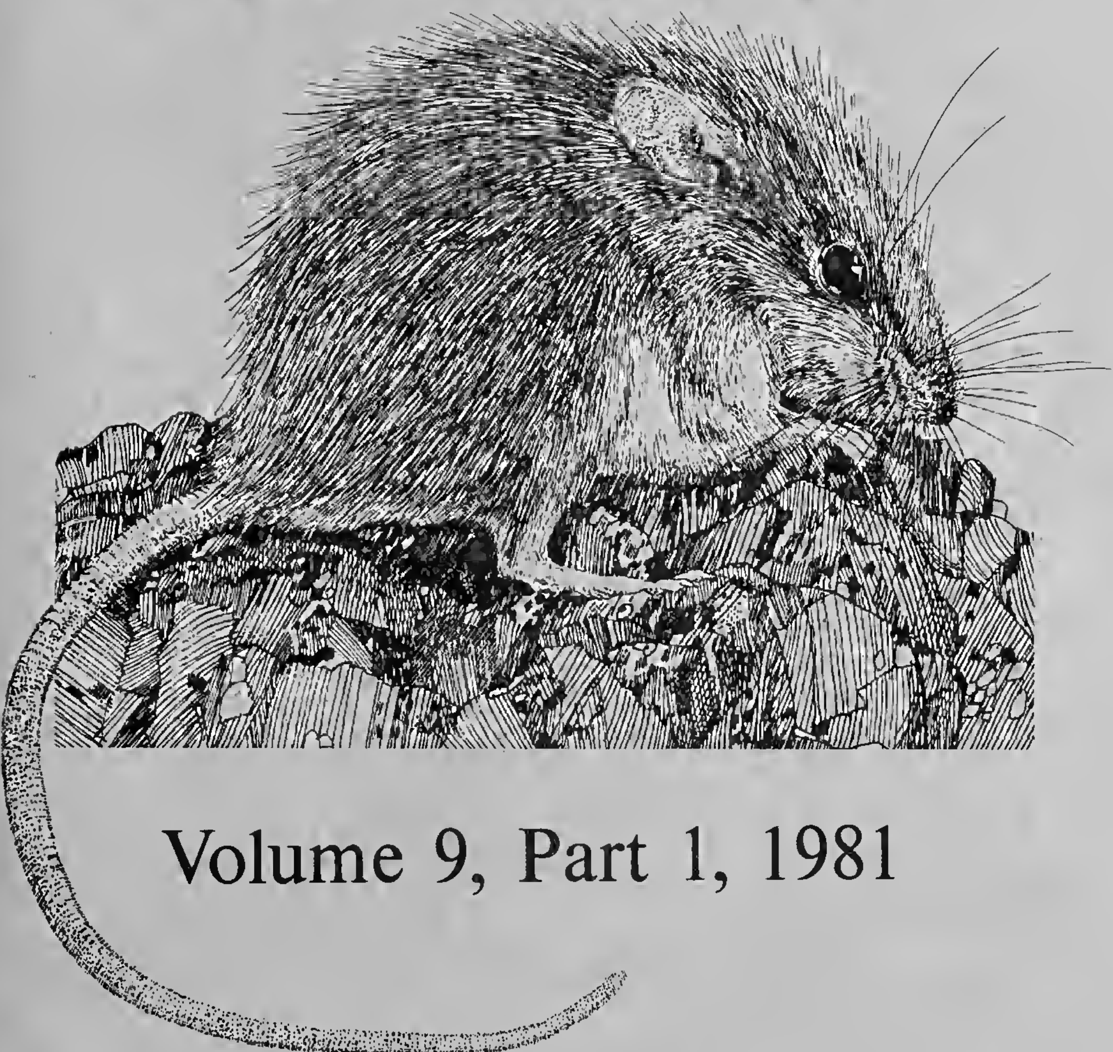
RECORDS OF THE WESTERN AUSTRALIAN MUSEUM



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RECORDS OF THE WESTERN AUSTRALIAN MUSEUM

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Cover: An adult female Pebble-mound Mouse *Pseudomys chapmani* from the Hamersley Range National Park, illustrated by Gaye Roberts.

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OBSERVATIONS ON THE PEBBLE-MOUND MOUSE *PSEUDOMYS CHAPMANI* KITCHENER, 1980

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&
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ABSTRACT

Observations are presented which indicate that the recently described native rodent *Pseudomys chapmani*, rather than *P. hermannsburgensis*, constructs the pebble mounds mentioned by Ride (1970). Some aspects of active mounds, and the habitats of the Pebble-mound Mouse, are described. The distribution of *P. chapmani* pebble mounds is outlined. In the Gascoyne and Murchison districts these stone nests may be relicts indicating the former distribution of the species.

