-44. Holotype, ♀, in alcohol, WAM 55-4982. V.N. Serventy; col. 7.xi.1950; Figure-of-Eight I. (Recherche Archipelago), W.A.; 34°02′S, 121°37′E.

Family Ctenizidae

Aganippe cupulifex Main, 1957, *Aust. J. Zool.* **5:** 436-437. Holotype, ♂, in alcohol, WAM 64-61. B.Y. Main; col. 3.iv.1953; Chittering Lake, W.A.; 31°24′S, 116°05′E.

Arbanitis festivus Rainbow and Pulleine, 1918, *Rec. Aust. Mus.* **12:** 111-112. Syntype, ♀, in alcohol, WAM 64-67. col. 9.xii.1917; Nannup, W.A.; 33°59′S, 115°45′E.

Eucyrtops eremaea Main, 1957, *Aust. J. Zool.* **5:** 421-423. Holotype, ♂, in alcohol, WAM 64-60. A.R. Main; col. 21.v.1956; Cardinia Creek, W.A.; 28°49′S, 121°35′E.

Eucyrtops riparia Main, 1957, *Aust. J. Zool.* **5:** 419-421. Holotype, ♀, in alcohol, WAM 64-59. B.Y. Main; col. 26.v.1954; Mt Misery, 1 mile [1.6 km]S of, W.A.; 30°42′S, 115°37′E.

Idiosoma hirsutum Main, 1952, *West. Aust. Nat.* **3:** 132-133. Holotype, ♀, in alcohol, WAM 29-1060. L.W. Gibbs; reg. 10.viii.1929; Victoria Park, W.A.; 31°57′S, 115°51′E.

Idiosoma nigrum Main, 1952, *West. Aust. Nat.* **3:** 133. Holotype, ♀, in alcohol, WAM 64-58. B.Y. Main; col. 19.vi.1952; Wongan Hills, W.A.; 30°54′S, 116°43′E.

Family Clubionidae

Chiracanthium mondrainensis Main, 1954, in the Archipelago of the Recherche. *Rep. Aust. geogr. Soc.* no. 1: 46. Holotype, ♀, in alcohol, WAM 55-4983. V.N. Serventy; col. 21.xi.1950; Mondrain I. (Recherche Archipelago), W.A.; 34°08′S, 122°15′E.

Family Dipluridae

Dekana wonganensis Main, 1977, in The Natural History of Wongan Hills. *Handbk West. Aust. Nat. Club* no. 11: 102-107. Holotype, ♀, in alcohol, WAM 78-596. B.Y. Main; col. 24.xi.1974; Wongan Hills [s. end of], W.A.; 30°54′S, 116°43′E.

Teyl luculentus Main, 1975, *West. Aust. Nat.* **13:** 73-78. Holotype, ♀, in alcohol, WAM 75-944. B.Y. Main; col. 29.viii.1956; Bruce Rock, 14.5 km N of, W.A.; 31°46′S, 118°09′E.

Troglodiplura lowyri Main, 1969, *J.R. Soc. West. Aust.* **52:** 9-11. Holotype, in alcohol, WAM 68-342. D.C. and J.W.J. Lowry; col. 29.vii.1966; Roaches Rest Cave, 27 miles [43 km] NE of Madura, W.A.; 31°54′S, 127°01′E.

Family Dysderidae

Ariadna decatetracantha Main, 1954, in The Archipelago of the Recherche. *Rep. Aust. geogr. Soc.* no. 1: 40. Holotype, ♀, in alcohol, WAM 55-4981. V.N. Serventy; col. 19-20.xi.1950; Twin Peaks I. (probably North I.) (Recherche Archipelago), W.A.; 35°59′S, 122°50′E.

Family Gnaphosidae

Encoptarthria serventyi Main, 1954, in The Archipelago of the Recherche. *Rep. Aust. geogr. Soc.* no. 1: 44-45. Holotype, ♀, in alcohol, WAM 55-4985. V.N. Serventy; col. 10.xi.1950; Sandy Hook I. (Recherche Archipelago), W.A.; 34°03′S, 122°00′E.

Family Linyphiidae

Laetesia leo van Helsdingen, 1972, *Zoöl. Meded. Leiden* **47:** 383-385. Holotype, ♀, in alcohol, WAM 72-734. J.W.J. Lowry; col. 3.iv.1970; Koonalda Cave, Nullarbor Plain, S.A.; 31°24′S, 129°50′E.

Family Lycosidae

Lycosa alteripa McKay, 1976, *Mem. Qd Mus.* **17:** 417-419. Holotype, ♂, in alcohol, WAM 71-40. R.J. McKay and R. Prince; col. 11.vii.1970; Fitzgerald River, near mouth of, W.A.; 34°05′S, 119°35′E.

Lycosa corallina McKay, 1974, *Mem. Qd Mus.* **17:** 21-26. Holotype, ♀, in alcohol, WAM 71-1645. R.J. McKay and L. Baird; col. 10.vii.1971; Wooded I., Houtman Abrolhos, W.A.; 28°46′S, 113°48′E.

Lycosa duracki McKay, 1975, *Mem. Qd Mus.* **17:** 316-318. Holotype, ♀, in alcohol, WAM 74-494. R.J. McKay and W.H. Butler; col. 23.x.1971; Old Argyle Downs Station (Ord River) [now submerged beneath Lake Argyle], W.A.; 16°17′S, 128°48′E.

Lycosa forresti McKay, 1973, *Mem. Qd Mus.* **16:** 385-389. Holotype, ♀, in alcohol, WAM 70-44. W.H. Butler; col. 17.viii.1953; Moorine Rock, 8 miles [13 km] W of, W.A.; 31°18′S, 119°00′E.

Lycosa salifodina McKay, 1976, *Mem. Qd Mus.* **17:** 421-423. Holotype, ♀, in alcohol, WAM 69-639. A.M. Douglas and L.E. Koch; col. 24.i.1968; Lake Lefroy, Widgiemooltha, W.A.; 31°30′S, 121°34′E.

Lycosa snelli McKay, 1975, *Mem. Qd Mus.* **17:** 313-316. Holotype, ♀, in alcohol, WAM 69-797. A. Snell; col. i.1952; Towera Station, W.A.; 23°11′S, 115°07′E.

Lycosa storri McKay, 1973, *Mem. Qd Mus.* **16:** 389-394. Holotype, ♀, in alcohol, WAM 70-240. W.H. Butler; col. 6.xi.1970; Yellowdine, 38 miles [61 km] S of, W.A.; 31°50′S, 119°39′E.

Family Miturgidae

Janusia muiri Gray, 1972, *J. Aust. ent. Soc.* **12:** 207-210. Holotype, ♀, in alcohol, WAM 73-77. J.W.J. Lowry; col. 20.ix.1966. Weebubbie Cave N2, near Madura, W.A.; 31°39′S, 128°46′E.

ORDER ACARINA

Family Ixodidae

Amblyomma calabyi Roberts, 1963, *Parasitology* **53:** 171-181. Holotype, ♂, in alcohol, WAM 64-70. J.H. Calaby; col. 18.ix.1961; Learmonth, 7 miles [11 km] SSW of, W.A.; 22°20′S, 114°00′E.

Haemaphysalis lagostropi Roberts, 1963, *Aust. J. Zool.* **11:** 53-57. Holotype, ♂, in alcohol, WAM 64-69. W.D.L. Ride; col. 26.vii.1959; Bernier I., W.A.; 24°52′S, 113°08′E.

Ixodes hydromyidis Swan, 1931, *Parasitology* **23:** 485-487. Syntype, ♀, in alcohol, and two microscope slides of parts, WAM 64-68 and 64-68a and 64-68b. D.C. Swan; col. 10.vi.1930; Mundaring Weir, W.A.; 31°57′S, 116°10′E.

Family Trombidiidae

Allothrombium antipodianum kondininum Hirst, 1928, *Proc. zool. Soc. Lond.* **1928:** 1030. Holotype, in alcohol, and two microscope slides, WAM 24-512 and 24-512a and 24-512b. A.D. Robens; reg. 27.v.1924; Kondinin, W.A.; 32°30′S, 118°16′E.

Chyzeria occidentalis Hirst, 1929, *Proc. zool. Soc. Lond.* **1929:** 167-168. Holotype, three microscope slides. WAM 67-72 and 64-72a to 64-72c. reg. 4.vi.1964; Rottnest I. (Ursula's Lake), W.A.; 32°00′S, 115°30′E.

Microtrombidium (Enemothrombium) koordanum Hirst, 1928, *Proc. zool. Soc. Lond.* **1928:** 1023. Holotype, in alcohol, and two microscope slides, WAM 25-431 and 25-431a and 25-431b. F. Bradshaw; reg. 25.v.1925; Koorda, W.A.; 30°50′S, 117°29′E.

CLASS CHILOPODA

ORDER LITHOBIIDA

Family Anopsobiidae

Dichelobius flavens Attems,1911, in vol. 3, pp. 154-157, *Die Fauna Südwest-Australiens;* ed. W. Michaelsen and R. Hartmeyer. Syntype, in alcohol, WAM 7177. Michaelsen and Hartmeyer Expd.; col. 20.vii.1905; Station 99, Lion Mill [= Mt Helena], W.A.; 31°53′S, 116°12′E.

Family Henicopidae

Henicops oligotarsus Attems, 1911, in vol. 3, pp. 150-151, *Die Fauna Südwest-Australiens;* ed. W. Michaelsen and R. Hartmeyer. Syntypes, 3, in alcohol, WAM 7172a to 7172c. Michaelsen and Hartmeyer Expd.; col. 7.x.1905; Station 139, Brunswick, W.A.; 33°15′S, 115°50′E.

ORDER GEOPHILIDA

Family Geophilidae

Polygonarea imparata Attems, 1911, in vol. 3, pp. 161-163, *Die Fauna Südwest-Australiens;* ed. W. Michaelsen and R. Hartmeyer. Syntype, in alcohol, WAM 7140. Michaelsen and Hartmeyer Expd.; col. 28.v.1905; Station 112, Karrakatta, W.A.; 31°58′S, 115°48′E.

CLASS DIPLOPODA

ORDER POLYZONIIDA

Family Polyzoniidae

Siphonotus flavomarginatus Attems, 1911, in vol. 3, pp. 201-204, *Die Fauna Südwest-Australiens;* ed. W. Michaelsen and R. Hartmeyer. Syntype, in alcohol, WAM 7156. Michaelsen and Hartmeyer Expd.; col. 19.viii.1905; Station 162, Torbay, W.A.; 35°02′S, 117°38′E.

ORDER SPIROSTREPTIDA

Family Cambalidae

Atelomastix albanyensis Attems, 1911, in vol. 3, pp. 194-195, *Die Fauna Südwest-Australiens;* ed. W. Michaelsen and R. Hartmeyer. Syntype, ♂, *in alcohol,* WAM 7145. Michaelsen and Hartmeyer Expd.; col. 13.viii.1905; Station 165, Albany, W.A.; 35°01′S, 117°53′E.

Dinocambala ingens Attems, 1911, in vol. 3, pp. 190-192, *Die Fauna Südwest-Australiens;* ed. W. Michaelsen and R. Hartmeyer. Syntype, in alcohol, WAM 7173. Michaelsen and Hartmeyer Expd.; col. 31.v.1905; Station 152, Gooseberry Hill, W.A.; 31°57′S, 116°03′E.

Podykipus collinus Attems, 1911, in vol. 3, pp. 184-186, *Die Fauna Südwest-Australiens;* ed. W. Michaelsen and R. Hartmeyer. Syntype, in alcohol, WAM 7146. Michaelsen and Hartmeyer Expd.; col. 9-16.vii.1905; Station 109, Subiaco, W.A.; 31°57′S, 115°49′E.

Podykipus leptoiuloides Attems, 1911, in vol. 3, pp. 186-189, *Die Fauna Südwest-Australiens;* ed. W. Michaelsen and R. Hartmeyer. Syntype, in alcohol, WAM 7153. Michaelsen and Hartmeyer Expd.; col. 26.viii.1905; Station 137, Collie, W.A.; 33°22′S, 116°09′E.

Samichus decoratus Attems, 1911, in vol. 3, pp. 198-199, *Die Fauna Südwest-Australiens;* ed. W. Michaelsen and R. Hartmeyer. Syntype, in alcohol, WAM 7150. Michaelsen and Hartmeyer Expd.; col. 19.viii.1905; Station 162, Torbay, W.A.; 35°02′S, 117°38′E.

ORDER POLYDESMIDA

Family Paradoxosomatidae

Antichiropus monacanthus Attems, 1911, in vol. 3, pp. 175-176, *Die Fauna Südwest-Australiens;* ed. W. Michaelsen and R. Hartmeyer. Syntype, in alcohol, WAM 7152. Michaelsen and Hartmeyer Expd.; col. 7-12.vi.1905; Station 68, Brown Station, Dirk Hartogs I., W.A.; 26°00′S, 113°10′E.

Antichiropus variabilis ingens Attems, 1911, in vol. 3, pp. 171-172, *Die Fauna Südwest-Australiens;* ed. W. Michaelsen and R. Hartmeyer. Syntypes, 2 ♂, in alcohol, WAM 7128a and 7128b. Michaelsen and Hartmeyer Expd.; col. 11.viii.1905; Station 155, York, W.A.; 31°53′S, 116°46′E.

Antichiropus whistleri Attems, 1911, in vol. 3, p. 174, *Die Fauna Südwest-Australiens;* ed. W. Michaelsen and R. Hartmeyer. Syntype, ♀, in alcohol, WAM 7151. Michaelsen and Hartmeyer Expd.; col. 1.vi.1905; Station 114, Buckland Hill (near Fremantle), W.A.; 32°03′S, 115°44′E.

Orthomorpha triaina Attems, 1911, in vol. 3, pp. 178-179, *Die Fauna Südwest-Australiens;* ed. W. Michaelsen and R. Hartmeyer. Syntype, in alcohol, WAM 7176. Michaelsen and Hartmeyer Expd.; col. 13.viii.1905; Station 165, Albany, W.A.; 35°01′S, 117°53′E.

CLASS INSECTA

ORDER THYSANURA

Family Lepismatidae

Acrotelsa splendens Nicholls and Richardson, 1926, *J. R. Soc. West. Aust.* **12:** 134-137. Syntypes, ♂ and ♀, five microscope slides of these and appendages, WAM 63-356 and 63-356a to 63-356e. reg. 19.ix.1963; Mt Nairn, (and Milly Milly District), W.A.; 25°55′S, 116°38′E.

Acrotelsa westralis Nicholls and Richardson, 1926, *J.R. Soc. West. Aust.* **12:** 137-139. Holotype ♂, seven microscope slides of it and appendages, WAM 63-357 and 63-357a to 63-357g. reg. 19.ix.1963; Beaconsfield, W.A.; 32°04′S, 115°46′E.

ORDER ODONATA

Family Coenagrionidae

Agriocnemis kunjina Watson, 1969, *Aust. J. Zool.* **17:** 76-78. Holotype, ♂, pinned, WAM 69-760. J.A.L. Watson; col. 1.viii.1958; Old Gardens, Tambrey (Coolawanyah) Station, W.A.; 21°38′S, 117°36′E.

Austroagrion pindrina Watson, 1969, *Aust. J. Zool.* **17:** 68-71. Holotype, ♂, pinned, WAM 69-759. J.A.L. Watson; col. 1.viii. 1958; Nuntara Pools, Tanberry Creek, Tambrey (Coolawanyah) Station, W.A.; 21°38′S, 117°36′E.

Family Corduliidae

Hemicordulia koomina Watson, 1969, *Aust. J. Zool.* **17:** 97-99. Holotype, ♂, pinned, WAM 69-764. J.A.L. Watson; col. 26.vii.1958; Deep Reach [Pool] (Fortescue River, Millstream Station), W.A.; 21°37′S, 117°06′E.

Family Gomphidae

Antipodogomphus neophytus Fraser, 1958, *Proc. R. zool. Soc. N.S.W.* **1956-57:** 71-73. Holotype, ♂, pinned, WAM 58-2. G.F. Bornemissza; col. ii.1954; Kimberley Research Station, W.A.;15°39′S, 128°42′E.

Antipodogomphus neophytus hodgkini Watson, 1969, *Aust. J. Zool.* **17:** 94-96. Holotype, ♂, pinned, WAM 69-766. J.A.L. Watson; col. 31.i.1958; Millstream Spring (Millstream Station), W.A.; 21°39′S, 117°03′E.

Indictinogomphus australis dobsoni Watson, 1969, *Aust. J. Zool.* **17:** 88-89. Holotype, ♂, pinned, WAM 69-763. J.A.L. Watson; col. 31.i.1958; Millstream Spring (Millstream Station), W.A.; 21°39′S, 117°03′E.

Family Libellulidae

Nannophlebia injibandi Watson, 1969, *Aust. J. Zool.* **17:** 100-103. Holotype, ♂, pinned, WAM 69-765. J.A.L. Watson; col. 30.i.1958; Millstream Spring (Millstream Station), W.A.; 21°39′S, 117°03′E.

Family Petaluridae

Petalura hesperia Watson, 1958, *Proc. R. ent. Soc. Lond.* (B) **27:** 116-118. Holotype, ♂, pinned, WAM 58-3. J.A.L. Watson; col. 1.xii.1957; Karragullen, 1¾ miles (3 km) SW of, W.A.; 32°05′S, 116°05′E.

Family Protoneuridae

Eurysticata coolawanyah Watson, 1969, *Aust. J. Zool.* **17:** 83-87. Holotype, ♂, pinned, WAM 69-762. J.A.L. Watson; col. 6.ii.1958; Deep Reach [Pool] (Fortescue River, Millstream Station), W.A.; 21°37′S, 117°06′E.

Notosticta solida pilbara Watson, 1969, *Aust. J. Zool.* **17**: 80-82. Holotype, ♂, pinned, WAM 69-761. J.A.L. Watson; col. 26.i.-6.ii.1958, Millstream Spring (Millstream Station), W.A.; 21°39′S, 117°03′E.

ORDER BLATTODEA

Family Blaberidae

Calolampra submarginalis Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blattariae, *Acta Univ. lund.* (2)**50**(13): 32. Holotype, ♂, pinned, WAM 46-274. P.J. Barwise; reg. 29.iv.1946; West Kimberley, W.A.; about 17°S, 124°E.

Paratemnopteryx atra Princis, 1963, *J.R. Soc. West. Aust.* **46**: 11-12. Holotype, ♂, pinned, WAM 63-355. A.M. Douglas; col. 10.x.1957; Marble Bar, W.A.; 21°07′S, 119°41′E.

Shawella douglasi Princis, 1963, *J.R. Soc. West. Aust.* **46**: 11. Holotype, ♂, pinned, WAM 63-354. A.M. Douglas; col. ix.1958; Jurien Bay, W.A.; 30°17′S, 115°00′E.

Family Blattellidae

Trogloblatella nullarborensis Mackerras, 1967, *J. Aust. ent. Soc.* **6**: 39-42. Holotype, ♂, pinned, WAM 68-88. D.C. and J.W.J. Lowry; col. 27.ix.1966; Abrakurrie Cave (about 24 miles [39 km] WNW of Eucla), W.A.; 31°21′S, 128°48′E.

Family Blattidae

Anamesia angusta Mackerras, 1966, *Aust. J. Zool.* **14**: 350-351. Holotype, ♂, pinned, WAM 63-316. A.M. Douglas; col. xi.1960; Bamboo Creek, W.A.; 20°56′S, 120°13′E.

Anamesia douglasi Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blattariae, *Acta Univ. lund.* (2)**50**(13): 11. Holotype, ♀, pinned, WAM 43-1736. A.M. Douglas; col. 1943; Clampton, W.A.; 29°57′S, 119°06′E.

Anamesia serrata Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blattariae, *Acta Univ. lund.* (2)**50**(13): 12. Holotype, ♀ [not ♂], pinned, WAM 24-968. H.W.B. Talbot; reg. xii.1924; Mt Wynne, W.A.; 18°06′S, 124°27′E.

Anamesia uniformis Mackerras, 1966, *Aust. J. Zool.* **14**: 349-350. Holotype, ♂, pinned, WAM 63-305. A.M. Douglas; col. 25.vii.1963; North West Cape, W.A.; 21°45′S, 114°10′E.

Euzosteria callosa Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blatteriae, *Acta Univ. lund.* (2)**50**(13): 29. Holotype, ♀, pinned, WAM 43-1375. R. Randall; reg. 13.xii.1943; Jitarning, W.A.; 32°47′S, 118°00′E.

Lamproblatta picea Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blattariae, *Acta Univ. lund.* (2)**50**(13): 8-9. Holotype, ♂, pinned, WAM 32-1542. O. Smith; reg. 10.viii.1932; Perenjori, W.A.; 29°26′S, 116°17′E.

Lamproblatta sublobata Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blattariae, *Acta Univ. lund.* (2)**50**(13): 8. Holotype, ♀, pinned, WAM 48-585. F. Lambert; col. iii.1948; Wittenoom Gorge, W.A.; 22°14′S, 118°20′E.

Lamproblatta zonata Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blattariae, *Acta Univ. lund.* (2)**50**(13): 9-10. Holotype, ♀, pinned, WAM 49-904. K.G. Buller; col. 15.viii.1949; Murchison, W.A.; 27°39′S, 114°14′E.

Megazosteria shawi Mackerras, 1966, *Aust. J. Zool.* **14:** 313-314. Holotype, ♂, pinned, WAM 66-385. R.P. McMillan; col. 19.vii.1958; Millstream, W.A.; 21°35′S, 117°04′E.

Melanozosteria lobipennis Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blattariae, *Acta Univ. lund.* (2)**50**(13): 13-14. Holotype, ♂, pinned, WAM 19-65. A. Caldwell; reg. 10.ii.1919; Badjebup, W.A.; 33°38′S, 117°54′E.

Platyzosteria denticulata Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blattariae, *Acta Univ. lund.* (2)**50**(13): 20. Holotype, ♀, pinned, WAM 52-172 [not 57-472]. K.G. Buller; reg. 4.ii.1952; Kundip, W.A.; 33°41′S, 120°11′E.

Platyzosteria fulva Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blattariae, *Acta Univ. lund.* (2)**50**(13): 27. Holotype, ♀, pinned, WAM 52-184. col. 1925; Darlington, W.A.; 31°55′S, 116°04′E.

Platyzosteria (Leptozosteria) latissima Mackerras, 1967, *Aust. J. Zool.* **15:** 1293-1295. Holotype, ♂, pinned, WAM 65-430. C. Snell; col. 18.iii.1965; Turee Creek, 2 miles [3 km] SE of, W.A.; 23°37′S, 118°39′E.

Platyzosteria (Leptozosteria) subaquila Mackerras, 1967, *Aust. J. Zool.* **15:** 1290-1292. Holotype, ♂, pinned, WAM 64-175. A.M. Douglas; col. 9.ix.1964; Halls Creek, 48 miles [77 km] N of, W.A.; 18°16′S, 127°47′E.

Platyzosteria marginalis Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blattariae, *Acta Univ. lund.* (2)**50**(13): 20-21. Holotype, ♀, pinned, WAM 27-182. H. Poole; reg. ii.1927; Mullewa, W.A.; 28°32′S, 115°30′E.

Playzosteria (Melanozosteria) aculeata Mackerras, 1968, *Aust. J. Zool.* **16:** 305-306. Holotype, ♂, pinned, WAM 55-4019. A.M. Douglas; col. vi.1955; Rough Range, W.A.; 22°26′S, 114°04′E.

Platyzosteria (Melanzosteria) barrominensis Mackerras, 1968, *Aust. J. Zool.* **16:** 327. Holotype, ♂, pinned, WAM 68-296. A.M. Douglas; col. xi.1963; Barromine, 150 miles [241 km] E of Marble Bar, W.A.; 21°11′S, 119°44′E.

Platyzosteria (Melanozosteria) flavofusca Mackerras, 1968, *Aust. J. Zool.* **16:** 322-325. Holotype, ♂, pinned, WAM 68-295. A.M. Douglas; col. 25. vii.1963; North West Cape, W.A.; 21°45′S, 114°10′E.

Platyzosteria (Melanozosteria) lentiginosa Mackerras, 1968, *Aust. J. Zool.* **16:** 325-326. Holotype, ♂, pinned, WAM 64-123. A.M. Douglas; col. 4.ix.1964; Halls Creek, W.A.; 18°16′S, 127°46′E.

Platyzosteria (Melanozosteria) minima Mackerras, 1968, *Aust. J. Zool.* **16:** 317-318. Holotype, ♂, pinned, WAM 68-294. A.M. Douglas; col. 1959; Dorre I., W.A.; 25°07′S, 113°08′E.

Platyzosteria (Melanozosteria) minor Mackerras, 1968, *Aust. J. Zool.* **16:** 316-317. Holotype, ♂, pinned, WAM 68-293. A.M. Douglas; col. 25.viii.1963; North West Cape, W.A.; 21°45′S, 114°10′E.

Platyzosteria (Melanozosteria) obesa Mackerras, 1968, *Aust. J. Zool.* **16:** 302-304. Holotype, ♂, pinned, WAM 66-16. A.M. Douglas and L.N. [not M.] McKenna; col. 21-23.i.1966; Dedari, W.A.; 31°05′S, 120°42′E.

Platyzosteria (Platyzosteria) albopilosa Mackerras, 1967, *Aust. J. Zool.* **15:** 1280-1282. Holotype, ♂, pinned, WAM 64-663 [= 64-664 in description]. A.M. Douglas; col. 8.x.1964; Cocklebiddy, 7 miles [11 km] SE of, W.A.; 32°04′S, 126°11′E.

Platyzosteria polita Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blattariae, *Acta Univ. lund.* (2)**50**(13): 18. Holotype, ♂, pinned, WAM 52-157. K.G. Buller; reg. 4.ii.1952; Kundip, W.A.; 33°41′S, 120°11′E.

Platyzosteria shelfordi Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blattariae, *Acta Univ. lund.* (2)**50**(13): 22. Holotype, ♂, pinned, WAM 4381. Michaelsen and Hartmeyer Expd.; col. 1905; Murchison District, W.A.; about 27°S, 115°E.

Platyzosteria similis Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blattariae, *Acta Univ. lund.* (2)**50**(13): 21-22. Holotype, ♂, pinned, WAM 52-173. K.G. Buller; reg. 4.ii.1952; Kundip, W.A.; 33°41′S, 120°11′E.

Platyzosteria tibialis Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blattariae, *Acta Univ. lund.* (2)**50**(13): 24. Holotype, ♀, pinned, WAM 34-1645. M. Dorotich; reg. 4.v.1934; Burngup, W.A.; 33°01′S, 118°41′E.

Platyzosteria tricaudata Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blattariae, *Acta Univ. lund.* (2)**50**(13): 23-24. Holotype, ♂, pinned, WAM 29-481. L. Glauert; col. iv-v.1929; Landor Station W.A.; 25°08′S, 116°54′E.

Polyzosteria flavomaculosa Mackerras, 1965, *Aust. J. Zool.* **13:** 867-868. Holotype, ♂, pinned, WAM 4520. D. Lund; col. 11.ix.1911; Williams, W.A.; 33°01′S, 116°52′E.

Polyzosteria fulgens Mackerras, 1965, *Aust. J. Zool.* **13:** 874-876. Holotype, ♂, pinned, WAM 24-1. W.A. Poole; col. 9.i.1924; Kalmia (Upper Swan) W.A.; 31°46′S, 116°01′E.

Pseudolampra venusta Mackerras, 1966, *Aust. J. Zool.* **14:** 361-362. Holotype, ♂, pinned, WAM 64-536. A.M. Douglas; col. 8.x.1964; Cocklebiddy, 7 miles [11 km] SE of, W.A.; 34°04′S, 126°11′E.

Pseudozosteria punctata Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blattariae, *Acta Univ. lund.* (2)**50**(13): 10. Holotype, ♀, pinned, WAM 24-302. R. Warren; reg. 4.iv.1924; Laverton, W.A.; 28°38′S, 122°24′E.

Zonioploca fullerae Mackerras, 1965, *Aust. J. Zool.* **13:** 910-911. Holotype, ♂, pinned, WAM 65-723. R.P. McMillan; col. 24.i.1968; Southern Cross, W.A.; 31°13′S, 119°19′E.

Family Polyphagidae

Tivia australica Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blattariae, *Acta Univ. lund.* (2)**50**(13): 3-4. Holotype, ♂, pinned, WAM 27-1541. P. Hopegood; reg. 27.x.1927; Lake Violet, W.A.; 26°32′S, 120°40′E.

Family Pseudomorphidae

Franwalkeria glauerti Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blattariae, *Acta Univ. lund.*

(2)**50**(13): 34. Holotype, ♂, pinned, WAM 32-2797. E. Buggenthin; reg. 20.xii.1914; Merredin, W.A.; 31°29′S, 118°16′E.

Hemsaussurea pedestris Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blattariae, *Acta Univ. lund.* (2)**50**(13): 43-44. Holotype, ♂, pinned, WAM 5139. W.B. Alexander; reg. 12.viii.1912; Mt Lawley, W.A.; 31°56′S, 115°52′E.

Robshelfordia simplex Princis, 1954, in Report from Professor T. Gislén's Expedition to Australia in 1951-1952, 10, Australian Blattariae, *Acta Univ. lund.* (2)**50**(13): 38-39. Holotype, ♂, pinned, WAM 43-377. L. Glauert; col. 1-7.v.1943; Wamenusking, W.A.; 32°07′S, 117°35′E.

ORDER ISOPTERA

Family Termitidae

Eutermes occasus Silvestri, 1909, in vol. 2, pp. 307-308, *Die Fauna Südwest-Australiaens;* ed. W. Michaelsen and R. Hartmeyer. Syntypes, 3, in alcohol, WAM 64-66a to 64-66c. Michaelsen and Hartmeyer Expd.; col. 26.viii.1905; Station 137, Collie, W.A.; 32°22′S, 116°09′E.

Microcerotermes distinctus Silvestri, 1909, in vol. 2, pp. 303-304, *Die Fauna Südwest-Australiaens;* ed. W. Michaelsen and R. Hartmeyer. Syntypes, 12, in alcohol, WAM 64-65a to 64-65l. Michaelsen and Hartmeyer Expd.; col. 2.vii.1905; Station 94, Coolgardie, W.A.; 30°57′S, 121°09′E.

Microtermes kraepelini Silvestri, 1909, in vol. 2, p.298. *Die Fauna Südwest-Australiaens;* ed. W. Michaelsen and R. Hartmeyer. Syntypes, 4, in alcohol, WAM 64-63a to 64-63d. Michaelsen and Hartmeyer Expd.; col. 9-10.vii.1905; Station 101, Mundaring Weir, W.A.; 31°57′S, 116°10′E.

Monodontermes hartmeyeri Silvestri, 1909, in vol. 2, pp. 299-300, *Die Fauna Südwest-Australiaens;* ed. W. Michaelsen and R. Hartmeyer. Syntype, in alcohol, WAM 64-64. Michaelsen and Hartmeyer Expd.; col. 9-10.vii.1905; Station 76, Day Dawn, W.A.; 27°28′S, 117°52′E.

ORDER DERMAPTERA

Family Labiduridae

Gonolabis michaelseni Burr, 1908, in vol. 2, pp. 73-76, *Die Fauna Südwest-Australiaens;* ed. W. Michaelsen and R. Hartmeyer. Syntype, ♀, pinned, WAM 4364. Michaelsen and Hartmeyer Expd.; col. 26.viii.1905; Station 137, Collie, W.A.; 33°22′S, 116°09′E.

Gonolabis woodwardi Burr, 1908, in vol. 2, pp. 76-79, *Die Fauna Südwest-Australiaens;* ed. W. Michaelsen and R. Hartmeyer. Syntypes, ♂ and ♀, pinned, WAM 4365 and 4366. Michaelsen and Hartmeyer Expd.; col. 31.v.1905; Station 152, Gooseberry Hill, W.A.; 31°57′S, 116°03′E.

ORDER EMBIOPTERA

Family Oligotomidae

Oligotoma glauerti Tillyard, 1923, *J.R. Soc. West. Aust.* **9:** 64-65. Holotype, ♂, microscope slide, WAM 22-355. L. Glauert; col. 26.v. 1922; Milly Milly Station, W.A.; 26°04′S, 116°41′E.

ORDER HEMIPTERA

Family Achilidae

Bunduica rubrovenosa Jacobi, 1909, in vol. 2, p. 345. *Die Fauna Südwest-Australiaens;* ed. W. Michaelsen and R. Hartmeyer. Syntype, ♂, pinned, WAM 4255. Michaelsen and Hartmeyer Expd.; col. 19.viii.1905; Station 162, Torbay, W.A.; 35°02′S, 117°38′E.

Family Cicadidae

Macrotristria douglasi Burns, 1964, *Mem. natn. Mus. Melb.* no. 26: 105-106. Holotype, ♂, pinned, WAM 64-71. A.M. Douglas; col. 12.x.1955; Wotjulum, W.A.; 16°07′S, 123°43′E.

Family Eurymelidae

Eurymeloides lenis Jacobi, 1909, in vol. 2, pp. 341. *Die Fauna Südwest-Australiaens;* ed. W. Michaelsen and R. Hartmeyer. Syntype, ♀, pinned, WAM 4252. Michaelson and Hartmeyer Expd.; col. 20.vii.1905; Station 99, Lion Mill [=Mt Helena], W.A.; 31°53′S, 116°12′E.

Ipoella douglasi Evans, 1977, *Rec. Aust. Mus.* **31:** 87. Holotype, ♂, carded, WAM I.75 (=78-597). H. Douglas; reg. 24.viii.1978; Three Rivers Station, W.A.; 25°08′S, 119°09′E.

Family Nepidae

Ranatra occidentalis Lansbury, 1972, *Trans R. ent. Soc. Lond.* **124:** 326-329. Holotype, ♂, pinned, WAM 66-435. R.P. McMillan; col. 23.vii.1955; Millstream, W.A.; 21°35′S, 117°04′E.

Family Notonectidae

Anisops nabilla Lansbury, 1969, *J. nat. Hist.* **3:** 451-452. Holotype, ♂, pinned, WAM 66-522. R.P. McMillan; col. 12.vii.1958; Marillana [not Marilana], 14 miles [22 km] W of, W.A.; 22°38′S, 119°34′E.

Family Pentatomidae

Cuspiona cigniterrae Gross, 1975, *Rec. S. Aust. Mus.* **17:** 132-134. Holotype, ♀, pinned, WAM 70-8. J. Dell; col. 3.iv.1963; Kalamunda, W.A.; 31°58′S, 116°03′E.

ORDER NEUROPTERA

Family Mantispidae

Mantispa tillyardi Esben-Petersen, 1915, *Proc. Linn. Soc. N.S.W.* **39:** 642-643. Syntype, ♂, pinned, WAM 7211. J. Gascoyne; reg. 20.iv.1913; Cuballing, W.A.; 32°49′S, 117°11′E.

Family Myrmeleontidae

Dendroleon lambda Tillyard, 1916, *Proc. Linn. Soc. N.S.W.* **41:** 52-53. Holotype, pinned, WAM 6601. I. Handley; col. i.1912; Harvey, W.A.; 33°04′S, 115°54′E.

Distoleon nigrosignatus Tillyard, 1916, *Proc. Linn. Soc. N.S.W.* **41:** 64-65. Syntype, ♀, pinned, WAM 6898. O. Lipfert; col. 2.iii.1913 [not W.B. Alexander, 12.iii.1913]; Subiaco, W.A.; 31°57′S, 115°49′E.

Pericylystus aureolatus Tillyard, 1916, *Proc. Linn. Soc. N.S.W.* **41:** 50-52. Holotype, pinned, WAM 6972. S. Lundy; reg. 25.iii.1913; Cunderdin, W.A.; 31°39′S, 117°14′E.

Protoplectron longitudinale Tillyard, 1916, *Proc. Linn. Soc. N.S.W.* **41:** 48-49. Holotype, pinned, H22 (=WAM 78-610). G.H. Hardy; reg. 24.viii.1978. [Locality unknown.]

Family Nemopteridae

Chasmoptera mathewsi Koch, 1967, *Proc. R. ent. Soc. Lond.* (B) **36** (9-10): 144. Holotype, ♂, pinned, WAM 35-435. H. Berry; reg. 12.xi.1934; Peron Peninsula (Shark Bay), W.A.; 25°50′S, 113°35′E.

Chasmoptera superba Tillyard, 1925, *J.R. Soc. West. Aust.* **12:** 2-4. Holotype, ♂, pinned, WAM 14-1386. C. Hamilton; reg. 19.xii.1914; Cunderdin, W.A.; 31°39′S, 117°14′E.

Family Psychopsidae

Psychopsis maculipennis Tillyard, 1925, *Proc. Linn. Soc. N.S.W.* **50:** 389-390. Holotype, ♂, pinned, WAM 20-130. A. Hall; reg. 1.vi.1920; Roebourne, W.A.; 20°47′S, 117°09′E.

ORDER COLEOPTERA

Family Buprestidae

Astraeus (Astraeus) smythi Barker, 1975, *Trans. R. Soc. S. Aust.* **99:** 118-119. Holotype, ♂, pinned, WAM 73-55. E. Smith; reg. xi.1956; Maryborough, Qld; 25°32′S, 152°42′E.

Astreaus (Astraeus) watsoni Barker, 1975, *Trans. R. Soc. S. Aust.* **99:** 134. Holotype, ♀, pinned, WAM 71-1761. R.P. McMillan and J.A.L. Watson; col. 16.xii.1957; Borden, W.A.; 34°04′S, 118°16′E.

Astraeus (Depollus) dedariensis Barker, 1975, *Trans . R. Soc. S. Aust.* **99:** 113-114. Holotype, ♂, pinned, WAM 71-1779. H.W. Brown; reg. 12.x.1971; Dedari, W.A.; 31°05′S, 120°42′E.

Family Cerambycidae

Ancita longicornis McKeown, 1948, *Rec. Aust. Mus.* **22:** 58-59. Holotype, ♂, carded, WAM 37-313. D. Wardell-Johnston; reg. 26.i.1937; Edjudina, W.A.; 29°49′S, 122°21′E.

Bethelium inconspicuum McKeown, 1948, *Rec. Aust. Mus.* **22:** 53. Holotype, carded, WAM 33-2392. A.K. Brown; reg. 1.xi.1933; Salmon Gums, W.A.; 32°59′S, 121°39′E.

Coptocercus sannio McKeown, 1948, *Rec. Aust. Mus.* **22:** 52-53. Holotype, pinned, WAM 38-2326. J. Daniels; reg. 26.x.1938; Hopetoun, W.A.; 33°57′S, 120°07′E.

Corrhenes glauerti McKeown, 1948, *Rec. Aust. Mus.* **22:** 62-63. Holotype, pinned, WAM 30-886. F. Jones; reg. 2.xii.1930; Hampton Hill Station (Bulong), W.A.; 30°45′S, 121°46′E.

Didymocantha picta McKeown, 1948, *Rec. Aust. Mus.* **22:** 53. Holotype, ♀, pinned, WAM 37-1737. D. Wardell-Johnson; reg. 6.iv.1937; Edjudina, W.A.; 29°49′S, 122°21′E.

Disterna forrestensis McKeown, 1948, *Rec. Aust. Mus.* **22:** 59. Holotype, carded, WAM 15-369. J.A. Dobson; reg. 29.iv.1915; Forrest River District, W.A.; 15°11′S, 127°50′E.

Emecia fulva McKeown, 1948, *Rec. Aust. Mus.* **22:** 57-58. Holotype, ♀, carded, WAM 36-4828. A.M. Douglas; reg. 24.xi.1936; Kukerin, W.A.; 33°12′S, 118°05′E.

Phacodes singularis McKeown, 1948, *Rec. Aust. Mus.* **22:** 51. Holotype, pinned, WAM 37-4588. A.M. Douglas; col. xii.1937; Narrogin, W.A.; 32°56′S, 117°11′E.

Uracanthus dentiapicalis McKeown, 1948, *Rec. Aust. Mus.* **22:** 55-57. Holotype, pinned, WAM 41-740. S. Gooch; reg. 13.vi.1941; Wandagee [not Wandadgee] Station, W.A.; 23°46′S, 114°33′E.

Uracanthus fusostriatus McKeown, 1948, *Rec. Aust. Mus.* **22:** 55. Holotype, ♂, carded, WAM 32-242. A.G. McKenna; reg. 2.ii.1932; Maylands, W.A.; 31°56′S, 115°53′E.

Uracanthus multilineatus McKeown, 1948, *Rec. Aust. Mus.* **22:** 54-55. Holotype, pinned, WAM 27-1497. P. Hopegood; reg. 27.x.1927; Lake Violet Station, W.A.; 26°32′S, 120°40′E.

Family Curculionidae

Catasarcus aerosus Thompson, 1968, *Bull. Br. Mus. nat. Hist.* (Ent.) **22**(8): 390-391. Holotype, ♂, pinned, WAM 70-359. E.B. Britton and A.M. Douglas; col. 14.xii.1961; Bolgart, W.A.; 31°16′S, 116°30′E.

Catasarcus albipectus Thompson, 1968, *Bull. Br. Mus. nat. Hist.* (Ent.) **22**(8): 425-426. Holotype, ♂, pinned, WAM 49-1090. B. York [now B.Y. Main]; col. 1.ix.1949, Murchison River [mouth of], W.A.; 27°42′S, 114°12′E.

Catasarcus aspergetus Thompson, 1968, *Bull. Br. Mus. nat. Hist.* (Ent.) **22**(8): 383-385. Holotype, ♂, pinned, WAM 70-356. F.H.U. Baker; col. ix.1959; Wialki, W.A.; 30°29′S, 118°07′E.

Catasarcus asphaltinus Thompson, 1968, *Bull. Br. Mus. nat. Hist.* (Ent.) **22**(8): 407-411. Holotype, ♂, pinned, WAM 70-632. E.C. Chapman; col. 1953; Fremantle, W.A.; 32°03′S, 115°44′E.

Catasarcus azureipes Thompson, 1968, *Bull. Br. Mus. nat. Hist.* (Ent.) **22**(8): 385-386. Holotype, ♂, pinned, WAM 51-2105. A.M. Douglas; reg. 17.xii.1951; Lake Grace, W.A.; 33°06′S, 118°28′E.

Catasarcus bakeri Thompson, 1968, *Bull. Br. Mus. nat. Hist.* (Ent.) **22**(8): 381-382. Holotype, ♀, pinned, WAM 70-354. F.H.U. Baker; col. 23.iv.1955; Esperance, W.A.; 33°52′S, 121°54′E.

Catasarcus bicolor Thompson, 1968, *Bull. Br. Mus. nat. Hist.* (Ent.) **22**(8): 427-428. Holotype, ♂, pinned, WAM 70-365. F.H.U. Baker; col. 17.ix.1958; Lynton, W.A.; 28°12′S, 114°18′E.

Catasarcus coruscus Thompson, 1968, *Bull. Br. Mus. nat. Hist.* (Ent.) **22**(8): 414-417. Holotype, ♂, pinned, WAM 45-771. L. Glauert; reg. 26.xi.1945; Yallingup, W.A.; 33°39′S, 115°01′E.

Catasarcus cygnensis Thompson, 1968, *Bull. Br. Mus. nat. Hist.* (Ent.) **22**(8): 412-414. Holotype, ♂, pinned, WAM 70-363. F.H.U. Baker; col. 5.x.1965; Applecross, W.A.; 31°57′S, 115°51′E.

Catasarcus frontalis Thompson, 1968, *Bull. Br. Mus. nat. Hist.* (Ent.) **22**(8): 402-404. Holotype, ♂, pinned, WAM 70-360. H.F. Broadbent; col. 1952?; Toodyay, W.A.; 31°33′S, 116°28′E.

Catasarcus laevior Thompson, 1968, *Bull. Br. Mus. nat. Hist.* (Ent.) **22**(8): 417. Holotype, ♂, pinned, WAM 70-364. H.F. Broadbent; col. 24.x.1952; Manjimup, W.A.; 34°15′S, 116°09′E.

Castasarcus murex Thompson, 1968, *Bull. Br. Mus. nat. Hist.* (Ent.) **22**(8): 441-443. Holotype, ♂, pinned, WAM 19-206. S.J. Clark; reg. xi.1919, Bridgetown, W.A.; 33°58′S, 116°08′E.

Catasarcus obesus Thompson, 1968, *Bull. Br. Mus. nat. Hist.* (Ent.) **22**(8): 382-383. Holotype, ♂, pinned, WAM 70-355. F.H.U. Baker; col. 20.ix.1954; Lake Varley, W.A.; 32°48′S, 119°31′E.

Catasarcus pallidiventris Thompson, 1968, *Bull. Br. Mus. nat. Hist.* (Ent.) **22**(8): 406-407. Holotype, ♀, pinned, WAM 70-361. F.H.U. Baker; col. 8.xii.1962; Hill River, W.A.; 30°17′S, 115°19′E.

Catasarcus ustulatus Thompson, 1968, *Bull. Br. Mus. nat. Hist.* (Ent.) **22**(8): 388-389. Holotype, ♀, pinned, WAM 70-358. J.A.L. Watson; col. 19.iv.1957; 161 mile peg [259 km] along Augusta Road, W.A.; 33°47′S, 115°08′E.

Catasarcus varus Thompson, 1968, *Bull. Br. Mus. nat. Hist.* (Ent.) **22**(8): 386-387. Holotype, ♂, pinned, WAM 70-357. F.H.U. Baker; col. 5.v.1960; Esperance, W.A.; 33°52′S, 121°54′E.

Notonophes gascoynensis Baker, 1972, *J. Aust. ent. Soc.* **11**: 123-125. Holotype, ♂, pinned, WAM 67-71. F.H.U. Baker; col. 22.viii.1962; Wooramel River (Gascoyne District), W.A.; 25°45′S, 114°16′E.

Notonophes hirsutina Baker, 1972, *J. Aust. ent. Soc.* **11**: 125-127. Holotype, ♂, pinned, WAM 69-1638. F.H.U. Baker; col. 4.ix.1967, Winning Station (Lyndon District), W.A.; 23°09′S, 114°32′E.

Family Dytiscidae

Hypodes giuliani Watts, 1978, *Aust. J. Zool.* (Suppl.) no. 57: 74. Holotype, ♂, carded, WAM 70-3366. D.D. Giuliani; col. 1.ix.1969; Beverley Springs, W.A.; 16°35′S, 125°29′E.

Hypodes josepheni Watts, 1978, *Aust. J. Zool.* (Suppl.) no. 57: 75-76. Holotype, ♂, carded, WAM 70-3367. D.D. Giuliani; col. ix.1969; Beverley Springs, W.A.; 16°35′S, 125°29′E.

Hypodes tambreyi Watts, 1978, *Aust. J. Zool.* (Suppl.) no. 57: 70-73. Holotype, ♂, pinned, WAM 69-1351. R.P. McMillan; col. 4.viii.1958; Tambrey, W.A.; 21°38′S, 117°36′E.

Family Scarabaeidae

Automolus phoxus Britton, 1957, *A revision of the Australian chafers* **1:** 97-98; London: British Museum (Natural History). Holotype, ♂, pinned, WAM 8229. S. Lundy; col. ix-x.1913; Cunderdin, W.A.; 31°39′S, 117°14′E.

Cryptoryctes psilus Carne, 1957, *A systematic revision of the Australian Dynastinae,* pp.156-157; Melbourne: CSIRO. Holotype, ♂, pinned, WAM 39-340 [=39-339 in description]. A.M. Douglas; reg. ii.1939; Mt Jackson, W.A.; 30°12′S, 119°06′E.

Cryptoryctes wingarus Carne, 1957, *A systematic revision of the Australian Dynastinae,* p.161; Melbourne: CSIRO. Holotype, ♂, pinned, "J.R.11-97" (=WAM 78-599). reg. 24.viii.1978. [Locality unknown, presumably in W.A.]

Epironastes abruptus Carne, 1957, *A systematic revision of the Australian Dynastinae,* p.127; Melbourne: CSIRO. Holotype, ♂, pinned, WAM 43-565. A.K. Brown; col. 8.vii.1943; Salmon Gums, W.A.; 32°59′S, 121°39′E.

Epironastes nigrisetosus Carne, 1957, *A systematic revision of the Australian Dynastinae,* p. 126; Melbourne: CSIRO. Holotype, ♂, pinned, WAM 48-2721. A.M. Douglas; reg. 11.xii.1948; Tarin Rock to Lake Grace, W.A.; 33°07′S, 118°14′E to 33°06′S, 118°28′E.

Haplopis rutila Britton, 1957, *A revision of the Australian chafers* **1:** 107; London: British Museum (Natural History). Holotype, ♂, carded, WAM 53-949. A.M. Douglas; reg. 18.v.1953; Chidlow, W.A.; 31°52′S, 116°16′E.

Maechidinus sculptilis Britton, 1957, *A revision of the Australian chafers* **1:** 78; London: British Museum (Natural History). Holotype, ♂, pinned, WAM 15-889. W.B. Alexander; reg. 17.x.1915; Waddouring [Hill], W.A.; 30°57′S, 117°51′E.

Neodon glauerti Carne, 1957, *A systematic revision of the Australian Dynastinae,* pp.44-45; Melbourne: CSIRO. Holotype, ♂, pinned, WAM 45-102. L.A.C. Dawson; reg. 27.ii.1945; Onslow, W.A.; 21°38′S, 115°07′E.

Neodon simplex Carne, 1957, *A systematic revision of the Australian Dynastinae,* pp.45-46; Melbourne: CSIRO. Holotype, ♂, pinned, WAM 48-576. F. Lambert; reg. iii.1948; Wittenoom Gorge, W.A.; 22°17′S, 118°19′E.

Phyllotocus pelus Britton, 1957, *A revision of the Australian chafers* **1:** 46; London: British Museum (Natural History). Holotype, ♂, pinned, WAM 36-4237. A.M. Douglas; reg. 4.xi.1936; Kukerin, W.A.; 33°12′S, 118°05′E.

Teinogenus annectens Carne, 1957, *A systematic revision of the Australian Dynastinae,* p.145; Melbourne: CSIRO. Holotype, ♂, pinned, WAM 32-2827. E. Buggenthin; reg. 20.xii.1932; Merredin, W.A.; 31°29′S, 118°16′E.

Termitophilus spadix Britton, 1957, *A revision of the Australian chafers* **1:** 126-127; London: British Museum (Natural History). Holotype, ♂, pinned, WAM 40-1537. L. Glauert; reg. 7.xi.1940; Calgardup, W.A.; 34°02′S, 115°00′E.

Tesserodon tenebroides Matthews, 1974, *Aust. J. Zool.* (Suppl.) no. 24: 84. Holotype, ♂, pinned, WAM 66-107. W.H. Butler; col. 26.v.1964; Barrow I., W.A.; 20°46′S, 115°24′E.

ORDER SIPHONAPTERA

Family Pygiopsyllidae

Glauertia scintilla Rothschild, 1936, *Novit. zool.* **40:** 9-13. Syntypes, 4 ♀, microscope slides, WAM 24-829a to 24-829c, and 28-2. F.R. Bradshaw; reg. 10.ix.1924; Tambellup, W.A.; 34°02′S, 117°38′E.

ORDER DIPTERA

Family Agromyzidae

Cerodontha (Cerodontha) augustensis Spencer, 1977, *Spec. Publs West. Aust. Mus.* no. 8: 145-147. Holotype, ♀, pinned, WAM 78-553. K.A. Spencer; col. 20.xi.1975; Augusta, W.A.; 34°19′S, 115°09′E.

Liriomyza cassiniae Spencer, 1977, *Spec. Publs West. Aust. Mus.* no. 8: 190-191. Holotype, ♂, pinned, WAM 78-554. K.A. Spencer; col. 2.xi.1975; Black Mountain, A.C.T.; 35°16′S, 149°06′E.

Liriomyza oleariana Spencer, 1977, *Spec. Publs West Aust. Mus.* no. 8: 205-206. Holotype, ♂, pinned, WAM 78-555. K.A. Spencer; col. 18.xi.1975; Busselton, 10 miles [16 km] S of, W.A.; 33°45′S, 115°09′E.

Liriomyza scaevolae Spencer, 1977, *Spec. Publs West. Aust. Mus.* no. 8: 208-210. Holotype, ♂, pinned, WAM 78-556. K.A. Spencer; col. 30.ix.1975; Cape Leeuwin, W.A.; 34°22′S, 115°08′E.

Melanagromyza prodigiosa Spencer, 1977, *Spec. Publs West. Aust. Mus.* no. 8: 52. Holotype, ♂, pinned, WAM 78-557. K.A. Spencer; col. 27.ix.1975; Eagle Bay, near Dunsborough, W.A. 33°33′S, 115°04′E.

Ophiomyia fera Spencer, 1977, *Spec. Publs West. Aust. Mus.* no. 8: 83-84. Holotype, ♂, pinned, WAM 78-558. K.A. Spencer; col. 26.ix.1975; Lake Cooloongup, W.A.; 32°17′S, 115°47′E.

Phytomyza anthocercidis Spencer, 1977, *Spec. Publs West. Aust. Mus.* no. 8: 223-224. Holotype, ♂, pinned, WAM 78-559. K.A. Spencer; col. 5.x.1975; Windy Harbour, S. of Northcliffe, W.A.; 34°38′S, 116°07′E.

Phytomyza ranunculicaulis Spencer, 1977, *Spec. Publs West. Aust. Mus.* no. 8: 230-231. Holotype, ♂, pinned, WAM 78-560. K.A. Spencer; col. 5.x.1975; Mt Chudalup, S. of Northcliffe, W.A.; 34°46′S, 116°05′E.

Family Apioceridae

Apiocera deforma Norris, 1936, *J.R. Soc. West. Aust.* **22**: 54-56. Holotype, ♂, pinned, WAM 36-1605. B.A. O'Connor; reg. 9.iv.1936; Gnangara, W.A.; 31°48′S, 115°42′E.

Apiocera englishae Paramonov, 1953, *Aust. J. Zool.* **1**: 511-512. Holotype, ♂, pinned, WAM 41-452. A.K. Brown; reg. 5.iii.1941; Salmon Gums, W.A.; 32°59′S, 121°39′E.

Apiocera flabellata Paramonov, 1953, *Aust. J. Zool.* **1**: 534-535. Holotype, ♂, pinned, WAM 48-3211. A.M. Douglas; reg. 31.xii.1948; Bullsbrook, W.A.; 31°40′S, 115°59′E. [Not in "Division of Entomology Museum, CSIRO, Canberra" as stated in description.]

Apiocera minor Norris, 1936, *J.R. Soc. West. Aust.* **22**: 61-62. Holotype, ♂, pinned, WAM 36-1625. D.C. Swan; col. xi., reg. iv.1936; Carlisle, W.A.; 31°59′S, 115°54′E.

Apiocera newmanni Norris, 1936, *J. Roy. Soc. West. Aust.* **22**: 62-63. Holotype, ♀, pinned, WAM 36-1620. B.A. O'Connor; col. xi.1930; Gnangara, W.A.; 31°48′S, 115°42′E.

Apiocera ordana Paramonov, 1953, *Aust. J. Zool.* **1**: 535-536. Holotype, ♂, pinned, WAM 51-1653. A.J. Drysdale, reg. 13.viii.1951; Ord River, W.A.; about 15°30′S, 128°30′E.

Apiocera pallida Norris, 1936, *J.R. Soc. West. Aust.* **22:** 59-60. Holotype, ♂, pinned, WAM 36-1608. K.R. Norris, col. 2.ii.1936; Carnac I., W.A.; 32°07′S, 115°40′E.

Apiocera pica Norris, 1936, *J.R. Soc. West. Aust.* **22:** 56-57. Holotype, ♂, pinned, WAM 36-1590. B.A. O'Connor, col. xi.1930; Gnangara, W.A.; 31°48′S, 115°42′E.

Apiocera tonnoiri Norris, 1936, *J.R. Soc. West. Aust.* **22:** 57-59. Holotype, ♂, pinned, WAM 36-1599. K.R. Norris; col. 9.ii.1936; Fremantle, W.A.; 32°03′S, 115°44′E.

Neorhaphiomidas hardyi Norris, 1936, *J.R. Soc. West. Aust.* **22:** 64-66. Holotype, ♂, pinned, WAM 36-1635. K.R. Norris; col. 9.ii.1936; Fremantle, W.A.; 32°03′S, 115°44′E.

Neorhaphiomydas pallida Paramonov, 1953, *Aust. J. Zool.* **1:** 531. Holotype, ♀, pinned, WAM 36-5567. A.M. Douglas; reg. 9.xii.1936; Wanneroo, W.A.; 31°45′S, 115°48′E.

Neorhaphiomidas pinguis Norris, 1936, *J.R. Soc. West. Aust.* **22:** 66-68. Holotype, ♂, pinned, WAM 36-1641. K.R. Norris; col. 23.ii.1936; Rottnest I., W.A.; 32°00′S, 115°30′E.

Neorhaphiomydas villosa Paramonov, 1953, *Aust. J. Zool.* **1:** 531-532. Holotype, ♂, pinned, WAM 35-3436. A.M. Douglas; reg. 15.xii.1935; Midland, W.A.; 31°53′S, 116°00′E.

Family Chironomidae

Anatopynia dalyupensis Freeman, 1961, *Aust. J. Zool.* **9:** 624. Holotype, ♂, pinned, WAM 64-1. D.H. Edward; adult emerged 7.v.1958; Dalyup River. W.A.; 33°44′S, 121°34′E.

Lundstroemia parthenogenetica Freeman, 1961, *Aust. J. Zool.* **9:** 721. Holotype, ♀, pinned, WAM 64-4. D.H. Edward; adult emerged 19.viii.1958; Lake Gwelup, W.A.; 31°53′S, 115°38′E.

Polypedilum (Polypedilum) watsoni Freeman, 1961, *Aust. J. Zool.* **9:** 710. Holotype, ♂, pinned, WAM 64-3. J.A.L. Watson; col. 18.vii.1958; Millstream Station, W.A.; 21°35′S, 117°04′E.

Stenochironomus watsoni Freeman, 1961, *Aust. J. Zool.* **9:** 705-706. Holotype, ♂, pinned, WAM 64-2. J.A.L. Watson; col. 25.vii.1958; Millstream Station, W.A.; 21°35′S, 117°04′E.

Tanytarsus (Tanytarsus) barbitarsus Freeman, 1961, *Aust. J. Zool.* **9**: 722-723. Holotype, ♂, pinned, WAM 64-5. D.H. Edward; col. 5.iv.1958; Bremer Bay, W.A.; 34°23′S, 119°23′E.

Family Culicidae

Theobaldia atra Lee, 1944, *Proc. Linn. Soc. N.S.W.* **64:** 220-221. Holotype, ♀, pinned, WAM 45-150. P.N. Forte; col. 16.xi.1943; Perth, W.A.; 31°57′S, 115°51′E.

Family Mydaidae

Diochlistus paragracilis Paramonov, 1955, *Ann. Mag. nat. Hist.* (12) **8:** 134. Holotype, ♂, pinned, WAM 48-2943. A.M. Douglas; reg. 24.xii.1948; Kukerin, W.A.; 33°12′S, 118°05′E.

Miltinus atripennis Paramonov, 1955, *Ann. Mag. nat. Hist.* (12) **8:** 134. Holotype, ♂, pinned, WAM 48-2942. A.M. Douglas; reg. 24.xii.1948; Kukerin, W.A.; 33°12′S, 118°05′E.

Miltinus cinctus Paramonov, 1955, *Ann. Mag. nat. Hist.* (12)**8:** 135. Syntypes, ♂ and ♀, pinned, WAM 51-2145 and 48-2944. A.M. Douglas; reg. 17.xii.1951; Lake Grace, W.A.; 33°06′S, 118°28′E, and A.M. Douglas; reg. 24.xii.1948; Kukerin, W.A.; 32°12′S, 118°05′E.

Miltinus confrater Paramonov, 1955, *Ann. Mag. nat. Hist.* (12)**8:** 134. Holotype, ♂, pinned, WAM 49-2145. K.G. Buller; reg. 28.xi.1949; Jandakot, W.A.; 32°07′S, 115°50′E.

Miltinus mackerrasi Norris, 1937, *J.R. Soc. West. Aust.* **23**: 46-48. Holotype, ♂, pinned, WAM 37-2375. K.R. Norris; reg. 8.vi.1937; Crawley, W.A.; 31°57′S, 115°51′E.

Family Nemestrinidae

Trichophthalma glauerti Paramonov, 1953, *Aust. J. Zool.* **1:** 286-287. Holotype, ♂, pinned, WAM 42-708. L. Glauert; reg. 30.xi.1942; Yallingup, W.A.; 33°39′S, 115°01′E.

Family Pyrgotidae

Adapsona fulva Paramonov, 1958, *Aust. J. Zool.* **6:** 107. Holotype, ♀, pinned, WAM 78-607 [not 41-1151]. reg. 24.viii.1978. Brookton (?), W.A.; 32°22′S, 117°00′E(?).

Family Tipulidae

Leptotarsus (Leptotarsus) kalamundensis Dobrotworsky, 1972, *Aust. J. Zool.*

(Suppl.) no. **16:** 26—27. Holotype, ♀, pinned, WAM 65-159. R.P. McMillan; col. 16.iv. 1960; Kalamunda, W.A.; 31°58′S, 116°03′E.

ORDER TRICHOPTERA

Family Leptoceridae

Triplectides delicatula Ulmer, 1908, in vol. 2, pp.27-29, *Die Fauna Südwest-Australiens;* ed. W. Michaelsen and R. Hartmeyer. Syntypes, 2 ♂, pinned, WAM 7086 and 7086a. Michaelsen and Hartmeyer Expd.; col. 7.x.1905, Station 139, Brunswick, W.A.; 33°15′S, 115°50′E.

Triplectides flava Ulmer, 1908, in vol. 2, pp.29-30, *Die Fauna Südwest- Australiens;* ed. W. Michaelsen and R. Hartmeyer. Syntype, ♂, pinned, WAM 7087. Michaelson and Hartmeyer Expd.; col. 23-25.ix.1905; Station 131, Serpentine, W.A.; 32°22′S, 115°58′E.

Family Philopotamidae

Dolophilus michaelseni Ulmer, 1908, in vol. 2, pp. 36-37, *Die Fauna Südwest-Australiens;* ed. W. Michaelsen and R. Hartmeyer. Syntype, ♂, pinned, WAM 7088. Michaelsen and Hartmeyer Expd.; col. 7.x.1905; Station 139, Brunswick, W.A.; 33°15′S, 115°50′E.

ORDER LEPIDOPTERA

Family Pyralidae

Hednota koojanensis Koch, 1966, *J.R. Soc. West. Aust.* **49:** 110-111. Holotype, ♂, pinned, and genitalia on microscope slide, WAM 63-441 and 66-441a. L.E. Koch; col. 24.iii.1961; Koojan, W.A.; 30°48′S, 116°01′E.

Family Geometridae

Amelora fucosa Turner, 1919, *Proc. Linn. Soc. N.S.W.* **44:** 307-308. Holotype, ♂, pinned, WAM 7208. J. Burnside; reg. 20.iv.1913; Perth, W.A.; 31°57′S, 115°51′E.

Angelia melancroca Turner, 1919, *Proc. Linn. Soc. N.S.W.* **44:** 300. Holotype, ♂, pinned, WAM 7320. Burnside; reg. 28.v. 1913; Perth, W.A.; 31°57′S, 115°51′E.

Chlenias basichorda Turner, 1919, *Proc. Linn. Soc. N.S.W.* **44:** 403. Holotype, ♂, pinned, and genitalia on microscope slide, WAM 7433 and 7433a. W.B. Alexander; col. 17.vi.1913; Claremont, W.A.; 31°59′S, 115°47′E.

Chlenias macrochorda Turner, 1919, *Proc. Linn. Soc. N.S.W.* **44:** 403-404. Holotype, ♀, pinned, and genitalia on microscope slide, WAM 6318 and 6318a. W.B. Alexander; col. 26.iv.1912; Claremont, W.A.; 31°59′S, 115°47′E.

Family Notodontidae

Antimima cryptica Turner, 1917, *Proc. R. Soc. Qd* **29:** 73. Holotype, ♀, pinned, WAM 4729. A. Ventris; reg. 3.iv.1911; Quindalup, W.A.; 33°38′S, 115°09′E.

Discophlebia lipauges Turner, 1917, *Proc. R. Soc. Qd* **29:** 74. Holotype, ♂, pinned, WAM 7300. W.R.V. Wing; reg. 22.v.1913; Nannup, W.A.; 33°59′S, 115°45′E.

Pheraspis symmetra Turner, 1917, *Proc. R. Soc. Qd* **29:** 73-74. Holotype, ♂, pinned, WAM 7457. Thorpe; reg. 26.vi.1913; Derby, W.A.; 17°19′S, 123°38′E.

ORDER HYMENOPTERA

Family Anthophoridae

Allodapula occidentalis Michener and Syed, 1962, *J. ent. Soc. Qd* **1:** 41. Holotype, ♂, pinned, WAM 65-732. R.P. McMillan; col. 2.vii. 1958; Tambrey, W.A.; 21°38′S, 117°36′E.

Crocisa albifrons Rayment, 1931, *J.R. Soc. West. Aust.* **17:** 172-173. Holotype, ♀, pinned, WAM 29-883. L. Glauert; col. iv-v.1929; Landor Station, W.A.; 25°08′S, 116°54′E.

Exoneura pictifrons Alfken, 1907, in vol. 1, pp.260-261, *Die Fauna Südwest Australiens;* ed. W. Michaelsen and R. Hartmeyer. Syntypes, 2, pinned, WAM 4796 and 4797. Michaelsen and Hartmeyer Expd.; col. 21.ix.1905; Station 127-128. Mundijong, W.A.; 32°18′S, 115°59′E.

Thyreus sicarius Lieftinck, 1962, *Zool. Verh. Leiden* no. 53: 200-203. Holotype, ♀, pinned, WAM 64-39. A.M. Douglas; reg. 6.ii.1964. W.A. [Exact locality unknown.]

Family Colletidae

Brachyhesma (Brachyhesma) dedari Exley, 1968, *Aust. J. Zool.* **16:** 186-188. Holotype, ♂, pinned, WAM 54-736. A.M. Douglas; reg. 28.i.1954; between Karalee and Dedari, W.A.; between 31°16′S, 119°51′E and 31°05′S, 120°42′E.

Brachyhesma (Microhesma) dichaeta Michener, 1965, *Bull. Am. Mus. nat. Hist.* **130:** 287-288. Holotype, ♀, pinned, WAM 33-662. L. Glauert; col. 26.ii.-1.iii.1933; Rottnest I., W.A.; 32°00′S, 115°30′E.

Ctenocolletes ordensis Michener, 1965, *Bull. Am. Mus. nat. Hist.* **130:** 267-268. Holotype, ♂, pinned, WAM 65-728. A.M. Douglas; col. 3.x.1955; Wotjulum, W.A.; 16°07′S, 123°43′E.

Dasyhesma robusta Michener, 1965, *Bull. Am. Mus. nat. Hist.* **130:** 284-285. Holotype, ♀, pinned, WAM 54-127. A.M. Douglas; col. 6.i.1954; Pearce, W.A.; 31°40′S, 116°01′E.

Euryglossa inconspicua lutea Rayment, 1934, *J.R. Soc. West. Aust.* **20:** 204. Holotype, ♀, pinned (abdomen missing), WAM 32-563. L. Glauert; reg. 7.iii.1932; Rottnest I., W.A.; 32°00′S, 115°30′E.

Euryglossa (Euryglossa) calaina Exley, 1976, *Aust. J. Zool.* (Suppl.) no. **41:** 9-10. Holotype, ♀, pinned, WAM 54-1417. A.M. Douglas; col. 3.ii.1954; Cranbrook, W.A.; 34°18′S, 117°33′E.

Euryglossa (Xenohesma) clypearis Michener, 1965, *Bull. Am. Mus. nat. Hist.* **130:** 278. Holotype, ♀, pinned, WAM 44-559. L. Glauert; reg. 29.ix.1944; Broomehill, W.A.; 33°51′S, 117°38′E.

Euryglossa (Xenohesma) scutellaris Michener, 1965, *Bull. Am. Mus. nat. Hist.* **130:** 280-281. Holotype, ♀, pinned, WAM 31-1255. L. Glauert; col. 18.x.1931; Seabrook, W.A.; 31°40′S, 116°44′E.

Euryglossina (Euryglossina) douglasi Exley, 1968, *Aust. J. Zool.* **16:** 941-942. Holotype, ♀, carded, WAM 54-678. A.M. Douglas; reg. 28.i.1954; between Karalee and Dedari, W.A.; between 31°16′S, 119°51′E and 31°05′S, 120°42′E.

Euryglossina microdonta Rayment, 1934, *J.R. Soc. West. Aust.* **20:** 203. Holotype, ♀, carded, WAM 33-824. L. Glauert; col. 4-5.iii.1933; Rottnest I., W.A.; 32°00′S, 115°30′E.

Euryglossula carnarvonensis Exley, 1968, *Aust. J. Zool.* **16:** 204-206. Holotype, ♀, carded, WAM 67-1. A. Snell; col. 2.ix.1953; Carnarvon, W.A.; 24°53′S, 113°40′E.

Hesperocolletes douglasi Michener, 1965, *Bull. Am. Mus. nat. Hist.* **130:** 262-263. Holotype, ♂, pinned, WAM 38-2607. A.M. Douglas; col. 9-12.xi.1938; Rottnest I., W.A.; 32°00′S, 115°30′E.

Hylaeus (Hylaeteron) hemirhodus Michener, 1965, *Bull. Am. Mus. nat. Hist.* **130:** 294-295. Holotype, ♀, pinned, WAM 65-731. A.M. Douglas; col. 12.x.1955; Wotjulum, W.A.; 16°07′S, 123°43′E.

Hylaeus (Prospisteron) albozebratus Michener, 1965, *Bull. Am. Mus. nat. Hist.* **130:** 289-290. Holotype, ♂, pinned, WAM 65-729. A. Snell; col. 2.ix.1953; Carnarvon, W.A.; 24°53′S, 113°40′E.

Hylaeus (Prosopisteron) douglasi Michener, 1965, *Bull. Am. Mus. nat. Hist.* **130:** 290-291. Holotype, ♂, pinned, WAM 50-4447. A.M. Douglas; col. ix.1950?; Morawa, W.A.; 29°13′S, 116°00′E.

Hylaeus (Prosopisteron) simplex Michener, 1965, *Bull. Am. Mus. nat. Hist.* **130:** 291-292. Holotype, ♀, pinned, WAM 65-730. A.M. Douglas; col. 20.x.1947; Merredin, W.A.; 31°29′S, 118°16′E.

Leioproctus (Andrenopsis) douglasiellus Michener, 1965, *Bull. Am. Mus. nat. Hist.* **130:** 259-260. Holotype, ♀, pinned, WAM 54-128. A.M. Douglas; col. 1.i.1954; Pearce, W.A.; 31°40′S, 116°01′E.

Leioproctus (Baecolletes) calcaratus Michener, 1965, *Bull. Am. Mus. nat. Hist.* **130:** 257-258. Holotype, ♀, pinned, WAM 52-3071. A. Snell; reg. x.1952; Belele, W.A.; 26°22′S, 118°01′E.

Leioproctus (Colletopsis) contrarius Michener, 1965, *Bull. Am. Mus. nat. Hist.* **130:** 252. Holotype, ♀, pinned, WAM 54-55. A.M. Douglas; col. 31.xii.1953; Bullsbrook, W.A.; 31°40′S, 115°59′E.

Leioproctus (Glossurocolletes) xenoceratus Michener, 1965, *Bull. Am. Mus. nat. Hist.* **130:** 254-255. Holotype, ♂, pinned, WAM 65-725. P.N. Forte; col. 10.xi.1940; Capel, W.A.; 33°33′S, 115°33′E.

Leioproctus (Leioproctus) megachalcoides Michener, 1965, *Bull. Am. Mus. nat. Hist.* **130:** 246-247. Holotype, ♀, pinned, WAM 65-724. L.J. Newman; col. ix; Mullewa, W.A.; 28°32′S, 115°30′E.

Leioproctus (Urocolletes) rhodurus Michener, 1965, *Bull. Am. Mus. nat. Hist.* **130:** 253. Holotype, ♀, pinned, WAM 37-3797. A.M. Douglas; reg. 14.ii.1937; Midland, W.A.; 31°53′S, 116°00′E.

Melitribus glauerti Rayment, 1930, *Victorian Nat.* **47:** 3-9. Holotype, ♀, pinned, WAM 19-224. L.V. Nock; reg. 21.xi.1919; Yorkrakine, W.A.; 31°22′S, 117°35′E.

Meroglossa miranda Rayment, 1930, *Proc. R. Soc. Vict.* **43:** 45. Holotype, ♂, pinned, WAM 22-284. L. Glauert; reg. 24.vi.1922; Milly Milly Station, W.A.; 26°04′S, 116°41′E.

Neopasiphae simplicior Michener, 1965, *Bull. Am. Mus. nat. Hist.* **130:** 262. Holotype, ♂, pinned, WAM 65-726. R.P. McMillan; col. 16.x.1954; Cannington, W.A.; 32°01′S, 115°57′E.

Paracolletes submacrodontus Rayment, 1934, *J.R. Soc. West. Aust.* **20:** 206-207. Holotype, ♂, pinned, WAM 33-528. L. Glauert; col. 18-19.ii.1933; Rottnest I., W.A.; 32°00′S, 115°30′E.

Trichocolletes (Callocolletes) pulcherrimus Michener, 1965, *Bull. Am. Mus. nat. Hist.* **130:** 265-266. Holotype, ♂, pinned, WAM 65-727. col. 1.xi.1935; Narrogin, W.A.; 32°56′S, 117°11′E.

Turnerella glauerti Rayment, 1934, *J.R. Soc. West. Aust.* **20:** 202. Holotype, ♀, carded, WAM 33-816a. L. Glauert; col. 4-5.iii.1933; Rottnest I., W.A.; 32°00′S, 115°30′E.

Xanthesma nigrior Michener, 1965, *Bull. Am. Mus. nat. Hist.* **130**: 282-283. Holotype, ♂, pinned, WAM 54-564. A.M. Douglas; reg. 28.i.1954; between Karalee and Dedari, W.A.; between 31°16′S, 119°51′E and 31°05′S, 120°42′E.

Xanthesma parva Exley, 1969, *Aust. J. Zool.* **17**: 522-523. Holotype, ♀, carded, WAM 48-3082. A.M. Douglas; reg. xii.1948; Kukerin, W.A.; 33°12′S, 118°05′E.

Family Formicidae

Calomyrmex glauerti Clark, 1930, *Proc. R. Soc. Vict.* **42**: 125. Holotype, worker, carded, WAM 22-391. L. Glauert; col. 13.v. 1922; Milly Milly Station, W.A.; 26°04′S, 116°41′E.

Leptanilla swani Wheeler, 1932, *Psyche* **39**: 54-58. Syntypes, 3 workers, carded, WAM 32-1252 to 32-1254. W.M. Wheeler; reg. 9.vi.1932; Goyamin Pool, Chittering, W.A.; 31°28′S, 116°06′E.

Lithomyrmex glauerti Clark, 1927, *J.R. Soc. West. Aust.* **14**: 31-32. Syntypes, ♂, ♀, and 2 workers, carded, WAM 26-605a to 26-605d. L. Glauert; col. viii.1926; Irwin River, W.A.; 29°13′S, 115°05′E.

Myrmecia inquilina Douglas and Brown, 1959, *Insectes soc.* **6**: 13-16. Holotype, ♀, pinned, WAM 64-38. A.M. Douglas; col. 23.iii.1955; Badjanning Rocks, 4 miles [6 km] NW of Wagin, W.A.; 33°19′S, 117°20′E.

Rhytidoponera tyloxys Brown and Douglas, 1958, *Bull. Mus. comp. Zool. Harv.* **118**: 282-284. Holotype, worker, carded, WAM 64-37. K.G. Buller; col. vi.1952; Woodstock Station, W.A.; 21°37′S, 118°57′E.

Family Gasteruptiidae

Gasteruption mirabilifemorale Pasteels, 1957, *Mem. Inst. Sci. nat. Belg.* **56**: 76-77. Holotype, ♀, pinned, WAM 36-1052. A.M. Douglas; reg. 19.iii.1936; W. Midland, W.A.; 31°53′S, 116°00′E.

Gasteruption nigerrimum Pasteels, 1957, *Mem. Inst. Sci. nat. Belg.* **56**: 92. Holotype, ♀, pinned, WAM 53-366. R.P. McMillan; col. 16.i.1953; Cannington, W.A.; 32°01′S, 115°57′E.

Gasteruption subconicum Pasteels, 1957, *Mem. Inst. Sci. nat. Belg.* **56**: 44-46. Holotype, ♀, pinned, WAM 37-4519. A.M. Douglas; reg. xi-xii.1937; Narrogin, W.A.; 32°56′S, 117°11′E.

Family Halictidae

Halictus bremerensis Rayment, 1931, *J.R. Soc. West. Aust.* **17**: 171. Holotype, ♀, pinned, WAM 16-63. W.B. Alexander; col. i.1916; Bremer Bay, W.A.; 34°23′S, 119°23′E.

Family Ichneumonidae

Habronyx (Austranomalon) atropos Gauld, 1976, *Aust. J. Zool.* **24:** 622. Holotype, ♀, carded, WAM 78-602. L. Glauert; col. ix.1943; Wamenusking, W.A.; 32°07′S, 117°35′E.

Family Megachilidae

Megachile clypeata grandis Rayment, 1934, *J.R. Soc. West. Aust.* **20:** 209. Holotype, ♀, pinned, WAM 32-89. L. Glauert; reg. i.1932; Rottnest I. (near Government House Lake), W.A.; 32°00′S, 115°30′E.

Megachile rottnestensis Rayment, 1934, *J.R. Soc. West. Aust.* **20:** 209-210. Holotype, ♂, pinned, WAM 31-1856. L. Glauert; reg. xii.1931; Rottnest I. (Bathurst Point), W.A.; 31°59′S, 115°32′E.

Megachile subremotula Rayment, 1934, *J. R. Soc. West. Aust.* **20:** 210. Holotype, ♀, pinned, WAM 31-1846. L. Glauert; reg. xii.1931; Rottnest I. (Bathurst Point), W.A.; 31°59′S, 115°32′E.

Family Pergidae

Clarissa hebe Benson, 1963, *J.R. Soc. West. Aust.* **46:** 83-84. Holotype, ♀, pinned, WAM 64-7. A.M. Douglas; col. 29.vii.1958; Tambrey, W.A.; 21°38′S, 117°36′E.

Eurys aglaia Benson, 1963, *J.R. Soc. West. Aust.* **46:** 82-83. Holotype, ♀, pinned, WAM 64-6. A.M. Douglas; col. 5.ix.1962; Yanchep, W.A.; 31°33′S, 115°41′E.

Phylacteophaga eucalypti occidens Benson, 1963, *J.R. Soc. West. Aust.* **46:** 84. Holotype, ♀, pinned, WAM 64-8. A.M. Douglas; col. 20.ix.1962; Nollamara, W.A.; 31°57′S, 115°51′E.

Family Sphecidae

Bembix goyarra Evans and Matthews, 1973, *Mem. Am. ent. Inst.* no. 20: 84-85. Holotype, ♂, pinned, WAM 71-804. T. Moriarty; col. 1963; Kathleen Valley, W.A.; 27°24′S, 120°39′E.

Bembix mundurra Evans and Matthews, 1973, *Mem. Am. ent. Inst.* no. 20: 179-183. Holotype, ♂, pinned, WAM 73-644. H.E. Evans and R.W. Matthews; col. 1.x.1969; Mullewa, 6 miles [10 km] W of, W.A.; 28°32′S, 115°27′E.

Sericophorus occidentalis Rayment, 1955, *Mem. natn. Mus. Melb.* no. 19: 28-29. Holotype, ♀, pinned, WAM 37-3929. A.M. Douglas; reg. 3.xii.1937; Narrogin, W.A.; 32°56′S, 117°11′E.

CLASS ONYCHOPHORA

ORDER MALACOPODA

Family Peripatopsidae

Peripatoides woodwardi Bouvier, 1909, in vol. 2, p.315, *Die Fauna Südwest-Australiens;* ed. W. Michaelsen and R. Hartmeyer. Holotype, ♀, in alcohol, WAM 4424. Michaelsen and Hartmeyer Expd.; col. 22.v.-11.x.1905; Station 99, Lion Mill [= Mt Helena], W.A.; 31°53′S, 116°12′E.

CLASS PYCNOGONIDA

ORDER PANTOPODA

Family Ammotheidae

Ammothella biunguiculata australiensis Williams, 1940, *J. R. Soc. West. Aust.* **25:** 197-200. Lectotype [designated by Child, 1975, *Smithson. Contr. Zool.* no. 190: 26], ♀, in alcohol, and four microscope slides of parts, WAM 70-80 and 70-80a to 70-80d. L. Glauert; reg. 28.v.1970; Rottnest I. (Bathurst Point), W.A.; 31°59′S, 115°32′E.

Nymphopsis acinacispinatus bathursti Williams, 1940, *J. R. Soc. West. Aust.* **25:** 200-201. Lectotype [designated by Child, 1975, *Smithson. Contr. Zool.* no. 190: 26-27], ♂, in alcohol, WAM 70-160. L. Glauert; reg. 28.v.1970; Rottnest I. (Bathurst Point), W.A.; 31°59′S, 115°32′E.

Family Callipallenidae

Pallenopsis cidaribatus Child, 1975, *Smithson. Contr. Zool.* no. 190: 16-18. Holotype, ♂, in alcohol, WAM 70-3938. CSIRO Station; col. 5.x.1963; at 128-141 metres depth, W. of North West Cape, W.A.; 21°50′S, 113°46′E.

Pycnothea flynni Williams, 1940, *J. R. Soc. West. Aust.* **25:** 202-204. Holotype, ♂, in alcohol, and six microscope slides of parts, WAM 135-62 (= 78-595 and 78-595a to 78-595f). L. Glauert; reg. 24.viii.1970; Rottnest I. (Bathurst Point), W.A.; 31°59′S, 115°32′E.

Family Colossendeidae

Rhopalorhynchus dampieri Child, 1975, *Smithson. Contr. Zool.* no. 190: 8-10. Holotype, ♂, in alcohol, WAM 70-3953. CSIRO Station; col. 5.ii.1964; at 113-122 metres depth, W. of Lancelin I., W.A.; 31°05′S, 114°55′E.

Family Nymphonidae

Nymphon flindersi Child, 1975, *Smithson. Contr. Zool.* no. 190: 3-5. Holotype, ♀, in alcohol, WAM 73-76. L.M. Marsh and M.H. Shepherd; col. 8.iii.1972; at 17-33 metres depth, W. of Garden I., W.A.; 32°13′S, 115°33′E to 32°13′S, 115°31′E.

Nymphon rottnesti Child, 1975, *Smithson. Contr. Zool.* no. 190: 5-7. Holotype, ♀, in alcohol, WAM 70-3985. CSIRO Station; col. 12.x.1963; at 137-143 metres depth, W. of Rottnest I., W.A.; 32°00′S, 115°16′E.

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TAXONOMY OF *DENISONIA PUNCTATA* AND *DENISONIA FASCIATA* (SERPENTES: ELAPIDAE)

L.A. SMITH*

ABSTRACT

The two species of *Denisonia (sensu stricto)* in Western Australia, namely *Denisonia punctata* Boulenger and *D. fasciata* Rosén, are described and their distribution given.

INTRODUCTION

Until 1960 most students followed Boulenger (1896) in placing all Australian elapid snakes with smooth scales and undivided subcaudals (excluding *Rhinoplocephalus, Brachyaspis* and *Notechis*) in *Denisonia*. Worrell (1961a, 1961b and 1963) used dental, cranial and other morphological characters to describe the genera *Drepanodontis, Drysdalia, Unechis, Suta, Parasuta, Cryptophis* and *Austrelaps*, restricting *Denisonia* to four species: *maculata* (Steindachner) 1867, *punctata* Boulenger 1896, *devisi* Waite & Longman 1920, and *fasciata* Rosén 1905.

This paper describes the two species of *Denisonia (sensu stricto)* which occur in Western Australia.

The following descriptions are based on material from the Western Australian Museum, Northern Territory Museums and Art Galleries, Australian Museum, South Australian Museum, National Museum of Victoria and Queensland Museum. Registered numbers of these specimens are prefixed with WAM, NTM, AM, SAM, NMV and QM respectively.

SPECIES

Denisonia punctata Boulenger, 1896

Diagnosis

Distinguished from other *Denisonia* by having 15, rather than 17 rows of scales at midbody.

*Western Australian Museum, Francis Street, Perth Western Australia, 6000.

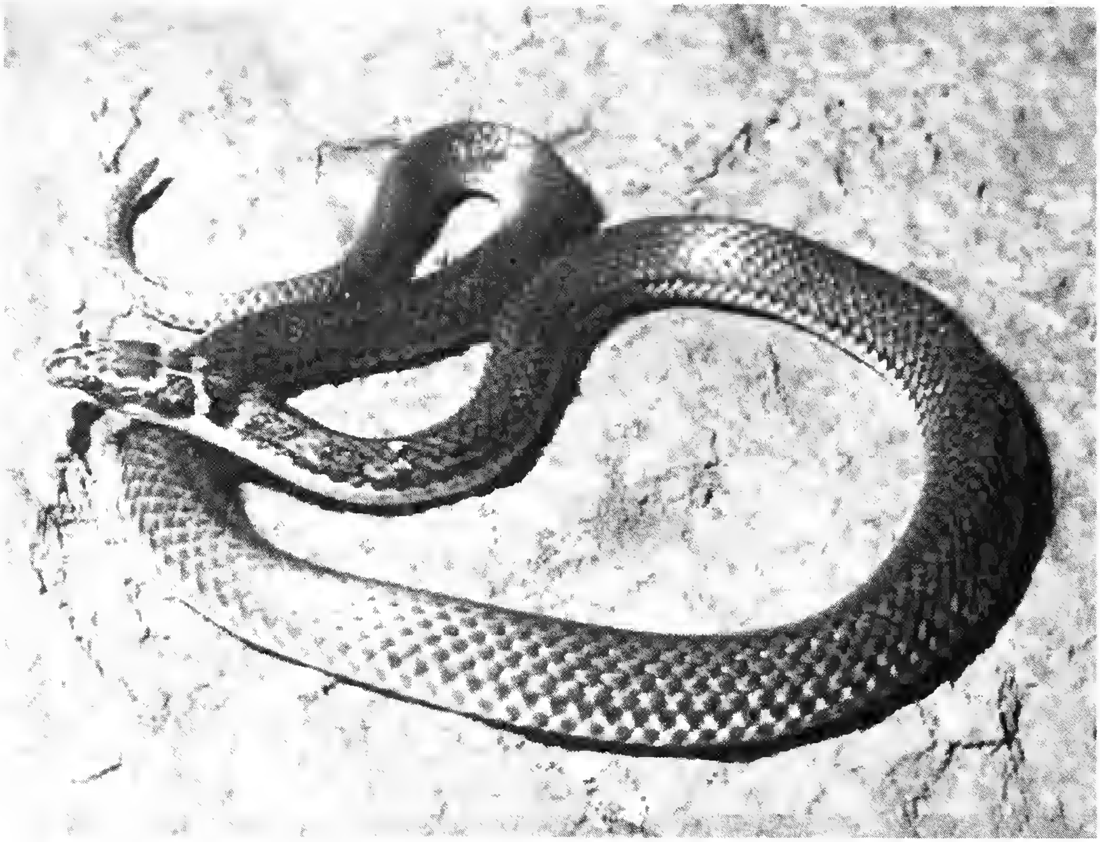

Plate 1: Photograph of specimen of *Denisonia punctata* from Coongan homestead, Western Australia.

Description

A small, moderately slender snake up to 523 mm (465 + 58). Tail 9.6-16.2% of SVL (N 32, mean 13.0). Head depressed; no canthus rostralis. Rostral about twice as wide as high, barely penetrating between internasals. Nasal entire, usually in contact with single preocular (84% of specimens). Frontal from slightly longer than wide to 1.3 times as long as wide and 1.5 to 3 times as wide as supraocular. Two subequal postoculars. Two anterior temporals, lower usually separated from postoculars (84% of specimens) and penetrating deeply between the fifth and sixth upper labial (touching lip both sides of one specimen). Two posterior temporals. Six upper labials, first smallest, last largest, third and fourth entering orbit. Usually 7 (rarely 6 or 8) lower labials, first 3, rarely 4, in contact with anterior chin shields.

Dorsals smooth, in 15 rows at midbody. Ventrals: 146-183 (N 69, mean 160.9). Anal entire. Subcaudals single, 23-42 (N 69, mean 31.5). Ventrals plus subcaudals: 174-213 (N 69, mean 191.7). Snout-vent length (mm): 125-523 (N 52, mean 323.2).

Ground colour pale buff, anterior part of each scale with a reddish brown smudge which can be very small or almost cover whole of scale. First and second rows of dorsals usually more heavily pigmented, forming zig-zag pattern on flanks, especially anteriorly. Vertebral stripe sometimes formed anteriorly by darkening of edges of scales in vertebral series. (One specimen had a series of dark blotches roughly aligned with vertebral column.) Most consistent of head markings are: dark streak from nasal, through lore, under eye to temporals; spot on rostral; spot on each of internasal-prefrontal sutures; spot on posterior of each supraocular; streak on periphery of each parietal, and a pair of nuchal blotches.

Variation

Considering its wide range this species shows surprisingly little variation. The average sum of ventrals plus subcaudals is highest in the Kimberley (195.7) and lowest in Queensland (182). The isolated population in the North-west Division of Western Australia averages 193.4. Two specimens had the nasal in contact with the preocular on one side but not the other.

Distribution

The population in the North-west Division of Western Australia from the Gascoyne River north to the De Grey River and east to Mount Newman is isolated from the Kimberley population which extends through the Northern Territory between about latitudes 14° and 23° south and into Queensland as far east as Longreach (see map). Type locality: Port Walcott, W.A.

Remarks

Cogger (1975, Fig. 165) and Gow (1975, Pl. 62) illustrate this species in colour.

The stomachs of three specimens were examined. One contained two *Diporiphora,* one a *Typhlina nigroterminata* and one a *Typhlina* sp. Another specimen was ingesting an *Amphibolurus isolepis.*

Material examined

Kimberley Division, (W.A.): WAM R53725 (King Edward River at 15°33'S, 126°09'E); AM R14935, NMV D8600 (Forrest River Mission); WAM R23810 (Kununurra); WAM R44824-29 (Lake Argyle); WAM R51644 (near Windjana Gorge); WAM R12957, 20347-48, 28094 (Derby); WAM R19989, 20356 (presumably Derby); WAM R34267 (5 km S of Derby); WAM R20355 (7 km E of Derby); SAM R3148 (junction of Fitzroy and Margaret Rivers); WAM R13959 (Fitzroy Crossing); WAM R44327 (Coulomb Point); WAM R32085 (Mt Anderson); WAM R26046 (Christmas Creek); WAM R32148 (St George Range, 18°39'S, 125°17'E).

North-west Division, (W.A.): WAM R11469 (Muccan); WAM R17080 (Boodarie); WAM 59711 (Coongan H.S.); WAM R29119-20 (Roebourne); WAM R21988, 41426 (Mardie); WAM R25196 (Mt Newman); WAM R34510 (Woodstock); WAM R36682 (White Springs, 112 km N of Wittenoom); WAM R12307 (Nullagine); WAM R10855 (Hooley Stn); WAM R5107 (De Grey Stn); NMV D5381 (Minilya Stn).

Eastern Division, (W.A.): R64705, 67567 (Balgo).

Northern Territory: NMV D8723, 10084 (Roper River Mission); NTM R2247 (179 km NW of Katherine); NTM R0219, 2274 (Katherine); NTM 2254 (5 km W of Katherine); NTM R0827 (25 km W of Katherine); NTM R0032, 0100, WAM R47685 (King River W of Katherine); NTM R1863 (13 km N of Larrimah); AM R55495 (80 km S of Borroloola); NTM R2340 (Victoria River Downs); NMV D8938, WAM R21510-12 (Tennant Creek); AM R51949 (Barrow Creek); AM R51950 (29 km S of Barrow Creek); SAM R14042 (35 km S of Barrow Creek); NTM R0446 (25 km N of Tea Tree); SAM R8168 (Yuendumu); NTM R1507-08 (2 km W of Rabbit Flat); NTM R1510 (13 km W of Rabbit Flat); NMV D7748 (Haasts Bluff).

Queensland: SAM R5754, 9364, QM J10325-26 (Doomagee Mission); NTM R1155, AM R46040 (Mt Isa); AM R49088 (Mt Isa District); QM J27516 (16 km W of Longreach).

Denisonia fasciata Rosén, 1905

Diagnosis

Distinguished from *D. punctata* by having 17, rather than 15 rows of scales at midbody, and from *D. devisi* and *D. maculata* of eastern Australia by having unbarred labials.

Description

A small, fairly thick-set snake up to 615 mm (542 + 73). Tail 9.0-15.5% of SVL (N 66, mean 11.7). Head depressed. No canthus rostralis.

Rostral about twice as wide as high, barely penetrating between internasals. Nasal entire, usually in contact with preocular (in 73% of specimens). Frontal slightly longer than to twice as long as wide and 1.5 to twice as wide as supraocular. Two subequal postoculars. Two anterior temporals, lower usually separated from postocular (61% of specimens) and penetrating deeply between fifth and sixth upper labials. Two posterior temporals. Six upper labials, first smallest, last largest, third and fourth entering orbit. Usually 7 (rarely 8) lower labials, first 3 or 4 in contact with anterior chin shields.

Dorsals smooth, in 17 (rarely 19) rows at midbody. Ventrals 144-182 (N 81, mean 160.2). Anal entire. Subcaudals single, 20-38 (N 86, mean 27.8).

Ventrals plus subcaudals: 177-220 (N 81, mean 187.1). Snout-vent length (mm): 147-542 (N 66, mean 321.4).

Ground colour of back buff with many ragged-edged reddish brown bands which are sometimes broken medially or on flanks to form blotches. Belly immaculate (sometimes a few dark streaks on chin shields). Head pale with a dark brown streak from rostral through eye to temporals. Head shields variably edged or blotched dark brown.

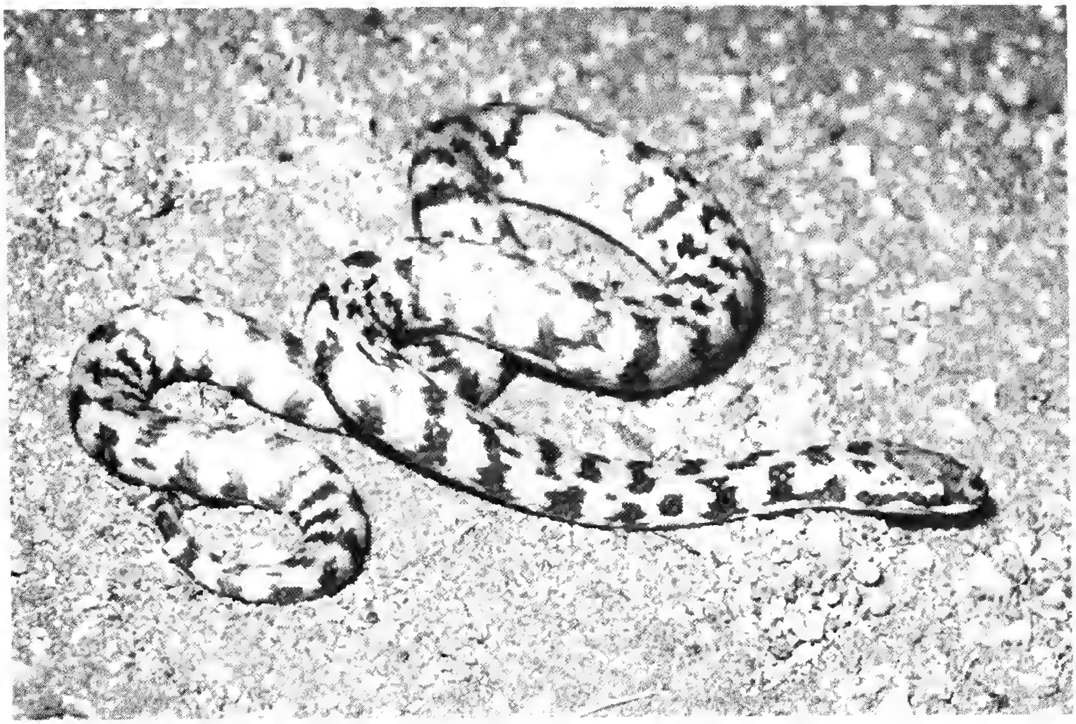

Plate 2: Photograph of specimen of *Denisonia fasciata* from Dairy Creek homestead.

Variation

One specimen had 19 rows of scales at midbody. Seven specimens had the nasal in contact with preocular on one side but not the other.

Distribution

Widely distributed through the North-west Division, the Eastern Division and drier parts of the South-west Division from Whim Creek south to Bendering and inland to the Rudall River, Weld Spring and Winduldarra Rockhole, Gibson Desert (see map). Type locality: "West Australia."

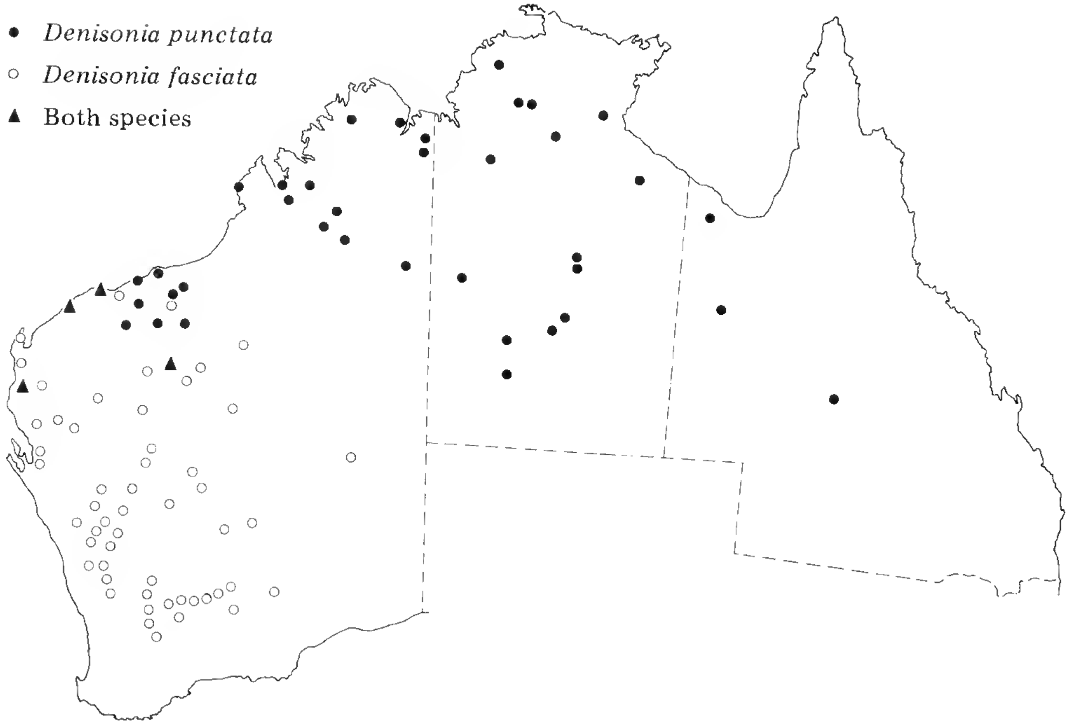

Fig. 1: Map showing location of specimens of *Denisonia punctata* and *Denisonia fasciata.*

Material examined (all Western Australian Museum)

Eastern Division: R40324 (Rudall River, 22°34′S, 122°13′E); R28092 (8 km N of Weld Spring), R26668 (40 km S of Wiluna); R11444 ("385 gauge via Wiluna"); R16904, R40521-22 (Kathleen Valley); R23848, R40520 (Yakabindie Stn); R48740 (Winduldarra Rockhole); R47375 (Sandstone); R1426, R22396 (Laverton); R13559, R55943 (Leonora); R5241 (Palmers Find); R10287, R5888, R23357 (Kalgoorlie); R45616 (160 km E of Kalgoorlie); R8811 (8 km E of Coolgardie); R19138 (Dedari); R6329 (13 km E of Karalee); R19880 (Yellowdine); R8952 (near Marvel Loch); R6338 (6 km E of Carrabin); R24044 (Widgiemooltha).

North-west Division: R31983 (2 km S of Whim Creek); R41568 (Roebourne); R14602 (Mardie); R538 (Marble Bar); R11493 (Learmonth District); R5042 (80 km from Learmonth); R31435 (Exmouth); R41233 (Rough Range); R13346 (Jiggalong); R28926-27, R31151 (Mount Newman); R17692 (Turee Creek Stn); R14058 (Wandagee Stn); R12281, R24164, R43457 (Mundiwindi); R22415 (32 km N of Minilya Stn); R10364-65 (Minilya Stn); R52871 (Mount Augustus); R22737 (Mulgul Stn); R36001 (Gascoyne Junction); R9299 (Ellavalla Stn); R51748 (Dairy Creek Stn); R47998 (Woodleigh Stn); R22416 (8 km N of Overlander); R42655-57 (presumably Karalundi Mission); R26792

(Meekatharra); R12292-93 (Meka Stn); R31526 (near Cue); R6458-60 (Day Dawn); R15069 (21 km W of Mt Magnet); R27373 (15 km N of Pindar); R5288, R5298 (Gullewa); R12249 (Rothsay); R15070 (24 km S of Yalgoo); R36116 (Tardie Stn); R22286 (5 km S of Thundelarra H.S.); R4760 (Gnows Nest mine, 40 km S of Yalgoo).

South-west Division: R394 (Mullewa); R20556 (32 km NE of Morowa); R9180, R8063 (Coorow); R26405, R27135, R41777 (Buntine); R43458 (Wubin); R6991 (Pithara); R42543 (Bonnie Rock); R6403 (Wongan Hills); R22426 Mukinbudin); R11754 (Merredin); R475 (Bruce Rock); R62503 (73 km S of Moorine Rocks); R52601 (8 km N of Bendering).

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I am grateful to G.E. Gow, Curator of Reptiles, Northern Territory Museums and Art Galleries, Darwin, Dr H.G. Cogger, Curator of Reptiles and Amphibians, Australian Museum, Sydney, Dr T.F. Houston, formerly Curator of Reptiles, South Australian Museum, Miss J. Covacevich, Curator of Reptiles, Queensland Museum and A.J. Coventry, Officer-in-Charge, Herpetology, National Museum, Victoria, for the loan of *Denisonia punctata* in their care. I also thank R.E. Johnstone and G. Harold, Western Australian Museum, for the loan of their photographs of *D. fasciata* and *D. punctata* respectively.

Dr G.M. Storr, Curator, Department of Ornithology and Herpetology, Western Australian Museum, read the manuscript.

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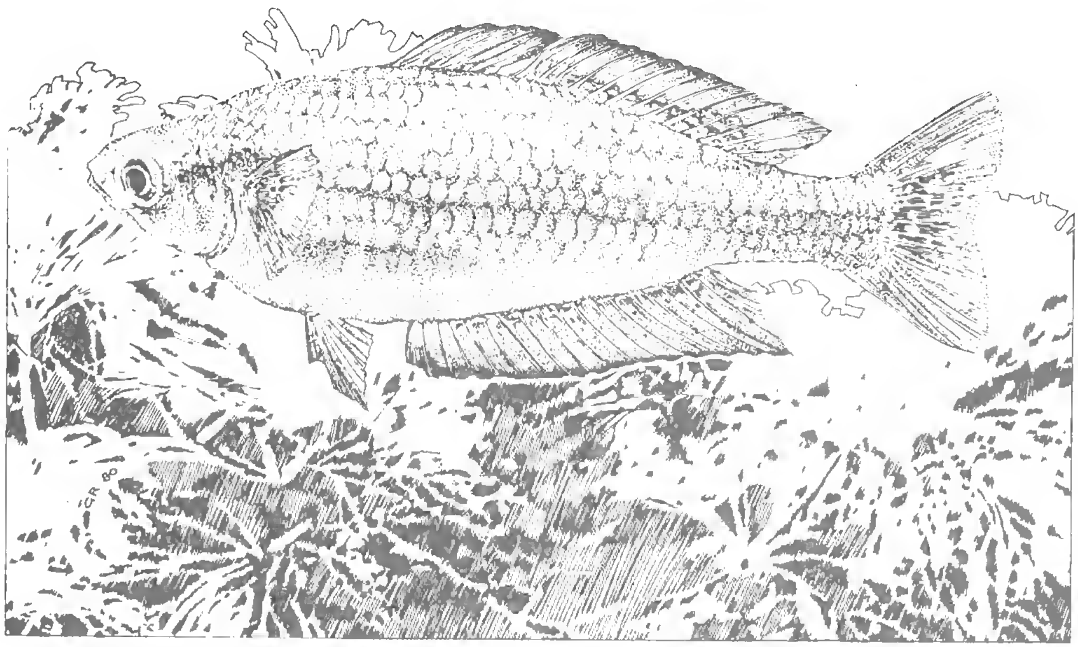

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RECORDS OF THE WESTERN AUSTRALIAN MUSEUM

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Cover: Australian Rainbowfish (*Melanotaenia splendida*), a common inhabitant of freshwater streams and lakes throughout northern Australia. Illustration by Gaye Roberts.

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THE MARINE AND ESTUARINE MOLLUSCS OF THE ALBANY AREA OF WESTERN AUSTRALIA

D. ROBERTS*
&
FRED E. WELLS**

INTRODUCTION

The State of Western Australia occupies the western third of the Australian continent and has a coastline of some 7 000 km. The marine and estuarine molluscs of the State are very poorly known. Only one attempt to summarize the entire molluscan fauna of the State has been made (Hedley 1916). References to the distribution in Western Australia of a number of species are recorded, where known, in most faunistic accounts of Australian molluscs (e.g. Cotton 1959, 1961, 1964; Allan 1950; MacPherson & Gabriel 1962; Wilson & Gillett 1971, 1979; Coleman 1975). Recently, molluscan faunas have been studied at points on the north coast (Wells in press) and the west coast (Chalmer, Hodgkin & Kendrick 1976; Wilson, Kendrick & Brearley 1978) but no similar studies have been made of the south coast of the state.

The marine fauna of Western Australia can be divided into two geographic zones (Wilson & Gillett 1971, 1979; Wells 1980). A tropical fauna on the north coast extends southward along the west coast and a warm temperate fauna extends northward. Thus the west coast fauna comprises an overlap mixture of southern temperate and northern tropical faunas. In addition, the overlap zone is characterized by species endemic to the area. The proportions of the three faunal components vary along the coast with tropical species predominant in the north and temperate species in the south. Of particular interest on the south coast, the Albany region may be regarded as the most important historical type locality for molluscs in the State. King George Sound was visited by the Astrolabe expedition in 1826. Quoy and Gaimard described a number of new species naming the Sound as the type locality (Quoy & Gaimard 1832-1835); Sir Joseph Verco visited the area early in this century and a number of species based on his collections were described by Cotton.

There is seldom an ideal time to publish a faunistic account for any region as new records are continually being documented. However, the importance of

* Queen's University, Belfast, Northern Ireland.
** Western Australian Museum, Francis Street, Perth, Western Australia 6000.

King George Sound as a type locality and the need for a contemporary account of the molluscs from the south coast of Western Australia prompted the authors to select the Albany region for this purpose. In addition, collections made by Western Australian Museum personnel from the south coast in recent years are predominantly from the Albany area, and provide a solid base for this preliminary faunistic account.

The Study Area

Albany is located on the south coast of Western Australia at 34°58′S and 117°57′E. The area has a mild climate with cool, wet winters and warm, dry summers. The mean maximum air temperature in July is 16.1°C and in February it is 23.4°C. Temperatures rarely exceed 35°C. The mean annual rainfall is 953.3 mm, 75% of which falls between May and October. The driest months are January and February (McKenzie 1962). Tidal range at Albany varies only 1.0 m during the year, from +0.2 m to +1.2 m (Anon 1978). The mean tidal range is 0.4 m. Tides are variable; most are semidiurnal, some are diurnal and occasionally the water remains static at the mid-tide level for several hours. Variations in barometric pressure may substantially alter predicted tidal levels (Hodgkin & DiLollo 1958).

Three marine embayments occur in the Albany area: Oyster Harbour, Princess Royal Harbour and King George Sound (**Fig. 1**).

Oyster Harbour is a shallow body of water, some 20 km^2 in area, which was formed by the drowning of the King and Kalgan Rivers systems during the Pleistocene. Both rivers still flow into the harbour with maximum flow during the winter and minimum flow in the summer. The only exchange with the sea is through a narrow channel at Emu Point which leads into King George Sound. In contrast to many other estuaries on the south coast the channel at the mouth of Oyster Harbour is kept constantly open by the scouring effect of water movement and the sand bar at the channel mouth never completely closes. McKenzie (1962) studied the geology of Oyster Harbour in detail. The lithotope of the harbour was found to be a composite of terrigenous and organogenic components. Most of the terrigenous sediment entering the harbour is brought in by the two rivers. The terrigenous fraction is well sorted medium-coarse to fine, silty sands. Organic carbonate is abundant throughout the harbour largely from the shells of molluscs which comprise over 90% of total animal biomass. Seagrass detritus is concentrated on the *Posidonia* slopes and in the deeper channels (McKenzie 1962).

Two zones were distinguished in Oyster Harbour by McKenzie (1962). He defined the upper harbour, which is most influenced by river flow and subject to large tidal effects, as brackish with salinities varying between 2.3‰ and 37.4‰. In contrast, the lower harbour has less tidal and salinity variation and was defined as marine. The annual range of water temperature at Emu Point in the marine zone is from 13-25°C. In addition to the brackish and

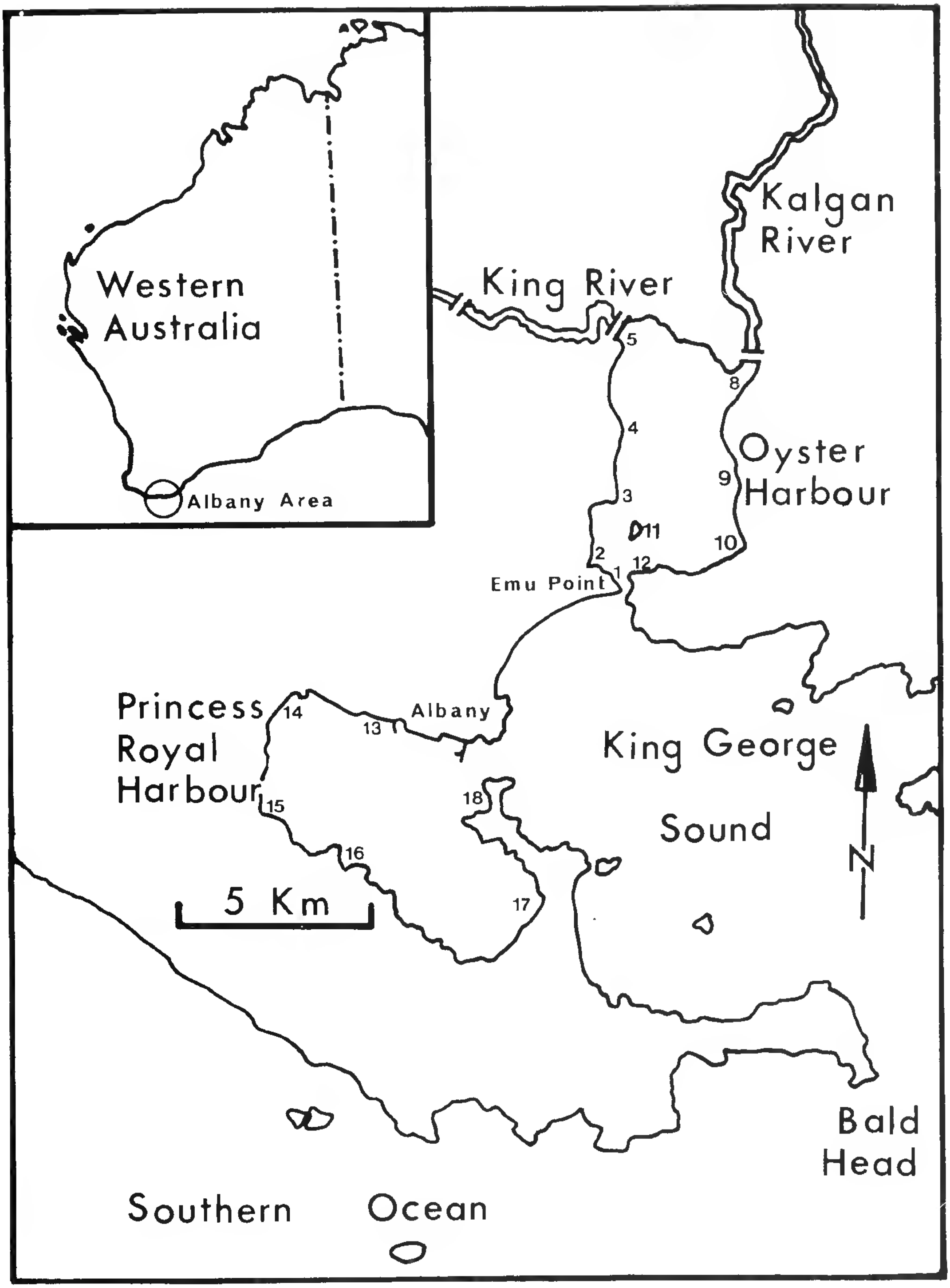

Figure 1. Map of the Albany area of Western Australia, showing the areas sampled in the surveys of Oyster Harbour and Princess Royal Harbour conducted in November and December, 1978.

marine zones McKenzie (1962) distinguished four habitats in Oyster Harbour: the littoral, which he considered to be from the high tide line to a depth of 0.5 m; sand banks, which occur down to 1.0 m; extensive *Posidonia* beds, on sublittoral slopes and deep channels which mark the former paths of the King and Kalgan rivers.

In contrast to Oyster Harbour, Princess Royal Harbour is poorly known. There are no rivers or streams leading into the harbour and fresh water input is from rainfall, runoff from adjacent land and groundwater seepage. Occupying an area of about 30 km^2 the harbour has a narrow channel at its eastern end which leads into the open ocean *via* King George Sound. The entrance channel and eastern end of the habour are subject to regular dredging to maintain a deep water channel to the port of Albany. Habitats within Princess Royal Harbour are more uniform than in Oyster Harbour. There are few areas of hard substrata apart from man-made structures such as piers and road bases. The harbour margins are gently sloping, sandy shores which give way subtidally to extensive *Posidonia* beds. The centre of the harbour has a mud bottom and seagrass is absent.

King George Sound lies between Oyster Harbour and Princess Royal Harbour and opens into the Southern Ocean. The Sound, which has an approximate area of 70 km^2, is protected from the full force of the open sea by Bald Head on its southern shore. The margins of King George Sound include granite rock and sandy shores. Subtidally, in areas where rock is absent, the bottom may be sand, mud or covered with seagrass.

METHODS

Two basic approaches were adopted to document the molluscan fauna of the Albany area: examination of existing museum collections, and additional collecting. The mollusc holdings of the Western Australian Museum were searched for material from the Albany region. In addition, the collections of the South Australian Museum were examined to confirm, where possible, records of species specifically mentioned by Cotton (1959, 1961, 1964) as occurring in the study area. Some of these records were confirmed but specimens could not be located for many species. However, since the records are in the published literature they are included in our list. McKenzie (1962) listed many mollusc species in Oyster Harbour but made no differentiation between living and fossil species. Since some of the species on McKenzie's (1962) list were based on fossil specimens (Hodgkin, pers. comm.) we have omitted these records. Additional collecting was carried out, primarily in littoral and shallow water areas, in the Albany region between September 1978 and June 1979. During November and December 1978, some dredging was carried out in the study area.

RESULTS AND DISCUSSION

Table 1 lists all species recorded to date specifically from the three study areas by previous workers and by ourselves; species recorded by previous workers, such as Cotton (1959, 1961, 1964), from south-western Australia but not specifically from Albany are not included. The heading 'Albany' includes species from adjacent areas such as the outer coast which have not been recorded in one of the three marine embayments and species recorded in the Museum collections from Albany without a specific area being indicated. Of the 318 species recorded to date there are 17 chitons, 189 gastropods, 107 bivalves, and 5 cephalopods. King George Sound is the type locality for 47 species: 9 chitons, 19 gastropods and 19 bivalves.

During November and December 1978, a detailed survey was made of the common molluscs at selected sites in Oyster Harbour and Princess Royal Harbour. Each site was visited and the intertidal and shallow subtidal molluscs were collected by hand. Species were assigned to semiquantitative cateogries of abundant, common and present. The localities of the sites are shown on **Fig. 1.**

The richest fauna in Oyster Harbour occurs at sites 1 and 2 which are just inside the harbour at Emu Point. This area was shown by McKenzie (1962) to be essentially marine in its faunal and water characteristics. Stations 1 and 2 are dominated by *Zeacumantus diemenensis, Batillariella estuarina, Salinator fragilis, Austrocochlea constricta, Hydrococcus graniformis, Katelysia scalarina,* and *Katelysia rhytiphora.* A detailed study of the molluscan community at site 2 has been made by Wells and Threlfall (in press). The fauna of stations 3 and 4 on the western side of Oyster Harbour is similar to that of stations 1 and 2, although densities appeared to be lower. *Posidonia* flats which characterise the subtidal areas of Oyster Harbour extend into the intertidal at stations 3 and 4. The eastern side of Oyster Harbour has the same mollusc species as the western side but the composition is somewhat different. *Salinator fragilis, Cominella tasmanica* and *Nassarius pauperatus* are all common on the western side of the harbour but are not as abundant on the eastern shore. The fauna at stations 5 and 8 at the mouths of the King and Kalgan Rivers respectively is impoverished. The dominant species in this area are *Bembicium melanostomum* and *Irus crenatus.* McKenzie (1962) reported that salinities at these two sites are essentially marine during most of the year. At the King River bridge the salinity varied from 31.7 to 37.3‰ during the entire year except for August when river flows were at their peak and the salinity declined to 2.3‰. A similar pattern occurred at the Kalgan River bridge. The minimum in August was 6.5‰. The only mollusc collected at both stations 6 and 7 in the rivers was *Xenostrobus pulex. Xenostrobus securis* and *Bembicium melanostomum* were collected at station 7 on the Kalgan River.

The bivalve *Pinna bicolor* was recorded in dense numbers in most areas of

Table 1. Mollusc species recorded from the Albany area. M=Marine, MA=Marine Affinity; E=Estuarine.

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
CLASS POLYPLACOPHORA							
Family Lepidopleuridae							
Terenochiton erratus Hull, 1923			X		END	M	Type: KGS
Family Ischnochitonidae							
Ischnochiton cariosus (Dall, 1878)				X	TEMP	M	
Ischnochiton contractus (Reeve, 1847)			X		TEMP	M	
Ischnochiton lineolatus (Blainville, 1825)			X		TEMP	M	
Ischnochiton torri (Iredale and May, 1916)			X		TEMP	M	
Ischnochiton virgatus exaggeratus (Iredale & Hull, 1924)			X		TEMP	M	= *Stenochiton longicymba historia* Iredale & Hull, 1924 Type: KGS
Stenochiton cymodocealis Ashby, 1918			X		TEMP	M	
Family Callistochitonidae							
Callistelasma meridionalis (Ashby, 1919)				X	TEMP	M	
Family Cryptochitonidae							
Acanthochiton subviridis Torr. 1911			X		TEMP	M	Type: KGS
Acanthochiton sueurii (Blainville, 1825)			X		TEMP	M	Type: KGS
Glyptelasma matthewsi occidentalis Iredale & Hull, 1925			X		TEMP	M	Type: KGS
Notoplax speciosa H. Adams, 1861				X	TEMP	M	
Family Cryptoplacidae							
Cryptoplax striata occidentalis Iredale & Hull, 1925		X	X		TEMP	M	Type: KGS
Family Chitonidae							
Clavarizona hirtosa (Blainville, 1825)	X	X	X		END	M	= *Chiton georgianus* Quoy & Gaimard 1835 and *Plaxiphora pustulosa* Torr. 1911 both Type: KGS
Rhyssoplax geraldtonensis Ashby, 1911				X	TEMP	M	
Rhyssoplax torrianus Hedley & Hull, 1911				X	TEMP	M	
Family Aulochitonidae							
Loricella paucipustulosa Hull, 1923			X		END	M	Type: KGS

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
CLASS GASTROPODA							
SUBCLASS PROSOBRANCHIA							
ORDER ARCHEOGASTROPODA							
Family Haliotidae							
Haliotis conicopora Peron, 1816			X		TEMP	M	
Haliotis laevigata Donovan, 1806			X		TEMP	M	Type: KGS
Haliotis roei Gray, 1827			X		TEMP	M	
Haliotis scalaris (Leach, 1814)			X		TEMP	M	
Family Fissurellidae							
Ambylchilepas javanicensis (Lamarck, 1822)				X	TEMP	M	
Ambylchilepas nigrita (Sowerby, 1835)				X	TEMP	M	
Macroschisma producta Adams, 1850			X		TEMP	M	
Notomella candida (A. Adams, 1852)			X		TEMP	M	
Scutus antipodes Montsort, 1810		X	X	X	TEMP	M	
Tugali cicatricosa A. Adams, 1851			X		TEMP	M	
Family Acmaeidae							
Acmaea alticostata (Angas, 1865)	X		X		TEMP	M	
Acmaea onychitis (Menke, 1843)	X		X		END	M	
Patelloida nigrosulcata (Reeve, 1855)			X		TEMP	M	
Family Patellidae							
Patella chapmani Tenison-Woods, 1876				X	TEMP	M	
Patella peroni Blainville, 1825		X	X		TEMP	M	Type: KGS
Patellanax laticostata (Blainville, 1825)	X	X	X		END	M	Type: KGS
Family Trochidae							
Bankivia octona (Tate, 1891)				X	TEMP	M	
Calliostoma australe (Broderip, 1835)				X	TEMP	M	
Calliostoma ciliaris (Menke, 1843)				X	END	M	
Calliostoma interrupta (Wood, 1828)				X	TEMP	M	
Cantharidus apicinus (Menke, 1843)				X	TEMP	M	
Cantharidus bellulus (Dunker, 1845)	X				TEMP	M	
Cantharidus eximus (Perry, 1811)				X	TEMP	M	
Cantharidus irisodontes (Quoy & Gaimard, 1834)	X	X	X		TEMP	MA	
Cantharidus lehmanni (Menke, 1843)	X		X		TEMP	M	
Cantharidus pulcherrimus (Wood, 1828)			X		TEMP	M	
Chloridiloma concamerata (Wood, 1828)		X			TEMP	M	

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Chloridiloma crinitus (Philippi, 1849)			X		END	M	
Clanculus consorbrinus (Tate, 1893)				X	TEMP	M	
Clanculus dunkeri (Koch, 1843)	X	X	X		TEMP	MA	
Clanculus maxillatus (Menke, 1843)				X	TEMP	M	Type: KGS
Clanculus personatus (Philippi, 1846)			X		TEMP	M	
Clanculus plebejus (Philippi, 1851)				X	TEMP	M	
Clanculus ringens (Menke, 1843)	X		X		TEMP	M	
Clanculus undatus (Lamarck, 1816)				X	TEMP	M	
Ethminolia vitiliginea (Menke, 1843)	X		X		TEMP	M	
Euchelus aspersa (Philippi, 1846)	X				TEMP	M	
Euchelus cf pumilio (Tate, 1893)				X	TEMP	M	
Gibbula lehmani (Menke, 1843)	X		X		TEMP	M	
Gibbula preissiana (Risso, 1826)				X	TEMP	M	
Monodonta constricta (Lamarck, 1822)	X	X			TEMP	MA	
Monodonta rudis (Gray, 1827)			X		TEMP	M	
Thalotia chlorostoma (Menke, 1843)			X		TEMP	M	
Thalotia conica (Gray, 1827)	X	X	X		TEMP	MA	
Family Stomatellidae							
Granata imbricata (Lamarck, 1822)	X	X	X		TEMP	M	
Stomatella auricula (Lamarck, 1816)	X	X	X		TEMP	M	Type: KGS
Family Turbinidae							
Astraea squamifera (Koch, 1844)	X	X	X		TEMP	M	
Elachorbis tatei (Angus, 1879)	X				TEMP	M	
Marmarostoma pulcher (Reeve, 1842)			X		END	M	
Ninella torquata (Gmelin, 1791)		X	X		TEMP	M	
Turbo jourdani (Kiener, 1839)			X		TEMP	M	
Family Phasianellidae							
Phasianella australis (Gmelin, 1791)		X	X		TEMP	M	
Phasianella ventricosa (Swainson, 1822)			X		TEMP	M	
Tricolia rosea (Angas, 1867)				X	TEMP	M	
Family Neritidae							
Nerita atramentosa (Reeve, 1855)	X	X	X		TEMP	M	
ORDER MESOGASTROPODA							
Family Littorinidae							
Bembicium auratum (Quoy & Gaimard, 1834)	X	X	X		TEMP	MA	
Bembicium melanostomum (Gmelin, 1791)	X	X	X		TEMP	MA	

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Littorina unifasciata (Gray, 1826)	X	X	X		TEMP	M	Type: KGS
Family Hydrococcidae							
Hydrococcus graniformis (Thiele, 1928)	X	X			TEMP	E	
Family Rissoidae							
Merelina cyrta (Cotton, 1944)			X		TEMP	M	Type: KGS
Family Rissoinidae							
Schwartziella fiscina (Cotton, 1952)			X		TEMP	M	Type: KGS
Family Architectonidae							
Philippia lutea (Lamarck, 1822)				X	TEMP	M	
Family Vermetidae							
Serpulorbis sipho (Lamarck, 1818)	X	X	X		TROP	MA	
Family Potamididae							
Batillaria turritella (Quoy & Gaimard, 1834)				X	TEMP	M	
Batillariella estuarina (Tate, 1893)	X	X			TEMP	E	
Velacumantus australis (Quoy & Gaimard, 1834)				X	TEMP	MA	
Zeacumantus diemenensis (Quoy & Gaimard, 1834)	X	X	X		TEMP	MA	
Family Diastomatidae							
Diastoma melanoides (Reeve, 1849)				X	TEMP	M	
Finella pupoides	X				TEMP	M	
Family Cerithiidae							
Alaba fragilis	X				TEMP	M	
Ataxocerithium serotinum (A. Adams, 1855)	X		X		TEMP	M	
Bittium granarium (Kiener, 1842)	X	X	X		TEMP	E	
Eubittium lawleyanum (Crosse, 1863)	X				TEMP	E	
Campanile symbolicum (Iredale, 1917)		X	X		END	M	
Diala lauta (A. Adams, 1862)	X	X	X		TEMP	MA	
Diala monile (A. Adams, 1862)	X				TEMP	M	
Diala translucida (Hedley, 1905)	X				TEMP	M	
Family Cerithiopsidae							
Specula regina (Cotton, 1951)			X		TEMP	M	Type: KGS
Family Triphoridae							
Notosinister pfeifferi (Cross & Fischer, 1865)				X	TEMP	M	

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Family Epitoniidae							
Epitonium australis (Lamarck, 1822)			X		TEMP	M	
Epitonium imperialis (Sowerby, 1844)				X	TROP	M	
Limascala rubrolineata (Sowerby, 1847)				X	TEMP	M	
Family Janthinidae							
Janthina exigua Lamarck, 1816			X		TROP	M	
Janthina janthina Linnaeus, 1758			X		TROP	M	
Janthina globosa Swainson, 1822			X		TROP	M	
Family Calyptraeidae							
Calyptraea calyptraeformis (Lamarck, 1822)	X				TEMP	M	
Crepidula immersa (Angas, 1865)	X		X		TEMP	M	
Family Hipponicidae							
Hipponix conicus (Schumacher, 1817)	X	X	X		TEMP	M	
Hipponix foliaceus (Quoy & Gaimard, 1834)				X	TROP	M	
Family Triviidae							
Ellatrivia merces (Iredale, 1924)		X	X		TEMP	M	
Family Cypraeidae							
Cypraea caputserpentis (Linnaeus, 1758)			X		TROP	M	
Cypraea comptoni (Gray, 1847)			X		TEMP	M	
Cypraea friendi (Gray, 1831)			X		TEMP	M	
Cypraea helvola (Linnaeus, 1758)			X		TROP	M	
Cypraea piperita (Gray, 1825)				X	TEMP	M	
Cypraea pulicaria (Reeve, 1846)				X	END	M	
Cypraea reevei (Sowerby, 1832)			X		TEMP	M	
Family Naticidae							
Eunaticina dingeldi (Iredale,)	X		X		TEMP	M	
Natica gualteriana (Recluz, 1844)			X		TROP	M	
Natica sagittata (Menke, 1843)	X				TEMP	M	
Polinices conicus (Lamarck, 1822)	X	X	X		TEMP	MA	
Sigaretotrema umbilicata (Quoy & Gaimard, 1833)	X				TEMP	M	
Sinum zonale (Quoy & Gaimard, 1832)	X	X	X		TEMP	MA	Type: KGS
Family Cassidae							
Cassis fimbriata (Quoy & Gaimard, 1833)		X	X		TEMP	M	
Phalium pauciruge (Menke, 1843)				X	TEMP	M	
Family Melanellidae							

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Eulima bilineata (H. & A. Adams, 1853)				X	TEMP	M	
Family Styliferidae							
Hypermastus georgiiregis (Cotton & Godfrey, 1932)			X		TEMP	M	Type: KGS
Family Cymatiidae							
Septa tabulata (Menke, 1843)	X	X	X		TEMP	M	
Cabestana waterhousei (Adams & Angas, 1864)	X	X	X		TEMP	MA	
Ranella australasia (Perry, 1811)			X		TEMP	M	
Turritriton labiosa (Wood, 1828)	X		X		TROP	M	
ORDER NEOGASTROPODA							
Family Muricidae							
Bedeva paivae (Crosse, 1864)	X	X	X		TEMP	MA	
Muricopsis planilirata (Reeve, 1845)			X		TEMP	M	
Pterynotus triformis (Reeve, 1845)	X	X	X		TEMP	M	
Typhis yatesi (Crosse, 1865)			X		TEMP	M	
Family Thaididae							
Cronia avellana (Reeve, 1846)			X		TEMP	M	
Dicathais orbita (Gmelin, 1791)	X	X	X		TEMP	M	= *D. aegrota* Reeve, 1846 Type: KGS
Lepsiella flindersi (Adams & Angas, 1864)	X	X	X		TEMP	M	
Lepsiella vinosa (Lamarck, 1822)	X	X	X		TEMP	M	
Family Columbellidae							
Dentimitrella lincolnensis (Menke, 1843)	X				TEMP	M	
Pyrene scripta forma *bidentata* (Menke, 1843)		X			TROP	M	
Zafra cf. *atkinsoni* (Tenison-Woods, 1876)				X	TEMP	M	
Family Buccinidae							
Cominella eburnea (Reeve, 1846)	X	X	X		TEMP	MA	
Cominella tasmanica (Tenison-Woods, 1879)	X	X	X		TEMP	MA	
Family Nassariidae							
Nassarius burchardi (Philippi, 1851)	X	X			TEMP	M	
Nassarius nigellus (Reeve, 1854)	X		X		TEMP	M	
Nassarius particeps (Hedley, 1915)	X		X		TEMP	M	
Nassarius pauperatus (Lamarck, 1822)	X	X			TEMP	MA	

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Nassarius pyrrhus (Menke, 1843)	X	X	X		TEMP	MA	
Nassarius rufulus (Kiener, 1834)				X	END	M	
Family Fasciolariidae							
Fusinus australis (Quoy & Gaimard, 1832)	X	X	X		TEMP	MA	
Fusinus tessellatus (Sowerby, 1830)				X	END	M	
Microcolus dunkeri (Jonas, 1846)	X				TEMP	M	
Family Olividae							
Amalda monilifera (Reeve, 1864)				X	TEMP	M	
Oliva australis (Duclos, 1835)			X		TEMP	M	
Family Marginellidae							
Marginella tridentata (Tate, 1878)				X	TEMP	M	
Family Mitridae							
Mitra australis (Swainson, 1820)			X		TEMP	M	
Mitra chalybeia (Reeve, 1844)				X	END	M	
Mitra glabra (Swainson, 1821)	X				TEMP	M	
Family Volutidae							
Amoria irvinae (Smith, 1909)				X	END	M	
Cottonia nodiplicata (Cox, 1910)				X	TEMP	M	
Ericusa fulgetrum (Sowerby, 1825)				X	TEMP	M	
Livonia roadnightae (McCoy, 1881)				X	TEMP	M	
Lyria mitraeformis (Lamarck, 1811)			X		TEMP	M	
Melo miltonis (Gray, 1834)			X	X	TEMP	M	
Family Cancellariidae							
Cancellaria spirata (Lamarck, 1822)			X		TEMP	M	
Sydaphera undulata (Sowerby, 1832)				X	TEMP	M	
Family Turridae							
Daphnella botanica (Hedley, 1918)			X		TEMP	M	
Guraleus vincentinus (Crosse & Fischer, 1865)			X		TEMP	M	
Kermia cf *periscelina* (Hedley, 1922)	X				TEMP	M	
Mitra guraleus australis (Adams & Angas, 1864)					TEMP	M	
Phenatoma harpularis (Desmoulins, 1842)					TEMP	M	Type: KGS
Splendrillia woodsi (Beddome, 1883)					TEMP	M	
Family Conidae							
Conus anenome (Lemarck, 1810)		X	X		TEMP	M	

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Conus cocceus (Reeve, 1844)				X	END	M	
Conus dorreensis (Linnaeus, 1758)		X	X		END	M	
Conus klemae (Cotton, 1942)			X		TEMP	M	
Conus rutilis (Menke, 1843)				X	TEMP	M	
Conus segravei (Gatliff, 1890)			X		TEMP	M	
SUBCLASS OPISTHOBRANCHIA							
ORDER BULLOMORPHA							
Retusa apiculata (Tate, 1879)			X		TEMP	M	Type: KGS
Ringiculadda australis (Hinds, 1844)				X	TEMP	M	
Bulla quoyii (Gray in Dieffenbach, 1843)	X	X	X		TROP	MA	
Liloa brevis (Quoy & Gaimard, 1833)	X		X		TEMP	M	
Adamnestia arachis (Quoy & Gaimard, 1833)	X		X		TEMP	M	Type: KGS
Acteocina fusiformis (A. Adams, 1854)	X				TEMP	M	Type: KGS
Akera bicincta (Quoy & Gaimard, 1833)			X		TEMP	M	Type: KGS
Akera soluta (Gmelin, 1791)	X				TEMP	M	
Philine angasi (Crosse & Fischer, 1865)	X	X	X		TEMP	M	
ORDER PYRAMIDELLOMORPHA							
Syrnola elliottae (Cotton & Godfrey, 1932)			X		TEMP	M	Type: KGS
Turbonilla acicularis (A. Adams, 1853)	X				TEMP	M	
Pyrgiscus fusca (A. Adams, 1853)	X				TEMP	M	
ORDER PLEUROBRANCHIOMORPHA							
Berthella mediatas (Burn, 1962)				X	TEMP	M	
Berthellina citrina (Ruppell & Leuckart, 1828)				X	TEMP	M	
ORDER SACOGLOSSA							
Elysia australis (Quoy & Gaimard, 1833)		X			TEMP	M	
ORDER APLYSIOMORPHA							
Aplysia dactylomela (Rang, 1828)			X		TEMP	M	
Aplysia sp.			X		TEMP	M	
Stylocheilus longicauda (Quoy & Gaimard, 1833)			X		TEMP	M	
ORDER NUDIBRANCHIA							
Ceratosoma brevicaudatum (Abraham, 1876)			X		TEMP	M	

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Chromodoris westraliensis (O'Donoghue, 1924)			X		TEMP	M	
Dendrodoris nigra (Stimpson, 1855)		X			TROP	M	
Doriopsilla carneola (Angas, 1864)				X	TEMP	M	
Doriopsilla miniata (Alder & Hancock, 1864)				X	TEMP	M	
Glaucus atlanticus (Forster, 1777)			X		TROP	M	
Madrella sanguinea (Angas, 1864)				X	TEMP	M	
Rostanga arbutus (Angas, 1864)				X	TEMP	M	
SUBCLASS PULMONATA							
Salinator fragilis (Lamarck, 1822)	X	X			TEMP	MA	
Siphonaria baconi (Reeve, 1856)	X		X		TEMP	M	
Siphonaria denticulata (Quoy & Gaimard, 1833)			X		TEMP	M	
CLASS CEPHALOPODA							
Hapalochlaena maculosa (Hoyle, 1883)			X		TEMP	M	
Octopus sp.			X		TEMP	M	
Sepia apama (Gray, 1849)			X		TEMP	M	
Sepia chirotrema (Berry, 1918)			X		TEMP	M	
Spirula spirula (Linnaeus, 1758)			X		TROP	M	
CLASS BIVALVIA							
ORDER NUCULOIDA							
Family Nuculidae							
Austronucula micans (Angas, 1878)			X		TEMP	M	
Family Nuculanidae							
Nuculana (Scaeoleda) verconis (Tate, 1891)			X		TEMP	M	
ORDER SOLEMYOIDA							
Family Solemyidae							
Solemya (Solemyarina) australis (Lamarck, 1818)	X		X		TEMP	M	Type: KGS
ORDER ARCOIDA							
Family Arcidae							
Barbatia pistachia (Lamarck, 1819)	X		X		TEMP	M	
Barbatia plicata (Dillwyn, 1817)				X	TEMP	M	

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Anadara trapezia (Deshayes, 1840)	X	X			TEMP	M	
Family Limopsidae							
Limopsis tenuiradiata (Cotton, 1930)			X		TEMP	M	
Family Glycymeridae							
Glycymeris radians (Lamarck, 1819)		X	X	X	TEMP	MA	
Glycymeris striatularis (Lamarck, 1819)			X	X	TEMP	M	
ORDER MYTILOIDA							
Family Mytilidae							
Mytilus edulis planulatus (Lamarck, 1819)	X	X	X	X	TEMP	MA	
Xenostrobus pulex (Lamarck, 1819)	X	X	X		TEMP	MA	Type: KGS
Xenostrobus inconstans (Dunker, 1856)	X	X			TEMP	E	
Xenostrobus securis (Lamarck, 1819)	X				TEMP	E	
Modiolus areolatus (Gould, 1850)			X		TEMP	M	
Modiolus albicostatus (Lamarck, 1819)	X	X	X		TEMP	MA	
Modiolus penetectus (Verco, 1907)			X		TEMP	M	
Brachidontes ustulatus (Lamarck, 1819)			X		END	M	
Brachidontes erosus (Lamarck, 1819)	X	X	X		TEMP	MA	
Musculus cumingianus (Reeve, 1857)	X		X		TEMP	M	
Lithophaga teres (Philippi, 1846)				X	TROP	M	
Septifer bioculoris (Linnaeus, 1758)				X	TROP	M	
Exosiperna scapha (Verco, 1908)			X		TEMP	M	
Exosiperna concava (Cotton, 1931)			X		TEMP	M	
Family Pinnidae							
Pinna bicolor (Gmelin, 1791)	X	X	X	X	TROP	MA	
Atrina (Servatrina) tasmanica (Tenison-Woods, 1876)			X		TEMP	M	
ORDER PTEROIDA							
Family Pteriidae							
Electroma georgiana (Quoy & Gaimard, 1835)	X		X		TEMP	M	Type: KGS
Pinctada fucata (Gould, 1850)		X			TROP	M	
Family Malleidae							
Malleus meridionalis (Cotton, 1930)		X	X		TEMP	M	
Vulsella spongarium (Lamarck, 1819)	X	X	X	X	ALL AUST	M	
Family Pectinidae							
Chlamys asperrimus (Lamarck, 1819)	X		X	X	TEMP	M	

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Chlamys aktinos (Pettard, 1886)				X	TEMP	M	
Chlamys famigerator (Iredale, 1925)				X	TEMP	M	
Chlamys australis (Sowerby, 1847)			X	X	TEMP	M	
Semipallium (Mesopeplum) anguineus (Finlay, 1927)			X	X	TEMP	M	
Chlamydella favus (Hedley, 1902)			X		TEMP	M	
Pecten modestus (Reeve, 1852)			X		END	M	
Pecten (Notovolva) alba (Tate, 1887)				X	END	M	
Amusium balloti (Bernardi, 1861)			X		END	ZM	
Family Spondylidae							
Spondylus tenellus (Reeve, 1856)			X	X	TEMP	M	
Family Limidae							
Lima nimbifer (Iredale, 1924)			X	X	TEMP	M	
Limaria orientalis (Adams & Reeve, 1848)	X		X		TEMP	M	
Family Ostreidae							
Ostrea angasi (Sowerby, 1871)	X	X	X	X	TEMP	MA	
Ostrea folium (Linnaeus, 1758)	X	X			TEMP	M	
Crassostrea australis (Lamarck, 1819)			X	X	TEMP	M	Type: KGS
ORDER TRIGONIOIDA							
Family Trigoniidae							
Neotrigonia bednalli (Verco, 1907)			X		TEMP	M	
Neotrigonia horia (Cotton, 1961)			X		TEMP	M	
ORDER VENEROIDA							
Family Lucinidae							
Callucina (Pseudolucinisca) lacteola (Tate, 1897)	X				TEMP	M	
Notomyrtea mayi (Gatliff & Gabriel, 1911)			X		TEMP	M	
Notomyrtea bractea (Hedley, 1911)			X		TEMP	M	
Divalucina cumingi (Admas & Angas, 1863)			X		TEMP	M	
Divaricella occidua (Cotton & Godfrey, 1938)			X		TEMP	M	
Montilora adelaideana (Cotton & Godfrey, 1938)			X		TEMP	M	
Montilora paupera (Tate, 1892)			X		TEMP	M	
Family Ungulinidae							
Felaniella globularis (Lamarck, 1819)		X	X		TEMP	M	Type: KGS

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Family Chamidae							
Chama ruderalis (Lamarck, 1819)	X			X	TEMP	M	
Family Leptonidae							
Myllita deshayesi (D'Orbigny & Recluz, 1850)				X	TEMP	M	
Myllita gemmata (Tate, 1879)			X		TEMP	M	
Family Lasaeidae							
Lasaea australis (Lamarck, 1818)		X	X		ALL AUST	M	Type: KGS
Mysella donaciformis (Angas, 1878)			X		TEMP	M	
Arthritica helmsii (Hedley, 1915)	X				END	MA	
Family Carditidae							
Megacardita incrassata (Sowerby, 1875)			X		END	M	
Venericardia amabilis (Deshayes, 1852)				X	TEMP	M	
Family Crassatellidae							
Eucrassatella decipiens (Reeve, 1842)		X	X		END	M	
Salaputium probleemum (Verco, 1907)			X		TEMP	M	
Family Cardiidae							
Fulvia tenuicostata (Lamarck, 1819)	X	X	X	X	TEMP	MA	
Acrosterigma cygnorum (Deshayes, 1854)				X	TEMP	M	
Hemidonax chapmani (Gatliff & Gabriel, 1923)				X	TEMP	M	
Family Mactridae							
Mactra australis (Lamarck, 1818)	X		X	X	TEMP	M	Type: KGS
Mactra pura (Deshayes, 1854)		X	X	X	TEMP	M	Type: KGS
Mactra (Mactroma) ovalina (Lamarck, 1818)	X	X		X	TROP	MA	
Mactra abbreviata (Linnaeus, 1818)		X			TEMP	M	
Spisula (Notospisula) trigonella (Lamarck, 1818)			X	X	ALL AUST	M	Type: KGS
Lutraria rhynchaena (Jonas, 1844)		X	X	X	TEMP	M	
Family Mesodesmatidae							
Taria angusta (Reeve, 1854)		X	X		TEMP	M	
Taria cuneata (Lamarck, 1818)	X	X		X	TEMP	M	
Family Solenidae							
Solen vaginoides (Lamarck, 1818)	X		X		TEMP	M	

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Family Tellinidae							
Tellina (Tellinota) albinella (Lamarck, 1818)		X		X	END	M	
Arcopagia (Pseudarcopagia) victoriae (Gatliff & Gabriel, 1914)			X	X	TEMP	M	Type: New Holland & KGS
Macomona mariae (Tenison-Woods, 1875)		X	X		TEMP	M	
Macomona deltoidalis (Lamarck, 1818)	X	X			TEMP	MA	
Family Donacidae							
Donax (Deltachion) electilis (Iredale, 1930)		X		X	TEMP	M	
Donax (Serrula) columbella (Lamarck, 1818)		X	X	X	END	M	Type: New Holland & KGS
Donacilla cuneata (Lamarck, 1818)		X			TEMP	M	
Family Psammobiidae							
Sanguinolaria (Psammotellina) biradiata (Wood, 1815)	X	X	X	X	TEMP	MA	
Gari alba (Lamarck, 1818)			X		TEMP	M	Type: KGS
Family Veneridae							
Circe scripta (Linnaeus, 1758)		X			TROP	M	
Circe sulcata (Gray, 1838)			X		TROP	M	
Callista (Costacallists) planatella (Lamarck 1818)			X	X	END	M	
Gomphina undulosa (Lamarck, 1818)			X	X	TEMP	M	Type: KGS
Paphia sulcosa (Philippi, 1844)		X			TROP	M	
Venerupis anomala (Lamarck, 1818)			X	X	TEMP	M	
Venerupis galactites (Lamarck, 1818)		X	X		TEMP	M	Type: KGS
Irus crenatus (Lamarck, 1818)	X	X		X	TEMP	MA	
Tawera lagopus (Lamarck, 1818)			X	X	TEMP	M	Type: KGS
Timoclea (Chioneryx) cardiodes (Lamarck, 1818)			X		TEMP	M	Type: KGS
Bassina disjecta (Perry, 1811)	X		X	X	TEMP	M	
Placamen placidum (Philippi, 1844)				X	TEMP	M	
Katelysia rhytiphora (Lamarck, 1818)	X	X	X	X	TEMP	MA	Type: KGS
Katelysia scalarina (Lamarck, 1818)	X	X	X	X	TEMP	MA	
Katelysia peroni (Lamarck, 1818)	X	X	X	X	TEMP	MA	Type: KGS
Family Petricolidae							
Petricola lucinalis (Lamarck, 1819)			X	X	TEMP	M	Type: KGS

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
ORDER MYOIDA							
Family Corbulidae							
Corbula iredalei (Cotton, 1930)	X				TEMP	M	
Family Gastrochaenidae							
Gastrochaena frondosa (Cotton, 1934)				X	TEMP	M	
Family Hiatellidae							
Hiatella australis (Lamarck, 1818)		X			TEMP	M	
Family Pholadidae							
Pholas australasiae (Sowerby, 1849)	X				ALL AUST	M	
ORDER PHOLADOMYOIDA							
Family Laternulidae							
Laternula creccina (Reeve, 1860)	X				TEMP	M	
Family Myochamidae							
Myadora triggi (Cotton & Godfrey, 1938)			X		TEMP	M	

Oyster Harbour. However, every shell examined was dead. The species was recorded by McKenzie (1962) in Oyster Harbour but no mention was made of whether or not living specimens were collected. Living individuals are common in Princess Royal Harbour. It seems likely that *Pinna bicolor* establish dense populations in Oyster Harbour during favourable periods but these may be wiped out in unfavourable conditions, such as periods of reduced salinity.

Princess Royal Harbour is characterised by soft substrata. The associations found on these substrata include intertidal and shallow-water communities dominated by bivalves of the genus *Katelysia,* the gastropods *Zeacumantus diemenensis, Batillariella estuarina, Nassarius pauperatus,* and *Austrocochlea constricta.* The intertidal community at station 15 at the western end of Princess Royal Harbour is described elsewhere (Wells & Roberts in press). The intertidal communities of sandy shores in Princess Harbour are similar to those found in Oyster Harbour but there are several differences worth mentioning. The densities of the gastropods *Salinator fragilis, Hydrococcus graniformis* and *Batillariella estuarina* are higher in Oyster Harbour than in Princess Royal Harbour. *Katelysia rhytiphora* and *K. peroni* are more common in Oyster Harbour and *K. scalarina* is more numerous in Princess Royal Harbour. The typically estuarine bivalves *Xenostrobus securis* and *X. inconstans* are restricted to Oyster Harbour, and do not occur in Princess Royal Harbour. Live oysters *(Ostrea angasi)* although not as common as they once were, are found in Oyster Harbour but are absent from Princess Royal Harbour. These differences between the harbours are largely the result of the greater fresh water influence in Oyster Harbour.

In both harbours the intertidal sandflats give way subtidally to beds of the seagrass *Posidonia.* The molluscan communities of the *Posidonia* flats have not been studied by us, but information on this in Oyster Harbour is contained in McKenzie (1962). The few hard substrata in Princess Royal Harbour have zoned communities characterised by a chiton *(Clavarizona hirtosa)* zone in the upper intertidal which grades into a zone dominated by the mussel *Mytilus edulis planulatus.* Associated with the chiton and mussel zones are the bivalves *Lasaea australis* and *Irus crenatus.* The major predatory gastropods in Princess Royal Harbour are *Dicathais orbita* in the intertidal and *Fusinus australis* subtidally.

King George Sound has the greatest habitat diversity in the study area. Habitats range from sheltered beaches to the more exposed shores of Frenchman's Bay. Substrata range from sand beaches to rock outcrops and boulders. The sheltered sandy areas of Middleton Beach support the seagrass *Posidonia* with large numbers of live *Pinna bicolor. Katelysia* is not present in number anywhere in King George Sound, but bivalves of the genera *Mactra* and *Glycymeris* are frequently washed up on the beach and are probably abundant subtidally. The more exposed sand beaches of Frenchman's Bay are characterised by the surf clams *Donax columbella* and *Taria angusta.* Rocks in the Sound are classically zoned with the littorinid *Littorina unifasciata* in the upper intertidal giving way to *Nerita atramentosa* in the lower intertidal. Limpets such as *Patella peroni* also occur in the lower intertidal. The intertidal of more exposed localities is covered by mats of *Xenostrobus pulex*. Haliotids, turbinids and trochids are common in the shallow subtidal area.

The molluscan fauna of the Albany area clearly belongs to the warm temperate category, with 88.5% of the species belonging to this grouping. Nineteen species were classified as tropical. While the classification of species as either warm temperate or tropical is useful in discussing distributions it is not an all or none phenomenon. This is particularly true for the neustonic species of *Janthina* and *Glaucus atlanticus*. Wells (1980) has shown that there is a gradual decline in the number of tropical species at points progressively farther south on the west coast. Some species which occur in tropical areas over most of their ranges are able to survive the colder water temperatures of the more southerly localities. While the fauna of southern Australia is largely distinct from that of the tropical north a number of tropical species have been recorded on the south coast. Cotton (1959) for example reported 10 species of euthecosomatous pteropods and six of *Janthina* from the waters of the southern shores of the continent; all of these are generally regarded as being tropical and are easily dispersed by currents. Burn (1966) discussed the zoogeography of 39 species with tropical or tropical/warm temperate distributions.

The west coast of Western Australia is an area of overlap between the tropical fauna of the north coast and the warm temperate fauna of the south coast (Wilson & Gillett 1971, 1979; Wells 1980). Most of the species endemic to the state occur in the overlap zone. Wells (1980) found that 8.6% of the prosobranch gastropods examined are endemic, and 29 of the 38 endemic species he studied have at least part of their distributions on the west coast. Wilson, Kendrick and Brearley (1978) studied the prosobranch gastropod and bivalve molluscs of Cockburn Sound on the west coast in detail. Of the 255 species examined, 14% are endemic to Western Australia. In contrast to these figures for the west coast, the south coast of Albany has a lower rate of endemicity, 8.0%.

Chalmer, Hodgkin & Kendrick (1976) examined the molluscs of the Swan River estuary, dividing them into four groupings based on a subjective assessment of their salinity tolerances. Marine species were defined as those with a marine distribution and only a temporary or sporadic estuarine representation. Species of marine affinity are those marine species which also have a more or less continuous estuarine representation. Estuarine species have no marine freshwater representation. Freshwater species are not found in the marine environment and have only limited estuarine distributions. Application of these subjective categories to the data for the Albany area resulted in **Table 2,** which also includes the comparable information for the Swan River estuary. The comparison illustrates a similarity in the faunal components of

Table 2. Environmental affinities of molluscs from the Albany area compared with those from the Swan River Estuary.

Affinity	* Swan River Estuary	Oyster Harbour		Princess Royal Harbour		King George Sound		Albany	
	%	No. Species	%	No. Species	%	No. Species	%	No. Species	%
Marine	66	70	64.2	54	60.0	169	86.2	277	87.0
Marine Affinity	26	33	30.3	32	35.5	26	13.3	35	11.3
Estuarine	7	6	5.5	4	4.5	1	0.5	6	1.7
Freshwater	1	0	0	0	0	0	0	0	0
Total	100.0	109	100.0	90	100.0	196	100.0	318	100.0

* After Chalmer, Hodgkin & Kendrick (1976)

the Swan estuary and Oyster Harbour, both of which have major fresh water inputs. It also illustrates the predominantly marine components of the King George Sound malacofauna. Interesting features to emerge from the comparison are the relative proportions of the different faunal components of Princess Royal Harbour. Although having a similar proportion of estuarine forms as Oyster Harbour, Princess Royal Harbour has a higher proportion of species falling into the marine affinity category and a lower proportion of marine forms than Oyster Harbour (**Table 2**). This is despite the fact that Princess Royal Harbour receives no large rivers as does Oyster Harbour and suggests a greater fresh water input than is apparent. In addition, an intertidal sandflat on the Oyster Harbour side of Emu Point (the boundary between King George Sound and Oyster Harbour) has many predominantly marine species which have not been reported at other points in the harbour; the water in this area is essentially marine throughout the year (McKenzie 1962). By contrast, the entrance to Princess Royal Harbour, where one would expect greatest marine influences, is subject to human disturbance in the form of dredging which might result in an impoverishment of the marine faunal component in this area. The analysis for 'Albany' is included in **Table 2** for completeness, but cannot be considered comparatively as it includes species from unspecified localities within the study area.

The molluscan fauna of the three embayments in the Albany area is largely marine. Of the 318 species recorded in this study, 312 (98%) are either marine or marine affinity. King George Sound is the most diverse with 196 species recorded. Of these, 195 are marine or marine affinity and only a single species is classified as estuarine. The molluscan faunas of both Oyster Harbour and Princess Royal Harbour are not as rich as that of King George Sound and many marine species occurring in the Sound are absent from the harbours. While there are a few estuarine species which live in the harbours and not in the Sound, these are not enough to offset the absence of marine species.

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HERPETOFAUNA OF THE ZUYTDORP COAST AND HINTERLAND, WESTERN AUSTRALIA

G.M. STORR*
&
G. HAROLD**

ABSTRACT

The area dealt with lies on the west coast of Western Australia between Shark Bay and the Murchison River. 39 genera and 83 species of frogs and reptiles are listed with brief notes on their local distribution, relative abundance and habitat preferences.

INTRODUCTION

The study area is located on the west coast of Western Australia between latitude 26°30' and 27°45'S. It is bounded in the north by the Overlander-Tamala road, in the east by the North-west Coastal Highway, and in the south by the Murchison River (but excluding the Kalbarri National Park, the herpetofauna of which is being studied by L.A. Smith of the Western Australian Museum). The herpetofauna of the country to its immediate north, i.e. the Shark Bay region, was described by Storr & Harold (1978), and that to the immediate east by the Department of Fisheries and Wildlife (Burbidge *et al.*, 1980). This paper thus forms one of a series of reports on the herpetofauna of the west coast of Western Australia; other reports include Storr & Hanlon (1980), Dell & Chapman (1977), and Storr, Harold & Barron (1978).

The present region is largely a rolling plateau about 200 m above sea-level that straddles the boundary between the arid and semi-arid climatic zones. Apart from the Murchison River in the very south of our area, the region is divisible into three north-south zones which to a large extent are continuations of those in our Shark Bay paper.

Western zone

This zone comprises the coast (here almost wholly occupied by the

* Western Australian Museum, Francis Street, Perth, Western Australia 6000.
** 204 Hamersley Road, Subiaco, Western Australia 6008.

Zuytdorp Cliffs) and the adjoining country inland for about 10 km. Mean annual rainfall ranges from 32 cm in the north to 40 cm in the south, nearly all of it falling between May and August. Almost everywhere the soil is sandy and varies in colour from white to grey and pale brown. Shallow soils, especially near the coast, are vegetated mainly with coastal heath and *Melaleuca* thickets. Deeper and more sheltered soils carry thickets of *Acacia rostellifera.*

Central zone

This zone is bounded in the west by the inland limit of coastal limestone, and in the east by the 'mulga-eucalypt' line. Annual rainfall ranges from 25-30 cm in the north to 30-35 cm in the south. For the most part the country consists of red, brown and yellow sandplains and sandridges. The vegetation is a highly varied assemblage of shrubs and low trees. In the north the soils are mostly reddish and the vegetation mainly a scrub of *Acacia*, *Eucalyptus*, *Banksia*, *Melaleuca*, *Hakea* and *Grevillea* spp, broken by patches of soft spinifex (*Plectrachne*). In the south the sands tend to be more yellowish and the scrub denser; the conifer *Actinostrobus arenarius* is common here. In the south-east there are extensive tracts of red loam carrying woodlands of York Gum (*Eucalyptus loxophleba*); the southernmost part of this country constitutes the extreme north of the wheat belt.

Eastern zone

This occupies the north-east of our area. It mainly consists of red-soil plains. Annual rainfall is 20-25 cm, with somewhat more in summer and autumn than the country to the west and south. The prevailing vegetation is *Acacia* scrub (known locally as bowgada); it is more open in the north where the soil is heavier and shallower over the limestone. West and north-west of Coburn HS there is a small area of hard spinifex (*Triodia*) and scattered eucalypts growing on reddish sandplains; it is notable for an isolated population of *Amphibolurus isolepis.*

Murchison River

This (the only watercourse in the area) and its narrow valley provide additional habitats. First there are the permanent river-pools and springs that afford a home for freshwater turtles and frogs. Then there are the fringing forests of *Eucalyptus camaldulensis* and *Casuarina obesa.* Finally there are the canyons and lateral gullies of the river; these sandstone cliffs and slopes constitute the only rocky habitats in the region apart from the Zuytdorp Cliffs. However most of the Murchison Gorge lies in the Kalbarri National Park and thus outside our area.

For detailed accounts of the climate, physiography, soils and vegetation of

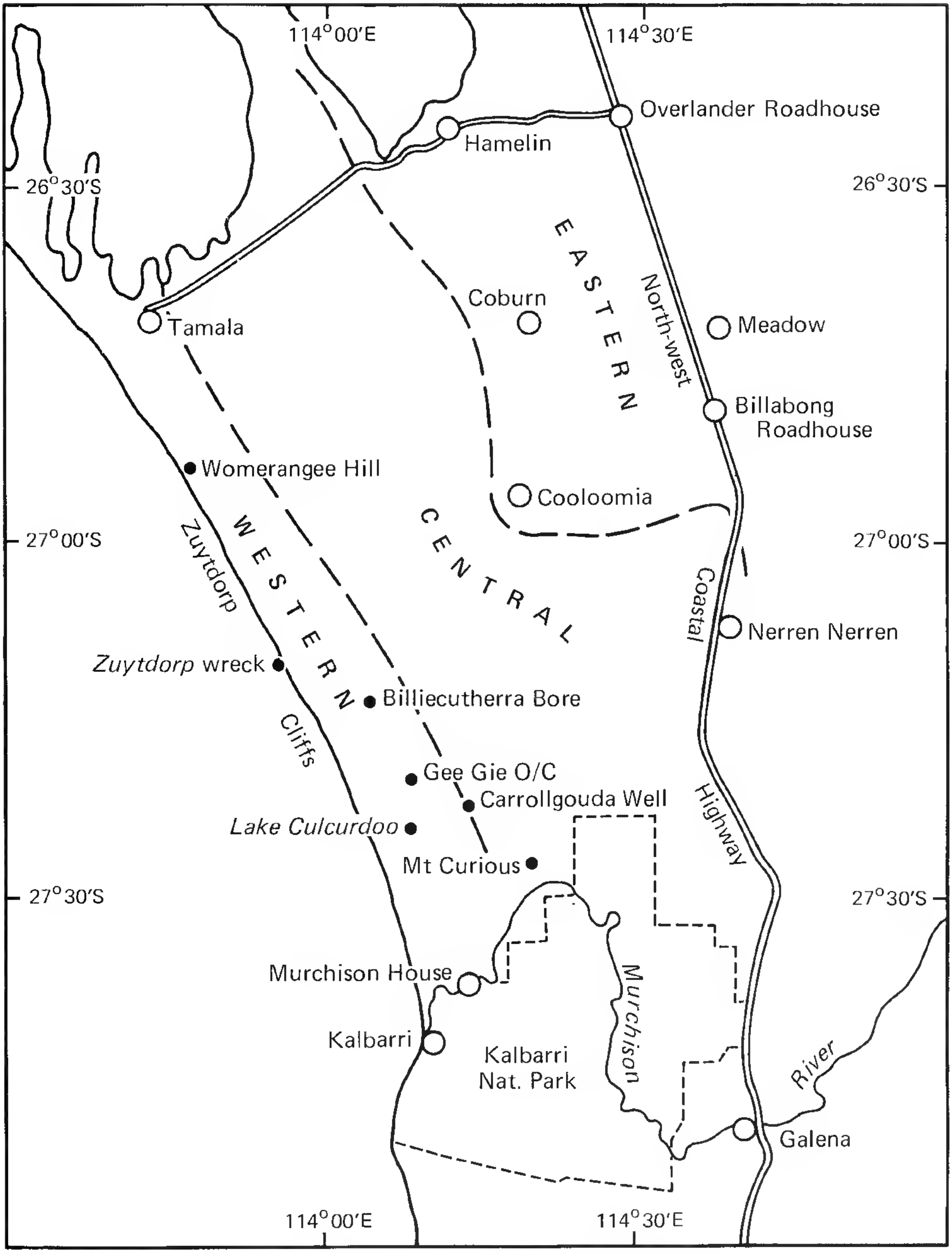

Fig. 1: Map of Zuytdorp region, Western Australia.

the region see Beard (1976). Our western zone roughly corresponds to Dr Beard's Zuytdorp System (p. 99), our central zone to his Tamala and Eurardy Systems (pp. 102-7), and our eastern zone to his Toolonga Plateau (p. 88).

Exploration

Collecting began in the late 1950s and early 1960s, mainly in the periphery of the region, i.e. along the Murchison River, the North-west Coastal Highway and the road from Overlander to Denham. In December 1963 G.M. Storr briefly visited the country between Murchison House and Tamala. A larger collection was made by the Hale School Expedition (led by R.B. Humphries) in the country north of Murchison House (Carrollgouda Well, Gee Gie Outcamp and Culcurdoo Lake) in late November and early December 1968. In January-February 1969 a Western Australian Museum party under the leadership of J.L. Bannister carried out a biological survey of the Kalbarri National Park, during the course of which some collecting was done in our area — at Billiecuthera Bore, near the *Zuytdorp* wreck, around Mt Curious, and along the Murchison downstream from Murchison House.

From 19 to 29 July 1979 G. Harold and D. Knowles worked the country around Coburn and Cooloomia homesteads, south-west of Billabong Roadhouse, south-west of Nerren Nerren, north-east and south of Tamala, and north of Murchison House. This work was partly financed by a grant to the Western Australian Museum by Mr and Mrs W.H. Butler.

In mid-September 1979 J.K. Rolfe and P.J. Fuller of the Fisheries and Wildlife Department collected in the country west of Cooloomia; they made smaller collections south-east of Womerangee Hill and north of Lake Culcurdoo. Later in the same month T.M.S. Hanlon and G. Harold collected in the northern part of the area.

Other people whose specimens have contributed to this report are G. Barron, A. Baynes, G. Bostock, D. Bradshaw, M.G. Brooker, A.A. Burbidge, W.H. Butler, B.T. Clay, M. DeGraaf, A.M. Douglas, J.R. Ford, G.W. Kendrick, J. Kirsch, N. Kolichis, G. Kontoolas, A.K. Lee, A.R. Main, Z. Oxenham, M. Peterson, R.L. Pink, W.D.L. Ride, R. Simmons and W.K. Youngson.

All specimens cited in this paper are lodged in the Western Australian Museum.

ANNOTATED LIST

Leptodactylidae

Arenophryne rotunda Tyler

Recorded from only a small part of the central zone. On the evenings of 17, 19 and 20 September 1979 J.K. Rolfe and P.J. Fuller pit-trapped 35 specimens on red sandplains 17 and 23 km WSW of Cooloomia HS; 17 of the specimens were released. At 1230 hr on 20 September they collected one that walked into their camp on a red sandplain 20 km WSW of Cooloomia; it was evidently attracted by the camp fire.

These records are the first inland from white coastal dunes.

Heleioporus albopunctatus Gray

A frog (35016) and egg-mass (35019) in the Western Australian Museum are labelled 'Murchison River'; they were collected on 6 September 1954 by A.R. Main and A.K. Lee, presumably within our area.

Limnodynastes dorsalis (Gray)

Occurring on the lower Murchison from its mouth upstream to at least Lockwood Spring.

Neobatrachus pelobatoides (Werner)

Restricted to the southern third of the area. In the evening of 19 July 1979 G. Harold and D. Knowles found one (64445) feeding in *Hakea* scrub on reddish soil 31 km SW of Nerren Nerren. On 29 November 1968 a Hale School party collected two larvae (34051-2) at Culcurdoo Lake believed to belong to this species.

Neobatrachus sutor Main

One record: a specimen (21316) found by G.M. Storr in the evening of 14 May 1963; it was feeding above the floodline of the Murchison at Galena.

Pseudophryne guentheri Boulenger

Confined to the south-west of the area (specimens from Culcurdoo Lake and the lower Murchison).

Ranidella pseudinsignifera (Main)

Calls heard by G.M. Storr on the Murchison at Galena during the evening of 14 May 1963 were attributed to this species. This frog is plentiful further down the river (upstream to at least Lockwood Spring).

Cheluidae

Chelodina steindachneri Siebenrock

On three separate occasions collected along the Murchison at Galena.

Gekkonidae

Crenadactylus ocellatus horni (Lucas & Frost)

Northern half of central zone. Moderately common. In soft spinifex (*Plectrachnc*) on reddish and yellowish sandplains.

Diplodactylus alboguttatus Werner

Central zone. Moderately common. Reddish and yellowish sandplains carrying mixed scrubs (*Acacia*, *Eucalyptus*, *Hakea*, *Banksia*, *Melaleuca*, *Grevillea*, *Xylomelum* etc.) and heaths (*Thryptomene*, sedges etc.).

Diplodactylus michaelseni Werner

Northern half of central zone. Scarce. In soft spinifex (*Plectrachne*) and sedges on reddish and brownish sandplains.

Diplodactylus ornatus Gray

Western parts of central zone. Scarce. Reddish and yellowish sandplains.

Diplodactylus pulcher (Steindachner)

Eastern zone and eastern parts of central zone. Moderately common on a wide variety of soil types.

Diplodactylus spinigerus Gray

Western zone and southern part of central zone. Uncommon. Yellow-eyed form.

Diplodactylus squarrosus Kluge

Eastern zone south to Billabong Roadhouse. Uncommon. Red loams and clays with open *Acacia* scrub.

Diplodactylus strophurus (Duméril & Bibron)

Central zone. Uncommon. Open scrubs on reddish sandy soils. Specimens from this area (e.g. 21837-43 and 64298) are somewhat spinier than from elsewhere and have the caudal rings white rather than golden yellow.

Gehyra variegata (Duméril & Bibron)

Very common throughout the area in a wide variety of trees and tall shrubs.

Heteronotia binoei (Gray)

Common in western and central zones but only recorded from far south of eastern zone.

Nephrurus levis occidentalis Storr

Central zone (where moderately common) and eastern parts of western zone (where scarce). Reddish and yellowish sandplains.

Phyllurus milii Bory

Western zone. Moderately common. Mainly in coastal limestone.

Rhynchoedura ornata Gunther

One record from extreme north of eastern zone: a specimen (44525) collected at Overlander. [Three specimens have been collected just east of our area at 27 and 39 km E of Meadow HS.]

Pygopodidae

Aclys concinna Kluge

One record: a specimen (66192) found by G. Harold and T.M.S. Hanlon in August 1979 on road through low shrubs and *Banksia* on orange-yellow soil 2 km NE of Tamala.

Aprasia smithi Storr

Mainly the western and central zones (north to 1 km S of Tamala, Cooloomia HS and 46 km N of Galena). Moderately common. In topsoil and litter and under logs on a wide variety of soils including reddish brown sandy loam and yellow sand.

Delma australis Kluge

Northern half of central zone. Moderately common. Mainly in soft spinifex (*Plectrachne*) on brown and yellowish sandplains.

Delma fraseri Gray

One record from extreme north of western zone: a specimen (56484) collected at 1 km S of Tamala.

Delma tincta DeVis

Only recorded from extreme north and south of area: one specimen from Hamelin and two from Murchison House.

Lialis burtonis Gray

Patchily distributed throughout the area. Uncommon.

Pygopus lepidopodus (Lacépède)

Two records: single specimens collected at 7 and 10 km NE of Tamala.

Pygopus nigriceps nigriceps (Fischer)

Confined to eastern zone and eastern parts of central zone (apart from an unconfirmed record from Tamala). Scarce.

Agamidae

Amphibolurus adelaidensis adelaidensis (Gray)

Far south-west, north to the *Zuytdorp* wreck and inland to Mt Curious. Uncommon.

Amphibolurus inermis (DeVis)

Patchily distributed (recorded from Overlander, 15 km W of Hamelin, Tamala, 15 km SSW of Nerren Nerren and 8 km NE of Carrollgouda Well). Uncommon. Mainly the yellow and reddish sands of the central zone.

Amphibolurus isolepis (Fischer)

Only known from the belt of *Triodia* and open mallee growing on reddish sandplains in the eastern zone. On 26 July 1979 G. Harold and D. Knowles collected three specimens (64438-40) at 17.5 km NW of Coburn HS, they were much larger (SVL 51-59 mm) than winter specimens from eslewhere in Western Australia (Storr 1965). On 29 August 1979 T.M.S. Hanlon and G. Harold collected a male (65000) at the same locality, it has SVL 60 mm and a small dark grey pectoral patch.

The subspecific identity of this isolated population has still to be determined. It is located 300 km south from the nearest population of *A. i. isolepis.*

Amphibolurus maculatus maculatus (Gray)

Western and central zones east to 33 km NE of Tamala, 13 km W of Cooloomia, 31 km SW of Nerren Nerren and 13 km N of Galena. Very common. All kinds of well-vegetated sandy country from white coastal dunes to red and yellow sandplains and sandridges.

Amphibolurus minor minor Sternfeld

Central and eastern zones and inland parts of western zone. Common on well-vegetated lighter soils; scarce on the heavy red soils of north-eastern part of area.

Amphibolurus parviceps butleri Storr

One record from western zone: a specimen (64446) collected by G. Harold and D. Knowles in July 1979 among low shrubs on white sand 19 km S of Tamala.

Amphibolurus reticulatus (Gray)

Common in western and central zones; scarce in eastern zone. Mainly loamy soils with open *Acacia* scrub; also in mallee, York Gum woodland and samphire.

Amphibolurus scutulatus Stirling & Zietz

Central and eastern zones, and far east of western zone (Carrollgouda Well). Moderately common (more plentiful to immediate east of our area). Mainly open *Acacia* and mallee on reddish sands and loams.

Lophognathus longirostris Boulenger

Confined to extreme south. Moderately common in waterside forests along the Murchison upstream to Galena.

Moloch horridus Gray

Central zone. Scarce. Sandy country.

Scincidae

Cryptoblepharus carnabyi Storr

Western and central zones. Uncommon. In a wide variety of habitats, e.g. rock face of cliffs near *Zuytdorp* wreck, river gums at Galena, open *Acacia* scrub near Tamala, *Eremaea/Hakea* thicket west of Cooloomia, and York Gum woodland south-west of Nerren Nerren.

Cryptoblepharus plagiocephalus (Cocteau)

Western and central zones. Uncommon.

Ctenotus fallens Storr

Western and central zones. Uncommon.

Ctenotus mimetes Storr

Eastern zone. Moderately common. Red clayey soils over limestone with open *Acacia* scrub.

Ctenotus pantherinus pantherinus (Peters)

Only recorded from extreme north and south of area, viz. at 7 km W of Hamelin and Galena. Rare. Heavy red soils.

Ctenotus schomburgkii (Peters)

Central and eastern zones. Scarce (more plentiful to immediate east of our area). Mainly in sedges and leaf litter under low open woodlands on loamy soils.

Ctenotus severus Storr

Only recorded from extreme south-east of area (Galena). Common. Red clay loam.

Ctenotus youngsoni Storr

One record from western zone: a specimen (64426) collected by G. Harold and D. Knowles among low shrubs on white sand 19 km S of Tamala on 25 July 1979.

Egernia depressa (Günther)

Two specimens from extreme north-east of area, including one found by N. Kolichis on 28 July 1978 in the spout of a dead *Acacia*.

Lerista connivens Storr

Western and central zones and south of eastern zone (north to 17 km NW of Coburn and 7 km N of Billabong Roadhouse). Very common. In topsoil and litter and under logs on a wide variety of sands and sandy loams.

Lerista elegans (Gray)

Eastern parts of western zone, central zone and south of eastern zone (north to 7 km N of Billabong Roadhouse). Uncommon. Mainly in leaf litter and under logs on sands and sandy loams.

Lerista humphriesi Storr

Central zone and adjacent parts of eastern and western zones. Moderately common. Until recently this species was known only from one specimen collected at Gee Gie Outcamp. In July 1979 G. Harold and D. Knowles collected a specimen at 16 km SW of Billabong Roadhouse, three at Cooloomia HS, one at 31 km SW of Nerren Nerren and four at 10 km N of Murchison House. In September 1979 J.K. Rolfe and P.J. Fuller collected single specimens at 17 and 26 km WSW of Cooloomia and 26 km N of Lake Culcurdoo. Specimens were obtained in stumps and bulldozer spoil and under leaf litter and logs on reddish and yellowish sandplains. The closely related and widespread *L. praepedita* was not found within the small area occupied by this species.

Lerista lineopunctulata (Duméril & Bibron)

Western and central zones and south of eastern zone (north to 7 km N of Billabong Roadhouse). Common. Mainly in litter below *Acacia*, *Banksia*, mallee and *Hakea* scrubs on white and red sands and reddish brown sandy loam.

Lerista macropisthopus (Werner)

Eastern zone and south-east of central zone. Very common. Mainly in litter beneath *Acacia* and mallee scrubs on red clay, loam, sandy loam and sand in eastern zone and on yellow sand in central zone (40-46 km N of Galena).

Lerista muelleri (Fischer)

Central and eastern zones and far north-east of western zone (1 km S of Tamala). Moderately common. In litter and rotten stumps and under logs, mainly below open scrubs and woodlands on sandy loams.

Lerista nichollsi (Loveridge)

Central and eastern zones and east of western zone (Gee Gie Outcamp). Uncommon. In litter and under rotten stumps below open *Acacia* and *Banksia* scrubs on red and yellowish sands.

Lerista petersoni Storr

Three records from northern half of central zone: a specimen (64360) collected by G. Harold and D. Knowles in July 1979 in litter beneath shrubs in *Banksia* woodland on yellowish sand 42 km NE of Tamala, and two specimens (66357, 66372) collected by J.K. Rolfe and P.J. Fuller in September 1979 in soft spinifex (*Plectrachne*) on brown and reddish brown sandplains respectively at 23 and 15 km WSW of Cooloomia HS.

Originally described as a subspecies of *L. connivens*, this skink has now proved to be sympatric with that species and must be elevated to a full species. Both *L. connivens* and *L. nichollsi* were collected at Coburn HS (27 km N of Cooloomia).

Lerista planiventralis decora Storr

One record from central zone: two specimens (67325-6) pit-trapped by J.K. Rolfe and P.J. Fuller in September 1979 in *Hakea-Acacia* scrub on coarse red sand at 23 km WSW of Cooloomia HS.

Lerista praepedita (Boulenger)

Western, central and eastern zones. Common. In topsoil, leaf litter and rotten stumps beneath a wide variety of scrubs and heaths on white, red and yellow sands.

Menetia greyii Gray

Western and central zones. Uncommon. Mainly open *Acacia* scrub on reddish sandy loam.

Menetia surda Storr

Central zone. Moderately common. Mainly in soft spinifex (*Plectrachne*) and leaf litter on yellow, brown and red sandplains.

Morethia butleri (Storr)

One record from extreme north of eastern zone: a specimen (55066) collected by G. Harold and M. Peterson in September 1976 in open *Acacia* scrub on red rocky soil 7 km W of Hamelin.

Morethia lineoocellata (Duméril & Bibron)

Western zone and adjoining part of central zone. Possibly common towards coast in low open heath on white dunes, but uncommon inland.

Morethia obscura Storr

One record from western zone, a specimen (18597) collected by G.M. Storr under a slab of limestone near the *Zuytdorp* wreck; and one from central zone, a specimen (66346) collected by J.K. Rolfe and P.J. Fuller on red sand with shrubby mallee over chenopods 23 km WSW of Cooloomia.

Omolepida branchialis (Günther)

Western and central zones. Common. Mainly in soft spinifex (*Plectrachne*) on reddish brown sandplains and in litter and topsoil beneath open to moderately dense *Banksia*, *Hakea* and *Acacia* scrubs on yellowish and reddish sands; also in coastal limestone.

Tiliqua rugosa (Gray)

Western zone and far south of central zone. Possibly common along the lower Murchison, but rare further north (collected at 1 km S of Tamala and 2 km E of Gee Gie Outcamp, and observed a few kilometers N of Galena).

Varanidae

Varanus caudolineatus Boulenger

Eastern zone (and probably south-east of central zone, judging from its occurrence at Ajana and 34 km SE of Nerren Nerren). Uncommon. Mainly in hollow logs and stumps in open *Acacia* scrub on red sandy loam.

Varanus eremius Lucas & Frost

Eastern zone. Scarce. Open *Acacia* scrub on red loam.

Varanus gouldii (Gray)

Two records from central zone: juveniles (18602-3) collected by G.M. Storr in January 1963 in mixed scrub on brown sandy loam at 18 and 27 km S of Nerren Nerren.

Typhlopidae

Typhlina australis (Gray)

One record from extreme north of western zone: a specimen (64351) collected in July 1979 by G. Harold and D. Knowles in a rotten stump in open *Acacia* scrub on reddish soil 1 km S of Tamala.

Typhlina bituberculata (Peters)

One record from western zone: a specimen (64382) collected in July 1979 by G. Harold and D. Knowles in a stump in coastal heath on white sand 19 km S of Tamala.

Typhlina leptosoma (Robb)

One record from central zone: a specimen (66343) collected in September

1979 by J.K. Rolfe and P.J. Fuller in soft spinifex (*Plectrachne*) on orange-brown soil 15 km WNW of Cooloomia HS.

Boidae

Liasis childreni Gray

One record from eastern zone: a specimen (58865) collected in December 1966 by W.H. Butler at 13 km S of Overlander. Also an unconfirmed report from western zone: a head from Tamala was sent in 1939 to the Western Australian Museum, where it was registered (7247) but not retained.

Elapidae

Demansia olivacea calodera Storr

Only recorded from extreme north of western zone (Tamala and 1 km S). Two of the three specimens were collected in open *Acacia* scrub on reddish sandy loam.

Demansia reticulata reticulata (Gray)

One record from western zone: a specimen (66336) collected by J.K. Rolfe and P.J. Fuller as it crossed track 9.6 km SE of Womerangee Hill at 1130 hr on 16 September 1979; the vegetation here was heath (*Acacia*, *Diplolaena* and Myrtaceae) on sandplain with much capstone.

Denisonia monachus Storr

Eastern zone. Scarce. Open *Acacia* scrub on red sands and loams.

Furina christieana (Fry)

One unconfirmed record from extreme north of western zone: two specimens (6530-1) from Tamala were registered in 1937 but cannot be found.

Pseudechis australis (Gray)
Pseudonaja modesta (Günther)
Pseudonaja nuchalis Günther

These three species seem to occur throughout the area. Summer collecting would probably show them to be more plentiful than the few specimens indicate.

Vermicella approximans (Glauert)

One record from far north-east of eastern zone: a specimen (28699) collected by W.H. Butler in December 1966 at 16 km S of Overlander. In our Shark Bay paper (Storr & Harold 1978) this specimen was listed as *V. s. semifasciata*; however it agrees with *V. approximans* in all respects except for having five rather than six upper labials.

Vermicella bertholdi (Jan)

Eastern zone and south-east of central zone (17 km SW of Nerren Nerren). Uncommon. Under leaf litter and logs in open *Acacia* scrub and open eucalypt scrub and woodland on reddish sandy loam.

Vermicella bimaculata (Duméril, Bibron & Duméril)

One record from extreme north of western zone: two specimens collected by G. Harold and M. Peterson at 1 km S of Tamala in August 1976.

Vermicella littoralis Storr

Western and central zones. Uncommon. This species has been collected at 15 km WNW of Cooloomia HS, and the closely related *bertholdi* at Cooloomia HS.

DISCUSSION

To date 39 genera and 83 species of amphibians and reptiles have been recorded from the area. They are distributed in ten families:

Leptodactylidae	—	6 genera, 7 species
Cheluidae	—	1 genus, 1 species
Gekkonidae	—	7 genera, 13 species
Pygopodidae	—	5 genera, 8 species
Agamidae	—	3 genera, 10 species
Scincidae	—	8 genera, 26 species
Varanidae	—	1 genus, 3 species
Typhlopidae	—	1 genus, 3 species
Boidae	—	1 genus, 1 species
Elapidae	—	6 genera, 11 species

Further collecting, especially in summer, should add several species to the list, notably the four taxa found to the immediate north and south of our area: *Ctenotus lesueurii*, *Eremiascincus richardsonii*, *Tiliqua occipitalis* and *Vermicella f. fasciolata*. We would be surprised if the ultimate total stood at less than 90 species.

The Murchison River marks the northern limit of three south-west Australian frogs, *Heleioporus albopunctatus*, *Limnodynastes dorsalis* and

Ranidella pseudinsignifera; another two species, *Neobatrachus pelobatoides* and *Pseudophryne guentheri*, only extend a little further north. Among south-western reptiles only *Delma grayii* and *Vermicella s. semifasciata* seem to be limited by the Murchison.

Seven south-western and southern Australian reptiles are locally restricted to the western zone: *Phyllurus milii*, *Aclys concinna*, *Delma fraseri*, *Amphibolurus a. adelaidensis*, *Morethia obscura*, *Demansia r. reticulata* and *Vermicella bimaculata*. Only one of these, *Amphibolurus a. adelaidensis*, fails to reach the Shark Bay region (where its place is taken by the closely related *A. parviceps*). An additional eight south-western and southern reptiles extend to the central zone: *Diplodactylus alboguttatus*, *D. michaelseni*, *D. spinigerus*, *Delma australis*, *Pygopus lepidopodus*, *Ctenotus fallens*, *C. p. pantherinus* and *Tiliqua rugosa*.

Another category that is largely confined to the western and central zones are the reptiles endemic to the west coast and coastal plains of Western Australia: *Diplodactylus ornatus*, *Nephrurus levis occidentalis*, *Lerista elegans*, *L. lineopunctulata*, *L. praepedita*, *Morethia lineoocellata*, *Demansia olivacea calodera* and *Vermicella littoralis*. Of these taxa only the three *Lerista* extend inland to the eastern zone and then only to its western and southern fringes.

Eight reptiles characteristic of the arid interior of Western Australia are locally restricted to the eastern zone, viz. *Rhynchoedura ornata*, *Amphibolurus isolepis*, *Ctenotus mimetes*, *Egernia depressa*, *Morethia butleri*, *Varanus caudolineatus*, *V. eremius* and *Vermicella approximans*.

One species, *Lerista humphriesi*, is endemic to the area. The isolated and slightly peculiar populations of *Diplodactylus squarrosus* and *Amphibolurus isolepis* possibly constitute endemic subspecies. A further five taxa are almost confined to the area: *Arenophryne rotunda* extending only to Dirk Hartog Island and the Kalbarri National Park, *Aprasia smithi* to Edel Land and Kalbarri, *Amphibolurus parviceps butleri* to Edel Land, *Ctenotus youngsoni* to Dirk Hartog Island, *Lerista connivens* to Kalbarri and the islands of Freycinet Estuary, and *Typhlina leptosoma* to Wooramel and the lower Murchison.

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DESCRIPTIONS OF FIVE NEW RAINBOWFISHES (MELANOTAENIIDAE) FROM NEW GUINEA

GERALD R. ALLEN*
&
NORBERT J. CROSS*

ABSTRACT

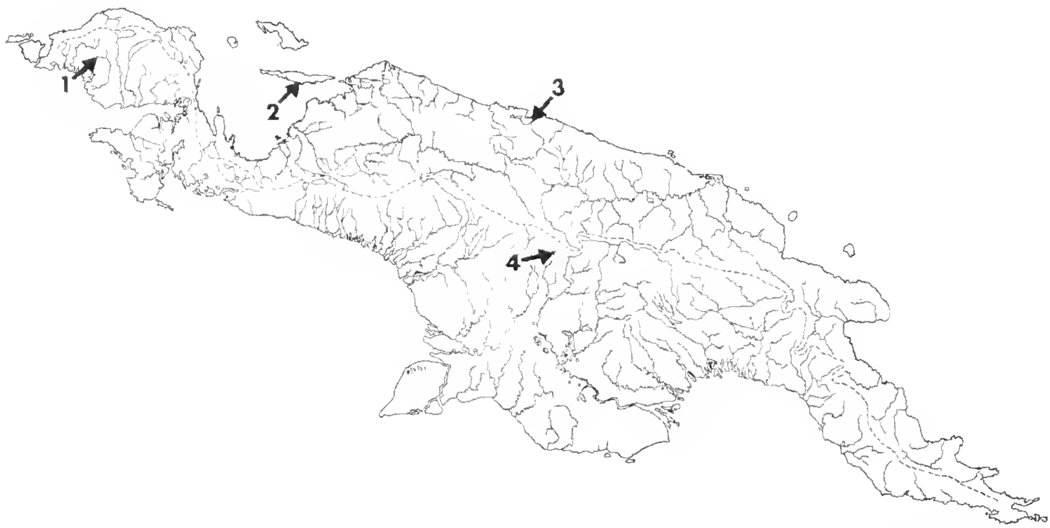
A collection of freshwater melanotaeniid fishes taken on an expedition to Dutch New Guinea (now Irian Jaya) by the Rijksmuseum van Natuurlijke Histoire (Leiden, Netherlands) during 1954-55 was studied. It contained four new species which are described herein: *Melanotaenia ajamaruensis* (Ajamaru Lakes, Vogelkop Peninsula), *M. boesemani* (Ajamaru Lakes), *M. japenensis* (Japen Island), and *Glossolepis pseudo-incisus* (Tami River, Djajapura district). An additional new species, *Melanotaenia oktediensis* is described on the basis of three specimens collected by the Smithsonian Institution (USA) and Papua New Guinea Fisheries Department from the head-waters of the Fly River System, southern Papua New Guinea. The five new species are described in detail, illustrated, and compared with allied species.

INTRODUCTION

Rainbowfishes of the family Melanotaeniidae inhabit freshwater streams, swamps, and lakes of northern and eastern Australia and New Guinea. The family contains nine genera and approximately 40 species (Allen, in press). All of these are small fishes, usually under 15 cm standard length, dwelling primarily in fresh water. Because of their diminutive size they are commercially unimportant, although they are eaten, usually dried, in some villages of New Guinea. Several species, primarily from Australia, are esteemed as aquarium fishes because of their attractive colours and ease of breeding in captivity.

The senior author is currently engaged in the study of melanotaeniids, with plans for an overall revision in the near future. In connection with this work specimens were examined at European museums during 1975 and 1977. A particularly valuable collection was brought to our attention by Dr M. Boeseman, Curator of Fishes at the Rijksmuseum van Natuurlijke Histoire of Leiden in The Netherlands. This collection was made by Dr Boeseman and colleagues during 1954-55 at numerous localities in Dutch New Guinea (now Irian Jaya). They are of particular interest, because this region is the most

* Western Australian Museum, Francis Street, Perth, Western Australia 6000.



Map 1—Collection sites for new species of melanotaeniids: 1—Ajamaru Lakes (*Melanotaenia ajamaruensis* and *m. boesemani*): 2—Japen Island (*M. japenensis*): 3—Tami River (*Glossolepis pseudoincisus*): 4—Ok Tedi River (*M. okrediensis*).

poorly collected of all the areas inhabited by melanotaeniids. Four new species from this collection are described herein. The other species will be treated in a later publication. The fifth species described in this paper first attracted our attention when it was reported as *Melanotaenia cf. vanheurni* by Roberts (1978) in his survey of the fishes of the Fly River System. Our subsequent examination of the single specimen obtained by Roberts and two others from the Papua New Guinea Fisheries Department form the basis of the description of this species.

We have deposited type specimens of the new melanotaeniids at the following institutions: Lembaga Biologi Nasional, Bogor, Indonesia (LBN); Kanudi Fisheries Research Laboratory, Port Moresby, Papua New Guinea (PNG); Rijksmuseum van Natuurlijke Histoire, Leiden (RMNH); U.S. National Museum of Natural History, Washington, D.C. (USNM); and Western Australian Museum, Perth (WAM).

Data in parentheses in the descriptions below apply to paratypes when different from the holotype. Additional counts and measurements are summarised in **Tables 1-7.** Proportions are expressed as percentage of the standard length.

Standard length (SL) is taken from the most anterior point of the upper lip to the midbase of the caudal fin (end of hypural plate). Head length is measured from the front of the upper lip to the end of the opercular membrane. The depth of the body is the maximum depth from the base of the first dorsal fin. The diameter of the eye is the horizontal fleshy diameter. The interorbital width is the bony width. The depth of the caudal peduncle is the least depth. The length of the caudal peduncle is the horizontal measurement connecting two vertical lines, one passing through the base of the last dorsal ray and the other through the base of the middle caudal rays. Predorsal, preanal, and prepelvic distances are measured from the snout tip to the base of the spine at the origins of the first dorsal, anal, and pelvic fins respectively. Predorsal scales are counted on the dorsal mid-line between the origin of the first dorsal fin and the interorbital. Preopercle scale counts refer to the total number of scales overlying the preopercle bone. Pectoral ray counts include the tiny, rudimentary lowermost rays. Gillraker counts include rudiments; the raker at the angle was incorporated into the lower-limb count.

The collection sites for the new species are shown in **Map 1.**

SYSTEMATICS

Melanotaenia boesemani sp. nov.
(Fig. 1)

Holotype

RMNH 28061, male, 66.3 mm SL, collected at Ajamaru Lakes, Vogelkop Peninsula, Irian Jaya, Indonesia (approximately 1°21'S, 132°16'E) by M. Boeseman on 4 March 1955.

Paratypes

LBN 2487, 3 specimens, 49.5-63.4 mm SL, collected with holotype; RMNH 28062, 27 specimens, 35.0-63.0 mm SL, collected with holotype; RMNH 28063, 9 specimens, 35.6-61.3 mm SL, same data as holotype except collected on 3 and 4 March 1955; RMNH 28064, 7 specimens, 31.9-52.5 mm SL, collected at

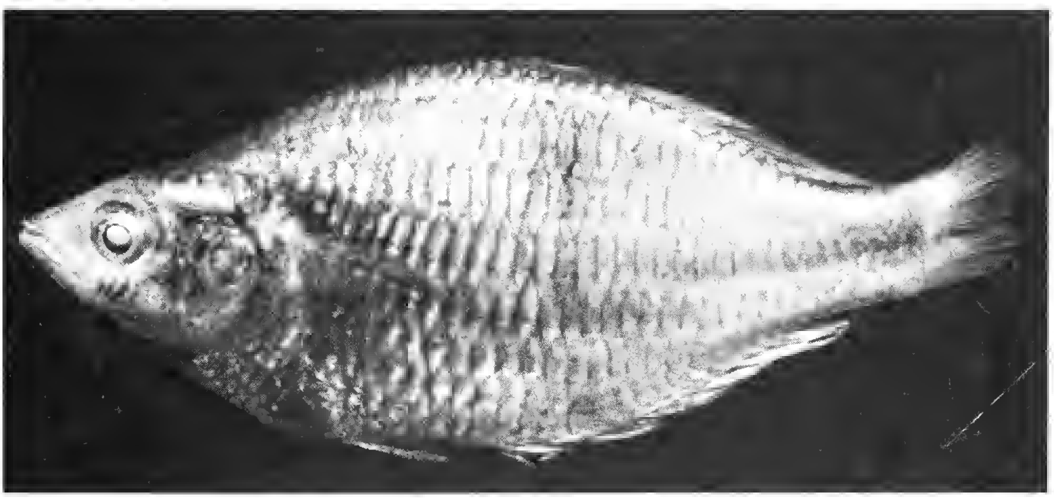


Fig. 1–*Medanotaenia boesemani,* holotype, 66.3 mm SL

Djitmau, about 3 km south of Ajamaru Lakes by M. Boeseman on 7-9 March 1955; RMNH 28065, 3 specimens, 27.3-49.3 mm SL, same data as holotype except collected on 3 March 1955; RMNH 28066, 3 specimens, 54.0-56.0 mm SL, collected at Aitinjo Lake, approximately 20 km SE of Ajamaru Lakes by M. Boeseman on 12 March 1955; RMNH 28067, 6 specimens, 41.7-86.5 mm SL, same data as holotype except collected on 4-6 March 1955; USNM 220904, 3 specimens, 46.8-53.2 mm SL, collected with holotype; WAM P26791-001, 3 specimens, 49.5-63.4 mm SL, collected with holotype.

Diagnosis

A species of *Melanotaenia* with the following combination of characters: dorsal rays IV to VI, 10 to 14; anal rays I, 17 to 23; pectoral rays 13 to 16; horizontal scale rows 7 or 8; vertical scale rows 32 to 37; predorsal scales 14 to 16; preopercle scales 7 to 15; anterior one-half to two-thirds of body overall purplish-brown, posterior portion yellow or tan (red-orange in life), sometimes with two or more diffuse dark bars on lower half of anterior body region.

Description

Data for counts and measurements are based on the holotype and 41 paratypes, 44.3-86.5 mm SL.

Dorsal rays IV-I, II (IV to VI-I, 10 to 14); anal rays I, 18 (I, 17 to 23); pectoral rays 16 (13 to 16); horizontal scale rows 7 (7 or 8); vertical scale rows 35 (32 to 37); predorsal scales 16 (14 to 16) ($\bar{x}$ = 15, N = 59); preopercle scales 10 (7 to 15) ($\bar{x}$ = 11, N = 60); gill rakers on first arch 2 + 15 (2 to 4 + 14 or 15).

Greatest body depth 43.6, greatest depth of paratypes by sex and size class as follows: *males*–(a) 40-49 mm SL, 28.8-42.6 ($\bar{x}$ = 37.8, N = 12), (b) 50-69 mm SL, 35.6-44.5 ($\bar{x}$ = 39.5, N = 20), (c) 70+ mm SL, 43.0 (N = 1); *females*–(a) 35-49 mm SL, 29.1-38.3 ($\bar{x}$ = 33.8, N = 15), (b) 50-65 mm SL, 33.6-39.4 ($\bar{x}$ = 35.5, N = 7); head length 28.8 (26.4-31.1); snout length 8.8 (6.7-9.1); eye diameter 8.9 (7.1-10.2); interorbital width 9.2 (8.0-11.9); caudal peduncle depth 12.8 (10.2-13.7); caudal peduncle length 13.2 (12.8-18.1); predorsal distance 56.1 (49.2-56.1); preanal distance 54.2 (50.7-58.4); prepelvic distance 42.1 (37.4-43.6).

Jaws about equal, oblique, premaxilla with an abrupt bend between the anterior horizontal portion and lateral part; maxilla ends opposite front border of eye or slightly beyond this level; lips thin; teeth conical with slightly curved tips, arranged in dense bands in upper and lower jaws; teeth at front of upper jaw in 4 or 5 irregular rows, reduced to 1 or 2 posteriorly; teeth of upper jaw and middle portion of lower jaw extending outside of mouth onto lip; teeth at front of lower jaw in about 6 to 8 irregular rows, tapering to 1-3 rows posteriorly; a narrow edentulous space at symphysis of lower jaw; several rows of small, conical teeth on vomer; palatines with a narrow band of similar teeth.

Scales relatively large, arranged in regular horizontal rows; most of body scales with crenulate margins; predorsal scales extending to posterior portion of interorbital; preopercle scale rows from posterior angle to edge of eye 2 or 3.

First dorsal fin originates about opposite of anal fin origin; first dorsal spine 10.1 (9.1-10.7), its length is slightly (in females) to distinctly (in males) shorter than longest (usually 2nd or 3rd) spine; longest spine of first dorsal fin 11.6 (11.0-18.8), its tip reaching base of about 1st soft ray of second dorsal fin in females and 2nd to 4th soft ray in males when depressed. Spine of second dorsal fin 7.5 (7.2-9.6); longest (rays approximately uniform height in females, usually penultimate or last ray in males) soft ray of second dorsal fin 16.6 (10.1-18.3); depressed posterior rays of second dorsal fin extends back about ½ length of caudal peduncle in females and to about caudal fin base in males. Anal fin spine 7.5 (7.1-8.1); longest anal rays 15.3 (10.7-15.5), most rays of uniform height. Soft dorsal and anal fin rectangular in outline, the posterior rays somewhat elongate and pointed, particularly in males. Pelvic fin tips when depressed not quite reaching base of anal spine in both males and females; length of pelvic fin 14.8 (12.5-19.3). Pectoral fins pointed, the length 20.8 (17.1-23.7). Caudal fin moder-ately forked, its length 21.1 (19.2-25.0).

Colour in alcohol: anterior one-half to two-thirds of body overall purplish-brown with lighter scale centres grading to silvery on ventral portion; posterior part of body yellowish or tan; some specimens with two or more diffuse bars of darker purple on lower half of anterior body region, the first of these generally faint and located just behind pectoral base, the last at middle of side; a series of faint red-brown stripes, one per scale row on sides, most noticeable on posterior half and very faint or absent in some specimens; first dorsal fin dusky brown, second dorsal fin mainly pale tan; caudal fin slightly dusky brown; and fin mostly pale tan with some duskiness anteriorly; pelvic fins dusky brown or purplish; pectoral fins translucent with some duskiness. Females have less contrast between the anterior and posterior body regions and the series of stripes on the sides are more apparent, even anteriorly.

Colour in life (from field notes), generally purplish or brown anteriorly and red-orange posteriorly.

Remarks

Melanotaenia boesemani is most closely related to *M. ajamaruensis*, a sympatric species. They do not appear to have close relatives elsewhere in the Australia-New Guinea region and may be confined to the Vogelkop Peninsula. They differ from all other *Melanotaenia* in colouration and by possessing a peculiar scale structure. The body scales are relatively tall compared with other members of the genus. The total horizontal scale row count ranges from 7 to 8, compared with 10 or more for most other *Melanotaenia*. Four Australian species, *M. exquisita* Allen (Northern Territory), *M. gracilis* Allen (Western Australia), *M. nigrans* (Richardson) (Northern Territory and Cape York Peninsula), and *M. pygmaea* Allen (Western Australia) also possess a low horizontal row count: the last named species usually has eight, occasionally nine rows and the others usually nine or ten rows. However, these species are very different in colour pattern (see Allen, 1978) and are noticeably more slender. Mature males (in excess of 40 mm SL) have a body depth which averages 32.4% of SL (N = 17) for *M. pygmaea*, 26.3% of SL (N = 15) for *M. exquisita*, 29.6% of SL (N = 23) for *M. gracilis*, and 30.3% of SL (N = 34) for *M. nigrans*. By contrast specimens of *M. boesemani* rarely are less than 35% of SL and regularly attain depths of 40% of SL or more.