OBSERVATIONS

Many observers have noted pebble mounds (Ride 1970) or stone nests (Davies 1970) in the north-west of Western Australia. Ride (1970) attributed these structures to the widespread Sandy Inland Mouse *Pseudomys hermannsburgensis* (Waite, 1896). However, over much of its range in arid Australia this mouse has been collected from short, simple burrows (Kitchener 1980, Philpott & Smyth 1967, A. Baynes, pers. comm. and P. Woolley, pers. comm.) and only in the north-west is it found inhabiting pebble mounds.

During a biological survey in 1979, specimens of an undescribed *Pseudomys* were pit-trapped by the authors 31 km south-east of Mt Meharry in the Pilbara region of Western Australia. During the year 12 individuals were captured on traplines set near active pebble mounds. A new species, *Pseudomys chapmani* Kitchener, 1980, was described using the first four specimens collected in 1979 and earlier specimens collected in the late 1950s by E.H.M. Ealey on stations north-east of the Hamersley Ranges (Kitchener 1980). Significantly, many of the earlier specimens, which were then not regarded as distinct from *P. hermannsburgensis*, were collected

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from pebble mounds. Kitchener (1980) provides photographs of the type locality and of an active mound (Fig. 1).

On 19 May 1980, during a biological survey of the Hamersley Range National Park, a gravid female *P. chapmani* was pit-trapped using a drift fence enclosing a pebble mound, 11 km south-east of Mindi Spring (22°48'S, 118°19'E). The mouse was placed in a photographic chamber and supplied with pebbles from its nest. During the following evening it was observed actively moving pebbles. These were transported short distances in the mouth to form a small heap in the corner of the chamber. The forelimbs were also employed in shuffling stones into position and burrowing into the mound. Subsequently this animal was maintained in captivity where it continued to demonstrate mound-building behaviour and on 24 May 1980 produced a litter of four young.

These observations suggest that *P. chapmani* builds pebble mounds and *P. hermannsburgensis* merely uses these nests in the Pilbara on an opportunistic basis. Thus the common name Pebble-mound Mouse should properly be assigned to *P. chapmani* whereas *P. hermannsburgensis* should be referred to only as the Sandy Inland Mouse.

Pebble mounds observed in the Pilbara district ranged in area from 0.5-9.0 m^2 with heaps of stones up to 25 cm above the ground surface. Large mounds had undulating surfaces and pop-holes connected by U-shaped tunnels. Frequently the mounds were added to deep crevices in the rocky substrate. Pebbles from an active mound were weighed to ± 0.1 g on a beam balance and their maximal length was measured to ± 0.1 mm using vernier calipers. The mean weight of 73 pebbles was 4.7 g (S.E. ± 0.7; range 1.3-13.7 g) which is about 30% of the adult body weight of *P. chapmani*. Pebble lengths ranged from 14.9-40.2 mm and their distribution was trimodal with peaks at 20, 26 and 30 mm. This distribution may indicate building activity by different age classes at a traditional mound.

The Pebble-mound Mouse is evidently an inhabitant of rocky, hummock grassland areas with little or no soil in which to burrow but with plentiful supply of pebbles. In the eastern Pilbara, nests of pebbles derived from the iron formation ridges and dolomite and calcrete outcrops were recorded. Mounds were most common on the spurs and lower slopes of ridges where weathering produces abundant pebbles of the preferred size. This habitat was usually vegetated with an open to mid-dense *Triodia basedowii* hummock grassland and scattered emergent *Cassia*, *Acacia* and *Ptilotus* spp. Stone nests were also observed at lower densities on the ridges and outcrops where there was hummock grassland of *T. wiseana* with many emergent *Eucalyptus* and *Acacia* spp.

Fig. 2 shows the localities where *P. chapmani* has been collected and the known distribution of pebble mounds. From the available data it would appear that the range of *P. chapmani* extended from the Pilbara through the Gascoyne to the Murchison district with a southern limit near Mileura (26°22'S, 117°20'E). The Pebble-mound Mouse has evidently never occurred on the coast (e.g. Cape Range) or on Barrow Island. Its other limits appear to have been the edge of the Great Sandy Desert to the north and the Gibson Desert to the east. From the efforts of workers in the Gascoyne and Murchison districts it now seems probable that the species is extinct in these areas (S.J.J.F. Davies, pers. comm.) and the remaining populations may be confined to the eastern Pilbara. The reasons for this decline are not known.

Fig. 1: An adult female Pebble-mound Mouse *Pseudomys chapmani* from the Hamersley Range National Park (photo: A.G. Wells).