TABLE 1

Fin-ray counts for type specimens of *Melanotaenia boesemani*

1st Dorsal fin spines

IV	*V*	*VI*
13	41	7

2nd Dorsal fin soft rays

10	*11*	*12*	*13*	*14*
1	4	22	29	5

Anal fin soft rays

17	*18*	*19*	*20*	*21*	*22*	*23*
2	9	18	19	8	3	2

Pectoral fin rays

13	*14*	*15*	*16*
1	37	18	5

TABLE 2

Proportional measurements of selected type specimens of *Melanotaenia boesemani* (expressed as a percentage of the standard length)

	Holotype RMNH 28061	RMNH 28067	RMNH 28062	Paratypes RMNH 28063	RMNH 28063	RMNH 28063
	male	male	male	female	female	female
Standard length (mm)	66.3	86.5	56.0	60.5	49.6	47.6
Depth	43.6	43.0	44.5	36.2	34.3	36.3
Head length	28.8	27.2	28.0	28.9	27.4	28.4
Snout length	8.8	7.9	7.7	8.3	7.9	8.2
Eye diameter	8.9	7.9	8.0	8.6	9.3	9.5
Bony interorbital width	9.2	10.2	10.2	8.9	9.1	9.2
Maxilla length	8.9	8.8	8.9	9.6	9.5	9.7
Depth of caudal peduncle	12.8	11.6	11.4	10.9	10.7	11.6
Length of caudal peduncle	13.2	16.0	16.4	17.0	15.9	16.6
Snout to 1st dorsal fin origin	56.1	52.5	52.3	54.0	51.8	54.6
Snout to anal fin origin	54.2	52.0	55.4	57.4	55.4	56.9
Snout to pelvic fin origin	42.1	38.4	39.1	41.8	41.3	43.1
Length of 1st dorsal fin base	7.7	7.6	9.1	8.9	9.1	9.9
Length of 2nd dorsal fin base	23.4	30.6	24.3	20.7	21.0	21.4
Length of anal fin base	36.6	40.7	37.9	32.7	31.7	32.8
Length of pectoral fin	20.8	18.5	20.7	18.7	19.8	20.2
Length of pelvic fin	14.8	12.8	13.9	12.7	12.9	16.6
Longest ray of 1st dorsal fin	11.6	13.9	15.9	12.1	14.1	13.7
Longest ray of 2nd dorsal fin	16.6	16.5	16.4	10.7	12.7	11.3
Longest anal ray	15.3	13.5	12.9	11.1	11.9	12.0
Length of caudal fin	21.1	23.1	22.3	22.0	22.5	25.0

Melanotaenia boesemani is readily separable from *M. ajamaruensis* on the basis of soft ray counts for the second dorsal and anal fins (see **Tables 1** and **3**). The former species has 10 to 14 (usually 12 or 13) dorsal rays and 17 to 23 (usually 18 to 21) anal rays compared with 15 to 19 (usually 15 to 17) and 21 to 27 (usually 22 to 24) for *M. ajamaruensis*. Although these species possess a similar colouration and general shape, the stripes on the sides tend to be more pronounced in *M. ajamaruensis*, particularly the mid-lateral one and the stripe just below it.

TABLE 3

Fin-ray counts for type specimens of *Melanotaenia ajamaruensis*

1st Dorsal fin spines

IV	*V*	*VI*
4	30	13

2nd Dorsal fin soft rays

15	*16*	*17*	*18*	*19*
10	25	9	1	2

Anal fin soft rays

21	*22*	*23*	*24*	*25*	*26*	*27*
2	9	23	10	1	1	1

Pectoral fin rays

13	*14*	*15*
3	32	12

TABLE 4

Proportional measurements of selected type specimens of *Melanotaenia ajamaruensis* (expressed as a percentage of the standard length)

	Holotype RMNH 28068	RMNH 28069	RMNH 28069	Paratypes WAM P26792-001	RMNH 28069	WAM P26792-001
	female	female	female	male	male	male
Standard length (mm)	78.0	63.7	56.9	67.7	62.0	56.9
Depth	39.2	35.8	36.9	40.1	39.9	36.9
Head length	26.1	27.3	28.8	27.0	26.6	28.8
Snout length	8.2	8.0	8.8	8.2	8.4	8.8
Eye diameter	7.7	8.3	9.1	7.8	7.7	9.1
Bony interorbital width	10.1	9.6	9.5	10.0	9.7	9.5
Maxilla length	9.4	9.4	9.7	10.0	9.2	9.7
Depth of caudal peduncle	11.0	11.1	11.2	11.5	11.5	11.2
Length of caudal peduncle	15.1	13.7	15.1	13.1	15.0	15.1
Snout to 1st dorsal fin origin	48.1	49.1	48.7	48.9	48.4	48.7
Snout to anal fin origin	53.7	53.1	54.5	52.9	51.8	54.5
Snout to pelvic fin origin	37.6	40.0	40.1	40.0	36.1	40.1
Length of 1st dorsal fin base	11.4	8.2	9.0	11.0	11.0	9.0
Length of 2nd dorsal fin base	28.0	28.0	27.4	29.2	26.1	27.4
Length of anal fin base	36.9	36.9	37.4	39.7	40.6	37.4
Length of pectoral fin	19.3	17.9	19.3	20.9	19.8	19.3
Length of pelvic fin	17.1	15.7	17.6	17.3	18.7	17.6
Longest ray of 1st dorsal fin	13.0	11.8	14.2	14.7	16.5	14.2
Longest ray of 2nd dorsal fin	13.5	12.4	11.2	15.4	16.3	11.2
Longest anal ray	11.4	12.7	13.7	14.0	13.5	13.7
Length of caudal fin	20.8	22.8	22.5	21.3	22.4	22.5

The types of *M. boesemani* and *M. ajamaruensis* were collected from the Ajamaru Lakes region which is located near the centre of the Vogelkop Peninsula at the western extremity of Irian Jaya (western New Guinea, see **Map 1**). The lakes are situated at the headwaters of the Ajamaru River which drains into the Kais River, eventually flowing into the Ceram Sea to the south. Several types were also collected at Aitinjo Lake, situated about 20 km south-east of the Ajamaru Lakes. Apparently it has a subterranean outlet connecting the Kais River. Boeseman (1963) gave further details about the areas from which the types were collected. He recorded elevations of 250 m and 90 m above sea level and a pH of 6.4-6.5 for the Ajamaru and Aitinjo locations respectively. It is possible that *M. boesemani* and *m. ajamaruensis* inhabit other areas on the Vogelkop Peninsula, but most of the region remains unsampled.

The gut contents of *M. boesemani* and *M. ajamaruensis* indicate a diet consisting mainly of small insects with lesser amounts of algae and crustaceans. Gonad development is apparent in female specimens of *M. boesemani* as small as 34 mm SL and they appear to be fully functional at 40-42 mm SL.

The species is named in honour of Dr Marinus Boeseman, Curator of Fishes at RMNH, and the collector of the type specimens. According to labels which accompany the types the native name for this species is 'sekiak' and it is also known as 'ikan rascado'.

Melanotaenia ajamaruensis sp. nov.
(Fig. 2)

Holotype

RMNH 28068, female, 78.0 mm SL, collected at Ajamaru Lakes, Vogelkop Peninsula, Irian Jaya, Indonesia (approximately 1°21'S, 132°16'E) by M. Boeseman on 4-6 March 1955.

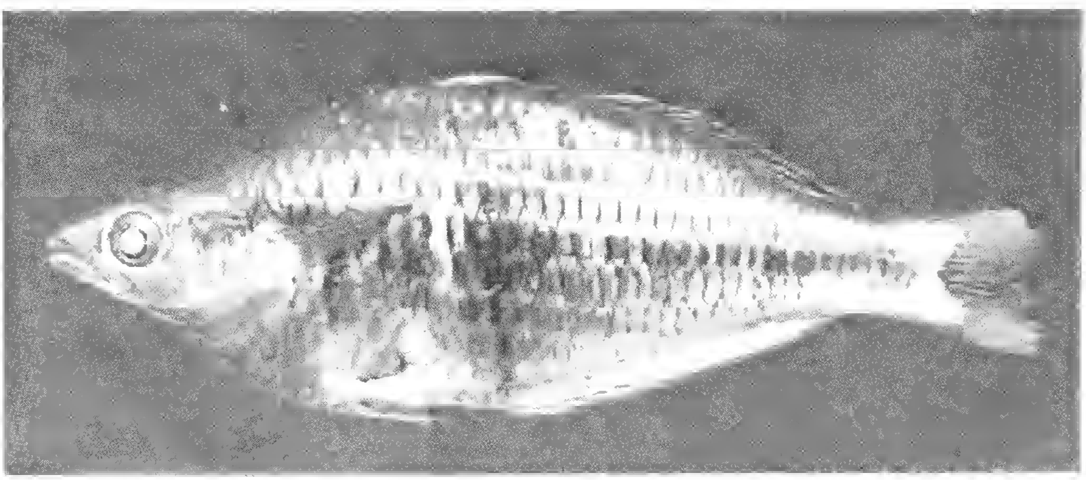


Fig. 2–*Melanotaenia ajamaruensis*, holotype, 78.0 mm SL.

Paratypes (same data as holotype)

LBN 2488, 4 specimens, 36.5-44.7 mm SL; RMNH 28069, 46 specimens, 25.5-63.7 mm SL; RMNH 28070, 6 specimens, 32.2-62.4 mm SL; RMNH 28071, 56.5 mm SL, USNM 220905, 3 specimens, 42.6-58.8 mm SL; WAM P26792-001, 6 specimens, 43.8-67.7 mm SL.

Diagnosis

A species of *Melanotaenia* with the following combination of characters: dorsal rays IV to VI, 15 to 19; anal rays I, 21 to 27; pectoral rays 13 to 15; horizontal scale rows 7 or 8; vertical scale rows 34 to 37; predorsal scales 13 to 16; preopercle scales 9 to 16; colour generally reddish-brown on back and anterior half of body grading to yellow or tan posteriorly with series of red-brown horizontal stripes on side, in life ground colour metallic blue to yellowish or green with yellow longitudinal stripes.

Description

Data for counts and measurements are based on the holotype and 28 paratypes, 42.5-67.0 mm SL.

Dorsal rays VI-I, 15 (IV to VI-I, 15 to 19); anal rays I, 22 (I, 21 to 27); pectoral rays 14 (13 to 15); horizontal scale rows 8 (7 or 8); vertical scale rows 36 (34 to 37); predorsal scales 16 (13 to 16) ($\bar{x}$ = 15, N = 36); preopercle scales 13 (9 to 16) ($\bar{x}$ = 13, N = 36); gill rakers on first arch 4 + 15 (2 to 4 + 14 or 15).

Greatest body depth 39.2, greatest depth of paratypes by sex and size class as follows: *males*–(a) 36-49 mm SL, 31.4-36.2 ($\bar{x}$ = 34.3, N = 8), (b) 50-69 mm SL, 36.0-40.1 ($\bar{x}$ = 38.0, N = 5); *females*–(a) 35-49 mm SL, 29.1-35.4 ($\bar{x}$ = 32.9, N = 16), (b) 50-65 mm SL, 31.6-36.9 ($\bar{x}$ = 33.5, N = 19); head length 26.1 (26.5-28.8); snout length 8.2 (7.6-9.2); eye diameter 7.7 (7.3-9.6); interorbital width 10.1 (8.6-11.2); caudal peduncle depth 11.0 (9.9-12.0); caudal peduncle length 15.1 (13.1-18.3); predorsal distance 48.1 (46.9-51.9); preanal distance 53.7 (50.9-57.3); prepelvic distance 37.6 (36.1-41.3).

Jaws about equal, oblique, premaxilla with an abrupt bend between the anterior horizontal portion and lateral part; maxilla ends opposite front border of eye or slightly beyond this level; lips thin; teeth conical with slightly curved tips, arranged in dense bands in upper and lower jaws; teeth at front of upper jaw in 4 or 5 irregular rows, reduced to 1 or 2 posteriorly; teeth of upper jaw and middle portion of lower jaw extending outside of mouth onto lip; teeth at front of lower jaw in about 6 to 8 irregular rows, tapering to 1-3 rows posteriorly; a narrow edentulous space at symphysis of lower jaw; several rows of small, conical teeth on vomer; palatines with a narrow band of similar teeth..

Scales relatively large, arranged in regular horizontal rows; most of body scales with slightly crenulate margins; predorsal scales extending to posterior portion of interorbital; preopercle scale rows from posterior angle to edge of eye 2 or 3.

First dorsal fin originates about one-half eye diameter in front of level of anal fin origin; first dorsal spine 9.1 (8.7-12.0); longest (3rd or 4th) spine of first dorsal fin 13.0 (10.9-16.9), its tip just reaching base of 2nd dorsal fin origin in females and base of 1st or 2nd soft ray of second dorsal fin in males when depressed. Spine of second dorsal fin 7.4 (7.2-10.4); longest (rays approximately uniform height in females, usually penultimate is longest in males) soft ray of second dorsal fin 13.5 (10.1-16.3); depressed posterior rays of second dorsal fin extends back about ½-⅔ length of caudal peduncle in females and nearly to caudal fin base in males. Anal fin spine 6.6 (6.2-8.7); longest (most rays of uniform height) anal rays 11.4 (9.6-14.1). Soft dorsal and anal fin rectangular in outline, the posterior rays somewhat elongate and pointed in males. Pelvic fin tips when depressed not reaching base of anal spine in females and extending to base of spine or 1st soft anal ray in males; length of pelvic fin 17.1 (15.1-19.1). Pectoral fins pointed, the length 19.3 (17.6-23.8). Caudal fin moderately forked, its length 20.8 (20.2-26.7).

Colour in alcohol: generally reddish-brown on back and anterior half of body grading to yellowish or tan posteriorly and silvery on abdomen and breast region (although scales in this area with dusky margins); series of red-brown horizontal stripes, one per scale row, and separated by pale lines, on sides, most prominent in females; mid-lateral stripe usually more distinct, slightly blackish in colour and continuing across opercle to rear edge of eye; 2 or 3 blackish vertical bars on lower half of sides near middle of body frequently present in adult males (in excess of about 60 mm SL); most of body scales with narrow dark outlines; first dorsal fin dusky brown; second dorsal fin mainly translucent with white margin and faintly blackish sub-marginal band; caudal fin slightly dusky brown; anal fin similar to second dorsal fin except it lacks white margin; pelvic and pectoral fins pale with dusky rays.

Colour in life (from field notes): ground metallic blue to yellowish or green with orange and yellow longitudinal stripes and dark scale edges.

Remarks

Morphological comparisons and ecological data are provided for this species under the remarks section for *M. boesemani,* its closest relative. It further differs from this species by being more slender (compare depth data in the descriptions), and by having the first dorsal fin origin in front (by about one-half eye diameter) of the anal fin origin compared to the approximately even position of these fins in *M. boesemani.*

Examination of the gonads of selected types indicates sexual maturity is attained between 40-45 mm SL.

The species is named *ajamaruensis* with reference to the Ajamaru Lakes, the type locality and only collection site for this species thus far. The local name for this specis is 'sigak' according to field notes.

Melanotaenia japenensis sp. nov.
(Fig. 3)

Holotype

RMNH 28140, male, 76.8 mm SL, collected near Serui, Japen Island, Irian Jaya, Indonesia (approximately 1°54′S, 136°14′E) by M. Boeseman on 9 May 1955.

Paratypes

RMNH 28141, females, 2 specimens, 56.5 and 59.8 mm SL, collected with holotype.

Diagnosis

A species of *Melanotaenia* with the following combination of characters: dorsal rays IV or V-I, 15 to 17; anal rays I, 26 to 28; pectoral rays 13; horizontal scale rows 9; vertical scale rows 36 or 37; predorsal scales 16 or 17; preopercle scale rows 21 to 23; greatest body depth 32.6 to 37.9 percent of standard length; colour overall light brown to pale tan with a faint longitudinal band of brown along middle of side.

Description

Data for counts and measurements are based on the holotype and two paratypes.

Dorsal rays IV-I, 16 (IV and V-I, 15 and 17); anal rays I, 26 (I, 26 and 28); pectoral rays 13; horizontal scale rows 9; vertical scale rows 36 (36 and 37);

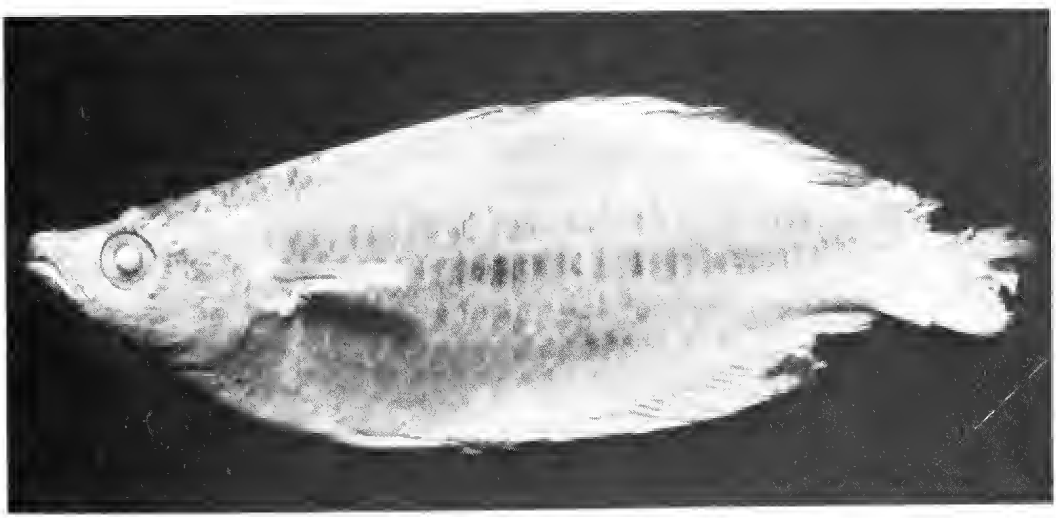


Fig. 3–*Melanotaenia japenensis,* holotype, 76.8 mm SL.

predorsal scales 16 (16 and 17); preopercle scales 22 (21 and 23); gill rakers on first arch 2 + 14 (2 + 13).

Greatest body depth 37.9 (32.6 and 33.6); head length 27.1 (27.8 and 27.9); snout length 8.3 (8.7 and 9.5); eye diameter 6.9 (8.4 and 8.5); interorbital width 9.1 (8.4 and 9.4); caudal peduncle depth 13.3 (11.5 and 12.0); caudal peduncle length 11.1 (14.2 and 14.3); predorsal distance 49.2 (48.5 and 49.4); preanal distance 49.6 (49.2 and 53.7); prepelvic distance 40.1 (40.5 and 42.5).

Jaws oblique, nearly equal, upper protruding slightly, premaxilla with an abrupt bend between the anterior horizontal portion and lateral part; maxilla extends slightly beyond level of front border of eye; lips thin; teeth conical with slightly curved tips, arranged in dense bands in upper and lower jaws; teeth at front of upper jaw in 5 to 7 irregular rows, reduced to 1 to 3 rows posteriorly, where they are most stout; teeth covering a substantial portion of lips outside mouth, particularly on upper jaw; teeth at front of lower jaw in about 5 or 6 irregular rows, tapering to 1 or 2 rows posteriorly; narrow edentulous space lacking at symphysis of lower jaw; several rows of small, conical teeth on vomer; palatines with a narrow band of similar teeth.

Scales relatively large, arranged in regular horizontal rows; most of body smooth or scales with slightly crenulate margins; predorsal scales extending to posterior portion of interorbital; preopercle scale rows from posterior angle to edge of eye 4 or 5.

First dorsal fin originates opposite anal fin origin or slightly behind this point; first dorsal spine 8.3 (8.0 and 8.4), its length is slightly (in females) to distinctly (in males) shorter than longest (usually 2nd or 3rd) spine; longest spine of first dorsal fin 13.4 (10.1 and 10.2), its tip reaching base of spine at beginning of second dorsal fin in females and 2nd soft ray in male holotype when depressed. Spine of second dorsal fin 8.1 (8.4 and 9.2); longest (6-8th in females, last or penultimate in male) soft ray of second dorsal fin 12.4 (12.7 and 13.5); depressed posterior rays of second dorsal fin extends back about ½-⅔ length of caudal peduncle in females and to caudal fin base in males. Anal fin spine 7.2 (7.6 and missing); longest (about 10th to 20th) anal rays 13.3 (11.4 and 12.0). Soft dorsal and anal fin rectangular in outline, the posterior rays somewhat elongate and pointed in males. Pelvic fin tips when depressed reaching to about base of anal spine in females and extending to base of 1st or 2nd soft anal ray in male; length of pelvic fin 14.2 (13.2 and 13.8). Pectoral fins pointed, the length 18.2 (15.6 and 17.7). Caudal fin damaged in all types, but probably slightly forked.

Colour in alcohol: overall light brown to pale tan, slightly lighter along ventralmost portion of head and body; dusky brown scale outlines on upper half of sides, most evident in female paratypes; a faint longitudinal band of brown nearly one scale wide along middle of sides, scarcely evident under pectoral fins, becoming most prominent on posterior half of body; fins white to dusky.

Remarks

Melanotaenia japenensis is clearly derived from the same phyletic line which includes *m. affinis* (Weber) and *M. vanheurni* (Weber & de Beaufort) of northern New Guinea. These species possess similar colour patterns and have dorsal and anal soft fin ray counts which are relatively high for the genus. However, *M. japenensis* differs from *M. affinis* by having a higher anal ray count (26-28 vs. 18-24, 41 specimens of *affinis* counted), and from *M. vanheurni* by having fewer soft dorsal rays (15-17 vs. 18-21 usually 19, 29 specimens of *vanheurni* counted). In addition, the male holotype of *M. japenensis* has a deeper body (37.9% of SL) compared to similar sized males of *M. vanheurni* (average 30.7% of SL for 4 specimens, 75-89 mm SL).

Melanotaenia japenensis is apparently restricted to Japen, a long (approximately 160 km), narrow island situated in the gulf (Teluk Sarera) on the north coast of Irian Jaya which isolates the Vogelkop Peninsula from the remainder of New Guinea (see **Map 1**). The island represents a continuation of a coastal mountain chain found on the nearby (30 km distance) New Guinea mainland and has a maximum elevation of 1500 m. Presumably speciation of *M. japenensis* has occurred in relatively recent times as a result of the separation of Japen from the mainland due to a post pleistocene rise in sea level.

Both paratypes contain ripe eggs.

This species is named *japenensis* with reference to the type locality.

Melanotaenia oktediensis sp. nov.
(Fig. 4)

Melanotaenia cf. *vanheurni* (non Weber & de Beaufort), Roberts, 1978: 48, **Fig. 26b.**

Holotype

USNM 217127, female, 73.5 mm SL, collected with rotenone from lower portion of Karamonge Creek, a tributary of the Ok Tedi, Fly River System, 32 km NNE of Ningerum, Papua New Guinea (approximately 5°26.6′S, 141°17.4′E), by T. Roberts, 1 November 1975.

Paratypes

PNG F.4214-02, females, 2 specimens, 85.5 and 99.0 mm SL, collected in the Ok Tedi River at Tabubil, Papua New Guinea (approximately 5°17′S, 141°13′E), by C. Boyden, 5-22 July 1974.

Diagnosis

A species of *Melanotaenia* with the following combination of characters:

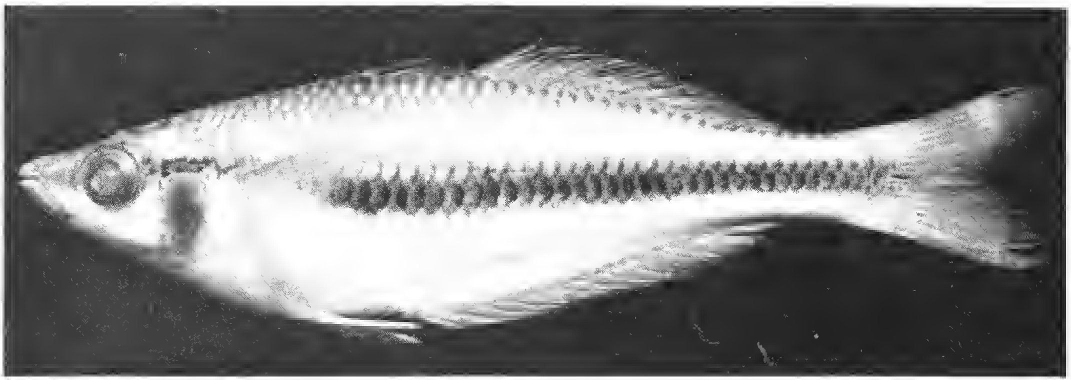


Fig. 4–*Melanotaenia oktediensis*, holotype, 73.5 mm SL.

dorsal rays V or VI-I, 18 or 19; anal rays I, 24 to 26; pectoral rays 14 or 15; horizontal scale rows 11; vertical scale rows 36 to 39; predorsal scales 13 to 15; preopercle scales 15 to 22; colour brown on upper half of body and white on lower portion, prominent black mid-lateral stripe along middle of side; five horizontal scale rows between first dorsal fin origin and black mid-lateral stripe.

Description

Data for counts and measurements are based on the holotype and two paratypes.

Dorsal rays VI-I, 19 (V-I, 19 and VI-I, 18); anal rays I, 26 (I, 24); pectoral rays 15 (14 and 15); horizontal scale rows 11; vertical scale rows 39 (36 and 37); predorsal scales 14 (13 and 15); preopercle scales 15 (21 and 22); gill rakers on first arch 2 + 15.

Greatest body depth 28.6 (33.3 and 33.9); head length 26.5 (26.9 and 27.5); snout length 8.2 (8.2 and 8.3); eye diameter 9.3 (7.3 and 8.2); interorbital width 9.5 (9.6 and 9.9); caudal peduncle depth 9.8 (10.9 and 11.2); caudal peduncle length 19.0 (15.8 and 16.7); predorsal distance 42.6 (41.0 and 45.0); preanal distance 49.3 (51.6 and 52.7); prepelvic distance 38.1 (40.0 and 40.1).

Jaws oblique, nearly equal, upper protruding slightly, oblique, premaxilla with an abrupt bend between the anterior horizontal portion and lateral part; maxilla extends slightly beyond level of front border of eye; lips thin; teeth conical with slightly curved tips, arranged in dense bands in upper and lower jaws; teeth at front of upper jaw in 4 or 5 irregular rows, reduced to 1 or 2 rows posteriorly; teeth covering a substantial portion of lips outside mouth, particularly on upper jaw; teeth at front of lower jaw in about 6 to 8 irregular rows, tapering to 1 or 2 rows posteriorly; a narrow edentulous space at symphysis of lower jaw; several rows of small, conical teeth on vomer; palatines with a narrow band of similar teeth.

Scales relatively large, arranged in regular horizontal rows; most of body scales smooth or with slightly crenulate margins; predorsal scales extending to posterior portion of interorbital; preopercle scale rows from posterior angle to edge of eye 2 or 3.

First dorsal fin originates about ½ to one full eye diameter ahead of level of anal fin origin; first dorsal spine 9.7 (8.6 and 9.6); longest spine (3rd) of first dorsal fin 14.4 (13.0 and 14.4), its tip reaching base of 1st or 2nd soft ray of second dorsal fin in female types when depressed. Spine of second dorsal fin 9.4 (7.6 and 9.4); soft rays of second dorsal fin about equal in length, anterior rays slightly longer, 11.8 (10.3 and 12.0); depressed posterior rays of second dorsal fin extends to about middle length of caudal peduncle in female types. Anal fin spine 6.5 (5.6 and 7.4); soft anal fin rays about equal in length, longest 11.6 (9.6 and 11.1). Soft dorsal and anal fin rectangular in outline. Pelvic fin tips when depressed not reaching base of anal spine in paratypes and extending to base of 1st soft anal ray in holotype; length of pelvic fin 15.0 (15.2). Pectoral fins pointed, the length 20.4 (16.2 and 18.7). Caudal fin moderately forked, its length 21.9 (21.4 and 22.8).

Colour in alcohol: brown on upper half of body with dusky scale outlines, white or pale yellow on lower portion; prominent black longitudinal band along middle of sides extending from pectoral region to caudal fin base, about 2 scales wide; operculum dusky brown, dotted with numerous chromatophores; dorsal fins dusky brown, slightly darker on outer edge; caudal fin dusky suffused with yellowish; anal fin primarily whitish with outer edge dusky brown; pelvic and pectoral fins translucent. The paratypes are generally lighter than the holotype, perhaps because of their longer preservation.

Remarks

Melanotaenia oktediensis appears to be closely related to *M. vanheurni* from the Mamberamo basin in northern New Guinea. Both species have a relatively elongate body shape (although the males of *oktediensis* are unknown), a prominent mid-lateral black band, and are characterised by relatively numerous soft dorsal and anal fin rays. The most significant difference is the position of the mid-lateral stripe, which is lower on the side in *M. oktediensis*. The stripe in this species is positioned at a level which is even with the middle of the pectoral fin base and there are five horizontal scale rows between the stripe and first dorsal fin origin. In *M. vanheurni* the stripe is level with the uppermost portion of the pectoral fin base and there are 3-3½ scale rows between it and the dorsal fin origin. Moreover, the stripe of *M. vanheurni* is usually bordered above, at least posteriorly, by a narrow pale stripe, a feature which is lacking in *M. oktediensis*. Also in *vanheurni* the stripe continues uninterrupted to the eye, whereas in *m. oktediensis* it commences about one eye diameter behind the pectoral fin base. Comparisons were made with 86 specimens of *M. vanheurni* deposited at the Zoologisch Museum, Amsterdam (ZMA) and the American Museum of Natural History, New York (AMNH).

Roberts (1978) reported that the holotype was collected at an altitude of approximately 450 m in water which was clear to slightly turbid. The type locality lies 934 km upstream from Toro Pass at the mouth of the Fly River (see **Map 1**).

Ripe eggs were present in all type specimens. The gut contents indicate a diet consisting mainly of small insects.

The species is named *oktediensis* with reference to the Ok Tedi River system, the only locality from which it has been collected.

Glossolepis pseudoincisus sp. nov. (Fig. 5)

Holotype

RMNH 28072, male, 75.7 mm SL, collected from ox-bow lake next to Tami River, 23 km SE of Jayapura, Irian Jaya, Indonesia (approximately 2°42'S, 140°55'E) by M. Boeseman on 19-21 November 1954.

Paratypes (collected with holotype)

LBN 2489, 4 specimens, 41.3-63.9 mm SL; RMNH 28073, 41 specimens, 33.1-78.5 mm SL; USNM 220907, 4 specimens, 48.0-67.4 mm SL; WAM P26793-001, 5 specimens, 60.2-76.9 mm SL.

Diagnosis

A species of *Glossolepis* with the following combination of characters: dorsal rays V or VI-I, 10 to 12; anal rays I, 18 to 22; pectoral rays 13 or 14; horizontal scale rows 12 to 16; vertical scale rows 38 to 43; predorsal scales 27 to 34;

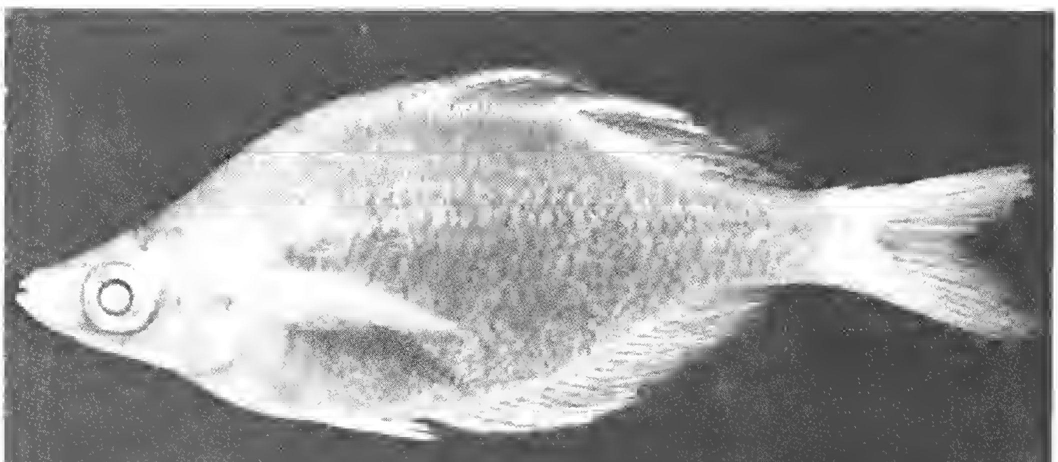


Fig. 5–*Glossolepis pseudoincisus,* holotype, 75.7 mm SL.

preopercle scales 21 to 29; gill rakers on first arch 6 to 9 + 26 to 30; predorsal distance greater than preanal distance; colour generally brown, darker on upper sides with silvery sheen on lower half of side and head; pectoral and pelvic fins pale.

Description

Data for counts and measurements are based on the holotype and 20 paratypes, 58.8-78.5 mm SL.

Dorsal rays V-I, 10 (V or VI-I, 10 to 12); anal rays I, 21 (I, 18 to 22); pectoral rays 14 (13 or 14); horizontal scale rows 15 (12 to 16); vertical scale rows 40 (38 to 43); predorsal scales 32 (27 to 34) ($\bar{x}$ = 31, N = 39); preopercle scales 26 (21 to 29) ($\bar{x}$ = 25, N = 39); gill rakers on first arch 6 + 28 (6 to 9 + 26 to 30).

Greatest body depth 41.0, greatest depth of paratypes by sex and size class as follows: *males*–(a) 46-49 mm SL, 31.9-32.6 ($\bar{x}$ = 32.1, N = 3), (b) 50-69 mm SL, 33.5-43.0 ($\bar{x}$ = 38.0, N = 12), (c) 70+ mm SL, 36.7-40.8 ($\bar{x}$ = 38.9, N = 5); *females*–(a) 47-49 mm SL, 31.9-35.4 ($\bar{x}$ = 33.2, N = 4), (b) 50-69 mm SL, 31.4-38.3 ($\bar{x}$ = 34.8, N = 11), (c) 70+ mm SL, 36.3 (N = 1); head length 28.5 (27.7-30.5); snout length 8.7 (7.6-9.4); eye diameter 9.6 (9.7-11.0); interorbital width 9.0 (8.9-10.6); caudal peduncle depth 10.8 (10.2-11.9); caudal peduncle length 18.0 (16.1-19.5); predorsal distance 54.8 (51.3-56.3); preanal distance 50.2 (48.7-53.4); prepelvic distance 35.9 (34.3-38.1).

Jaws about equal, oblique, premaxilla with an abrupt bend between the anterior horizontal portion and lateral part; maxilla ends well in front of anterior border of eye; lips thin; teeth conical with slightly curved tips, those in outer row stouter; teeth in upper jaw arranged in about 2 or 4 irregular rows anteriorly, reduced to a single row posteriorly, where they are most stout and extend outside the mouth onto the lip; about 35-50 teeth in outer row of upper jaw; teeth at front of lower jaw in about 5 rows reduced to a single row posteriorly, outer row consisting of 4 to 8 strong curved teeth on each side of symphysis; no edentulous space between outer row teeth and those inside; a narrow edentulous space at symphysis of lower jaw; several rows of small, conical teeth on vomer; palatines with a narrow band of similar teeth.

Scales moderate sized, arranged in regular horizontal rows; most of body scales with strongly crenulate margins; predorsal scales extending to posterior portion of interorbital; preopercle scale rows from posterior angle to edge of eye 3 or 4.

First dorsal fin originates opposite anal fin origin or slightly behind this level; first dorsal spine 14.7 (14.5-17.8), its length is slightly greater (in females) to slightly shorter (in males) than longest (usually 2nd or 3rd) spine; longest spine of first dorsal fin 16.5 (13.0-16.9), its tip reaching base of 2nd dorsal fin origin or slightly beyond this level when depressed. Spine of second dorsal fin 16.0 (12.2-21.5); longest (1st in females, about 4th to 8th in males) soft ray of second dorsal fin 14.5 (12.7-19.3); depressed posterior rays of second dorsal fin extends back to middle of caudal peduncle in females and about ⅔-¾ length of caudal peduncle in mature males. Anal fin spine 9.8 (9.1-12.2); longest (about 4th to 8th) anal rays 15.9 (13.8-17.0). Soft dorsal and anal fin rectangular in outline. Pelvic fin tips when depressed reaching base of anal spine in females and extending slightly beyond this level in males; length of pelvic fin 17.8 (15.2-18.0). Pectoral fins pointed, the length 26.2 (21.5-26.4). Caudal fin moderately forked, its length 25.8 (26.1-28.7).

Colour in alcohol: generally brown, darker on upper sides, lower half of sides and most of head with silvery sheen; dorsal and anal fins dusky brown with translucent rays; caudal fin pale tan with slight duskiness; pectoral and pelvic fins translucent.

Remarks

Allen & Kailola (1979) discussed the taxonomy of *Glossolepis* and provided a key to the three species contained in this genus: *G. incisus* Weber, *G. multisquamatus* (Weber & de Beaufort), and *G. wanamensis* Allen & Kailola. These fishes differ from other melanotaeniids by a combination of characters which includes distinctly crenulate scale margins, a high gill raker count, spine at the beginning of the second dorsal fin taller than first spine of first dorsal fin, relatively elongate pectoral fins, a unique premaxillary dentition and characteristic profile of the head, nape, and dorsal and anal fins.

TABLE 5

Fin-ray counts for type specimens of *Glossolepis pseudoincisus*

1st Dorsal fin spines

V	*VI*
15	25

2nd Dorsal fin soft rays

10	*11*	*12*
22	16	2

Anal fin soft rays

18	*19*	*20*	*21*	*22*
1	4	9	20	6

Pectoral fin rays

13	*14*
18	22

TABLE 6

Comparison of certain characters for *Glossolepis pseudoincisus* and *G. incisus*

Character	*G. pseudoincisus*	*G. incisus*
Horizontal scale rows	12-16	16-20
Vertical scale rows	38-43	50-60
Predorsal scales	27-34 ($\bar{x}$ = 31, N = 39)	30-36 ($\bar{x}$ = 36, N = 13)
Preopercle scales	21-29 ($\bar{x}$ = 25, N = 39)	26-38 ($\bar{x}$ = 31, N = 13)
Predorsal-Preanal distance	Predorsal > Preanal	Predorsal < Preanal
Pectoral fin colour	uniformly pale	outer portion dusky brown
Pelvic fin colour	mainly pale	mainly dusky brown

The four members of the genus are restricted to northern New Guinea. All except *G. multisquamatus*, from the Sepik and Mamberamo Rivers, appear to have extremely limited distributions. *Glossolepis incisus* is known only from Lake Sentani, which lies approximately 30 km west of the single collection site for *G. pseudoincisus*, and *G. wanamensis* is known only from Lake Wanam, near Lae, Papua New Guinea. *Glossolepis pseudoincisus* is most closely allied to *G. incisus*. They differ from the other members of the genus by possessing more gill rakers on the first arch (26-32 *vs.* 19-23) and by having more pronounced crenulations on the scale margins. These species differ from one another on the basis of the characters presented in **Table 6** below.

Boeseman (1963) gave a detailed description of the type locality (see **Map 1**) in the Tami River region near Hollandia (now Jayapura). The site represents an isolated ox-bow lake of the Tami River with an estimated width of 35-40 m and uncertain depth. The lake is surrounded by heavy rainforest and steep banks. At the time of collection the bottom was muddy with areas of dense aquatic vegetation.

TABLE 7

Proportional measurements of selected type specimens of *Glossolepis pseudoincisus* (expressed as a percentage of the standard length)

	Holotype RMNH 28072	Paratypes RMNH 28073	WAM P26793-001	RMNH 28073	RMNH 28073	RMNH 28073
	male	male	male	female	female	female
Standard length (mm)	75.7	78.5	64.0	71.8	66.0	59.0
Depth	41.0	37.6	43.3	37.2	37.3	35.4
Head length	28.5	28.8	29.7	29.9	29.5	29.7
Snout length	8.7	8.5	7.8	8.4	8.5	8.1
Eye diameter	9.6	9.7	11.1	10.9	10.3	11.2
Bony interorbital width	9.0	9.6	9.8	9.7	9.5	9.3
Maxilla length	7.3	7.1	7.2	7.7	7.6	7.8
Depth of caudal peduncle	10.8	10.6	11.7	10.9	11.1	10.8
Length of caudal peduncle	18.0	18.0	16.6	18.7	17.1	16.9
Snout to 1st dorsal fin origin	54.8	54.8	53.6	54.7	52.3	54.2
Snout to anal fin origin	50.2	50.1	51.9	52.2	51.5	53.4
Snout to pelvic fin origin	35.9	36.3	35.6	37.6	36.1	37.8
Length of 1st dorsal fin base	10.0	9.9	13.0	9.7	10.6	11.0
Length of 2nd dorsal fin base	18.6	18.1	20.0	19.1	18.8	20.0
Length of anal fin base	38.6	37.5	39.8	36.6	36.8	37.6
Length of pectoral fin	26.2	24.8	25.2	22.8	23.2	23.4
Length of pelvic fin	17.8	17.6	17.5	15.5	15.2	15.6
Longest ray of 1st dorsal fin	16.5	15.9	16.4	15.2	15.2	15.3
Longest ray of 2nd dorsal fin	14.5	14.5	13.9	16.3	16.8	18.8
Longest anal ray	15.9	16.3	16.1	14.5	14.2	14.6
Length of caudal fin	25.8	26.8	28.1	26.5	27.3	21.2*

*damaged

The gut contents of the types indicate a diet consisting mainly of small insects (such as ants) with lesser amounts of tiny crustaceans and algae. The gonads were poorly preserved and it was therefore difficult to determine the minimum size at maturation. The smallest ripe female examined was 47 mm SL.

The species is named *pseudoincisus* with reference to its similar appearance and geographic proximity to *Glossolepis incisus*.

ACKNOWLEDGEMENTS

We are greatly indebted to Dr M. Boeseman of RMNH for the loan of his valuable collections from Irian Jaya which formed the basis of this study. We also thank Dr L. Knapp of USNM and Dr T. Roberts of the Tiburon (California) Center for Environmental Studies for providing the holotype of *M. oktediensis*, and Mr B. Smith of PNG for the paratypes of this species. Dr H. Nijssen of ZMA and Dr D. Rosen of AMNH sent loans of specimens used for comparisons. Finally, we thank Mrs C. Allen for her careful preparation of the typescript.

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A NEW *BRACHYASPIS* (SERPENTES: ELAPIDAE) FROM WESTERN AUSTRALIA

G.M. STORR*

ABSTRACT

A new species of snake *Brachyaspis atriceps* is based on two specimens from Lake Cronin in the southern interior of Western Australia.

INTRODUCTION

The generic classification of the Australian Elapidae urgently requires revision, none more so than the small snakes with undivided anal and subcaudals. The placing of the present species in *Brachyaspis* is therefore only tentative.

Brachyaspis atriceps sp. nov.

Holotype

R67330 in Western Australian Museum, collected on 6 October 1979 by P. Griffin and G. Barron in open eucalypt woodland on sandy loam at Lake Cronin, Western Australia, in 32°23'S, 119°45'E.

Diagnosis

A small elapid snake with large black head; large, somewhat obtrusive eyes; narrow neck; 19 scale rows at midbody; anal and subcaudals single. Further distinguishable from *B. curta* (Schlegel) by head parallel-sided in plan (rather than widest at rear, from which it steadily narrows towards pointed snout), fewer temporals, longer tail, more numerous ventrals and subcaudals, and iris entirely golden orange (rather than uppermost sector only). Further distinguishable from *Denisonia suta* (Peters) by lack of pale stripe through eye, longer tail and more numerous subcaudals.

* Western Australian Museum, Francis Street, Perth, Western Australia 6000.

Fig. 1. Holotype of *Brachyaspis atriceps* photographed in life by G. Barron at type locality.

Distribution

Only known from two specimens from one locality in semi-arid southern interior of Western Australia.

Description

Snout-vent length (mm): 379 (holotype), 430 (paratype). Length of tail (% SVL): 17.9, 18.2. Weight of holotype: 18 g.

Rostral wider than high. Internasals less than half as long as prefrontals. Frontal nearly twice as long as wide; anterior facet almost straight, i.e. transverse; sides almost parallel; a little wider than supraocular. Nasal entire, long and narrow (widest at contact with rostral). Preocular in short contact with nasal, widely separated from frontal. Postoculars 2, subequal. Temporals 2 + 2; lower primary much the largest, widely separated from lower postocular, in contact with lip (in point contact in paratype and on one side of holotype; in moderately broad contact on other side of holotype). Upper labials 6. Lower labials 7. Dorsals narrow near midline, gradually widening on sides; not striate; in 19 rows at mid-body, reducing to 13 well before cloaca. Anal entire. Subcaudals 48, 46; single. Ventrals 179, 177.

Top and sides of head matt black, upper lips narrowly edged with white. First transverse row of scales behind black of neck partly brownish white. Rest of upper and lateral surfaces moderately dark brown. Lower labials and chin shields greyish black, each with a wide central white streak. Gulars and first few ventrals whitish, anteriorly edged broadly and irregularly with blackish grey. Rest of under parts very pale reddish brown.

Paratype

Eucla Division (W.A.): Lake Cronin (29770).

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A POSSIBLE PENDANT OF MARL FROM DEVIL'S LAIR, WESTERN AUSTRALIA

C.E. DORTCH*

ABSTRACT

A perforated fragment of marl recovered from a part of the Devil's Lair cave deposit radiocarbon dated 12 000 to 19 000 BP is interpreted as a possible pendant.

In 1973 Western Australian Museum excavators recovered a small perforated piece of stone, possibly an ornamental pendant (Fig. 1), from the floor deposit in Devil's Lair cave in the 'Coastal Limestone' of extreme south-western Western Australia. This specimen, registered B3653 in the Western Australian Museum archaeological collection, is from Trench 8_7, layer 0, depth 136-142 cm below Cave Datum (*cf.* stratigraphical sections in Dortch 1979 a, 1979 b, 1979 c). An age of perhaps 14 000 BP for this specimen is suggested by interpolation of two pairs of radiocarbon dates, respectively 12 000 and 19 000 BP, for layers above and below layer 0 (Dortch 1979 b, Table 1; Dortch and Merrilees 1973, Table 1).

Dr A.E. Cockbain, Western Australian Geological Survey, has identified the light grey stone as a marl with scattered, rounded quartz grains, and states that it is not typical of the south-western 'Coastal Limestone' though it could have come from an interdunal swamp within this formation (pers. comm. A.E. Cockbain). It is suggested here that a human being brought the piece into Devil's Lair or its immediate vicinity.

The object weighs 18.65 gm; it has a maximum thickness of 12 mm; a maximum length of 55 mm; and its central perforation is 6.5 mm in diameter. With the exception of three fracture surfaces terminating its lower neck-like extremity (as oriented in Fig. 1) the piece has generally softly rounded or blunted edges. These three fracture surfaces do not seem to be as weathered as the rest of the piece, suggesting that it may not be complete; only the largest fracture (measuring 12 x 7 mm) could represent the removal of a relatively large amount of material.

* Western Australian Museum, Francis Street, Perth, Western Australia 6000.

Recent re-examination of the object's surfaces, including the edges of the perforation, shows no definite marks of artificial shaping (*cf.* Dortch 1979 b, p. 269). Yet it is considered that the perforation was produced by boring or gouging perhaps from both faces, judging by its asymmetric biconical section, formed by an adjacent hollow on each face (*cf.* Fig. 1). Possibly these hollows result from abrasion by a gouging tool wielded at a very low angle so that its shaft was in contact with a part of the face adjacent to the perforation.

No function has been determined for this object. Since the stone is soft it could have served as pigment; or the perforation could perhaps have been used for polishing the tips or shafts of wooden artifacts or of bone points as found in the Devil's Lair deposit (Dortch 1979 b). In the absence of more plausible functions it is conceivable that the piece is an ornamental pendant.

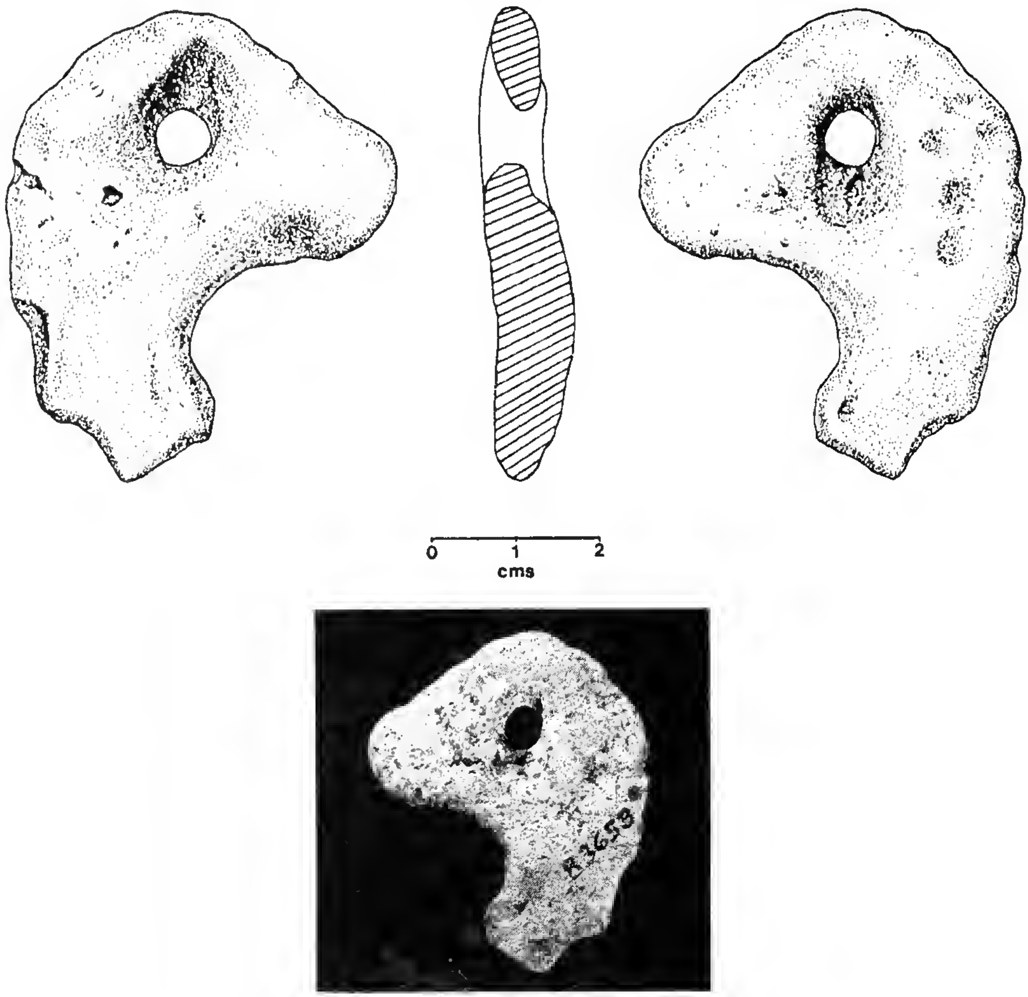

Fig. 1: Photograph and scale drawing of a possible pendant of marl from Devil's Lair, Western Australia.

Its resemblance in plan view to the profile of a bird's head, e.g. a Wood Duck, may be purely fortuitous though this possibility, however remote, should be considered. It may be significant that the position of the perforation is essential to the bird's head likeness; in other possible positions, even a few mm away, the resemblance would be very much decreased. It should also be noted that the two faces of the beak-like protuberance converge at an acute angle to form a narrow though still smoothly contoured edge.

The least that can be said about this object is that it is humanly transported. Following that, it is reasoned that it is probably an artifact, and is possibly an ornament, judging by its size, weight and pendant-like appearance, and the absence of any features suggesting a utilitarian function. If the object is a perforated stone pendant it is by far the oldest known example of this rare Australian artifact class (*cf.* McBryde 1968, pp. 82-83; Massola 1970). Because of the object's weathered condition there seems no way of confirming the possibility of its being an artifact by means of microscopic examination; and it is virtually impossible to assess the likelihood of its being an ornament given the very limited data presently available for late Pleistocene Aboriginal material culture. Nevertheless it seems reasonable to assume that the occupants of Devil's Lair, who manufactured a variety of sophisticated stone and bone artifacts including bone beads (Dortch 1979 a, 1979 b), were also capable of making and perhaps disposed to wearing perforated stone pendants; if they were it is plausible that some could have been shaped to represent familiar species.

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A NEW SPECIES OF *PSEUDOMYS* (RODENTIA:MURIDAE) FROM WESTERN AUSTRALIA.

D.J. KITCHENER*

ABSTRACT

Pseudomys chapmani sp. nov., a lithophilous rodent, is described from the Pilbara, Western Australia, and is compared to *P. hermannsburgensis* with which it is sympatric.

INTRODUCTION

Recently four rodent specimens were collected by J.N. Dunlop from East Hammersley Range, Pilbara District, Western Australia. These specimens differed in external morphology, and skeletal and dental characters from the closely related *Pseudomys hermannsburgensis*. Further specimens of this hitherto unrecognised form, here described as a new species, were located in the collections of the Western Australian Museum—including specimens from Woodstock Homestead, Pilbara, where they had been collected in sympatry with *P. hermannsburgensis*.

SYSTEMATICS

Pseudomys chapmani sp. nov.
Figs 2, a-c, 3; Table 1

Holotype

Western Australian Museum Collection (WAM) Reg. No. M18251, adult male in alcohol with skull separate, pit-trapped by J.N. Dunlop on 15 June 1979.

Type Locality: 31 km. 136° Mt. Meharry (West Angelas Mine Site) (23°11′05″S, 118°47′31″E), on stony banks edging drainage lines at interphase of shallow red earths and gibber plain. (The red earths were vegetated with *Triodia*

*Western Australian Museum, Francis Street, Perth, Western Australia 6000

Fig. 1: Type locality of *Pseudomys chapmani*: the 'drift' fence leading to the pit trap from which the holotype was collected, is in the foreground among *Triodia pungens*. (photo: J.N. Dunlop)

pungens and *T. basedowii* with scattered *Acacia aneura*, *Cassia desolata* and *C. helmsii*; the gibber plain with *Eucalyptus gamophylla*, *E. oleosa*, *C. desolata* and *C. helmsii*) (**Fig. 1**).

Paratypes

Mount Edgar Homestead (21°18′S, 120°04′E), M5767, adult male, skinned carcase only, in alcohol with skull separate, collected by E.H.M. Ealey on 8 October 1957.

Woodstock Homestead (21°37′S, 118°57′E), M3419, adult female, M3420, juvenile—unknown sex, skulls only, both animals dug from same 'mound, with small stones on stony ridge' by S. Barker, field numbers 16 and 16A, respectively. Date of collection not recorded but catalogued on 25 June 1959.

White Springs Homestead (21°47′S, 118°48′E), M5865, adult male, M5866-68, juvenile males, all alcohol specimens with skull separate, collected by E.H.M. Ealey 'in stony mounts' on 18 September 1956.

West Angelas (23°11′05″S, 118°47′31″E), M18242 and M18249, both adult males, and M18250, adult female, pit-trapped at type locality by J.N. Dunlop between 15-18 June 1979.

Diagnosis

A member of the genus *Pseudomys,* distinguished from all other species of this genus by a combination of its small size, large auditory bullae and short and broad palatine foramina.

Description

Comparison is made throughout with *Pseudomys hermannsburgensis* (5 ♂♂, 2 ♀♀ from Woodstock Homestead, Pilbara, Western Australia), a species with which *P. chapmani* was confused in the past (see also measurements for both species in Table 1).

Skull (**Fig.** 2a-c)—in *P. chapmani* rostrum more slender as a result of slightly narrower nasals and premaxillae which do not bulge laterally to extent of

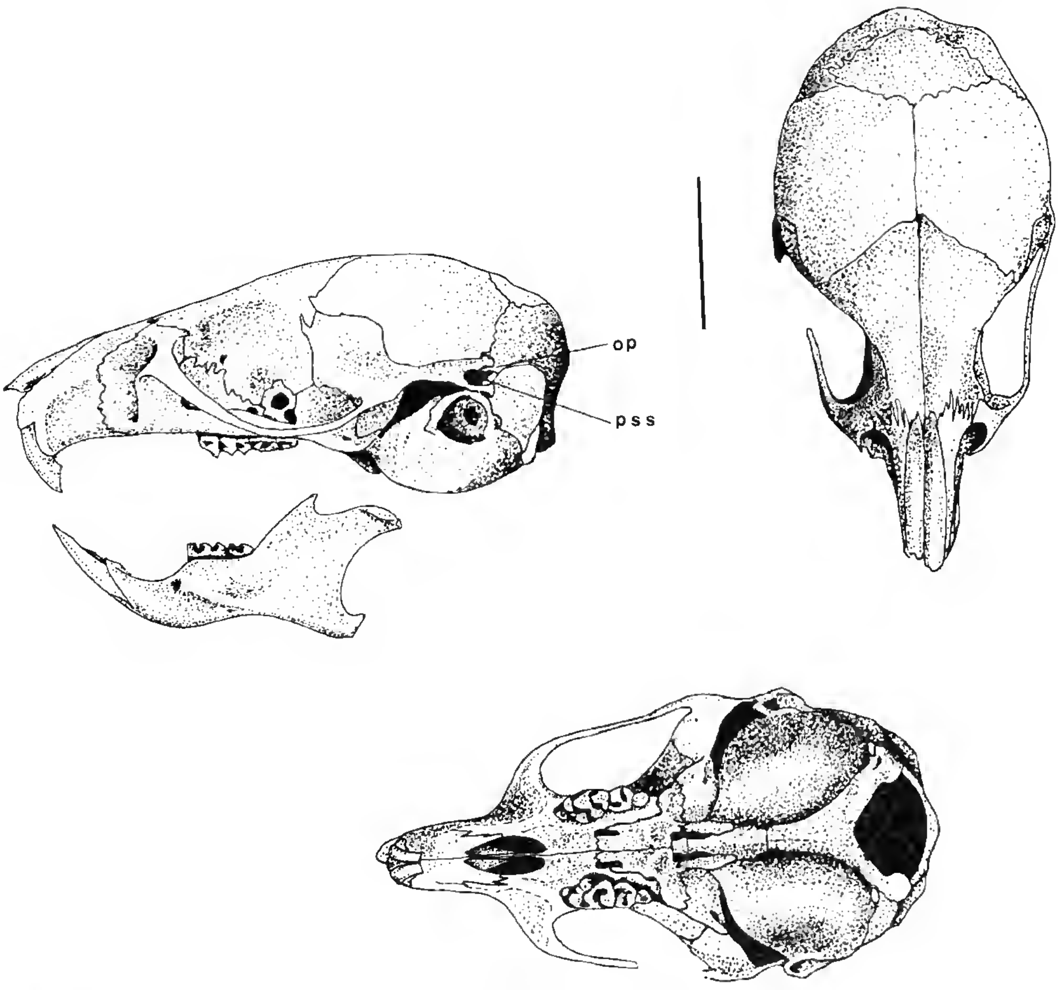

Fig 2 a—c: Ventral, dorsal and lateral view of skull of holotype of *Pseudomys chapmani* sp. nov. Scale line is 5 mm. op = occipital process, pss = post squamosal sinus.

TABLE 1. Measurements in mm of holotype and paratypes of *Pseudomys chapmani* and the mean ($\bar{x}$), standard deviation (SD), range, and number of measurements (N) from 5♂♂ and 2♀♀. *Pseudomys hermannsburgensis*. Body measurements taken from alcohol stored specimens.

TABLE 1

Pseudomys chapmani

Catalogue number	M3419	M3420	M5767	M5865	M5866	M5867	M5868
Locality	Woodstock Homestead	Woodstock Homestead	Mt Edgar Homestead	White Springs Homestead	White Springs Homestead	White Springs Homestead	White Springs Homestead
Sex	♀	?	♂	♂	♂	♂	♂
Age	adult	juvenile	adult	adult	juvenile	juvenile	juvenile
(a) Skull/Dental							
greatest length	21.5	16.8	21.5	22.0	17.2	17.5	–
nasal length	7.3	5.3	7.2	7.6	5.1	5.1	–
nasal width	1.9	2.0	2.0	2.0	1.9	1.9	–
interorbital width	3.2	3.3	3.3	3.3	3.1	2.9	3.1
zygomatic width	11.3	9.6	11.2	11.4	–	–	9.3
mastoid width	9.0	8.4	8.8	8.9	8.3	8.1	8.1
braincase width	10.7	10.0	10.7	11.0	9.7	–	9.5
braincase depth (basisphenoid to parietal)	7.2	6.4	7.0	7.1	7.0	–	7.1
palatal length	10.9	9.6	11.2	11.3	8.5	8.6	8.5
ant. palatal foramen length	3.5	2.5	3.3	3.5	2.6	2.7	2.6
basicranial length	17.6	14.0	17.3	18.0	13.8	13.6	13.8
*bulla length	5.5	4.6	5.6	5.7	4.9	4.8	4.9
bullae width	11.2	9.1	10.6	11.1	9.2	8.9	9.0
upper molar row length	3.7	+e.i.	3.7	3.7	e.i.	e.i.	e.i.
M^1 length	2.1	2.1	2.0	2.0	1.9	2.1	2.1
M^1 width	1.2	1.0	1.1	1.1	1.1	1.1	1.1
M^3 length	0.7	–	0.7	0.8	–	–	–
lower molar row length	3.5	e.i.	3.5	3.4	e.i.	e.i.	e.i.
coronoid tip to angle length	–	–	–	4.6	3.5	–	3.7
condyle to incisor tip length	13.0	10.4	12.5	13.2	10.4	10.3	10.2
(b) Body							
head and body length	–	–	–	59.2	38.1	37.7	40.5
tail length	–	–	–	63.6	31.5	31.3	30.4
hind foot length	–	–	–	15.2	11.1	11.6	11.3
ear (from notch)	–	–	–	9.7	4.7	4.2	4.5
weight (gm)	–	–	–	–	–	–	–

Pseudomys hermannsburgensis

2	M18249	M18250	M18251 holotype	M3418, M5587, M5583·1–·2 M7734, M5735–36			
as	West Angelas	West Angelas	West Angelas	Woodstock Homestead			
	♂	♀	♂	5♂♂, 2♀♀			
	adult	adult	adult	$\bar{x}$	SD	Range	N
	23.5	21.1	21.2	21.9	0.28	21.6-22.2	5
	7.5	6.4	6.9	7.5	0.33	7.2- 8.0	5
	2.1	2.0	2.0	2.2	0.08	2.1- 2.3	5
	3.4	3.4	3.4	3.3	0.20	3.0- 3.6	7
	11.6	10.8	10.8	11.3	0.23	11.0-11.6	7
	8.9	8.8	8.8	8.8	0.18	8.5- 9.0	6
	10.7	10.5	10.5	10.6	0.13	10.4-10.7	7
	7.2	7.0	6.9	6.9	0.16	6.6- 7.1	7
	12.0	10.9	10.7	11.1	0.32	10.7-11.6	7
	3.5	3.3	3.4	4.2	0.24	3.9- 4.6	7
	19.8	17.7	17.6	18.2	0.45	17.7-18.8	7
	6.5	5.7	5.7	5.0	0.15	4.8- 5.2	7
	11.0	10.7	10.6	10.5	0.18	10.3-10.8	6
	3.8	3.5	3.7	3.5	0.18	3.3- 3.8	7
	2.1	2.0	2.0	1.8	0.07	1.7- 1.9	7
	1.2	1.1	1.1	1.1	0.05	1.1- 1.2	7
	0.8	0.6	0.7	0.7	0.05	0.7- 0.8	7
	3.5	3.2	3.3	3.2	0.16	3.1- 3.5	7
	3.3	4.5	4.8	5.3	0.15	5.1- 5.4	3
	14.1	13.0	13.0	13.0	0.28	12.7-13.4	7
	65.1	52.2	56.0	58.7	3.80	56.6-64.6	6
	79.1	73.2	75.9	81.6	6.72	70.4-88.4	5
	15.4	15.1	15.2	16.7	0.41	16.1-17.0	6
	9.7	9.2	10.0	12.7	0.44	12.0-13.2	6
	12.0	7.5	9.0	–	–	–	–

* eustachian portion excluded
+e.i. = eruption incomplete

P. hermannsburgensis; nasals exceeding premaxillae; anterior edge of zygomatic plate straight and without backward inflexion at anterobasal edge of infra-orbital fissure; outline of parieto-squamosal suture strongly sigmoidal-shaped and more so than *P. hermannsburgensis;* post squamosal sinus deep, thin hook-like process of occipital intrudes along dorsal edge of sinus to about two-thirds its length (see **Fig. 2c**)—in *P. hermannsburgensis* this occipital process thicker, shorter and partly closes entrance of sinus; anterior palatine foramina short, broad and slightly oval-shaped, length not exceeding 3.5 mm or 32 per cent of palatal length and unlike *P. hermannsburgensis* terminating anterior to M^{11} alveoli, premaxillary part of median septum inflated, premaxillary-maxillary septal suture near middle; central body of presphehoid broad and flat narrowing anteriorly, with slight upward expansion encircling optic foramina; mesopterygoid fossa broad in front and not narrowing posteriorly as in *P. hermannsburgensis,* parapterygoid fossae broad and shallow with low ectopterygoids, entopterygoids project downwards, more so than in *P. hermanns burgensis;* bullae very large ranging in length in adults from 5.5 to 6.5 mm or 151 to 171 per cent of molar row length—compared to 132 to 152 per cent of molar row length in *P. hermannsburgensis.* Dentary with coronoid and condylar processes more slender and angular process with longer keel than in *P. hermannsburgensis,* these differences in shape reflected in distance between tips of coronoid and angular processes: in *P. chapmani* not exceeding 4.8 mm, and not less than 5.1 mm in *P. hermannsburgensis.*

Dentition—in *P. chapmani* upper incisors strongly opisthodont (**Fig. 2c**); as in *P. hermannsburgensis* laminae of molar cusps tilted backwards and labial cusps reduced; first loph of M^1 considerably elongated with accessory cuspule (slightly smaller than in *P. hermannsburgensis*) in all specimens except M5865 (its three presumed offspring, M5866-68, have accessory cuspules on M^1) (**Fig. 3**); first loph of M_1 bicuspid in three specimens, but to lesser degree than in *P. hermannsburgensis,* the lingual cusp being larger; m^3 small.

Externals—tail slightly longer than head and body with average ratio for adults of 1:0.82 but proportionately shorter than in *P. hermannsburgensis* (1:0.72); ears much shorter than the other species; hind foot narrow, short, not exceeding 16.0 mm; large plantar pads, particularly the hallucal and fourth interdigital pads; second interdigital pad reaches anteriorly half length of third interdigital pad (*cf.* three-quarters length in *P. hermannsburgensis*).

Pelage and skin colour—described following Ridgway's (1912) colour

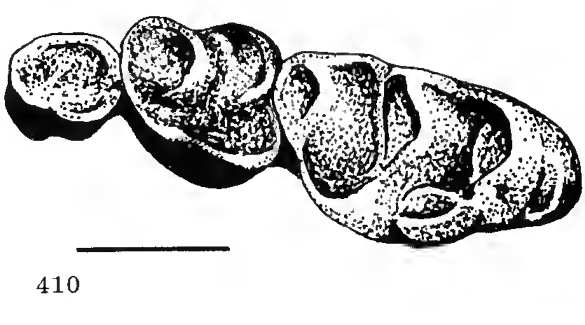

Fig. 3: Occlusal view of upper right molar tooth row of holotype of *Pseudomys chapmani* sp. nov. Scale line is 1 mm.

standard from the recently collected alcohol-preserved specimens from West Angelas, after careful drying. Predominant pelage colour on dorsal surface, including top of head, cheeks, rhinarium, arms and legs, is Avellaneous; on the back and head and rostrum this is tipped with Blackish Brown. The ventral surface of the body, including hands, feet, throat and beside the mouth, is White. The base half to two-thirds of all hairs is Deep Neutral Gray. Tail and ventral surface of feet and hands Dusky Drab, dorsal surface of feet and hands Cartridge Buff, ears Blackish Brown.

In comparison dried alcohol specimens of *P. hermannsburgensis* have a predominant pelage colour on dorsal surface of Clay Color; the ventral surface is White. The base of all hairs is Drab. Feet, hands and tail are Cream Buff. Hairs on tail about 1.5 mm long, average of 35 hairs/scale in both *P. chapmani* and *P. hermannsburgensis*.

Remarks

The genus *Pseudomys* Gray, 1832 was diagnosed by Thomas (1910) on the basis that the mammary formula of its species was $0-2=4$, with none having pectoral mammae. The skull was lightly built and without supraorbital ridges; the interorbital region was narrow, parallel-sided with rounded, or in a few species, squared edges.

Pseudomys chapmani is most similar to *P. hermannsburgensis* which was placed into the sub-genus *Leggadina* by Thomas (1910). *Leggadina* was characterised by him as having the following features: small size, straight or convex anterior zygomatic plate, narrow palatine foramina, broad and shallow parapterygoid fossae, low pterygoid processes, and molars with well-marked antero-internal cingular cusps on M^1, molar laminae tilted backwards, and labial cusps reduced in size.

Although both Iredale and Troughton (1934) and Tate (1951) considered *Leggadina* a full genus I have followed the opinions of more recent authorities, the development of which are summarized below, in placing both *P. chapmani* and *P. hermannsburgensis* in *Pseudomys* and restricting the use of *Leggadina* to the *'forresti'* group.

Originally, Thomas (1910) recognised four species within the sub-genus *Leggadina: P. delicatulus* (Gould, 1842), *P. hermannsburgensis* (Waite, 1896), *P. patrius* (Thomas and Dollman, 1909) and *P. forresti* (Thomas, 1906). Tate (1951) considered *Leggadina* to also include *L. waitei* (Troughton, 1932) and *L. messoria* (Thomas, 1925). Tate distinguished two main groups within *Leggadina:* the *forresti* group (also *L. waitei* and *L. messoria*) and the *delicatula* group (also *L. patria* and *L. hermannsburgensis*). Ride (1970), using Mahoney's concepts, again placed *Leggadina* as a sub-genus of *Pseudomys* and synonomysed *L. forresti, L. waitei* and *L. messoria* under *Pseudomys forresti.* Further, he considered *L. patria* a sub-species of *Pseudomys delicatulus.* Mahoney (in Morton, 1974) subsequently believed *'Leggadina* (Thomas, 1910)

Fig 4: Entrance to *P. chapmani* burrow in mound of pebbles, from the type locality. (photo: J.N. Dunlop)

to be generically distinct from *Pseudomys,* with *L. forresti* being the type species'. Watts (1976) supports Mahoney's view that only one species is involved in Tate's (1951) *L. forresti* group but describes a second species, *L. lakedownensis* Watts, 1976, in this group. Baverstock *et al.* (1976), based on chromosomal and biochemical evidence, supported the maintenance of *Leggadina* as a separate genus 'comprising only *L. forresti* and *L. lakedownensis.*

P. chapmani has been dug from burrow systems topped with small stony mounds (see **Fig. 4**) on several occasions, and at West Angelas is commonly trapped nearby such mounds (J.N. Dunlop pers. comm.). Recent extensive mammal surveys within Western Australia have collected numerous *P. hermannsburgensis* over much of the arid zone outside the Pilbara but have not found any 'pebble mounds'. Ride (1970) treated *P. chapmani* and *P. hermannsburgensis* as conspecific and used the name *P. hermannsburgensis* to include both forms covered by the common names Pebblemound Mouse and Sandy Inland Mouse.

Referred Specimens

Three female alcohol-stored specimens, but with skulls missing. They have the body proportions and hind-foot pad structure of *Pseudomys chapmani* and have the same collection data as *P. chapmani* M5865 to 68—and are probably part of the same social group. Their identity, however, cannot be absolutely confirmed because of the absence of their skulls for examination. M5864 is a female with four distended abdominal teats and probably lactating shortly before death; M5869 is a smaller but apparently adult female; and M5870 is a juvenile with body proportions similar to M5866-68.

Other Specimens Examined

Pseudomys hermannsburgensis (Waite, 1896): lectotype, Australian Museum No. M1070A, skin and skull, collected 1895 at Hermannsburg, Central Australia.

P. hermannsburgensis: CSIRO catalogue Nos Cm6032, 6058, 6061, 6063, 6065, 6074, 6078, 6375, skulls only, Central Australia.

Pseudomys hermannsburgensis bolami (Troughton, 1932): holotype, Australian Museum No. M4938, adult female, skin and skull, collected from Ooldea.

Pseudomys hermannsburgensis brazenori (Troughton, 1937): holotype, National Museum of Victoria, No. C984, skin and skull, collected from junction of the Murray and Darling Rivers on Blandowski Expedition of 1857.

ACKNOWLEDGEMENTS

Pseudomys chapmani is named after Andrew Chapman, formerly of the Mammal Department, Western Australian Museum. I am grateful to J.N. Dunlop for details and photograph of the type locality; and to J.H. Calaby, C.S.I.R.O., for loaning me specimens and for comparing *P. chapmani* with a new species of *Pseudomys (sensu lato)* which he is describing. Ms J. Dixon, National Museum of Victoria and B. Marlow, Australian Museum, kindly arranged for a loan of type specimens. A. Baynes, Western Australian Museum, criticised a draft manuscript.

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THE *CTENOTUS GRANDIS* SPECIES-GROUP (LACERTILIA: SCINCIDAE)

G.M. STORR*

ABSTRACT

This species-group consists of three spinifex-inhabiting taxa from the arid zone of the western half of Australia, viz. *C. g. grandis* Storr, *C. g. titan* nov. and *C. hanloni* nov.

INTRODUCTION

Financed by grants from Mr and Mrs W.H. Butler, the Western Australian Museum engaged two collecting parties in the North West Cape region in December 1978. One of them, comprising G. Harold and G. Barron, collected mammals and reptiles on the North West Cape peninsula. The other, comprising T.M.S. Hanlon and D. Knowles, collected reptiles mainly in the deserts south and south-east of Exmouth Gulf.

Harold and Barron collected a series of *C. grandis* ranging in snout-vent length from 103 to 120 mm. In the same period, but 50-100 km to the south-east, Hanlon and Knowles collected a series of *grandis*-like skinks with SVL 55-63. The second series also differed considerably in coloration from the first, and the field parties not unreasonably believed that two species were involved. In the laboratory, however, I found the second series to be compatible with my description of *C. grandis* and tentatively concluded that the specimens were immature.

Subsequently Andrew Chapman kindly dissected the second series and assured me that on the contrary it was adult. I then compared the second series directly with the first and found it to differ in several additional characters, e.g. the subdigital calli were much narrower, midbody scale rows, supraciliaries and palpebrals were fewer, the nasals were contiguous rather than separated, and the second loreal was narrower and had a high, angular apex.

It was clear now that the second series belonged to a new species, and it was only compatible with my description of *C. grandis* because that description was partly based on the new species. It thus became necessary to redescribe *C. grandis,* which itself proved to be divisible into two subspecies.

* Western Australian Museum, Francis Street, Perth, Western Australia 6000

Unless otherwise indicated, all material is lodged in the Western Australian Museum.

SYSTEMATICS

Ctenotus grandis species-group

Moderately small to very large *Ctenotus* with dorsal pattern of five dark stripes and lateral pattern of pale flecks on a dark ground. Three supraoculars in contact with frontal, the second much wider than third and usually wider than first. Fourth to penultimate supraciliaries noticeably smaller than others. Second loreal usually pentagonal with an angular apex in one taxon and occasionally so in others. Presuboculars usually two, rarely three. Upper labials usually 8. Midbody scale rows 30-38. Subdigital lamellae narrowly to widely callose (for description and illustration of this condition see Storr *et al.*, in press).

Ctenotus grandis grandis

Ctenotus grandis Storr, 1968, J. Proc. R. Soc. West. Aust. **51:** 100. 39 km ENE of Laverton, W.A.

Diagnosis

A large, stout, reddish brown member of the *C. grandis* group with nasals usually separated, supraciliaries seldom fewer than 8, and subdigital calli narrow to moderately wide.

Distribution

Great Sandy, Gibson and Great Victoria Deserts of Western Australia and the Tanami Desert of the Northern Territory (see **Fig. 1**).

Description

Snout-vent length (mm): 48-105 (N 25, mean 79.5). Length of appendages (% SVL): foreleg 24-29 (N 19, mean 26.3), hindleg 36-45 (N 19, mean 40.5), tail 163-218 (N 9, mean 195).

Nasals separated (N 24) or in short contact (2). Prefrontals in contact (N 24) or very narrowly separated (2). Supraciliaries 7-9 (N 20, mean 8.0), fourth to penultimate usually much smaller than others. Palpebrals (i.e. upper ciliaries) 10-13 (N 17, mean 11.5). Second loreal 0.9-1.5 times as wide as high (N 23, mean 1.21), top of scale usually bowed upwards. Upper labials 8 (N 22) or 9 (1). Nuchals 1-5 (N 24, mean 2.6). Ear lobules 4-7 (N 20, mean 5.6), usually acute or subacute, third usually (second or fourth occasionally) largest. Midbody

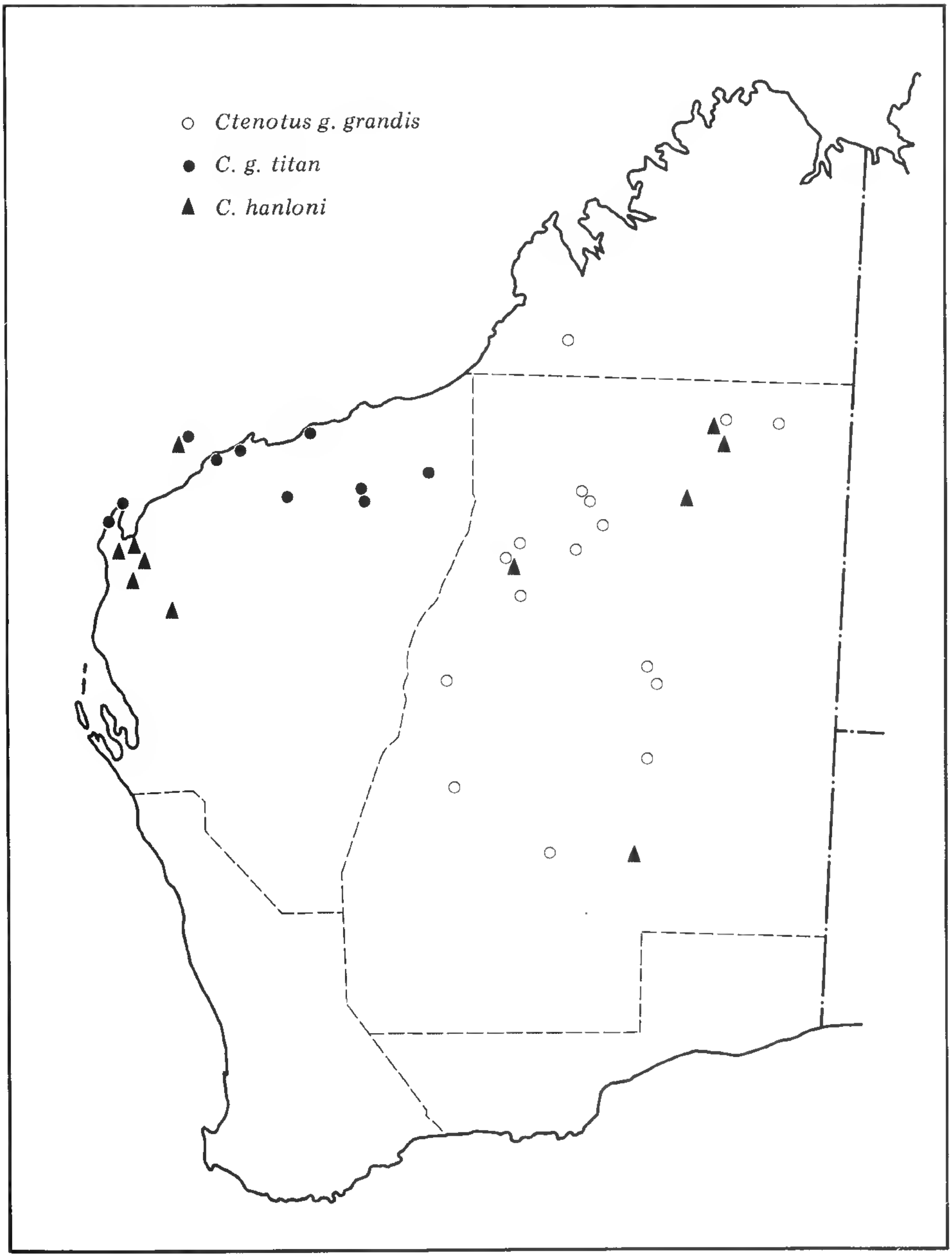

Fig. 1. Map of Western Australia showing location of specimens of *Ctenotus g. grandis*, *C. g. titan* and *C. hanloni*.

scale rows 30-32 (N 21, mean 31.0). Lamellae under fourth toe 21-28 (N 21, mean 23.0).

Head olive brown. Tail greyish brown. Back pale brown (dark chestnut in life) with 5 dark stripes: vertebral blackish brown; dorsal and laterodorsal dark brown, narrower and less priminent than vertebral and sometimes broken and barely discernible. Side of body dark greyish brown flecked with white, flecks tending to cluster and align vertically. Side of tail with irregular white or buff vertical bars edged with dark brown.

Material

Kimberley Division (W.A.): Edgar Ranges (18°55′S, 123°15′E) (54077).

Eastern Division (W.A.): Godfrey Tank (63416); Djalawon Creek (20°20′S, 127°26′E) (64128); Staffords Bore (20°21′S, 127°24′E) (64095); 38 km SSW of McTavish Claypan (20°56′S, 123°15′E) (64293); 50 km S of McTavish Claypan (21°02′S, 123°20′E) (64237); 12 km NNE of Well 29, Canning Stock Route (22°28′S, 123°55′E) (63954-5); 4 km S of Talbot Soak (22°34′S, 122°22′E) (63848); 29 km S of Nooloo Soak (22°52′S, 121°57′E) (63721, 63727, 63762); Well 26, CSR (3901); Durba Springs (23°45′S, 122°31′E) (51930, 51938-9); 8 km S of Charlies Knob (53605); 17 km NW of Mt Beadell (28813); S of Carnarvon Range (53646, 53672); 10 km SW of Manunda Rockhole (25941); 30 km SE of Mt Keith (27°24′S, 120°42′E) (62760); 23 km NE of White Cliffs (51072); 43 km E of Laverton (28830-1).

Northern Territory: 48 km SW of Wauchope (24334).

Plate 1. A *Ctenotus grandis titan* from Pannawonica photographed in life by G. Harold.

Ctenotus grandis titan subsp. nov.
Plate 1

Holotype

R61444 in Western Australian Museum collected on 17 December 1978 by G. Harold and G. Barron at 1 km S of Exmouth, Western Australia, in 21°56′S, 114°08′E.

Diagnosis

Differing from *C. g. grandis* in its greater size, paler coloration (in life), wider subdigital calli and more numerous midbody scale rows.

Distribution

Arid north-western Western Australia, i.e. the Pilbara with isolated populations on Barrow Island and the North West Cape peninsula (see **Fig. 1**).

Description

Snout-vent length (mm): 65-120 (N 27, mean 104.1). Length of appendages (% SVL): foreleg 23-29 (N 25, mean 25.2), hindleg 36-44 (N 25, mean 39.4), tail 152-218 (N 15, mean 189).

Nasals separated (N 22) or in short contact (4). Prefrontals in contact (N 22) or very narrowly separated (2). Supraciliaries 8 or 9 (7 on one side of one specimen, N 23, mean 8.3), fourth to penultimate usually much smaller than others. Palpebrals (i.e. upper ciliaries) 10-13 (N 20, mean 11.5). Second loreal 1.0-1.8 times as wide as high (N 25, mean 1.37), top of scale usually bowed upwards. Upper labials 7 (N 1), 8 (20) or 9 (2). Nuchals 1-5 (N 26, mean 3.1). Ear lobules 5-7 (N 23, mean 6.0), usually acute or subacute. Midbody scale rows 32-36 on mainland (N 23, mean 33.4), 38 on Barrow Island (N 3). Lamellae under fourth toe 19-27 (N 25, mean 23.2), widely callose.

Coloration generally as in *C. g. grandis* but paler in life (e.g. dorsal ground colour orange-brown) and with a stronger tendency for pale lateral flecks to cluster and align vertically.

Paratypes

North-west Division (W.A.): Mundabullangana (17293); Myaree Pool, lower Maitland River (60506-7); Balmoral (28727); Meentheena (46176-7); Abydos (10804); Woodstock (13093, 13234, 27860-1, 28725); Tambrey (20006); Barrow Island (28456, 45361, 56706); North West Cape (28726); 3 km SE of Cape Vlaming (31434); 1 km S of Exmouth (62441); Yardie Creek Station (13210); 3-8 km N of Yardie Creek watercourse (61448-9, 61452, 61463, 61485).

Ctenotus hanloni sp. nov.
Plate 2

Holotype

R60952 in Western Australian Museum, collected on 19 December 1978 by T.M.S. Hanlon and D. Knowles on a reddish sandplain 22 km NNW of Giralia, Western Australia, in 22°30′S, 114°19′E.

Diagnosis

A moderately small greenish or reddish brown member of the *C. grandis* group, distinguishable from both subspecies of *C. grandis* by its contiguous nasals, narrower subdigital calli, fewer supraciliaries, higher and apically more angular second loreal, and pale lateral flecks not aligned vertically.

Distribution

Arid north-western Western Australia (Barrow Island and the country south and east of Exmouth Gulf from the Sandalwood Peninsula south-east through Winning to Williambury) and the Great Sandy Desert (see **Fig. 1**). Almost certainly extending to the Tanami Desert of Northern Territory and the Great Victoria Desert of Western Australia (see under Remarks).

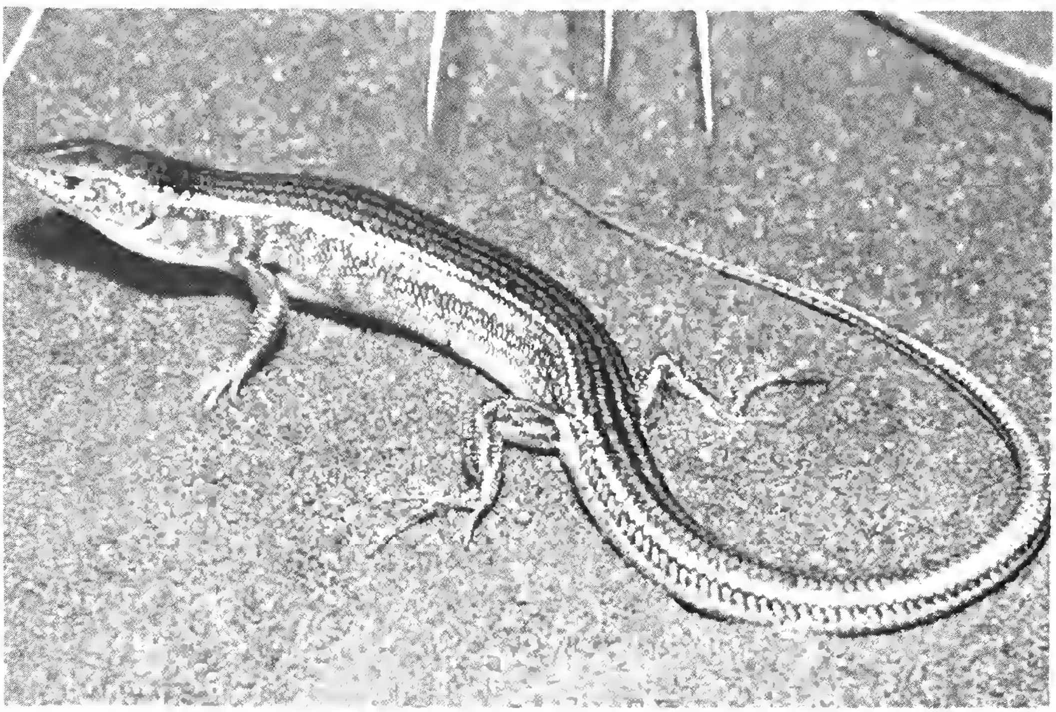

Plate 2. Holotype of *Ctenotus hanloni* photographed in life by T.M.S. Hanlon.

Description

Snout-vent length (mm): 33-71 (N 21, mean 52.5). Length of appendages (% SVL): foreleg 23-31 (N 21, mean 27.8), hindleg 38-50 (N 21, mean 44.6), tail 157-201 (N 11, mean 188).

Nasals in contact. Prefrontals in contact (N 13) or narrowly separated (N 7). Supraciliaries 6-8 (N 21, mean 7.0), fourth to penultimate a little smaller than others. Palpebrals (i.e. upper ciliaries) 9-11 (N 20, mean 10.0). Second loreal 0.9-1.6 times as wide as high (N 21, mean 1.17), usually pentagonal with a high angular apex. Upper labials 8 (N 20) or 9 (1). Nuchals 1-8 (N 21, mean 3.3). Ear lobules 4-7 (N 21, mean 4.9), acute or subacute in adults, obtuse in juveniles, third usually largest. Midbody scale rows 30-32 (N 16, mean 30.9) south-east of Exmouth Gulf; 34 (N 4) at Barrow Island and in the Great Sandy Desert. Lamellae under fourth toe 19-27 (N 21, mean 23.1), each with a dark brown obtuse keel or narrow callus.

Head olive brown. Legs and tail brown. Back rich reddish brown in adults, olive green in juveniles, with 5 dark stripes (dark brown in adults, black or dark grey in juveniles; the most distinct being the vertebral and laterodorsals). Dorsolateral stripe bluish white. Side of body dark olive brown densely flecked with whitish; flecks tending to be longitudinally orientated. Under surface white, the belly suffused with blue in alcohol.

Remarks

This skink is named after T.M.S. Hanlon who, alone or with D. Knowles, collected most of the type series.

Judging from my notes on the paratypes of *C. grandis* I am almost certain that several of those collected by Dr E.R. Pianka in the Great Victoria Desert of Western Australia were in fact *C. hanloni*, e.g. ERP 11075, 11086, 11092, 11094 and 12423 from 13 km W of Neale Junction (28°17′S, 124°50′E). My account of *C. grandis* in the Northern Territory (Storr 1970) was similarly vitiated by the inclusion of specimens that were almost certainly *C. hanloni*, e.g. ERP 11659 and 11672-3 from 11 km SE of The Granites and SAM 5038 from Yuendumu.

Paratypes

North-west Division (W.A.): Barrow I. (28455, 40028); 22 km NNW of Giralia (60953, 60961-4, 61036); 1 km N of Bullara (61007); Giralia HS (60978); 3 km E of Giralia (61151); 17 km S of Giralia (61199); Marrilla (5341); 23 km S of Winning (36153); Williambury (62430) and 5 km S (62420-2).

Eastern Division (W.A.): Godfrey Tank (63420); 16 km S of Mt Romilly (40898); 2 km E of Well 39, Canning Stock Route (64198); 30 km S of Nooloo Soak (22°53′S, 121°58′E) (63176).

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HERPETOFAUNA OF THE EXMOUTH REGION, WESTERN AUSTRALIA

G.M. STORR*
&
T.M.S. HANLON**

INTRODUCTION

This paper is essentially an annotated list of the 114 species of amphibians and reptiles inhabiting the North West Cape peninsula, Exmouth Gulf and adjacent lands and seas. For our purposes the Exmouth region is delimited in the south by latitude 23°S and in the east by longitude 114°45′E. Brief notes are given on the local distribution of each taxon and its abundance and habitat preferences. Finally there is a discussion on the faunistics of the region, including a comparison with the herpetofauna of Shark Bay. To avoid confusion between two well-separated localities, 'Yardie Creek' in this paper means the watercourse; when we refer to the former Yardie Creek sheep station we simply call it 'Yardie'.

We are grateful to W.H. Butler, G. Harold, G. Barron and P. Griffin for assistance in preparing this paper.

COLLECTIONS

It has taken a long time for the rich herpetofauna of the Exmouth region to become known. The first collections were made in 1933-35 by R. Ammon at Marrilla; his specimens included several undescribed species, e.g. *Ctenotus hanloni* and *C. calurus,* but this was not appreciated at the time. In winter 1959, A.M. Douglas and G.F. Mees collected at Yardie, Point Cloates and Learmonth. G.M. Storr and B.T. Clay briefly visited the region in October 1961 and November 1962; they concentrated on agamids, especially the *Amphibolurus maculatus* group. In August 1962, T.M. Scott collected at Ningaloo and Bullara, and a few years later D.G. Bathgate collected around Exmouth. In the course of collecting mammals jointly for the Western Australian Museum and the American Museum of Natural History, W.H. Butler obtained many

* Western Australian Museum, Francis Street, Perth, Western Australia, 6009
** 38 Genesta Crescent, Dalkeith, Western Australia, 6000.

reptiles on Yardie in June and July 1963. In June 1970, W.K. Youngson and R.I.T. Prince visited the Muiron Is, the largest islands in the region. In August 1973, R. Rowe made a small but valuable collection of sea snakes. In August-September 1975, T.M.S. Hanlon collected and observed reptiles at Yardie Creek, Exmouth, Bullara and Shothole Canyon. By the end of 1975 most of the common and easy-to-find species had been collected, and the regional list stood at 91 species.

Intensive field work began in March 1976 when G. Harold and G. Barron collected frogs and reptiles at Yardie, Vlaming Head, Exmouth and Shothole Canyon. They added four species to the list: *Neobatrachus centralis, Diplodactylus elderi, D. taeniatus* and *Delma pax.* A grant from Mr and Mrs W.H. Butler allowed the Museum to put two parties in the field in December 1978: T.M.S. Hanlon and D. Knowles collected throughout the region and obtained the first local examples of *Diplodactylus squarrosus, Rhynchoedura ornata, Cryptoblepharus carnabyi, Ctenotus colletti rufescens, C. duricola, Lerista praepedita, Varanus eremius, V. gouldii* and *Typhlina diversa;* and G. Harold and G. Barron, while primarily engaged in trapping small mammals, were able to collect many reptiles in the Cape Range and its vicinity, including the first *Aprasia rostrata fusca, Lerista elegans* and *L. nichollsi.* In April-June 1979, T.M.S. Hanlon returned to the far south-east of the region and obtained the first regional specimens of *Chelodina steindachneri, Amphibolurus scutulatus, Ctenotus piankai, C. schomburgkii, C. u. uber, Egernia depressa* and *Varanus panoptes rubidus.*

Other people whose specimens contributed to this report are I. Abbott, Dr Atkins, W.G. Bocksette, F. Barrett-Lennard, S. Bartlett, A. Baynes, J.H.Calaby, M. DeGraaf, P.A. Cawthorne, P.J. Fuller, S.R. Gare, R. Gedling, G. Hitchins, R.B. Humphries, C.F.H. Jenkins, R.E. Johnstone, G. Kendrick, A.G. Kluge, L.E. Koch, N. Kolichis, K.A. Lance, M. Lane, N.M. Milward, Mr Richies, J. Seabrook, L.G. Smith, N. Smith, A. Snell, M. Stott, R. Thomas, A.G. Wells, G.P. Whitley and B.R. Wilson.

ENVIRONMENT

The region lies entirely within the arid zone, mean annual rainfall ranging from 22 cm in the south-east to *ca* 35 cm in the Cape Range. On the west coast most rain falls in winter and autumn; elsewhere most in summer and autumn. Summers are very hot in the eastern interior with mean daily maximum temperature in January *ca* 40°C; the west coast is much cooler with mean daily maximum temperature in January *ca* 32°C. Away from the Cape Range, relief is gentle and elevation is mostly less than 100 m above the sea. The region is divisible into four zones, two of which are easily defined. The other two, the eastern and western lowlands, merge into each other in about the longitude of Bullara.

West coast

The narrow strip of country close to the west coast (south of Vlaming Head) is considerably cooler in summer and wetter in winter than other parts of the region. The white calcareous sands of the coastal dunes are sparsely vegetated with the tussock grass *Spinifex longifolius* and low sprawling shrubs such as *Nitraria schoberi* and *Acanthocarpus preissii.* Characteristic reptiles are *Diplodactylus rankini, Amphibolurus p. parviceps, Lophognathus g. gilberti, Lerista elegans, Morethia lineoocellata* and *Vermicella littoralis.*

Cape Range

This is essentially a heavily dissected limestone plateau rising to 315 m. The steep rocky slopes are sparingly covered with *Triodia,* shrubs and low eucalypts. The bottoms of gorges are more heavily wooded. The fauna is somewhat impoverished. However four species are regionally confined to the range: *Pseudophryne douglasi, Diplodactylus elderi, D. mitchelli* and *Delma pax.*

Eastern lowlands

East of Giralia there is a large area of red sandridges; these and sandy interdunes carry *Triodia, Owenia reticulata, Grevillea eriostachya, Acacia pyrifolia* and small shrubs. On clayey interdunes and plains *Triodia* is replaced with soft grasses, and mixed shrubbery with open *Acacia* scrubs. Watercourses and low lying areas (claypans) are margined with *Eucalyptus camaldulensis.* Regionally confined to the eastern lowlands are *Chelodina steindachneri, Rhynchoedura ornata, Amphibolurus isolepis rubens, Amphibolurus scutulatus, Ctenotus calurus, C. piankai, C. hanloni, C. schomburgkii, C. u. uber, Egernia depressa, Varanus caudolineatus* and *V. panoptes rubidus.*

Western lowlands

Under this heading we include the rest of the region. At the inland foot of the west-coastal dunes there are frequently samphire flats. These quickly give way to an undulating, treeless belt of shallow red sands and clays over limestone (which is exposed on rises and along watercourses). The sandier country is dominated by *Triodia* and a variety of shrubs including *Banksia ashbyi.* The heavier soils are dominated by *Acacia* scrubs. Watercourses are lined with *Eucalyptus camaldulensis* and *Erythrina vespertilio,* and *Ficus platypoda* grows on limestone outcrops. This zone is especially rich in agamid lizards, including *Amphibolurus maculatus badius, A. femoralis, A. i. isolepis, A. clayi* and *Moloch horridus.*

ANNOTATED LIST

Leptodactylidae

Cyclorana maini Tyler & Martin

Collected in summer (December-March) at Exmouth and in the claypan country of the eastern lowlands (Koordarrie, Winning).

Neobatrachus centralis (Parker)

G. Harold and G. Barron collected seven specimens at Exmouth in early March 1976; the frogs were feeding at night on a road and on the airstrip.

Pseudophryne douglasi Main

In our region confined to the Cape Range. In June 1955, A.M. Douglas collected the first known examples of this peculiar frog at a spring in Shothole Canyon; his specimens comprised eggs, larvae and five adults (only the last were retained by L. Glauert). At the same locality A.G. Kluge and J.H. Calaby found larvae on 1 August 1961, and G. Kendrick and G. Hitchin, adults and larvae on 17 May 1965. A.R. Main (1964) believes that this relict species depends on early winter rains for its breeding.

Hylidae

Litoria rubella (Gray)

This ubiquitous frog is no doubt common about claypans and watercourses in the east, despite there being only one record from the area, namely three specimens collected by G.M. Storr and B.T. Clay on the evening of 3 November 1961 at a water-trough 8 km E of Giralia.

Cheloniidae

Caretta caretta (Linnaeus)

On 12 June 1970, W.K. Youngson and R.I.T. Prince collected two hatching loggerheads outside a nest in the dunes on the east side of South Muiron I.; tracks of other hatchlings led down to the sea.

Chelonia mydas (Linnaeus)

Judging from the number of specimens in the Museum (15), the Green Turtle is the most plentiful turtle in the region. They nest in summer on west-coastal beaches between North West Cape and Yardie Creek (A.A. Burbidge, pers. comm.).

Eretmochelys imbricata (Linnaeus)

Carnarvon fisherman D. Wellington told Dr A.A. Burbidge that he had found Hawksbill Turtles nesting in a sandy bay 5 km south of Yardie Creek in summer 1977-78 (A.A. Burbidge, pers. comm.).

Cheluidae

Chelodina steindachneri Siebenrock

One record from the eastern lowlands: adults and juveniles were seen by T.M.S. Hanlon on 4 June 1979 in a dam 24 km west of Marrilla; one of them was collected.

Gekkonidae

Crenadactylus ocellatus horni (Lucas & Frost)

Moderately common in south-west from Yardie Creek to Ningaloo in *Triodia* on near-coastal sandplains and in the *Spinifex longifolius* of white coastal dunes. Also among rocks and *Triodia* in the Cape Range (Shothole Canyon).

Diplodactylus ciliaris Boulenger

Regionally confined to the peninsula, i.e. the west-coastal plain south to Yardie Creek, the Cape Range south to 40 km north-east of Ningaloo, and the east-coastal plain south to Exmouth. Moderately common in acacias and other trees and shrubs.

Diplodactylus conspicillatus Lucas & Frost

Lowlands west to the eastern foot of the Cape Range, north on the peninsula to Exmouth. Moderately common. Mainly on heavy or stony red soils carrying acacias and other shrubs.

Diplodactylus elderi Stirling & Zietz

One record: a specimen collected by G. Harold and G. Barron at Shothole Canyon in March 1976. Here the ground was stony and the vegetation open mallee over *Triodia*.

Diplodactylus mitchelli Kluge

Regionally confined to the Cape Range. Moderately common on stony ground at Shothole Canyon. A female (R52929) laid two eggs after its capture by G. Harold and G. Barron on 10 March 1976.

Diplodactylus ornatus Gray

This gecko almost certainly reaches the region. One was collected on 31 October 1961 in sand dunes at Maud Landing on the west coast 13 km beyond our southern boundary. A specimen (R11515) is registered as coming from the Learmonth district, but as the same collection includes an *Amphibolurus cristatus*, its provenance could be questioned. We cannot find a specimen (R13220) from Yardie that L. Glauert registered as '*D. vittatus*'.

Diplodactylus pulcher (Steindachner)

Eastern lowlands near Bullara and west of Giralia. Uncommon. Red clayey plains vegetated with open *Acacia* scrub, a habitat it shares with the more plentiful *D. squarrosus*.

Diplodactylus rankini Storr

Confined to the west coast north to Yardie Creek. Moderately common in trees and shrubs of white coastal dunes, a habitat that it shares with the closely related *D. ciliaris*. Endemic to the region, where it replaces the closely related *D. spinigerus* of south-western Western Australia. [The specimen of '*D. spinigerus*' from Point Cloates (Kluge 1967: 1062) is in fact a *rankini*.]

Diplodactylus squarrosus Kluge

Eastern lowlands. Moderately common between Bullara and Giralia on red clayey plains carrying open *Acacia* scrub.

Diplodactylus stenodactylus Boulenger

Widespread in lowlands, but not recorded from the Cape Range. Moderately common. All kinds of country (sandy, clayey, stony and rocky) vegetated with *Triodia*.

Diplodactylus strophurus (Duméril & Bibron)

Widespread in eastern and central zones, west to Vlaming Head, but not recorded from the Cape Range or the west-coastal plains. Common. Foraging on the ground and in low vegetation (shrubs, small trees, *Triodia* and *Spinifex longifolius*) on sandy and clayey soils.

Diplodactylus taeniatus (Lönnberg & Andersson)

Locally restricted to far north of peninsula. Common in *Triodia* in red sand dunes at Vlaming Head. Also a specimen collected in *Triodia* at Exmouth.

Gehyra pilbara Mitchell

Within the region it has only been collected on the Muiron Is and the peninsula (in the Cape Range as well as on the coastal plains). Moderately common in stony country.

Gehyra punctata (Fry)

Locally recorded only on the Muiron Is, where W.K. Youngson and R.I.T. Prince collected three specimens on 12 June 1970.

Gehyra variegata (Duméril & Bibron)

Widespread in lowlands. Very common in shrubs and trees in most habitats. At Yardie Creek it is confined to the white coastal dunes; rocky habitats along the watercourse are occupied by its congener *G. pilbara*.

Heteronotia binoei (Gray)

Common and widespread in the west. Reported from the Muiron and Anchor Is but not as yet from the deserts around Giralia and Marrilla.

Nephrurus levis occidentalis Storr

Widespread in lowlands. Moderately common. Mainly in red sand dunes and interdunes; also in white coastal dunes and on clayey soils. Here, in the absence of congeners, its habitat preferences are broad.

Rhynchoedura ornata Günther

Eastern lowlands, about Giralia and Marrilla. Locally common. Red clays and sands carrying acacias and spinifex.

Pygopodidae

Aprasia rostrata fusca Storr

Probably widespread, judging from the two very different habitats it has been found in to date. On 8 December 1978 G. Harold and G. Barron collected one in leaf litter beneath an acacia tree growing in white sand dunes at the mouth of Yardie Creek. In the late afternoon of 14 December 1978, T.M.S. Hanlon and D. Knowles dug three specimens from the top of a red spinifex-covered sand-ridge 3 km NW of Bullara. Endemic to the region.

Delma nasuta Kluge

Widespread in sandy lowlands. Found in the *Triodia* of red sandridges and sandplains and in the *Spinifex longifolius* of white coastal dunes.

Delma pax Kluge

One record from the Cape Range; two specimens found by G. Harold and G. Barron under dead *Triodia* at Shothole Canyon on 10 March 1976.

Delma tincta DeVis

Eastern and central zones, west to Shothole Canyon. Scarce.

Lialis burtonis Gray

Common and widespread in sandy lowlands.

Pygopus nigriceps (Fischer)

Eastern lowlands. Scarce. There is a specimen in the University of Michigan from 80 km south of Exmouth Gulf HS (Kluge 1974) and three in the Western Australian Museum from Marrilla.

Agamidae

Amphibolurus caudicinctus (Günther)

Only recorded from the Muiron Is, a single specimen obtained by W.K. Youngson and R.I.T. Prince on 12 June 1970.

Amphibolurus clayi Storr

Central zone (lowlands at 5 km south of Learmonth, 1 km north of Bullara, 22 km west of Giralia and 50 km north of Warroora). Scarce. Among *Triodia* on red soils (clayey as well as sandy).

Amphibolurus femoralis Storr

Lowlands (north to Vlaming Head and west to the Minilya-Exmouth road) and dunes on the plateau of Cape Range east of Yardie Creek. Common. Mainly the crests of red sandridges; also interdunes (clayey as well as sandy, provided *Triodia* is present).

Amphibolurus inermis (DeVis)

Widespread in lowlands, but absent from the Cape Range. Very common. Mainly in sandy country; also on heavy soils.

Amphibolurus isolepis isolepis (Fischer)

Western lowlands, east to Bullara. Common in eastern part of range; uncommon and patchily distributed towards west coast (the stronghold of *A. maculatus badius*). Red clayey, sandy and stony soils with scattered tussocks of *Triodia* and other grasses.

Amphibolurus isolepis rubens Storr

Eastern lowlands, west to Giralia. Common. Red sandplains and red sandy or clayey interdunes with scattered tussocks of *Triodia*. In view of the great size difference between adults of *rubens* and the preceding taxon, it is doubtful whether they are conspecific.

Amphibolurus maculatus badius Storr

South-western part of region, north to Ningaloo and east to the Minilya-Exmouth road (30 km SSW of Bullara). Common. Near-coastal sandplains and interdunes with low open vegetation especially *Triodia*.

Amphibolurus minor minor Sternfeld

Common in western lowlands north to Yardie and Exmouth, mainly on rolling sandplains with *Triodia* and low open shrubbery. Also far south-east (two specimens from Marrilla and one from 25 km NNW of Winning).

Amphibolurus parviceps parviceps (Storr)

West coast north to 9 km north of Yardie Creek. Common. White coastal dunes with *Spinifex longifolius* and other low open vegetation; occasionally among *Triodia* on adjacent sandplains (the stronghold of *A. maculatus badius*).

Amphibolurus reticulatus (Gray)

Eastern and central zones (i.e. absent from west-coastal plains). Common. Mainly red clayey soils with open *Acacia* scrub.

Amphibolurus scutulatus Stirling & Zietz

Recorded only from far south-east: in early May 1979 T.M.S. Hanlon found it common on a red loamy plain with open *Acacia* scrub 25 km NNW of Winning.

Diporiphora winneckei Lucas & Frost

Eastern (Bullara, Giralia, Marrilla etc.); also Vlaming Head. Moderately common. Among *Triodia,* mainly on red sandridges, but also on sandy and clayey interdunes.

Lophognathus gilberti gilberti Gray

Patchily distributed on west coast north to North West Cape (collected at

Neds Well, Tantabiddi Creek, Ningaloo and just south of our region at Coral Bay and 5 km north of Maud Landing). Also observed by T.M.S. Hanlon in mangroves on the Sandalwood Peninsula.

Lophognathus longirostris Boulenger
Widespread but only common on the east-coastal plains of the peninsula; scarce elsewhere. Wooded habitats, especially in gullies or along watercourses.

Moloch horridus Gray
Uncommon. One record from the far south-east (4 km west of Marrilla); the rest from the Minilya-Exmouth road, north to Learmonth.

Scincidae

Carlia foliorum (DeVis)
Cape Range and western lowlands south to Yardie Creek and Bullara. Uncommon. Among *Triodia*, low bushes and leaf litter, especially on heavy soils and among rocks.

Cryptoblepharus carnabyi Storr
One record: T.M.S. Hanlon and D. Knowles collected one in a thicket at the foot of a cliff in Mandu Mandu Gorge.

Cryptoblepharus plagiocephalus (Cocteau)
Two records from west coast: one specimen from Yardie and one from a limestone outcrop 13 km N of Cardabia.

Ctenotus calurus Storr
One record: a specimen collected by R. Ammon at Marrilla in 1935.

Ctenotus colletti rufescens Storr
Only known from four specimens collected by T.M.S. Hanlon and D. Knowles in December 1978 in and near red sand dunes at Vlaming Head and 3 km E of Giralia. A specimen was pit-trapped at Yardie Creek but discarded by G. Harold and G. Barron because of ant-damage (before which it was identified by T.M.S. Hanlon). Among *Triodia* on dunes, clayey interdunes and sandplains. Endemic to the region.

Ctenotus duricola Storr
Only collected at Yardie Creek and 22 km west of Giralia. Among *Triodia* on clayey or stony soils.

Ctenotus grandis Storr
Western lowlands: coastal plains of the peninsula south to Yardie Creek and Exmouth. Moderately common. Among *Triodia* on reddish sands and loams.

Ctenotus hanloni Storr
Eastern lowlands (around Bullara, Giralia and Marrilla). Moderately com-

mon. Among *Triodia* on reddish sandplains and reddish clayey, loamy and sandy interdunes. In burnt country 22 km NNW of Giralia seven specimens were dug from small burrows beneath burnt clumps of *Triodia*.

Ctenotus helenae Storr

Eastern lowlands west to Giralia; also observed by T.M.S. Hanlon at Vlaming Head. Moderately common. Among *Triodia, Acacia* and eucalypts growing on interdunal red clay flats and sandy and loamy plains.

Ctenotus iapetus Storr

Lowlands, but not the west coast south of Yardie Creek. Common. Among *Triodia* on red sandridges and adjacent clayey interdunes. Endemic to the region.

Ctenotus pantherinus ocellifer (Boulenger)

Lowlands, but not the west coast south of Yardie Creek. Common. Among *Triodia*, mainly on red clayey plains or interdunes, occasionally on red sand dunes and sandplains.

Ctenotus piankai Storr

One record from far south-east: a specimen collected by T.M.S. Hanlon on a red sandplain with eucalypts and *Triodia* at Marrilla homestead on 18 May 1979.

Ctenotus saxatilis Storr

Most of the region, including the Muiron Is but not sandy deserts. Very common. In a wide range of habitats, but preferring heavy soils to light, and *Triodia* to other vegetation.

Ctenotus schomburgkii (Peters)

Eastern lowlands (around Bullara, Giralia and Marrilla). Uncommon. In *Acacia* scrubs or *Triodia* on red clayey, loamy and stony soils.

Ctenotus uber uber Storr

Locally confined to far east. Common. Open *Acacia* scrub on red loamy plains.

Egernia depressa (Günther)

One record from far south-east: a specimen found by T.M.S. Hanlon in a dead tree trunk in open *Acacia* scrub 25 km NNW of Winning on 5 May 1979.

Eremiascincus fasciolatus (Günther)

Eastern lowlands (around Giralia and Marrilla) and at Vlaming Head. Scarce. Among *Triodia* on red sand dunes.

Eremiascincus richardsonii (Gray)

Western lowlands, including east-coastal plains of the peninsula. Uncommon. In coastal dunes and near-coastal limestone.

Lerista bipes (Fischer)

Mainly the eastern lowlands, but also the northern coastal plains of the peninsula (south in the west to Milyering Well, and in the east to Exmouth). Common. Red sandy and loamy soils with sparse vegetation, especially *Triodia.*

Lerista elegans (Gray)

Only recorded from the white coastal dunes near the mouth of Yardie Creek and red coastal dunes at Vlaming Head. Uncommon. In *Spinifex longifolius* and *Triodia* and among *Acacia* leaf litter.

Lerista lineopunctulata (Duméril & Bibron)

West coast north to North West Cape. Common. Most specimens were dug from under acacias in white dunes, but also found under *Triodia* in red dunes at Vlaming Head.

Lerista macropisthopus (Werner)

Only recorded from west coast at or near Yardie Creek. Scarce. One of the specimens was pit-trapped in heavy reddish soil with open *Triodia.*

Lerista muelleri (Fischer)

Patchily distributed in lowlands. Uncommon. Under *Triodia* and leaf litter.

Lerista nichollsi (Loveridge)

Patchily distributed in lowlands. Uncommon. Red dunes and interdunes of eastern zone, near-coastal reddish sandplains, and white coastal dunes.

Lerista planiventralis (Lucas & Frost)

Regionally there are two forms of this lizard. First, that inhabiting the white coastal dunes at Yardie Creek and 15 km further south; it has 22 rows of midbody scale rows, the sides of body white and the back very pale greyish brown. Second, the form from the spinifex-covered red dunes near Bullara and Marrilla; there the number of midbody scale rows is 20, the sides of body pinkish white and the back reddish brown. Material is required from intermediate localities for determining the taxonomic status of these forms. Both forms are moderately common.

Lerista praepedita (Boulenger)

Locally known only from near the mouth of Yardie Creek, where it is moderately common under *Spinifex longifolius* and *Acacia* leaf litter in white coastal dunes.

Menetia greyii (Gray)

Patchily distributed in lowlands, but not in vicinity of west coast (the stronghold of *M. surda*). Uncommon. In leaf litter and among *Triodia* and other tussock grasses growing on red clays and loams.

Menetia surda Storr

Common on west coast (north to Yardie), mainly among *Triodia* on near-coastal sandplains, but also under *Spinifex longifolius* on white coastal dunes. One record from 20 km NW of Giralia, a specimen collected in *Triodia* on heavy red soil.

Morethia lineoocellata (Duméril & Bibron)
West coast, north to Vlaming Head. Common. Coastal sand dunes (white and red) and near-coastal sandplains, mainly among *Triodia*.

Morethia ruficauda exquisita Storr
Widespread but patchily distributed. Moderately common. Among *Triodia*, rocks and *Acacia* leaf litter, mainly on clayey and stony soils.

Notoscincus ornatus ornatus (Broom)
Lowlands west to Vlaming Head (i.e. absent from Cape Range and west-coastal plains). Common. Among *Triodia* on red dunes and red clayey plains and interdunes.

Omolepida branchialis (Günther)
Cape Range and western lowlands east to Exmouth and Bullara. Common in coastal dunes and near-coastal sandplains; scarce inland. Mainly among *Triodia*.

Sphenomorphus isolepis isolepis (Boulenger)
Regionally known only from the Muiron Is, where W.K. Youngson and R.I.T. Prince collected four specimens in June 1970.

Tiliqua multifasciata Sternfeld
Patchily distributed in lowlands. Scarce.

Varanidae

Varanus acanthurus Boulenger
Lowlands, including the Muiron Is. Stony and clayey plains. Uncommon.

Varanus brevicauda Boulenger
Sandy country vegetated with *Triodia* (recorded from Vlaming Head, Ningaloo, Bullara and Marilla). Scarce.

Varanus caudolineatus Boulenger
Only recorded from far east, around Marilla. Scarce. *Acacia* scrubs.

Varanus eremius Lucas & Frost
Only two records: specimens collected by T.M.S. Hanlon and D. Knowles in December 1978. One was chased into a burrow in a spinifex-covered interdune at Vlaming Head; the other was collected at Giralia among *Acacia* and *Triodia* on heavy red soil.

Varanus giganteus (Gray)
Western lowlands. Uncommon. Mainly in rocky country.

Varanus gouldii (Gray)
Eastern and central lowlands west to Vlaming Head. Uncommon. Mainly in sandy country.

Varanus panoptes rubidus Storr
Eastern lowlands (around Giralia and Marrilla). Uncommon. Red clayey soils with *Acacia* over *Triodia.*

Varanus tristis tristis (Schlegel)
The only local record is a specimen collected by D.G. Bathgate, presumably in the vicinity of Exmouth.

Typhlopidae

Typhlina diversa (Waite)
Regionally known only from coastal lowlands near Yardie Creek and between Exmouth and Learmonth. Scarce. Collected on red sandy and clayey soils and on a saltpan.

Typhlina nigroterminata (Parker)
Normal specimens of this blind snake have been collected in the eastern and central lowlands west to Vlaming Head. A specimen from Cape Range (R25101) is more like *T. affinis* in the shape of its rostral and its relatively short snout.

Boidae

Aspidites melanocephalus (Krefft)
Two records: a specimen collected at Yardie and a head collected presumably at Learmonth.

Liasis childreni Gray
Regionally known from six specimens from the coastal plains of the peninsula between Tantabiddi Well and Learmonth.

Liasis perthensis Stull
Regionally known from three specimens collected near North West Cape (Vlaming Head and Neds Well).

Elapidae

Acanthophis pyrrhus Boulenger
Patchily distributed in lowlands. Uncommon. Among *Triodia* on sandy, stony and clayey soils.

Demansia olivacea calodera Storr
Moderately common on west-coastal plains and dunes, north to Vlaming Head. Elsewhere only recorded in far south-east (Marrilla).

Demansia reticulata cupreiceps Storr

Moderately common in eastern and central lowlands west to North West Cape; also an observation by T.M.S. Hanlon of one among limestone rocks and *Triodia* at Yardie Creek. To a large extent the ranges of the two whipsnakes (*Demansia* spp.) seem to be mutually exclusive in this region.

Denisonia fasciata Rosén

Regionally known only from three specimens, collected at Exmouth, Rough Range and Marrilla.

Denisonia punctata Boulenger

Regionally known only from the far south-east (Marrilla district): a specimen collected by R. Ammon in 1935, and one found dead in May 1979 by T.M.S. Hanlon.

Furina christieana (Fry)

The four specimens in the Western Australian Museum came from the coastal plains of the peninsula between Yardie and Learmonth.

Pseudechis australis (Gray)

Western lowlands. Moderately common.

Pseudonaja modesta (Günther)

East-coastal plains of the peninsula and eastern lowlands (especially the spinifex-covered sandplains around Marrilla and Winning). Moderately common.

Pseudonaja nuchalis Günther

Widespread in lowlands. Common.

Vermicella approximans (Glauert)

One record: a specimen collected by M. DeGraaf at Bullara on 1 January 1970.

Vermicella bertholdi (Jan)

One record from far south-east: a specimen collected by R. Ammon at Marrilla in 1934.

Vermicella littoralis Storr

Western lowlands. Moderately common near coast.

Hydrophiidae

Aipysurus apraefrontalis M.A. Smith

The Western Australian Museum has five specimens from Exmouth Gulf, all but one taken by prawn trawlers in winter.

Aipysurus duboisii Bavay

The two specimens in the Western Australian Museum were collected in

Exmouth Gulf by prawn trawlers in winter; one of them was taken at eight fathoms.

Aipysurus eydouxii (Gray)

A sea snake from Exmouth Gulf (R47749) was tentatively identified by L.A. Smith with this species.

Aipysurus laevis laevis Lacépède

There are two specimens in the Western Australian Museum from off Locker I., two from Exmouth Gulf, and one trawled in eight fathoms off Sunday I.

Astrotia stokesii (Gray)

The only regional record is a specimen collected by R. Rowe in August 1973; it was trawled at eight fathoms off Sunday I. (south-east of the Muiron Is).

Ephalophis greyii M.A. Smith

In October 1978, N. Kolichis collected two specimens in mangrove creeks near Learmonth; one of the snakes was searching the burrows of mud-skippers (Gobiidae). R. Ammon's specimen from 'Marrilla' probably came from Exmouth Gulf.

Hydrophis elegans (Gray)

In the Western Australian Museum are seven specimens trawled at eight fathoms off Sunday I. and one from North West Cape.

Hydrophis major (Shaw)

R. Rowe collected three specimens in August 1973; they were trawled at eight fathoms off Sunday I.

Hydrophis ocellatus (Gray)

Two of the specimens in the Western Australian Museum were collected near Sunday I.; the other was taken by prawn trawlers in Exmouth Gulf.

DISCUSSION

Freshwater habitats have been somewhat neglected and further work, especially in the eastern lowlands, should add some leptodactylid frogs. As it is, the list is formidable with 49 genera and 114 species, distributed among 13 families as follows:

Leptodactylidae—3 genera, 3 species.
Hylidae—1 genus, 1 species.
Cheloniidae—3 genera, 3 species.
Cheluidae—1 genus, 1 species.
Gekkonidae—6 genera, 18 species.
Pygopodidae—4 genera, 6 species.
Agamidae—4 genera, 15 species and subspecies.

Scincidae – 12 genera, 34 species.
Varanidae – 1 genus, 8 species.
Typhlopidae – 1 genus, 2 species.
Boidae – 2 genera, 3 species.
Elapidae – 7 genera, 12 species.
Hydrophiidae – 4 genera, 9 species.

It is instructive to compare these counts with those made by Storr & Harold (1978) for the Shark Bay region, nearly 4 deg. of latitude further south on the west coast of Western Australia (noting that *Physignathus longirostris* is now in the genus *Lophognathus,* and *Sphenomorphus richardsonii* in *Eremiascincus*). Overall diversity is greater in the Exmouth region, owing largely to the increase in species and genera of such predominantly tropical groups as the monitors, pythons, sea snakes and marine turtles. Geckos and agamids are more diverse in the Exmouth region, but skink and elapid totals are much the same. Pygopodids are considerably less diverse in the Exmouth region, which is to be expected as we move away from the south-west of Western Australia, the stronghold of this relict family.

Together the two regions support a herpetofauna of *ca* 150 species. However only 59 species are shared. In other words almost half of the species of the Exmouth region do not extend to Shark Bay, and *vice versa.* This rate of turnover is characteristic of most families, e.g. 9 of 18 Exmouth geckos, 8 of 15 Exmouth agamids and 17 of 34 Exmouth skinks fail to reach Shark Bay. Within families there can be considerably differences between genera in turnover of species and subspecies. Whereas 7 of 8 Exmouth *Lerista* are shared with Shark Bay, only one of 11 *Ctenotus* is shared.

The high turnover in *Ctenotus* is due to the presence in the Exmouth region, but not at Shark Bay, of large areas of red sandridges and other desert habitats very like those of the eastern interior of Western Australia. Here are found such desert taxa as *Ctenotus calurus, C. hanloni, C. helenae, C. pantherinus ocellifer* and *C. piankai* or derivatives of desert taxa such as *Ctenotus colletti rufescens* (from *C.c. nasutus*) and *C. iapetus (from C. quattuordecimlineatus*). Other desert reptiles occurring in the Exmouth region but not at Shark Bay include *Diplodactylus conspicillatus, D. elderi, D. taeniatus, Amphibolurus clayi, A. i. isolepis, Diporiphora winneckei, Ctenotus grandis, Eremiascincus fasciolatus, Lerista bipes, Varanus brevicauda* and *Acanthophis pyrrhus.* The desert species are especially characteristic of the eastern lowlands, but several of them are also found in the red coastal dunes at Vlaming Head (whether the latter reached Vlaming Head *via* the eastern lowlands or *via* a route now submerged by postpleistocene seas has still to be ascertained).

Also present in the Exmouth region but not at Shark Bay are such Pilbara endemics as *Pseudophryne douglasi, Diplodactylus mitchelli, Delma pax, Amphibolurus c. caudicinctus, Ctenotus duricola* and *Liasis perthensis.* To these we could add five taxa, whose distribution is centred on the Pilbara but which extend to southern Kimberley (*Gehyra pilbara* and *Ctenotus saxatilis*) or to the southern interior of the North-west Division (*Gehyra punctata, Morethia ruficauda exquisita* and *Vermicella approximans*). The Pilbara endemics are largely inhabitants of rocky places or heavy stony soils; hence the local restriction of many of them to the Cape Range and the Muiron Is.

Apart from the marine turtles and sea snakes the northern component in the Shark Bay herpetofauna consisted of only five species. Not surprisingly, this component is much stronger in the Exmouth region and includes an additional 10 species: *Lophognathus g. gilberti, Carlia foliorum, Notoscincus o. ornatus, Sphenomorphus i. isolepis, Varanus acanthurus, Typhlina diversa, Aspidites melanocephalus, Denisonia punctata* and *Furina christieana.*

In compensation, the southern component of the fauna is much weaker in the Exmouth region and consists only of *Lerista elegans, L. lineopunctulata, L. praepedita, Morethia lineoocellata* and *Vermicella littoralis,* compared to Shark Bay which has these and an additional 14 southern species and subspecies. In the Exmouth region southern taxa are almost wholly confined to the west coast.

Only four species and subspecies are endemic to the Exmouth region: *Diplodactylus rankini, Aprasia rostrata fusca, Ctenotus colletti rufescens* and *C. iapetus.*

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A NEW *LERISTA* AND TWO NEW *CTENOTUS* (LACERTILIA: SCINCIDAE) FROM WESTERN AUSTRALIA

G.M. STORR*

ABSTRACT

The new taxa are *Lerista ips* from desert sandridges, *Ctenotus uber johnstonei* from the north-eastern interior, and *Ctenotus rutilans* from the Hamersley Range.

INTRODUCTION

Lerista Bell and *Ctenotus* Storr are the largest genera of Australian skinks; they are especially numerous in the arid and semiarid zones. For revisions of *Lerista* the reader is referred to Storr (1972, 1976), and of *Ctenotus* to Storr (1968, 1971, 1975).

NEW TAXA

Lerista ips sp. nov.

Holotype

R63562 in Western Australian Museum, collected by Dr A.A. Burbidge on 9 May 1979 near Lake Auld, Western Australia, in 22°07'S, 123°52'E.

Diagnosis

A member of the *L. bipes* species-group (Storr, 1972), most like *L. bipes* and *L. labialis* but with stouter body, broader head, no dark upper lateral stripe, and single loreal.

Distribution

Known from one locality in the Great Sandy Desert of Western Australia and one in south-west of Northern Territory.

* Western Australian Museum, Francis Street, Perth, Western Australia 6000.

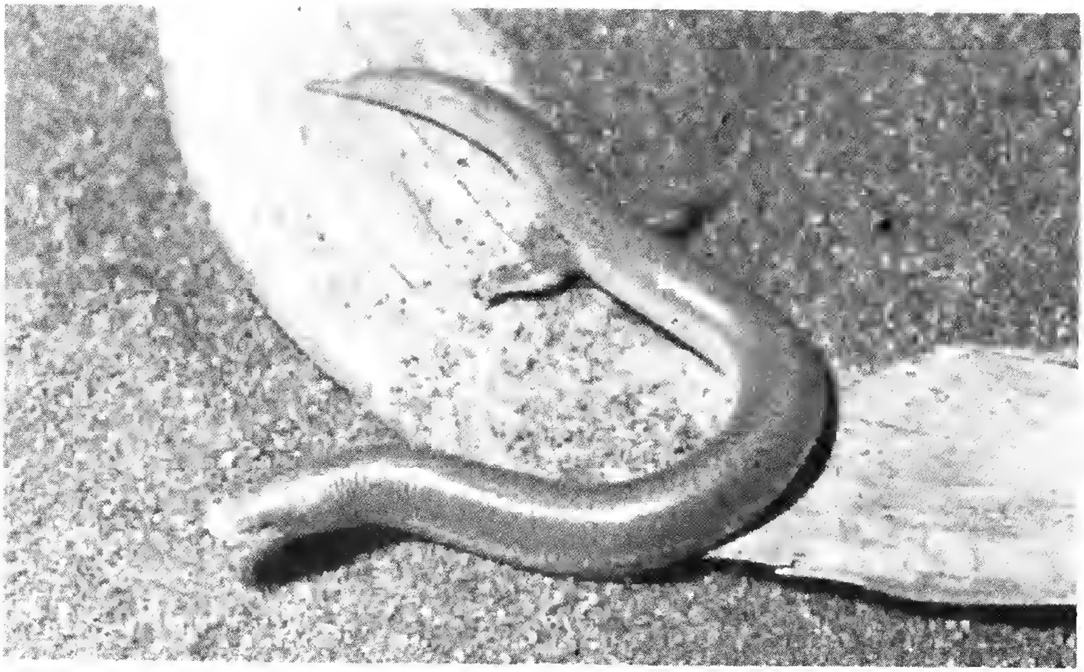

Plate 1: Holotype of *Lerista ips* photographed in life by R.E. Johnstone.

Description

Snout depressed, very sharp in profile and extending well beyond mouth. Eye very small. Eyelid movable. No trace of foreleg (including groove). Toes 2. Snout-vent length (mm): 56-60. Length of appendages (% SVL): hindleg 17 (N 2), tail 68 (N 1).

Nasals separated moderately widely. No prefrontals. Frontal a little wider than long. Frontoparietals and interparietal fused into a large triangular shield. Parietals long and narrow, in short contact. Nuchals 1 or 2. Supraoculars 2, both in contact with frontal. Supraciliaries 0 + 1. Loreals 1, very much wider than high. Preoculars 1. Postoculars 3. Temporals 3, lower secondary much smaller than subequal primary and upper secondary. Upper labials 6, fourth subocular, last much smaller than fifth. Ear aperture minute. Midbody scale rows 20. Lamellae under longer toe 9, smooth.

Coloration of holotype. Tip of snout white. Rest of dorsal and dorsolateral surfaces brownish white ('earthworm pink' in life, *fide* L.A. Smith). Eight uppermost series of dorsal and dorsolateral scales each with a faint brown spot, strongest on outermost series; spots on next-to-outermost series represented on temple and lores by a faint brown streak. Lower surfaces white.

Remarks

The holotype had fallen overnight into a pit set by Dr A.A. Burbidge in the crest of a sandridge. The ridge was vegetated with *Triodia* and scattered

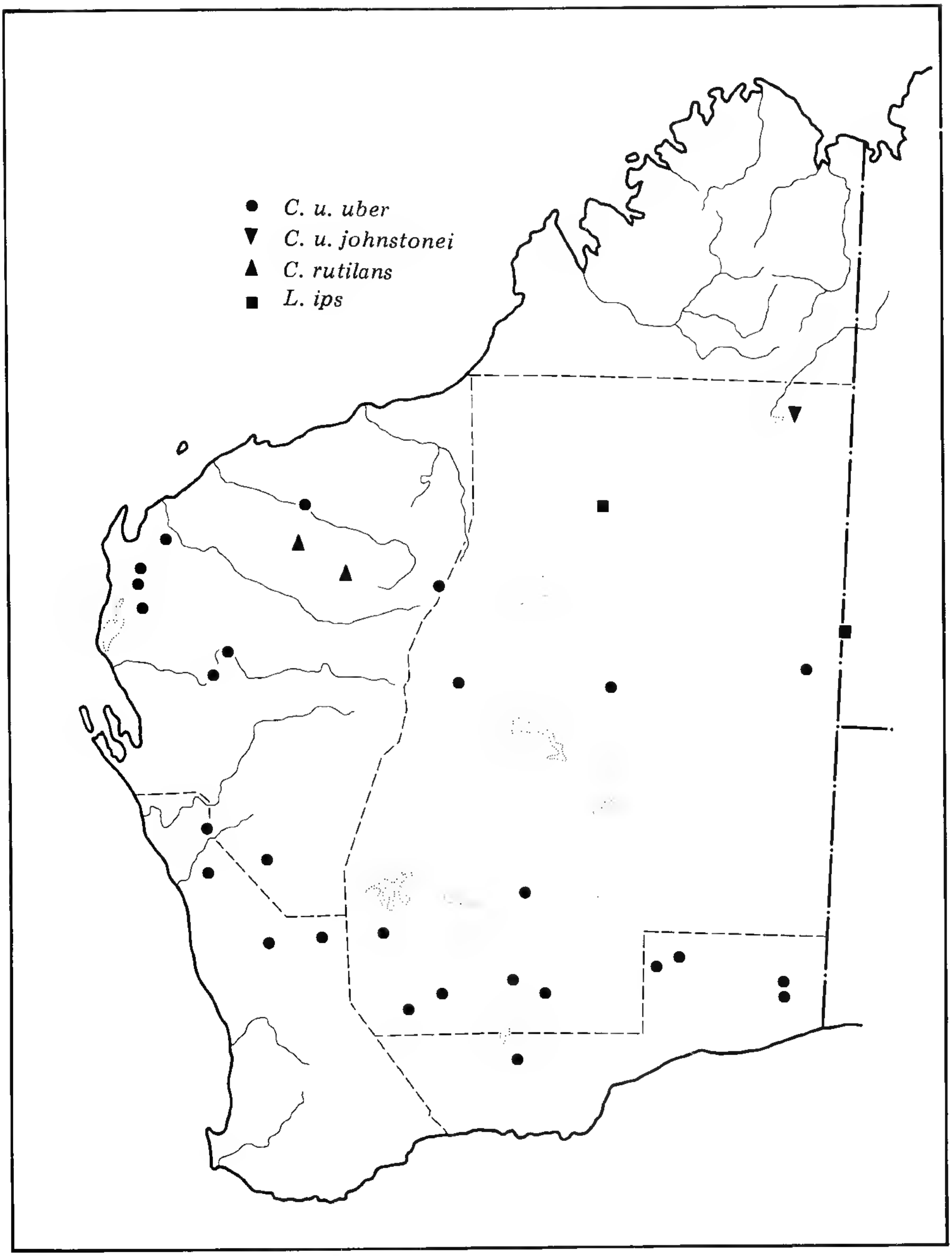

Fig. 1: Map of Western Australia showing location of specimens of *Lerista ips*, *Ctenotus uber johnstonei*, *Ctenotus uber uber* and *Ctenotus rutilans*.

shrubs of *Grevillea stenobotrya* and *Thryptomene maisonneuvii* (L.A. Smith, pers. comm.).

The paratype (field number JSE 179) was collected by Mr W.H. Butler on 11 April 1967 when a member of the Joint British Services Expedition to Central Australia; the specimen was buried in shallow sand at the crest of a *Triodia*-covered sandridge east of the Bonython Range. I am grateful to Mr A.F. Stimson of the British Museum for a loan of the paratype.

Paratype

Northern Territory: 20 km S of Lake Macdonald in 23°42'S, 129°02'E (BMNH 1970.354).

Ctenotus uber johnstonei subsp. nov.

Holotype

R63277 in the Western Australian Museum, collected by Messrs L.A. Smith and R.E. Johnstone on 21 April 1979 at Balgo Hill, Western Australia, in 20°07'S, 127°48'E.

Diagnosis

Differing from other subspecies of *C. uber* in its contiguous nasals. Agreeing with *C. uber uber* (Storr, 1968) in its predominantly reddish (rather than

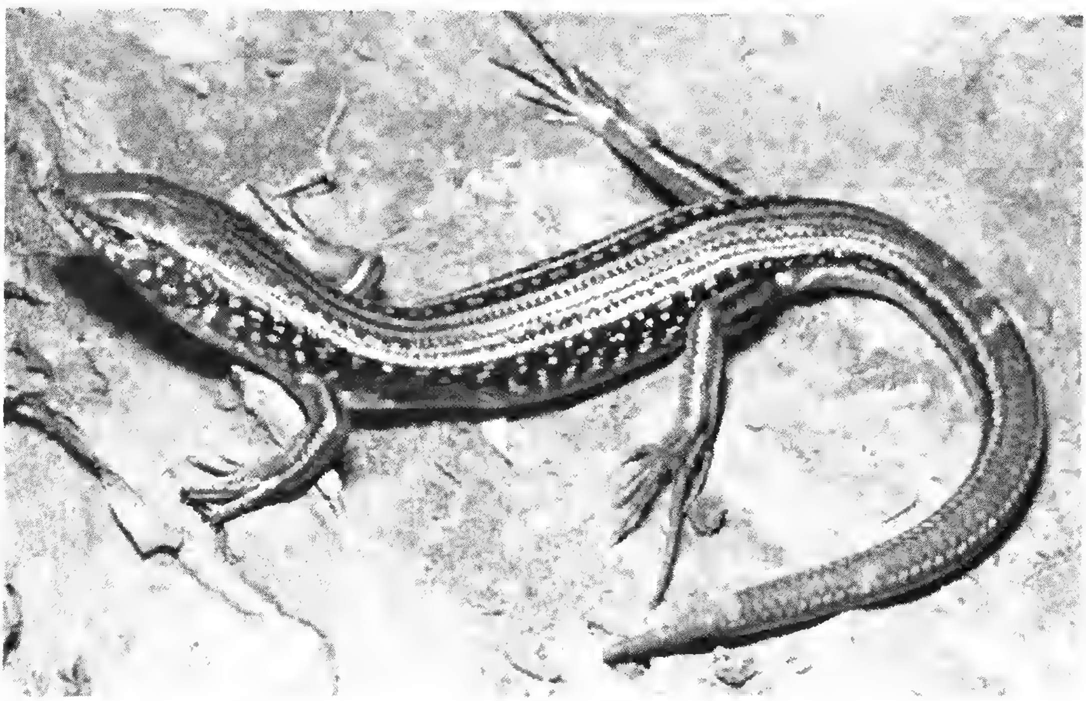

Plate 2: Holotype of *Ctenotus uber johnstonei* photographed in life by R.E. Johnstone.

olive) coloration and in the well-developed laterodorsal and dorsolateral stripes, and with *C. uber orientalis* (Storr, 1971) in the well-developed vertebral stripe and relatively short tail.

Distribution

Known from a single locality in the arid north-eastern interior of Western Australia.

Description

Snout-vent length (mm): 32-69 (N 9, mean 44.8). Length of appendages (% SVL): foreleg 28-33 (N 9, mean 30.4), hindleg 47-55 (N 9, mean 50.4), tail 170-197 (N 4, mean 180.7).

Nasals in contact (varying from just touching to forming a long median suture). Prefrontals separated or in very short contact. Supraoculars 4, first 3 in contact with frontal, first as wide as or wider than second. Supraciliaries 7, fourth to penultimate markedly smaller than others (8 in one specimen with fifth to penultimate smaller). Palpebrals (*recte* upper ciliaries) 9-12 (N 9, mean 10.1). Second loreal 1.5-1.9 (N 9, mean 1.68) times as wide as high. Presuboculars 2 (3 in two specimens). Upper labials 8. Ear lobules 3-6, subacute in adults, rounded in juveniles. Nuchals 2-5 (N 9, mean 3.6). Mid-body scale rows 32-35 (N 8, mean 33.2). Toes slightly to moderately compressed; 24-32 (N 9, mean 26.3) lamellae under fourth, each with a dark brown obtuse keel.

Dorsal ground colour reddish brown, the tail tinged with olive (especially in juveniles). Narrow black vertebral stripe from neck to base of tail. Wide black laterodorsal stripe from back of head to proximal part of tail, enclosing a series of reddish spots (these spots and paravertebral stripe whitish in juveniles). Narrow creamy white dorsolateral stripe from brow to proximal part of tail. Brownish black upper lateral zone enclosing two series of white dots; represented on tail by wide greyish brown stripe (dark proximally, pale distally). No white midlateral stripe. Lower lateral zone rich reddish brown with 4 or 5 series of small white flecks.

Remarks

Named after co-collector of the type series, Ronald E. Johnstone of the Western Australian Museum.

I am grateful to Mr L.A. Smith for a colour description in life and for notes on the habitat. The specimens were caught under low chenopod shrubs (*Bassia* and *Atriplex*) growing on colluvium at the foot of a sandstone hill.

Paratypes

Eastern Division (W.A.): Balgo Hill (63278-84, 63290).

Ctenotus rutilans sp. nov.

Holotype

R63628 in Western Australian Museum, collected by Mr J.N. Dunlop in June 1979 at 27 km SE of Mt Meharry, Western Australia, in 23°10'S, 118°45'E.

Diagnosis

A member of the *C. leonhardii* species-group, most like *C. uber uber* (Storr, 1968) but head and neck coppery red and midbody scale rows and subdigital lamellae more numerous.

Distribution

The Hamersley Range, north-western Western Australia.

Description

Snout-vent length (mm): 36-53. Length of appendages (% SVL): foreleg 31-33, hindleg 53-57, tail 178-202.

Nasals in very short contact or separated. Prefrontals separated. Supraoculars 4, first 3 in contact with frontal, second not wider than first. Supraciliaries 7 or 8. Palpebrals (*recte* upper ciliaries) 9. Second loreal 1.4-1.8 times as wide as high. Presuboculars 2. Upper labials 8. Ear lobules 5-7. Nuchals 2-5. Midbody scale rows 34 in holotype; 40 in paratypes. Toes compressed; 31-33 lamellae under fourth, each with a dark narrow callus or obtuse keel.

Coloration of holotype. Upper and lateral surfaces of head, neck and foreleg coppery red; of tail and hindleg greyish brown. Narrow black vertebral stripe from neck to base of tail. Paravertebral stripe from neck to base of tail, successively coppery red, reddish brown and greyish brown. Wide black laterodorsal stripe enclosing a series of spots of same colour as paravertebral stripe; inner edge on hindback splitting off to form a narrow black dorsal stripe. Narrow dorsolateral stripe from neck to base of tail, of same colour as paravertebral stripe. Upper lateral zone blackish brown, enclosing *ca* 3 irregular series of pale reddish brown dots; represented on tail by broad stripe. Broad white midlateral stripe restricted to immediately in front of and behind hindleg. Lower lateral zone reddish brown with 2 or 3 irregular series of reddish white dots. Limbs boldly striped with black.

Coloration of paratypes. As in holotype but pattern less distinct, e.g. dorsolateral stripe reduced to a series of short dashes.

Remarks

C. rutilans is the latest addition to the ever-growing list of Pilbara endemics. Other lizards in this category include *Egernia pilbarensis*, *Ctenotus* *rubicundus*, *Diplodactylus savagei*, *D. mitchelli*, *D. wombeyi*, *Varanus pilbarensis* and *Delma elegans*.

The paratypes of *C. rutilans* were pit-trapped by Mr C. Dawe on a scree slope vegetated with *Triodia* and scattered *Acacia*.

Paratypes

North-west Division (W.A.): 26 km NNW of Mt Brockman (22°15'S, 117°11'E) (63611, 64449).

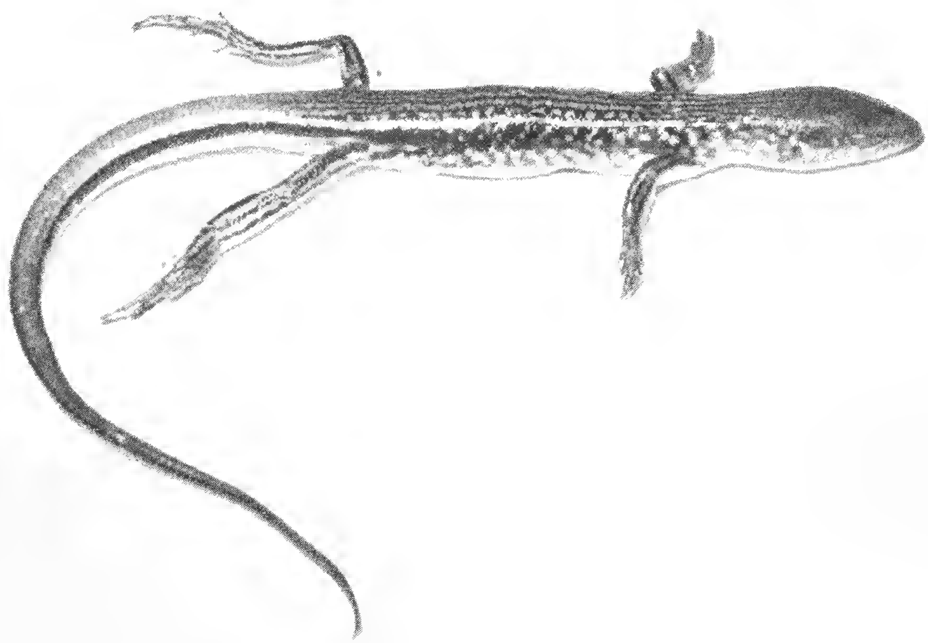

Plate 3: Holotype of *Ctenotus rutilans*.

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Erratum: Illustrations (but not captions) on pp. 474 and 477 are transposed. *Melanotaenia goldiei* is illustrated on p. 477; *Glossolepis wanamensis* is illustrated on p. 474.

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A GENERIC CLASSIFICATION OF THE RAINBOWFISHES (FAMILY MELANOTAENIIDAE)

GERALD R. ALLEN*

ABSTRACT

A generic classification of the rainbowfishes (Melanotaeniidae) of Australia-New Guinea is proposed. The family is considered to be a probable sister group of the Atherinidae. An important character state which is apparently apomorphic among the Melanotaeniidae is the presence of a modified inter-pelvic region consisting of a membrane between the innermost pelvic ray and abdomen which forms a scaleless, V-shaped enclosure containing the uro-genital openings. The following eight genera are recognised, including two which are described as new: *Cairnsichthys*, new genus; *Chilatherina* Regan; *Glossolepis* Weber; *Iriatherina* Meinken; *Melanotaenia* Peters; *Popondetta*, new genus; *Psuedomugil* Kner; and *Rhadinocentrus* Regan. *Centratherina* Regan, previously recognised as a distinct genus, is placed in the synonymy of *Chilatherina*. Each genus is diagnosed or described and illustrations which show important anatomical features are included. A key to the genera of melanotaeniids and freshwater atherinids of Australia-New Guinea is presented. The genus *Quirichthys*, whose familial affinity was previously in doubt, is placed in the Atherinidae. A list of the nominal species of Melanotaeniidae and their present allocation is given in tabular form.

INTRODUCTION

The rainbowfishes (Melanotaeniidae) of northern Australia and New Guinea comprise a group of approximately 45 species, all of relatively small size (usually under 14 cm TL), which inhabit freshwater streams, lakes, and swamps. They are generally recognised as having evolved from a marine atherinid ancestor and share many anatomical similarities with the members of that family. Indeed, many previous authors (including Regan 1914; Jordon & Hubbs 1919; Weber & de Beaufort 1922; Fowler 1928; and Taylor 1964) have included the rainbowfishes as a subfamily within the Atherinidae. However, Munro (1964, 1967), and Rosen (1964) suggested that on the basis of certain morphological features the rainbowfishes should be accorded separate family status. This view was also shared by Greenwood *et al.* (1966) in their provisional classification of living teleost fishes.

* Western Australian Museum, Francis Street, Perth, Western Australia, 6009

Since 1974 the present author has become greatly involved with the study of rainbowfish taxonomy. During this period extensive collections of melanotaeniids and other freshwater fishes were procured from Western Australia, Northern Territory, Queensland, New South Wales, and Papua-New Guinea. In addition, rainbowfish collections were studied in major museums of Australia, Europe, and America. This paper is the first of a series which will encompass the respective melanotaeniid faunas of Australia and New Guinea. The primary purpose of the present work is to define the generic relationships within the family, which until now have been poorly understood. As a result of this investigation two genera (*Pseudomugil* and *Iriatherina*) previously considered to be atherinids are re-assigned to the Melanotaeniidae. Evidence is also presented which confirms the separation of this group from the Atherinidae. The following eight genera are recognised: *Cairnsichthys,* new genus; *Chilatherina* Regan; *Glossolepis* Weber; *Iriatherina* Meinken; *Melanotaenia* Peters; *Popondetta,* new genus; *Pseudomugil* Kner; and *Rhadinocentrus* Regan.

MATERIALS AND METHODS

Specimens of melanotaeniids and other freshwater fishes were procured on seven field expeditions to northern Australia and Papua-New Guinea between August 1974 and October 1979. Approximately 6000 specimens of rainbowfishes were obtained representing 23 species and eight genera. This material, now deposited at the Western Australian Museum, formed the basis for this study, but was also supplemented by valuable collections made in northern Australia by Drs D.R. Rosen and J.P. Beumer, and in New Guinea by Drs M. Boeseman and T. Roberts. Most of the melanotaeniid holdings at the following institutions were also examined (abbreviations which appear in parentheses are used in the subsequent text): American Museum of Natural History, New York (AMNH); Australian Museum, Sydney (AMS); British Museum of Natural History, London; California Academy of Sciences, San Francisco (CAS); Field Museum of Natural History, Chicago; Museum National d'Histoire Naturelle, Paris; Rijksmuseum van Natuurlijke Histoire, Leiden (RMNH); United States National Museum of Natural History, Washington, D.C. (USNM); Western Australian Museum, Perth (WAM); and Zoologisch Museum, Amsterdam (ZMA).

Approximately 75 specimens, representing all the known genera of melanotaeniids and several atherinids were cleared in KOH and stained with Alizarin Red-S. These were stored in 100% glycerin and studied with the use of a dissecting microscope. Illustrations of certain bones were obtained by photo microscopy or were made with the aid of the Wild drawing attachment on the M-5 dissecting microscope.

Outgroup comparisons were made on approximately 400 specimens of Australian atherinids deposited in the WAM collection belonging to the follow-

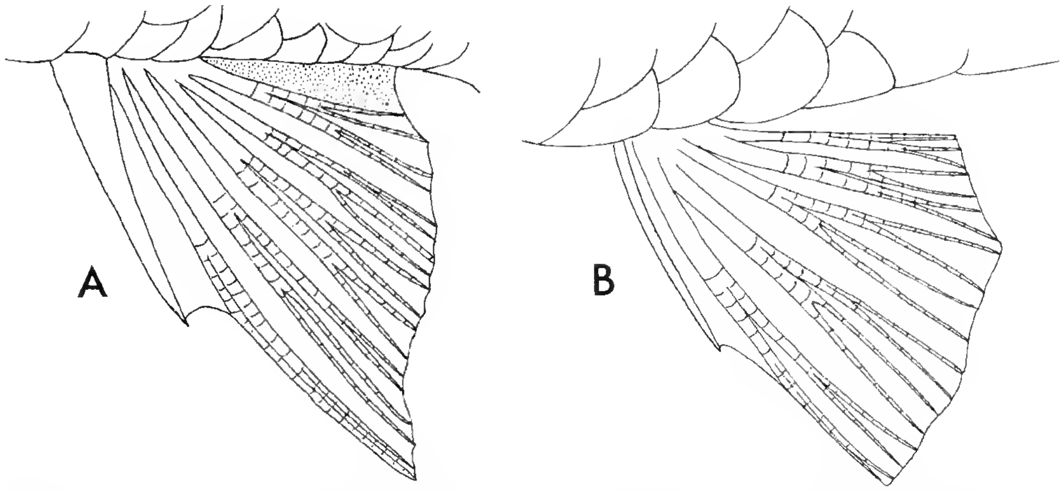


Fig. 1–Pelvic fins of melanotaeniids (A) and atherinids (B). The stippled area represents the membrane which connects the innermost ray and the abdomen.

ing genera: *Allanetta, Atherinosoma, Craterocephalus, Hypoatherina, Pranesus,* and *Quirichthys.* In addition, several loan specimens of *Bedotia* from Madagascar and *Telmatherina* from the Celebes were obtained from CAS and ZMA respectively.

Relationships within the Melanotaeniidae were evaluated using the methods of phylogenetic analysis described by Hennig (1966).

DEFINITION OF CHARACTERS

Selected characters which are used to define inter- and intra-familial relationships are briefly discussed below. A given character or character state was judged to be plesiomorphic (primitive) or apomorphic (derived) primarily on the basis of outgroup comparisons with the Atherinidae, which is considered to be the sister group of the Melanotaeniidae (see discussion section). This analysis should be regarded as provisional because mainly Australian atherinids were examined.

Inter-pelvic modification (Figs. 1-2)–Melanotaeniids possess an apparent unique external modification of the area between the pelvic fins consisting of a naked V-shaped enclosure containing the uro-genital openings. The enclosure is formed by a membranous attachment between the innermost pelvic ray and the abdomen with the uro-genital pores positioned near the open end of the V. This condition is considered to be apomorphic in comparison with the typical atherinid state which lacks membranes and has the uro-genital openings surrounded by scales. The function of this modification is not known, but it is probably related to reproductive activities.

A general survey of teleosts in the WAM collection revealed that the major-

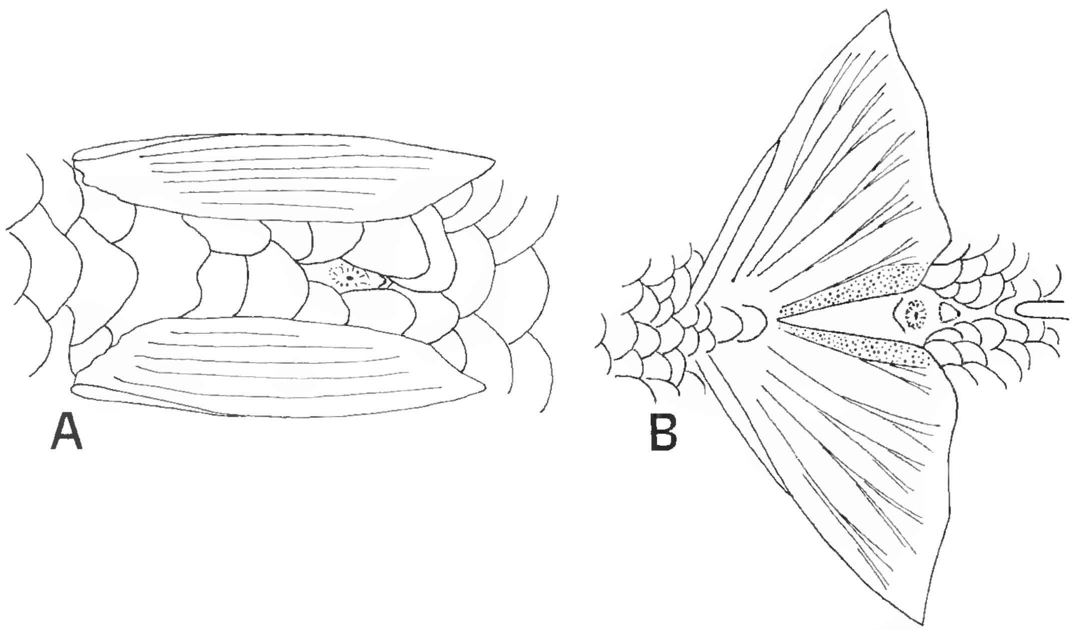


Fig. 2–Ventral view of pelvic regions of atherinids (A. *Pranesus* sp.) and melanotaeniids (B. *Melanotaenia* sp.)). The stippled area represents the membrane which connects the innermost ray and the abdomen.

ity of sub-perciform level groups lack the membrane which binds the pelvic fin to the abdomen, therefore reinforcing the apomorphic status of this membrane. However, a partial membrane is present in scorpaenids and a number of higher groups such as some serranids, grammistids, pseudogrammids, apogonids, carangids, lutjanids, kyphosids, lethrinids, pomacentrids, acanthurids, and mugilids. A very well developed membrane is found in several groups including priacanthids, kuhliids, pomatomids, toxotids, and the freshwater apogonid genus *Glossamia*. In addition, Patten (pers. comm.) has informed me that a partial membrane is present at the base of the pelvic fin in some specimens of the Australian freshwater atherinid *Quirichthys,* in most American atherinids, and in *Bedotia* a freshwater atherinoid from Madagascar. However, in all the abovementioned groups, the overall inter-pelvic area does not resemble the modified condition of melanotaeniids. In non-atherinoid fishes which display membrane development the uro-genital aperatures are generally situated well behind the inter-pelvic area.

Caudal skeleton–The overall morphology of the caudal skeleton of melanotaeniids and atherinids is very similar (**Figs. 3-5**). The main difference involves the lowermost hypural element (parahypural) which is fused to the lower hypural plate in most melanotaeniids (except *Cairnsichthys* and *Pseudomugil*) and autogenous in the Atherinidae. The latter condition is considered to be pleisiomorphic.

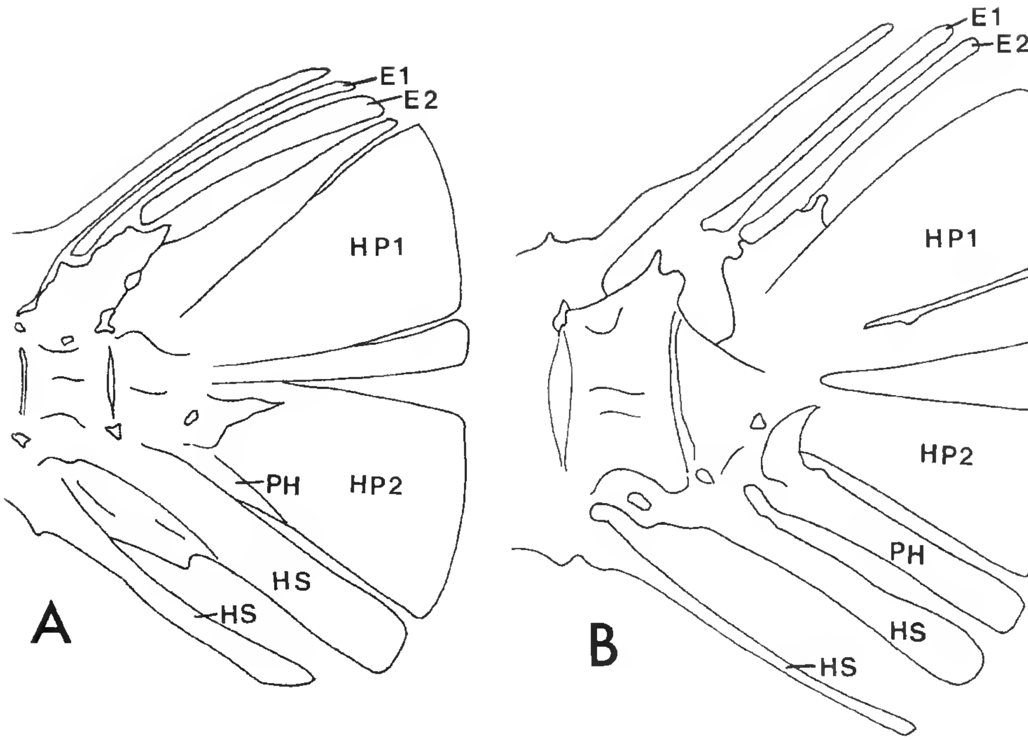


Fig. 3—Caudal skeletons of *Glossolepis incisus* (A, Melanotaeniidae) and *Atherinosoma* sp. (B, Atherinidae). Symbols are as follows: E1 and E2 = epurals; HP1 and HP2 = fused hypural elements representing upper and lower hypural plates respectively; PH = parahypural; HS = hemal spine.

Premaxillary shape and dentition—Melanotaeniids are characterised by a relatively short median ascending process on the premaxillary (**Fig. 6**). Furthermore, this bone usually supports a liberal number of conical to caniniform teeth, frequently extending outside of the mouth onto the lips (**Figs. 7-9**). Most Australian atherinids have a relatively elongate median process and lack external teeth of the melanotaeniid type (except in *Quirichthys*, **Fig. 6L,** and the marine genus *Atherion*). According to Patten (pers. comm.) basal autherinoids such as the Notocheirinae, *Atherion* and the most primitive atherinines possess a short premaxillary process and therefore this state is considered to be primitive. However, it is possible that the melanotaeniid condition has been secondarily derived from a marine ancestor possessing an elongate premaxillary, which as mentioned previously is typical of recent Australian atherinids.

Vomerine and palatine dentition—The presence of tiny conical teeth on the vomer and palatine bones (**Fig. 9**) is provisionally considered to be an apomorphic character. However, I have not examined a sufficient number of atherinids. The detection of this condition in small specimens is facilitated by dissection after clearing and staining.

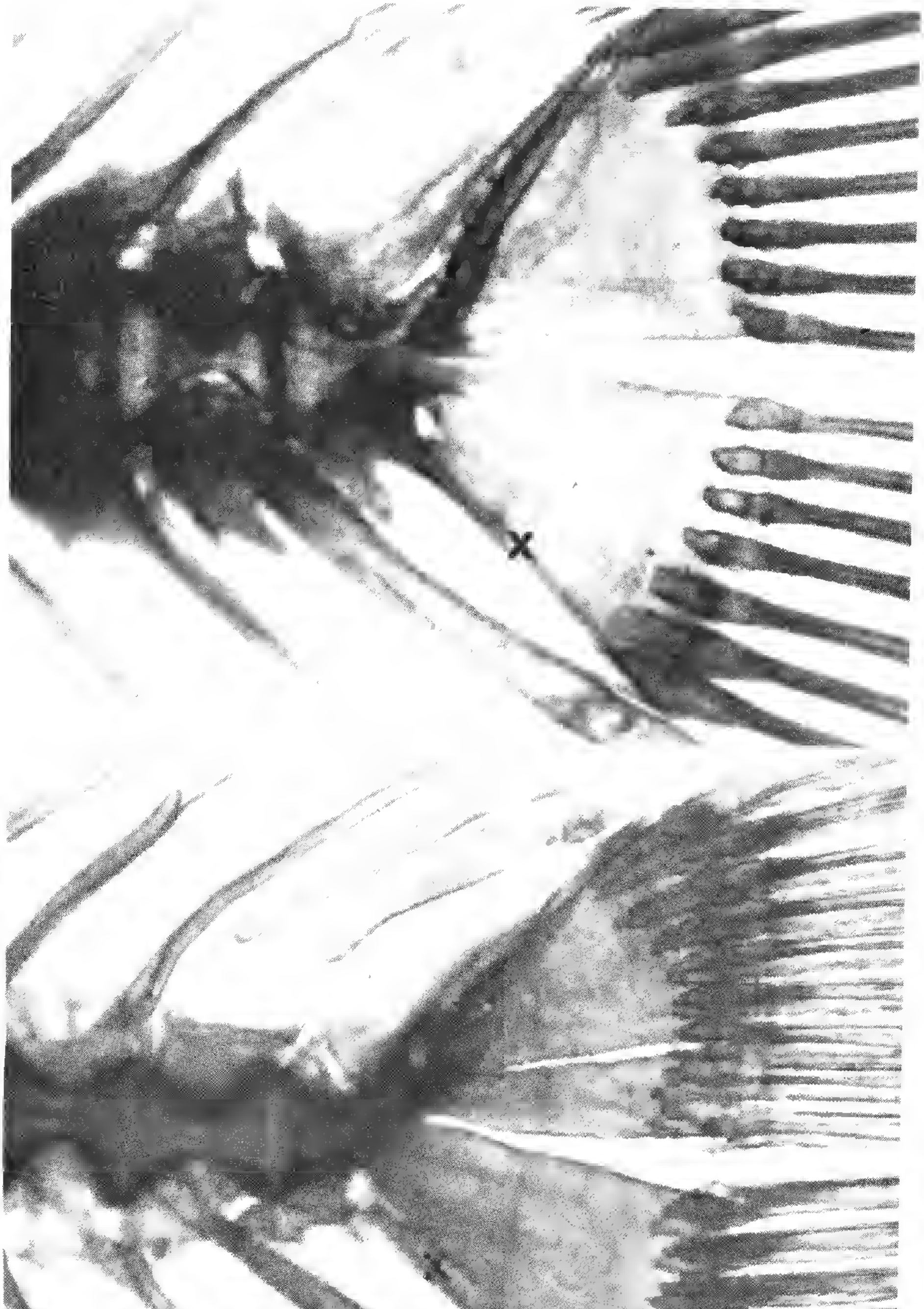


Fig. 4–Caudal skeletons of selected melanotaeniids: (upper) *Rhadinocentrus ornatus;* (lower) *Iriatherina werneri.* The fused parahypural is indicated by the symbol "X."

Fig. 5—Caudal skeletons of selected atherinids: (upper) *Hypoatherina barnesi;* (lower) *Quirichthys stramineus.* The autogenous parahypural is indicated by the symbol "X."

Fin-rays—Several characters or character states pertaining to fin-rays were useful in defining the various genera. These include: (1) presence or absence of stout spines at the beginning of the pelvic, anal, and both dorsal fins; (2) the presence or absence of segmentation of the first ray of the second dorsal fin in species lacking a stout spine in this position; (3) the number of unbranched rays in the second dorsal and anal fins; (4) the number of branched rays in the

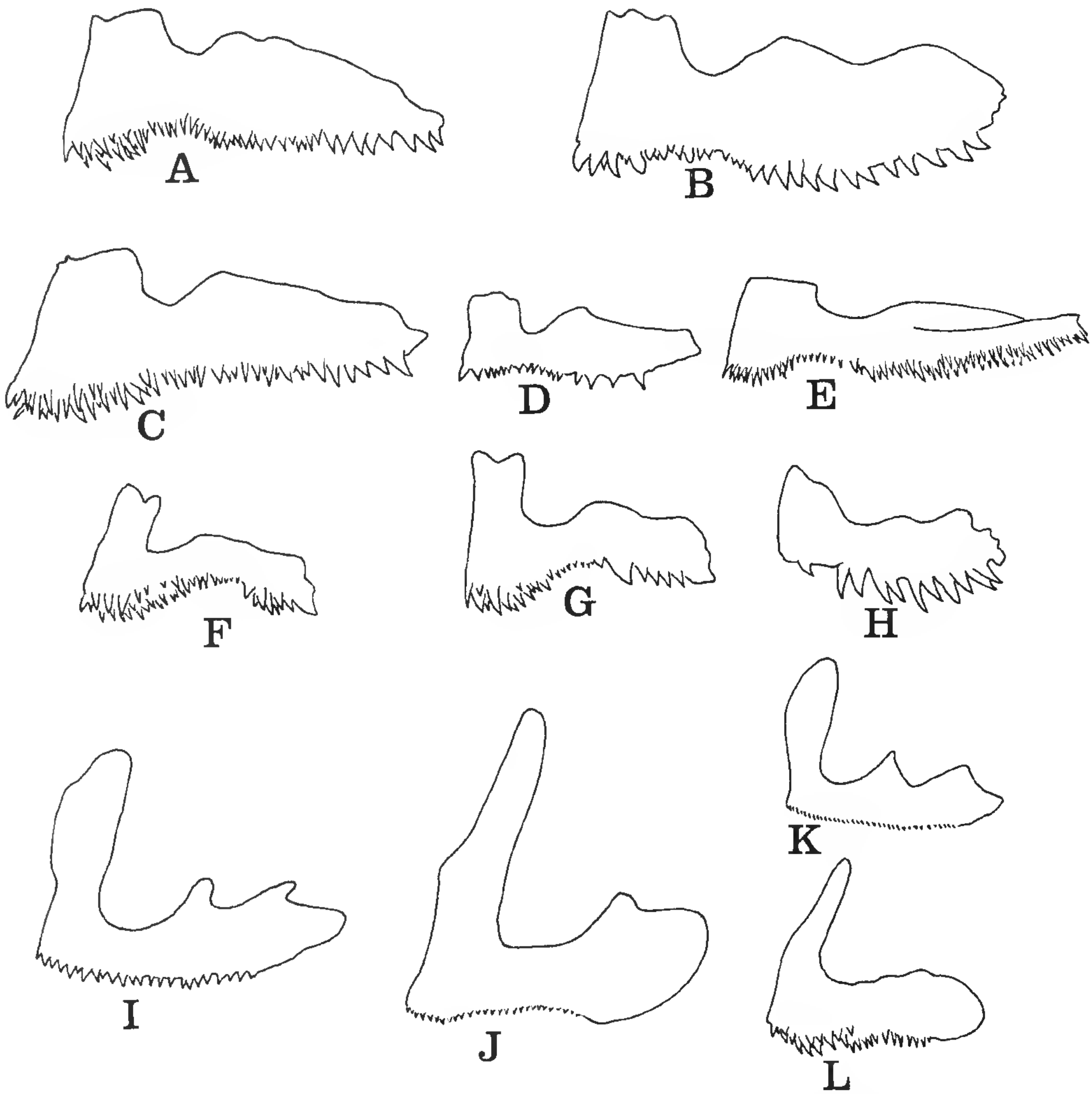


Fig. 6—Premaxillary bones of melanotaeniid (A-H) and selected atherinid genera (I-L) shown at equal magnification except H and J which are twice the scale of the others: (A) *Melanotaenia splendida*, 53 mm SL; (B) *Glossolepis incisus*, 74 mm SL; (C) *Chilatherina sentaniensis*, 67 mm SL; (D) *Rhadinocentrus ornatus*, 43 mm SL; (E) *Cairnsichthys rhombosomoides*, 48 mm SL; (F) *Popondetta furcatus*, 43 mm SL; (G) *Pseudomugil signifer*, 41 mm SL; (H) *Iriatherina werneri*, 33 mm SL; (I) *Atherinosoma presbyteroides*, 53 mm SL; (J) *Craterocephalus pauciradiatus*, 30 mm SL; (K) *Hypoatherina barnesi*, 43 mm SL; (L) *Quirichthys stramineus*, 40 mm SL.

caudal fin; and (5) the soft anal fin-ray count. The presence of stout spines, lack of segmentation in the first ray of the second dorsal fin, presence of several unbranched rays in the second dorsal and anal fins, a branched caudal fin-ray count of less than 15 and soft anal fin-ray count of more than 15 were all considered to be apomorphic character states.

Inter-dorsal pterygiophores–The number of non-supportive pterygiophores between the two dorsal fins is 2 or 3 in most melanotaeniids (**Fig. 22A**), except in *Pseudomugil* and *Popondetta* these elements are either lacking or represented by a rudiment. These character states are provisionally considered to be apomorphic compared to the atherinid condition in which there are gen-

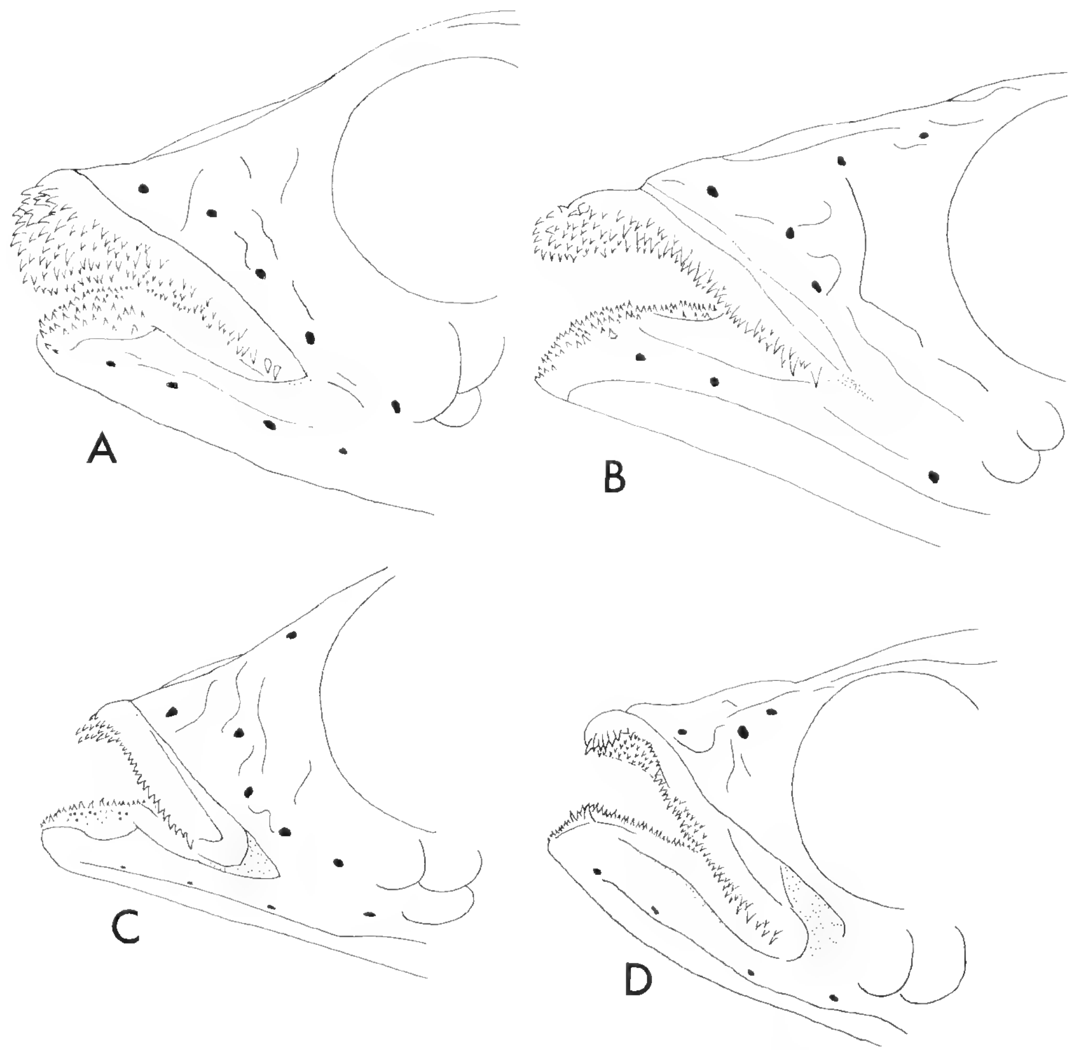


Fig. 7–Snout region of certain melanotaeniids showing external dentition: (A) *Chilatherina crassispinosa*, 82 mm SL; (B) *Chilatherina sentaniensis*, 77 mm SL; (C) *Glossolepis wanamensis*, 70 mm SL; (D) *Cairnsichthys rhombosomoides*, 54 mm SL.

erally more than four elements. However, my comparison with atherinids was limited to the Australian genera.

Pelvic girdle–The general shape of the pelvic girdle is extremely variable among melanotaeniid and atherinid genera (**Fig. 10**). Most genera possess finger-like projections anteriorly and posteriorly at the ventral mid-line, but

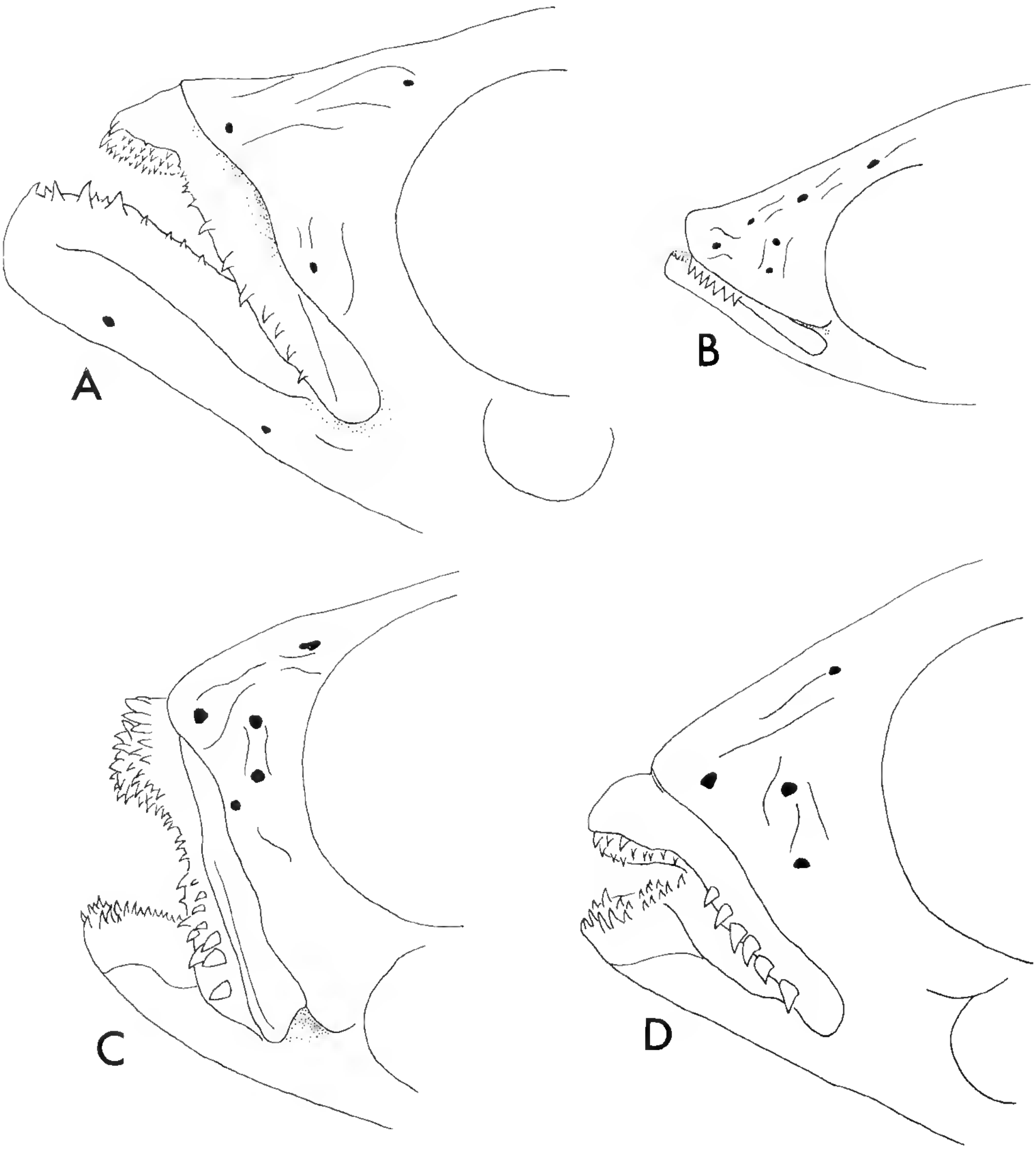


Fig. 8–Snout region of certain melanotaeniids showing external dentition: (A) *Rhadinocentrus ornatus,* 48 mm SL; (B) *Iriatherina werneri,* 19 mm SL; (C) *Popondetta furcatus,* 43 mm SL; (D) *Pseudomugil signifer,* 41 mm SL.

two melanotaeniid genera lack the anterior projections (**Fig. 10F & H**). Generally, the lateral "wings" of melanotaeniids are better developed than in atherinids. There is also variation in the muscular attachment or 'anchoring' of the lateral 'wing' to the pleural ribs; in melanotaeniids the attachment is with the

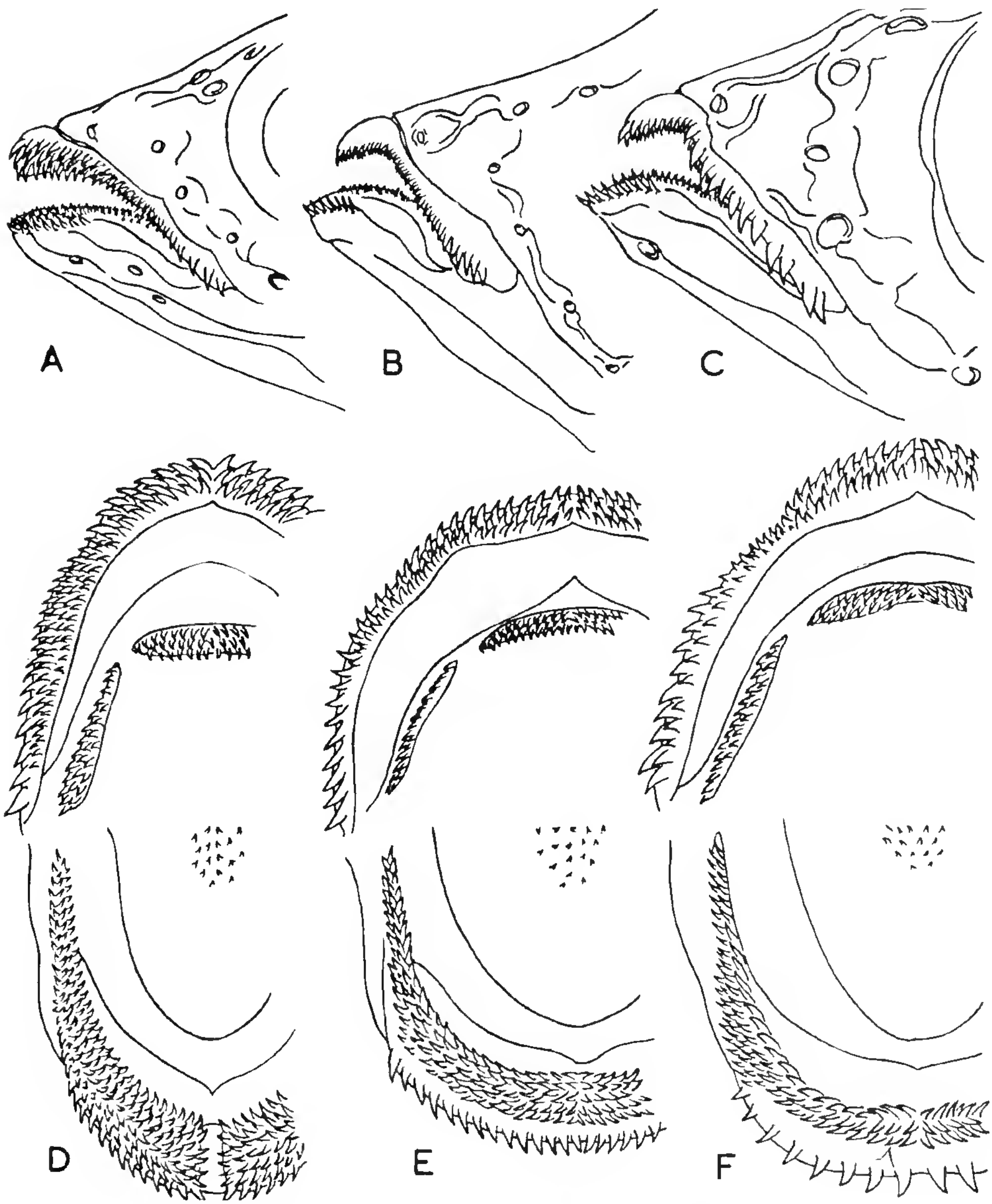


Fig. 9—Dentition of the genus *Melanotaenia*: (A & D) *M. affinis*, 98 mm TL; (B & E) *M. splendida rubrostriata*, 142 mm TL; (C & F) *M. splendida splendida*, 96 mm TL (drawings from Munro, 1964).

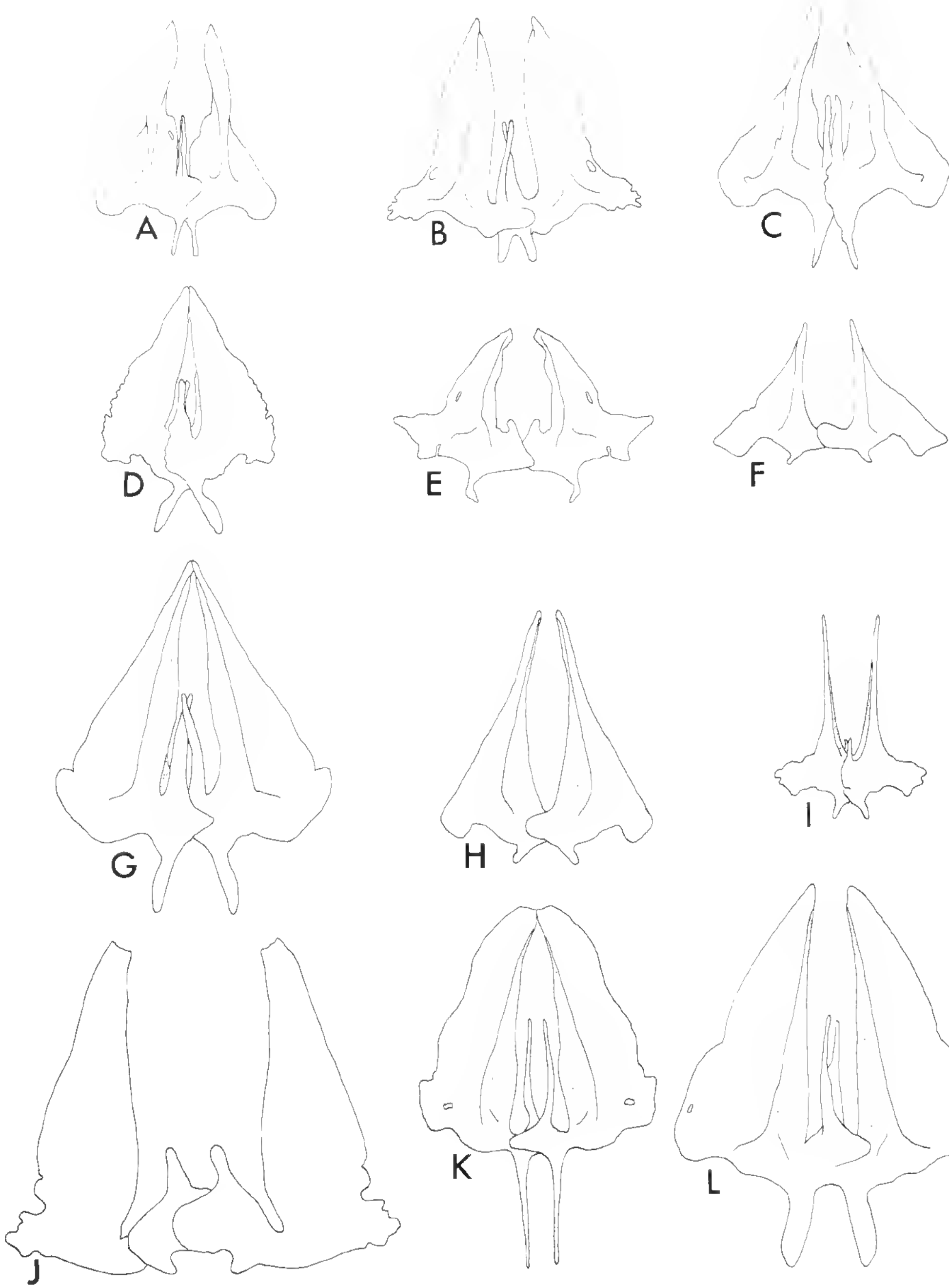


Fig. 10–Ventral view of pelvic girdles of melanotaeniid (A-I) and selected atherinid genera (J-L) shown at equal magnification except D which is half the scale of the others: (A) *Melanotaenia exquisita*, 42 mm SL; (B) *Melanotaenia* sp. (Lake Eacham, Queensland), 52 mm SL; (C) *Chilatherina crassispinosa*, 42 mm SL; (D) *Glossolepis incisus*, 74 mm SL; (E) *Rhadinocentrus ornatus*, 41 mm SL; (F) *Cairnsichthys rhombosomoides*, 32 mm SL; (G) *Pseudomugil signifer*, 41 mm SL; (H) *Popondetta furcatus*, 40 mm SL; (I) *Iriatherina werneri*, 30 mm SL; (J) *Atherinosoma presbyteroides*, 53 mm SL; (K) *Hypoatherina barnesi*, 43 mm SL; (L) *Quirichthys stramineus*, 40 mm SL.

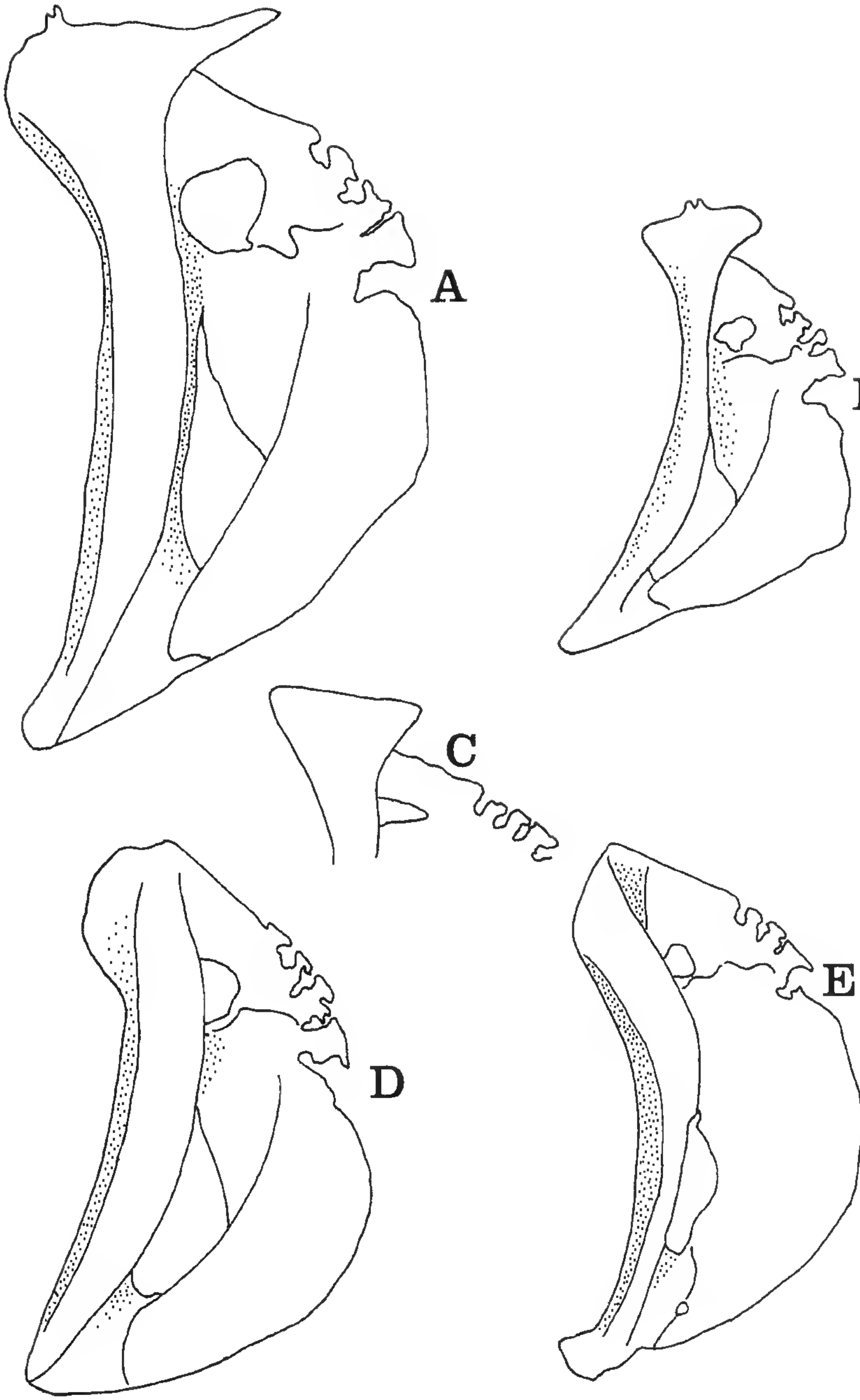


Fig. 11–Lateral view of left pectoral girdle of selected melanotaeniids: (A) *Melanotaenia splendida,* 53 mm SL: (B) *Rhadinocentrus ornatus,* 37 mm SL; (C) *Iriatherina werneri,* 33 mm SL; (D) *Pseudomugil signifer,* 41 mm SL; (E) *Popondetta furcatus,* 38 mm SL.

second, third, or fourth rib, whereas in the Australian atherinid genera examined the fourth or fifth ribs were involved. The lack or reduction of anterior projections at the ventral mid-line, presence of well-developed lateral 'wings' and their attachment to the second or third pleural rib are provisionally considered to be apomorphic character states, pending further study of a wider range of atherinid genera.

Pectoral girdle—Atherinids and some melanotaeniid genera possess a well-developed posteriorly directed process on the dorsal head of the cleithrum (**Fig. 11**). The presence of this feature in only the more advanced melanotaeniid groups is therefore difficult to interpret, but may represent a form of secondary convergence. The majority of melanotaeniids have a reduced process or this feature is lacking.

Scalation—A count of eight or less horizontal scale rows at the level of the anal fin origin is provisionally considered to be plesiomorphic and is found in three melanotaeniid genera and most Australian atherinids. Most melanotaeniids possess a probable apomorphic condition consisting of 10 to 18 rows. The scale margins are generally cycloid or slightly crenulate in both atherinids and melanotaeniids, except in the genus *Glossolepis,* a member of the latter group which exhibits a specialised condition characterised by prominent crenulations (**Fig. 12**). In addition, two melanotaeniid genera, *Popondetta* and *Cairnsichthys,* lack well-developed radii, another feature considered to be apomorphic within the melanotaeniidae.

Gill-rakers—There is a trend towards an increased gill raker count in the more advanced melanotaeniids. Counts for the various genera range from 8 to 25 rakers on the lower limb of the first gill arch. A similar range of counts is found in Australian atherinids.

Vertebrae—Total vertebral counts in melanotaeniids usually range from 27 to 38, which is considered to be an apomorphic character state compared to the atherinid condition in which there are usually more than 38 vertebrae. However, this vertebral count trend is reversed within the Melanotaeniidae as the most advanced genera possess the highest counts (i.e., usually 34-38).

Otolith morphology—Approximately 100 melanotaeniid otoliths were analysed. Generic differences appear to be associated mainly with overall shape (**Fig. 13**), but there is a great deal of variation, even within species. No atherinid otoliths were examined and therefore no attempt has been made to ascertain specialisation trends.

FAMILY MELANOTAENIIDAE

(type genus: *Melanotaenia* Gill, 1862)

Diagnosis: Small, laterally compressed fishes, oblong to slender in shape; head more or less pointed; top of snout and interorbital region flattened; eye relatively large. Mouth opening moderate or small, usually not extending

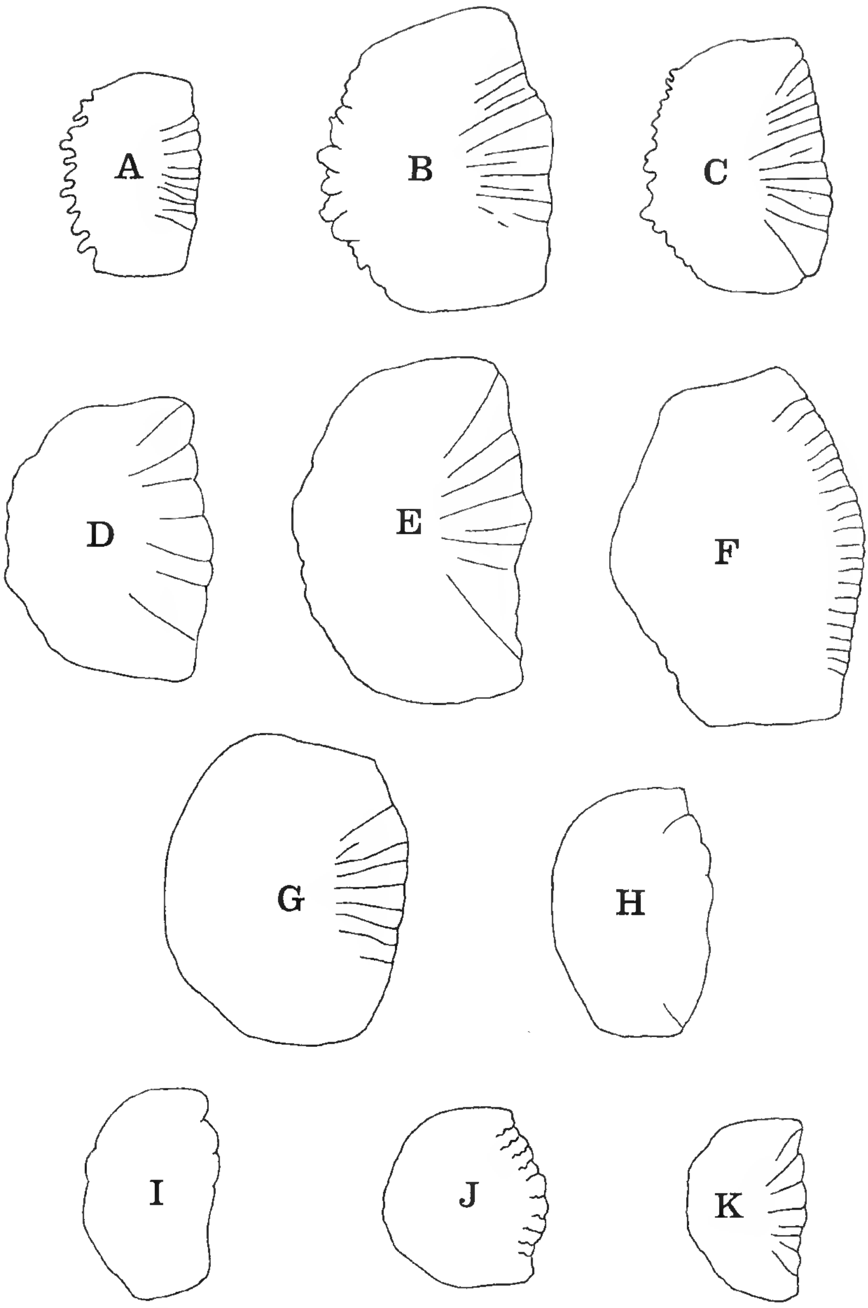


Fig. 12–Scales of selected melanotaeniids taken from the approximate same position of each fish, three rows directly below origin of first dorsal spine. (A) *Glossolepis incisus*, 79 mm SL; (B) *G. multisquamatus*, 87 mm SL; (C) *G. wanamenis*, 78 mm SL; (D) *Chilatherina crassispinosa*, 85 mm SL; (E) *C. lorentzi*, 89 mm SL; (F) *Melanotaenia splendida*, 80 mm SL; (G) *Rhadinocentrus ornatus*, 48 mm SL; (H) *Cairnsichthys rhombosomoides*, 66 mm SL; (I) *Popondetta furcatus*, 43 mm SL; (J) *Iriatherina werneri*, 30 mm SL; (K) *Pseudomugil signifer*, 41 mm SL. All scales shown at equal magnification, except G and H which are twice the scale of the others.

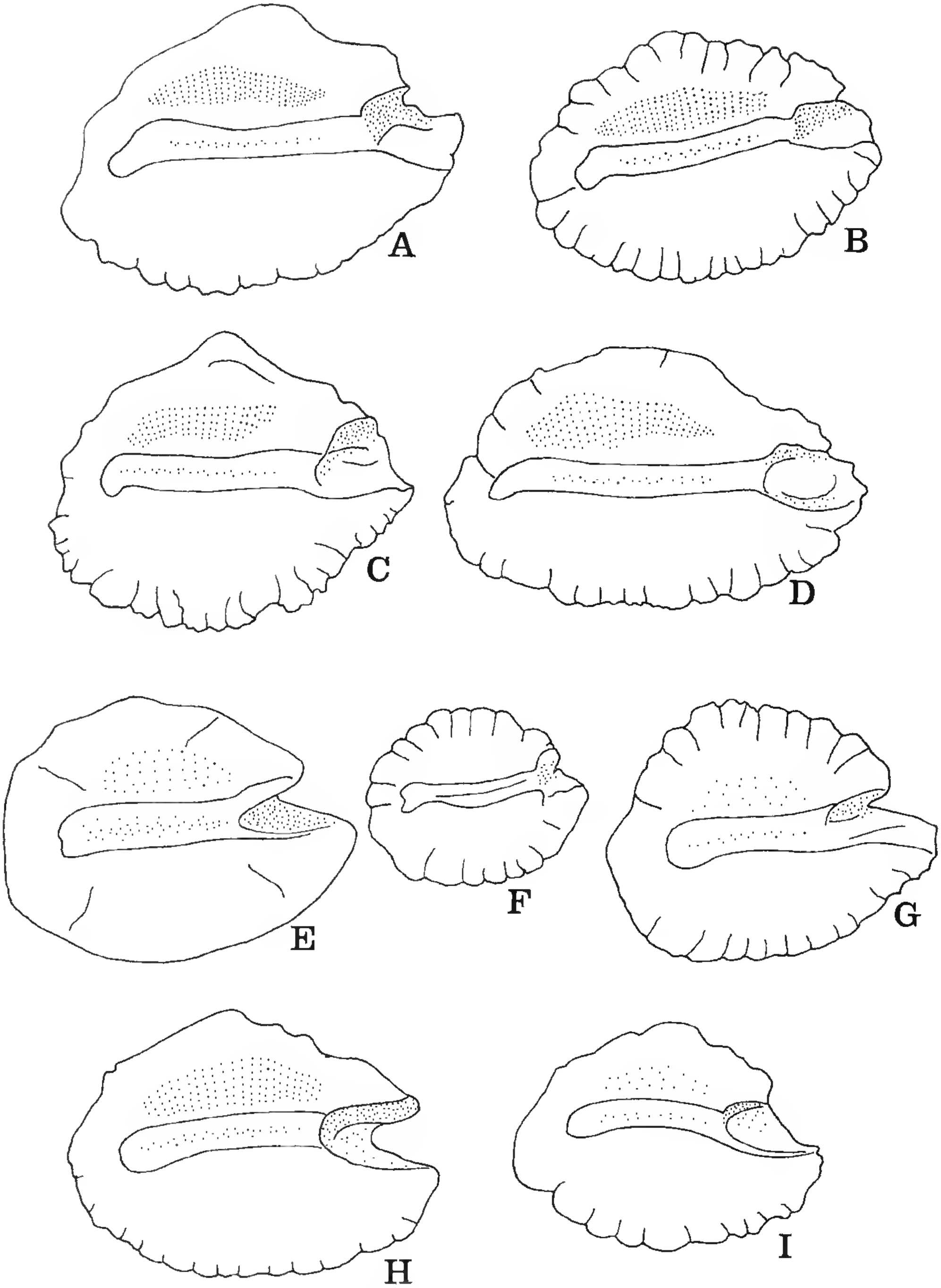


Fig. 13–Sagittal otoliths from left side of certain melanotaeniids: (A) *Melanotaenia trifasciata*, 73 mm SL; (B) *M. goldiei*, 64 mm SL; (C) *Glossolepis wanamensis*, 74 mm SL; (D) *Chilatherina lorentzi*, 79 mm SL; (E) *Rhadinocentrus ornatus*, 48 mm SL; (F) *Cairnsichthys rhombosomoides*, 46 m SL; (G) *Popondetta furcatus*, 39 mm SL; (H) *Pseudomugil signifer*, 41 mm SL; (I) *Iriatherina werneri*, 31 mm SL. Otoliths A-D and F shown at equal magnification; E and G-I are twice the scale of the others.

beyond level of anterior edge of eye; lips frequently thickened and often bearing one or more rows of teeth; premaxillaries bordering the mouth opening, nearly straight, gently curved, or with an abrupt bend between the anterior horizontal portion and lateral part; ascending median process or premaxillary relatively short; maxillaries rod-like, visible or not when mouth is closed; jaw teeth conical to caniniform, usually arranged in several rows, often extending outside of mouth onto lips; teeth on vomer, palatines, and tongue present or absent; two dorsal fins present; first dorsal fin usually composed of 3 to 7 spines, the first of which is often several times larger in diameter than the others, second dorsal fin composed of 6 to 22 rays, the first a stout spine in some genera; anal fin with 10 to 30 rays, the first a stout spine in some genera; pelvic fins composed of one spine and 5 soft rays; innermost pelvic ray attached to abdomen by membrane along its entire length; inter-pelvic region naked between pelvic axillary scale cluster and anus; preopercle, opercle, and body covered with scales, horizontal rows on body at level of anal fin origin 6 to about 18, vertical rows from upper corner of gill opening to caudal fin base about 28 to 60; hind margin of scales smooth to deeply crenulate; lateral line absent or represented by shallow pits on some scales; a few weakly developed rakers on upper limb and about 8 to 30 rakers on lower limb of first gill arch; vertebrae 27 to 38; lowermost element of hypural (para-hypural) fused to lower hypural plate in most genera; inter-dorsal pterygiophores 0-3 (rarely 4).

Remarks: The most useful character for separating the Melanotaeniidae from the closely related Atherinidae is the possession of a membrane between the full length of the innermost pelvic ray and the abdomen (**Fig. 1**) which forms a V-shaped enclosure or furrow around the naked inter-pelvic area (**Fig. 2**). The membrane is frequently damaged in preserved specimens. Great care must be exercised when extending the fin with a probe while searching for this feature as the membrane is easily split. The pelvic fins of Australian atherinids are generally set wider apart than those of melanotaeniids and the pelvic girdle of the former group is larger in relation to size. The posterior finger-like projections at the ventral mid-line of the girdle (**Fig. 10**) are readily visible in cleared and stained atherinids, but are hidden by the over-lying pelvic fins in melanotaeniids. The premaxillary shape and associated dentition of melanotaeniids is also very distinctive (**Fig. 6**), although a few atherinids have some teeth outside the mouth (for example, *Atherion* and *Quirichthys*) or a reduced ascending process (for example, *Pranesus* and *Atherion*). Another difference between these groups is the presence of pronounced secondary sexual characteristics among most melanotaeniids, usually manifested in the brighter colours and more elongate dorsal, anal, and pelvic fin rays of mature males. Most atherinids, on the contrary, exhibit little or no sexual dimorphisim.

Rosén (1964), in comparing atherinoid caudal skeletons, stated that atherinids had an autogenous parahypural (**Fig. 5**) and two epurals, whereas melanotaeniids have the parahypural fused to the other hypural elements and possess a single epural. However, the present study indicates that the parahypural is autogenous in two melanotaeniid genera, *Pseudomugil* and *Cairnsichthys,* and the presence of two epurals is common in most members of the family (**Fig. 4**).

The following key will serve to distinguish the genera of Melanotaeniidae and sympatric freshwater atherinids.

Key to the Genera of Melanotaeniidae and Freshwater Atherinidae of N. Australia and New Guinea

1a. Innermost pelvic ray not attached to abdomen by membrane (**Fig. 1B**); scales present on abdomen between pelvic base and anus (**Fig. 2A**) (Family ATHERINIDAE) 2

1b. Innermost pelvic ray attached to abdomen by membrane (**Fig. 1A**); scales absent on abdomen between pelvic base and anus (**Fig. 2B**) (Family MELANOTAENIIDAE) 3

2a. No conical teeth on lips outside of mouth; first dorsal fin never taller than second dorsal fin (N. Australia and New Guinea .... *Craterocephalus*

2b. Conical teeth present on lips outside of mouth; first dorsal fin of males significantly taller than second dorsal fin (N. Australia) .... *Quirichthys*

3a. No rigid fin spines present, all rays slender and flexible 4

3b. Some rigid fin spines present, usually at beginning of first dorsal (except in *Iriatherina*), second dorsal, anal, and pelvic fins 7

4a. Total anal fin rays usually 9-13; anal fin usually originates on posterior half of body (caudal fin excluded) (N. and E. Australia and New Guinea) .... *Pseudomugil*

4b. Total anal fin rays usually 17-21; anal fin usually originates on anterior half of body 5

5a. Pores in interorbital region well-developed and conspicuous; a large scale covering much of interorbital; first dorsal fin originating well in advance of level of first anal ray; first dorsal fin of males elongate and filamentous, extending as far as fifth ray of second dorsal fin when depressed; middle caudal rays dark (vicinity of Popondetta, New Guinea) .*Popondetta,* n.gen.

5b. Pores in interorbital region very small and inconspicuous; no large scale covering most of interorbital; first dorsal fin originating slightly behind to slightly ahead of level of first anal ray; first dorsal fin of males not elongate and filamentous; middle caudal rays not contrasted with remainder of fin (Australia) 6

6a. Lower jaw prominant (**Fig. 8A**); exposed lateral part of premaxillary with a single row of 15 or less widely separated teeth (**Fig. 8A**); horizontal scale rows at level of anal fin origin 8 or 9 (S. Queensland and N. New South Wales) .. *Rhadinocentrus*

6b. Jaws about equal (**Fig. 7D**); exposed lateral part of premaxillary with numerous teeth arranged in several rows (**Fig. 7D**); horizontal scale rows at level of anal fin origin 10 or 11 (N. Queensland) .... *Cairnsichthys,* n.gen.

7a. A stout, rigid spine present at beginning of first dorsal fin; soft anal fin rays 15-30; first few rays of second dorsal and anal fins not produced into elongate filaments; exposed teeth on premaxillary numerous and well-developed (**Figs. 7A & B, & 9**) 8

7b. All spines of first dorsal fin relatively soft and flexible; soft anal fin rays 11 or 12; first few rays of 2nd dorsal and anal fins produced into elongate filaments in adult males; exposed premaxillary teeth restricted to a single row of about 7-8 enlarged canines (**Fig. 7B**) (S. New Guinea and Cape York Peninsula) .... *Iriatherina*

8a. Scale margins deeply crenulate (**Fig. 12, A-C**); vertical scale rows from upper edge of gill opening to caudal fin base 37-60 (N. New Guinea) .... *Glossolepis*

8b. Scale margins smooth or with only shallow crenulations (**Fig. 12, D-F**); vertical scale rows from upper edge of gill opening to caudal fin base 29-44 9

9a. Premaxillaries with an abrupt bend between anterior horizontal portion and lateral portion (**Fig. 9**) (Australia-New Guinea .... *Melanotaenia*

9b. Premaxillaries without an abrupt bend between anterior horizontal portion and lateral portion (**Fig. 23**) (N. New Guinea .... *Chilatherina*

Genus *Pseudomugil*
(Fig. 14)

Pseudomugil Kner, 1865: 275 (type species, *Pseudomugil signifer* Kner, 1865, by monotypy).

Diagnosis—Relatively elongate, laterally compressed body; greatest body depth 3.4 to 5.0 in standard length; premaxillaries with a distinct bend between the anterior horizontal portion and lateral part; jaw teeth conical to caniniform, with or without one or more rows extending outside of mouth;

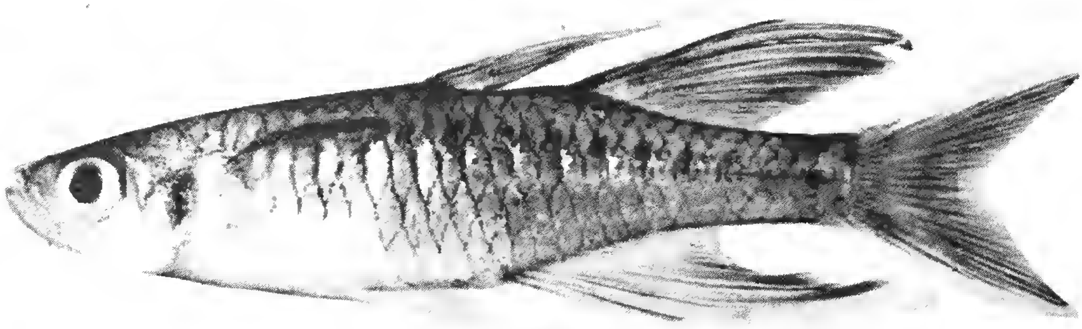


Fig. 14–*Pseudomugil signifer,* male, 40 mm SL, Saltwater Creek, Cape York Peninsula, Australia.

vomer and palatines toothless; inter-dorsal pterygiophores absent; first dorsal fin consisting of 3 to 5 slender, flexible spines; second dorsal fin composed of 6 to 12 segmented rays; anal fin with or without slender, flexible spine, and 8 to 12 segmented rays; anal fin originates on posterior half of body; all soft, segmented fin rays usually branched except first ray of second dorsal and anal fins; branched caudal rays 9 to 14; parahypural autogenous; pelvic girdle with well-developed finger-like projections anteriorly at ventral mid-line; lateral 'wing' of pelvic girdle anchored to fourth pleural rib; dorsal head of cleithrum without posteriorly directed projection; scales cycloid with well-developed radii, horizontal rows on body at level of anal fin 6 to 8, vertical rows from upper corner of gill opening to caudal fin base 27 to 30; gill rakers on lower limb of first gill arch 8 to 11; vertebrae 27 to 32; sexual dimorphism characterised by more elongate rays in first dorsal, second dorsal, anal, and pelvic fins of males.

Remarks–*Pseudomugil* contains six known species and perhaps three or more undescribed forms. The distribution includes coastal fresh and brackish water of New South Wales and Queensland, Arnhem Land (Northern Territory), southern New Guinea, and the Aru Islands.

Popondetta gen. nov. (Fig. 15)

Type species, *Pseudomugil furcatus* Nichols, 1955: 2.

Description–A genus of Melanotaeniidae with the following combination of characters: relatively elongate, laterally compressed body; greatest body depth 3.4 to 4.4 in standard length; premaxillaries with a distinct bend between the anterior horizontal portion and lateral part; jaw teeth conical to caniniform, several rows extending outside of mouth; vomer and palatines

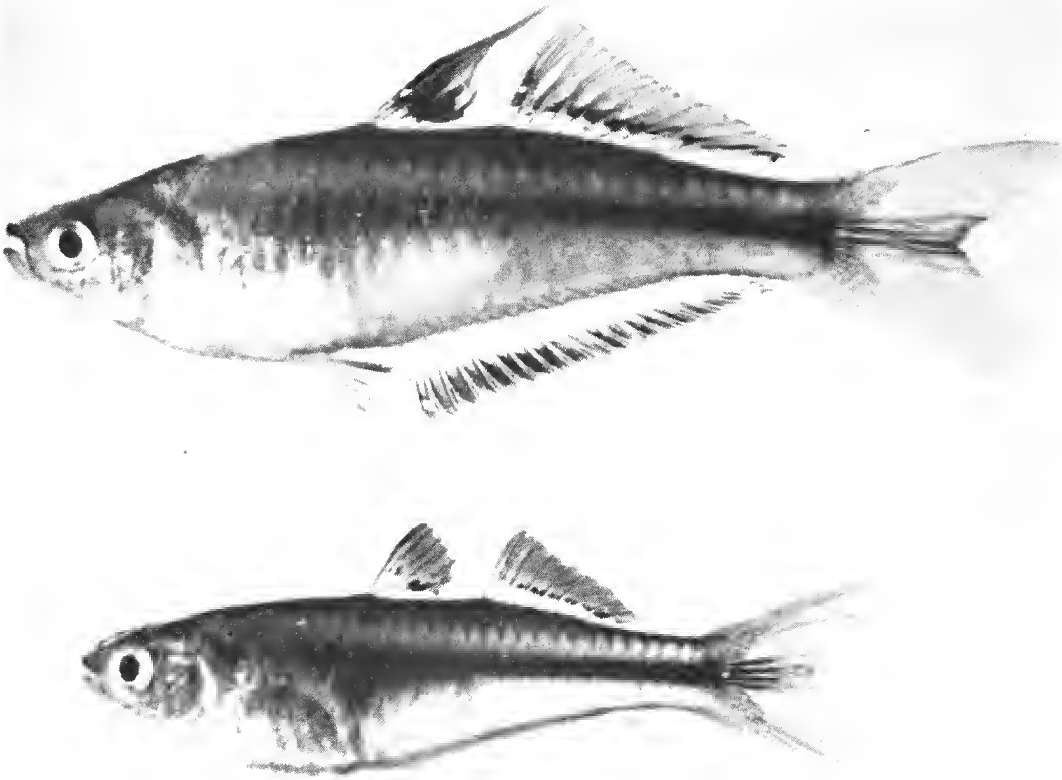


Fig. 15–*Popondetta furcatus,* male (top), 39 mm SL, and female, 33 mm SL, Auga Creek, near Popondetta, Papua New Guinea.

toothless; usually a single, rudimentary inter-dorsal pterygiophore; first dorsal fin consisting of 5 to 8 slender, flexible spines; second dorsal fin composed of 10 to 12 segmented rays; anal fin with a slender, flexible spine and 16 to 20 segmented rays; anal fin originates on anterior half of body; all soft, segmented fin rays usually branched except first ray of second dorsal fin and second ray of anal fin, branched caudal rays 9 to 12; parahypural fused to lower hypural plate; pelvic girdle without anterior projections at ventral mid-line; lateral 'wing' of pelvic girdle anchored to fourth pleural rib; dorsal head of cleithrum without posteriorly directed projection; scales cycloid with radii absent or poorly developed; horizontal rows on body at level of anal fin 6 to 8, vertical rows from upper corner of gill opening to caudal fin base 29 to 33; gill rakers on lower limb of first gill arch 8 to 10; vertebrae 32; sexual dimorphism characterised by more elongate rays in first dorsal fin and posteriormost part of second dorsal fin of males.

Remarks–This genus contains a single known species, *furcata,* which was originally described as a species of *Pseudomugil* by Nichols (1955). This species differs from *Pseudomugil,* however, on the basis of the following characters: (1) presence of 16 to 20 soft anal rays (8 to 12 in *Pseudomugil*); (2) pelvic girdle without anterior projections at ventral mid-line (**Fig. 10H**); and (3) absence of distinct scale radii (**Fig. 12I**). *Popondetta* and *Pseudomugil* are clearly monophyletic. Their relationship is outlined in detail under the discussion section.

The genus is named after the town of Popondetta (approximately 8°45′S, 148°15′E), as the distribution of the type species is confined to the vicinity of this location. The gender is considered to be feminine.

Genus *Rhadinocentrus*
(Fig. 16)

Rhadinocentrus Regan, 1914: 280 (type species, *Rhadinocentrus ornatus* Regan, 1914, by original designation).

Diagnosis—Moderately elongate, laterally compressed body; greatest body depth 3.5 to 4.0 in standard length; premaxillaries with a more or less distinct bend between the anterior horizontal portion and lateral part; jaw teeth conical to caniniform, one or more rows extending outside of mouth; vomer and palatines toothless; inter-dorsal pterygiophores 2 or 3; first dorsal fin consisting of 3 to 5 slender, flexible spines; second dorsal fin composed of 11 to 15 segmented rays (first ray occasionally unsegmented); anal fin with a slender, flexible spine and 18 to 22 segmented rays; anal fin originates on anterior half of body; usually only last few dorsal and anal rays branched; branched caudal rays 10 to 13; parahypural fused to lower hypural plate; pelvic girdle with anterior finger-like projections at ventral mid-line; lateral 'wing' of pelvic girdle anchored to second or third pleural rib; dorsal head of cleithrum with moderately developed, posteriorly directed projection; scales cycloid with well-developed radii, horizontal rows on body at level of anal fin 8 or 9, vertical rows from upper corner of gill opening to caudal fin base 31 to 37; gill rakers on

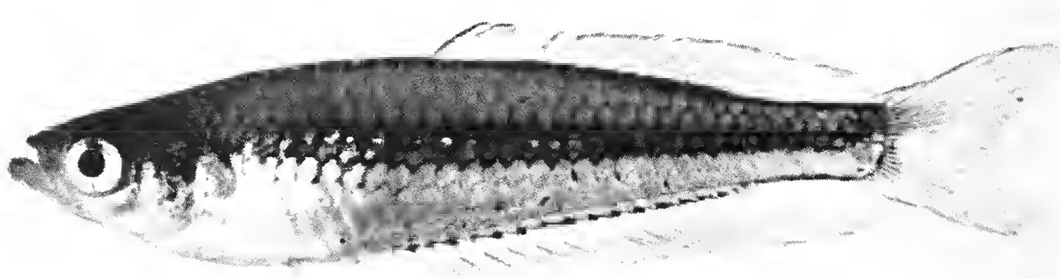


Fig. 16—*Rhadinocentrus ornatus,* male, 43 mm SL, small creek near Lake Cooroiba, S. Queensland, Australia.

lower limb of first gill arch 11 or 12; vertebrae usually 35; sexual dimorphism characterised by more elongate rays in second dorsal and anal fins of males.

Remarks—*Rhadinocentrus* contains a single species, *R. ornatus*, confined to coastal areas of northern New South Wales and southern Queensland, Australia. A second species, *rhombosomoides* was also described as a member of this genus by Nichols & Raven (1928), but the present study indicates it is deserving of separate generic status. It is placed in *Cairnsichthys*, which is herein described as new.

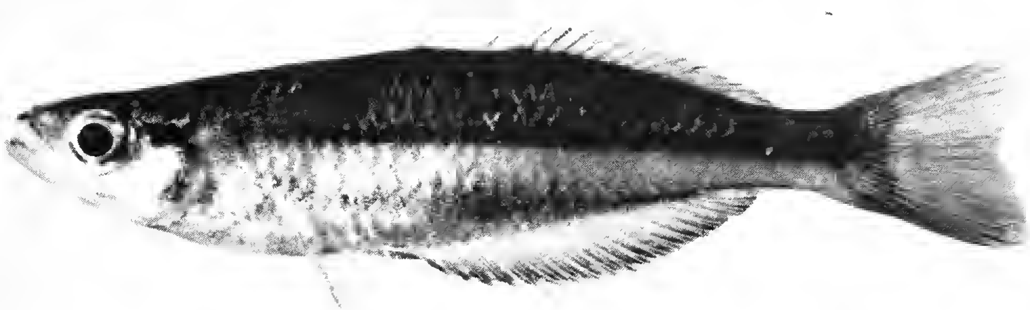


Fig. 17—*Cairnsichthys rhombosomoides*, male, 48 mm SL, Harvey Creek, near Cairns, N. Queensland, Australia.

Cairnsichthys gen. nov.
(Fig. 17)

Type species, *Rhadinocentrus rhombosomoides* Nichols & Raven, 1928: 1.

Description—A genus of Melanotaeniidae with the following combination of characters: relatively elongate, laterally compressed body; greatest body depth 3.3 to 4.4 in standard length; premaxillaries with a distinct bend between the horizontal anterior portion and lateral part; jaw teeth conical to caniniform, several rows extending outside of mouth; vomer and palatines toothless; inter-dorsal pterygiophores 2 or 3; first dorsal fin consisting of 5 or 6 slender, flexible spines, second dorsal fin composed of 14 segmented rays (except first ray sometimes unsegmented or with very weak segmentation visible only under high magnification); anal fin with a slender, flexible spine and 18 to 20 segmented rays; anal fin originates on anterior half of body; all soft, segmented rays branched except first 2 or 3 rays of second dorsal fin and first 6 or 7 rays of anal fin; branched caudal rays 13 or 14; parahypural autogenous; pelvic girdle without anterior projections at ventral mid-line; lateral 'wing' of pelvic girdle anchored to fourth pleural rib; dorsal head of cleithrum with moderately developed posterior projection; scales cycloid with well-developed radii, horizontal rows on body at level of anal fin 10 or 11, vertical rows from upper edge of gill opening to caudal fin base 36 to 38; gill rakers on lower limb of first gill arch 10 to 12; vertebrae 36 or 37; sexual differences slight, related mainly to fin colouration.

Remarks—The type species, *rhombosomoides,* was placed in *Rhadinocentrus* by Nichols & Raven (1928), but they stated "This fish is quite unlike the type of *Rhadinocentrus, R. ornatus* Regan." Likewise, Munro (1958) questioned the inclusion of this species in *Rhadinocentrus.* The present study indicates there are several significant differences between *R. ornatus* and *'Rhadinocentrus' rhombosomoides;* therefore the latter species is placed in a separate genus. These differences include: (1) scale radii absent or weakly developed in *rhombosomoides,* and well-developed in *ornatus* (**Figs. 12G & H**); (2) no denticulations on margin of otolith of *ornatus,* and well-developed denticulations in *rhombosomoides* (**Figs. 13E & F**); (3) no anterior projections of pelvic girdle at ventral mid-line of *rhombosomoides,* and projections present in *ornatus* (**Figs. 10E & F**); (4) lateral 'wing' of pelvic girdle anchored to second or third rib in *ornatus,* and fourth rib of *rhombosomoides;* (5) usually 8 or 9 horizontal scale rows in *ornatus,* and 10 or 11 in *rhombosomoides;* (6) parahypural autogenous in *rhombosomoides* and fused to lower hypural plate in *ornatus* (**Fig. 4**); (7) vertebrae 35 in *ornatus* and 36 or 37 in *rhombosomoides;* (8) external teeth on edge of lateral portion of premaxillary low in number, arranged in a single row in *ornatus* (**Fig. 8A**), and numerous arranged in several rows in *rhombosomoides* (**Fig. 7D**); and (9) lower jaw of *ornatus* with definite protrusion (**Fig. 8A**) and that of *rhombosomoides* nearly equal with upper jaw (**Fig. 7D**).

The genus is named *Cairnsichthys* with reference to the city of Cairns, Queensland. *C. rhombosomoides,* the only known member of the genus, is confined to relatively few streams in the vicinity of Cairns. The gender is considered to be masculine.

Genus *Iriatherina* (Fig. 18)

Iriatherina Meinken, 1974: pages not numbered (type species, *Iriatherina werneri* Meinken, 1974, by original designation).

Diagnosis—Relatively elongate, laterally compressed body; greatest body depth 4.6 to 5.6 in standard length; premaxillaries with a more or less distinct bend between the anterior horizontal portion and lateral part; jaw teeth conical to coniniform, one or more rows extending outside of mouth; vomer and palatines toothless; inter-dorsal pterygiophores 2 or 3; first dorsal fin consist-

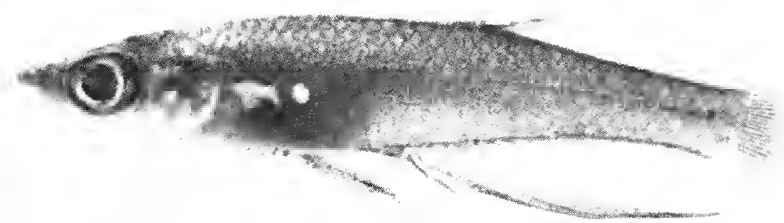


Fig. 18—*Iriatherina werneri*, male, 19 mm SL, Jardine River, Cape York Peninsula, Australia.

ing of 6 to 9 slender flexible spines; second dorsal fin with a stiff spine and 7 segemented rays; anal fin with a stiff spine and 10 to 12 segmented rays; anal fin originates on anterior half of body; only last 3 to 4 rays of second dorsal fin and last 3 to 8 rays of anal fin branched; branched caudal rays 11 to 13; parahypural fused to lower hypural plate; pelvic girdle with anterior finger-like projections at ventral mid-line; lateral 'wing' of pelvic girdle anchored to third pleural rib; dorsal head of cleithrum with moderately developed, posteriorly directed projection; scales cycloid with well-developed radii, horizontal rows on body at level of anal fin origin usually 9 or 10, vertical rows from upper corner of gill opening to caudal fin base 30 or 31; gill rakers on lower limb of first gill arch 11 to 13; vertebrae 32 or 33; sexual dimorphism characterised by extremely elongate rays at beginning of anal and second dorsal fins of males.

Remarks—*Iriatherina* contains a single species, which is confined to the tip of Cape York Peninsula, Australia and south-central New Guinea between the Merauke and Fly River systems (Allen and Hoese, in press).

Genus *Melanotaenia*
(Figs. 19 & 20)

Melanotaenia Gill, 1862: 280 (type species, *Atherina nigrans* Richardson, 1843, by original designation).

Nematocentris Peters, 1866: 516 (type species, *Nematocentris splendida* Peters, 1866, by monotypy).

Strabo Kner and Steindachner, 1867: 372 (type species, *Strabo nigrofasciatus* Kner & Steindachner, 1867, by monotypy).

Zantecla Castelnau, 1873: 88 (type species, *Zantecla pusilla* Castelnau, 1873, by monotypy).

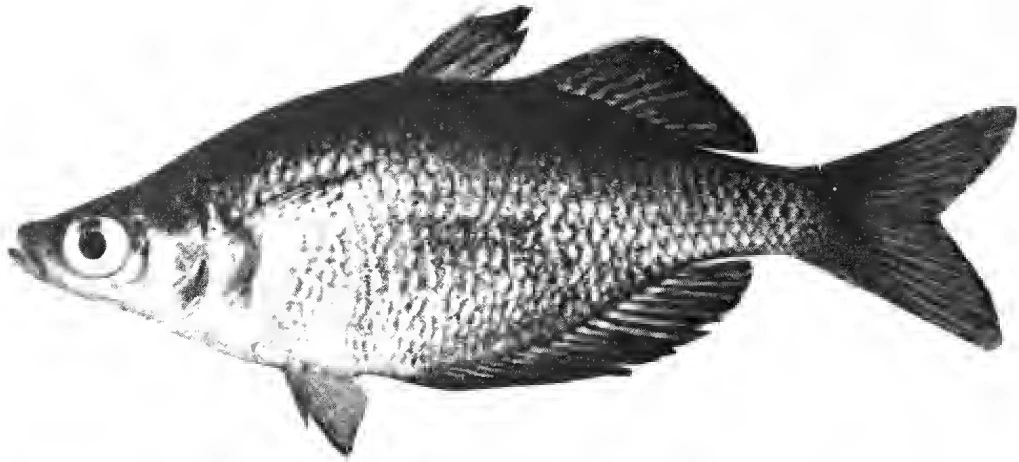


Fig. 19—*Melanotaenia goldiei,* male (top), 65 mm SL and female, 57 mm SL, Laloki River, Papua New Guinea.

Aida Castelnau, 1875: 10 (type species, *Aida inornata* Castelnau, 1875, by monotypy).

Neoatherina Castelnau, 1875: 31 (type species, *Neoatherina australis* Castelnau, 1875, by monotypy).

Aristeus Castelnau, 1878: 141 (type species, *Aristeus fitzroyensis* Castelnau, 1878, by subsequent designation of Jordan & Hubbs, 1919: 24).

Rhombatractus Gill, 1894: 709 (substitute name for *Aristeus* Castelnau, 1878, preoccupied by *Aristeus* Duvernoy, a crustacean genus).

Anisocentrus Regan, 1914: 281 (type species, *Nematocentrus rubrostriatus* Ramsay & Ogilby, 1886, by original designation).

Rhombosoma Regan, 1914: 283 (type species, *Nematocentrus novaeguineae* Ramsay & Ogilby, 1886, by subsequent designation of Jordan & Hubbs, 1919: 23).

Amneris Whitley, 1935a: 37 (type species, *Nematocentrus rubrostriatus* Ramsay & Ogilby, 1886, by original designation).

Aidapora Whitley, 1935b: 224 (type species, *Aidapora carteri* Whitley, 1935, by original designation).

Charisella Fowler, 1939: 90 (type species, *Charisella fredericki* Fowler, 1939, by original designation).

Diagnosis—Oblong, laterally compressed body; body depth generally increasing with age, particularly in males; body depth 1.9 to 4.9 in standard length; premaxillaries with an abrupt bend between the anterior horizontal portion and lateral part; jaw teeth conical to caniniform, several rows extending outside of mouth; teeth present on vomer and palatines; inter-dorsal pterygiophores 2 or 3 (rarely 4); first dorsal fin with a stout spine and 3 to 6 slender flexible spines; second dorsal fin with a stout spine and 7 to 22 segmented rays; anal fin with a stout spine and 15 to 28 segmented rays; anal fin originates on anterior half of body; all soft segmented fin rays usually branched except first soft ray of anal and second dorsal fins; branched caudal rays usually 15; parahypural fused to lower hypural plate; pelvic girdle with well-developed finger-like projections anteriorly at ventral mid-line; lateral 'wing' of pelvic girdle anchored to third pleural rib; dorsal head of cleithrum with well-developed posteriorly directed projection; scales cycloid to slightly crenulate with well-developed radii, horizontal rows on body at level of anal fin origin 7 to 13, vertical rows from upper corner of gill opening to caudal fin base 29 to 40, gill rakers on lower limb of first gill arch usually 13 to 15; vertebrae 32 to 37; sexual dimorphism characterised by deeper body and more elongate posterior dorsal and anal fin rays in males.

Remarks–A number of mainly monotypic generic names were introduced for the members of this group between 1862 and 1894 (see synonymy above). The proliferation of names during this period was evidently due to poor descriptions in the literature and lack of communication between widely scattered researchers. The first serious revisionary attempt of the melanotaeniids was undertaken by Regan (1914) in his account of a collection of freshwater fishes from Dutch New Guinea. He recognised seven genera, including *Melanotaenia, Anisocentrus*, and *Rhombosoma.* Regan stated that the latter two genera closely resembled *Melanotaenia,* but differed in the degree of expansion of the posterior section of the premaxillary and the disposition of the jaw teeth (*Anisocentrus* with outer row teeth of lower jaw enlarged and separated from inner band by a space; *Rhombosoma* without enlarged outer row teeth; *Melanotaenia* with enlarged outer row teeth, but without space between inner band). This separation was accepted by Weber & de Beaufort (1922), although with some modification. They replaced Regan's *Rhombosoma* with the name *Rhombatractus* which had been proposed by Gill (1894) as a substitute name for *Aristeus* Castelnau. Weber and de Beaufort separated the two genera on the basis of the dentition on the lips outside the mouth (present in *Rhombatractus,* absent in *Melanotaenia*) and the extent of the mouth opening (reaching level of eye in *Rhombatractus* and not reaching in *Melanotaenia*). They did not recognise Regan's *Anisocentrus,* stating that Ramsay & Ogilby's (1886) description of *Nematocentrus rubrostriatus,* the type species, was insufficient for determining its correct generic position.

Munro (1964), likewise recognised two genera based principally on dentition. He maintained *Melanotaenia* for species having thick lips and a dense patch of teeth on the lower jaw which is separated by an edentulous suture at the symphysis (**Figs. 9, A & D**). This group included species placed in *Rhombatractus* by Weber and de Beaufort, with Munro basing this nomenclatural change on an examination of the type of *Atherina nigrans* Richardson, the type species for *Melanotaenia.* Munro ressurected *Nematocentrus* Peters for species having thin lips, lacking the edentulous median suture on the lower jaw, and possessing an outer row of enlarged teeth on the lower jaw separated from the inner teeth by a space (**Figs. 9B, C, E & F**). This group corresponds with *Anisocentrus* Regan and *Melanotaenia* (non Gill) of Weber & de Beaufort (1922). More recently, Allen (1978) placed *Nematocentrus* in the synonymy of *Melanotaenia,* noting that the dentition arrangement was variable with specimens frequently possessing intermediate patterns or more rarely with both patterns present in a single species. This character was also found to be unreliable in juvenile and sub-adult specimens. In addition, no other differences were detected to support the separation of two genera.

The monotypic *Amneris* and *Aidapora* described by Whitley (1935a & b) were based on differences in the size of mouth, dentition, body shape, and colour. However, the species involved do not differ significantly from other *Melanotaenia.*

Four of Fowler's five paratypes of *Charisella* were examined and I have determined these as small (18-22 mm SL) juveniles of *Melanotaenia goldiei.* They agree well in every respect with similar sized specimens of *M. goldiei* recently collected in the Port Moresby District.

Melanotaenia is the largest genus in the family containing approximately 22 known species, which are distributed over a wide area of Australia and New Guinea, including the Aru Islands and Waigeo Island.

Genus *Glossolepis*
(Fig. 20)

Glossolepis Weber, 1908: 241 (type species, *Glossolepis incisus* Weber, by monotypy).

Diagnosis–Oblong, laterally compressed body; body depth generally increasing with age, particularly in males; body depth 1.9 to 3.1 in standard length; premaxillaries with an abrupt bend between the anterior horizontal portion and lateral part; jaw teeth conical to caniniform, with curved tips, several rows extending outside of mouth; a single row of enlarged teeth on exposed lateral edge of premaxillary; teeth present on vomer and palatines; inter-dorsal pterygiophores 2 or 3 (rarely 4); first dorsal fin with a stout spine and 4 to 6 slender flexible spines; second dorsal fin with a stout spine and 9 to 12 segmented rays; anal fin with a stout spine and 18 to 23 segmented rays; anal fin originates on anterior half of body; all soft segmented fin rays usually branched except first soft ray of anal and second dorsal fins; branched caudal rays usually 15; parahypural fused to lower hypural plate; pelvic girdle with well-developed finger-like projections anteriorly at ventral mid-line; lateral 'wing' of pelvic girdle anchored to third pleural rib; dorsal head of cleithrum with well-developed posteriorly directed projection; scales deeply crenulate with well-developed

Fig. 20–*Glossolepis wanamensis,* male, 70 mm SL, Lake Wanam, near Lae, Papua New Guinea.

radii, horizontal rows on body at level of anal fin origin 12 to 17, vertical rows from upper corner of gill opening to caudal fin base 36 to 60, gill rakers on lower limb of first gill arch usually 19 to 32; vertebrae 27 or 28; sexual dimorphism characterised by deeper body and more elongate middle dorsal and anal fin rays in males.

Remarks–*Glossolepis* appears to be a specialised offshot of *Melanotaenia.* The two genera are similar in overall morphology, but *Glossolepis* differs by having distinctly crenulate scale margins, the middle dorsal and anal rays elongated in males instead of the posterior rays, a distinct head profile, particularly in adult males, characterised by a steep forehead and pointed snout, and the lateral wing of the premaxillary typically with a single row of enlarged teeth which are exposed when the mouth is closed.

Weber & de Beaufort (1922) separated this genus from other melanotaeniids on the basis of an irregular scale arrangement (i.e., scales not in uniform parallel rows) and the smaller size and crenulations of the scales. At that time *G. incisus* Weber was the only known member of the genus. Three additional species are now included and the irregular small scales are diagnostic only from *G. incisus* (see Allen & Kailola 1979).

The four known species are restricted to northern New Guinea between the Markham and Mamberamo River systems.

Genus *Chilatherina*
(Fig. 21)

Chilatherina Regan, 1914: 282 (type species, *Rhombatractus fasciatus* Weber, 1913, by subsequent designation of Jordon and Hubbs, 1919: 22).
Centratherina Regan, 1914: 283 (type species, *Rhombatractus crassispinosus* Weber, 1913, by original designation).

Diagnosis—Oblong, laterally compressed body; body depth generally increasing with age, particularly in males; greatest body depth 2.3 to 5.4 in standard length; premaxillaries more or less straight, without abrupt bend between the anterior horizontal portion and lateral part; jaw teeth conical to caniniform, several rows extending outside of mouth; teeth present on vomer and palatines; inter-dorsal pterygiophores 2 or 3; first dorsal fin with a stout spine (rarely 2 stout spines) and 2 to 5 slender flexible spines; second dorsal fin with a stout spine and 8 to 17 segmented rays; anal fin with a stout spine and 20 to 30 segmented rays; anal fin originates on anterior half of body; all soft segmented fin rays usually branched except first soft ray of anal and second

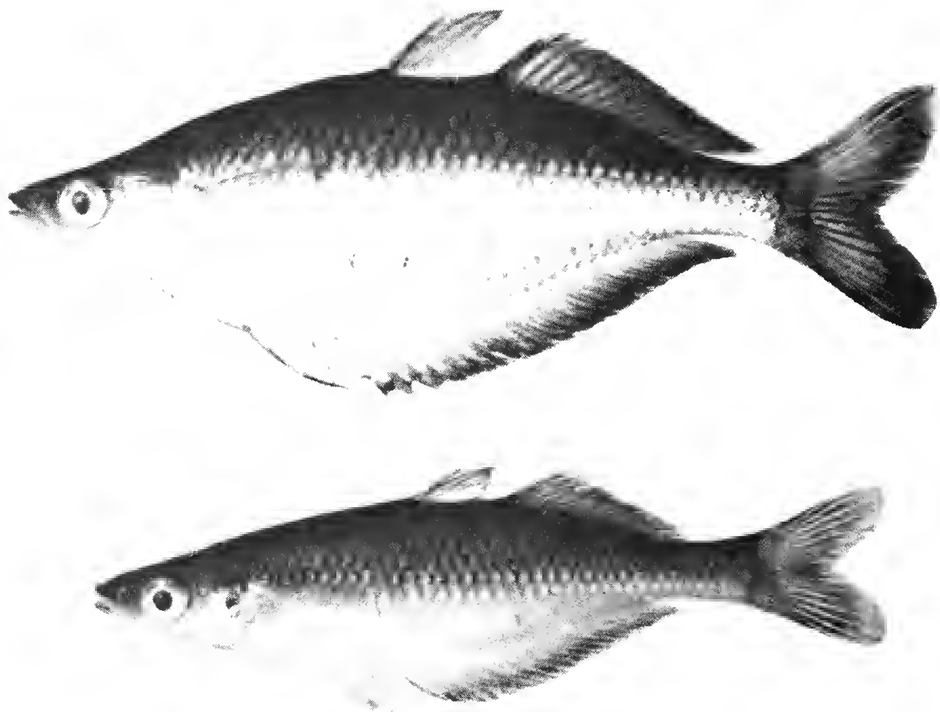
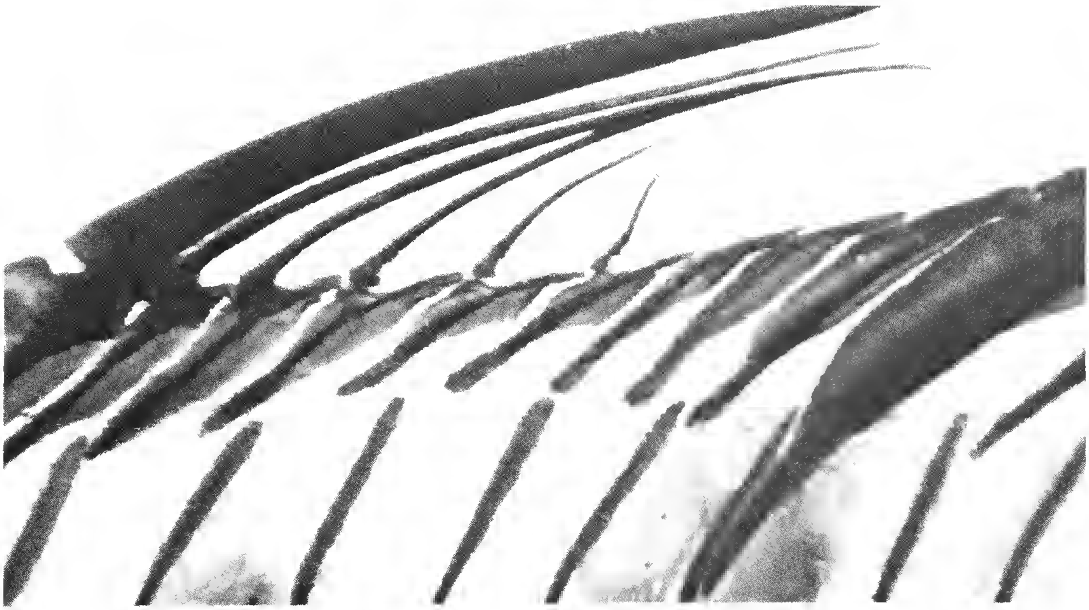


Fig. 21—*Chilatherina lorentzi,* male (top), 78 mm SL and female, 65 mm SL, Lake Wanam, near Lae, Papua New Guinea.

dorsal fin; branched caudal rays usually 15; parahypural fused to lower hypural plate; pelvic girdle with well-developed finger-like projections anteriorly at ventral mid-line; lateral 'wing' of pelvic girdle anchored to third pleural rib; head of cleithrum with well-developed posteriorly directed projection; scales cycloid to slightly crenulate with well-developed radii, horizontal



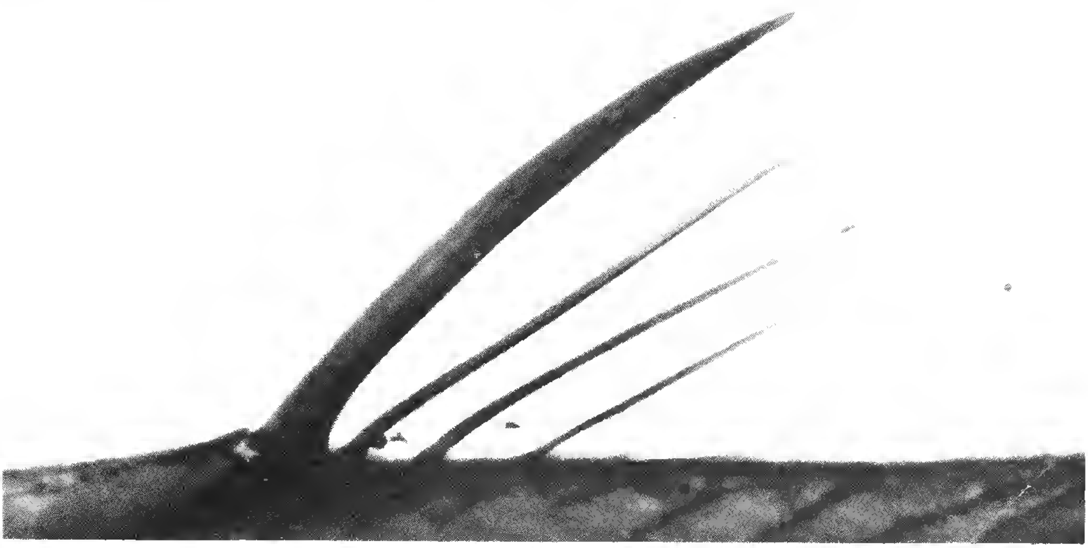


Fig. 22–First dorsal fin of *Chilatherina:* (top) *C. sentaniensis,* 64 mm SL; (bottom) *C. crassispinosa,* 41 mm SL.

rows on body at level of anal fin origin 10 to 15, vertical rows from upper corner of gill opening to caudal fin base 34 to 44; gill rakers on lower limb of first gill arch usually 13 or 14; vertebrae usually 37 or 38; sexual dimorphism characterised mainly by deeper body of males, but in some species males have the second dorsal and anal fin outline more pointed posteriorly and the posteriormost rays of the second dorsal fin are more elongate.

Remarks—*Chilatherina* and *Centratherina* have previously been recognised as distinct genera (Regan 1914; Weber & de Beaufort 1922; and Munro 1967). The traditional character used to separate these groups is the constitution of the slender rays of the first dorsal fin; in *Chilatherina* they are supposedly segmented, and unsegmented in *Centratherina.* I have examined a large series of both forms and find no difference in the composition of these spines. They are invariably unsegmented (**Fig. 22**). Therefore, I have placed *Centratherina* in the synonymy of *Chilatherina.* Munro (1964), after examining the spination of several *Centratherina* commented "possibly *Centratherina* cannot be retained as a separate genus."

This genus is separable from the closely related *Melanotaenia* on the basis of the shape of the premaxillary bone. It generally lacks the abrupt bend between

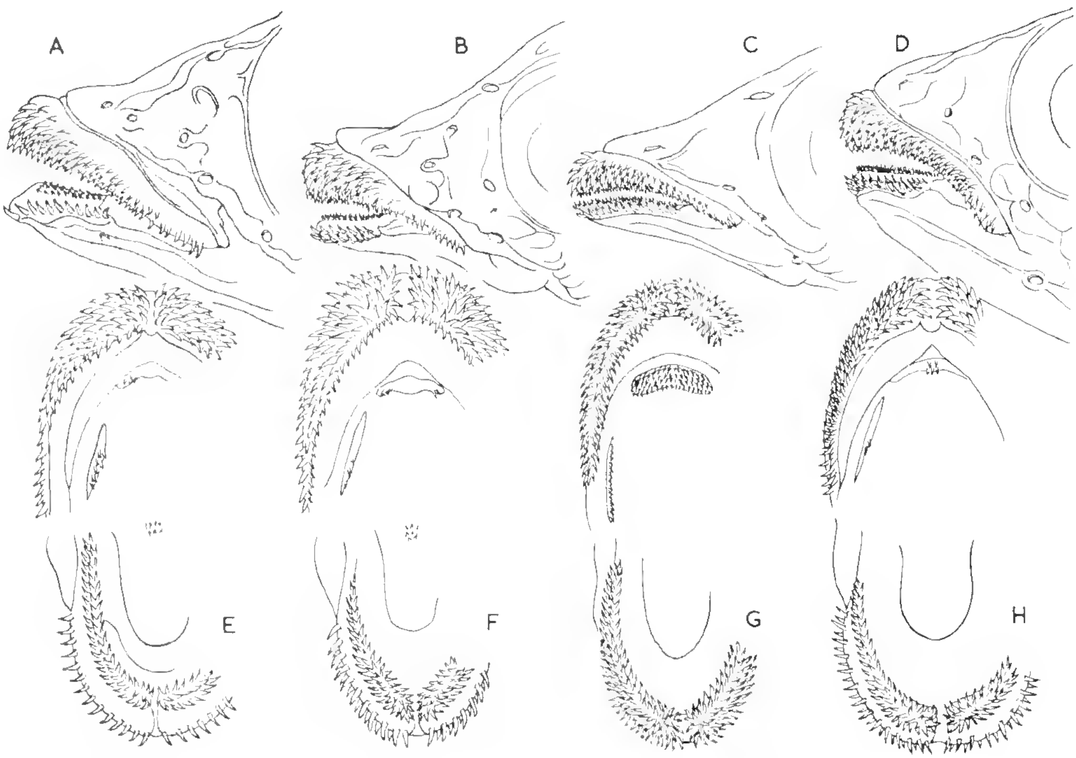


Fig. 23—Dentition of *Chilatherina:* (A & E) *C. campsi,* 88 mm TL; (B & F) *C. lorentzi,* 135 mm TL; (C & G) *C. sentaniensis,* 95 mm TL; (D & H) *C. crassispinosa,* 100 mm TL (drawings from Munro, 1964).

the anterior horizontal portion and the lateral part (**Figs. 23, A-D**). However, the lip swelling at the tip of the snout frequently conveys the impression of a bent premaxillary (**Figs. 7A & B**). The difference in this feature with relation to the various genera is not readily apparent in **Fig. 6**, because of the two-dimensional restrictions of the drawings.

The genus contains four known species which are confined to northern New Guinea.

DISCUSSION

Rosen (1974) discussed the taxonomic position of the atherinoid fishes and their relatives. He introduced a new ordinal name, Atheriniformes, which encompasses three suborders, Exocoetoidei, Cyprinodontoidei, and Atherinoidei. The latter group contains two superfamilies including Atherinoidea which is comprised of Melanotaeniidae, Atherinidae, and Isonidae, the latter a small group of specialised marine fishes mainly adapted to shallow coastal areas of heavy surge. These families are separable from the superfamily Phallostethidae on the basis of the following characters: pelvic fins abdominal, subabdominal, or thoracic in position, not modified into clasping organ; first pleural rib on third vertebra; adductor arcus paltini muscle restricted to posterior part of orbit. On the basis of these characters and other anatomical features mentioned by Rosen the melanotaeniids and atherinids are considered to be monophyletic sister groups. It is probable that the melanotaeniids evolved from a marine or estuarine atherinid-like ancestor.

A phylogenetic analysis of the genera of Melanotaeniidae is presented in **Fig. 24.** *Pseudomugil* and *Popondetta* are considered to be sister groups on the basis of several similarities. Both genera have the pectoral fins inserted in a peculiar fashion which results in these fins extending well above the dorsal profile of the body during the "up-stroke" movement while swimming. Although reduction characters are not necessarily indicative of a common phylogeny, these genera are unique among the melanotaeniids in having lost the inter-dorsal pterygiophores (sometimes represented by a single, small rudiment), and in possessing a rounded dorsal head on the cleithrum without a posterior projection (**Figs. 11D & E**). Several other features are shared by these genera, which are found in only a few other members of the family including: (1) lateral 'wing' of pelvic girdle attached to fourth pleural rib (present only in *Cairnsichthys*); (2) eight or less horizontal scale rows (only *Rhadinocentrus* has so few); (3) 27 to 32 vertebrae (only *Iriatherina* has a similar count); and (4) all fin spines weakly developed (this feature shared also by *Cairnsichthys* and *Rhadinocentrus*). In addition, the shape of the premaxillary is very similar (**Figs. 6, F & G**).

Although some of these characters or character states represent apparent specialisations, the majority appear to be plesiomorphic. Thus, these genera are considered to be the most primitive members of the family. It is noteworthy that some *Pseudomugil* populations are estuarine dwellers which parallels the mode of life which is hypothesized for the ancestral melanotaeniid stock.

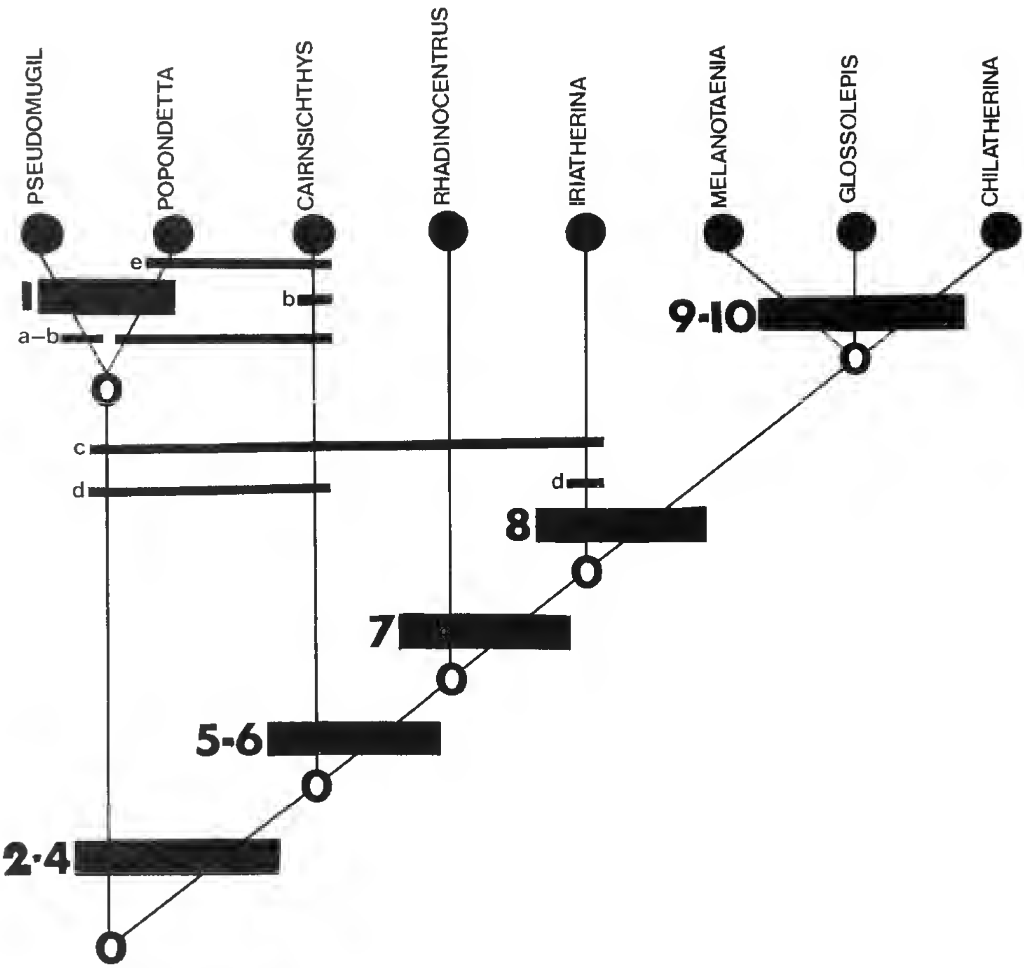


Fig. 24—Phylogenetic analysis of the genera of melanotaeniidae. Shaded squares represent the following apomorphic character expressions: (1) pectoral fins extend well above the dorsal profile while swimming; (2) modified inter-pelvic area (Fig. 2B); (3) distinctive premaxillary shape with a few to many teeth on outside of lips; (4) characteristic sexual dimorphism usually featuring elongated fin rays in males and colour intensity differences; (5) 2 or 3 (rarely 4) inter-dorsal pterygiophores; (6) horizontal scale rows usually in excess of 9 (i.e., greater overall scale density); (7) lateral "wing" of pelvic girdle anchored to 3rd pleural rib; (8) strong spine at beginning of second dorsal fin; (9) strong spines at beginning of first dorsal, anal, and pelvic fins; (10) teeth on vomer and palatines. Hypothesized convergent characters are indicated by thin horizontal lines: (a) anal fin originates on posterior half of body; (b) lower hypural plate autogenous; (c) loss or some reduction of posterior process of cleithrum; (d) reduced vertebral counts, usually less than 35 total elements; (e) lack or weakness of scale radii.

However, *Pseudomugil* retains the atherinid-like position of the anal fin (i.e., on posterior half of body).

The remaining five genera are hypothesized to be a monophyletic assemblage based on the common possession of 2 or 3 (rarely 4) inter-dorsal pterygiophores, a condition considered to be apomorphic for melanotaeniids. In addition, all except *Cairnsichthys* are synyapomorphic with regards to the lateral muscular attachment of the pelvic girdle to the third pleural rib. *Cairnsichthys, Rhadinocentrus,* and *Iriatherina* represent a complex of phyletic lines considered to represent an intermediate stage of specialisation. They retain certain primitive features such as the lack of stout, well-developed fin spines and relatively low gill raker counts. In addition, the posterior process on the cleithral head (**Figs. 11, B & C**) is intermediate in shape between *Popondetta* and *Pseudomugil,* which lack the process, and *Melanotaenia, Glossolepis* and *Chilatherina* which have a well-developed process.

Melanotaenia, Glossolepis, and *Chilatherina* share many morphological features and are hypothesized to be monophyletic sister groups. The most prominent synapomorphy in these genera is the presence of an enlarged, stout spine at the beginning of the pelvic, anal, and two dorsal fins, and also the presence of conical teeth on the vomer and palatines (**Fig. 9**). They also have the highest gill raker, branched caudal ray, and vertebral counts for the family. In addition, the development of external jaw teeth (**Figs. 7, A-C; 9, A-C; and 24, A-D**) is most strongly manifested in this trio. On the basis of these features they are considered to be the most advanced members of the family.

Quirichthys stramineus (Whitley) is a small atherinoid fish which has been collected from the Ord, Katherine, and Gregory River systems of northern Australia. It has been variously shuffled between the Atherinidae and Telmatherinidae (considered by the author as a subfamily of Atherinidae confined to fresh waters of the Celebes). Some workers whom I have recently communicated with suggested it may, in fact, belong to the Melanotaeniidae, primarily on the basis of the similar premaxillary dentition (**Fig. 6l**). The present study indicates that it is an atherinid, possessing features typical of the Australian members of the family, including a relatively long median ascending process on the premaxillary (**Fig. 6l**), an autogenous parahypural (**Fig. 5**, lower), lateral muscular attachment of pelvic girdle to the fourth rib, and lack of the inter-pelvic modification (**Figs. 1-2**).

Convergent characters—Several character states appear to be incongruous with the proposed phylogeny and therefore represent probable examples of convergence within the family. These include the rearward position of the anal fin in *Pseudomugil,* an autogenous lower hypural plate in *Pseudomugil* and *Cairnsichthys,* the lack or weakness of scale radii in *Popondetta* and *Cairnsichthys,* the loss or reduction of the posterior process of the cleithrum in all genera except *Pseudomugil* and *Popondetta,* and a trend towards reduced vertebral counts in the groups which are here considered to be most primitive. These convergent character states are summarised in **Fig. 24** (horizontal lines **a-e**).

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LIST OF NOMINAL SPECIES OF MELANOTAENIIDAE

The nominal species of melanotaeniids are listed alphabetically (by species) below. Each species name is followed by the author(s) name, year of publication, page number, and locality (Aru = Aru Islands; Aus. = Australia; N.N.G. = northern New Guinea; S.N.G. = southern New Guinea; Wag. = Waigeo). The right column contains the present allocation. Complete references are given at the end of the paper.

Species	Present allocation
Pseudomugil signatus affinis Whitley, 1935b: 228 (Aus.)	*Pseudomugil signifer*
Rhombatractus affinis Weber, 1908: 234 (N.N.G.)	*Melanotaenia affinis*
Melanotaenia ajamaruensis Allen & Cross, in press (S.N.G.)	*Melanotaenia ajamaruensis*
Rhombatractus archboldi Nichols & Raven, 1934: 1 (S.N.G.)	*Melanotaenia goldiei*
Neoatherina australis Castelnau, 1875: 32 (Aus.)	*Melanotaenia splendida australis*
Chilatherina axelrodi Allen, 1980: 48 (N.N.G.)	*Chilatherina axelrodi*
Melanotaenis boesemani Allen & Cross, in press (S.N.G.)	*Melanotaenia boesemani*
Centratherina bulolo Whitley, 1938: 227 (N.N.G.)	*Chilatherina crassispinosa*
Anisocentrus campsi Whitley, 1956: 26 (N.N.G.)	*Chilatherina campsi*
Aidapora carteri Whitley, 1935b: 224 (Aus.)	*Melanotaenia splendida inornata*
Rhombatractus catherinae de Beaufort, 1910: 250 (Wag.)	*Melanotaenia catherinae*
Aristeus cavifrons Macleay, 1882: 69 (Aus.)	*Melanotaenia splendida inornata*
Rhombatractus crassispinosa Weber, 1913: 567 (N.N.G.)	*Chilatherina crassispinosa*
Atherinichthys duboulayi Castelnau, 1878: 143 (Aus.)	*Melanotaenia fluviatilis*
Melanotaenia dumasi Weber, 1908: 240 (S.N.G.)	*Melanotaenia goldiei*
Melanotaenia exquisita Allen, 1978: 97 (Aus.)	*Melanotaenia exquisita*

Chilatherina fasciata Regan, 1914: 282 (N.N.G.)	*Chilatherina lorentzi*
Aristeus fitzroyensis Castelnau, 1878: 141 (Aus.)	*Melanotaenia splendida splendida*
Aristeus fluviatilis Castelnau, 1878, 141 (Aus.)	*Melanotaenia fluviatilis*
Charisella fredericki Fowler, 1939: 90 (S.N.G.)	*Melanotaenia goldiei*
Pseudomugil furcatus Nichols, 1955: 2 (N.N.G.)	*Popondetta furcatus*
Pseudomugil gertrudae Weber, 1911: 23 (Aru)	*Pseudomugil gertrudae*
Aristeus goldiei Macleay, 1883: 269 (S.N.G.)	*Melanotaenia goldiei*
Melanotaenia gracilis Allen, 1978: 98 (Aus.)	*Melanotaenia gracilis*
Glossolepis incisus Weber, 1908: 241 (N.N.G.)	*Glossolepis incisus*
Pseudomugil inconspicuus Roberts, 1978: 53 (S.N.G.)	*Pseudomugil inconspicuus*
Aida inornata Castelnau, 1875: 10 (Aus.)	*Melanotaenia splendida inornata*
Melanotaenia japenensis Allen & Cross, in press (N.N.G.)	*Melanotaenia japenensis*
Melanotaenia kabia Herre, 1935: 397 (N.N.G.)	*Glossolepis multisquamatus*
Rhombatractus kochii Weber, 1908: 237 (S.N.G.)	*Melanotaenia goldiei*
Melanotaenia lacustris Munro, 1964: 159 (S.N.G.)	*Melanotaenia lacustris*
Aristeus lineatus Macleay, 1881: 626 (Aus.)	*Melanotaenia fluviatilis*
Rhombatractus lorentzii Weber, 1908: 236 (N.N.G.)	*Chilatherina lorentzi*
Aristeus loriae Perugia, 1894: 549 (S.N.G.)	*Melanotaenia splendida rubrostriata*
Melanotaenia maculata Wber, 1908: 239 (S.N.G.)	*Melanotaenia splendida rubrostriata*
Melanotaenia maccullochi Ogilby, 1915: 118 (Aus.)	*Melanotaenia maccullochi*
Melanotaenia monticola Allen, in press (S.N.G.)	*Melanotaenia monticola*
Melanotaenia multisquamata Weber & de Beaufort, 1922: 290 (S.N.G.)	*Glossolepis multisquamatus*

Melanotaenia neglecta Rendahl, 1922: 179 (Aus.)	*Melanotaenia fluviatilis*
Atherina nigrans Richardson, 1843: 180 (Aus.)	*Melanotaenia nigrans*
Strabo nigrofasciatus Kner & Steindachner, 1867: 373 (Aus.)	*Melanotaenia splendida splendida*
Nematocentrus novaeguineae Ramsay & Ogilby, 1886: 13 (S.N.G.)	*Melanotaenia goldiei*
Pseudomugil novaeguineae Weber, 1908: 233 (S.N.G.)	*Pseudomugil novaeguineae*
Melanotaenia ogilbyi Weber, 1910: 230 (S.N.G.)	*Melanotaenia ogilbyi*
Melanotaenia oktediensis Allen & Cross, in press (S.N.G.)	*Melanotaenia oktediensis*
Rhadinocentrus ornatus Regan, 1914: 280 (Aus.)	*Rhadinocentrus ornatus*
Pseudomugil paludicola Allen & Moore, in press (S.N.G.)	*Pseudomugil paludicola*
Melanotaenia papuae Allen, in press (S.N.G.)	*Melanotaenia papuae*
Melanotaenia parkinsoni Allen, in press (S.N.G.)	*Melanotaenia parkinsoni*
Rhombatractus patoti Weber, 1907, 403 (Aru)	*Melanotaenia splendida rubrostriata*
Aristeus perporosus De Vis, 1884: 694 (Aus.)	*Melanotaenia fluviatilis*
Rhombatractus praecox Weber & de Beaufort, 1922: 298 (N.N.G.)	*Melanotaenia praecox*
Glossolepis pseudoincisus Allen & Cross, in press (N.N.G.)	*Glossolepis pseudoincisus*
Zantecla pusilla Castelnau, 1873: 88 (Aus.)	*Melanotaenia nigrans*
Melanotaenia pygmaea Allen, 1978: 99 (Aus.)	*Melanotaenia pygmaea*
Melanotaenia rosacea Herre, 1935: 398 (N.N.G.)	*Glossolepis multisquamatus*
Nematocentris rubrostriatus Ramsay & Ogilby, 1886: 14 (S.N.G.)	*Melanotaenia splendida rubrostriata*
Aristeus rufescens Macleay, 1881: 625 (Aus.)	*melanotaenia splendida splendida*
Rhadinocentrus rhombosomoides Nichols & Raven, 1928: 1 (Aus.)	*Cairnsichthys rhombosomoides*
Rhombatractus senckenbergianus Weber, 1911: 25 (Aru)	*Melanotaenia goldiei*

Rhombatractus sentaniensis Weber, 1908: 235 (N.N.G.)	*Chilatherina sentaniensis*
Rhombosoma sepikensis Herre, 1935: 400 (N.N.G.)	*Melanotaenia affinis*
Nematocentris sexlineatus Munro, 1964: 162 (S.N.G.)	*Melanotaenia sexlineata*
Atherina signata Gıunther, 1867: 64 (Aus.)	*Pseudomugil signifer*
Pseudomugil signifer Kner, 1865: 275 (Aus.)	*Pseudomugil signifer*
Melanotaenia solata Taylor, 1964: 129 (Aus.)	*Melanotaenia splendida australis*
Nematocentris splendida Peters, 1866: 516 (Aus.)	*melanotaenia splendida splendida*
Nematocentris tatei Zietz, 1896: 178 (Aus.)	*Melanotaenia splendida tatei*
Pseudomugil tenellus Taylor, 1964: 132 (Aus.)	*Psuedomugil tenellus*
Centratherina tenuis Nichols, 1956: 1 (N.N.G.)	*Chilatherina campsi*
Rhombosoma trifasciata Rendahl, 1922: 182 (Aus.)	*Melanotaenia trifasciata*
Rhombatractus vanheurni Weber & de Beaufort, 1922: 299 (N.N.G.)	*Melanotaenia vanheurni*
Glossolepis wanamensis Allen & Kailola, 1979: 40 (N.N.G.)	*Glossolepis wanamensis*
Rhombatractus weberi Regan, 1908: 155 (S.N.G.)	*Melanotaenia goldiei*
Iriatherina werneri Meinken, 1974: (S.N.G.)	*Iriatherina werneri*
Nematocentris winneckei Zietz, 1896: 179 (Aus.)	*Melanotaenia splendida tatei*

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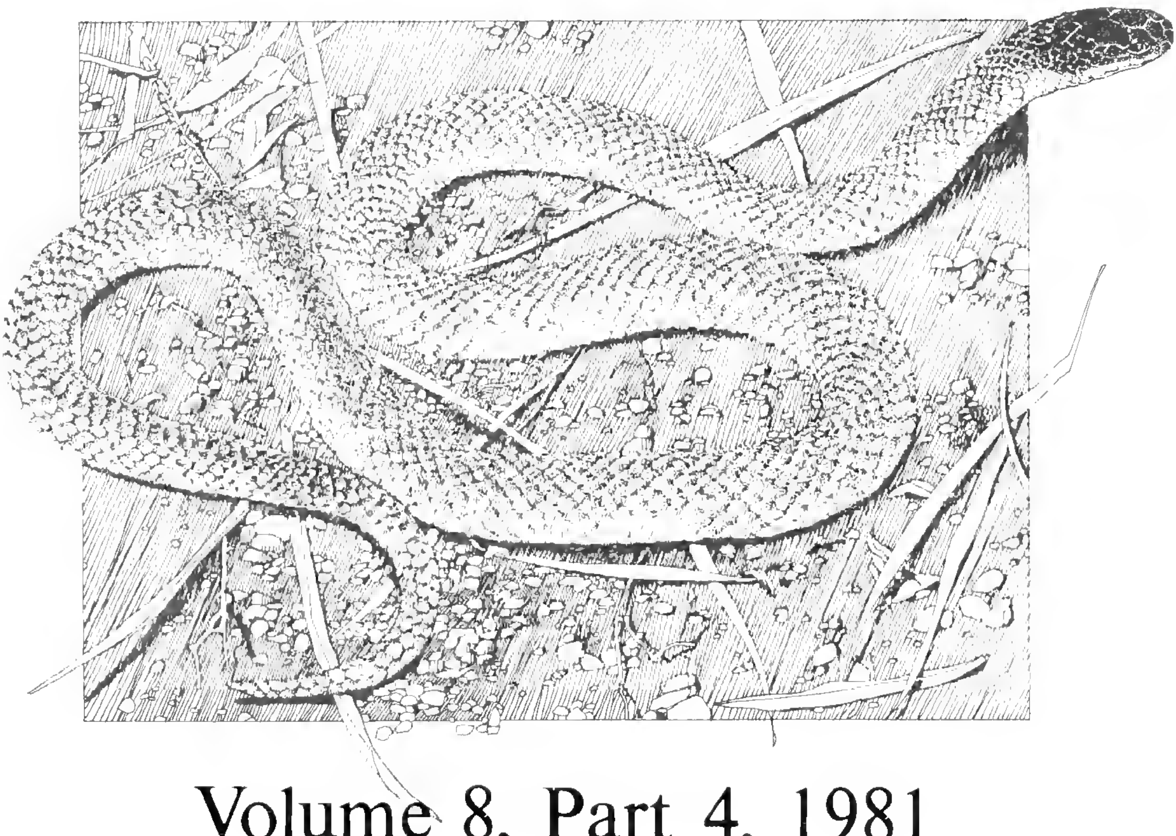

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Cover: A *Denisonia nigriceps* drawn by Gaye Roberts. This small non-dangerous snake inhabits southern Australia.

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DESCRIPTION OF A NEW SPECIES OF SERRANID FISH FROM WESTERN AUSTRALIA, WITH A KEY TO THE AUSTRALIAN SPECIES OF *ACANTHISTIUS*

J.B. HUTCHINS*

ABSTRACT

A new species of serranid fish *Acanthistius pardalotus*, is described from subtropical seas of Western Australia. It is distinguished from other Australian members of *Acanthistius* by its distinctive colour pattern and slight morphological differences. *A. serratus* (Cuvier) from south-western Australia and *A. ocellatus* (Günther) from eastern Australia, previously united under the former name, are here recognised as distinct species. A key is provided for the Australian species of the genus.

INTRODUCTION

The serranid genus *Acanthistius* Gill contains six marine species confined to Australasia, South America and Easter Island. The best known Australian member, *A. serratus* (Cuvier [in Cuvier & Valenciennes], 1828), has generally been considered a wide-ranging species. However, it is apparent that this name has served as a catch-all for Australian spotted serranids that possess 13 dorsal spines. Allen *et al.* (1976: 393) provisionally recognised *A. serratus* from Lord Howe Island but noted colour differences between specimens from the south-west of Australia (type locality of *A. serratus*) and its eastern coast. They stated that *A. ocellatus* (Günther, 1859) was the next available name for the eastern form, should it prove distinct. The present paper provides evidence that *A. serratus* and *A. ocellatus* are discrete species and describes a third closely related species from Western Australia as new.

Measurements were made with needle-point dial calipers to the nearest mm (to the nearest 0.1 mm for measurements less than 10 mm) and follow Katayama (1960) unless otherwise stated.

Type specimens have been deposited at the Australian Museum, Sydney (AMS), British Museum (Natural History), London (BMNH) and the Western Australian Museum, Perth (WAM).

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* Western Australian Museum, Francis Street, Perth, Western Australia 6000.

SYSTEMATICS

Key to the Australian species of *Acanthistius*

1a Body pale with 6 well defined dark cross bars, continued on dorsal and anal fins (Fig. 1a); head with 2 prominent dark bars radiating from posterior half of eye, the upper continued through eye to snout tip (Lord Howe and Norfolk Islands, Kermandec Islands, northern New Zealand and New South Wales) ..... *A. cinctus* (Günther, 1859)

1b Body spotted, blotched, irregularly barred or markings absent, never with 6 prominent cross bars 2

2a Scales relatively large, 20-26 in diagonal row from upper origin of gill cover to base of first dorsal spine; usually 2-3 narrow dark bars radiate from posterior half of eye (Fig. 1b); head and body pale with leopard-like pattern of spots, blotches and lines, increasing in complexity with size (Western Australia) .... *A. pardalotus* sp. nov.

2b Scales relatively small, 26-35 in diagonal row from upper origin of gill cover to base of first dorsal spine; usually 2 broad dark bars radiate from posterior half of eye, or postorbital bars absent; body either spotted or non-spotted, or with a series of large pale blotches breaking up ground colour into a series of irregular dark cross bars 3

3a Head and body brown, covered with ocellated spots, the centres coloured blue in life (Fig. 1c); postorbital bars either indistinct or absent (Southern Queensland, New South Wales, eastern Victoria, northern Tasmania and Lord Howe Island) .... *A. ocellatus* (Günther, 1859)

3b Spots on head and body, when present, never ocellated; head with 2 broad postorbital bars and a few scattered dark brown spots (Fig. 1d), or spots absent; body colour variable, either brown with scattered dark brown spots (Fig. 1d), dark brown with several large whitish blotches (Fig. 1e) or with combination of both patterns (South Australia and Western Australia) .... *A. serratus* (Cuvier, 1828)

Note: in addition to the characters mentioned above for distinguishing *A. ocellatus* from *A. serratus* it is noteworthy that specimens of *A. ocellatus* as small as 30 mm SL possess prominent body spotting whereas juveniles of *A. serratus* are either unspotted or possess only a few spots on the upper sides. Furthermore, the postorbital bars are always prominent in the young of *A. serratus* and mostly indistinct in *A. ocellatus*.

Acanthistius pardalotus sp. nov.
(Figs 1b & 2; Table 1)

Holotype

WAM P.5113, 189 mm SL, collected with derris powder from rock pool at mouth of the Murchison River, Kalbarri (27°42'S, 114°12'E), Western Australia, by zoology students from the University of Western Australia, 14 October 1957.

Paratypes

Fifteen specimens from Western Australia, 62-370 mm SL (unless otherwise designated, all specimens at WAM): P.3784, 236 mm SL, City Beach (near Perth), F. Paxman, November 1954; P.4465, 184 mm SL, Mullaloo Beach (north of Perth), N. Cross, 3 July 1959; P.4502, 183 mm SL, north of Rottnest Island (off Fremantle), 36 m, N. Milward, November 1954; P.4791, 197 mm SL, Strickland Bay, Rottnest Island, zoology students, U.W.A., 20 March 1959; P.4792, 248 mm SL, Port Gregory (north of Geraldton), D. McKorkall, 20 August 1959; P.5577, 62 mm SL, Port Gregory, B.R. Wilson *et al.*, 26 December 1962; P.5777, 275 mm SL, Margaret River mouth (Prevelly Park, north of Cape Leeuwin), B. Burbidge, 2 June 1963; P.14532, 370 mm SL, Houtman Abrolhos, F. Barrett-Lennard, May 1952; P.14533, 163 mm SL, Point Quobba (north of Carnarvon), F. Barrett-Lennard, October 1959; P.16775, 265 mm SL, off Prevelly Park, F.J. McCann, 9 October 1968, P.26664-004, 277 mm SL, Steep Point, Shark Bay, by spear at 14 m, J.B. Hutchins, 11 April 1979; P.26825-001, 2 specimens, 94-118 mm SL, Salmon Bay, Rottnest Island, from rock pool with rotenone, J. Scott, 18 January 1976; AMS I.21432-001, 186 mm SL, Mullaloo Beach, G. Clohessy, March 1963; BMNH 1980.3.24.1, 191 mm SL, Burns Beach (north of Perth), G. Knight, 15 April 1963.

Diagnosis

This species is placed in the genus *Acanthistius* on the basis of the 13 dorsal fin spines and the large number of vertical scale rows above the lateral line (99 or more). Within *Acanthistius*, *A. pardalotus* is distinguished

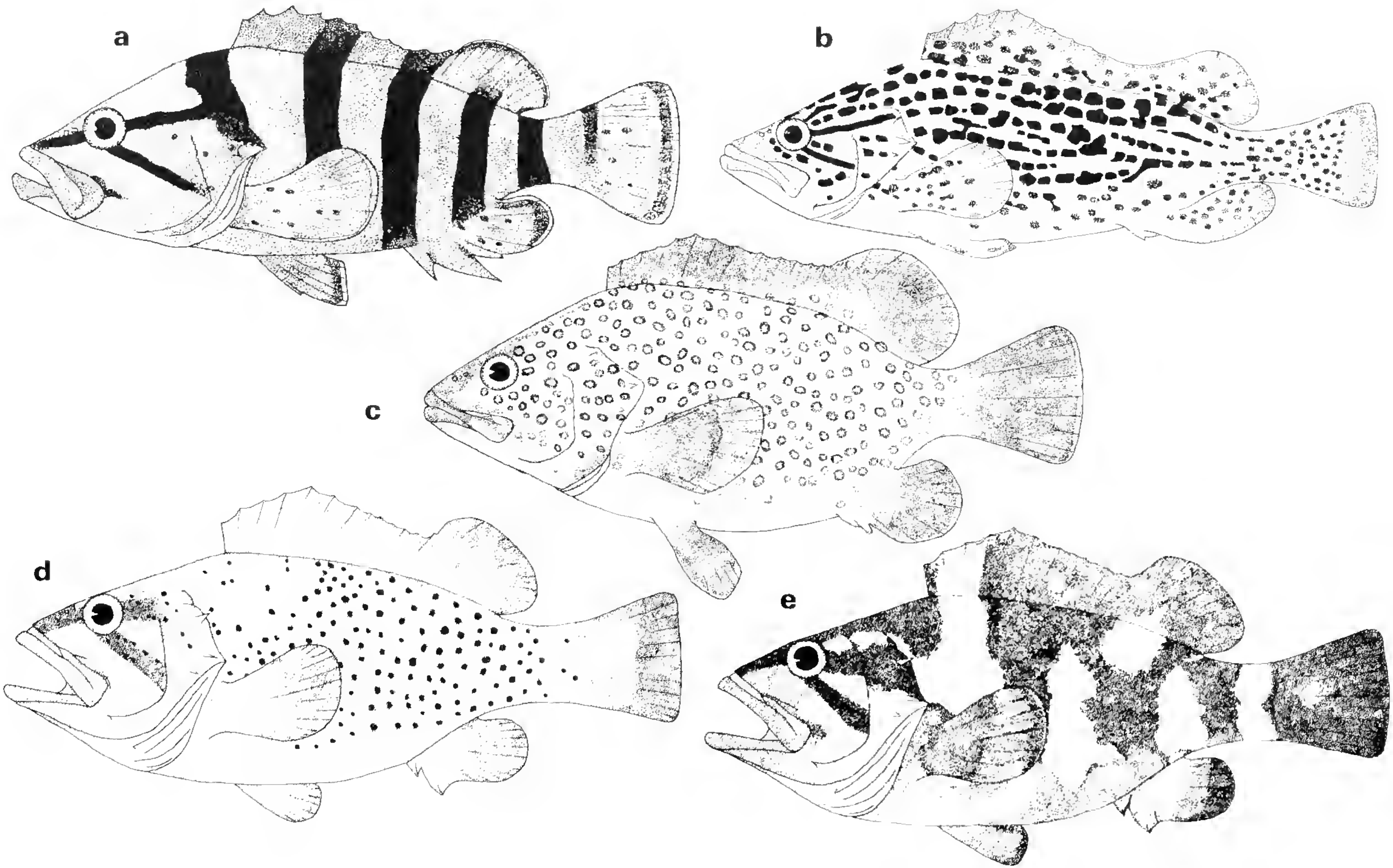

Fig. 1: Comparison of colour patterns in life of *Acanthistius* (measurements are approximate standard lengths): a, *A. cinctus* (200 mm); b, *A. pardalotus* (230 mm); c, *A. ocellatus* (210 mm); d, *A. serratus*, spotted colour variety (270 mm); e, *A. serratus*, blotched colour variety (230 mm).

from other Australian members on the basis of its relatively large scales (20-26 in a diagonal row from the upper origin of gill cover to the base of the first dorsal spine) and leopard-like colour pattern of spots, blotches and lines. *A. cinctus*, *A. ocellatus* and *A. serratus* all possess smaller scales (26-35) and colour patterns as described in the key above. *A. pardalotus* particularly differs from its sympatric species *A. serratus*, by possessing less vertical scale rows above the lateral line (99-105 as against 110-137 respectively), and stronger serrations on the scales producing a coarser feel than that experienced with *A. serratus*. *A. cinctus* also possesses a similar coarseness of its scales but as well as having a totally different colour pattern, its longest dorsal spine is considerably shorter than that of *A. pardalotus* (2.9-3.2 in head length, as against 2.1-2.5 respectively, for specimens of 128 mm SL and less).

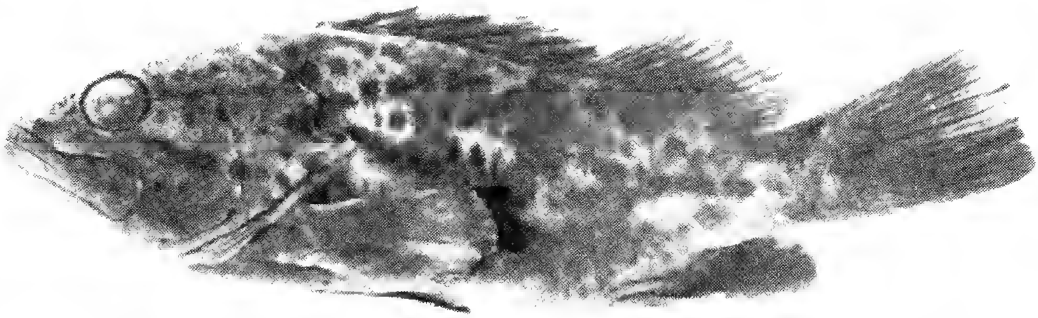

Fig. 2: *Acanthistius pardalotus* sp. nov., holotype, WAM P.5113, 189 mm SL.

Description

Measurements and counts of holotype and selected paratypes are presented in Table 1.

Dorsal rays XIII, 14-15; anal rays III, 8; pectoral rays 17-18; lateral line pores to caudal base 50-56; vertical scale rows from upper origin of gill opening to base of caudal fin 99-106; scales in diagonal row from upper origin of gill opening to base of first dorsal spine 20-26; scales in diagonal row from origin of first anal spine to lateral line 48-60; gill rakers (including rudiments) on lower half of first gill arch 11-13.

Greatest body depth 2.6-3.1, head length 2.4-2.6, snout to origin of dorsal fin 2.7-3.0, lower lip to origin of anal fin 1.2-1.8, postorbital length of head 3.7-4.3, length of spinous dorsal base 2.8-3.5, length of soft dorsal base 3.9-4.7, all in standard length. Snout 4.2-4.7, eye 3.9-6.1, least width of bony interorbital 5.5-8.3, least depth of caudal peduncle 3.0-3.7, length of caudal peduncle 2.0-2.7, length of pectoral fin 1.5-1.8, length of pelvic fin 1.6-2.3, length of longest dorsal spine (4th-5th) 2.0-3.0, length of longest dorsal ray (3rd-5th) 2.2-3.2, length of longest anal spine (2nd) 2.4-3.7, length of

TABLE 1

Measurements in mm and counts of selected type specimens of *Acanthistius pardalotus*.

	Holotype	Paratypes				
	WAM P.5113	WAM P.14532	WAM P.26664-004	WAM P.3784	WAM P.26825-001	WAM P.26825-001
Standard length	189	370	277	236	118	94
Head length	79	159	114	98	50	40
Snout length	18	38	26	23	11	8.9
Eye diameter	16	26	21	18	12	9.9
Interorbital width	12	29	19	14	6.8	5.1
Postorbital length of head	48	101	71	60	28	23
Greatest depth of body	61	140	104	88	40	33
Least depth of caudal peduncle	23	43	36	28	14	11
Length of caudal peduncle	31	63	53	41	22	19
Snout to origin of dorsal fin	74	137	103	81	43	32
Lower lip to origin of anal fin	38	281	210	178	95	76
Length of spinous dorsal base	60	115	100	72	34	30
Length of soft dorsal base	43	89	63	58	28	22
Length of pectoral fin	45	88	68	56	30	24
Length of pelvic fin	39	70	53	49	27	21
Length of longest dorsal spine	35	55	43	38	24	20
Length of longest dorsal ray	33	55	45	39	23	16
Length of longest anal spine	27	48	34	30	20	16
Length of longest anal ray	37	66	53	46	20	15
Length of caudal fin	43	77	60	53	29	23
Dorsal fin count	XIII,15	XIII,15	XIII,15	XIII,15	XIII,15	XIII,15
Anal fin count	III, 8	III, 8	III, 8	III, 8	III, 8	III, 8
Pectoral fin count	18	18	18	18	18	18
Lateral line count	55	50	55	53	54	56
Vertical scale rows above lateral line	105	100	100	99	103	105
Scales above lateral line	21	21	25	25	20	22
Scales below lateral line	52	59	48	53	52	52
Number of gill rakers	—	13	11	13	13	13

longest anal ray (3rd-4th) 2.0-2.7, length of caudal fin 1.6-2.1, all in head length.

Interorbital space flat to slightly concave; maxilla reaching level below posterior half of eye to slightly behind; opercle with three spines, middle spine much closer to lower than upper one; opercular flap pointed; preopercular margin rounded, upper limb coarsely serrate (lowermost serration somewhat larger than rest), three strong recurved spines on lower limb; scales on head and body (except breast and preopercle) mostly ctenoid, those on head and anterior portion of back becoming less serrate with increasing SL; predorsal scales extend forward to posterior nostrils; outer row of small conical acute teeth in both jaws, and an inner band of villiform teeth separated at the symphysis (some symphysial teeth in upper jaw more cardiform), a V-shaped band of villiform teeth on vomer and a band of similar teeth on each palatine.

Colour of holotype in alcohol: head and body pale brown with a leopard-like pattern of spots, blotches and lines; three narrow lines radiate rearwards from margin of posterior half of eye, uppermost parallel to and just below upper profile of head, central one to upper margin of gill opening and lowermost to above angle of preoperculum; fins brown with indication of darker blotches on basal portion of dorsal fin. Paratypes as above with the following exceptions: spots, blotches and lines become more numerous and smaller with increasing SL, as well as the leopard-like pattern becoming more complex; occasionally only two lines (rarely one) radiate from posterior half of eye and, as in the case of the largest paratype (WAM P.14532, 370 mm SL), these lines may be irregular and difficult to distinguish from the surrounding pattern of spots and blotches; ground colour varies from pale grey to brown.

Colour in life (based on colour transparencies of live fish underwater): head, body and fins pale greyish green with a leopard-like pattern of blackish brown spots, blotches and lines, the spots on fins somewhat lighter in colour; margins of fins greyish blue and unspotted.

Distribution

Acanthistius pardalotus is confined to subtropical waters of Western Australia, from Prevelly Park, just north of Cape Leeuwin, northwards to Point Quobba, just north of Carnarvon. Its range partly overlaps that of *A. serratus*, a temperate species (Ceduna, South Australia [see Glover & Branden, 1978: 57] to Kalbarri, Western Australia).

Remarks

Like *A. serratus*, *A. pardalotus* spends its juvenile life stage in shallow coastal rocky areas, including intertidal rock pools. The adult generally occurs on reefs to depths of 36 m where it shelters in caves during the daytime.

This species is named *pardalotus* (from the Greek word meaning 'spotted like a leopard') with reference to its characteristic colour pattern.

Together with both *A. serratus* and *A. ocellatus*, *A. pardalotus* has been referred to in the vernacular as 'Wirrah'. It is here suggested that the following common names be employed to separate the four Australian species of *Acanthistius*:

A. serratus — Western Wirrah
A. ocellatus — Eastern Wirrah
A. pardalotus — Leopard Perch
A. cinctus — Yellow-banded Perch (after Doak, 1972)

Additional material examined

Acanthistius cinctus, 4 specimens, 53-128 mm SL (all at AMS): I.16250-024, 128 mm SL, Seal Rocks, New South Wales, 24 May 1972; I.17360-021, 109 mm SL, Lord Howe Island, February 1973; I.20095-013, 53 mm SL, Arrawarra Headland, New South Wales, 4 May 1977; I.20262-007, 104 mm SL, Duncombe Bay, Norfolk Island, 10 September 1975.

Acanthistius ocellatus, 20 specimens, 18-212 mm SL (unless otherwise designated, all at AMS): I.10697, 128 mm SL, Lord Howe Island, April 1910; I.16848-001, 3 specimens, 18-86 mm SL, Jervis Bay, New South Wales, 24 June 1971; I.20833-003, 5 specimens, 67-135 mm SL, Arrawarra Headland, New South Wales, 4 May 1977; WAM P.26781-001, 212 mm SL, Wynyard, Tasmania, September 1979; P.26827-001, 11 specimens, 21-133 mm SL, Seal Rocks, New South Wales, 18 August 1970.

Acanthistius pardalotus: WAM P.12161, 253 mm SL, Houtman Abrolhos, Western Australia, 29 March 1965.

Acanthistius serratus, 21 specimens from Western Australia, 17-317 mm SL (all at WAM): P.28, 210 mm SL, Garden Island, 11 March 1912; P.652, 123 mm SL, Garden Island, 22 April 1918; P.680, 280 mm SL, 30 January 1920; P.3383, 246 mm SL, Cottesloe, 2 January 1951; P.4255, 284 mm SL, Lancelin, 2 October 1958; P.7582, 268 mm SL, Albany, 3 June 1964; P.14534, 230 mm SL, Garden Island, November 1959; P.15683, 239 mm SL, Fremantle Harbour, 20 January 1967; P.21800, 238 mm SL, Denmark, 25 July 1972; P.23399, 235 mm SL, Bunker's Bay, July 1973; P.25096-001, 317 mm SL, Yallingup, September 1974; P.25765-001, 164 mm SL, Recherche Archipelago, 9 April 1977; P.25195-006, 2 specimens, 48-56 mm SL, Cape Naturaliste, 17 March 1975; P.25256-003, 4 specimens, 17-78 mm SL, Geographe Bay, 26 April 1975; P.26545-003, 2 specimens, 69-89 mm SL, Augusta, 2 February 1979, P.26826-001, 114 mm SL, Kalbarri, 14 November 1957.

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THE *DENISONIA GOULDII* SPECIES-GROUP (SERPENTES, ELAPIDAE) IN WESTERN AUSTRALIA

G.M. STORR*

ABSTRACT

The Hooded Snakes, variously placed in *Denisonia*, *Unechis*, *Parasuta* or *Cryptophis*, are herein treated as a species-group within the large genus *Denisonia* Krefft. In Western Australia this species-group is represented by *Denisonia nigriceps* (Günther), *D. monachus* Storr, *D. gouldii* (Gray) and *D. spectabilis* (Krefft). The western representative of *D. spectabilis* is described as a new subspecies *D. s. nullarbor*. *D. s. spectabilis* of South Australia is redescribed.

INTRODUCTION

Boulenger's concept of the genus *Denisonia* (Boulenger, 1896) satisfied herpetologists for 65 years, even though it was zoogeographically anomalous in including species from the Solomon Islands but no others from outside of Australia and Tasmania.

In 1961 Worrell began the dismemberment of *Denisonia* by proposing five new genera, namely *Drysdalia* (for *coronoides*, *mastersii* and *coronata*), *Unechis* (*carpentariae*), *Suta* (*suta*), *Parasuta* (*gouldii* and *nigrostriata*) and *Cryptophis* (*pallidiceps*, *nigrescens*, *flagellum* and *dwyeri*); he restricted *Denisonia* to *D. maculata*, *devisi* and *fasciata*. Worrell's concepts of *Denisonia* and *Drysdalia* have been largely accepted, but the other four genera have been combined and redefined in as many ways as there are investigators.

Reappraisal of the genera of Australian Elapidae has thus become urgent. McDowell (1967, 1969) provided many valuable insights into the subject, but his survey of two characters (venom gland musculature and morphology of the hemipenis) constituted a starting point, not a framework, for a broadly based phylogeny of Australian elapids. Until such a phylogeny is produced it seems best to divide *Denisonia* informally, i.e. into species-groups. The present paper deals with the western members of one such group. For a review of the eastern members see Coventry (1971).

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* Western Australian Museum, Francis Street, Perth, Western Australia 6000.

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SYSTEMATICS

Denisonia gouldii species-group

Small cryptozoic elapid snakes that feed on small snakes and lizards. Head flat, without a canthus rostralis; eye small; little or no narrowing at neck; tail short (except in *D. nigrostriata*). Head shields typically elapine, i.e. there is no fragmentation and no fusion (except for temporals in *D. monachus*); preocular separated from frontal and normally in contact with nasal; upper labials 6; lower labials 7; midbody scale rows 15 (mostly 17 in *D. flagellum*), normally reducing to 13 well before vent. Head and nape black, broken or not by pale markings; a dark vertebral stripe in two species (*D. nigriceps* and *nigrostriata*), otherwise dorsals with or without dark edging or basal spot; ventral surfaces pearly white.

Seven species in southern and eastern Australia: *Denisonia nigrostriata* (Krefft, 1864), *D. nigriceps* (Günther, 1863); *D. monachus* Storr, 1964; *D. gouldii* (Gray, 1841); *D. spectabilis* (Krefft, 1869); *D. flagellum* (McCoy, 1878); *D. dwyeri* Worrell, 1956.

Key to Western Australian Species

1 Narrow to broad, more or less diffuse, black stripe or zone along middle of back and tail .... *D. nigriceps*

No black vertebral stripe or zone 2

2 Black hood broken by pale spot or bar in front of eye and extending back on to first 4-9 vertebral scales; dorsals with dark edge or dark basal spot; two secondary temporals 3

Black hood usually not broken and extending back on to first 1-6 vertebrals; dorsals red without black markings; one secondary temporal (except in Hamersley Range) .... *D. monachus*

3 Dorsals reddish brown, black edging of scales giving a reticulate pattern; ventrals usually more than 160 . . . . *D. gouldii*

Dorsals greyish brown with a dark basal spot and no reticulate pattern; ventrals usually fewer than 160 . . . . *D. spectabilis*

Denisonia nigriceps
(Fig. 1)

Hoplocephalus nigriceps Günther, 1863, Ann. Mag. nat. Hist. (3) **12**: 362.

Denisonia nigrostriata brevicauda Mitchell, 1951, Rec. S. Aust. Mus. **9**: 50. Fowlers Bay, S.A.

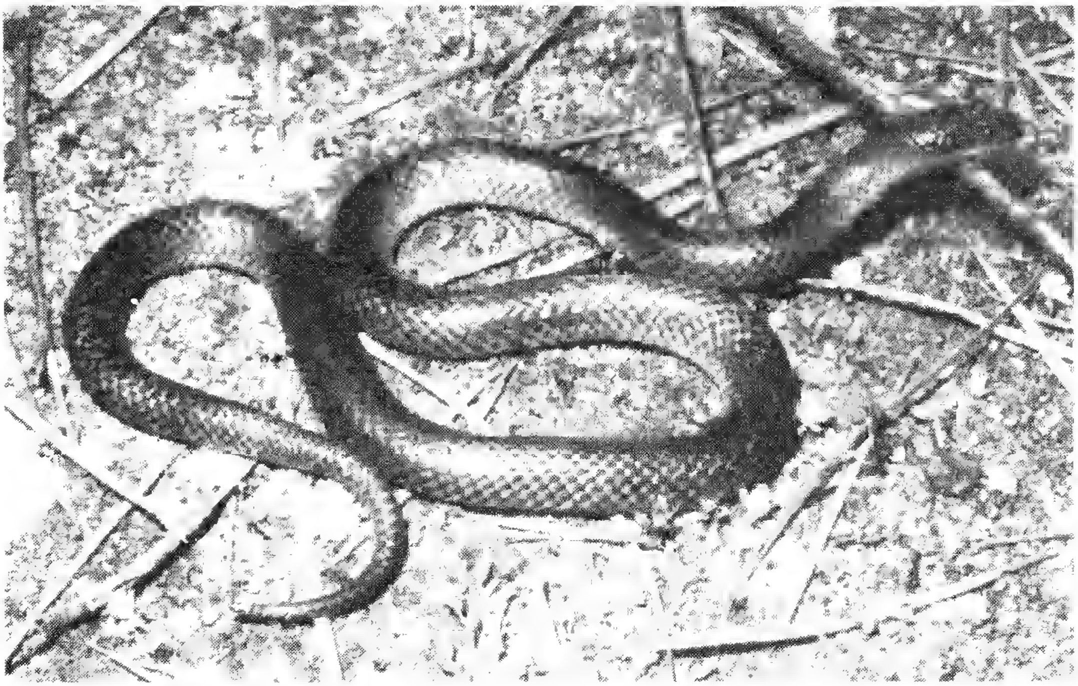

Fig. 1: A *Denisonia nigriceps* from Perth, photographed by G. Harold.

Diagnosis

A large, stout member of the *D. gouldii* group distinguishable from all other members, except *D. nigrostriata* of eastern Queensland, by black dorsal stripe. Distinguishable from *D. nigrostriata* by stouter body, very much shorter tail (less than 16% of SVL) and many fewer subcaudals (fewer than 35).

Distribution

Southern Western Australia, north to Dandaragan, Gingin, Mundaring, Bruce Rock, Holleton, Widgiemooltha and Cocklebiddy, but absent from far south (east of Scott River and south of Bridgetown, Mt Barker and Bremer Bay) (see Fig. 2). Also southern South Australia, south-western New South Wales and north-western Victoria.

● *D. nigriceps*
▲ *D. monachus*

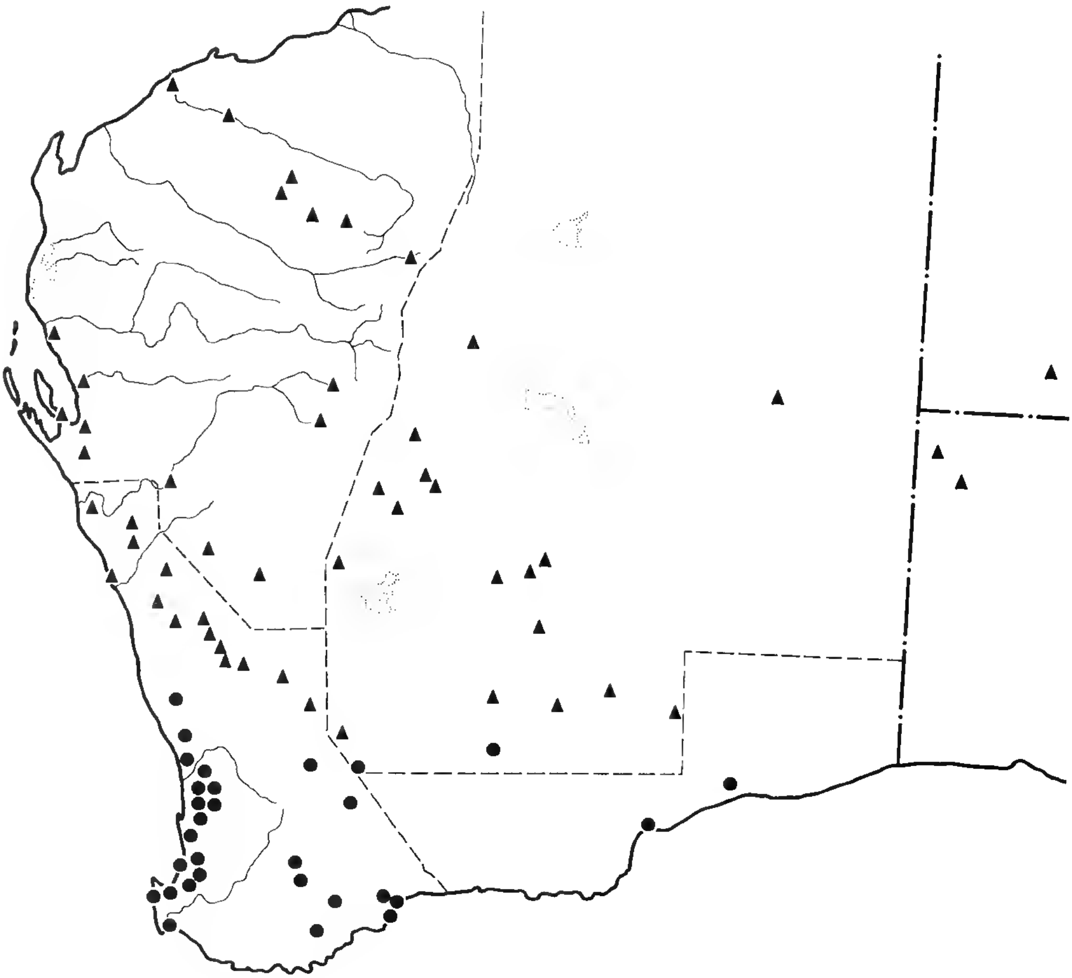

Fig. 2: Southern Western Australia showing location of specimens of *Denisonia nigriceps* and *D. monachus*.

Description

Snout-vent length (mm): 169-530 (N 65, mean 329.2). Length of tail (% SVL): 9.9-15.2 (N 63, mean 12.3).

Internasals 0.5-0.95 (N 48, mean 0.70) times as long as prefrontals. Frontal 1.4-1.9 (N 48, mean 1.69) times as long as wide, 1.8-2.4 (N 46, mean 2.11) times as wide as supraoculars; posterior facets more strongly concave than in other species; posterior apex acute but rounded. Preocular usually widely separated from frontal and usually in very short contact with nasal. Postoculars usually 2, upper nearly always the larger. Temporals 2 + 2. Upper labials 6. Lower labials 7. Midbody scale rows 15, increasing to 19-21 on neck (N 49, mean 20.0) and normally decreasing to 13 well before vent (2 specimens have 15 and one specimen has 12 rows just before vent). Ventrals 148-171 (N 59, mean 158.3). Subcaudals 19-33 (N 63, mean 25.9). Ventrals plus subcaudals 169-197 (N 59, mean 184.2).

Head and nape glossy greyish black, continuous with a greyish black vertebral stripe or zone 0-9 (N 47, mean 4.7) scales wide, more or less sharply delimited from laterals, which are whitish with a dark purplish (sometimes reddish) brown basal blotch (blotches becoming larger and blacker dorsally and gradually merging with wholly dark scales of back). Lips and lower surface whitish.

Geographic variation

In the western population (east to Widgiemooltha) the number of ventrals (and to a lesser extent subcaudals) decrease from north-west to south-east. For example, north of latitude 32°30'S ventrals range from 156 to 164 (N 15, mean 160.6); south of 34°S ventrals range from 149 to 159 (N 14, mean 153.8). These data indicate that the holotype of *D. nigriceps* (ventrals 148) probably came from the hinterland of King George Sound.

The eastern populations (Eucla Division and South Australia) differ from the western in their slightly longer tail (12.4-14.8% of SVL, N 8, mean 13.8; *vs* 9.9-15.2, N 55, mean 12.1), more numerous subcaudals (26-33, N 9, mean 29.6; *vs* 19-32, N 54, mean 25.3) and the tendency for a small pale blotch to form in front of the eye. These differences seem too slight for recognising an eastern subspecies *brevicauda*.

Material

South-West Division (W.A.): Dandaragan (9262); Gingin (8461); Wanneroo (68992); Mussel Pool (51562); Bruce Rock (474); East Muntadgin, 63 km E of Narembeen (51167, 68274); Mundaring Weir (15666, 15827, 19986, 39738); Helena Valley (31539), Kalamunda (47791); Pickering Brook (14047); Canning Dam (9842); Mt Dale (56104); 8 km SE of Byford (29821); Jarrahdale (10509); Mt Cooke (12648, 34547-8); Hyden (10694); Huntly (5397-8); Wagerup (19048); Yarloop (7338, 9229); Bunbury (19801); 25 km W of Collie (49257); Dongolocking Reserve (33°02'S, 117°43'E) (49648); Badgebup (3432); Lowden (6600, 6727, 8123); Argyle

State Forest, S of Donnybrook (68374); near Busselton (25904, 26840, 47655); Yelverton (12132); Ongerup (29792) and 10 km SE (42623, 42625); middle Fitzgerald River (36867-9, 36936, 37040); lower Fitzgerald River (36809, 36836); Doubtful Island Bay (19791, 19793-4); 12 km S of Chester Pass (31978); Scott River (36042).

Eastern Division (W.A.): Wanaway, 10 km SSW of Widgiemooltha (4693).

Eucla Division (W.A.): Mullendunya Tank (32°53'S, 124°35'E) (45360); Cocklebiddy (66497).

South Australia: Denial Bay (SAM R117); Flinders I. (SAM R13147); Yardea (SAM R15121); Iron Duke (SAM R17357); Moonabie Hill (SAM R14453); 20 km NNE of Hawker (55496, 55801).

Denisonia monachus
(Fig. 3)

Denisonia monachus Storr, 1964, West. Aust. Nat. 9: 88. Kalgoorlie, W.A.

Fig. 3: A *Denisonia monachus* from Linden, photographed by G. Harold.

Diagnosis

A small member of the *D. gouldii* group without a dorsal stripe and normally with black hood unbroken by pale markings; further distinguishable from all other members of group by single secondary temporal. (Specimens from the Hamersley Range are moderately large and have two secondary temporals.)

Distribution

Western arid and semiarid zones of Western Australia, north to the lower Fortescue and Hamersley Range; east to Mundiwindi, Well 6 (Canning Stock Route), Kathleen Valley, Laverton, and Naretha; and south to Geraldton, Three Springs, Dalwallinu, Mukinbudin, Westonia and Kalgoorlie. Also an apparently isolated population in far east of Western Australia (Warburton Range), south-western Northern Territory and north-western South Australia. (See Fig. 2.)

Description

Snout-vent length 123-460 (N 89, mean 271.1). Length of tail (% SVL): 10.8-15.3 (N 85, mean 12.8).

Internasals 0.55-0.8 (N 33, mean 0.74) times as long as prefrontal. Frontal 1.1-1.85 (N 55, mean 1.53) times as long as wide, and 1.8-2.9 (N 56, mean 2.31) times as wide as supraoculars. Preocular separated from frontal and in short contact with nasal (rarely narrowly separated). Postoculars 2. Primary temporals 1 (18% of specimens) or 2 (lower occasionally reaching lip). Secondary temporals 1 (2 in Hamersley Range). Upper labials 6. Lower labials 7. Midbody scale rows 15, increasing to 15-21 on neck (usually 17 or 19, N 19, mean 18.0) and normally decreasing to 13 well before vent (14 just before vent in one specimen, 15 in another). Ventrals 153-171 (N 48, mean 163.7). Subcaudals 21-33 (only one specimen with fewer than 24, N 54, mean 28.0). Ventrals plus subcaudals 178-200 (N 48, mean 191.4).

Top of head glossy black, black extending back on to first 1-6 (N 85, mean 3.6) vertebrals. Rest of upper surface bright brick-red. Lips and under surface white.

Geographic variation

In the western populations size increases from south to north. For example, no specimen from south of a line joining Wooramel and Laverton exceeds 370 mm in snout-vent length; whereas four specimens from north of that line exceed 400 mm. All specimens from the Hamersley and Ophthalmia Ranges, and none from elsewhere, have 2 + 2 temporals. Two of three specimens from the Warburton Range have a pale spot in front of each eye.

Material

North-West Division (W.A.): Fortescue River at North-West Coastal Highway (57355); Millstream (20081, 57358); near Mt Bruce (51654, 54338, 62460); 64 km NNE of Paraburdoo (64666); 27 km SE of Mt Meharry

(66321); 48 km W of Mt Newman (54215); Mundiwindi (42912); Callagiddy (40696); Wooramel (54598, 54990); Karalundi (42650); 19 km N of Meekatharra (34591); 15 km S of Nanga (54586); Overlander (21217); 16 km SSW of Wannoo (64428-9); Billabong (50092-3, 51671-2); 32 km W of Yalgoo (51033); Burnerbinmah (29614).

South-West Division (W.A.): 42 km ESE of Kalbarri (33811); 47 km NNE of Yuna (57540) and 35 km NE (26504) and 29 km NE (57561-4) and 25 km NE (57538); Wilroy (57664); Geraldton (9845, 25903); Newmarracarra (1718-9, 21221); Mingenew (2918), Three Springs (4843); Perenjori (15132); Bunjil (1273-4); Maya (21876, 31192), Buntine Reserve (43656, 44924); Buntine (27132-4); Nugadong (58776); 12 km NE of Dalwallinu (51104) and 23 km E (53162), Cleary (29602-4); Mukinbudin (29739).

Eastern Division (W.A.): Well 6, Canning Stock Route (27247); Warburton Range (22003, 22084-5); 10 km S of Wiluna (31525); Gidgee (6589); Albion Downs (30977); Kathleen Valley (14368, 19776-7); Booylgoo Spring (1111, 2992); Youanmi (28091); Laverton (11475, 41774); Mt Margaret (17682); Malcolm (41778); Yarri (46619); Kalgoorlie (20606); Eastern Goldfields (450, 26632); Karonie (29671); Cundeelee (21711); Kanandah (37896); Naretha (15084, 29670, 37657-8); Westonia (39800).

Northern Territory: Ayers Rock (46639).

South Australia: Mt Lindsay (31786) and 64 km NW (31726).

Denisonia gouldii
(Fig. 4)

Elaps gouldii Gray 1841, In: G. Grey's Journals of two expeditions of discovery in north-west and western Australia during the years 1837, 38 and 39. 2: 444. Western Australia.

Diagnosis

A medium-sized member of the *D. gouldii* group without a dorsal stripe and with black hood broken by a pale mark in front of eye. Most like *D. spectabilis* but differing in its greater size; reddish, black-edged dorsal scales; and more numerous ventrals and subcaudals.

Distribution

Southern Western Australia east to the western hinterland of the Great Australian Bight (Mt Coobaninya) and generally north to Eneabba, Coorow, Koorda, Corinthian and Kalgoorlie, with an apparently isolated population much further north on the middle Murchison (Billabalong). Absent from deep south-west (south of Bunbury and west of Walpole). (See Fig. 5.)

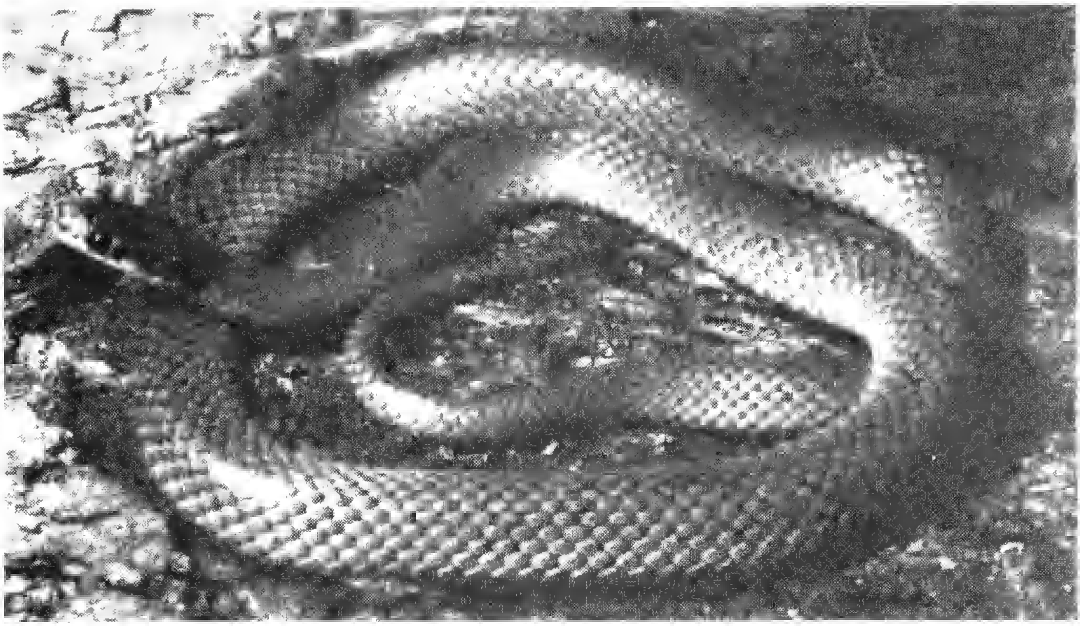

Fig. 4: A *Denisonia gouldii* from Yanchep, photographed by G. Harold.

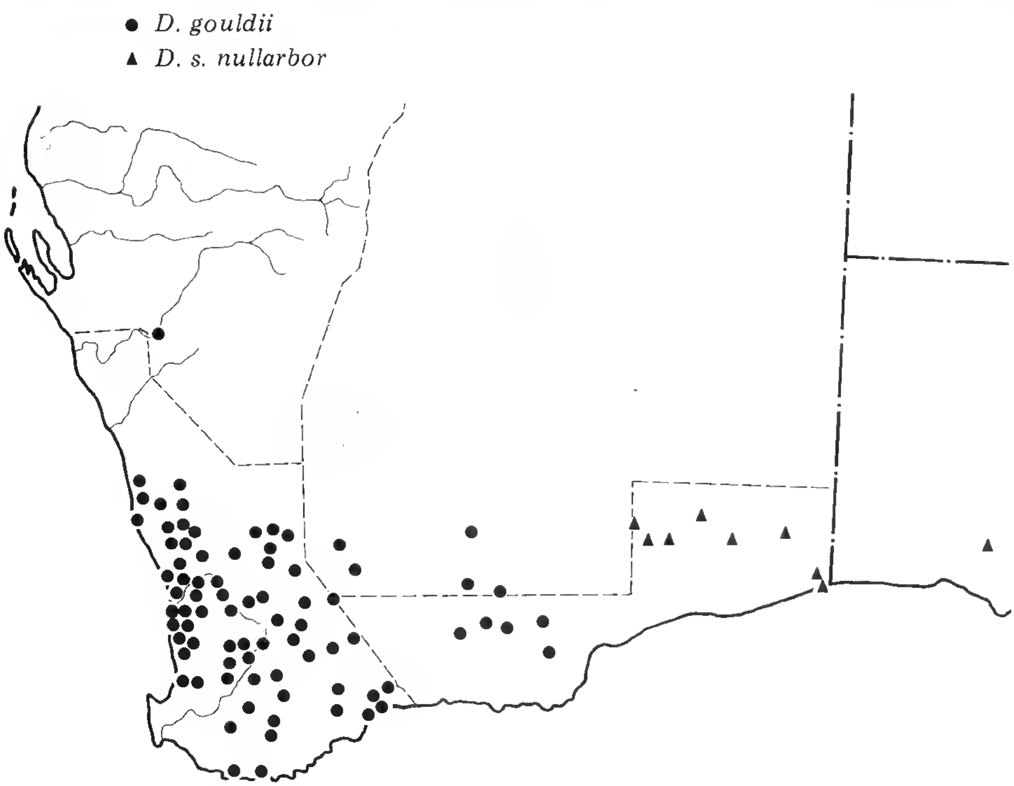

Fig. 5: Southern Western Australia showing location of specimens of *Denisonia gouldii* and *D. spectabilis nullarbor.*

Description

Snout-vent length (mm): 131-469 (N 347, mean 296.8). Length of tail (% SVL): 10.3-15.9 (N 160, mean 13.3).

Internasals 0.6-0.9 (N 42, mean 0.72) times as long as prefrontals. Frontal 1.2-1.8 (N 45, mean 1.49) times as long as wide, and 1.8-2.7 (N 41, mean 2.14) times as wide as supraoculars. Preocular widely separated from frontal and in short contact with nasal. Postoculars 2. Temporals 2 + 2. Upper labials 6. Lower labials 7. Midbody scale rows 15, increasing to 18-22 (N 45, mean 20.3) on neck, and decreasing to 13 before vent. Ventrals 153-177 (N 57, mean 165.5). Subcaudals 25-38 (N 66, mean 31.5). Ventrals plus subcaudals 183-212 (N 57, mean 196.8).

Head and nape glossy black, broken by orange-brown mark in front of eye (fading to creamy or brownish white in alcohol), black extending back on to first 4-9 (N 65, mean 6.4) vertebrals. Rest of upper surface orange-brown or reddish brown, each scale finely edged with black (giving dorsum a reticulate pattern); dorsals in some specimens (especially on side of body) with dark basal blotch. Lips and lower surfaces whitish.

Material

North-West Division (W.A.): Billabalong (51673).

South-West Division (W.A.): Stockyard Gully, near Eneabba (28087-9); 15 km N of Marchagee (49994, 57799); 4 km E of Mt Peron (48991, 49008-9); Watheroo (2085); 25 km NNW of Badgingarra (67422) and 18 km N (34318); SE of Jurien (29209); Cervantes (34409, 37723); Dandaragan (28151); Moora (26079); Koorda (1508); Bencubbin (31153); Mukinbudin (34697); 18 km N of New Norcia (50026) and 11 km N (29784); Regans Ford (58780); Mogumber (27141); Trayning Reserve (46378); 9 km NE of Dowerin (50024-5); 13 km W of Bolgart (29081-4); Gingin (21247-50); 7 km E of Bindoon Hill (28085-6); Yorkrakine (22763, 25589); 25 km N of Kellerberrin (56540-1, 56550) and 7 km NW (52369-72); Merredin (1366); Culham (15077, 19874-7); Chittering (32610); proposed reserve SW of Gingin (59298); Yanchep National Park (59445, 59555); SW of Yanchep (15078) and 7 km S (41769) and 10 km S (15826); Neerabup National Park (59351-3, 59386-7); Lake Pinjar (29755); 16 km N of Wanneroo (29750); Melaleuca Park (59456); Pearce (29165); Bailup (21340); Cunderdin (939); Northam (4221, 4927); Wanneroo (26686, 31221, 31223); Upper Swan (3008); Wooroloo (3856); Gidgiegannup (19802, 19879); Red Hill (3869); West Swan (879); Mussel Pool (51560-1); Wanneroo Road (2717); Balcatta (3855); North Beach (10907); Osborne Park (3352); Dianella (20882, 26901); Morley (20566); Guildford (645); West Midland (4758); Midland (25835, 28045); John Forrest National Park (6922); Glen Forrest (16906); Parkerville (5269); Mahogany Creek (765, 4728); Mundaring (4639, 40833); Chidlow (29164); York (10558); Badjaling (52532-4); Dangin (12651);

Mundaring Weir (15023-5, 19985, 20605, 21325) and 2 km SW (14543-4, 17091, 19157, 19497); Darlington (6487, 28899); Helena Valley (196, 198); South Guildford (39791); Bayswater (1102, 3367); Maylands (3826); Mt Lawley (4145, 14495); North Perth (3857); City Beach (62502); West Leederville (2808); Perth (1177, 3366, 3424, 4415, 4936, 5112); Rivervale (7002); Belmont (2438); South Belmont (4216); Maida Vale (34005-6); Kalamunda (25611, 29283); Forrestfield (4432, 40198, 43855); Lesmurdie (22893); Bickley (3828); Carmel (14170); Wattle Grove (2798, 26875); Cannington (65581); Manning (25972, 25982); Salter Point (12667); Bicton (31174); Coolbellup (27253); Bibra Lake (14920); Gosnells (387, 1737, 47792); Bartons Mill (31939, 32017); Beverley (29737); Darkin (1541, 22860); Beraking (21207-8); Mt Dale (19134, 49887, 56103, 57606); 24 km SE of Karragullen (56080-1) and 8 km SE (15079); Roleystone (5896, 22655, 26162-3); Canning Dam (5235, 36331); Armadale (2321-3); Forrestdale (14481, 49886); Jandakot (51655, 62154-7); Naval Base (25069); Bedfordale (10875); Narembeen (1158) and 53 km E (25828) and 64 km E (25825); Gibb Rock, 61 km ESE of Narembeen (59721); Corrigin (19878); 6 km E of Jarrahdale (19383); Rockingham (21299); Warnbro Beach (25677); Serpentine (4670) and 2 km SE (64983); Mandurah (41756); North Dandalup (4416-7); Bendering Reserve (52599-600, 55295); Kondinin (1271); Lake Varley (21604); Kulin (4406, 7873, 37712); Popanyinning (19988); Pinjarra (8113-6); Harvey Estuary (29221); Coolup (7292); Dwellingup (26618); Dryandra Forest Reserve (26002); Mooterdine (28090); Yornaning (5016) and 25 km E (51358); Yornaning Reserve (51374-5); Wickepin (623); 13 km NNW of Dragon Rocks (43698-9) and 6 km NNW (43696-7, 43717-8) and 3 km NNW (43719); Dragon Rocks Reserve (42980, 43689-90, 43693-5, 43700-2, 43722, 43737, 43763); Kuender (28272); Narrogin (521, 524, 526, 25961-3); Williams (368, 781, 4707, 22860); Waroona (395) and 8 km N (60715); Yarloop (67580); North Tarin Rock Reserve (40059, 40081, 44441-2); Tarin Rock Reserve (40046, 40056); Lake Grace (5362); Dumbleyung (374); Wagin (709-10); Mornington (5368-70); Burekup (31213); 8 km SW Collie (15082); West Arthur (632); Dongolocking Reserve (49642-7, 49649, 49651-2); 25 km E Pingrup (29163, 39806); Lake Magenta Reserve (39907, 39928-30, 39945, 45322, 47331); Ravensthorpe (60435) and 26 km W (44857-8) and 9 km ESE (67348-9); Badgebup (3331); Jerramungup (21880); East Mt Barren (15083); Dempster Inlet (37727); Kojonup (24982); Tambellup (2746); between the upper reaches of the Perup and Tone Rivers (42548); Cranbrook (785, 6568, 67563); Brittens Rock, Walpole district (49908); Denmark (6569).

Eastern Division (W.A.): 32 km E of Kalgoorlie (3749); Corinthian (1794); Marvel Loch (1522, 3870); 48 km S of Widgiemooltha (46612); 70 km ENE of Norseman (65474).

Eucla Division (W.A.): 56 km S of Norseman (252); 31 km WNW Clear Streak Well (59940) and 28 km WNW (59939) and 7 km NE (58005); 10 km E of Boingaring Well (58033); Mt Coobaninya (33°02'S, 123°21'E) (59755).

Denisonia spectabilis nullarbor subsp. nov. (Fig. 6)

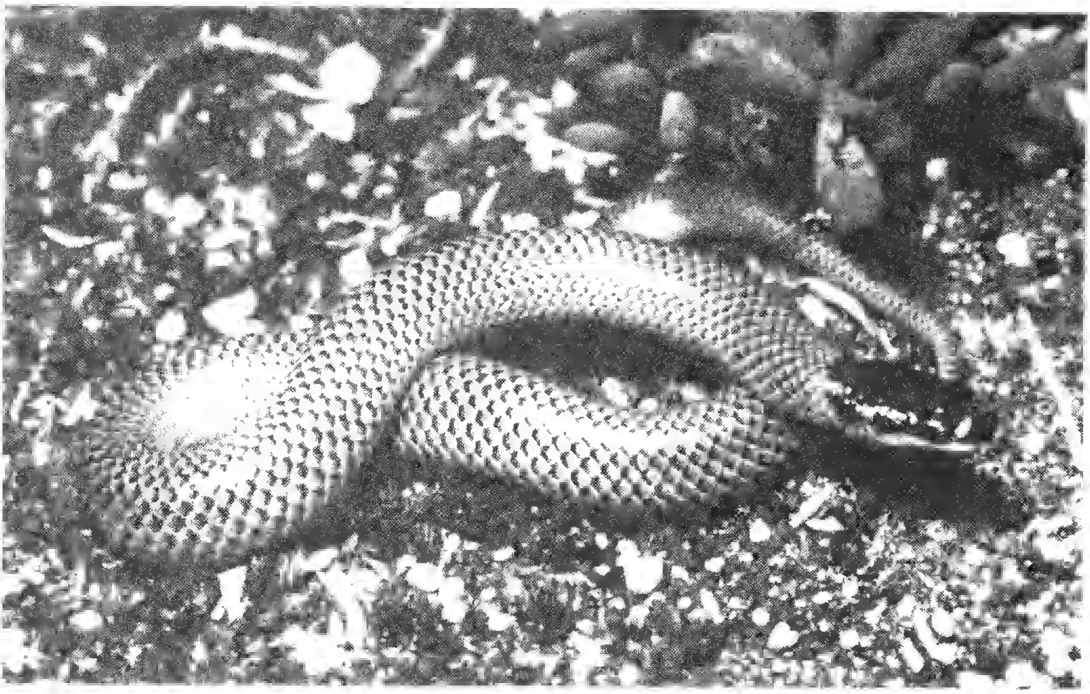

Fig. 6: Holotype of *Denisonia spectabilis nullarbor* photographed in life by T.M.S. Hanlon.

Holotype

R66626 in Western Australian Museum, collected on 23 September 1979 by T.M.S. Hanlon and G. Harold at 4 km S of (new) Eucla, Western Australia, in 31°43'S, 128°52'E.

Diagnosis

A small member of the *D. gouldii* group without a dorsal stripe and with black hood broken by a pale mark in front of eye. Distinguishable from *D. s. spectabilis* by much smaller extent of pale markings on head, longer tail and more numerous subcaudals, and from *D. gouldii* by more greyish, less reddish, dorsals which are not finely black-edged all round, fewer ventrals and lesser size.

Distribution

The Nullarbor Plain of south-eastern Australia and western South Australia and adjacent coastal plain (see Fig. 5).

Description

Snout-vent length (mm): 145-337 (N 14, mean 237.9). Length of tail (% SVL): 11.5-18.5 (N 14, mean 14.2).

Internasals 0.7-0.9 (N 14, mean 0.78) times as long as prefrontals. Frontal 1.2-1.7 (N 14, mean 1.49) times as long as wide, and 1.7-2.3 (N 14, mean 2.06) times as wide as supraoculars. Preocular widely separated from frontal and in short contact with nasal (N 12) or separated (N 2). Postoculars 2. Temporals 2 + 2. Upper labials 6. Lower labials 7. Midbody scale rows 15, increasing to 19-23 (N 14, mean 20.0) on neck, and decreasing to 13 before vent. Ventrals 135-158 (N 14, mean 144.4). Subcaudals 24-36 (N 14, mean 30.2). Ventrals plus subcaudals 163-189 (N 14, mean 174.6).

Head and nape glossy black broken by orange-brown mark in front of eye (fading to white in alcohol), black extending back on to first 4-7 (N 14, mean 5.5) vertebrals. Rest of upper surface greyish brown with or without an orange tinge, each scale with a black basal blotch which may extend back as a fine edge on anterior facets (posterior facets not black-edged). Lips and lower surface whitish.

Paratypes

Eucla Division (W.A.): Rawlinna (15187) and 35 km NW (43585) and 38 km E (14106) and 112 km ENE (45656); 8 km S of Loongana (29441-2); Forrest (14472, 15085-6, 16898); 4 km S of (new) Eucla (24645) and 10 km NNW (66498).

South Australia: 40 km SSE of Ooldea (25468).

Denisonia spectabilis spectabilis

Hoplocephalus spectabilis Krefft, 1869, The snakes of Australia, p. 61. Port Lincoln, S.A.

Diagnosis

A small member of the *D. gouldii* group without a dorsal stripe and with black hood extensively broken by pale markings in front of and behind eye. Distinguishable from *D. flagellum* of Victoria and south-eastern South Australia by shorter tail, longer and slenderer body, fewer midbody scale rows (15 *vs* usually 17) and more numerous ventrals.

Distribution

Southern South Australia.

Description

Snout-vent length (mm): 146-356 (N 20, mean 264.8). Length of tail (% SVL): 10.1-17.4 (N 20, mean 12.6).

Internasals 0.6-1.1 (N 19, mean 0.79) times as long as prefrontals. Frontal 1.2-1.9 (N 19, mean 1.63) times as long as wide, and 1.7-2.6 (N 19, mean 2.07) times as wide as supraoculars. Preocular widely separated from frontal and in short contact with nasal. Postoculars 2. Temporals normally 2 + 2 (3 secondaries on one side of one specimen). Upper labials 6. Lower labials normally 7 (5/6 in one specimen). Midbody scale rows 15, increasing on neck to 19-23 (N 18, mean 20.4) and decreasing to 13 before vent (12 in one specimen). Ventrals 138-168 (N 17, mean 149.5). Subcaudals 21-33 (N 20, mean 26.9). Subcaudals plus ventrals 164-199 (N 17, mean 176.4).

Hood black, broken by broad pale (white in alcohol) transverse bar in front of eye (which is usually continuous with its opposite number and often medially breaking narrow dark bar across snout) and pale area behind eye (continuous with white of lips), and usually pale apices of parietals; in orbital region black of hood represented by narrow ring around eye; hood extending back for 4-6 (N 19, mean 4.7) vertebrals. Rest of upper surface greyish brown, each scale with a dark basal blotch. Lips and lower surface whitish.

Material

South Australia: 32 km N of Fowlers Bay (SAM R14663); 23 km W of Penong (SAM R13863*a-b*); Denial Bay (SAM R292); Uro Bluff (SAM R16849); Lincoln Gap (SAM R12478); Wilcherry (SAM R12082, 12800); Mamblin (SAM R10704); Mt Wedge (SAM R3150); Hambidge Conservation Park (SAM R8388); 28 km N of Cowell (SAM R9503); Hincks Conservation Park (SAM R10189); Tumby Bay (SAM R903); Port Lincoln (SAM R11094; syntypes AM 6593-5, 6597, 6599).

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PARASITES OF WESTERN AUSTRALIA

X

LABIDOCARPINAE FROM BATS (ACARI: LISTROPHOROIDEA, CHIRODISCIDAE)

A. FAIN*

&

F.S. LUKOSCHUS†

ABSTRACT

Eight named species of labidocarpine fur-mites belonging to four genera are recorded from Western Australian bats: *Labidocarpus australiensis* sp. nov., *Olabidocarpus malayi* Fain, *Alabidocarpus recurvus* Womersley, *A. fujii* Wada, *A. yandinae* Domrow & Moorhouse, *A. yandinae intersitus* subsp. nov., *A. chalinolobi* sp. nov., *A. parvulus* sp. nov. and *Dentocarpus (Paradentocarpus) kimberleyensis* sp. nov. Two forms of *Alabidocarpus* could not be determined.

INTRODUCTION

The labidocarpine fur-mites of Australian bats were reviewed by Domrow & Moorhouse (1975) who recorded four species in two genera: *Alabidocarpus recurvus* (Womersley, 1943), *A. yandinae* Domrow & Moorhouse, 1975, *A. fujii* Wada, 1967 and *Dentocarpus chaerephon* Fain, 1970.

During the Western Australia Field Programme the junior author collected many labidocarpines on various species of bats. These mites belong to 10 species and four genera and include four new species and one new subspecies. This material is studied below.

The holotypes and allotypes of the new species are deposited in the Western Australian Museum, Perth (WAM). Paratypes are in the Field Museum of Natural History, Chicago, U.S.A. (FMNH) and in the authors' collections Department of Zoology, University of Nijmegen, The Netherlands (DZUN) and Institute of Tropical Medicine, Antwerp (IMT). Paratypes of

* Institute of Tropical Medicine, Antwerp, Belgium.
† Catholic University of Nijmegen, The Netherlands.

Labidocarpus australiensis sp. nov. and *Alabidocarpus chalinolobi* sp. nov., and specimens of *Olabidocarpus malayi* Fain, 1970, are deposited as follows: United States National Museum, Washington (USNM); Institute of Acarology, Columbus (IA); Museum d'Histoire Naturelle, Paris, France (MHNP); British Museum, Natural History, London (BM); Rijksmuseum Natural History, Leiden, The Netherlands (RMNH); Hamburg Museum of Natural History, Germany (HM); Museum of Natural History, Frankfurt (MNHF); Academy of Tchecoslovaquia, Prague (AT); Institut royal des Sciences naturelles, Brussels (IRSNB), and Queensland Institute of Medical Research (QIMR).

The length of the body includes the gnathosoma.

SYSTEMATICS

Order Astigmata
Family Chirodiscidae Trouessart, 1892
Subfamily Labidocarpinae Gunther, 1942
Genus ***Labidocarpus*** Trouessart, 1895

Labidocarpus australiensis sp. nov.

Diagnosis

This species is distinguished from *Labidocarpus rollinati* Trouessart, 1895 in both sexes by the different aspect of the lateral sclerotized areas, which are smaller and more regularly rectangular and have anterior border sinuous. In the male these areas number only 10 (11-12 in *L. rollinati*) and the striations only 14 (17-19 in *L. rollinati*).

Description

Holotype: female (Fig. 1) 330 μm long, 120 μm wide. Cuticle with 32 striations in midline and bearing laterally 13 small shields on one side and 12 on other. Gnathosoma 40 μm long, prescapular shield 75 μm long (in midline). Legs III larger than legs IV. Tarsus III with apical curved spine 27 μm long, tarsus IV with similar but shorter spine (18-20 μm). Chaetotaxy: setae *sc i*, *sc e* and *h* 25 μm, 8 μm and 45 μm long respectively. Posterior extremity with two pairs of setae 45 μm and 105 μm long respectively.

Allotype: male (Fig. 2) 270 μm long, 105 μm wide with 10 lateral shields and 15 transverse striations (in midline). Gnathosoma 36 μm long, prescapular shield 72 μm long. Opisthosomal shield 78 μm long. Legs as in *L. rollinati* but apical peduncle of tarsus III more conical and apical spine more curved. Chaetotaxy: setae *sc i*, *sc e* and *h* 25-30 μm, 4 μm and 40 μm long respectively. Posterior extremity with one pair of long setae (80 μm) and one pair of short setae; a third pair of very small setae is present more internally and is not visible from outside.

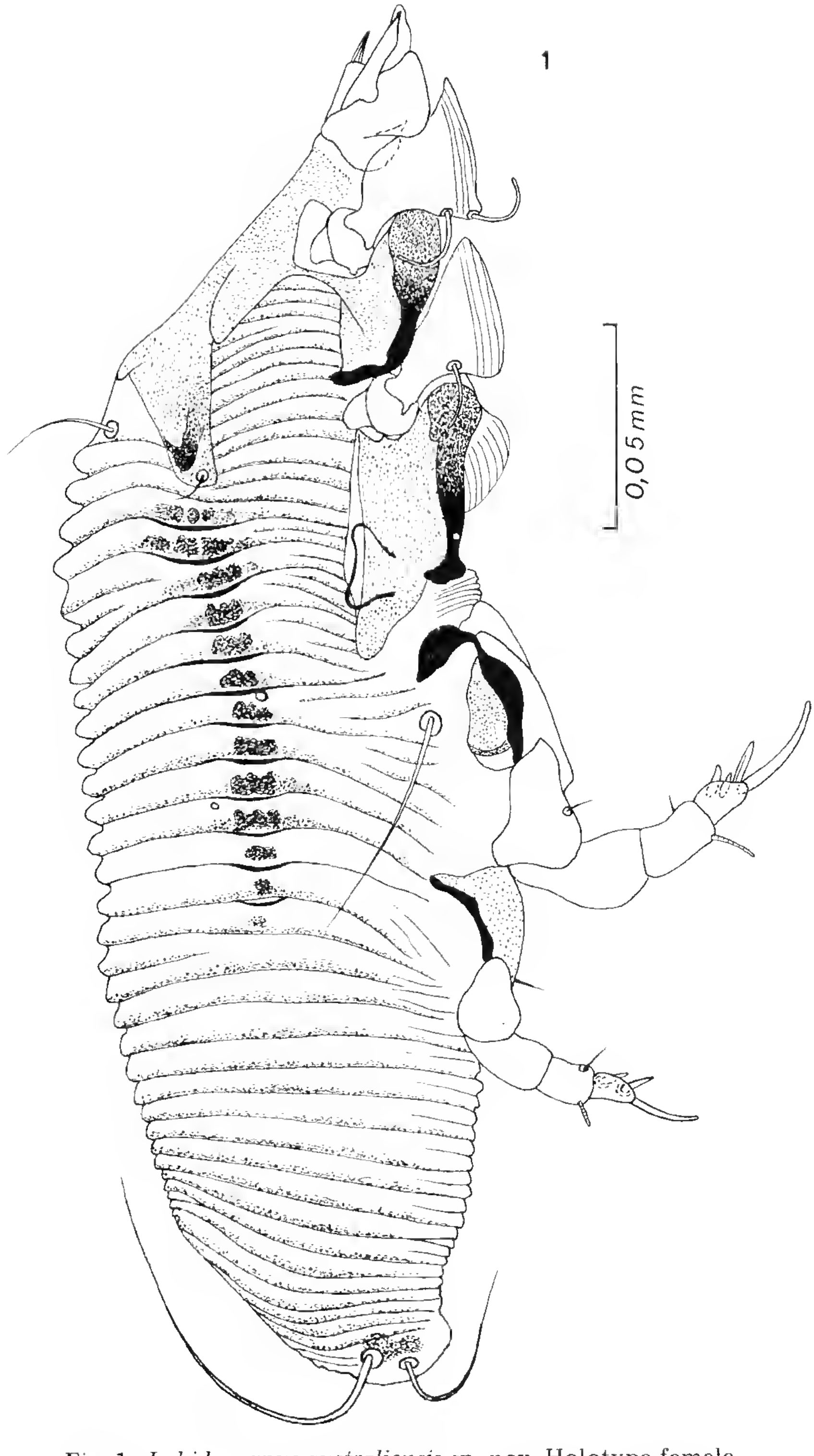

Fig. 1: *Labidocarpus australiensis* sp. nov. Holotype female.

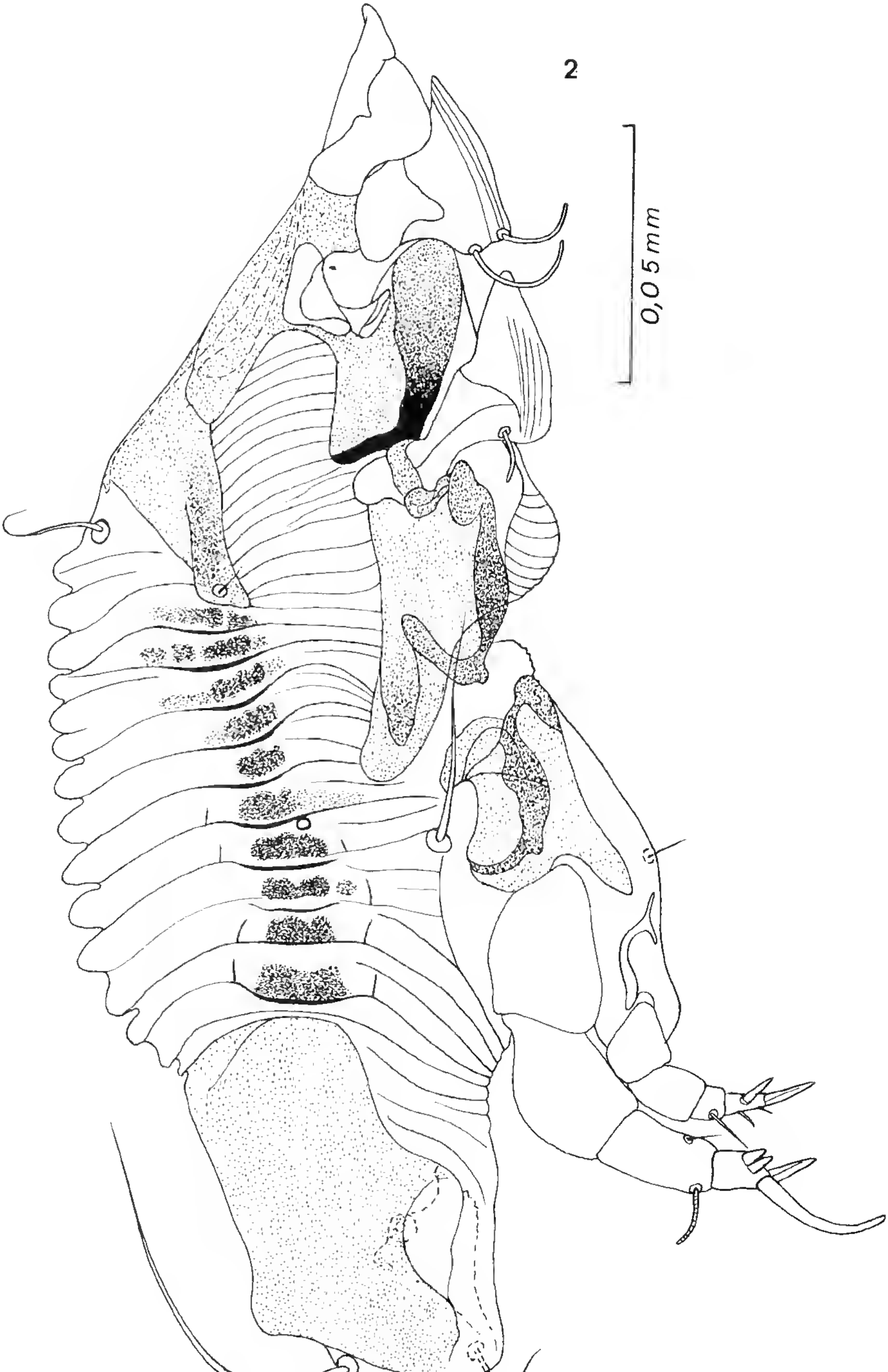

Fig. 2: *Labidocarpus australiensis* sp. nov. Allotype male.

Host and locality

Holotype: WAM 80-334, parasitic on *Hipposideros ater* Templeton, 1848, collected at Geikie Gorge, Western Australia (18°05'S, 125°43'E), 6.X.1976. Host registration FMNH 2959.

Allotype: from the same animal WAM 80-336.

Paratypes: 26 from the same animal, WAM 80-150 to 80-162, 80-335. Host registration numbers FMNH 2959 and 2862. From the same animal: 34 paratypes (males, females and immatures). From the same host but 3.X.1976 (eight females and 28 immatures all paratypes) and 7.X.1976 (42 females, 19 males, nine immatures all paratypes). Paratypes are deposited in the following institutions: USNM, two females, one male, one nymph; FMNH, 25 females, three males, three nymphs; MHNP, two females, one nymph; BM, two females, one male, one nymph; IA, two females, one male; RMNH, two females, one male; AT, three females, one male; HM, two females, one male, one nymph; QIMR, three females, one male; IMT, 22 females, three males, 13 nymphs; DZUN, 25 females, three males, 13 nymphs.

Genus *Olabidocarpus* Lawrence, 1948

Olabidocarpus malayi Fain, 1970

The type series of *O. malayi* (from *Pterygistes stenopterus*, Kuala Lumpur), cannot be separated from our specimens, which were found attached to the body hairs of *Eptesicus douglasi* Kitchener 1976, Geikie Gorge, 4, 20 and 30.X.1976 (60 females, 30 males and immatures).

Genus *Alabidocarpus* Ewing, 1943

To the three species already recorded from Australia, F.S.L. was able to add two new ones. All four are keyed below.

Key to Females of Genus *Alabidocarpus* in Australia

1 Body in larvigerous females more than 1 000 μm long. Setae *g p* short and thick spines. Gnathosoma with four strong horns. On *Miniopterus* spp. . . . . *A. fujii* Wada, 1967

Body in larvigerous females not more than 637 μm long. Setae *g p* thin and long. Gnathosoma with horns less developed 2

2 Larger species (415 to 637 μm). Posterior border of prescapular shield not sinuous and without rounded prolongations 3

Small species (less than 250 μm). Posterior border of prescapular shield sinuous (**Fig. 6**) and with four small rounded prolongations. On *Eptesicus* spp. . . . . *A. parvulus* sp. nov.

3 Prescapular shield with distinct triangular posterolateral projections (**Fig. 4**). Gnathosoma with well-developed horns. On *Chalinolobus gouldii* . . . . *A. chalinolobi* sp. nov.

Prescapular shield without distinct triangular posterolateral projections. Gnathosoma variable 4

4 Gnathosoma with horns poorly developed. Prescapular shield narrow, not produced laterally. Body 390-415 μm long. On *Nyctophilus geoffroyi* . . . . *A. recurvus* (Womersley, 1943)

Gnathosoma with well-developed horns. Prescapular shield wider, with corners slightly produced. Body 615-637 μm long. On *Rhinolophus megaphyllus* and *Eptesicus* spp. . *A. yandinae* Domrow & Moorhouse, 1975

Alabidocarpus recurvus (Womersley, 1943)
Labidocarpus recurvus Womersley, 1943: 17
Alabidocarpus recurvus Domrow, 1959: 238 (in part), Fain, 1972: 182

This species was described from an unidentified bat in Australia. Fain (1972) illustrated the holotype female. Domrow & Moorhouse (1975) recorded the species from *Nyctophilus geoffroyi* Leach, 1822 and figured the male.

The species is characterized by the presence on the posterior border of gnathosoma of four quite distinct horns, but these are much less developed than in *A. calcaratus* Lawrence. The prescapular shield is short, narrow and with its lateral corners rounded and not produced. In the female seta *sh* is spinous and seta *g p* long and thin. Tarsus IV, in both sexes, bears a simple seta longer than the corresponding apical spine.

We attribute to this species two females found on the nasal vibrissae of (1) *Tadarida jobensis* (Miller, 1902), Mount Hart (16°48′S, 124°56′E), 11.IX.1976, and (2) *Nycticeius greyi* (Gould, 1858), Beverley Springs (16°35′S, 125°29′E), 21.IX.1976.

Alabidocarpus fujii Wada, 1967

This species was described from *Miniopterus schreibersi niponiae* in Japan. Domrow & Moorhouse (1975) recorded it from *M. australis* Tomes, 1858, in Papua New Guinea and Australia. A.F. found one female and one larva on *M. australis*, from the New Hebrides.

According to the original drawing of Wada, setae *g p* are short spines in the female and simple setae in the male. This character, the strongly horned gnathosoma and the narrow and short aspect of the prescapular shield not produced laterally, are shared by *A. calcaratus* Lawrence. *A. fujii* therefore appears very close to the latter species. Males are distinguished by the presence in *A. calcaratus* of a long simple seta on tarsi IV (this seta short in *A. fujii*) and the smaller length of the median pair of terminal setae.

Alabidocarpus yandinae Domrow & Moorhouse, 1975
Alabidocarpus recurvus Domrow, 1959: 238 (in part)
non Alabidocarpus recurvus Womersley, 1943

This species was described from *Rhinolophus megaphyllus* Gray, 1834 in Australia.

According to Domrow's (1959) figures, the gnathosoma is distinctly horned, though less than in *A. calcaratus* and *A. fujii*, and the posterior margin of the prescapular shield is slightly produced laterally. Setae *g p* in the female are long and thin and tarsus IV bears a simple seta shorter than the corresponding apical spine.

Alabidocarpus yandinae intersitus subsp. nov.

Diagnosis

This subspecies differs from the typical form by the greater development and pointed aspect of the four gnathosomal horns, the shorter apical spine of tarsus III compared with that of tarsus IV (ratio 1 : 2), the greater length of the thin seta of tarsus IV, and the shape of the prescapular shield (less produced laterally).

Description

Holotype: female (larvigerous) 615 μm long, 210 μm wide (maximum). Lengths of gnathosoma 63 μm (to tip of submedian horns), of prescapular shield 70 μm (in midline). Gnathosoma with four pointed horns, submedians 18 μm long. Prescapular shield with broadly rounded lateral corners. With 50 transverse striations in midline. Apical spine of leg III 24 μm long, of leg IV 48 μm (measured in straight line). Chaetotaxy: *sh* a spine 18 μm long;

h and l 5 140 μm long, setae g p long and very thin. Tarsus IV with thin seta 75 μm long.

Allotype: male (Fig. 3) 395 μm long, 170 μm wide. Gnathosoma and prescapular shield as in female but gnathosomal horns longer (21 μm for paramedian). Posterior extremity with three pairs of long setae, middle pair longest.

Host and locality

Holotype: WAM 80-337, parasitic on *Eptesicus douglasi*, collected at Beverley Springs, Western Australia (16°35'S, 125°29'E), 20.IX.1976. Host registration FMNH 2745.

Paratypes: one female from the same animal, WAM 80-179. Paratypes from the same host from Geikie Gorge (18°05'S, 125°43'E), host registration FMNH 2931, 5.X.1976; WAM 80-338, allotype male and WAM 80-178 one paratype female; FMNH, one female, one male and two nymphs. Paratypes from *Eptesicus pumilus* (Gray, 1841), Mitchell Plateau, Western Australia (14°50'S, 125°49'E), 23.X.1976; DZUN, one male and one female; IMT, one female and one nymph.

Alabidocarpus chalinolobi sp. nov.

Diagnosis

This species closely resembles *A. calcaratus intercalatus* Fain 1971, briefly described from *Myotis myotis* in Belgium. In both species the prescapular shield is produced laterally in a triangular pointed projection, the gnathosoma bears four strong horns and setae g p are thin and long. However, the new species is distinguished from *A. c. intercalatus* by the more incised shape of the posterior border of gnathosoma, the smaller number of dorsal striations and in the male by the different shape of the opisthosomal shield.‡

Description

Holotype: female (Fig. 4) idiosoma 615 μm long, 185 μm wide (larvigerous). Gnathosoma with four strong horns (paramedian 20 μm long) smaller than in *A. calcaratus*. Prescapular shield with lateral triangular projections. Length of gnathosoma 66 μm (paramedian horn included), of prescapular shield 70 μm in midline and 102 μm along lateral prolongation; 49 transverse striations in midline. Legs: apical spine of tarsus III 27 μm long, of tarsus IV 51 μm long. Tarsi III-IV with fine seta longer than the apical spine; thick lateral spine on tarsus IV lacking. The two ridged

‡ We now consider that *A. calcaratus intercalatus* is specifically distinct from *A. calcaratus* Lawrence, 1952.

Fig. 3: *Alabidocarpus yandinae intersitus* subsp. nov. Allotype male.

Fig. 4: *Alabidocarpus chalinolobi* sp. nov. Holotype female.

ventral spines on tarsus III are unequal (21 and 12 μm long respectively). Setae *g p* long and thin. Setae *l 5* very long (about 150 μm). Setae *sh* thin spines 18 μm long.

Allotype: male (**Fig. 5**) 380 μm long, 135 μm wide. Gnathosoma, prescapular shield, setae *sh* and *g p* as in the female. With 30-35 transverse striations in midline (39 striations in *A. intercalatus*). Opisthosomal shield 45 μm long. There are three pairs of long subequal postero-terminal setae (in the paratype, median pair longer than others). Apical spines of tarsi III and IV 27 μm and 60 μm long respectively (latter fused with tarsi).

Host and locality

Holotype: WAM 80-339, from *Chalinolobus gouldii* (Gray, 1841), collected at Beagle Bay, Western Australia (16°59'S, 122°40'E), 23 and 25.VIII.1976. Host registration 2616. Holotype male from the same animal as holotype: WAM 80-340.

Alabidocarpus parvulus sp. nov.

Diagnosis

This very small species resembles *A. eptesicus* Fain 1970, described from Central Africa. It differs, however, in the female by the presence of only one pair of long setae on the posterior extremity of the body.

Description

Holotype: female (**Fig. 6**) (larvigerous) 230 μm long, 54 μm wide (four paratypes: 210 μm x 60 μm, 213 μm x 55 μm, 223 μm x 57 μm and 225 μm x 55 μm). Gnathosoma 24 μm long (horn included), prescapular shield 28 μm long (in midline). Gnathosoma with two thick, curved paramedian horns. Posterior border of prescapular shield sinuous with four small rounded prolongations. With 39 striations in midline. Setae *sc i*, *sc e* and *sh* vestigial, *h* 45 μm long; setae *l 5* 250 μm, *d 5* 7 μm. Legs III and IV small, ending in rather long spine.

Male unknown.

Host and locality

Holotype: WAM 80-341, from *Eptesicus douglasi*, Geikie Gorge (18°05'S, 125°43'E), 5.X.1976 (from the head). Host registration 2926.

Paratypes: two females from the same animal, FMNH. Paratypes from *Eptesicus pumilus*, Brooking Springs, Western Australia (18°07'S, 125°39'E), 2.X.1976, host registration 288; WAM 80-185 to 80-187; FMNH, four females; DZUN, four females, IMT, three females (and one incomplete female not paratype from Mitchell Plateau, 23.X.1976).

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Fig. 5: *Alabidocarpus chalinolobi* sp. nov. Allotype male.

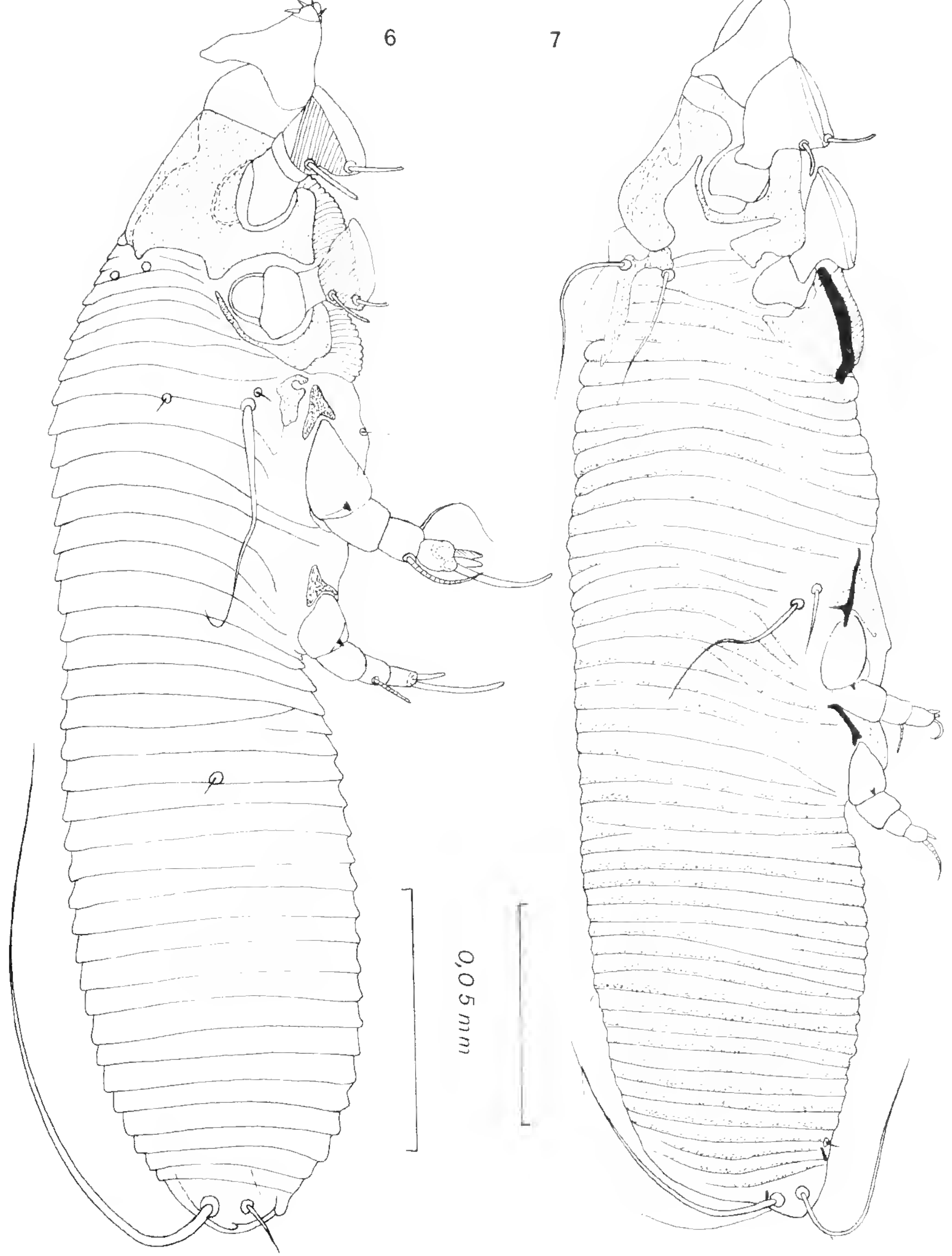

Fig 6-7: *Alabidocarpus parvulus* sp. nov. Holotype female (Fig. 6). *Dentocarpus (Paradentocarpus) kimberleyensis* sp. nov. Holotype female (Fig. 7).

Alabidocarpus sp. indet 1

From the head of *Nycticeius greyi*, Beagle Bay, 23.VIII.1976 and Geikie Gorge (18°05'S, 125°43'E), 21.IX.1976: one male, four specimens (either non-gravid females or male tritonymphs) and two larvae. These specimens (females) are very close to *A. parvulus*. They differ from these by the greater size of the body (slightly longer and thicker; one specimen 250 μm long, 75 μm wide) and the smaller size of the gnathosomal horns.

In many species of Labidocarpinae it is not possible to recognise a non-gravid female from a male tritonymph (Fain, 1971). Thus, in the absence of a larvigerous female, we prefer not to identify these specimens.

Alabidocarpus sp. indet 2

From the head of *Nyctophilus arnhemensis* Johnson 1959, from Beagle Bay (16°59'S, 122°40'E), 23.VII.1976: one male and five specimens that could be male tritonymphs or non-gravid females. These specimens resemble *A. parvulus* except for the greater size of the body (one 'female' is 300 μm long). These specimens are also close to the *Alabidocarpus* sp. 1 but they are slightly larger and in some of them *h* setae are distinctly inflated and *d 5* setae a little longer. More specimens, and especially larvigerous females should be seen before we can identify these specimens.

Genus *Dentocarpus* Dusbabek & Cruz, 1966
Subgenus *Paradentocarpus* Fain, 1976

The genus *Dentocarpus* was previously represented in Australia by *D. chaerephon* (Fain, 1970), found on *Tadarida jobensis* (Miller, 1902) (Domrow & Moorhouse, 1975).

Fain (1976) divided this genus into two subgenera, the subgenus *Paradentocarpus* differing from the typical one by the shape of the prescapular shield (presenting a straight or concave posterior border without any posterior projection).

To the two known species of *Paradentocarpus* (*D. [P.] phyllodermae* Fain, 1976 and *D. [P.] abyssinicus* Fain, 1976), a third species is now added from Australia.

Dentocarpus (Paradentocarpus) kimberleyensis sp. nov.

This new species is clearly distinct from the two other species in the subgenus by the much smaller size of the body, the shape of the postscapular shields and the different lengths of the setae. Thus, in *D. (P.) abyssinicus* the female is 540 μm long and setae *s h* are more than 100 μm long; in *D. (P.) phyllodermae* the body is 385 μm long, setae *sh* are very short (3 μm), and *h* 25-30 μm long.

Holotype: female (Fig. 7) 279 μm long, 72 μm wide (two paratypes 210 μm x 69 μm and 245 μm x 68 μm). Maximum lengths of gnathosoma 27 μm, of prescapular shield 41 μm. Postscapular paramedian shields poorly sclerotized and shaped in an L (longitudinal portion 25 μm long), bearing setae *sc i* and *sc e*. With 34 transverse striations in midline. Posterior legs very small ending in thick seta that is finely attenuated at apex. Chaetotaxy: setae *sc i*, *sc e*, *sh* and *h* 30 μm, 30 μm, 12-15 μm and 36 μm long respectively. Setae *d 5* and *l 5* 45 μm and 70 μm long respectively.

Male unknown.

Host and locality

Holotype: WAM 80-344 from *Eptesicus douglasi*, from Geikie Gorge (18°05′S, 125°43′E), 20.X.1976. Host registration 2979. Five paratypes from the same host and locality (host registration 2846; 5 and 8.X.1976): WAM 80-193, one female; FMNH, one female; DZUN, one female and one larva; IMT, one nymph.

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PARASITES OF WESTERN AUSTRALIA
XI
ATOPOMELIDAE FROM MARSUPIALS (ACARI: LISTROPHOROIDEA)

A. FAIN*

&

F.S. LUKOSCHUS†

ABSTRACT

Twenty-three species of atopomelid fur-mites belonging to 11 genera are recorded from Australian marsupials: *Austrochirus perameles* Fain, *A. armatus* Fain, *A. dorreensis* sp. nov., *Dasyurochirus trouessarti* (Domrow), *D. sminthopsis* (Womersley), *D. sminthopsis leucopus* subsp. nov., *D. intercalatus* Fain, *D. longissimus* sp. nov., *D. longicaudus* sp. nov., *D. australis* Fain, *D. tapoatafa* sp. nov. *D. granulipes* sp. nov., *Neodasyurochirus squamatus* Fain, *Labidopygus squamatus* sp. nov., *Scolonoticus medius* Fain, *S. quasinudus* sp. nov., *Petaurobia australiana* sp. nov., *Campylochirus (Campylochirus) brevicepsicola* sp. nov., *Campylochirus (Campylochiroides) petauricola* Fain, *Cytostethum (Metacytostethum) tasmaniense* Fain & Domrow, *Notoryctobia notoryctes* gen. nov., sp. nov., *Murichirus petaurus* sp. nov., *M. notomys* Fain, *Listrophoroides (Marquesania) queenslandicus* Womersley.

Among this material one new genus, 11 new species and one new subspecies are described and figured.

INTRODUCTION

This paper deals with a collection of atopomelid mites, partly collected by F.S.L. on marsupials from Western Australia during an expedition to the Kimberley Region of Western Australia in 1976-77. We also add some mites found by F.S.L. or by A.F. on Australian marsupials in several institutions.

The types of species found on mammals in the Western Australian Museum Perth, or during the Kimberley expedition are deposited in that museum. Those found on Australian mammals conserved elsewhere in other institutions are deposited in the respective museums.

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* Institute of Tropical Medicine, Antwerp, Belgium.

† Catholic University of Nijmegen, The Netherlands.

The length of the body includes the gnathosoma, the width is the maximum width of the body.

Abbreviations utilized for the institutions: BM (British Museum, Natural History, London); DZUN (Department of Zoology, University of Nijmegen, The Netherlands); FMNH (Field Museum, Natural History, Chicago); HM (Hamburg Museum of Natural History, Germany); IMT (Institute of Tropical Medicine, Antwerp); IRSNB (Institut royal des Sciences naturelles, Brussels); MHNP (Museum d'Histoire Naturelle, Paris, France); FMNH (Rijksmuseum Natural History, Leiden, The Netherlands); USNM (United States National Museum, Washington D.C.); WAM (Western Australian Museum, Perth).

SYSTEMATICS

Family Atopomelidae Gunther, 1942
Genus *Austrochirus* Womersley, 1943
Subgenus *Austrochirus* Womersley, 1943: Fain, 1972

1 *Austrochirus perameles* Fain, 1971

This species was previously known from *Perameles* sp. (type host), Australia and from *Perameles moresbyensis*, New Guinea.

Our specimens were collected on *Perameles* sp., New South Wales, (nine females, one male, 10 nymphs) (animal in USNM 23241).

2 *Austrochirus armatus* Fain, 1972

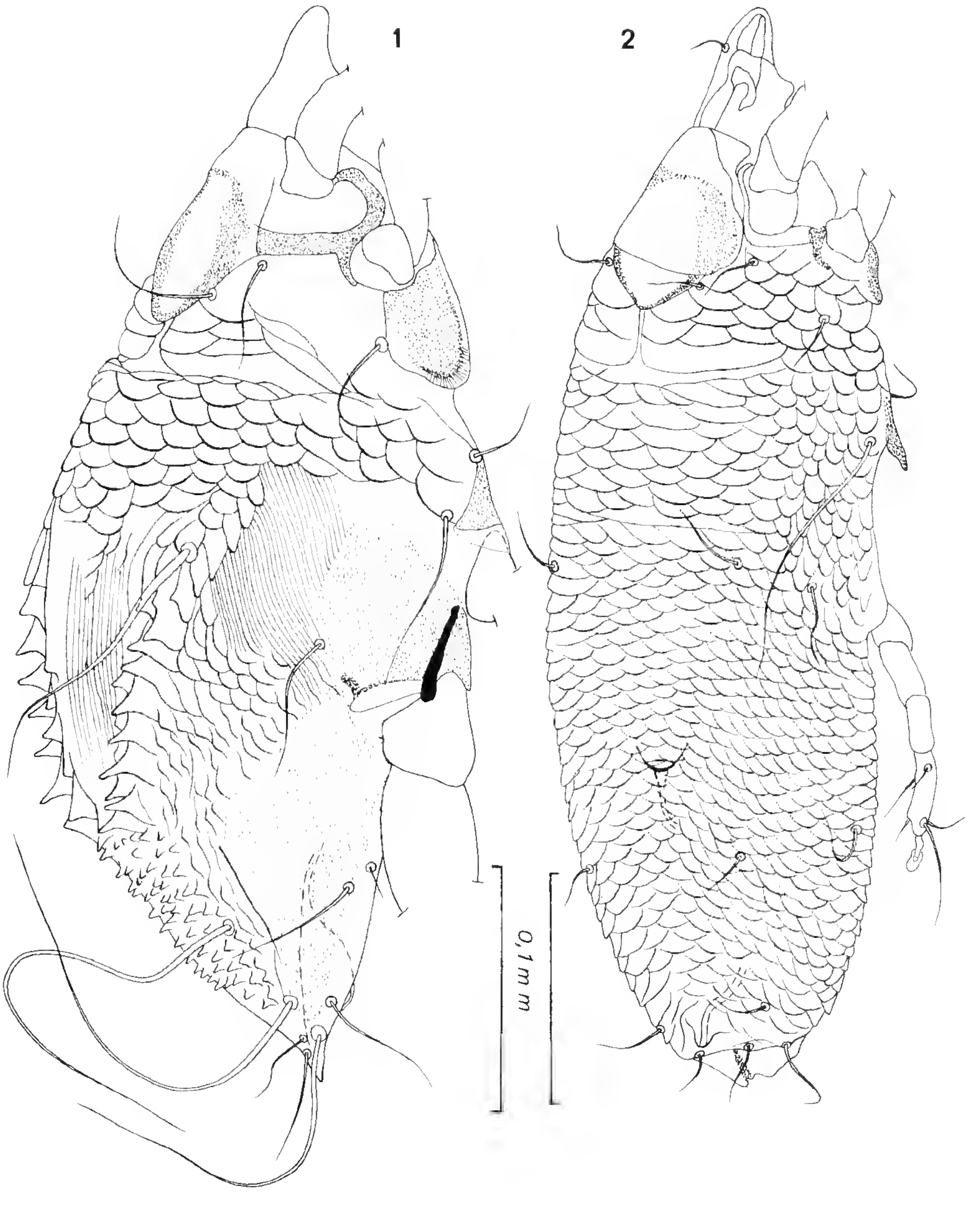
We attribute to this species a series (four females, two males, 20 nymphs, some containing a male in moulting stage) collected from *Isoodon obesulus* (previously *Perameles obesula*), (animal in USNM 218008, locality unknown).

The male corresponds closely to *A. armatus*. The female of the species was unknown. It resembles that of *A. squamatus*, being also covered by scales, though these are triangular, not rounded; the shape of the postscapular shield is different and the small Y-shaped sclerite is absent in our specimens. The size of two females is 480 μm x 150 μm and 485 μm x 158 μm.

3 *Austrochirus dorreensis* sp. nov.

Diagnosis

The female of this species resembles *A. squamatus* except that the Y-shaped sclerite situated behind the postscapular shield is lacking. The male is clearly distinguished by the presence on the dorsum of unequal scales, some being very large.



Figs 1-2: *Austrochirus dorreensis* sp. nov. 1—Holotype male; 2—Allotype female.

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Fig. 3: *Austrochirus dorreensis* sp. nov. Holotype male, posterior half in ventrolateral view.

Description

Holotype: male (**Figs 1, 3**) 435 μm x 180 μm (in lateral view). Hysteronotum scaly except small median area striated. This striated area is flanked laterally by one or two longitudinal rows of very strong erect scales. There is a pair of large lateral opisthosomal shields. Penis small, situated between legs IV. With two very small, rounded adanal suckers. Legs IV strongly inflated.

Allotype: female (**Fig. 2**) 465 μm x 140 μm. Dorsal surface close to *A. squamatus* except that Y-shaped sclerite is missing and that copulatory papilla is larger. Ventral surface and legs not separable from *A. squamatus*.

Material examined and host information

Holotype: WAM 80-342, parasitic on *Perameles bougainville* Quoy & Gaimard, 1824, collected at Dorre I., Western Australia (25°06′S, 113°06′E), 16 November 1963. Host registration WAM M11337.

Paratypes: from the same animal as holotype, WAM 80-343 and 80-196, 197, one female, three nymphs; FMNH, one male, one female, three nymphs; IMT, one male, one female, three nymphs; DZUN, one female, three nymphs.

Genus *Dasyurochirus* Fain, 1970
Subgenus *Dasyurochirus* Fain, 1970

1 *Dasyurochirus trouessarti* (Domrow, 1961)

This species was previously known from several dasyurids in Australia (*Antechinus flavipes godmani*, *A. flavipes* and *Dasyurus hallucatus*). F.S.L. found three males and four females on *Antechinus* sp. from Sydney, New South Wales, in the Hamburg Museum. Another female specimen was discovered on *Antechinus flavipes* (Waterhouse, 1838) from Australia (host in Leiden museum).

2 *Dasyurochirus sminthopsis* (Womersley, 1954)

This species was previously known from *Sminthopsis crassicaudata* (type host), *S. leucopus* and *S. murina* (see Fain, 1972) (**Figs 4-5**).

We found new specimens on the following hosts:

1 *Sminthopsis crassicaudata* (Gould, 1844), from 'Australia', March 1884 (10 females and two males, host in RMNH. From South Australia, 9 February 1898 (five females and one male), host in HM T635. From Bolgart, Australia, 25 May 1963 (14 females, 15 males, six nymphs), host in WAM 7795.

2 *Sminthopsis murina* (Waterhouse, 1838), 'Australia', 18 December 1884 (four females and two males), host in RMNH.

Dasyurochirus sminthopsis leucopus subsp. nov.

Diagnosis

This new subspecies differs from the typical form by the following characters. In both sexes the postscapular shields lack the anterior sclerotized band, only the posterior sclerotized band being present. In the female the copulatory papilla is shorter and inconspicuous and the distal tubuli of the sclerite between bursa and spermatheca are shorter.

Description

Holotype: female (Figs 6-7) 414 μm x 120 μm (in ventral view). Morphology as in *D. sminthopsis* except for the characters mentioned above.

Male: the only specimen is in bad condition and crushed. General characters as in *D. sminthopsis.*

Material examined and host information

Holotype: WAM 80-345, parasitic on *Sminthopsis leucopus* (Gray, 1842), collected at Western Port, Victoria, 5 December 1974 (coll. P. Wooley). Host registration WAM M12947.

Paratypes: from the same animal as holotype, WAM 80-204 and 205, five females; FMNH, five females, one male; IMT, five females; DZUN, five females.

3 *Dasyurochirus intercalatus* Fain, 1972

The only known host previously for this species was *Sminthopsis murina*, from Albany, Western Australia.

Three female and one male specimens were collected by F.S.L. on *Antechnius flavipes* from an unknown locality in Australia, March 1884, host in RMNH 716.

The male resembles *D. trouessarti*, being 315 μm x 120 μm (in ventral view).

4 *Dasyurochirus longissimus* sp. nov.

Diagnosis

The holotype is lacking gnathosoma and the legs I-II. The species is however clearly distinguished from all the other species in the genus by the great elongation of the body and the presence on it of very numerous and small scales.

Description

Holotype: female (Fig. 8) (ovigerous) 460 μm long (from anterior extremity of prescapular shield to the tip of the short copulatory tube) and 90 μm side. There are two prescapular and two postscapular shields rather well sclerotized and distinctly separated in midline. Behind these shields there are nine transverse not scaly striations. Hysterosoma completely covered with small rounded scales. Opisthosoma 290 μm long. Legs small. Copulatory tube terminal, small. Vulva distinctly ventral.

Material examined and host information

Holotype: HM A73/78, parasitic on *Acrobates pygmaeus* (Shaw, 1793), collected in Queensland, 11 July 1893. Host registration HM T657.

Paratypes: from the same animal; HM, one nymph; IMT, one female.

5 *Dasyurochirus longicaudus* sp. nov.

Diagnosis

This species is close to *D. trouessarti* (Domrow, 1961). The female, however, is distinguished from that species by the shape of the copulatory tube which is longer and narrower.

Description

Holotype: female (Fig. 9) 385 μm (copulatory tube not included) x 150 μm (in lateral view). Propodosomal shields, dorsal striations and scales as in *D. trouessarti.* Copulatory tube 73 μm x 6 μm.

Allotype: male 310 μm x 105 μm as in *D. trouessarti.* Lateral shields of opisthosoma 105 μm long. Legs IV stronger than legs III.

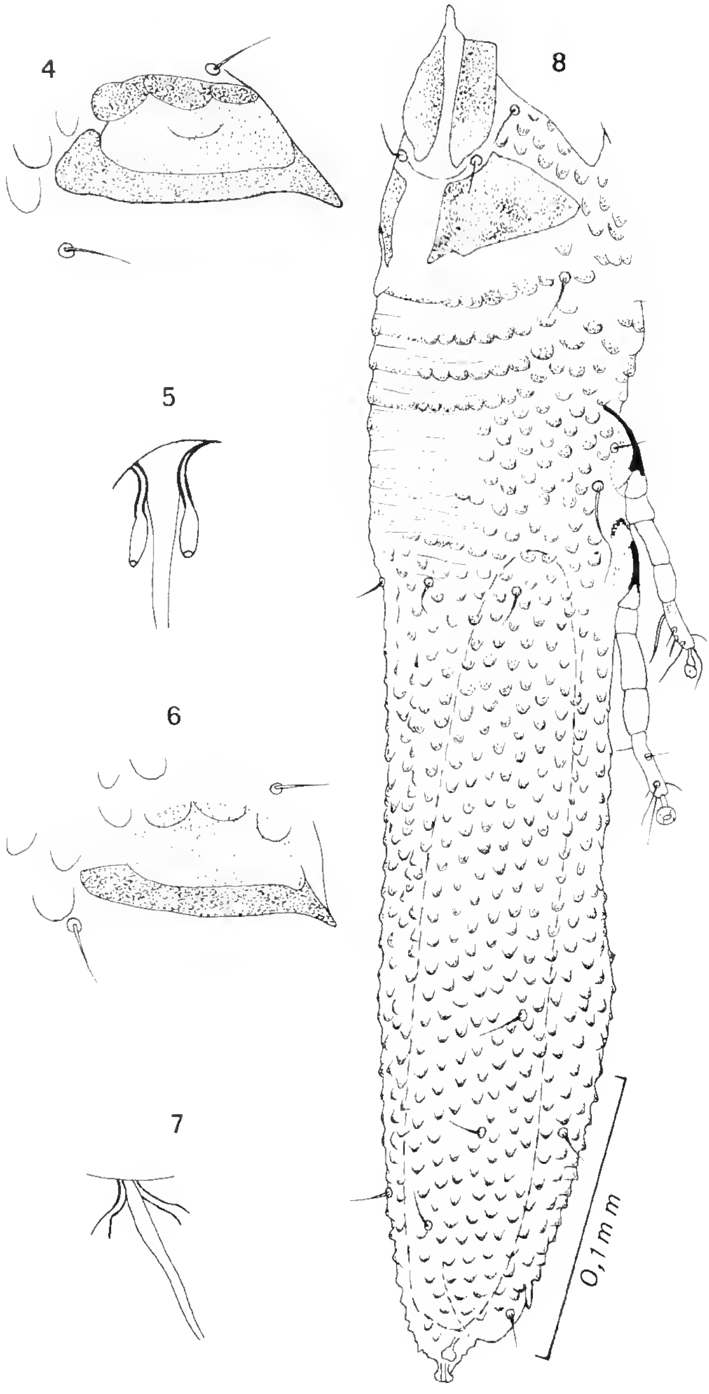
Material examined and host information

Holotype: USNM 3936, parasitic on *Phascogale godmani* Thomas, 1923, collected at Atherton Tableland, Queensland (approximately 17°16'S, 145°29'E), 30 July 1921. Host registration USNM 238575.

Paratypes: from the same animal as holotype, USNM, one female and two males; IMT, one female and one male; DZUN, one female and one male.

6 *Dasyurochirus australis* Fain, 1972

This species was known from *Antechinus minimus* (Geoffroy, 1803) (type host), Tasmania (animal in BM 52.1.15.5.7) and *A. unicolor*, New South Wales (animal in BM 26.3.11.268-76) (Fain, 1972).



Figs 4-8: Figs 4-5: *Dasyurochirus (Dasyurochirus) sminthopsis* (Womersley): 4—Postscapular shield; 5—Internal extremity of bursa. Figs 6-7: *Dasyurochirus (Dasyurochirus) sminthopsis leucopus* subsp. nov. 6—Postscapular shield; 7—Internal extremity of bursa copulatrix. Fig. 8: *Dasyrochirus (Dasyurochirus) longissimus* sp. nov. Holotype female in lateral view.

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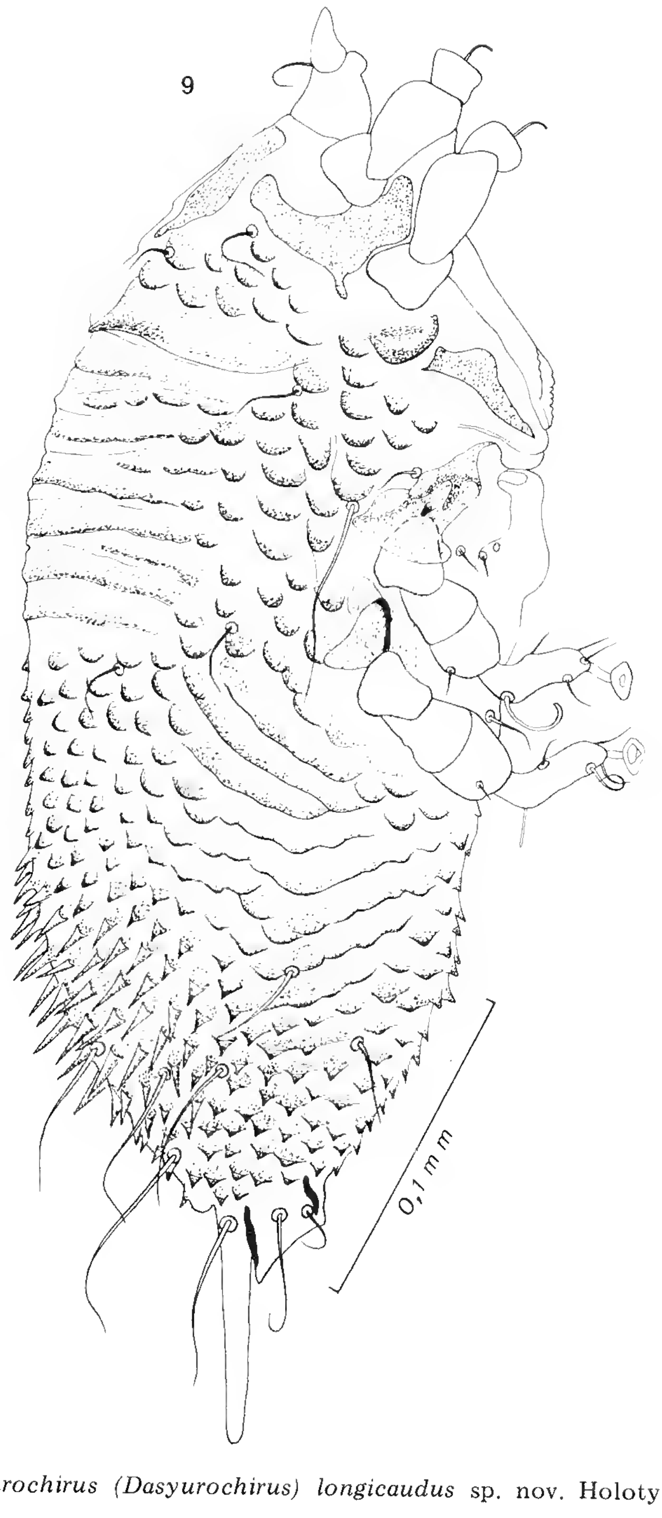


Fig. 9: *Dasyurochirus (Dasyurochirus) longicaudus* sp. nov. Holotype female in lateral view.

New specimens were found by F.S.L. on the following hosts:

1 On typical host, Perkins I., Tasmania, 3 May 1921 (16 females and 10 males). Host registration USNM 238574.

2 On *Antechinus stuartii* Macleay, 1841, Western Port, Victoria, 23 April 1974 (37 females, five males and 11 nymphs). Host registration WAM M12797 (coll. P. Wooley).

3 On *Antechinus flavipes*, Upper Allyn, 1 November 1957 (eight females and three nymphs). Host registration WAM 4689 (coll. P. Marto).

4 On *Antechinus flavipes burelli*, Ebor, New South Wales, 5 February 1921 (one female). Host registration USNM 237909.

5 On *Phascogale calura* Gould, 1844, Lake Grace, Western Australia (33°06'S, 118°28'E), 16 December 1960 (four females and one male). Host registration WAM M6163 (coll. D.G. Bathgate).

7 *Dasyurochirus tapoatafa* sp. nov.

Diagnosis

This species is close to *Dasyurochirus australis* Fain. It differs from it in the female by the greater number of scales on the opisthogaster. These scales are disposed in a continuous median band formed of transverse rows of 4-5 scales each. This band is fused laterally to larger scaly areas. The opisthogaster bears only a few poorly developed transverse striations (not figured).

Description

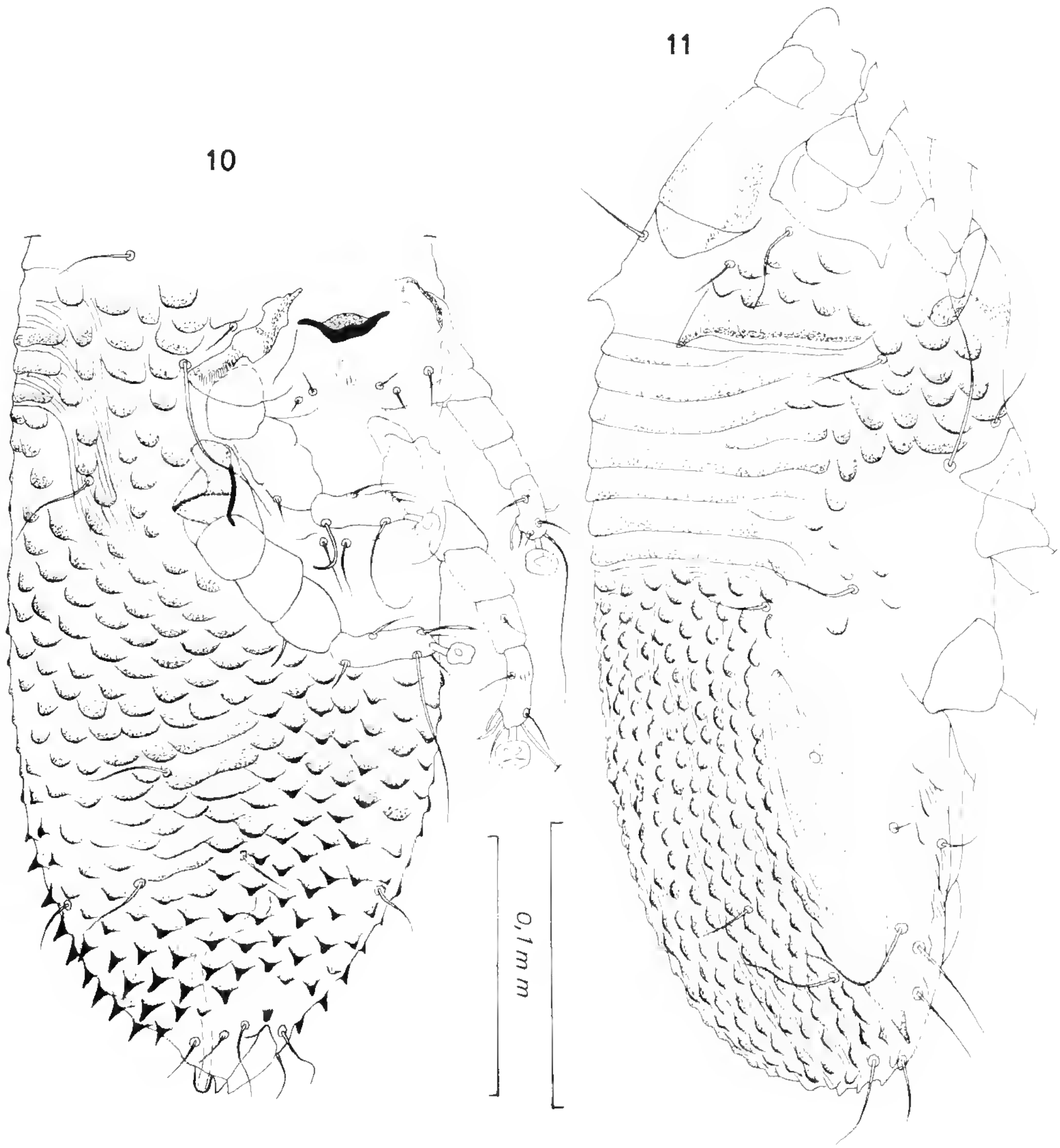
Holotype: female (Figs 10-11) 450 μm x 160 μm. Propodosma as in *D. australis*. Hysteronotum completely covered with scales, small and rounded in anterior half and longer and more pointed in posterior half. Opisthogaster with anterior portion immediately behind *g p* setae finely striated but without scales, behind this area opisthogaster is completely scaly. Copulatory papilla cylindrical, thick, 15 μm long.

Allotype: male (Fig. 11) 375 μm x 150 μm. Propodosoma as in female. Hysterosoma: dorsum covered with small, narrow and rounded scales, except on the sides which bear two triangular shields 140 μm x 30 μm. Anus surrounded by ellopsoidal ring 66 μm long; anal area with two genital discs. Legs III-IV rather strong, IV more inflated than III. Penis curved, short (15-18 μm long).

Material examined and host information

Holotype: WAM 80-326, parasitic on *Phascogale tapoatafa* (Meyer, 1793), collected at Mahogany Creek, Western Australia (31°54'S, 116°08'E), 12 December 1974. Host registration WAM M12506.

Paratypes: collected from the same animal as holotype, WAM 80-327, 80-245 and 80-246: allotype male, four females and four nymphs; FMNH, four females, one male, four nymphs; IMT, four females and one male; DZUN, four females and three nymphs.



Figs 10-11: *Dasyurochirus (Dasyurochirus) tapoatafa* sp. nov. 10—Holotype female; 11—Allotype male.

8 *Dasyurochirus granulipes* sp. nov.

In the female of this new species the opisthosoma bears two lateral shields as in *D. biscutatus* Fain, but these shields are more than twice as long and much wider than in this species.

Holotype: female (Figs **12-13**) 340 μm x 88 μm (in oblique view). Post-scapular shields large and with two dark bands as in *D. biscutatus.* With 7-8 transverse unscaled and relatively wide striations in midline behind post-scapular shields. Anterior part of hysterosoma with small scales only in median region, lateral parts being striated. Opisthosoma with two large lateral shields, 100-110 μm x 35-40 μm. Opisthogaster covered with small scales. Legs III-IV relatively long.

Allotype: male 330 μm x 90 μm (in dorsoventral view). Propodosoma as in female. Hysterosoma: dorsum scaly; on each side with a large shield (90-105 μm x 30 μm) that is punctate and strongly attenuated anteriorly. Anus 45 μm from posterior extremity. With two genital discs inside an ellipsoidal poorly sclerotized ring 45 μm long. Penis thick and short (18 μm long). Legs III-IV strong, slightly unequal, IV slightly thicker than III.

Material examined and host information

Holotype: WAM 80-322, parasitic on *Sminthopsis granulipes* Troughton, 1932, collected at Lake Grace, Western Australia (33°06′S, 118°28′E) 10 March 1973. Host registration WAM 10205.

Paratypes: collected from the same animal, WAM 80-323, 80-298 and 80-249, two males and three females, three nymphs; FMNH, three females, one male and two nymphs; IMT, three females, one male, only nymph; DZUN, three females, one male and eight nymphs.

Genus *Neodasyurochirus* Fain, 1972

Neodasyurochirus squamatus Fain, 1972

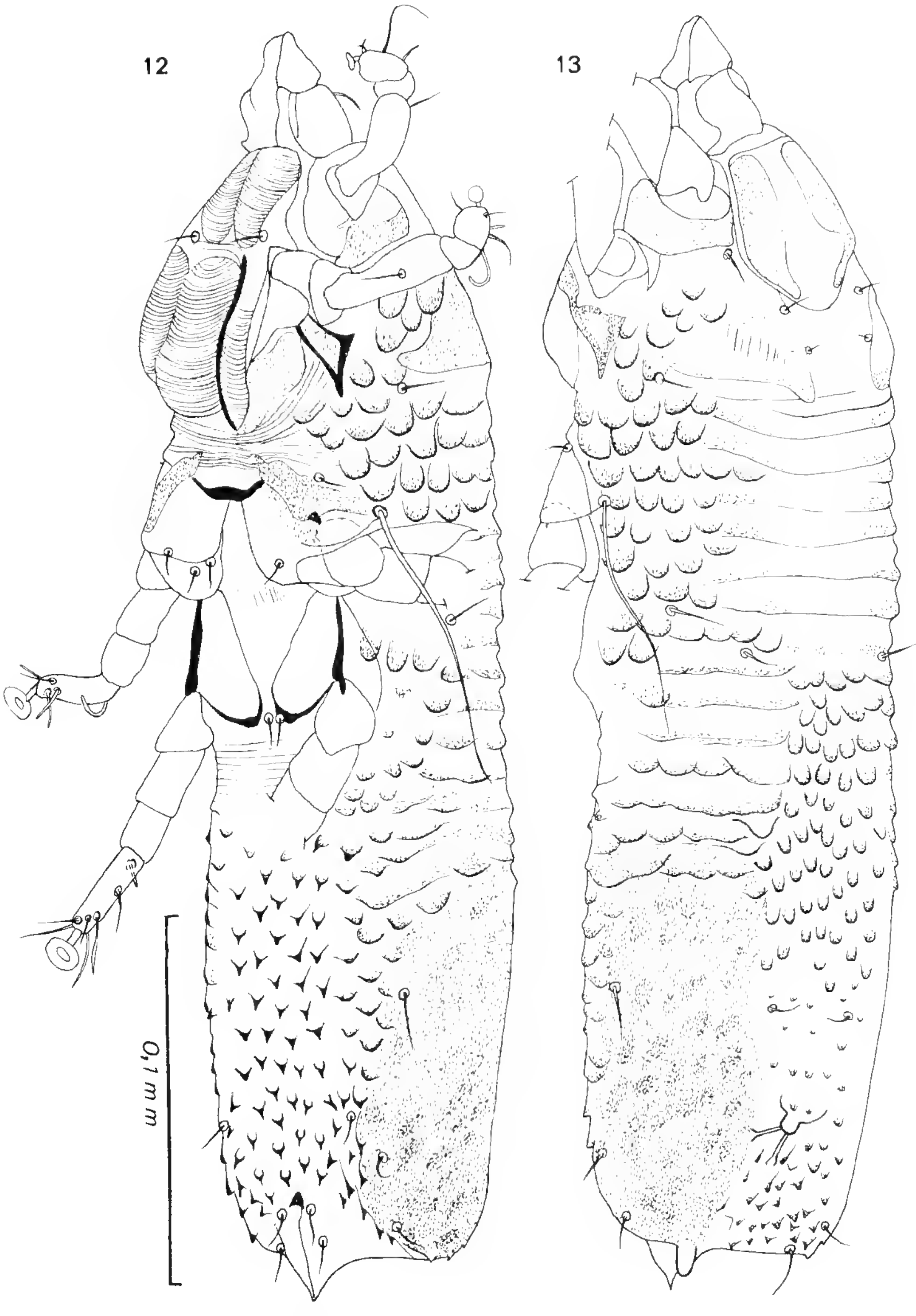
This species was previously known only from the type host, *Antechinus flavipes*, Australia (exact locality unknown).

New specimens were found by F.S.L. on the following hosts:

1 *Antechinus flavipes*, locality unknown (one female and one male). Host in RMNH.

2 *Phascogale swainsoni* Waterhouse, 1840, south-western Australia (one female). Host in MHNP.

3 *Phascogale* sp., Peak Downs, Australia (four females). Host in HM.



Figs 12-13: *Dasyurochirus (Dasyurochirus) granulipes* sp. nov. Holotype female in ventrolateral (12) and dorsolateral (13) view.

Genus *Labidopygus* Fain & Domrow, 1973

This genus was previously known only by the type species *L. australiensis* Fain & Domrow, 1973 described from *Dasyurus maculatus* (Kerr), in New South Wales.

Labidopygus squamatus sp. nov.

Diagnosis

This species is clearly distinguished from the typical species by the presence of numerous scales on the dorsum of the body.

Description

Holotype: male (Figs 14-15) 285 μm x 120 μm (in lateral view). With median prescapular shield. Postscapular shield absent. Cuticle behind prescapular shield scaly except posterior region. Epimera III-IV as in *L. australiensis.* Penis small. Two small but well-formed adanal suckers, flanked by a pair of forward copulatory processes conical and carrying fine transverse ridges directed forward. Posterior legs rather long.

Female unknown.

Material examined and host information

Holotype: MNHR 43F10, parasitic on *Phasćogale swainsoni* Waterhouse, 1840, collected in south-western Australia in 1895. Host registration MHNP 450.

Paratypes: collected from the same

Paratypes: collected from the same animal as holotype, IMT, one male. Paratype from *Phascogale flavipes*, Australia (date unknown) IRSNB, one female.

Genus *Scolonoticus* Fain, 1971

1 *Scolonoticus medius* Fain, 1972

This species was originally described from *Sminthopsis crassicaudata*, Australia.

Recently R. Domrow sent to A.F. a female specimen from *Antechinus stuartii* (Melbourne, 29 August 1972).

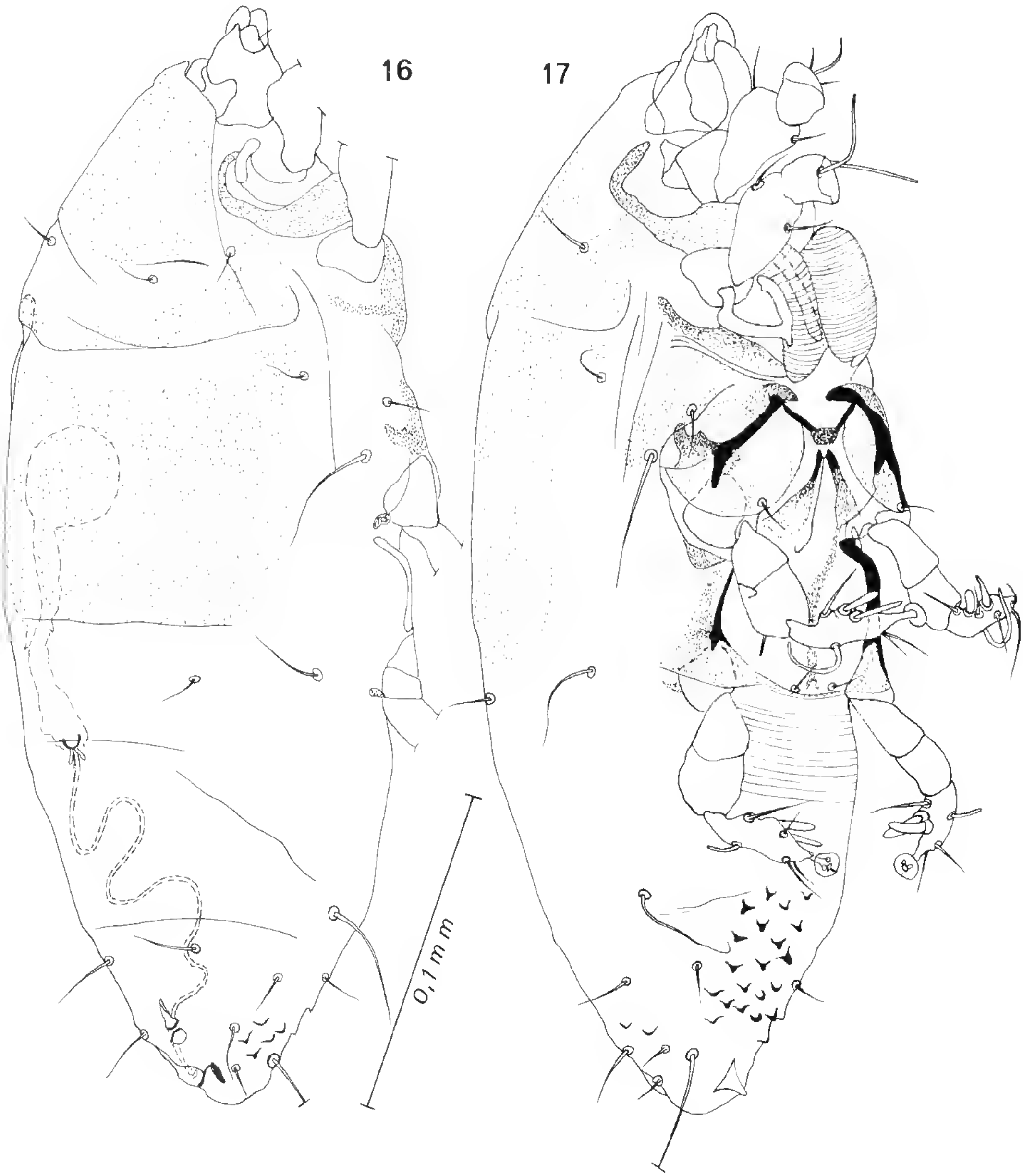
We have also found five female specimens that we attribute to this species, on *Aerobates pygmaeus* collected in Queensland, 11 July 1893. Host registration HM T657.

Figs 14-15: *Labidopygus squamatus* sp. nov. Holotype male, in ventrolateral (14) and dorsolateral (15) view.

2 *Scolonoticus quasinudus* sp. nov.

Diagnosis

This species is characterized by the complete absence of scales on the dorsal surface of the body in both sexes.



Figs 16-17: *Scolonoticus quasinudus* sp. nov. Holotype female, in dorsolateral (16) and ventrolateral (17) view.

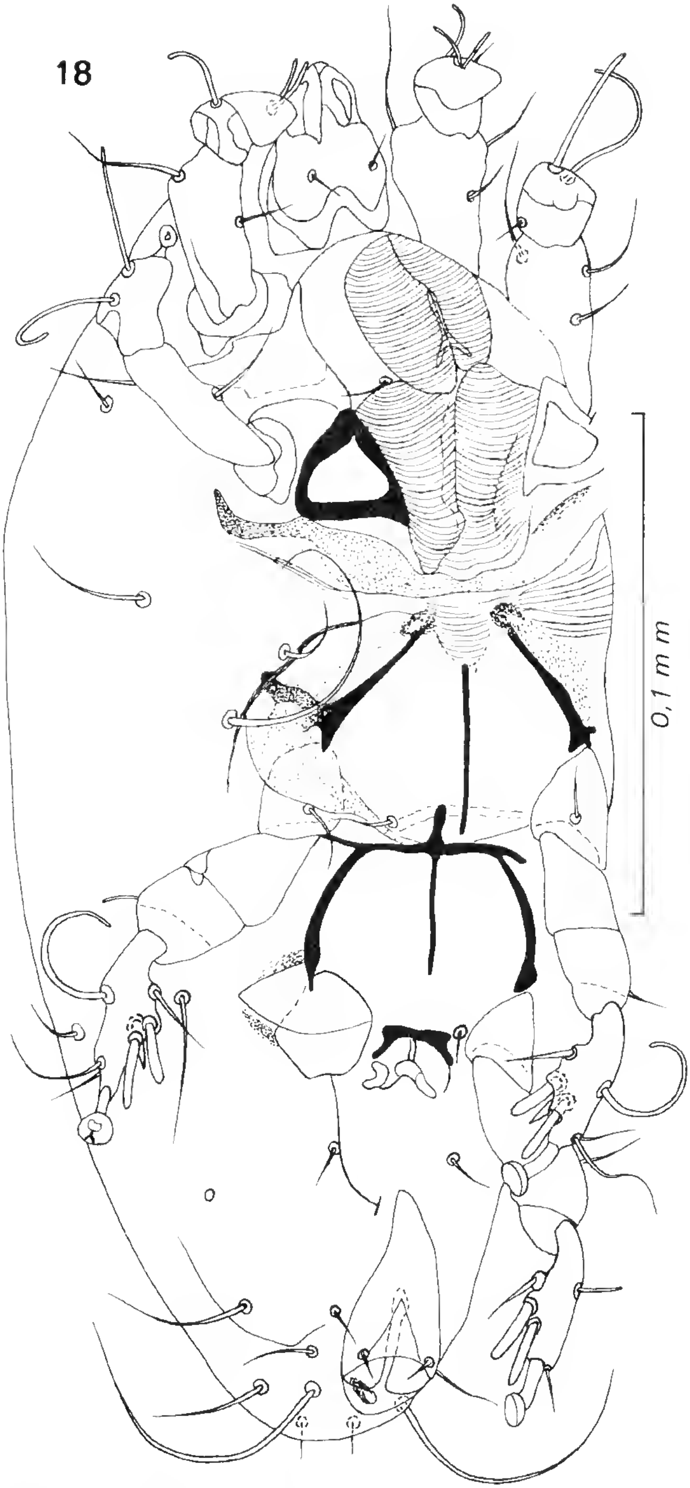


Fig. 18: *Scolonoticus quasinudus* sp. nov. Allotype male.

Description

Holotype: female (Figs 16-17) 332 μm x 126 μm (in lateral view). Dorsal surface covered with poorly sclerotized shields, without any scales. Venter: epimerae united to epigynium by means of punctate band. Opisthosoma bearing a few small scales in its posterior half. Legs III-IV strong; tibio-tarsi with two strong cylindrical setae. Solenidion of tibio-tarsus III at about mid-length of this segment.

Allotype: male (Fig. 18) 270 μm x 120 μm. Dorsum as in female. Venter: penis small, situated between legs IV. Adanal discs absent. Cuticular scales absent. Legs IV slightly thicker than legs III, structure as in female.

Material examined and host information

Holotype: HM A75/78, collected from *Petaurus breviceps* Waterhouse, 1839, collected in 'Australia', 29 November 1913. Host registration HM T663.

Paratypes: from the same animal, HM, three females, one male; IMT, two females; DZUN, two females.

Genus *Petaurobia* Fain, 1971

Petaurobia australiana sp. nov.

Diagnosis

This species is distinguished from *P. papuana* Fain, 1971 and *P. dactylopsila* Fain, 1971 in the female by the reduction of the scales on opisthonotum and opisthogaster, the longer postscapular shield, and from *P. papuana* by the narrower shape of the bursa copulatrix. The male differs from *P. papuana* by the smaller penis.

Description

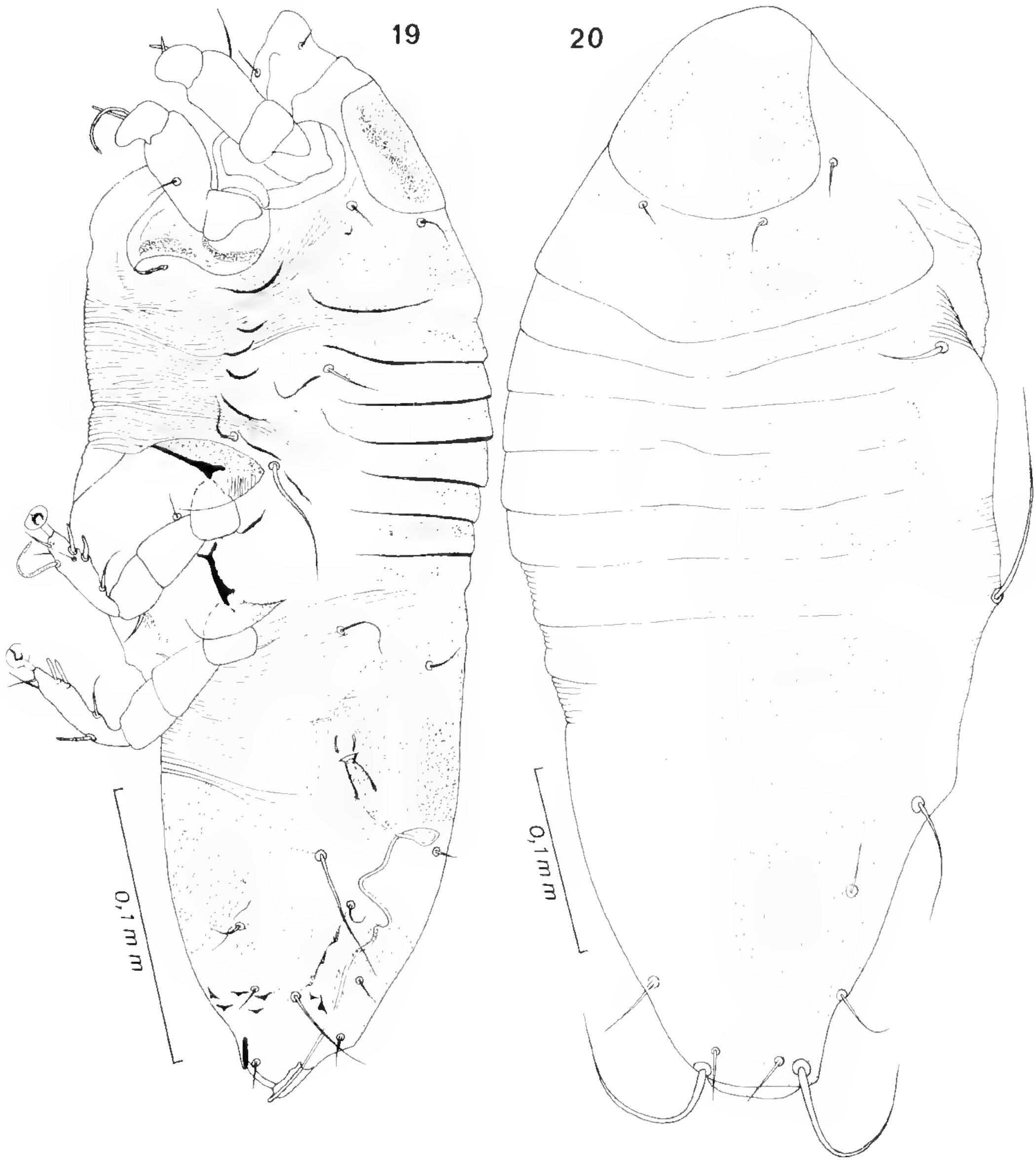
Holotype: female (Fig. 19) 390 μm x 145 μm (one paratype: 350 x 140 μm). Dorsum: propodosomal shield median, entire. Postscapular shield 21 μm long in midline. Seven transverse striations behind this shield. Dorsum punctate behind these striations. Venter: epimerae as in *P. papuana.* Opisthogaster: anterior third finely striated, posterior two-thirds punctate and bearing posteriorly a few very small scales. Bursa very long and narrow. Legs III-IV rather long. Tibio-tarsi III-IV with two cylindrical setae. Solenidion of tibio-tarsus III with solenidion in apical third.

Allotype: male (Figs 20-21) 296 μm x 135 μm. Dorsum as in female. Venter: anterior and posterior legs widely separated. Cuticle between these legs with fine transverse striations. Penis small, between legs IV. Legs IV inflated. Legs III as in female.

Material examined and host information

Holotype: WAM 80-324, parasitic on *Petaurus breviceps*, collected at Kalumburu, Western Australia (14°18'S, 126°38'E), 20 June 1960. Host registration WAM M4218 (coll. Douglas).

Paratypes: from the same animal, WAM 80-325 and 251, two females and two males; FMNH, three females and two males; IMT, two females and two males; DZUN, two females and one male.



Figs 19-20: *Petaurobia australiana* sp. nov. 19—Holotype female in lateral view; 20—Allotype male in dorsal view.

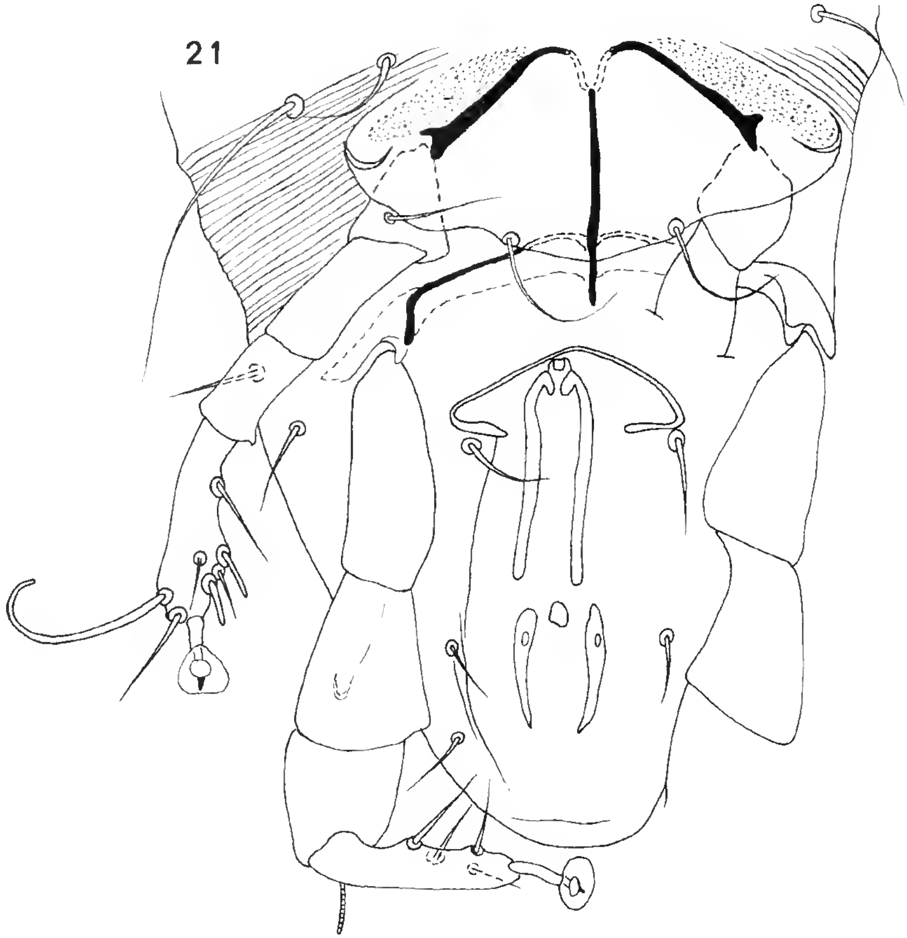


Fig. 21: *Petaurobia australiana* sp. nov. Allotype male, hysterosoma in ventral view.

Genus *Campylochirus* Trouessart, 1893
Subgenus *Campylochiroides* Fain, 1971

1 *Campylochirus (Campylochiroides) petauricola* Fain, 1972

The holotype of this species was described from *Petaurus papuanus*, New Guinea, the allotype female from *Petaurus breviceps*, Gippsland, Australia, but it now appears that the two specimens are not conspecific. Recently, F.S.L. found on *P. papuanus*, Elat Gross Kei, Irian Jaya, males that are identical to the holotype of *C. petauricola* but females that differ distinctly from the allotype described from *P. breviceps*. These females are now described here the true female of *C. petauricola*. Moreover, from *P. breviceps*, Wandandian, New South Wales, we collected females identical to the allotype of *C. petauricola* which do not correspond with the holotype of this species. These, in turn, are described herein.

Description

Female (Figs 22-23): body 340 μm x 105 μm (in lateral view). Dorsum: two pairs of propodosomal shields clearly separated in midline. Behind these shields are two other long punctate shields. Posterior part of dorsum with a few small rounded scales. Internal sclerite of bursa thin, without hair-like formations and without pair of small rounded sclerites. Copulatory orifice 25 μm from posterior extremity. Venter: posterior half of opisthogaster with small rounded scales. Legs III-IV subequal, reaching about to mid-length of opisthosoma.

Male: described by Fain (1972).

2 *Campylochirus (Campylochiroides) brevicepsicola* sp. nov.
Campylochirus (Campylochiroides) petauricola Fain, 1972: 131 (in part)

Diagnosis

This species is distinguished from *C. petauricola* by two characters: (1) the shape of the internal sclerite of the bursa which is wide, with several hair-like formations apically and two very small globulose sclerites basally; (2) the greater number of scales on the posterior part of opisthonotum.

Description

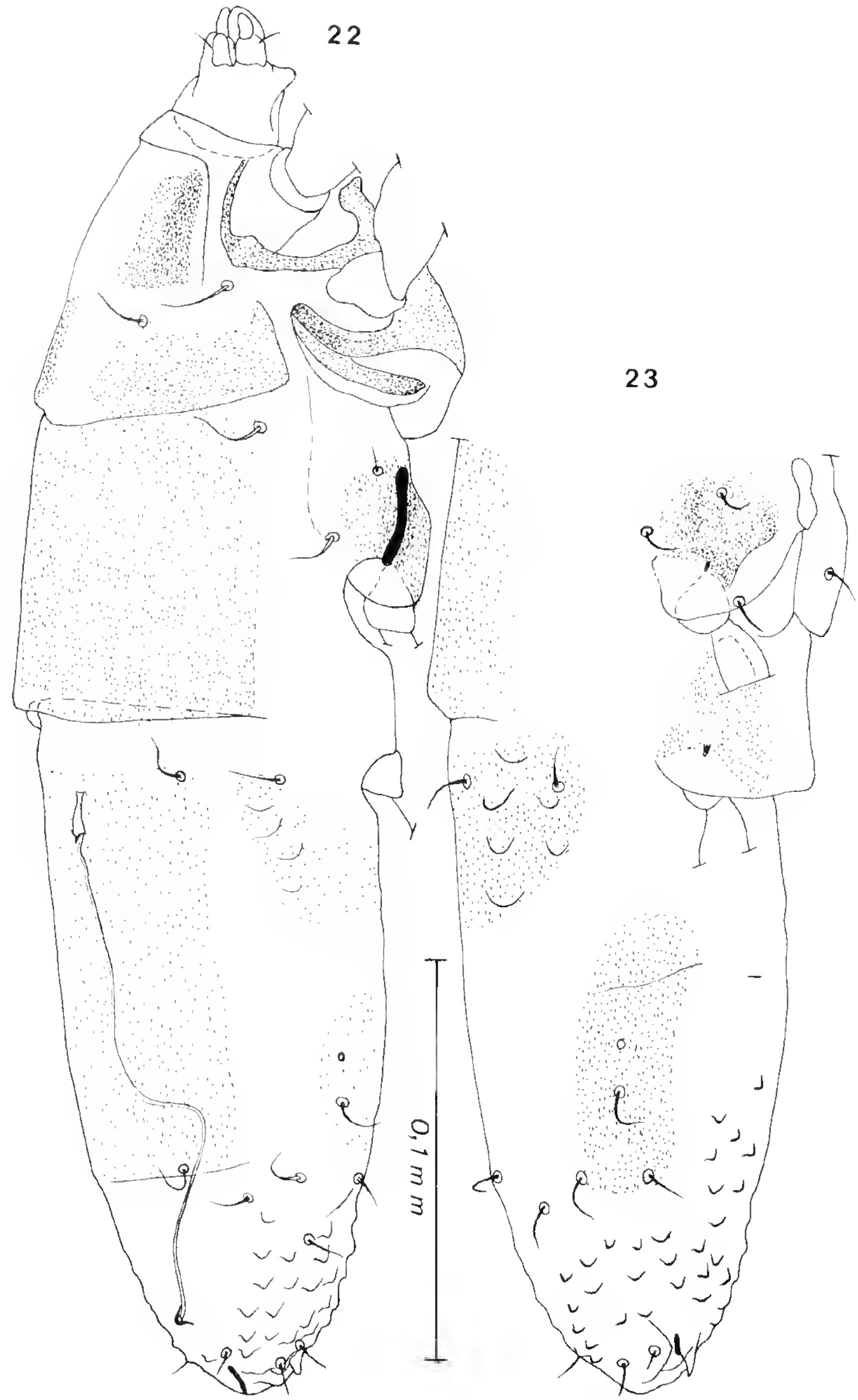
Holotype: male (Figs 24-25) 300 μm x 114 μm (in ventral view). Dorsum as in *C. petauricola.* Venter: propodosoma, epimerae III and coxae III as in *C. petauricola.* Opisthosoma rounded posteriorly, without membranes. Penis very progressively attenuated and about 90 μm long. Anus flanked by two adanal organs. Legs IV strongly inflated. Tarsi IV slightly reduced, ending in a sucker, smaller than that on tarsi III.

Allotype: female 366 μm x 111 μm (in ventral view) (see Fain, 1972).

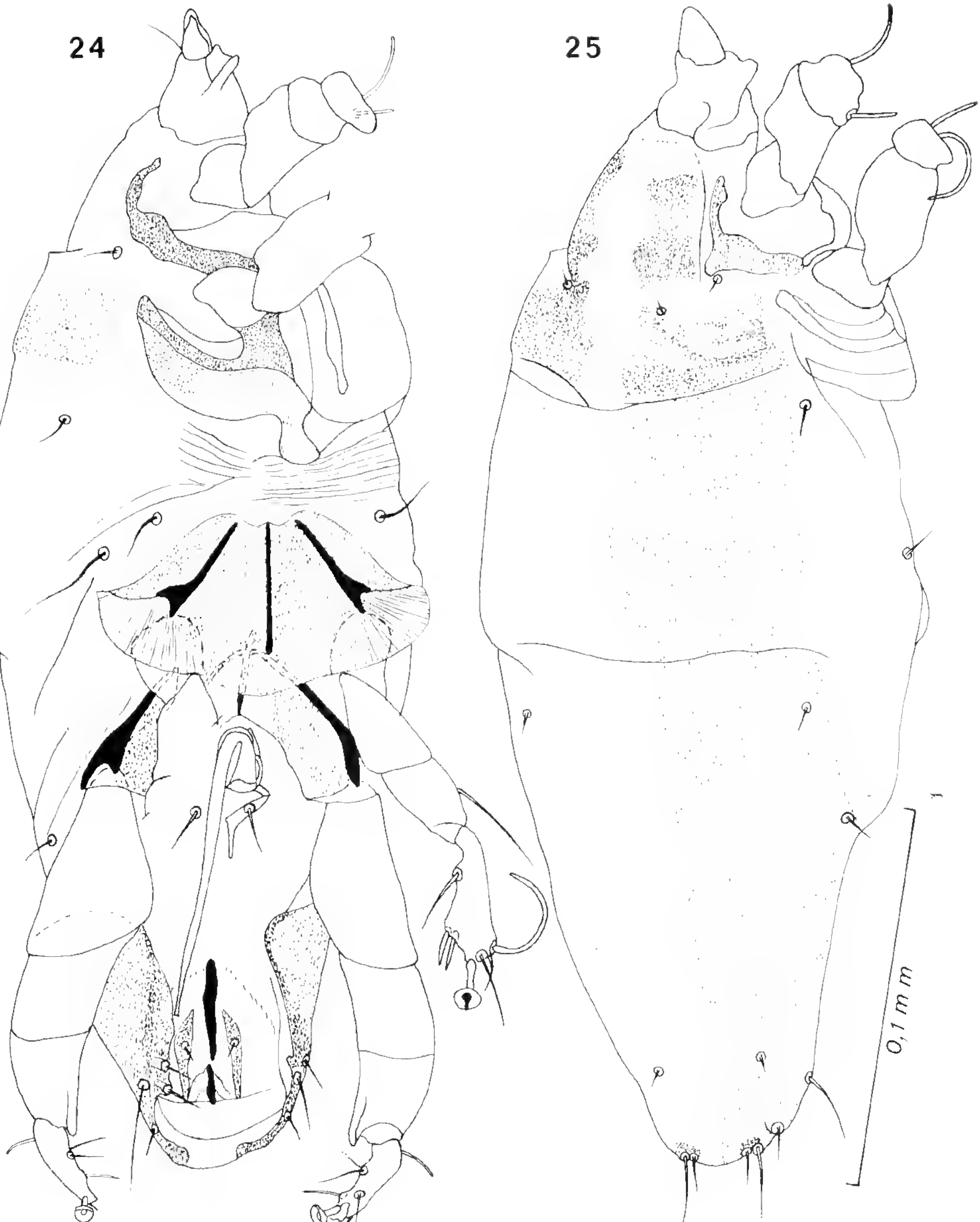
Material examined and host information

Holotype: USNM 3937, collected from *Petaurus breviceps*, at Wandandian. New South Wales, 17 June 1919. Host registration USNM 221.327.

Paratypes: from the same animal as holotype, USNM, 20 males, nine females, five nymphs; IMT, 10 males, four females, two nymphs; DZUN, 10 males, four females and two nymphs.



Figs 22-23: *Campylochirus (Campylochiroides) petauricola* Fain. Female in dorsal (22) and ventral (23) view (both figures after a specimen from *Petaurus papuana*, Elat Gross Kei, New Guinea).



Figs 24-25: *Campylochirus (Campylochiroides) brevicepsicola* sp. nov. Holotype male in ventral (24) and dorsal (25) view.

Genus *Cytostethum* Domrow, 1956
Subgenus *Metacytostethum* Fain, 1971

Cytostethum (Metacytostethum) tasmaniense Fain & Domrow, 1974

This species was described from *Bettongia gaimardi cuniculus* (Ogilby), Tasmania.

We attribute to this species a poorly sclerotized male, two males still in their nymphal skin, and nine nymphs all from *Bettongia penicillata*, Busselton, Western Australia, 26 May 1920. Host registration USNM 237902.

Genus *Notoryctobia* gen. nov.

Definition

This genus differs from all other atopomelid genera in both sexes by the pseudosegmentation of tibio-tarsi III and IV, which present a median annular constriction forming a pseudoarticulation. Only one rather large well-sclerotized, median prescapular shield present. Female with hysteronotum and opisthogaster scaly without shields. Male with hysteronotum scaly, with a pair of lateral longitudinal shields on the opisthosoma; with a pair of very small but apparently normally formed adanal suckers.

Type species: *Notoryctobia notoryctes* sp. nov.

Evolution of the genus *Notoryctobia*

This genus presents a mixture of primitive and evolved (regressive) characters, but the former seem more important than the latter. As primitive characters we list: (1) the structure of the tibio-tarsi III and IV which are incompletely fused; (2) the great development and the median situation of the prescapular shield; (3) the rather great development of the chaetotaxy; and (4) the basal situation of the solenidion of tibio-tarsi III-IV. As evolved characters we note the absence of postscapular and hysterosomal shields in the female.

Notoryctobia notoryctes sp. nov.

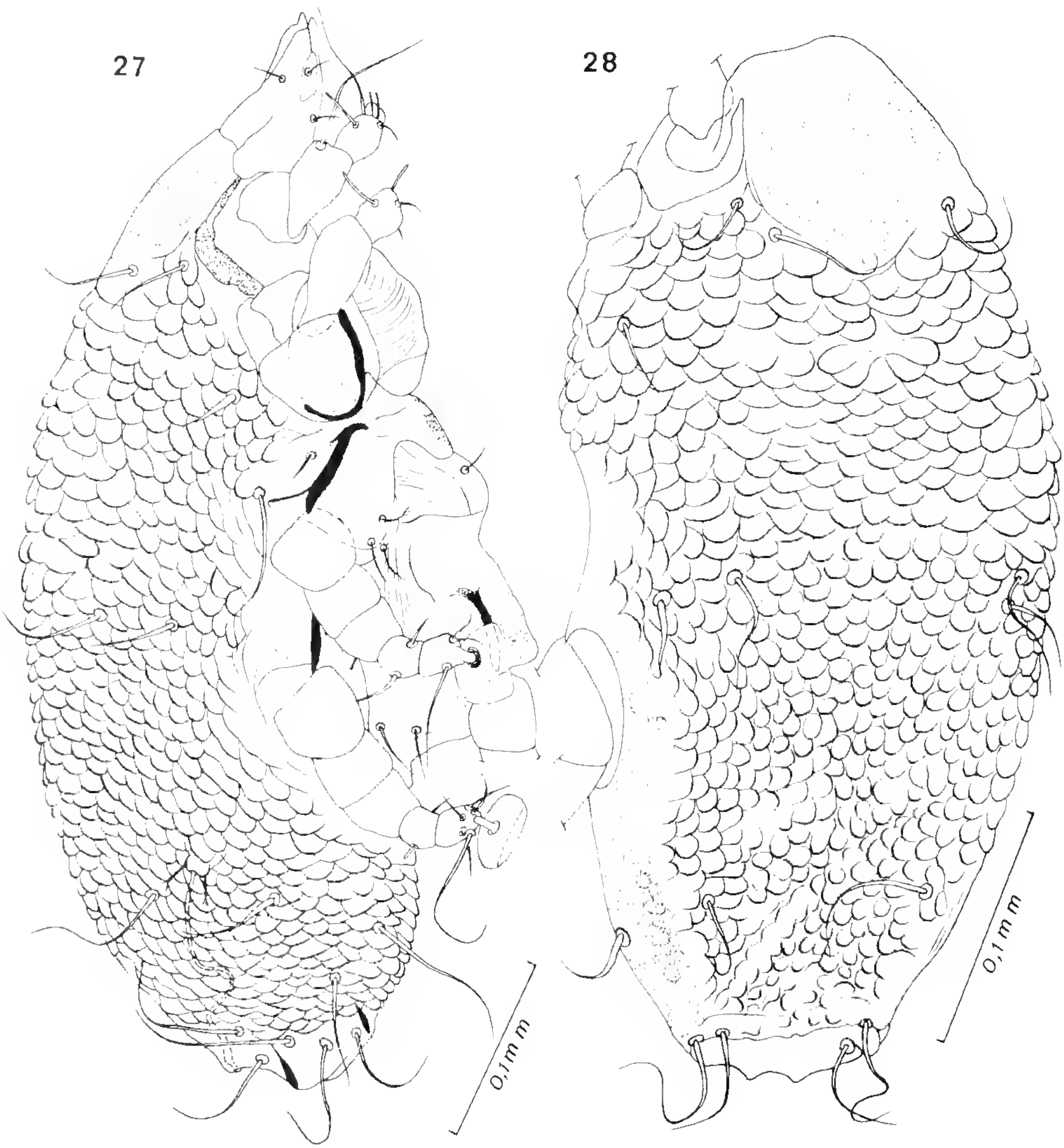
Description

Holotype: male (Figs 26, 28) 480 μm x 192 μm (ventral view). Posterior extremity truncate. Dorsum: completely squamous except for punctate median shield anteriorly and elongate punctate shields postero-laterally. Venter: epimera III and IV fused in midline. Anus flanked by a pair of small suckers. Genital organ short and thick, strongly sclerotized. Legs IV much stronger than III. Solenidion of leg III situated on basal half of tibio-tarsus.

Fig. 26: *Notoryctobia notoryctes* sp. nov. Holotype male.

All legs ending in sucker, those on posterior legs very large. Gnathosoma strongly attenuated at front.

Allotype: female (Fig. 27) 560 μm x 245 μm. Dorsum as in male. No opisthosomal lateral shields. Venter: opisthogaster covered with rounded scales. Posterior legs well developed, tibio-tarsi and apical suckers as in the male. Bursa opening at 30-40 μm behind the anus. Chaetotaxy: idiosoma enlarged basally, with setae 40-100 μm long.



Figs 27-28: *Notoryctobia notoryctes* sp. nov. 27—Allotype female; 28—Holotype male (in lateral view).

Material examined and host information

Holotype: WAM 80-332, parasitic on *Notoryctes typhlops* (Stirling, 1889), collected at Warburton Range, Western Australia (26°06'S, 126°40'E), in 1968. Host registration WAM 7711 (coll. T. Carr).

Paratypes: from the same animal as holotype, WAM 80-257 and 80-258, one male, one female, three nymphs; FMNH, two males, one female, three nymphs; IMT, two males, one female, two nymphs; DZUN, one male, one female, three nymphs. Paratypes from the same host, from South Australia, 20 October 1968: HM, two females; host registration HM 815. From the same host, in Charlotte Waters, Central Australia; BM, one female 1980.5.20.3, one male 1980.5.20.4. Host registration BM 97.11.3.13.

Genus *Murichirus* Fain, 1971

The genus *Murichirus* is now represented by 16 species, of which 12 are endemic to New Guinea, three to Australia and one to both areas. It is found on both murid rodents (13 species) and marsupials (three species), and is divided into two subgenera: *Murichirus* Fain, 1971 and *Murichiroides* Fain, 1971.

1 *Murichirus (Murichirus) petaurus* sp. nov.

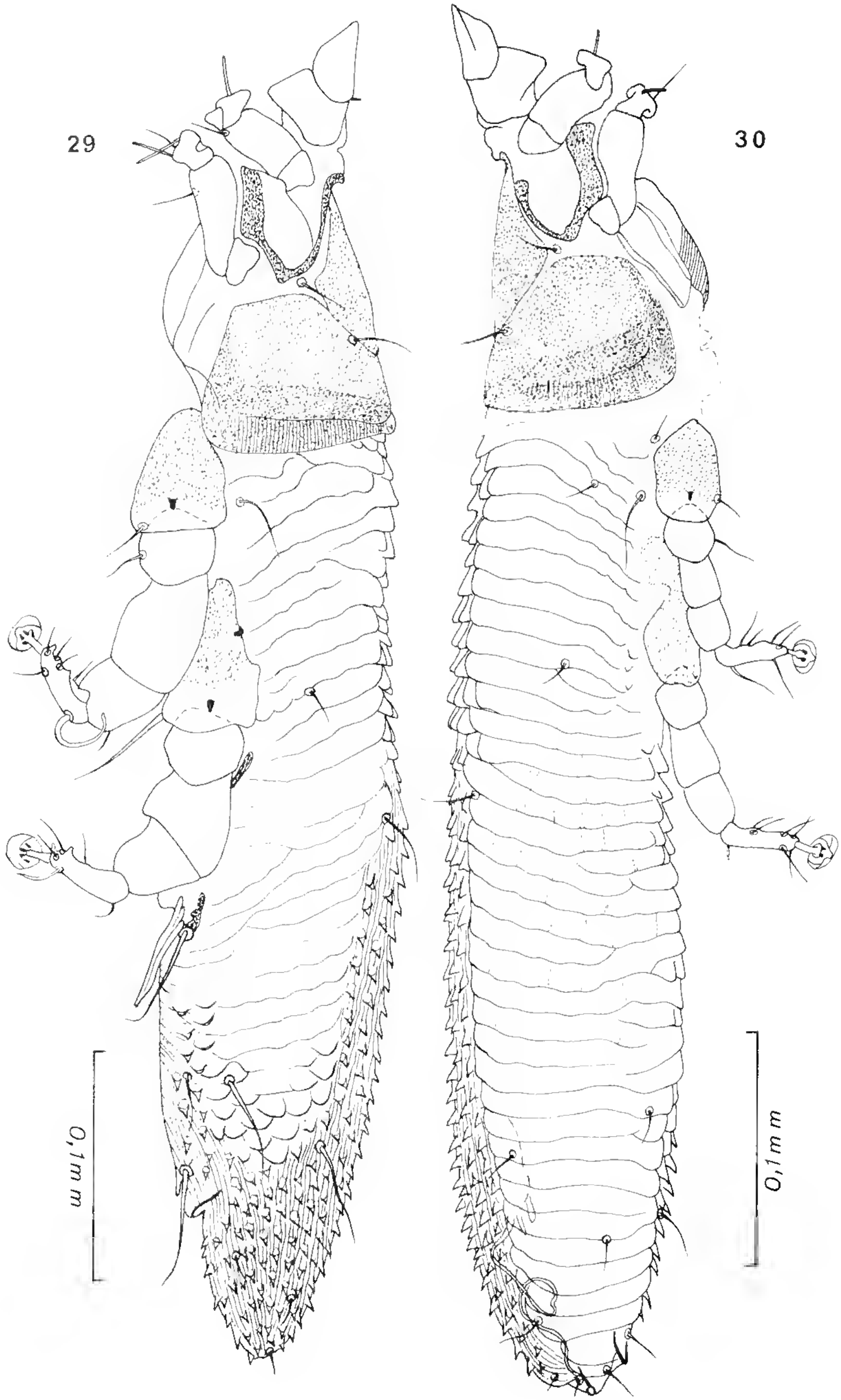
This new species is characterized in both sexes by the absence of a shield in the anterior part of the hysteronotum and the presence of numerous scales on the hysterosoma, mainly on the opisthonotum. In the male the penis is close to coxae IV.

Holotype: male (**Fig. 29**) body 570 μm x 100 μm (in lateral view). Pre- and postscapular shields strongly sclerotized. Hysterosoma: anterior part striated laterally and scaly in midline, opisthosoma with anterior half striated laterally, are scaly elsewhere. Penis strong, situated near coxae IV and strongly sclerotized. Anus ventral, situated in posterior third of opisthogaster. Legs III-IV stout, legs IV slightly thicker than III.

Allotype: female (**Fig. 30**) body 605 μm x 105 μm. Dorsal shields as in male. Hysterosoma with lateral surfaces striated, dorsal and ventral parts scaly. Bursa rather long and twisted. Copulatory orifice immediately behind anus, which is large and subterminal (ventral). Legs relatively short, IV not reaching mid-length of opisthosoma.

Material examined and host information

Holotype: USNM 3938, parasitic on *Petaurus breviceps*, collected at Wandandian, New South Wales, 17 June 1919. Host registration USNM 221.327 (coll. C.M. Hoy).



Figs 29-30: *Murichirus petaurus* sp. nov. 29—Holotype male; 30—Allotype female, in lateral view.

Paratypes: from the same animal, USNM, one female, one nymph; IMT, one female.

2 *Murichirus (Murichirus) notomys* Fain, 1971

We attribute to this species one male and one female found on *Cercartetus concinnus* Gould, 1845, Israelite Bay, Western Australia (33°37'S, 123°53'E), 31 May 1968. Host registration WAM 8668.

As the type host of this species is a murid rodent, its presence on a marsupial was probably accidental.

Genus *Listrophoroides* Hirst, 1923
Subgenus *Marquesania* Womersley, 1943

Listrophoroides (Marquesania) queenslandicus Womersley, 1943

The type series of this species was described from murid rodents (including *Rattus youngi*).

Domrow (1958) recorded it from several Australian murids and Fain (1972) on a marsupial, *Phascogale unicolor*, in New South Wales. F.S.L. found five males and three females on a marsupial *Cercartetus concinnus*, from Israelite Bay, Western Australia (33°37'S, 123°53'E), 31 May 1968. Host registration WAM 8668.

It appears from these findings that this species is able to live on both murids and marsupials unless its presence on museum specimens was accidental.

ACKNOWLEDGEMENTS

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PARASITES OF WESTERN AUSTRALIA XII ATOPOMELIDAE PARASITIC ON RODENTS (ACARI: LISTROPHOROIDEA)

A. FAIN*

&

F.S. LUKOSCHUS†

ABSTRACT

Eleven named species of atopomelid fur-mites belonging to three genera (including *Teinochirus* gen. nov.), are recorded from Western Australian rodents. These are: *Murichirus quasimelomys* sp. nov., *M. alatus* sp. nov., *M. alatus prosquamatus* subsp. nov., *M. dorsostriatus* sp. nov., *M. dorsoscutatus* sp. nov., *M. lobatitarsis* sp. nov., *M. zyzomys* sp. nov., *M. mastacomys* sp. nov., *Teinochirus vermicularis* sp. nov., *Listrophoroides (Marquesania) queenslandicus* Womersley and *L. (M.) papuanus* Fain.

INTRODUCTION

Only two genera of Atopomelidae were previously known from Australian rodents: *Listrophoroides* Hirst, 1923 and *Murichirus* Fain, 1971. Each of these genera were represented by two species: *Listrophoroides queenslandicus* (Womersley, 1943), *L. papuanus* Fain, 1970, *Murichirus enoplus* (Domrow, 1956) and *M. notomys* Fain, 1971.

In the present paper we describe a new genus, *Teinochirus*, represented by a new species *T. vermicularis*, and seven new species of the genus *Murichirus*, all from murid rodents from Australia.

Length of the body includes the gnathosoma, the width is the maximum width of the body.

Abbreviations utilized for the institutions: BM (British Museum, Natural History, London); DZUN (Department of Zoology, University of Nijmegen, The Netherlands); FMNH (Field Museum, Natural History, Chicago); IMT

* Institute of Tropical Medicine, Antwerp, Belgium.
† Catholic University of Nijmegen, The Netherlands.

(Institute of Tropical Medicine, Antwerp); RMNH (Rijksmuseum Natural History, Leiden, The Netherlands); USNM (United States National Museum, Washington D.C.); WAM (Western Australian Museum, Perth).

SYSTEMATICS

Family Atopomelidae Gunther, 1942
Genus *Murichirus* Fain, 1971

If we include the new species described herein, *Murichirus* contains 23 species of which 12 are endemic to New Guinea, 10 are endemic to Australia and one is present in both areas. This genus is represented both on murid rodents (by 20 species) and marsupials (by three species). It is divided into two subgenera: *Murichirus* Fain, 1971 and *Murichiroides* Fain, 1971.

Key to the Males of Genus *Murichirus (Murichirus)*

(Partly after Fain, 1977)

(N.B. The males of *M. longior* and *M. ornatus* are unknown)

1 Posterior part of opisthonotum with numerous erect scales 2

Posterior part of opisthonotum without erect scales (in some species, striations in this region are sinuous) 3

2 Anterior region of hysteronotum with a punctate shield. Penis short, situated close to posterior extremity of body . . . . *M. moschati* (Domrow, 1961)

Anterior region of hysteronotum soft, without shield. Penis longer, situated close to coxae IV . . . . *M. petaurus* Fain & Lukoschus (in press)

3 Posterolateral corners of postscapular shield with a triangular flat process directed posteriorly 4

Posterolateral corners of postscapular shield rounded without a posterior process 5

4 Coxae II with large, membranous, posterior processes. About 15-20 μm thick and rounded scales close together in middle part of hysteronotum. Posterolateral process of postscapular shield long and slightly curved . . . . *M. alatus* sp. nov.

Coxae II without posterior processes. Hysteronotum striate, without scales or shields. Posterolateral process of postscapular shield short and straight . . . . *M. dorsostriatus* sp. nov.

5 Body 756 μm long. Coxa III tapering posterolaterally into a narrow, straight process. Nearly all dorsal striations strongly oblique or longitudinal . . . . *M. maximus* Fain, 1975

Body not longer than 480 μm. Coxa III of different shape. Dorsal straitions mainly transverse 6

6 Coxa II prolonged posteriorly into a long (40-45 μm) and thick sclerotized cylindrical process. Hysterosoma soft, striate, without shields. Coxa III without a flat posterolateral process . . . . *M. zyzomys* sp. nov.

Coxa II without process, other characters variable 7

7 Coxa III prolonged posterolaterally into a flat, slightly striate, curved, crescentic process 8

Coxa III either without process or with a short posterolateral, uncurved process 13

8 Opisthogaster striate, without scales. Ventral surface of femur IV with two small toothlike processes; ventral surface of genu IV with a small, apical toothlike process . . . . *M. simplex* Fain, 1977

Opisthogaster striate with several well-developed scales. Ventral processes of femur and genu IV variable 9

9 Ventral surface of femur IV with two stout processes: one subbasal, triangular in shape and directed perpendicularly to segment, the other apical and parallel to segment . . . . *M. leopoldi* Fain, 1974

Ventral surface of femur IV either with one apical process or with two apical and a third small, rounded basal process 10

10 Femur IV with three ventral processes: one apical, long narrow and strongly pointed; one preapical, small and toothlike; one basal small

and rounded. Genu IV without process. Opisthonotum completely striate. Penis flanked by two punctate longitudinal lines . . . . *M. coxatus* Fain, 1977

Femur IV with only one ventroapical, either rounded, truncate or bifid process. Genu IV with one apicoventral pointed process. Opisthonotum not striated in the midline. Penis variable 11

11 Crescentic process of coxa III broad. Ventral process of femur IV broad. Without an inverted Y sclerite in front of penis. Metapodonotal shield partly or completely striate. Body 360-430 μm long 12

Crescentic process of coxa III small. Ventral process of femur IV smaller and rounded. With an inverted Y sclerite in front of penis. Metapodonotal shield not striate. Body 320-340 μm long . . . . *M. pogonomys* Fain, 1972

12 Ventral process of femur IV truncate . . . . *M. melomys* Fain, 1972

Ventral process of femur IV bifid . . . . *M. quasimelomys* sp. nov.

13 Penis cylindrical, very long (225 μm) . . . . *M. scorteus* Fain, 1972

Penis small, 2-3 times longer than wide 14

14 Opisthonotum completely punctate, non-striate. Penis conical . . . . *M. dorsoscutatus* sp. nov.

Opisthonotum striate, either punctate or soft. Penis variable 15

15 Tibiotarsus IV with a ventral bifid lobe. Femur IV with a small apical process. Genu IV with a long ventroapical process. Penis wide at its base and abruptly narrowed near apex, surrounded by a large and thick U-shaped sclerite. Hysteronotum strongly punctate laterally with sinuous striations. Body 556 μm long . . . . *M. lobatitarsis* sp. nov.

Without bifid lobe on ventral surface of tibiotarsus IV. Femur, genu IV and penis variable. Hysteronotal striations not sinuous. Body 330-480 μm long 16

16 Penis bifid apically, surrounded by a U-shaped sclerite. Striate posterior margin of postscapular shield very narrow. Striations of metapodonotum

directed obliquely. Without ventral processes on genu and femur IV .... *M. notomys* Fain, 1971

Penis not bifid apically, may or may not be surrounded by a U-shaped sclerite. Striate posterior margin of postscapular shield wider. Striations of metapodonotum directed transversely. With toothlike processes on genu or femur IV 17

17 Body 320-330 μm long, strongly sclerotized. Setae *a 3* and *ℓ 5* shorter than penis .... *M. coriaceus* Fain, 1974

Body 450-470 μm long, less sclerotized; hysteronotum bearing only transverse punctate bands. Setae *a 3* and *ℓ 5* longer than penis 18

18 Setae *d 4*, *ℓ 3*, *ℓ 5* and *a 3* about 75 μm long. Setae *a e* very thin and shorter (15 μm) than *a i*. Penis 21 μm long, conical with a pointed apex, surrounded by a U-shaped sclerite. Postscapular shields widely fused in the midline ... *M. mastacomys* sp. nov.

Setae *d 4*, *ℓ 3*, *ℓ 5* and *a 3* shorter. Setae *a e* longer and stronger than *a i*. Penis 14 μm long, with rounded apex, and flanked by two sclerotized curved bands. Postscapular shields contiguous in the midline .... *M. enoplus* (Domrow, 1956)

1 *Murichirus (Murichirus) melomys* Fain, 1972

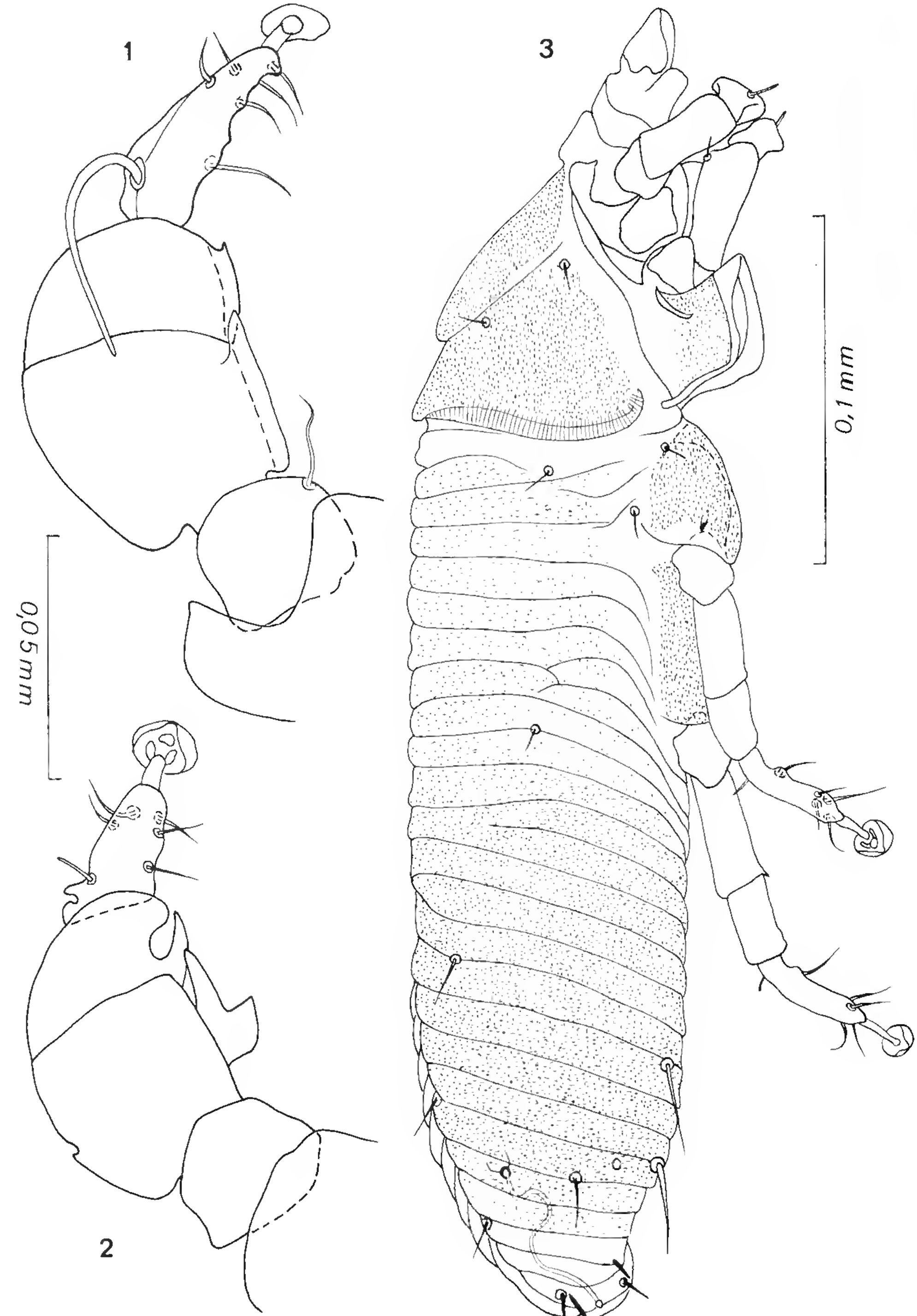
Material examined and host information

WAM: one female parasitic on rat *Melomys* sp. collected at Port Warrender (14°30'S, 125°50'E), 30 October 1976 (Kimberley Expedition). Host registration 3141. RMNH: three males and three nymphs on *Uromys brunyii* Peters & Doria, collected at Kapa Kapa, New Guinea. Host registration RMNH 1901.

2 *Murichirus (Murichirus) quasimelomys* sp. nov.

Description

This new species is close to *M. melomys* Fain. It is distinguished from this species in the female by the smaller length of the setae *a 3* and *ℓ 3* and the shorter length of the bursa. The male differs from that of *M. melomys* by the different shape of the ventral process of the femur IV.



Figs 1-3: *Murichirus (Murichirus) quasimelomys* sp. nov. 1-2—Holotype male, legs III (1) and IV (2). Fig. 3: Paratype female.

Holotype: male (Figs 1-2) 375 μm long and 117 μm wide (in lateral view). Posterior shield with a striated border. Coxa III with a large curved and striated flat process. Opisthonotum striated, slightly punctate. Opisthosoma 90 μm long. Legs III-IV strongly inflated. Femur IV with a large bifid ventral process, genu IV with a pointed process. Tibiotarsus IV distinctly shorter than tibiotarsus III. Chaetotaxy of opisthosoma well developed, setae up to 60 μm long.

Allotype: female (Fig. 3) 360 μm long and 96 μm wide (in oblique view). Hysteronotum well sclerotized, especially in its posterior half. Bursa 65-70 μm long. Setae *a 3* and *ℓ 3* 21-25 μm long. Copulatory pore situated laterally to anus, closer to dorsum than to venter.

Material examined and host information

Holotype: WAM 80-328, parasitic on rat *Melomys* sp., collected at Port Warrender, Western Australia (14°30′S, 125°50′E), 30 October 1976 (Kimberley Expedition). Host registration 3140.

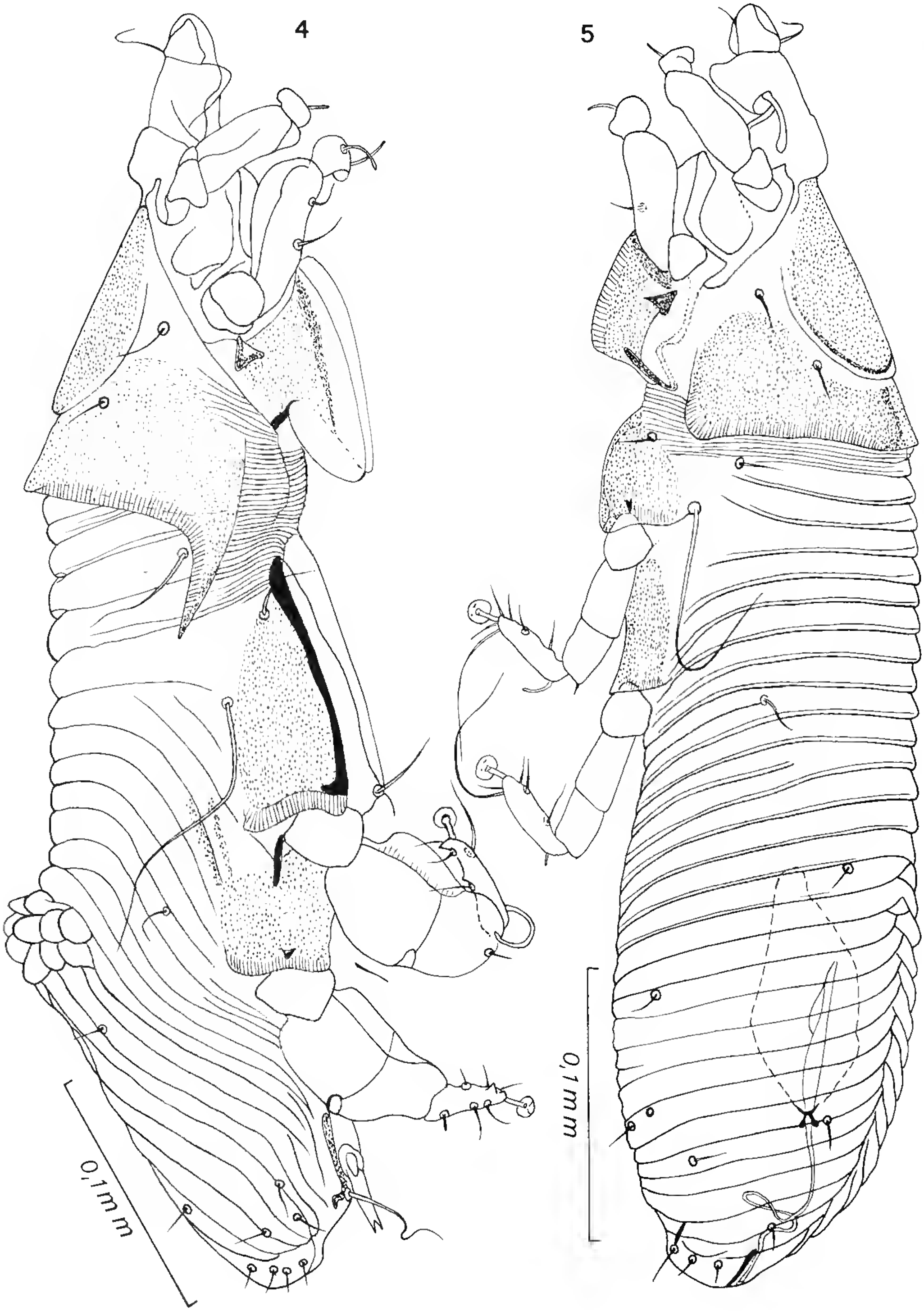
Paratypes: from the same species of rat FMNH 3141; WAM 80-329, one male, allotype and three females; WAM 80-193, two nymphs; FMNH, one male, four females; IMT, one male, three females; DZUN, one male, three females; USNM, five males and five females parasitic on *Melomys cervinipes* (Gould, 1852), collected at Atherton Tableland, Queensland (approximately 17°16′S, 145°29′E), August 1921; animal in USNM.

3 *Murichirus (Murichirus) alatus* sp. nov.

Description

Holotype: male (Fig. 4) 510 μm long and 135 μm wide (in lateral view). Measurements in two male paratypes: 490 μm x 135 μm and 495 μm x 130 μm. Postscapular shield with long (45 μm) posterolateral prolongation slightly curved dorsally and strongly tapering apically. Hysteronotum soft, mostly obliquely striated except in its middle part where there is a group of approximately 20 thick and rounded scales. This group of scales is situated between coxae III and IV and is separated from the postscapular shield by about 13-14 thick striations. Coxa II with a well-developed, rounded membranous posterior process. Coxae III separated in the midline by a deep groove 105 μm long. Penis bifid. Legs III-IV strongly inflated. Postero-lateral process on coxa III absent.

Allotype: female (Fig. 5) 453 μm long and 115 μm wide (in lateral view). Prescapular and postscapular shields separated. Opisthonotum and opisthogaster poorly sclerotized and striated transversely. Coxae II and III without processes. Legs III-IV well developed, the femora 1-5 times longer than the



Figs 4-5: *Murichirus (Murichirus) alatus* sp. nov. 4—Holotype male. 5—Allotype female.

respective genua. Chaetotaxy of the idiosoma very thin and short. Copulatory pore situated immediately above the anus.

Material examined and host information

Holotype: WAM 80-346, parasitic on rat *Notomys alexis* Thomas, 1922; collected at Wanjarri Reserve, Western Australia (27°24′S, 120°39′E), 8 January 1975. Host registration WAM M12964 (Coll. P. Lambert).

Paratypes: WAM 80-262 to 265 and 80-347, five males and eight females; FMNH, four males, seven females; IMT, four males and seven females; DZUN, four males, seven females, collected from the same animal as holotype.

Murichirus (Murichirus) alatus prosquamatus subsp. nov.

Description

This subspecies differs from the typical form in the male by the following characters: dorsal scales smaller, more numerous (about 30), wider than long and situated closer to the posterior margin of the postscapular shield. This group of scales is situated at the level of coxa III and is separated from the postscapular shield by only nine thick striations.

Holotype: male 448 μm long and 125 μm wide (in lateral view) (Fig. 6).

Allotype: female 420 μm long and 96 μm wide. Except for the smaller size of the body the female is not separable from that of the typical form.

Material examined and host information

Holotype: WAM 80-330, parasitic on rat *Pseudomys hermannsburgensis* (Waite, 1896), collected at Disappointed Hill, Western Australia (28°03′S, 125°02′E), 12 March 1975. Host registration WAM M13280 (Coll. A.A. Burbidge).

Paratypes: collected from the same animal WAM 80-331 and 260, allotype two females and two nymphs; FMNH, one male, two females, two nymphs; IMT, two females, one nymph; DZUN, two females, one nymph.

4 *Murichirus (Murichirus) dorsostriatus* sp. nov.

Description

This species presents, as in *M. alatus*, a membranous pointed prolongation on the lateral corners of the postscapular shield. It differs from this species by the much smaller length of this prolongation and by the absence of scales on the dorsum of the male. The female is unknown.

Figs 6-7: 6—*Murichirus (Murichirus) alatus prosquamatus* spp. nov. Holotype male. 7—*Murichirus (Murichirus) dorsostriatus* sp. nov. Holotype male.

Holotype: male (Fig. 7) 465 μm long and 118 μm wide (in lateral view). Postero-lateral prolongation of postscapular shield 30 μm long. Hysteronotum soft, striated, without scales or shields. Opisthosoma 135 μm long, with striations obliquely directed. Coxal groove III 75 μm long. Penis conical, short, apparently bifid apically and surrounded by a U-shaped sclerite. Legs III-IV inflated. Opisthosomal setae short except *g p* which is 30 μm long.

Female: unknown.

Material examined and host information

Holotype: WAM 80-353, parasitic on rat *Notomys alexis*, collected at Wanjarri Reserve, Western Australia (27°24'S, 120°39'E), 8 January 1975 (Coll. P. Lambert). Host registration WAM M12964.

Paratypes: WAM 80-269, one male; FMNH, two males; IMT, two males; DZUN, two males, from the same host as the holotype.

5 *Murichirus (Murichirus) dorsoscutatus* sp. nov.

Description

The body is well sclerotized in both sexes. In the male coxae II and III and the postscapular shields are devoid of membranous or sclerotized processes. The opisthonotum is covered by a large unstriated shield. In the female coxa II presents a sclerotized process on the posterior border of coxa II.

Holotype: male (Fig. 8) 340 μm long and 115 μm wide (in oblique view). In two paratypes: 310 μm x 90 μm and 315 μm x 90 μm (in ventral view). Prescapular and postscapular shields fused. Hysteronotum sclerotized and striated in its anterior half, with a non-striate shield on opisthonotum. Opisthosoma 72 μm long. Coxal II groove 60 μm long. Penis conical, not bifid, flanked by two curved sclerites. Posterior legs rather long and inflated. Legs III longer and thicker than legs IV. Chaetotaxy of opisthosoma very thin, not longer than 20 μm.

Allotype: female (**Fig.** 9) 315 μm long and 90 μm wide (in lateral view). Body well sclerotized. Prescapular and postscapular shields large, fused. Hysteronotum striated transversely and strongly punctate. Opisthogaster soft with posterior quarter tranversely striate and anterior three-quarters longitudinally striate. Coxa II with a posterointernal narrow pointed process 18 μm long. Bursa relatively short. Chaetotaxy of idiosoma very short. Legs III-IV long, especially femora which are more than twice as long as respective genua. Copulatory pore situated dorsally 40 μm above anus.

Material examined and host information

Holotype: WAM 80-349, parasitic on rat *Notomys alexis* collected at Wanjarri Reserve, Western Australia (27°24'S, 120°39'E), 16 January 1975. Host registration WAM M12964 (Coll. P. Lambert).

Figs 8-9: *Murichirus (Murichirus) dorsoscutatus* sp. nov. 8—Holotype male. 9—Allotype female.

Paratypes: WAM 80-358, 266 to 268, five males, allotype female; FMNH, five males, one female; IMT, five males, one female; DZUN, five males, from the same animal as holotype and from host WAM M13330, from Miss Gibson Hill; BM, one male (no. 1980.5.20.2) and one female (no. 1980.5.20.1) (the mites were fixed in the middle of the dorsum), collected from the same host from Armstrong Creek, Central Australia (25°6'S, 130°14'E). Host registration BM 701295.

6 *Murichirus (Murichirus) lobatitarsis* sp. nov.

Description

This species is well characterized by the presence of a bilobate lobe on the ventral surface of tarsus IV in the male.

Holotype: male (Fig. 10) 556 μm long and 126 μm wide (in lateral view). Coxae II and III without processes. Postscapular shield with wide striated membranous posterolateral margins. Hysteronotum with sinuous and partly scaly striations, cuticle punctate. Coxal III groove 95 μm long. Opisthosoma 105 μm long. Legs III-IV inflated. Leg III longer but thinner than leg IV. Tarsi IV with a large bifid ventral process. Penis short, apparently bifid.

Allotype: female (Fig. 11) 516 μm long and 110 μm wide (in lateral view). Body strongly sclerotized. Hysteronotum with a sinuous striation. Coxae II-III without processes. Bursa relatively very long (160 μm) and twisted, with a distal part thickened and sclerotized. Copulatory pore situated at the lateral side of the anus. Legs III-IV well developed with femora a little more than twice as long as the respective genus. Opisthosoma without long or stout setae.

Material examined and host information

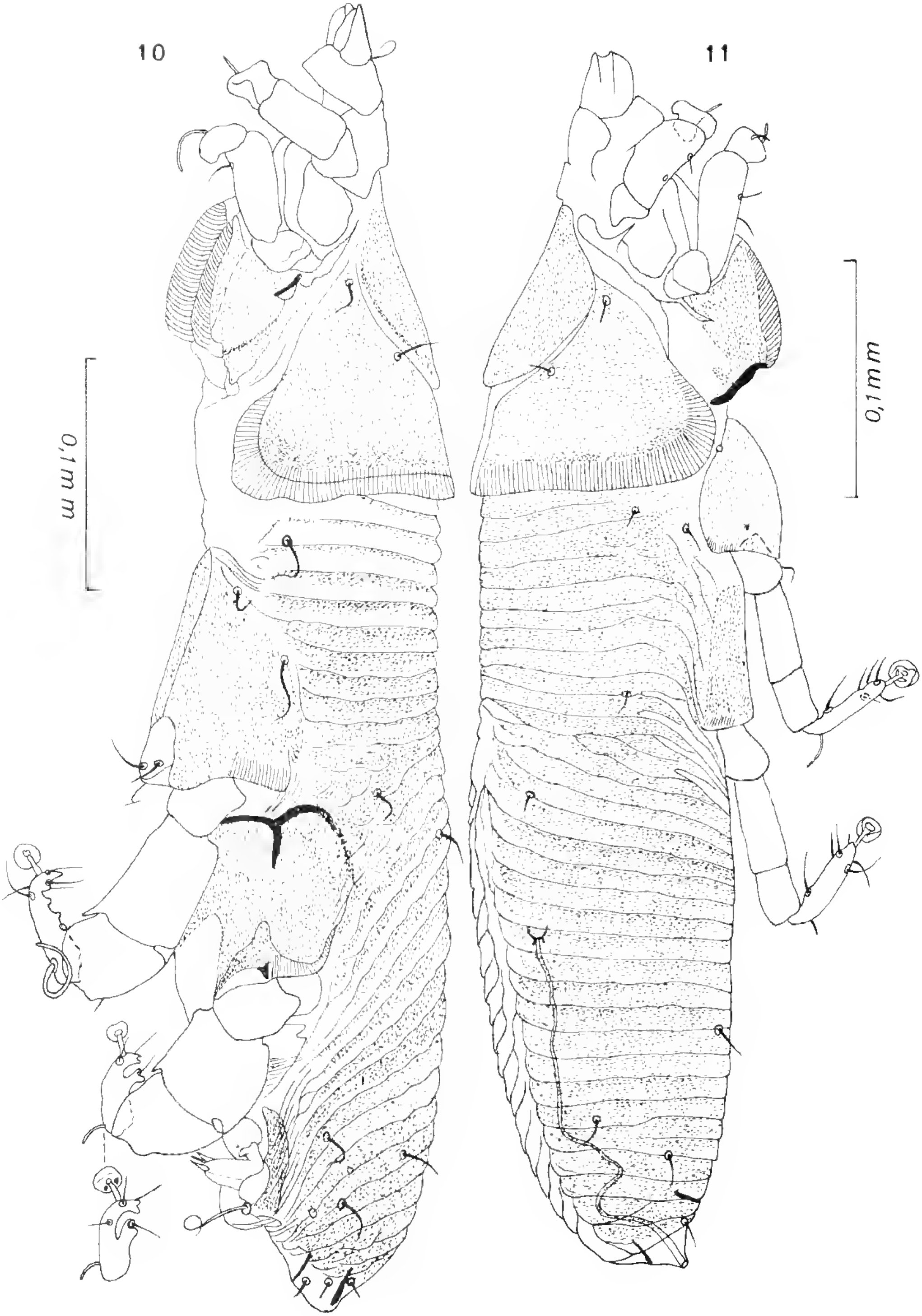
Holotype: WAM 80-354, parasitic on rat *Melomys* sp., collected at Port Warrender, Western Australia (14°30'S, 125°50'E), 30 October 1976 (Kimberley Expedition). Host registration FMNH collection 3141.

Paratypes: WAM 80-355 and 270 to 275, allotype and four females; FMNH, five females; IMT, five females; DZUN, four females, collected on the same animal as holotype; USNM, seven males and 38 females collected from *Melomys cervinipes* at Atherton Tableland, Queensland, August 1921. Rat in USNM.

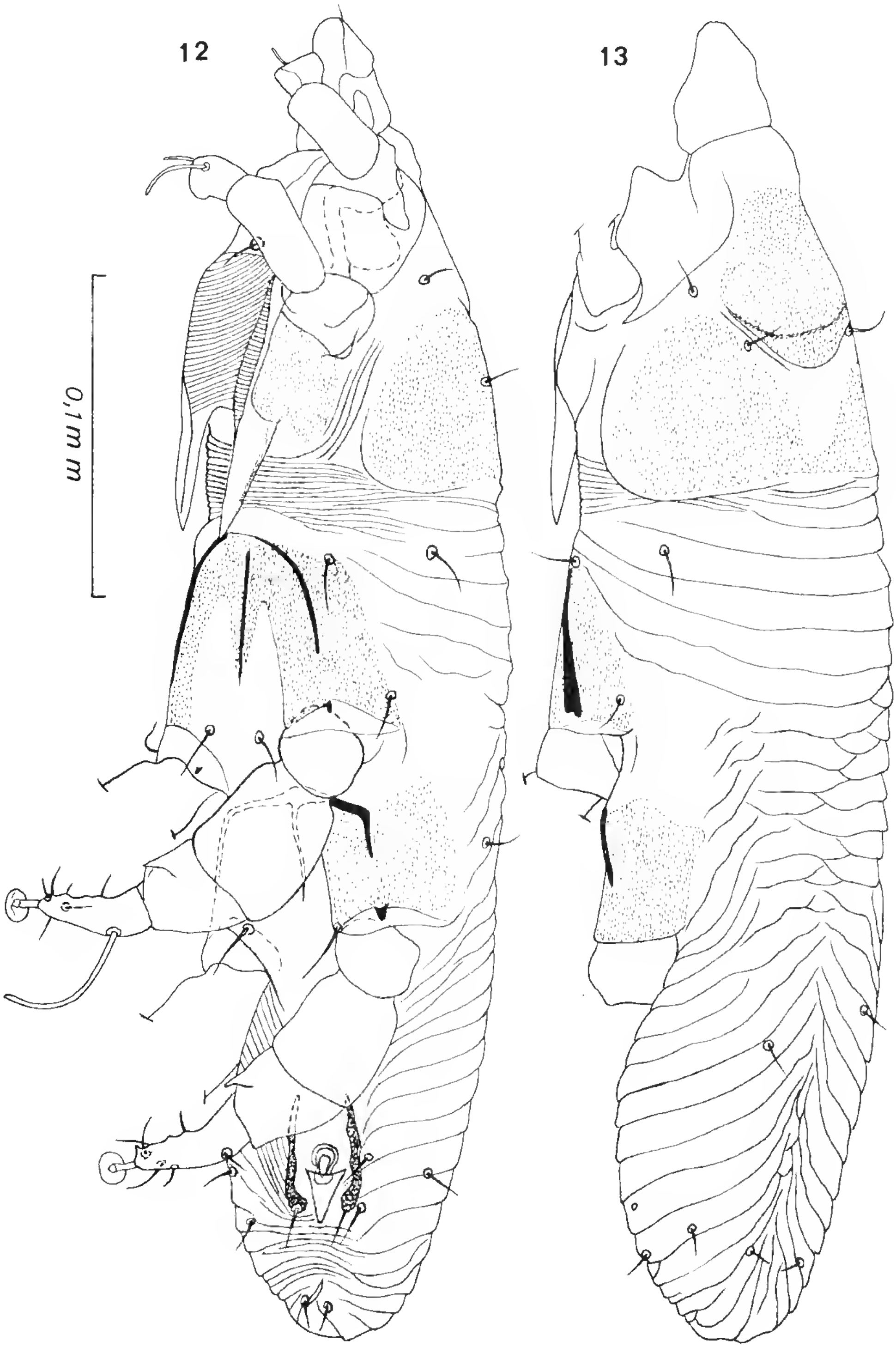
7 *Murichirus (Murichirus) zyzomys* sp. nov.

Description

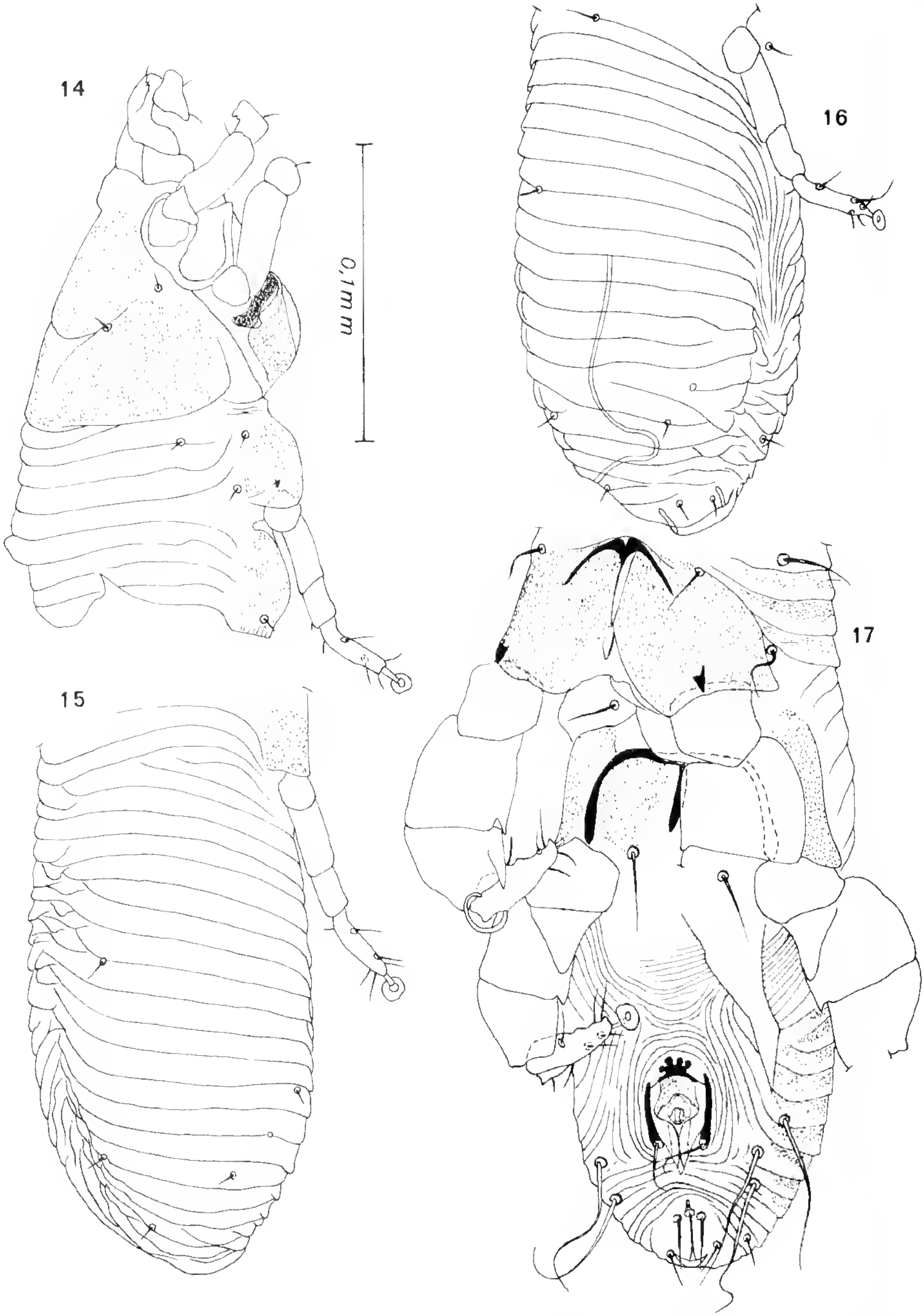
This species is clearly distinguished in the male by the presence on coxa II of a sclerotized cylindroconical process directed posteriorly. The female resembles *M. alatus* but the copulatory pore is more anterior.



Figs 10-11: *Murichirus (Murichirus) lobatitarsis* sp. nov. 10—Holotype male. 11—Allotype female.



Figs 12-13: *Murichirus (Murichirus) zyzomys* sp. nov. Holotype male in ventrolateral (12) and dorsolateral (13) view.



Figs 14-17: 14-16—*Murichirus (Murichirus) zyzomys* sp. nov. Allotype female: Anterior half (14); posterior half in dorsolateral (15) and ventrolateral view (16). 17—*Murichirus (Murichirus) mastacomys* sp. nov. Holotype male, hysterosoma ventrally.

Holotype: male (Figs 12, 13) 418 μm long and 105 μm wide (in oblique view). Prescapular and postscapular shield separated, the latter is very short in the midline. Hysteronotum soft, striated, these striations are slightly sinuous in the median part of dorsum. Coxa II with a strong cylindroconical process 40 μm long. Coxa III without process. Opisthosoma 120 μm long, opisthogaster without scales. Penis conical, flanked by two punctate longitudinal stripes. Legs III-IV inflated. Femur IV with a short apical prolongation, genu IV with a longer apical process.

Allotype: female (Figs 14-16) 420 μm long and 117 μm wide (in lateral view). Pre- and postscapular shields separated, the posterior shield shaped as in the male. Hysteronotum striate, distinctly punctate in the lateral parts of opisthosoma. Copulatory pore situated dorsally at 33 μm in front of anus. Bursa poorly distinct, about 100 μm long. All opisthosomal setae very short. Legs III-IV: femora slightly less than twice as long as the respective genua.

Material examined and host information

Holotype: WAM 80-356, parasitic on rat *Zyzomys argurus* (Thomas, 1889), Port Warrender, Western Australia (14°42′S, 125°57′E), 31 October 1976 (Kimberley Expedition). Host registration WAM M3156.

Paratypes: WAM 80-357, 80-276 and 80-277, three males, allotype female, two nymphs; FMNH, three males, one female and two nymphs; IMT, three males, one female, two nymphs; DZUN, three males, one nymph, from the same animal as holotype.

8 *Murichirus (Murichirus) mastacomys* sp. nov.

Description

This species is close to *Murichirus enoplus* (Domrow, 1956). It is distinguished from the latter in the male by the greater length of setae *d 4*, *ℓ 3*, *ℓ 5* and *a 3*, the smaller length of setae *a e* (15 μm) which are shorter than the *a i*, the greater length of the penis, which terminates in a pointed apex, and the different shape of the postscapular shields which are widely fused in the midline.

Holotype: male (Figs 17, 18) 480 μm long and 135 μm wide (in lateral view). Postscapular shield long in the midline, with a distinct striated border. Hysteronotum striated tranversely, and presenting wide punctated bands along the striations. Opisthogaster non-scaly. Penis conical, short, not bifid, surrounded by a U-shaped sclerite. Coxae II-III without posterior processes. Legs III-IV inflated. Femur IV with two ventral processes, genua IV with one apical ventral process.

Allotype: female (Figs 19, 20) 465 μm long and 135 μm wide (in lateral view). Hysteronotum as in the male, the transverse punctate bands do not reach the midline. In the opisthonotum the median area presents a series of small lozenges. Most of the opisthogaster is finely striated longitudinally. Absence of processes on coxae II-III. Bursa very long (225 μm), copulatory orifice at the lateral side of the anus. Posterior part of opisthosoma with some setae 30 μm long. Legs III-IV with femora about twice as long as respective genua.

Material examined and host information

Holotype: WAM 80-351, parasitic on rat *Mastacomys fuscus* Thomas, 1882, collected at White's River, probably Mt Kosciusko area, New South Wales, 11 February 1958. Host registration WAM M5285 (Coll. D. Wimbosh).

Paratypes: from the same animal as holotype, WAM 80-352, 80-278 to 286, four males, allotype and 16 females, nymphs; FMNH, five males, 16 females, nymphs; IMT, four males, 16 females; DZUN, four males, 15 females.

Genus *Teinochirus* gen. nov.

Definition

Only the male is known. This genus differs from the genus *Murichirus* by the great elongation of the hysterosoma and the posterior situation of the legs III-IV and the penis. Podosomal shields as in the genus *Murichirus*. Type species: *Teinochirus vermicularis* sp. nov.

Teinochirus vermicularis sp. nov.

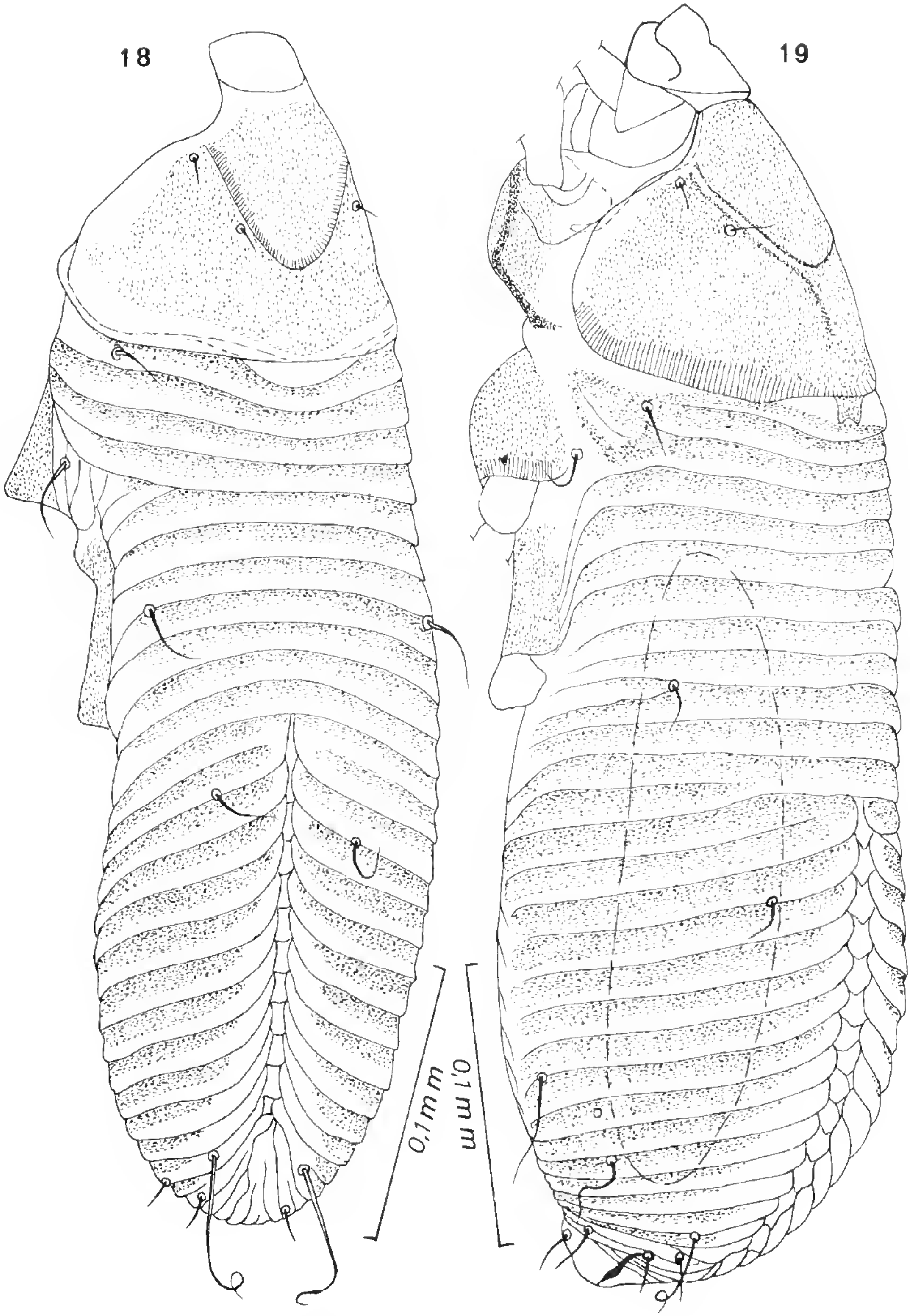
Description

Holotype: male (Figs 21-23) 825 μm long and 135 μm wide (in lateral view). Prescapular and postscapular shields strongly sclerotized, the latter bordered by a large striated membrane. Hysterosoma with thick transverse striations widely separated in its anterior part and with obliquely directed striations behind the coxae III. Behind these coxae the hysteronotum is distinctly punctate in its lateral parts. Distance between coxae II and coxae III is 300 μm. Opisthosoma short (110 μm). Penis stout, conical, surrounded by a thick crescentic sclerite open forwards. Legs inflated. Tibiotarsi IV with a slightly bilobed ventral process.

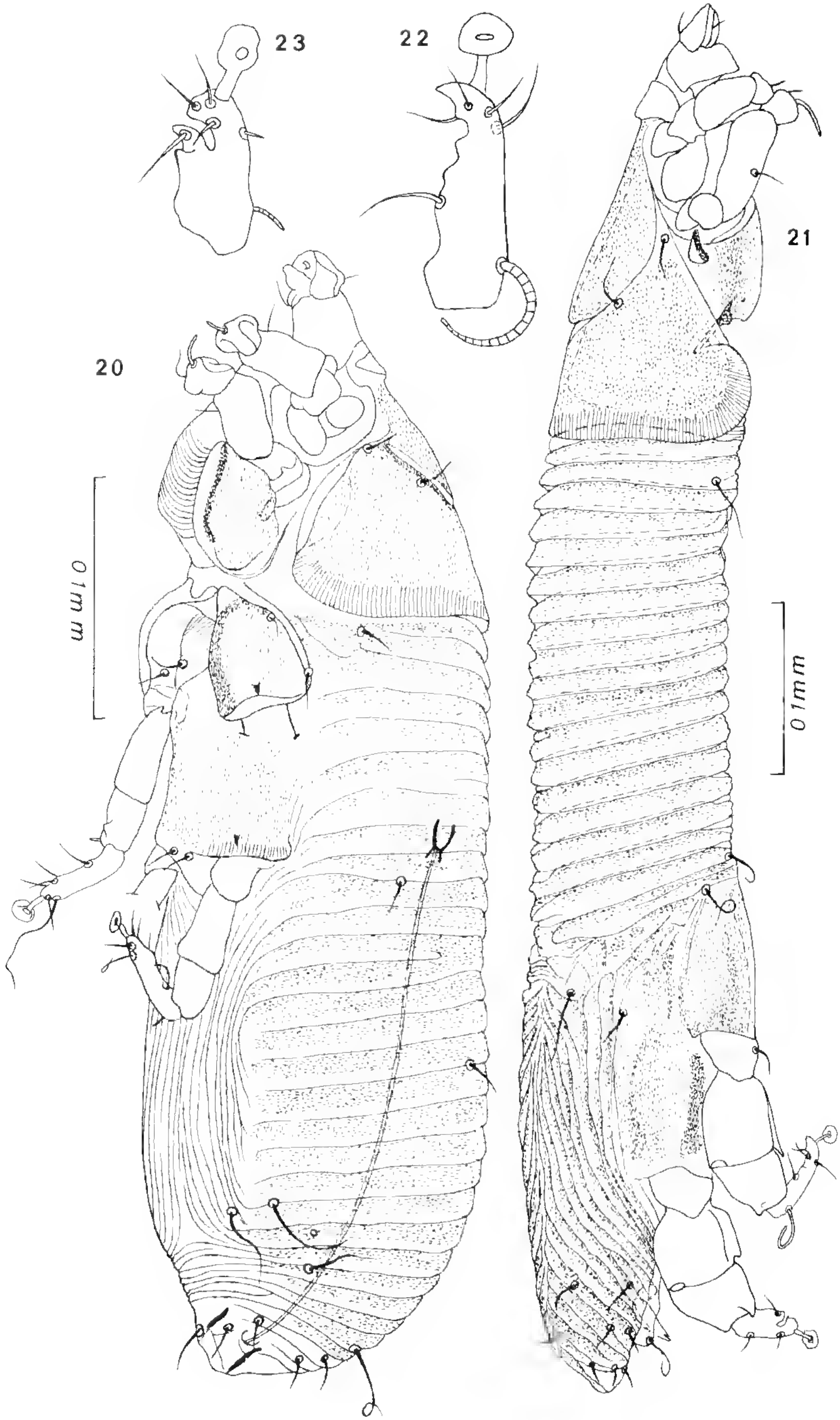
Material examined and host information

Holotype: USNM 3935, parasitic on rat *Melomys cervinipes* collected at Atherton Tableland, Queensland (17°16'S, 145°29'E), August 1921.

Paratypes: from the same animal as holotype, USNM, one male; IMT, one male; DZUN, one male.



Figs 18-19: *Murichirus (Murichirus) mastacomys* sp. nov. 18—Holotype male. 19—Allotype female in dorsolateral view.



Figs 20-23: 20—*Murichirus (Murichirus) mastacomys* sp. nov. Allotype female in ventrolateral view. 21-23—*Teinochirus vermicularis* sp. nov. Holotype male in lateral view (21); tarsi III (22) and IV (23).

Genus *Listrophoroides* Hirst, 1923
Subgenus *Marquesania* Womersley, 1943

1 *Listrophoroides (Marquesania) queenslandicus* Womersley, 1943

Species was described from *Rattus youngi* (which is probably not a valid species) and from a rat in Queensland.

Domrow (1958) recorded the species from several Australian murids. It has also been found on Australian marsupials: *Phascogale unicolor* (? *Antechinus stuartii* Macleay) and *Cercartetus concinnus* (Gould, 1845) (Fain, 1972; Fain & Lukoschus, in press).

The junior author found this species on an Australian murid: *Rattus fuscipes* (Waterhouse, 1839), Australia, 1869; rat in the RMNH, no. 20359 (8 males and 15 females).

L. queenslandicus seems to be able to live on both murid rodents and marsupials.

2 *Listrophoroides (Marquesania) papuanus* Fain, 1970

This species is common in New Guinea and Australia. In New Guinea it is represented by three subspecies: *papuanus, interpolatus* and *crenatus.* In Australia only the typical subspecies has been recorded so far.

In the Kimberley area the junior author collected numerous specimens of that species in the following hosts, all during Kimberley Expedition:

1 *Conilurus penicillatus* (Gould, 1842) — about 150 specimens, males and females, have been collected from this rat which is the typical host. Locality: Port Warrender (14°30'S, 125°50'E), 29.X.1976 (rat FMNH 3111).

2 *Rattus tunneyi* (Thomas, 1904) — about 100 specimens (males and females) from several rats (FMNH 3102, 3112, 3113, 3116, 3127, 3140), at Port Warrender (14°30'S, 125°50'E), 28-30.X.1976. This is a new host for this species.

3 *Pseudomys nanus* (Gould, 1858), from Mitchell Plateau (14°50'S, 125°49'E), 21.X.1976 (rat FMNH 3050) (eight females, four males and seven nymphs). It is a new host for that species.

ACKNOWLEDGEMENTS

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A NEW SPECIES OF CHIGGER (ACARI: TROMBICULIDAE) FROM A SKINK IN WESTERN AUSTRALIA

M. LEE GOFF*

ABSTRACT

Schoengastia gutekunsti sp. nov., from the skink *Ctenotus inornatus* (Rosén) in Western Australia is described from the larval stage. This is the first record of *Schoengastia* from Australia.

INTRODUCTION

Examination of ectoparasites from a skink *Ctenotus inornatus* (Rosén) (Squamata: Lacertilia, Scincidae), taken in the Kimberley district of Western Australia, has revealed a new species of *Schoengastia* Oudemans, 1910. Womersley (1952) assigned many species from Australia to the genus *Schoengastia, sensu lato*; however, all of these species have subsequently been assigned to other genera, most notably *Ascoschoengastia* Ewing, 1946, *Guntheria* Womersley, 1939 and *Neoschoengastia* Ewing, 1929. As indicated by Audy (1954), *Schoengastia* is an Old World genus, with no species reported from the New World. Although widely reported from the Asiatic-Pacific region (Womersley, 1952), the species described here represents the first record of *Schoengastia, sensu stricto*, from Australia. Collections were made under the direction of Dr F.S. Lukoschus, Katholieke Universiteit, Nijmegen, and Dr J.B. Kethley, Field Museum of Natural History, Chicago. All measurements are in micrometers and are given for the holotype, followed by means and ranges of type series in parentheses. Terminology follows Brennan and Goff (1977).

SYSTEMATICS

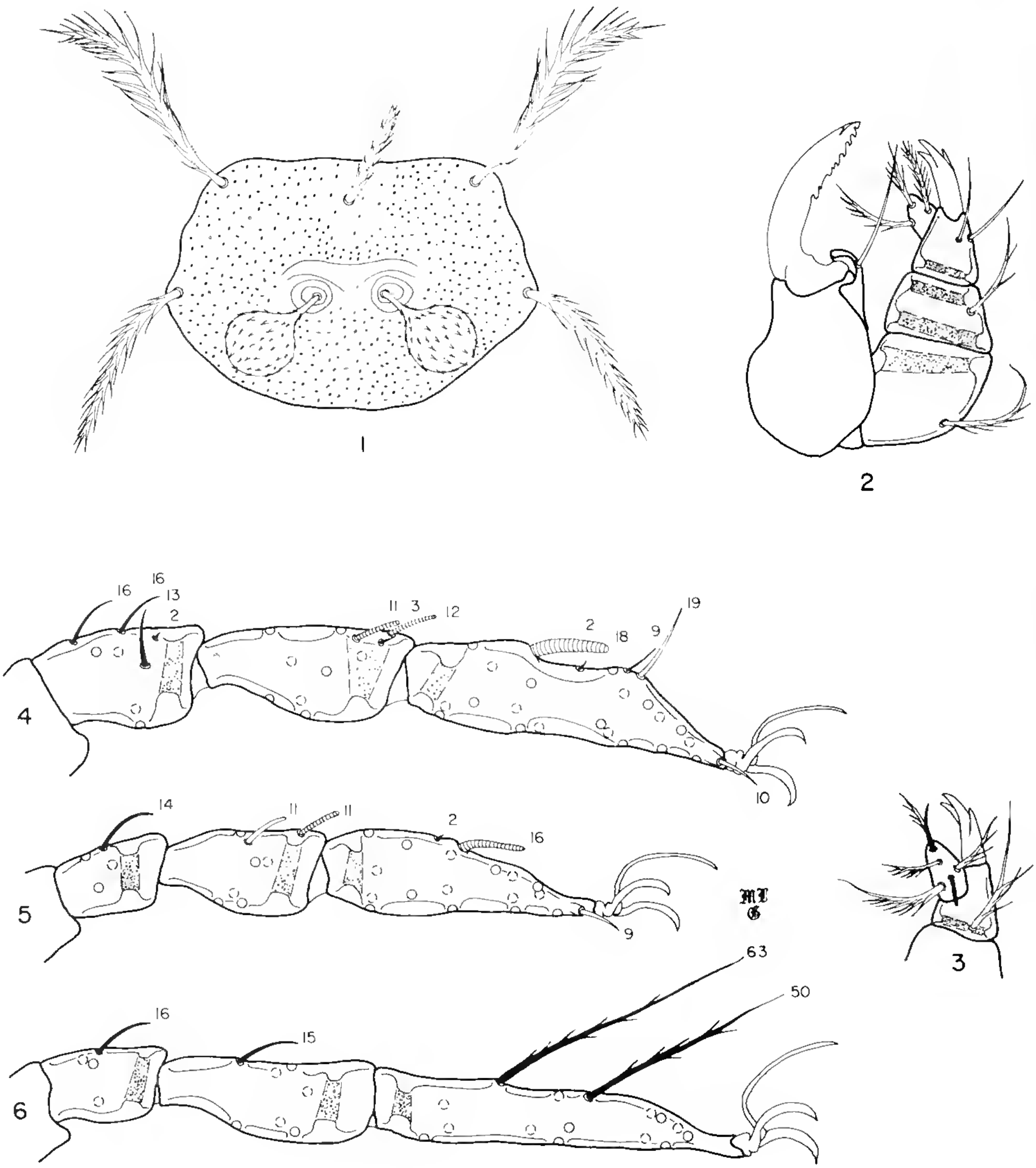
Schoengastia gutekunsti sp. nov.
(Figs 1-6)

Type data

Holotype and 10 paratypes from Mt Hart, Kimberley Division, Western Australia from the skink *Ctenotus inornatus* (131), 10.IX.1976. Holotype

* Bishop Museum, P.O. Box 19000-A, Honolulu, Hawaii 96819, U.S.A.

(WAM no. 80-213) in Western Australian Museum (Perth) and paratypes there and in Bishop Museum (Honolulu), Field Museum of Natural History (Chicago), University of Nijmegen and U.S. National Museum of Natural History (chigger collection currently housed at Bishop Museum).



Figs 1-6: *Schoengastia gutekunsti* sp. nov. **Fig. 1**: Scutum. Fig. 2: Dorsal aspect of right chelicera and palp. Fig. 3: Ventral aspect of palpal tibia and tarsus. **Figs 4-6**: Distal three segments of legs I-III showing specialized setae (numbers equal lengths in micrometers) and only bases of branched setae.

Description of species (larval stage)

Idiosoma: 280 x 200 (partially engorged). Eyes 2/2, anterior larger, on ocular plate. One pair of humeral setae, 32-36 long; 34 dorsal body setae, 24-27 long, arranged 8-8-6-6-4-2; two pairs of sternal setae, anterior 27-28 long, posterior 21-25 long; 26-28 preanal setae, 21-23 long, 6-8 postanal setae 23-25 long; total body setae 72-76. Gnathosoma: Palpal setal formula B/B/NNB/7BS; palpal claw 3-pronged; galeala N; cheliceral blade (40-42 long) with one ventral and 8-10 dorsal recurved teeth. Scutum: Lightly punctate with sinuous anterior margin; posterior margin deeply rounded; AM base slightly posterior to line of AL bases; SB in line with PL bases; AL > PL > AM; sensilla capitate, head with setules; PW/SD 1.27-1.43. Scutal measurements: AW 57 (55, 52-57); PW 80 (75, 69-80); SB 16 (13, 11-16), ASB 30 (28, 25-30); PSB 26 (27, 25-29); AP 27 (25, 24-30); AM 26 (24, 21-27); AL 58 (59, 55-63); PL 49 (47, 42-49), Sens. 27 (26, 24-27) (head 16-17 x 16). Legs. All 7-segmented, terminating in a pair of claws and a claw-like empodium. Onychotriches absent. IP 809-839. Leg I: 285-292; coxa with one branched seta (1B); trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, three genualae, microgenuala; tibia 8B, two tibialae, microtibiala; tarsus (80 x 21) 20B, tarsala (17-18 long), microtarsala, subterminala, parasubterminala, pretarsala. Leg II: 241-253; coxa 1B; trochanter 1B; basifemur 2B; telofemur 4B; genu 3B, genuala; tibia 6B, two tibialae; tarsus (67 x 19) 16B, tarsala (15-16 long), microtarsala, pretarsala. Leg III: 283-294; coxa 1B; trochanter 1B; basifemur 2B; telofemur 3B; genu 3B, genuala; tibia 6B, tibiala; tarsus (86 x 16) 13B, two barbed mastitarsalae (50-63 long).

Remarks

Schoengastia gutekunsti is similar to *Schoengastia palmata* Domrow, 1962, and *Schoengastia philipi* Womersley and Kohls, 1947, in having three genualae I and a 3-pronged palpal claw. *Schoengastia gutekunsti* may be separated from *S. philipi* in having somewhat expanded AL scutal setae (unexpanded in *S. philipi*), larger scutal measurements, 34 dorsal body setae (26-30 in *S. philipi*) and two barbed mastitarsalae III (one nude mastitarsala III in *S. philipi*). The expanded palmate AL setae are present in both *S. palmata* and *S. gutekunsti*, although not as marked in *S. gutekunsti* and only the AL setae are involved (AL and PL setae in *S. palmata*). *Schoengastia gutekunsti* further differs from *S. palmata* in having palpotibial setation NNB (NNN in *S. palmata*) and two barbed mastitarsalae III (one barbed mastitarsala III in *S. palmata*).

This species is named in honour of John Gutekunst, Histopathology Laboratory USAH, Ft Ord, California. It corresponds to *Schoengastia* sp. A of Nadchatram *et al.* (1980).

ACKNOWLEDGEMENT

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LICE (PHTHIRAPTERA: BOOPIIDAE) PARASITIC ON MARSUPIALS

THERESA CLAY*

ABSTRACT

A small collection of marsupial lice made by Dr F.S. Lukoschus in the Kimberley Division of Western Australia contains a new species of *Boopia* and of *Latumcephalum*, described below, and one known species of *Boopia* and one of *Paraboopia*.

DESCRIPTION OF MATERIAL

Genus *Boopia* Piaget, 1880

Two species of *Boopia* are present in the collection, both from members of the Dasyuridae: *B. uncinata* Harrison & Johnston, 1916 and the new species described below (see **Table 1** for host and localities).

Boopia occidua sp. nov.
(Figs 1-5, 15)
Type host: *Antechinus* cf. *bilarni* Johnston, 1954.

This species belongs to the *spinosa* species-group (Clay 1972:403, 1976:333-338) and the characters given in the former publication are not repeated here in the specific description. It is distinguished from the other known species of this group by the reduction of frontal seta 3 (Kéler† 1971, Fig. 100=seta 23, Clay 1969:5); by the absence, as in *spinosa*, of the pair of stout spinform setae each side of the venter of the head and the absence of a typical 'handle' (sens. Kéler) in the male copulatory apparatus.

Description

Head in many of the mounted specimens shows the deformation described by Kéler: 40, head measurements are therefore given only for those specimens without this deformation; breadth less than in other species. Dorso-lateral margin of head (**Fig. 1**) with postocular notch smaller but similar to that of *spinosa* (see Kéler: Fig. 111); this margin in *murrayi, greeni, aquilonia* and

*C/- British Museum (Natural History), Cromwell Road, London SW7, U.K.

†All references to Kéler refer to Kéler 1971: 1-126.

lukoschusi as in *brevispinosa* (see Kéler: Fig. 107). Venter without a stout spiniform seta each side; seta 23 which in all the other species is stout and spiniform is here represented by a minute seta. Pronotum as in Kéler: Fig. 111 except that the minute central seta (dps 2, Clay 1969:5) and the inner of the two long marginal setae have been omitted. The prosternal plate in all the species normally has three postero-marginal setae spinform and of uniform length except *spinosus* in which the central one is thinner and longer or occasionally equal in length (not as shown in Kéler: Fig. 111‡) in addition the prosternal plate in all the species has two minute anterior setae and a long antero-marginal one each side and a varying number on the surface of the plate, 3-4 in this species. Meso- and metanotum as in Werneck & Thompson (1940: Fig. 42) with the addition of 2-3 minute setae; mesosternum with 4 long stout setae, metasternum with 3 + 3 setae, the anterior 1 + 1 being shorter and finer than the posterior 2 + 2. Trochanter, as in the whole group, with three ventral sensilla (Clay 1969. Fig. 13). Tergites without lateral sutures forming three plates. Male copulatory apparatus (**Figs 3-5**) distinct from other members of the group in the absence of an anterior "handle" and in the details of the vesicle sclerites. These sclerites may become somewhat distorted during preparation and appear different in different specimens. Gonapophysis, as in other members of the group, with an apical alveolar seta as described by Kéler:23 for *Boopia biseriata* Kéler, 1981 and not a spur as stated by Kéler: 41,42 for *brevispinosus* and *spinosus*. Actually a number of species of *Boopia* said by Kéler to have a gonapophysal spur appear to have a seta similar to that of *biseriata*. True spurs are found, for instance, in *Macropophilia clayae* Kéler, 1971 (Kéler: Fig. 113) and *Heteroduxus spiniger* (Enderlein, 1909) (Kéler: Fig. 119). Genital papilla elongated conical as in Kéler: Fig. 115, H, but with a more rounded head. Sensilla of tergite IX of female 3-4 each side. Inner edge of gonapophyses with sensilla as illustrated for *brevispinosus* in Clay 1972: Fig. 14.

Chaetotaxy of the Abdomen

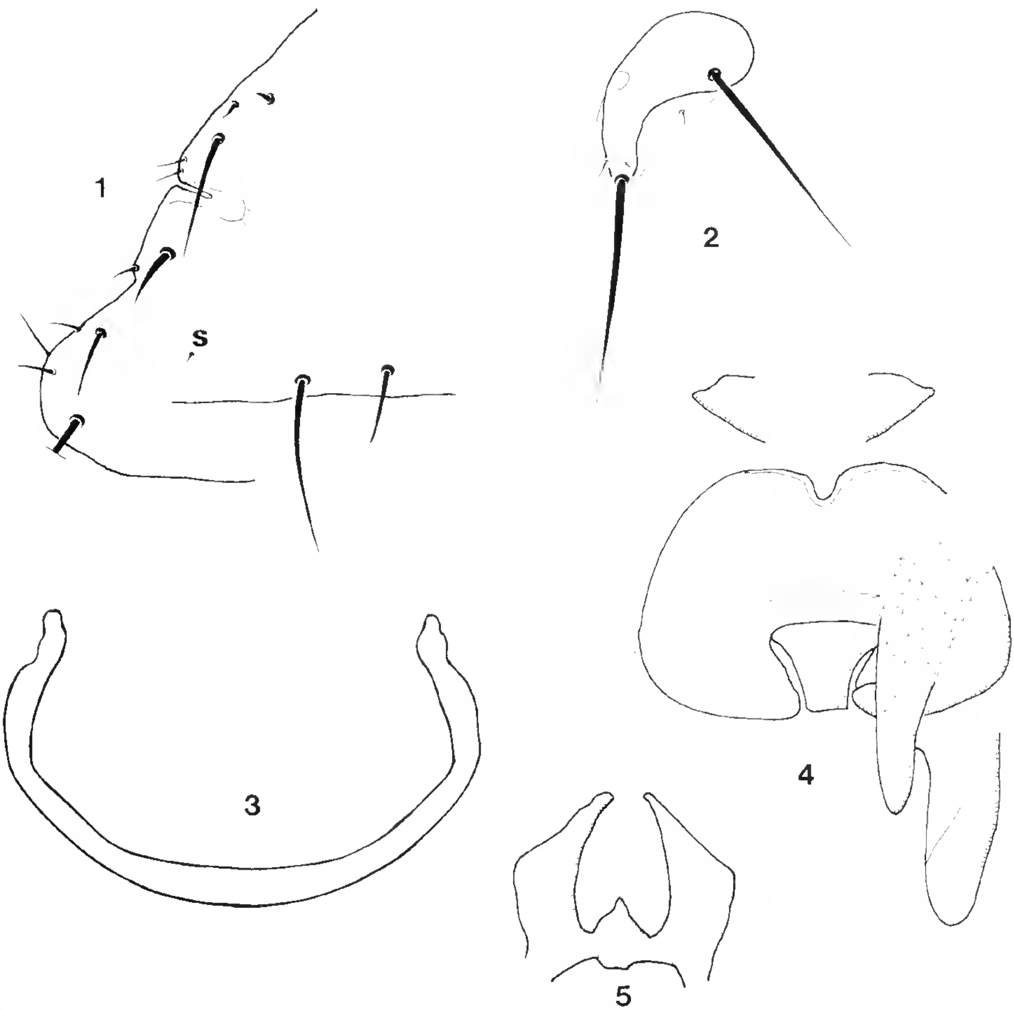
Terga with single row of setae: II, 1 + 4 + 1; III-VIII, 2 + 4 + 2, the inner of the two outer setae on VIII being finer than the other of the pair; last segment, ♂ 3-5 each side, one being longer and stouter than the rest, and 5-6 fine setae centrally, ventral to these a row of 5-7 similar setae; posterior margin with 1 + 1 setae; ♀ 4-5 each side; supraanal margin 4 + 4 short setae. Sternum II, 4 and 2 fine, short setae each side; III-VIII with two irregular rows: III-VII, 8 in the posterior row, 2-5 in the anterior row; VIII, 6-7 posteriorly, 3-5 anteriorly; last segment, ♂ three pairs arranged horizontally, the posterior pair being marginal. Vulva with 10 setae, thickness and length as shown in Fig. 16; postgenital setae 10 each side with 4 posterior more median setae.

‡One specimen of the new species has the central seta abnormally shorter and finer than the outer two.

Lateral setae present on IV-VII of approximate uniform length and thickness (**Fig. 2**). Postspiracular complex: II as in Clay 1976: Fig. 3, but one or both of the two smaller setae each side of the stout seta may be shorter and finer; III-IV, 1-2 short, fine setae each side of trichobothrium, in some specimens one of these may be longer and thicker; V-VIII as in Fig. **2**, with the setae each side of the postspiracular setae longer and thicker on VIII.

Dimensions (in mm)

Temple width, ♂, 0.35 (2); ♀, 0.35-0.36 (2). Head length, ♂, 0.21-0.22 (2); ♀, 0.21-0.22 (2). Pronotum width, ♂, 0.32-0.33 (5); ♂, 0.32-0.34 (4). Total length, ♂, 1.27-1.28 (2); ♀, 1.35-1.50 (2).



Figs 1-5: *Boopia occidua* sp. nov., 1; head ♂ (dorsal), s, seta 23. 2; lateral plate, segment V. 3-5: Parts of ♂ copulatory organ (drawn to same scale). 3; mesosomal arch. 4; central and lateral sclerites, dorsal view. 5; central sclerite (ventral).

Material Examined

9♂, 4♀ from *Antechinus* cf. *bilarni* Johnson, 1954 from Mitchell Plateau and Brooking Springs, Western Australia, Kimberley Division.

Holotype: ♂ in the Western Australian Museum, WAM 79.1583 from the type host species Field Museum of Natural History, Chicago, 2844, Brooking Springs (18°01'30"S, 125°42'30"E).

Paratypes: 8♂, 4♀ from the host and localities as given above.

Genus *Latumcephalum* Le Souëf, 1902

Four species, including the new species described below, are known from species of *Macropus* and *Wallabia*. It is now realized that some of the characters which prove to be diagnostic are shown in Werneck & Thompson (1940) and Kéler (1971) and were not discussed in Clay (1974); these are now included in a comparative manner in the description of the new species.

Described species of *Latumcephalum* and their hosts are:

L. macropus Le Souef, 1902
Macropus dorsalis (Gray, 1837) Unconfirmed.

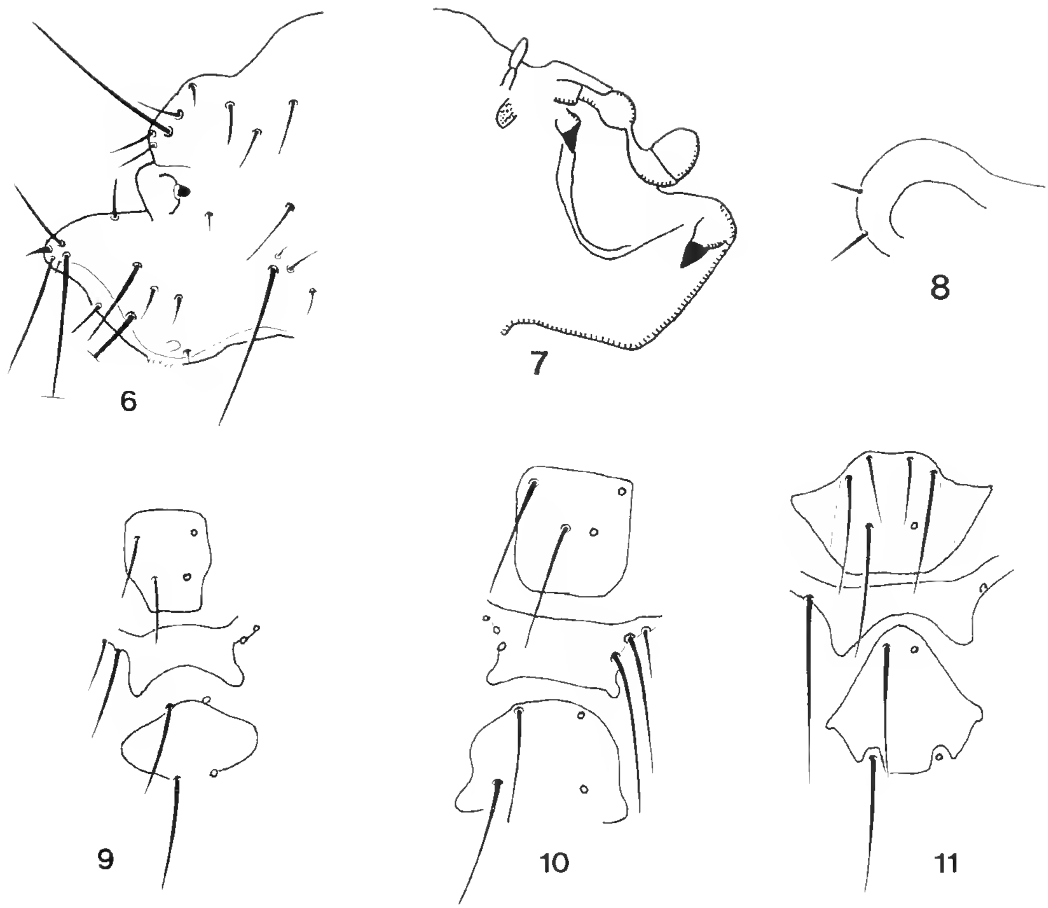
L. lesouefi Harrison & Johnston, 1916
Wallabia bicolor (Desmarest, 1804).

L. greeni Clay, 1974
Macropus rufogriseus (Desmarest, 1817).

Latumcephalum tenax sp. nov.
(Figs 6-14, 16-17)

Type Host: *Macropus agilis* (Gould, 1842)

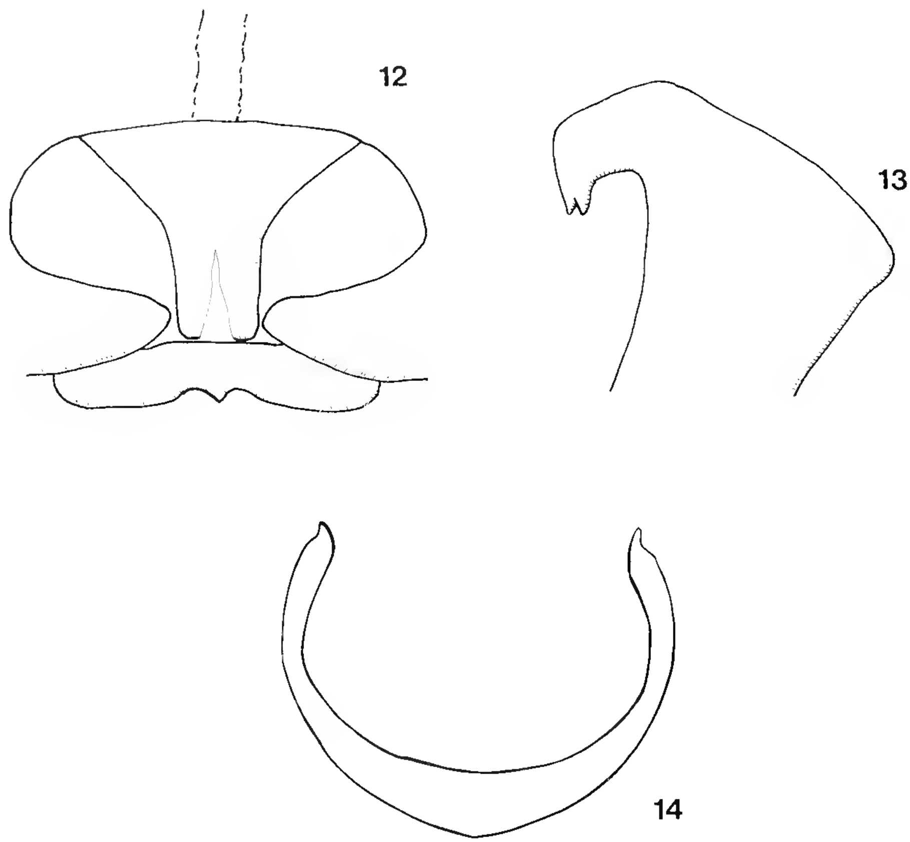
The four species are distinguished from each other by the shape and size of the head, especially in the shape of the area lying between the preocular and postocular slits, this being large and rectangular in *macropus* and *greeni* and triangular and bluntly pointed in *lesouefi* and the new species (**Fig. 6**). The two latter species can be separated by the presence in *tenax* of a long lateroventral seta on segment III and by its smaller size. The venter of the head has three thickened areas (**Fig. 7**): one on the anterior temple angle, one near the base of the antenna and one near the base of the maxillary palp; the area on the temple usually has a well developed projection which is reduced in *greeni;* the antennal area has a small point, best developed in *tenax* and *lesouefi;* and the third area is small but definite in *macropus* and *tenax* and minute to absent in the other two species. A small colourless projection on the dorsal posterior temple angle is well marked in *lesouefi* and *macropus* but weak and small in the other two species; the ocular seta of *tenax*, unlike that of the other species, is short and blunt-ended.



Figs 6-11: 6-8; *Latumcephalum tenax* sp. nov., 6; head ♂ (dorsal). 7; head ♂ (ventral) to show sclerotized projections. 8; mesonotal wart. 9-11; *Latumcephalum* spp., thoracic sternal plates (some setae shown by alveolus only). 9; *L. tenax*. 10; *L. lesouefi*. 11; *L. greeni*.

Thorax of *tenax*. Pronotum as in *macropus* (Kéler: Fig. 130) and as in the other species has 6-7 marginal setae each side, 2 of which are long and stout, 2 + 2 lateral submarginal and 1 + 1 minute more central setae. Mesonotal warts (**Fig. 8**) with thickened outer rim absent in the other species with the possible exception of *macropus*, but material of this species in too poor condition to be certain; the outer seta of the warts finer and less spiniform than in *lesouefi* and *greeni*. Metanotum, as in the other species, with 10-12 setae of medium length and a varying number of short fine setae; the reduction in number of the longer setae is due to the outer of the 2 + 2 central marginal stae being short and fine in some specimens. Thoracic sternal plates as **Figs 9-11** (*macropus* see Werneck & Thompson (1940: Fig. 61); *greeni* with two extra prosternal setae. Second femur of male with a stout spiniform seta as in *macropus* and *lesouefi*. Trochanter with three ventral sensilla.

Male copulatory apparatus (Figs 12-14) similar to that of the other species (Kéler: Figs 133-134), but differs in the shape of the mesosomal arch and details of the vesical plates; armature of the genital sac composed of finer particles than in the other species (Figs 16-17). Details of female genital sclerites not clear in single available female, but a well marked arched lunula present. Gonopohyses with apical seta and 5-6 (number not clear in single female) outer lateral setae; inner and supraanal margin with row of 8 minute setae each side of midline. Shape of genital papilla similar to Kéler: Fig. 115 J, but somewhat more elongated. Abdominal spiracles with aperture noticeably smaller in *macropus* than in the other species: ratio of diameter, *macropus: greeni: tenax: lesouefi:* 1 : 1.7 : 1.8 : 2.0.



Figs 12-14: *Latumcephalum tenax*, parts of ♂ copulatory organ, 12; central sclerites, h, 'handle', length: range 0.066-0.084 mm. 13; lateral sclerite. 14; mesosomal arch (same scale as Clay 1974: Figs 2-4).

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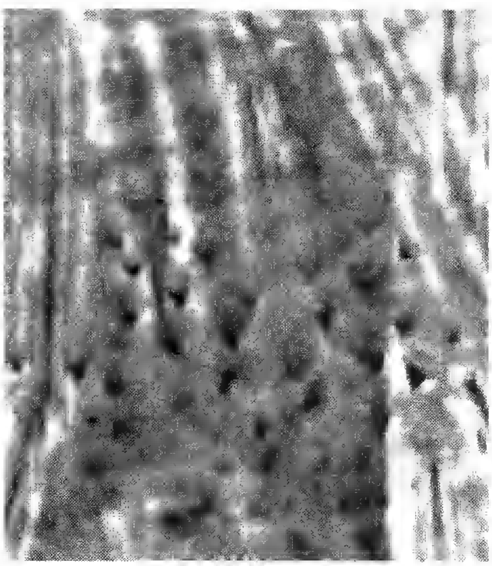

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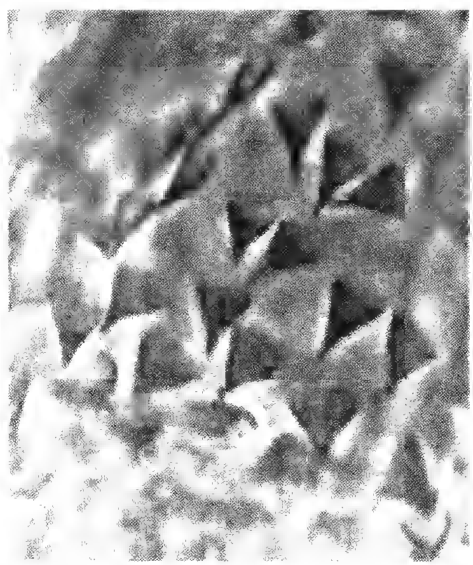

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Figs 15-17: 15; *Boopia occidua* sp. nov., vulval setae. 16-17; armature of genital sac. 16; *Latumcephalum tenax* sp. nov. 17; *L. greeni* Clay.

Abdominal Chaetotaxy

Tergal setae§ similar in the four species except that *macropus* is distinguished in having the 4 central setae of segments III-VIII in the upper row, whereas in the other species these are in the lower row (with occasionally 4 setae in the upper row, see below). There may be a number of fine short setae which are not included in the following tergal counts, which include all four species except where stated. Tergocentral setae II, 4; III-VIII, lower row 4, except *macropus* ♂, ♀ which has 6; III-VIII, upper row, *macropus* ♂, ♀ 4; upper row in the other species ♂, ♀: III, 4-6; IV, 5-6; V, 6-7; VI, 5-7; VII, 3-4. IX with single row: ♂ *tenax* 3 + 3, outer seta each end long and stout; *greeni*, 3 + 3 inner two setae the longest; ♀ *tenax*, *macropus* and *lesouefi*, 5-6 + 5-6, outer seta long and stout. Laterotergal setae II and VIII, 1 long seta except *greeni* in which on II the seta is minute and on VIII a single seta varying from medium to minute; III-VII, *tenax* and *lesouefi*, 2 long to medium setae each side, *macropus* and *greeni* 1 long with 1-2 short fine setae, which may vary from minute to medium in *greeni*. Sternum ♂ *tenax* II, 4; III-VIII two rows (the upper row given first, small, fine setae omitted), III, 4/10; IV, 4-5/9-10; V, 4-6/10-11, VI, 4-5/10; VII, 4-5/9-11; VIII, 5-6/6-7. ♀ II, 4; III, 3/4; IV, 4/4; V, 4/6; VI, 5/7; VII, 5/7; VIII, 4/6, IX, 4/5. Vulva: 8 marginal setae, one of which each side is long and stout, the remainder short and fine. Lateroventral II, all species 0; III, *tenax* 1, others 0; IV-VI, 2 except *greeni* which has 1 with 2 of varying lengths at its base; VII, all 1; VIII, all 0. There is usually a short, fine seta associated with the longer ones, which is some specimens may take the place of one of the long seta. Postspiracular setae II-VIII long with 2-3 fine setae near the base.

Dimensions

2♂, 1♀ of *tenax* (in mm): Temple width ♂ 0.37-0.38, ♀ 0.33. Head length ♂, 0.19-0.21, ♀ 0.18. Pronotum width ♂, 0.20-0.21, ♀ 1.95. Abdomen width ♂, 0.54-0.55, ♀ 0.52. Total length ♂ 1.10-1.20, ♀ 1.12. Breadth of ♂ head of *macropus:* 0.41; *lesouefi:* 0.46; *greeni:* 0.51.

Material Examined

2 ♂ from *Macropus agilis* (Gould), Western Australia, Napier Downs. 5.IX.1976, Field Museum of Natural History, Chicago, 2673. 1 ♂, 1 ♀ from the same host, Western Australia, Beverley Springs. 18.IX.1976, Field Museum of Natural History, Chicago, 2725.

Holotype: ♂ in the Western Australian Museum, WAM 79.1584 from the above host from Napier Downs (17°14'20"S, 124°13'40"E).

Paratypes: 2♂, 1♀ with data as given above.

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§Clay, 1974:2 line 24, for III-IV read III-VI

TABLE 1

Host-parasite list of Phthiraptera collected by Dr F.S. Lukoschus in Western Australia

Marsupial Host‖	Genera & Species of Boopiidae
Dasyuridae	
Antechinus cf. *bilarni* Johnston, 1954 5 tubes, see above for localities	*Boopia occidua* sp. nov.
Dasyurus hallucatus Gould, 1842 6 tubes from the following localities: Mitchell Plateau (2), Mount Hart (3), Port Warrender (1)	*Boopia uncinata* Harrison & Johnston, 1916 Formerly known from this host (see Kéler: 35)
Macropodidae	
Macropus agilis (Gould, 1842) 2 tubes, see above for localities	*Latumcephalum tenax* sp. nov.
Macropus robustus Gould, 1841 1 tube from Brooking Springs	*Paraboopia flava* Werneck & Thompson, 1940. Type host.

I am grateful to Mr John Calaby for advice on host names.

‖Name of hosts as given by Kirsch & Calaby, 1977. Localities in the Kimberley Division of Western Australia.

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THREE NEW AGAMID LIZARDS FROM WESTERN AUSTRALIA

G.M. STORR*

ABSTRACT

Three recently discovered species are described as new: *Tympanocryptis aurita* from east Kimberley, *Amphibolurus yinnietharra* from the North-West and *A. mckenziei* from the western hinterland of the Great Australian Bight.

INTRODUCTION

In a revision of *Tympanocryptis* I wrote 'the generic classification of Australian Agamidae has remained exactly as Boulenger left it in 1885, and a thorough and simultaneous revision of all Australian genera is long overdue' (Storr, 1964). Such a revision has become even more urgent since the discovery of a species of *Tympanocryptis* with an exposed ear aperture and numerous femoral pores. I have placed *aurita* in *Tympanocryptis* because I believe its closest relatives are *T. cephala* and *T. intima*, species that have always been regarded as congeneric with *T. lineata*, the type species of the genus.

The genus *Amphibolurus* is equally ill-defined. However there can be no question but the new species described herein are closely related to species (*A. ornatus* and *scutulatus*) that have always been placed in that genus.

All specimens cited in this paper are lodged in the herpetological collection (R series) of the Western Australian Museum (WAM).

SYSTEMATICS

Tympanocryptis aurita sp. nov.
(Fig. 2)

Holotype

WAM R66296, an adult male collected by M.C. Ellis on 4 September 1979 among small tussocks of *Triodia* on a stony hillside 27 km SSE of Halls Creek, Western Australia, in 18°27'S, 127°45'E.

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* Western Australian Museum, Francis Street, Perth, Western Australia 6000.

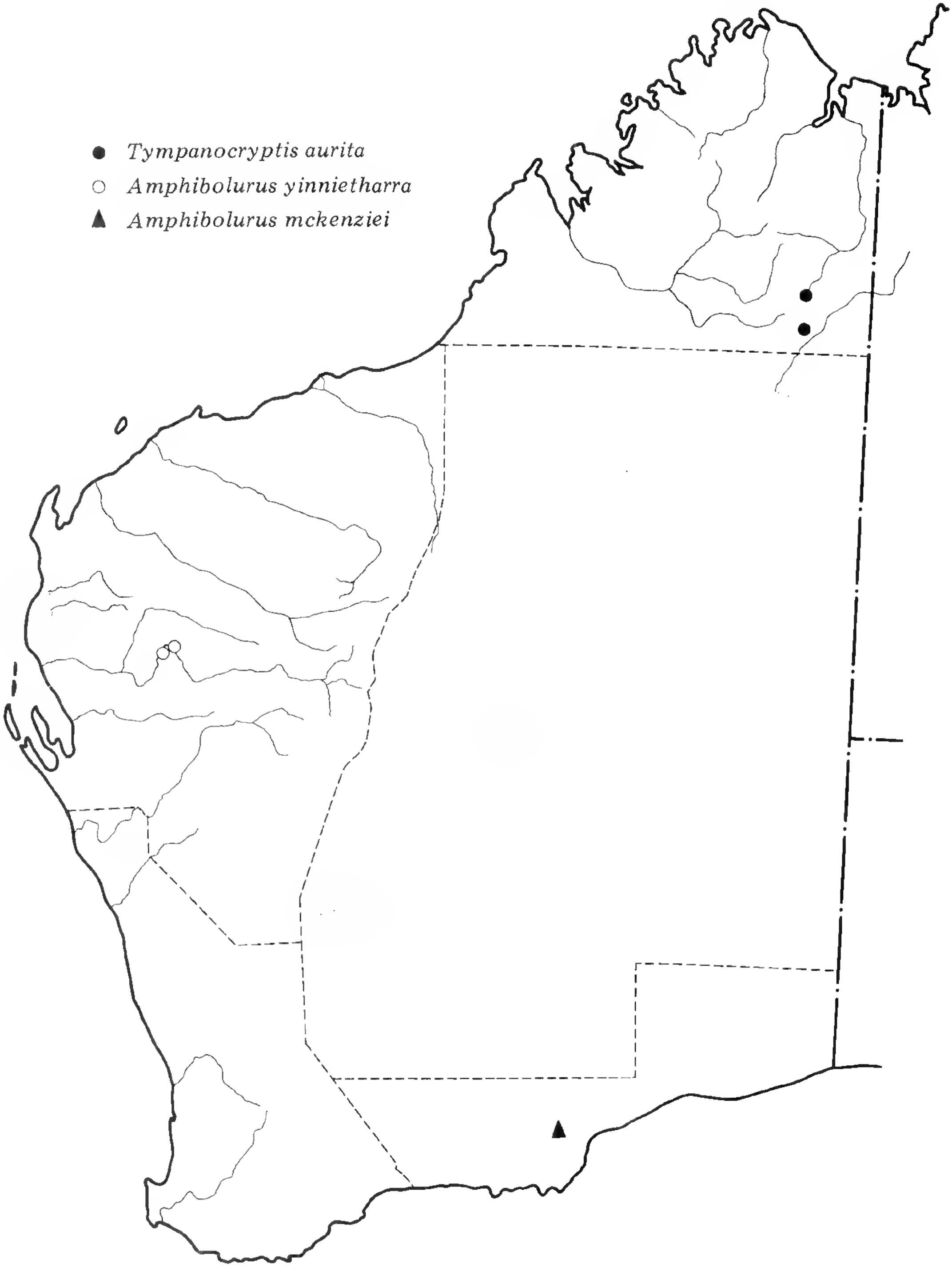

Fig. 1: Map of Western Australia showing location of specimens of *Tympanocryptis aurita*, *Amphibolurus yinnietharra* and *Amphibolurus mckenziei.*

Diagnosis

Distinguishable from all other *Tympanocryptis* by exposed tympanum. Otherwise generally similar to *T. cephala* but having much shorter tail, which ends abruptly rather than tapering to point; dorsal tubercles not arranged in clusters, distributed over whole of back (rather than leaving vertebral zone free) and extending to tip (rather than only base) of tail.

Distribution

Arid north-eastern interior of Western Australia (Fig. 1).

Description

Snout-vent length (mm): 29-46. Length of appendages (% SVL): foreleg 41-42, hindleg 61-63, tail 69-77. Nostril located on swollen canthus rostralis.

Scales on head feebly rugose or unicarinate (almost smooth). Scales on neck, back, flanks, tail and legs very small, densely intermixed with slightly to much larger keeled scales (though still not large by agamid standards); enlarged scales not arranged in any pattern and spreading right across back, i.e. not absent from vertebral zone as in *T. cephala* and *intima*. Scales of under surface smooth or very weakly keeled. Upper labials 16-20. Lamellae

Fig. 2: Holotype of *Tympanocryptis aurita*.

under fourth toe 15-18. Femoral pores: 5/6 in holotype, 2/2 in larger of paratypes, and 0/0 in smaller paratype. Preanal pores: 3/3 in holotype, 0/0 in paratypes.

Dorsal and lateral surfaces pale reddish brown, suffused on head and back with pale brownish grey. Neck, back and rump with or without an irregular series of small dark brown blotches on each side of midline. Tail irregularly banded with dark brown or dark brownish grey; bands approximately transverse and about as wide as pale interspaces.

Paratypes

Kimberley Division (W.A.): WAM R64051-2 (juveniles collected on 22 April 1979 by A.A. Burbidge *et al.* in bulldozed *Triodia* on lateritic plain 0.4 km W of Wolf Creek Meteorite Crater in 19°10'S, 127°48'E).

Amphibolurus yinnietharra sp. nov.
(Figs 3, 4)

Holotype

WAM R51675, adult male, collected by M. Peterson on 3 October 1975 at 5 km E of Yinnietharra, Western Australia, in 24°41'S, 116°13'E.

Diagnosis

A member of the *A. decresii* species-group (Houston, 1978), very like *A. ornatus* (Gray) but smaller, with head and body less strongly depressed, and having much less dark pigmentation (e.g. males lacking black blotches on back and black bands on proximal third of tail). Distinguishable from *A. caudicinctus* (Günther), with which it is sympatric, by the depressed head, body and tail, much weaker nuchal crest, stronger spines in vicinity of ear aperture and on side of neck, and in males the lack of a black pectoral patch and much wider and less numerous caudal bands.

Distribution

Only known from two localities near Yinnietharra in arid western interior of Western Australia (Fig. 1).

Description

Snout-vent length (mm): 34-87 (N 13, mean 71.5). Length of appendages (% SVL): foreleg 38-44 (N 13, mean 41.1), hindleg 79-92 (N 13, mean 84.9), tail 178-204 (N 9, mean 194). Depth of head (% length of head): 42-52 (N 11, mean 46.7). Nostril located on swollen canthus rostralis.

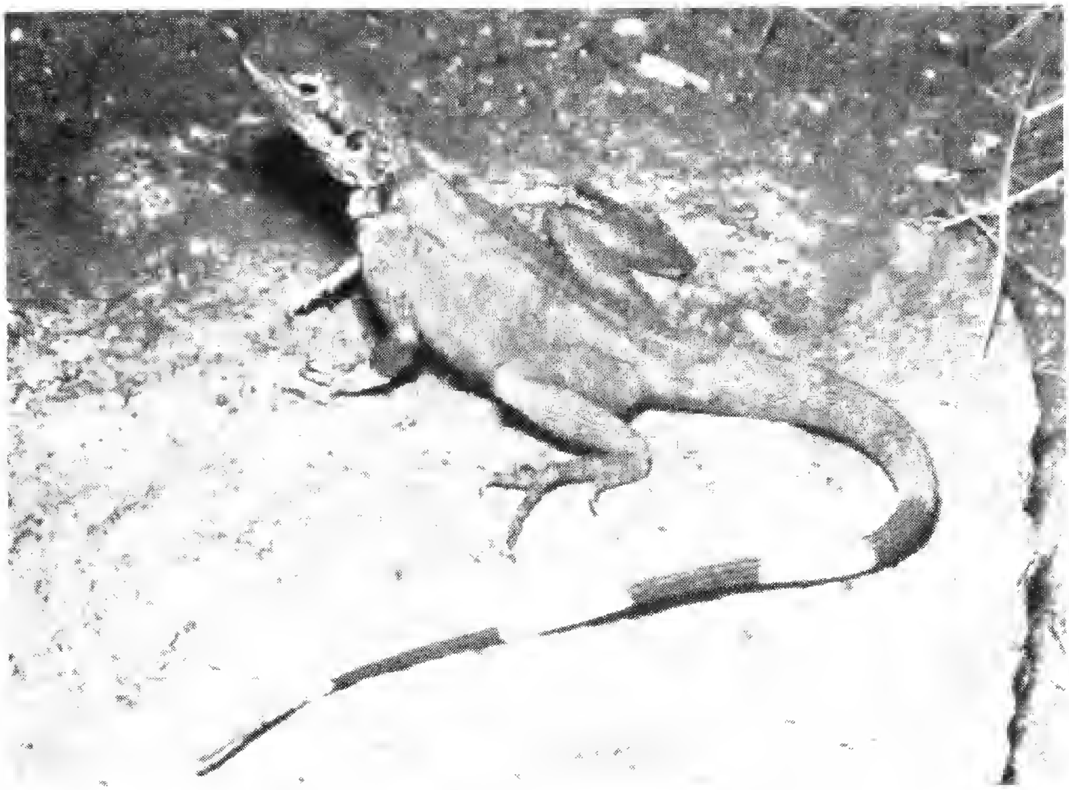

Fig. 3: Holotype male of *Amphibolurus yinnietharra* photographed in life by R.E. Johnstone.

Head scales small, rugosely keeled anteriorly, almost smooth posteriorly. Nuchal crest very low. Dorsal scales uniformly small, their keels converging on midline. Scales on legs and tail larger and more strongly keeled. Rows and clusters of strong spines below and behind ear aperture and on side of neck. Gular fold strong. Gular and ventral scales small and smooth. Scales under tail larger and weakly keeled. Femoral and preanal pores well developed in both sexes, 20-25 (N 12, mean 22.4) on each side; line of preanal pores curving forwards, well separated at midline from those of other side. Subdigital lamellae strongly bicarinate, 24-29 (N 13, mean 27.0) under fourth toe.

Adult male coloration: Upper surface mostly dull reddish brown suffused with grey (suffusion in life a bluish grey bloom that largely masks ground colour). Distal two-thirds of tail orange-brown, boldly banded with blackish brown; bands completely encircling tail, four in number and up to 2 cm wide. Eyelids brownish white. Blackish brown streak from below orbit to ear aperture. Blackish spot on side of neck, vertically elongate. Throat and sometimes breast buffy white or very pale orange-brown, stippled with brownish grey. Rest of under surface pale orange-brown.

Juvenile male: Coloration as in female except for four wide, dark brown bands around distal two-thirds of tail.

Female coloration: Upper surface mostly dull reddish brown marked with dark grey; markings on midline of back taking form of hollow blotches; markings on legs and proximal third of tail taking form of narrow irregular bands.

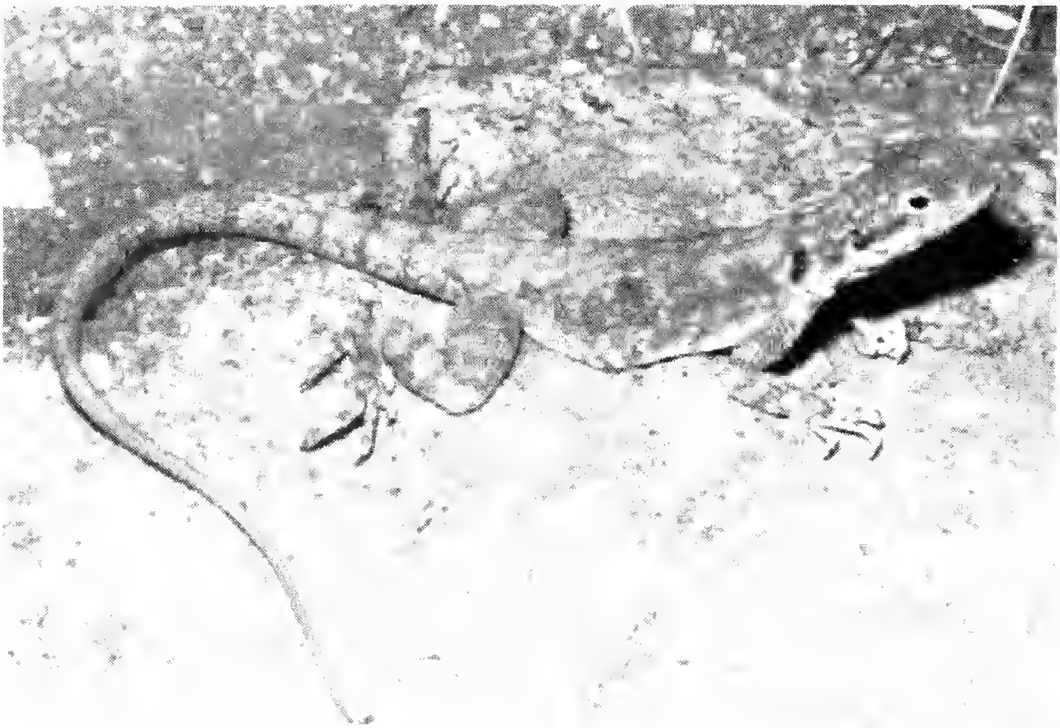

Fig. 4: A paratype female of *Amphibolurus yinnietharra* photographed in life by R.E. Johnstone.

Remarks

To date this lizard has only been found in two localities, at both of which there are outcrops of granite. T.M.S. Hanlon has observed it running across gibber flats between granite outcrops and climbing stunted acacias, and he has taken it from beneath exfoliating granite and from burrows under granite boulders. Additionally M. Peterson has collected it in a hollow acacia log. Its close relative *A. ornatus* is much more dependent on exfoliating granite for shelter, with which is correlated its more strongly depressed head and body.

Paratypes

North-West Division (W.A.): 5 km E Yinnietharra (51739-41, 51674); 25 km SW Yinnietharra (47704-6, 52042-5, 56860).

Amphibolurus mckenziei sp. nov.
(Fig. 5)

Holotype

WAM R59754, an adult male collected by N.L. McKenzie and P.J. Fuller on 1 March 1978 in bluebush-saltbush steppe with scattered eucalypts at 8 km SW of Ponier Rock, Western Australia, in 32°59'S, 123°26'E.

Diagnosis

A medium-sized *Amphibolurus*, very like *A. scutulatus* in scalation but differing markedly in coloration, e.g. back blackish brown with whitish vertebral stripe and transverse lines, rather than pale brown with paired dark brown blotches that merge on foreback to form crossbands; also smaller, with deeper head (depth 55-57% of length, *vs* 44-54) and fewer subdigital lamellae (25-27 under longest toe, *vs* 33-38).

Distribution

Only known from a small area in semiarid southeastern interior of Western Australia between Balladonia and Israelite Bay (Fig. 1).

Description (based on holotype and paratype female)

Snout-vent length (mm): 66 and 62 respectively. Length of appendages (% SVL): foreleg 40, 39.5; hindleg 88, 86.5; tail 238, 220. Nostril located below sharp canthus rostralis.

Head scales small and sharply keeled. Low nuchal crest of laterally compressed spinose scales. Dorsal scales sharply keeled, very small laterally but increasing slightly in size towards midline, which is marked by a series of slightly enlarged and raised scales (which continue on to proximal third of tail); keels of dorsals slightly and irregularly converging on midline. Scales on legs and tail keeled, larger than dorsals. Three clusters of small spines on dorsolateral fold of neck (spines much lower in female), and a low, oblique spinose ridge below and behind ear (much shorter in female). Scales on side of body very small, not keeled, but apices tending to be raised (as in dorsals). Scales on lower surface smooth except for bicarinate subdigital lamellae. Femoral and preanal pores 24 + 22 and gorged with wax in male; 18 + 18 and much smaller in female; each located in centre of cluster of small scales; line of preanal pores curving slightly forwards and well separated from those of other side.

Head brownish grey. Back and sides blackish brown marked with greyish white as follows: narrow irregular vertebral stripe, connected by several transverse lines to wide irregular dorsolateral stripe (which extends forward to eye and back to base of tail), upper lateral spots (mostly hollow in male);

and irregular midlateral stripe. Legs and tail brown, finely and faintly cross-banded with whitish colour. Under surface in male whitish except for dark grey narrow triangular patch on throat and kite-shaped patch on chest which extends narrowly to belly. Under surface in female whitish, the throat, chest and belly finely and densely stippled with dark grey.

Fig. 5: Holotype of *Amphibolurus mckenziei.*

Remarks

Named after N.L. McKenzie of the Department of Fisheries and Wildlife, co-collector of the type specimens and donor of much other material in the Western Australian Museum.

Paratype

Eucla Division (W.A.): WAM R59753, collected by N.L. McKenzie and P.J. Fuller on 1 March 1978 in low open eucalypt woodland over low open shrubbery and leaf litter at 3 km NE of type locality.

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ARCHAEOLOGICAL INVESTIGATIONS AT THE QUININUP BROOK SITE COMPLEX, WESTERN AUSTRALIA*

W.C. FERGUSON†

ABSTRACT

Cultural materials recovered in recent archaeological investigations at the coastal Quininup Brook Site Complex in the south-west of Western Australia include a South-West Early Phase assemblage of flaked and ground stone artifacts and several clusters of granite-gneiss manuports. On Site 4 of the complex most of these artifacts appear to come from a single cultural horizon buried deep within siliceous sands. This horizon has been radiocarbon dated from before 18 000 BP to after 10 000 BP. The site complex is suggested to have been a series of inland domestic camping sites which were abandoned during the early to early-middle Holocene, perhaps because of the deterioration and reduction of exploitable environment resulting from the onset of wetter conditions and rising sea levels.

INTRODUCTION

Quininup Brook is a small stream which drains into the Indian Ocean on the south-western coast of Western Australia (Fig. 1 inset). In December 1976, C.E. Dortch of the Archaeology Department, Western Australian Museum, recorded the presence of four open sites surrounding the mouth of the brook. When the author began intensive investigations in February 1977, two other sites were discovered bringing the total number in the complex to six. These important sites are all actively eroding and the initial aim of the investigations was simply to salvage as much of the remaining archaeological information as possible. The ultimate goal, however, was to use this information to gain further insight into the processes of environmental adaptation by the late Pleistocene-early Holocene human inhabitants of this region; this has previously been studied in detail only from excavations at the nearby cave site of Devil's Lair (Dortch 1979a and references).

* This paper is based in part on a B.A. Honours thesis submitted to the Anthropology Department of the University of Western Australia, November 1977. The research was completed while the author was Assistant Curator of Archaeology, Western Australian Museum, Perth, W.A.

† Department of Prehistory and Anthropology, School of General Studies, The Australian National University, Canberra, A.C.T.

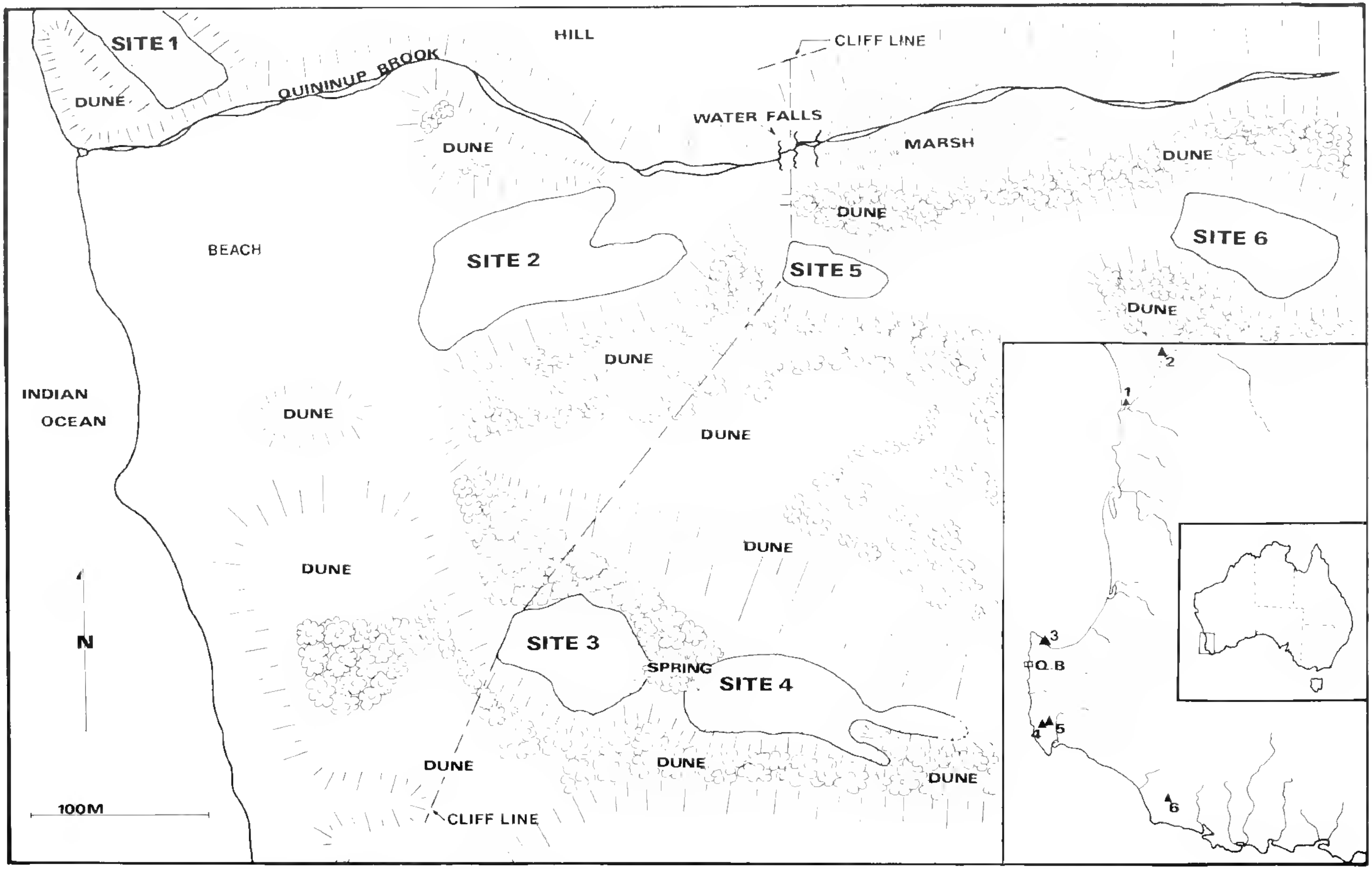

Fig. 1: Map of Quininup Brook Site Complex with inset showing locations of south-western archaeological sites referred to in the text. *Inset:* 1—Minim Cove; 2—Walyunga; 3—Dunsborough; 4—Devil's Lair; 5—Arumvale; 6—Northcliffe.

A description of the flaked stone implements recovered from these sites has already been published (Ferguson 1980). This present paper provides a general summary of the results of the archaeological investigations. It describes the sites and their setting, and as much as possible attempts to isolate the changes in the archaeological deposit brought about by erosion. The artifacts and cultural features are discussed placing emphasis where possible on the information they provide about the range of past human behaviour in this setting. Finally, an attempt is made to fit the site complex into a regional pattern of Aboriginal adaptation to the prehistoric environment, and some suggestions are made as to why these sites were apparently abandoned in the early to mid-Holocene after a long history of occupation.

THE SITE COMPLEX

Environmental Setting

The site is located on the coastal Leeuwin-Naturaliste ridge, a formation of a medium grained Precambrian granulite with concordant bodies of granite-gneiss. Overlying the basement rock in many places along the coast is a Pleistocene aeolian calcarenite known locally as 'Coastal Limestone'. Overlying the calcarenite are soils of primarily Pleistocene and Holocene sands (Lowry 1965).

Extreme south-western Australia is a region of forests, woodland, sand heath and swamp. It has a Mediterranean climate characterized by high winter rainfall and summer drought (Gardner 1942, 1959). Locally, water is plentiful throughout the year. Quininup Brook flows nearly year-round, and immediately above a waterfall 300 m from the mouth of the brook there is a long, narrow marsh which contained standing water at the end of the exceptionally dry summer of 1976-77. There is also a small, apparently permanent spring within the site complex.

The local vegetation has been described by Smith (1973). The coastal limestone area adjacent to the coast is covered with *Acacia* dominated open heath, and the lee side of the ridge supports peppermint open scrub, primarily *Agonis flexuosa*. Jarrah-Marri (*Eucalyptus marginata-E. calophylla*) low open forest predominates on the undulating lateritic plateau east of the ridge. Today, Quininup Brook is an ecotonal centre and Smith's vegetation map shows no less than 10 different formations and plant associations, including the northernmost stand of Karri (*E. diversicolor*) forest, within a 2 km radius of the site complex.

Sites

The site complex is a roughly rectangular area, 500 by 800 m, extending inland from the rugged and retrograding coast. This area includes the beach formed at the mouth of the brook and a field of partially vegetated, grey calcareous sand dunes behind the beach (**Fig. 1**). The sites comprise scatters of stone artifacts and granite-gneiss manuports on weathered, reddish-brown siliceous sands in deflation zones within the eroding grey sands.

Site 1 is the only site north of the brook. It is situated on a severely eroded elevation overlooking the beach. On this site the reddish-brown sands have been entirely deflated leaving only a few stone artifacts lying on the exposure of calcarenite rubble and loose, probably redeposited, calcareous sands.

Sites 2, 3 and 5 are also extremely eroded, although the brown sands are still present. Site 2 is adjacent to the beach at the base of the dune covered cliffs. It is subject to storm-wave action and flooding from the brook. Sites 3 and 5 are located on the edge of the cliffs directly behind the beach. The ground here slopes steeply, and these sites are badly eroded by both wind and water. The spring at the top of Site 3 has produced deep gullies across the surface of the site, and Site 5 has been worn down in many places to the basement granulite. It is extremely unlikely that the archaeological material on any of these sites is in primary position.

Sites 4 and 6 are in the dunes behind the top of the slope. They are not subject to water erosion and are partially protected from the winds by the surrounding vegetated dunes. Site 4 is a 160 x 40 m area of weathered brown siliceous sands exposed in a deep depression within the younger grey sand. It is immediately to the east of Site 3 and separated from it only by the spring. Here is preserved an apparent occupational surface whose most striking feature is a number of slightly mounded clusters of granite-gneiss stones. These are scattered over the western two-thirds of the site (Fig. 8). Site 6 is somewhat smaller (90 m x 50 m), but stratigraphically similar, with the difference that erosion has been greater and the stone clusters occur only on the south-east corner of the site. In the central portion of the site the brown sands are blown-out well below the level of the clusters, exposing a number of calcarenite pinnacles, and leaving a hollow depression which is strewn with granite-gneiss stone.

THE STRATIGRAPHY OF SITE 4

Site 4 perhaps is representative of the entire site complex, and with the exception of a single test trench (Trench 2) on Site 6, all collection and excavation took place here (**Fig. 2**). Two surface samples were collected. Sample A is a total collection from a 10 m^2 square near the centre of the site. Sample B is a salvage collection from 107 one metre squares so arranged as to include a broad range of artifact forms.

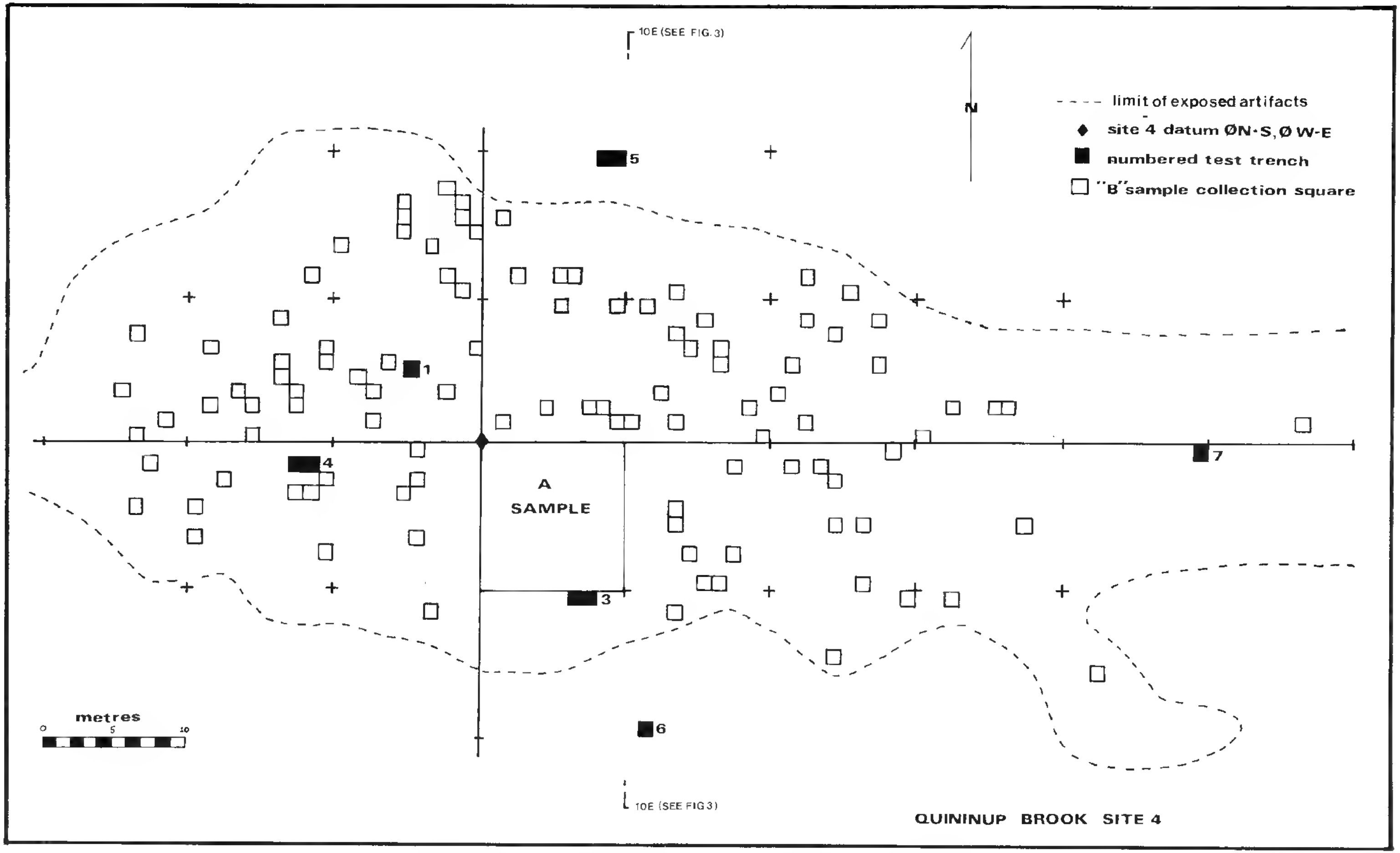

Fig. 2: Plan of archaeological investigations on Site 4.

The seven 1 x 1 m and 1 x 2 m test trenches were excavated in 5 and 10 cm arbitrary levels except where a buried humic horizon was encountered and the natural stratigraphy followed. The following examination of the Site 4 stratigraphy is based on Trenches 1, 5, 6 and 7 but chiefly on Trenches 5 and 6 which are located on either side of the narrow axis of the site, just outside the main deflation zone. Trenches 2, 3 and 4 are discussed in a later section.

Geological Strata

On the north side of Site 4, the grey calcareous sands reach a height of approximately 15 m above the surface of the deflation zone. Buried in the eroded face of this dune are three immature humic horizons. These sands are slightly alkaline throughout, and composed primarily of sub-angular organic grains with 20 to 30 per cent sub-rounded quartz grains. Samples taken from the humic horizons show heavy organic staining.

The interface between this deposit and the underlying siliceous sands is marked by a dark brown, weathered humic horizon exposed on the north side of the site. On the south side of the site, this humic horizon was intercepted in Trench 6. Here the overlying calcareous sand is largely deflated and the humic horizon is overlain instead by redeposited siliceous sands derived from the adjacent deflation zone (Fig. 3).

The siliceous sands below the humic horizon are minimally 2 m thick, but excavation in all trenches ended before reaching any underlying stratum. The colour of this soil grades uniformly from strong brown, just below the humic horizon, to reddish-yellow at a depth of 160 cm. It consists entirely of sub-rounded quartz grains with no traces of calcium carbonate. It is slightly alkaline, has heavy iron staining which decreases with depth, and occasionally shows traces of charcoal.

Following Lowry (1967) the calcareous and siliceous sands are equated respectively with the Quindalup and Spearwood Dune Systems as described for the Swan Coastal Plain, 30 km to the north (McArthur & Bettenay 1960). The geological history of the Spearwood Dunes (siliceous sands) is still subject to some controversy (Clarke & Dortch 1977) but there is general agreement that the Quindalup Dunes (calcareous sands) began to accumulate only when sea level reached its present position (McArthur & Bettenay 1960, Clarke & Dortch 1977). It can therefore be estimated from sea level curves (e.g. Chappell & Thom 1977) that the terminal date for the accumulation of the brown siliceous sands would be sometime around 6 000 BP.

The Cultural Sequence

There are apparently no artifacts associated with the calcareous sand anywhere within the site complex. All the artifacts found were either lying

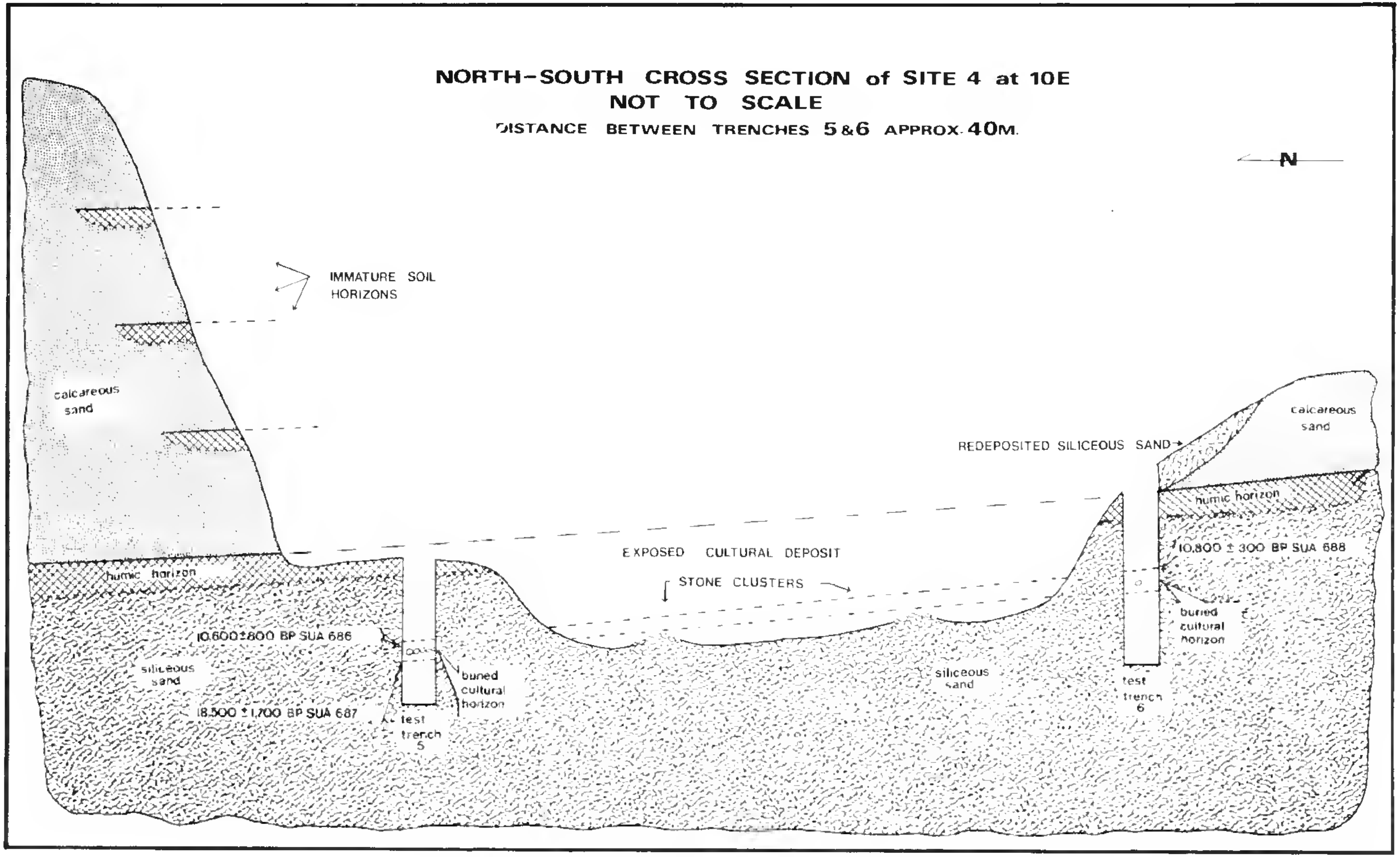

Fig. 3: North-south cross-section of Site 4.

on the surface of the deflated siliceous sand or buried within it. Excavations in the undisturbed siliceous sand below the humic horizon on Site 4 revealed that the vertical structure of the buried cultural deposit is quite similar on both the north and south sides of the site (**Fig.** 3). This can be seen on Table 1 where the depths of artifacts for Trenches 5 and 6 are compared, and leads to the provisional assumption that the sequences in these two trenches are representative, although peripheral, remnants of the now partly deflated deposit. Depths used in the description of the deposit are from the top of the humic horizon which divides the siliceous sand from the calcareous sand. This is 26 cm below the surface of Trench 6 and approximately at the surface of Trench 5.

Artifacts are rare down to 50 cm below the top of the humic horizon. From this depth their numbers increase until, at a depth of 70 to 80 cm, the vast majority are found concentrated within a 30-40 cm thick vertical zone. This zone of artifact concentration contains almost all the large granite-gneiss stones excavated (94 per cent in Trench 5 and 93 per cent in Trench 6). In Trench 5 several of these stones are clustered, and resemble the previously mentioned stone clusters on the deflation surface. Below this zone (approximately 100 cm in Trench 5 and 110 cm in Trench 6), artifact numbers decline rapidly. No artifacts are found in Trench 5 below 140 cm, but isolated pieces are still encountered in Trench 6 where the excavation ended at 160 cm below the top of the humic horizon. The total depth of the cultural deposit remains unknown.

Trenches 1 and 7 are located in areas of Site 4 where the siliceous sand is partially deflated; they provide truncated sequences similar to the lower portions of those found in Trenches 5 and 6. Trench 7 is located on the eastern end of the deflated area where there are few artifacts exposed, and no stone clusters. This trench reaches a depth of 120 cm, but artifacts are recovered only between 20 and 60 cm below the surface. This 40 cm thick band probably equates with the zone of artifact concentration found in Trenches 5 and 6, but since the humic horizon is not present here, correlation is difficult. Trench 1 is located in the central part of the deflated area, between trenches 5 and 6, where the surface is littered with artifacts and granite-gneiss manuports. The trench reaches a depth of 115 cm below the surface, and artifacts are only found in the top 15 cm. It is probable that deflation in this area has continued to a level somewhat below the zone of artifact concentration, corresponding to the lower parts of Trenches 5 and 6.

Many small artifacts (each less than 2.5 g) in the redeposited siliceous sands above the humic horizon in Trench 6 are derived from the adjacent deflated area and were carried to their present position by the wind. Evidence for this is obtained by comparing the percentage of chips (flakes less than 1.5 cm long) in the excavated assemblages with the percentage of chips in the assemblage collected from the surface of the deflated area. Below the

TABLE 1

Numbers and percentages of artifacts recovered from Trenches 5 and 6, by depth below surface.

	Trench 5										Trench 6										
		DBS	Granite		Chert & Qtz				Total			DBS	Granite		Chert & Qtz				Total		Total
					Chips		Other								Chips		Other				
			no.	%	no.	%	no.	%	no.	%			no.	%	no.	%	no.	%	no.	%	
												0-18			25		5		30		
												18-26	2		17		4		23		53
Humic Horizon																					
		0-10			1				1			26-36					1		1		
		10-20										36-46									
		20-30			1				1			46-56									
		30-40		4	2	17		15	2	13		56-66		7		4		12		7	
		40-50			6		1		7			66-76									
		50-60	1		6		4		11			76-86	1				1		2		
		60-70	2		3		2		7			86-96			2				2		
Zone of Artifact Concentration		70-80	8		16		2		28			96-106	3		2		2		7		
	10 600 ± 800 BP SUA 686	80-90	14	94	27	65	13	79	51	77	10 800 ± 300 BP SUA 688	106-116	2	93	10	62	3	63	15	68	76
	18 500 ± 1 700 BP SUA 687	90-100	46		31		22		99			116-126	5		7		3		15		
		100-110	1				3					126-136	4		9		2		15		
		110-120			20				24			136-146			3				3		
		120-130		2		10		6		10		146-156			7		3		10		
		130-140										156-166					1		1		
		140-150										166-176			2	33		25	2	25	
		150-160										176-186			3				3		
		Total	69		113		47		229				15		54		16		76		129

humic horizon in the test trenches, chips account for 58 per cent (Trench 5) and 49 per cent (Trench 6), while the surface assemblage contains only 6 per cent of these small artifacts (Sample A).

Radiocarbon Dates

Charcoal samples were taken from about the middle of the zone of artifact concentration, between 80 and 90 cm below the top of the humic horizon, in both Trenches 5 and 6. These provide the very similar dates of 10 600 ± 800 BP (SUA 686) from Trench 5 and 10 800 ± 300 BP (SUA 688) from Trench 6, reinforcing the assumption that these two zones are extensions of the same, now partially deflated, cultural deposit.

Only 5 cm below this level in Trench 5, however, a charcoal sample associated with the buried cluster of granite-gneiss stones at 90 to 95 cm below the surface of the humic horizon provided the much older date of 18 500 ± 1 700 BP (SUA 687). This suggests that the zone of artifact concentration accumulated over several thousand years, and is not the product of a single period of relatively intensive occupation. Whether the concentration results from a period of long stability in soil accumulation, or from a previous episode of deflation is a matter of conjecture as there is no evidence for either of these suggestions in the soil profile.

THE CULTURAL RESIDUE

Flaked Stone Artifacts

A total of 1 437 flaked stone pieces were collected from the two surface samples and seven test trenches (Tables 2, 3 and 4). Post-depositional alteration of this assemblage during deflation has been extensive since winds have removed and probably shifted many of the artifacts. Deflation in the central portion of the site where Sample A was collected has reached at least the bottom of the zone of artifact concentration (see above). From the numbers of artifacts above the bottom of the zone in the test trenches on either side of this area it can be predicted that the density on the exposed surface should be between 42 (Trench 6) and 126 (Trench 5E) flaked stones per square metre. Since the actual density on that surface as shown by Sample A is only 6.42 artifacts per square metre, the relative composition of the assemblage shown on Table 2 and referred to below is most certainly not a reflection of that present at the time of deposition.

TABLE 2

Summary of flaked stone artifact assemblage: Sample A.

		Chert		Quartz		Granite		Silcrete		Total	
		no.	%	no.	%	no.	%	no.	%	no.	%
Unworked Fragment		10	3.9	64	16.4					74	11.4
	Flake	146		200		1		1		348	
	Chip	7		33						40	
Debitage	Flaked Frag.	39	76.0	58	76.0	2	100		100	99	76.1
	Core	1		1						2	
	Scalar Core			5						5	
Utilized Debitage		45	17.7	27	6.8					72	11.1
Re-	Cutting	1		1						2	
touched Impl.	Scraping	5	2.4	2	0.8					7	1.4
Total		254	39.1	391	60.2	3	0.5	1	0.2	649	100

TABLE 3

Summary of flaked stone artifact assemblage: Sample B.

	Chert	Quartz	Granite	Silcrete	Total
Flake	17	5			22
Flaked Piece	8	7	1		16
Core	2			1	3
Scalar Core	8	2			10
Utilized Piece	12	7			19
Cutting Implement	14				14
Scraping Implement	38	6	1		45
Composite Implement	10	1			11
Microlith		1			1
Chopper			1		1
Upper Grindstone			3		3
Lower Grindstone			4		4
Total	109	29	10	1	149

TABLE 4

Summary of flaked stone artifact assemblage: Test Trenches.

	Trench 1		Trench 2		Trench 3		Trench 4		Trench 5		Trench 6		Trench 7		Total		Total
	Chrt	Qtz	Chrt	Qtz	Chrt	Qtz	Chrt	Qtz	Chrt	Qtz	Chrt	Qtz	Chrt	Qtz	Chrt	Qtz	
Fragment		3	1	4	3	1		3		1					4	12	16
Flaked Fragment		1				1	2	5	1	2	2	1		1	5	11	16
Flake	1	2	8	1	2	10	13	4	21	20	12	7	1		58	44	102
Chip		6	1	2	2	10	12	18	64	56	34	53	5	5	118	150	268
Utilized Piece	1								1		2	1			4	1	5
Scraping Implement							1		1		1				3		3
Total	2	12	10	7	8	22	27	30	88	79	51	62	6	6	192	218	
Total	14		17		30		57		167		113		12				408

Petrology

Four types of stone were used in the flaked stone industry at Quininup Brook: quartz, chert, granite-gneiss and silcrete. The last two are found only as very minor components, together comprising only 0.7 per cent of the assemblage. The quartz, which makes up 60.2 per cent of the flaked stone includes rock crystal quartz, white milky quartz, and smaller amounts of what is more accurately defined as quartzite as it consists of quartz grains cemented with quartz. Most of these stones were probably taken from veins in the nearby granite-gneiss outcrops, although some of the fragments show a remainder of pebble cortex and indicate a stream bed or shoreline source.

The second major component of the flaked stone assemblage is fossiliferous chert. This stone is yellowish-orange in appearance as a result of iron staining from the surrounding sands. The colour of the freshly cut interior varies from white to brownish-grey. Analysis shows this to be cryptocrystalline Bryozoan chert formed from the silicification of fossiliferous

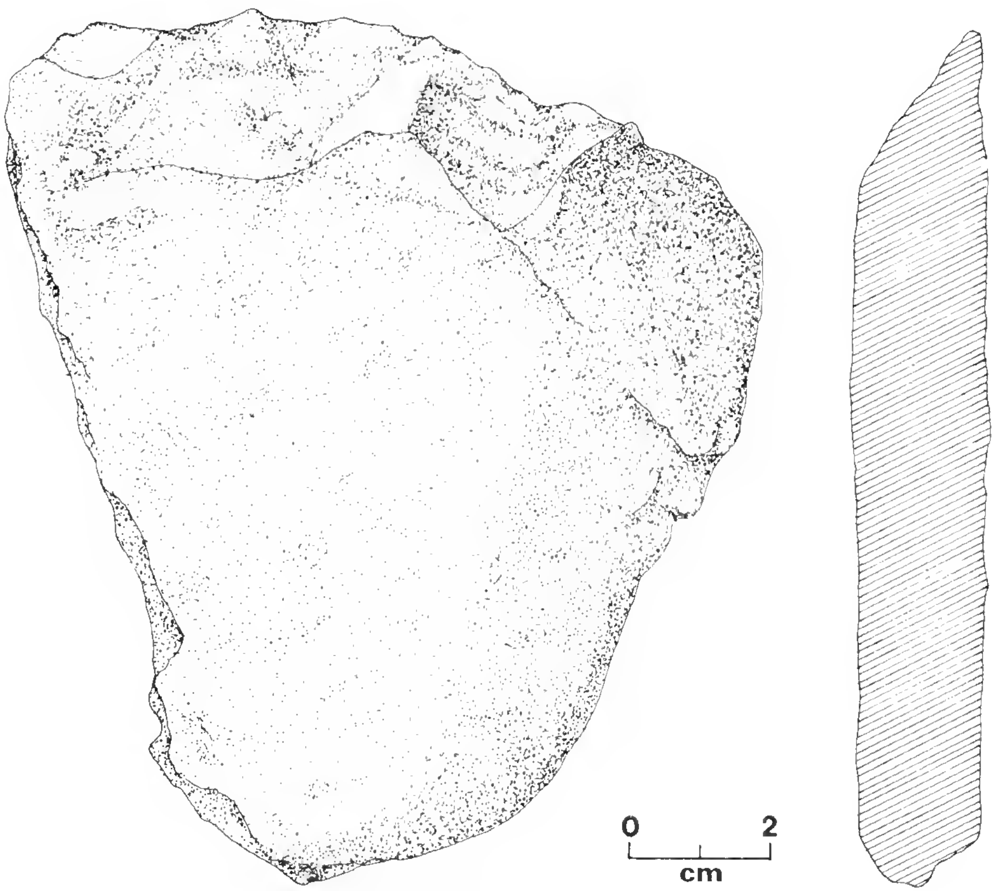

Fig. 4: Granite-gneiss chopper from Site 4.

limestone (J.E. Glover, pers. comm.). This chert is similar to that described from the nearby Devil's Lair deposit (Glover 1974) and to that found on the surface sites of the Swan Coastal Plain (Glover 1975b, Glover & Cockbain 1971). The source of this stone has been postulated as quarries on the continental shelf drowned by rising sea level approximately 6 000 BP (Glover 1975a), a proposal which is supported by recent archaeological finds at the site of Walyunga, near Perth (Pearce 1977, 1978). At Quininup Brook this chert seems to have been preferred to the more abundant quartz for more elaborate stone working. While chert comprises only 39.1 per cent of the flaked stone assemblage, 84 per cent of the retouched tools are of this material.

The granite-gneiss component of the flaked stone assemblage is understandably quite small since this stone, although readily available and extensively utilized on the site for other purposes, possesses few of the fracture qualities desirable for stone knapping. However, two retouched tools, a scraping implement and a chopper (Fig. 4), as well as two flakes and two flaked pieces are present in the assemblage.

The fourth stone type, silcrete, is represented only by two pieces, a flake and a globular core. The specific source of this material is unknown. However, a quarry near Northcliffe, approximately 140 km south-east, has been investigated (Dortch 1975, Dortch & Gardner 1976), and it has been suggested that a similar, nearer south-coast quarry could be the source of the small amounts of silcrete found in the Leeuwin-Naturaliste region (Dortch 1977a: 128).

Stoneworking Technology

Site 4 at Quininup Brook is a single phase site, and the entire assemblage is typical of the 'South-West Early Phase'. This phase extends back to include the oldest recovered materials in this region at Devil's Lair. It terminated sometime after the abandonment of Quininup Brook, between 6 000 BP and 3 000 BP with the introduction to the area of microlithic industries (Dortch 1977a, Dortch & Bordes 1977). The only representative of the subsequent phase, whether it be called 'Late Phase' (Dortch 1977a) or 'Middle Phase' (Hallam 1972), is a single anomalous microlith which was collected from the undeflated surface on the eastern end of Site 4 (Fig. 5).

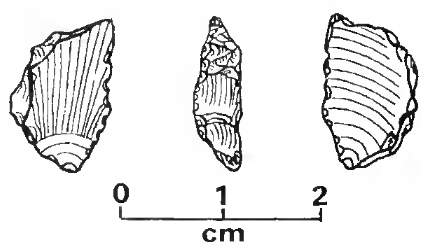

Fig. 5: Quartz microlith from east end of Site 4.

No evidence of deliberate blade production is found at Quininup Brook. Consequently, the term 'blade' is not used in classification even though occasional flakes might be of blade proportions, twice or more as long as wide. Most of the flakes from Site 4 were evidently knapped from pieces chosen at random. The majority of these flaked pieces are formless, possessing no other distinguishing characteristics than one to three negative flake scars, and are classified simply as flaked fragments. Only a few recognizable cores were recovered. Four of these, two globular cores and two amorphous cores, are entirely covered with negative flake scars. There are also six chert 'micro-cores with single striking platforms' (Gould 1977: 81), and two ovate discoidal cores of chert very similar to those which Stockton describes as 'alternatively flaked double domed discs with wavy margins' (1971: 46). All of the single platform cores and one of the discoidal cores show further modification in the form of use-wear and are classified with the implements.

The bipolar stoneworking technique was used on the site and 15 scalar cores were recovered (White 1968). These artifacts, made equally from quartz and chert, show battering on opposed margins with visible negative flake scars invading the piece below the battering on both faces. Two of these specimens had been re-oriented in the course of battering, resulting in the above characteristics on more than one axis. Quatrapolar specimens of this type are noted by McCarthy (1976: 38), and one of the pieces from Quininup Brook is hexipolar with three different axes along which battering was directed.

Flaked Stone Implements

Most of the flaked stone from Site 4 appears to be merely a by-product of stoneworking, and was not utilized or further modified. About 11 per cent of the flakes and flaked fragments show traces of what was initially considered to be use-wear, but since the majority of the pieces are badly weathered, this classification is often doubtful. In the few cases where use-wear is clearly present, these artifacts, along with the 1.4 per cent of the assemblage which exhibits secondary retouch, are classified as implements.

The flaked stone implements from Quininup Brook are described fully elsewhere (Ferguson 1980). They are a collection of generally amorphous flakes and flaked fragments, including notched and denticulated pieces, typical of the South-West Early Phase. From an analysis of the angles of their working edges and from their use-wear patterns a model of function has been developed and tested against an array of ethnographic implements. This confirms that these artifacts can be divided into two basic functional categories. scraping implements, used for scraping wood and possibly bone, and cutting implements, probably used for cutting flesh.

Several of the artifacts which have been classified as scraping implements resemble worn adze flakes (Mulvaney 1975: 77-83). Artifacts of this type were present at Puntutjarpa in the Western Desert by 10 000 years ago (Gould 1977: 103) and similar pieces are found in late Pleistocene deposits at Devil's Lair and in Kimberley (Dortch 1977a). Since in ethnographic time adzes were an exclusively male tool (Spencer & Gillen 1904: 638) the inclusion of adze flakes in the assemblage suggests the presence of men at the site.

Grinding Stones

The Quininup Brook Site Complex has yielded the first grindstones associated with a South-West Early Phase assemblage. Such a discovery is not surprising since an antiquity of 18 000 years has been claimed for these implements elsewhere in Australia (Dortch 1977b, Mulvaney 1975: 133). On Site 4 grinding material is not rare, and the surface of the deflation zone is littered with fragments of granite-gneiss exhibiting smooth surfaces which may be the result of artificial grinding.

Seven unequivocally ground pieces were collected in the surface samples. These are four lower and three upper grindstones. Of the former, one has four ground surfaces, two of which are concave, and another, which was found broken in two pieces approximately a metre apart, is a small (17 x 7 cm) 2 cm thick slab with one surface polished very smooth (**Fig. 6a**). The remaining two lower grindstones have deep dimples pecked into one or more surfaces. One of these is quite large, weighing over two kilograms (**Fig. 6b**). The rounded upper grindstones are smoothly worn on several of their surfaces, and one also shows percussion damage on the edge, probably as a result of use as a hammer stone.

During historical times grinding stones were used in the South-West for preparing several varieties of edible or otherwise useful seeds, nuts, leaves, vines, roots, barks and gums (Meagher 1974), and many of the species of plants so prepared are available in the Quininup Brook region at the present time. Since grindstones were implements used primarily by females, their inclusion in the assemblages suggests the presence of women at the site (Peterson 1968).

Granite-gneiss Manuports — The Stone Clusters

The surface of the deflation zone on Site 4 is strewn with thousands of granite-gneiss stones at an average density of 5.75 stones per m^2 (Sample A). Since the closest outcrops are over 100 m distant, many hours of work are represented in transporting these stones to the site. Their distribution across the site is uneven, and as suggested above, many seem to be clustered together in groups, taking on a slightly mounded appearance (**Fig. 7**).

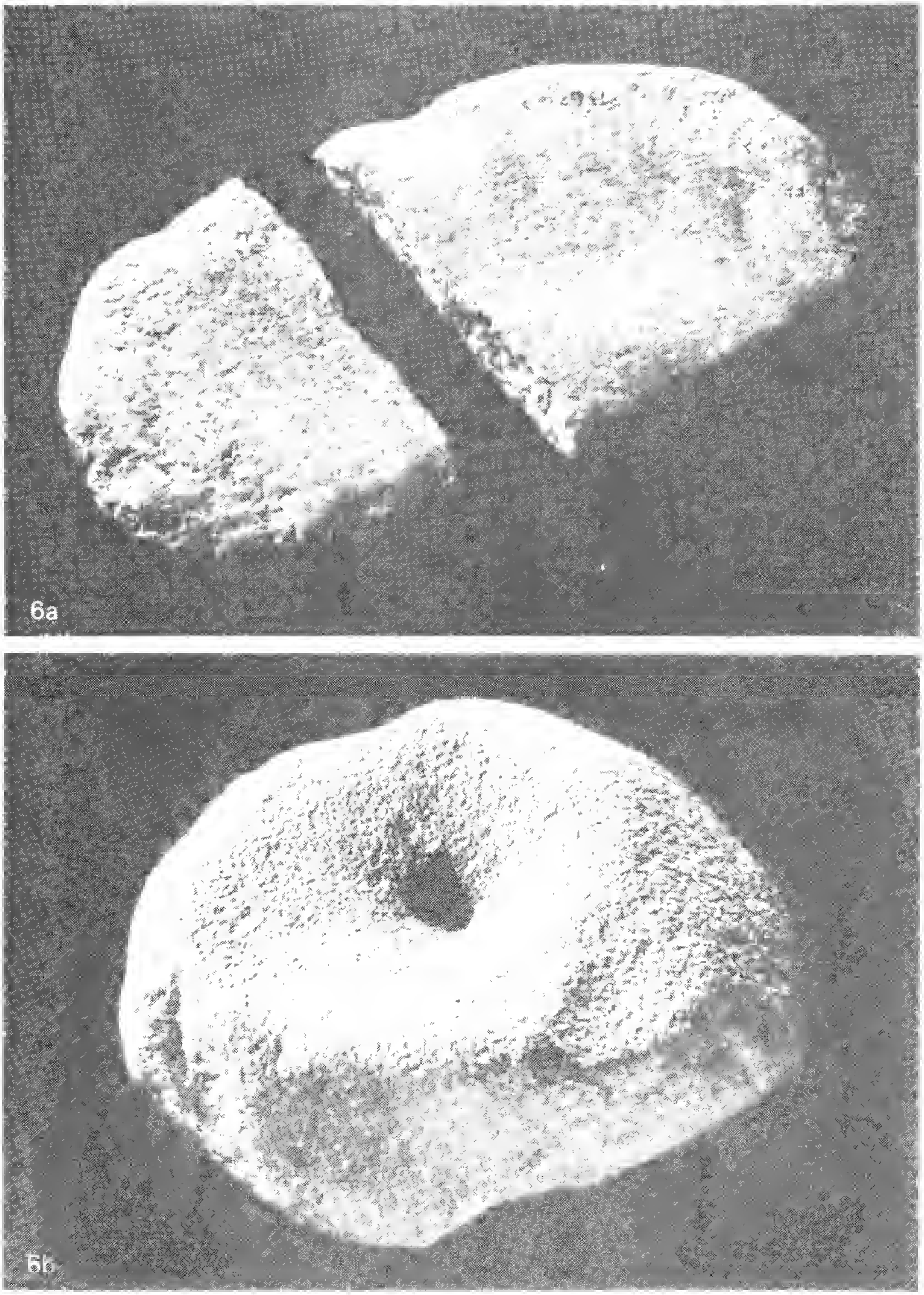

Fig. 6: Photographs of grindstones from Quininup Brook, Site 4.

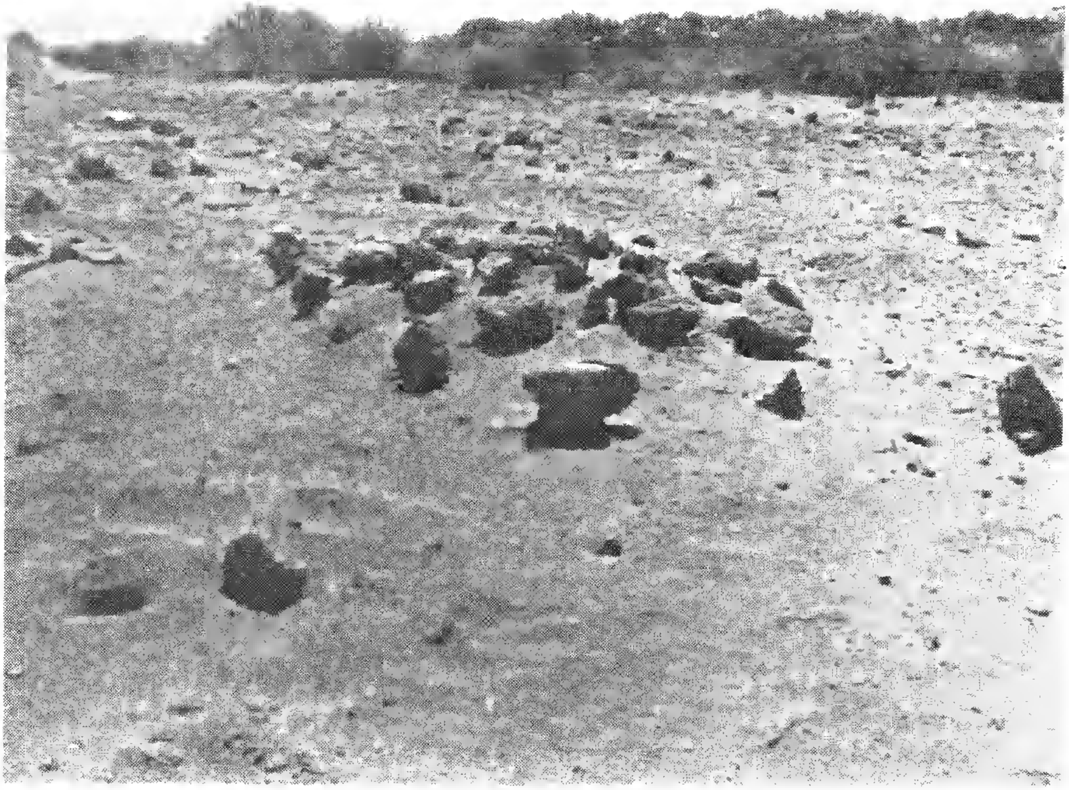

Fig. 7: Photograph of stone cluster, surface of Trench 4, Site 4. (See also **Fig. 8e**, for plan and elevation.)

Nearest-Neighbour Analysis (Pinder & Witherick 1972) applied to those stones within the Sample A area confirms this visual impression. The analysis produced a statistical value of R = .0451, indicating a strong degree of clustering which is significant at the .001 level. It can only be assumed that these stones were purposefully grouped together by the people who carried them to the site.

Thirty-eight clusters can be visually isolated on Site 4, and another five on Site 6 (Fig. 8). They range from one to two metres in diameter, and consist of from 27 to 81 stones which vary in diameter from 1.2 to 25 cm. With the exception of a single stone (**Fig. 8c**), only sand was found within the mounds beneath the surface clusters excavated in Trenches 2, 3 and 4. It is probable that before these clusters became exposed, their stones were arranged on a horizontal plane like those of the unexposed cluster excavated in Trench 5 (Fig. 9). The mounds appear to be only a result of the deflation process, created because the clustered stones prevented the sand directly beneath them from being blown away.

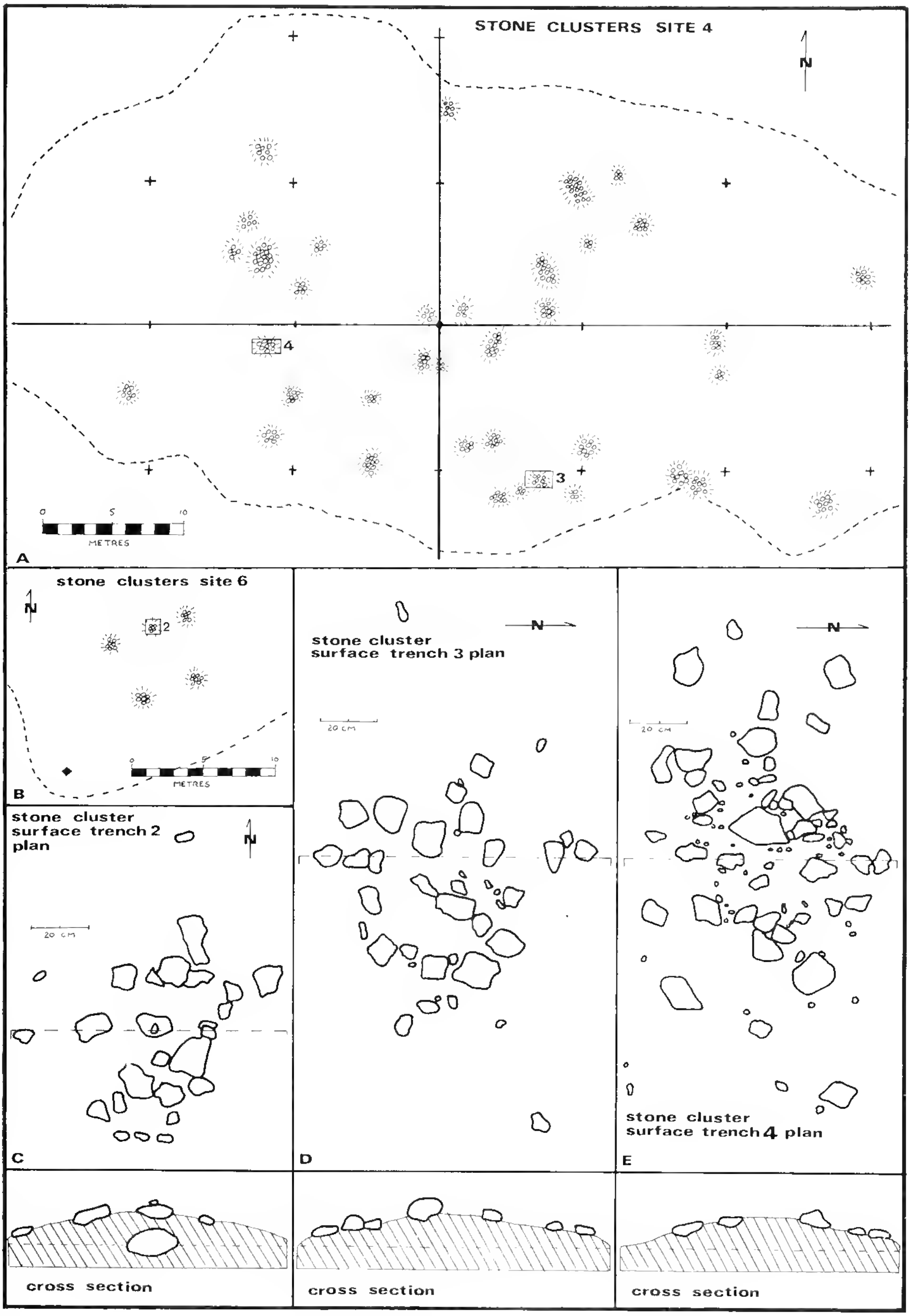

Fig. 8: Stone clusters on Sites 4 and 6.

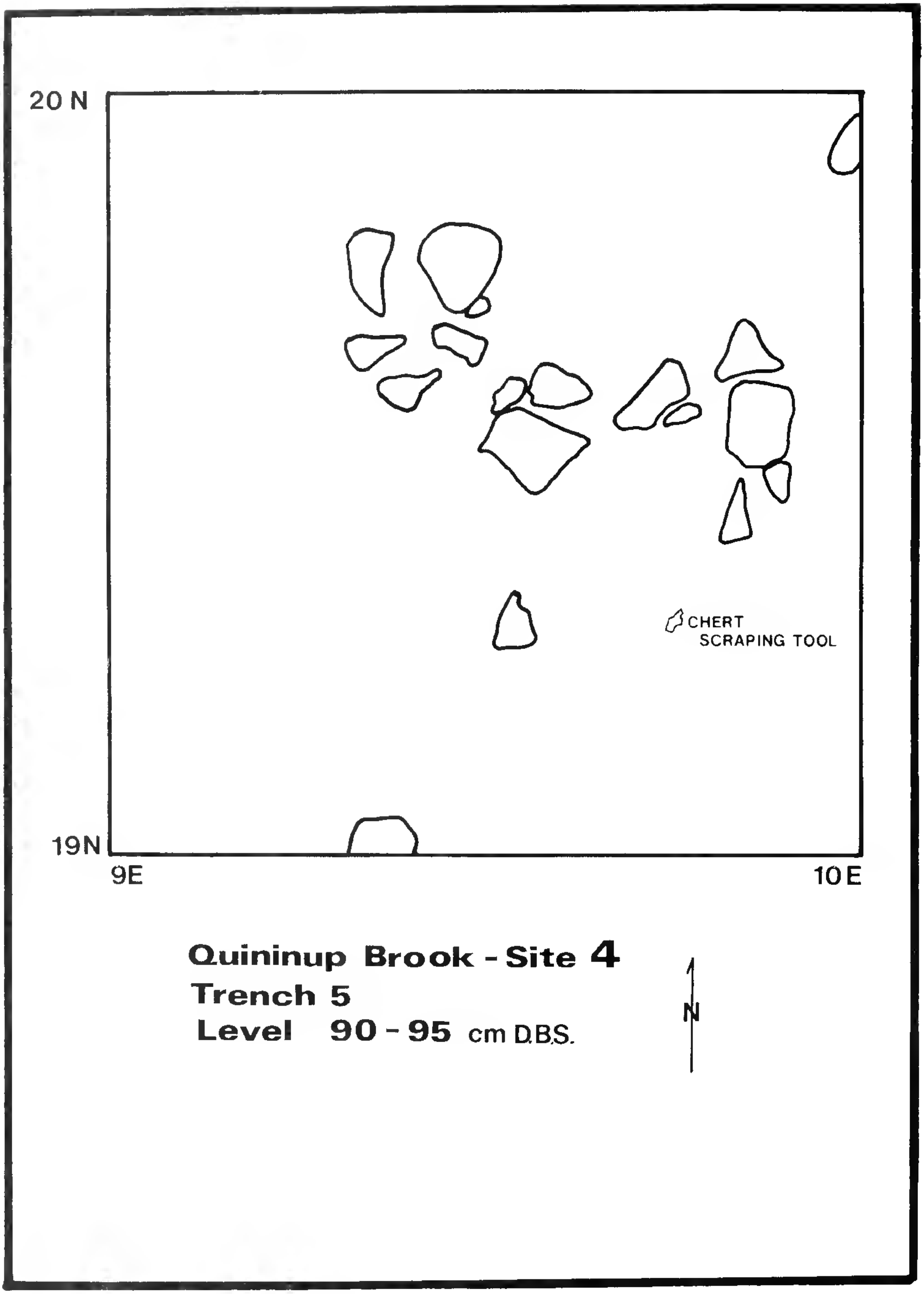

Fig. 9: Buried stone cluster in Trench 5.

The purpose of the clusters is still unknown, although numerous possibilities, both domestic and ritual, have been considered. As described above, the diverse range of ground and flaked stone also found on the site suggests that a number of domestic activities took place here. In Aboriginal Australia ritual sites are normally removed from domestic sites, and since the clusters bear little resemblance to any known form of Aboriginal ritual stone arrangements, it has been concluded that they probably served a domestic rather than a ritual function.

Of several domestic purposes considered only two seem feasible. The most obvious is that clusters could be remnants of hearths, an interpretation perhaps supported by the presence of charcoal and a chert flake with thermal fracturing in association with the buried cluster in Trench 5. Unfortunately such fracturing and fire crazing is not uncommon on artifacts from all parts of the site, and no more charcoal is found in direct association than in the rest of the relatively intensive occupational horizon. Several of the stones in this cluster are fractured in place with sand filling the cracks between the pieces. These fractures could result from the high temperature of a fire, but the structure of the granite-gneiss is such that fracturing can also be easily produced under normal weathering conditions. The fire hearth interpretation remains the most plausible, but no real confirmation is possible at present.

The only other plausible suggestion seems to be that the stones were shelter weights. Scott Nind, an early observer at King George Sound 250 km to the east, noted that the Aborigines placed stones on top of their huts of bowered branches in order to prevent the strips of bark used as roofing material from blowing away during rainy weather (Nind 1831: 27). Collapse and decay of such a structure might result in a cluster of stones similar to those at Quininup Brook, but corroborating evidence such as post holes is not found on the Quininup Brook sites.

DISCUSSION

Quininup Brook and South-West Prehistory

Prehistory in the South-West, as elsewhere in Australia, can be approached in two different but complementary ways. The first uses the traditional archaeological method of excavation, and builds a picture of the past from the cultural residue and the contexts of its recovery. A second approach, ethnohistorical inference, establishes its picture by projecting backward from the period of terminal hunter-gatherer exploitation as revealed in the writing of the early 19th century explorers and settlers. Both methods are used in the following attempt to gain an understanding of the prehistoric Quininup Brook Site Complex.

Archaeology

Two other sites quite close to Quininup Brook have also been dated to the late Pleistocene. Most notable is the cave site of Devil's Lair, 40 km south of Quininup Brook, where excavation has produced evidence of intermittent human occupation of the region from 33 000 to 5 000 years ago (Dortch 1979a). Preservation within the cave is good and a large sample of faunal remains as well as bone implements and ornaments, engraved limestone plaques, stone artifacts, living floors and features, and human skeletal remains have been recovered and reported (Allbrook 1976; Balme 1978; Balme, Merrilees & Porter 1978; Baynes, Merriless & Porter 1975; Davies 1968; Dortch 1974, 1976, 1979a, 1979b; Dortch & Merrilees 1971, 1973; Freedman 1976; Glover 1974; Shackley 1978). The highest frequency of occupation within the cave was between about 24 000 and 12 000 years ago (Balme *in press*).

The second site is at Arumvale, 2-3 km south of Devil's Lair. This is a stratified open site which has charcoal dated at 18 400 ± 540 BP (SUA 456) and 9 220 ± 136 BP (SUA 455) in association with chert and quartz artifacts (Dortch & McArthur *in prep.*).

A third nearby site may also date from the late or terminal Pleistocene. At Dunsborough, 20 km north of Quininup Brook, the author has recently conducted a test excavation of an open site previously reported by Glover, Dortch & Balme (1978). Here there is a 2 m deep cultural deposit containing chert and quartz artifacts. The lowest charcoal in the test trench was found about the middle of the deposit, 100 to 110 cm below the surface, and this yielded a date of 7 145 ± 275 BP (SUA 888).

Only one other site in the entire South-West, Minim Cove near Perth, has been dated to the late Pleistocene. Although approximately 250 km north, Minim Cove is similar in location to the Quininup Brook sites, being a coastal site situated within Spearwood Dunes. It is dated to 9 930 ± 130 BP (SUA 454) from charcoal which was recovered over 1 m below the surface and 90 cm above the lowest chert artifact (Clarke & Dortch 1977).

Ethnohistory

In historical times the coastal region between Capes Leeuwin and Naturaliste was within the *Wardandi* 'tribal' area (Tindale 1974). The Aboriginal inhabitants of this region were a mobile people utilising a variety of sometimes widely spaced resources which they exploited via a series of interconnecting pathways. These pathways were along zones of easy movement, often following stream courses, and were kept open by periodic burning. Camping places were nodes in this network of exploitation, located where paths came together at sources of permanent water (Hallam 1975: 66-71).

When Europeans first arrived, this region appears to have been more sparsely populated by Aborigines than the neighbouring Swan Coastal Plain to the north (Birdsell 1953; Hallam 1977). Hallam believes this was due primarily to the comparatively high rainfall which nurtured the thick Karri and Jarrah forests. These forests were detrimental to high human population densities because they supported a relatively low herbivore biomass and restricted the ease of human movement (Hallam 1977: 172-173).

The Late Pleistocene South-West

Recent research suggests that in southern Australia the late Pleistocene climate was generally cooler and more arid than at present (Bowler 1976a, 1976b; Rognon & Williams 1977; Wyrwoll 1977; Wyrwoll & Milton 1976). This aridity may have been somewhat ameliorated under the maritime conditions of the extreme south-west, but evidence from faunal studies in the local limestone caves suggests that this region, too, was notably drier. In Devil's Lair much of the vertebrate fauna recovered from this period appears to be adapted to a drier, more open environment. The range of species from diverse ecological zones suggests water was still plentiful nearby, but that large sections of what is now forest might have been more sparsely vegetated (Balme, Merrilees & Porter 1979).

Merrilees has recently published a paper dealing with the fossil remains of a now locally extinct rock wallaby (probably *Petrogale penicillata*) found in Devil's Lair and other limestone cave deposits of the region (1979). This animal is thought to require a more open environment than is currently present in the region and first appears in the local fossil record about 30 000 BP, increasing significantly in numbers from about 21 000 BP. The presence of rock wallaby remains in the Yallingup Cave deposit, near Dunsborough, has led Merrilees to suggest that in the northern part of the Leeuwin-Naturaliste region where Quininup Brook is located, conditions must have been so dry that much of the now forested areas would have then been covered with open plant formations (1979: 82).

This postulated more open environment would have enabled freer movement by humans. It would have also probably supported a much larger population of game animals. In the South-West today, populations of the larger macropods are lowest in the wet sclerophyll (Karri) formations with a dense shrub layer and highest in the more open dry sclerophyll (Jarrah-Marri) forests (Christensen & Kimber 1975: 98-99). In Devil's Lair radiocarbon dated stratigraphic layers containing the richest vertebrate remains roughly coincide with the glacial maximum about 19 000 to 12 000 years ago (Balme, Merrilees & Porter 1978: 54-55, Table 3).

At the height of the last glacial maximum there was also a larger area of land in the South-West available for exploitation. About 17,000 years ago, not long after occupation seems to have begun at Quininup Brook, sea level was 150 m lower than at present (Chappell & Thom 1977: 282). From the bathymetric data on Lowry's geological map (1965) it appears the shoreline was about 40 km west of the present mouth of the brook. These sites which are now being eroded by the sea, were then situated well inland on a ridge overlooking a vast coastal plain.

The Use and Abandonment of Quininup Brook

Although the late Pleistocene environment was considerably different from that of the present, the technology by which it was exploited was probably similar. The Quininup Brook investigations have shown that grindstones were part of the South-West Early Phase tool assemblage. This addition reinforces Dortch's suggestion (1974: 202) that these assemblages seem to indicate methods of exploitation which are similar to those of the Aborigines found in this region in historical times.

Information presented above and elsewhere (Ferguson 1980) suggests that the Quininup Brook Site Complex was a cluster of domestic sites at which family groups were present. It was a generalized camping area where fires were built, stone and wooden implements were made, and probably both vegetable and animal foodstuffs were prepared. In view of apparent similarities in the methods of exploitation it seems reasonable to draw an analogy with the campsites of the ethnohistorical period (Ascher 1961: 319), and to see the site complex as part of a late Pleistocene exploitation network, a node where paths of this network came together at permanent water.

One of these Pleistocene paths possibly followed Quininup Brook toward the sea across the now submerged coastal plain. Modern paths often followed the stream courses, and the presence of the fossiliferous chert from the continental shelf at the Quininup Brook sites indicates that at least part of that coastal plain must have been included in the late Pleistocene network. Other paths may have run through the then more open country along the ridge and across the undulating plateau east of it. Some of these possibly connected Quininup Brook with the nearby sites of Arumvale, Devil's Lair and Dunsborough which were then also located well inland. All of these sites appear to be at least in part contemporaneous, and all are within the boundaries of the ethnographic *Wardandi* network.

There is little likelihood that any remains of these paths are preserved, and attempts to reconstruct the exact patterns of such a Pleistocene network will probably always remain speculative. At the same time is is useful to view these late Pleistocene sites as part of a larger exploitative network in order to understand how their use may have changed gradually over time. During the more than eight thousand years that Quininup Brook seems to have been frequented, the land to the west was slowly but steadily disappearing under the encroaching sea. Eventually, as the sea neared its present level, there would, of course, have been radical alterations to the resource area immediately surrounding the site complex. However, perhaps hundreds or even thousands of years before this happened, marine transgression could already have been changing the regional pattern of human movement. Changes of this kind may have influenced the frequency and duration of visits to the site complex, so altering the way in which the resource area immediately surrounding it was exploited.

Much has been said in the Australian literature about the effect of rising sea levels on Aboriginal ecological adaptation in coastal and near coastal environments (Bowdler 1977; Flood 1974; Jones 1968; Lambert 1977; Wright 1971). In the South-West this stress of a shrinking exploitation area is suggested to have been coupled with a deterioration in the habitability of that part which remained. In southern Australia generally there was an increase in wet conditions during the terminal Pleistocene-early Holocene that peaked between 7 000 and 5 000 years ago (Rognon & Williams 1977: 305). This was about the time that sea level reached its present position, and may correspond with the development of the thick weathered humic horizon in the reddish-brown siliceous sands at Quininup Brook. Pollen studies have shown a major increase in the distribution of the Karri forests at this time (Churchill 1968). This formation probably then spread to include at least the locally wet areas of the northern Leeuwin-Naturaliste ridge, e.g. the area around Quininup Brook where an outlier of Karri remains today. Faunal studies in the region document the local extinction of a number of non-forest species in the early to middle Holocene (Balme, Merrilees & Porter 1978; Merrilees 1979; Porter 1979). The ranges of other species, such as the Brush Wallaby (*Macropus irma*) which is one of the commonest large marsupials in the area today (Christensen & Kimber 1975: 99), are believed to have contracted northward at this time, with recolonization only after the first felling of the forests during the 19th century (Baynes, Merrilees & Porter 1975).

The abandonment of the Quininup Brook Site Complex after a long history of occupation can be seen in the context of this shrinking and possibly deteriorating environment. Under such conditions human population might have dwindled in the region, perhaps with the focus of the exploitation shifting further inland. East of the forested block the onset of wetter conditions would have enhanced the habitability of regions which had been extremely arid during the late Pleistocene. In the heavily forested regions, the zones of easy movement would have become more difficult to maintain with less reward for doing so. As more and more land disappeared beneath the sea, there would have been less and less reason to venture down the paths that once joined at what is now the mouth of Quininup Brook.

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