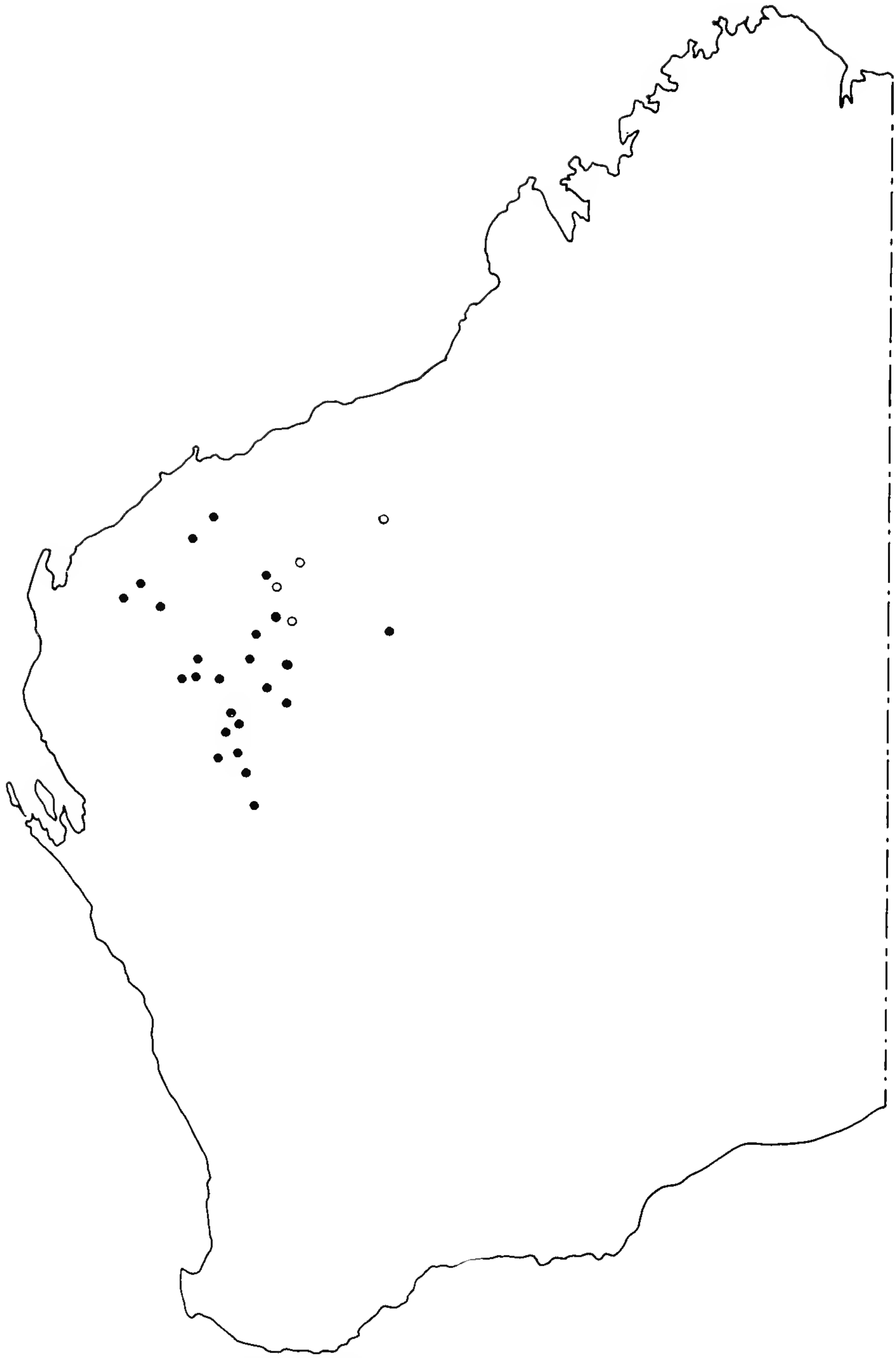

Fig. 2: The distribution of pebble mounds in Western Australia. Open circles (○) indicate locations where *Pseudomys chapmani* has been collected. Closed circles (●) indicate records of the pebble mounds alone, compiled from the observations of S.J.J.F. Davies, T.A. Knight, P. de Rebeira, I.J. Rooke and the authors.

ACKNOWLEDGEMENTS

We gratefully acknowledge the assistance of Cliffs International, Inc., Texasgulf (Australia) Ltd, Hamersley Iron Pty Ltd and the Western Australian National Parks Authority in making the Hamersley Range National Park survey possible. S.J.J.F. Davies, T.A. Knight, P. de Rebiera and I.J. Rooke kindly made available unpublished data on the distribution of pebble mounds. The staff of the Western Australian Museum, particularly D.J. Kitchener, A. Baynes and G. Barron, provided valuable technical support and encouragement. R.D. Wooller helpfully criticised the manuscript and A.G. Wells provided the photograph.

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NOTES ON THE DISTRIBUTION, ECOLOGY AND TAXONOMY OF THE RED-CROWNED PIGEON (*PTILINOPUS REGINA*) AND TORRES STRAIT PIGEON (*DUCULA BICOLOR*) IN WESTERN AUSTRALIA

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ABSTRACT

Data on distribution, status, habitat, food, breeding and colour of soft parts are given for the Red-crowned Pigeon (*Ptilinopus regina ewingii*) and the Torres Strait Pigeon (*Ducula bicolor spilorrhoa*) in Kimberley, Western Australia. Geographic variation in both species is analysed. Three subspecies are recognised in the Red-crowned Pigeon, *P. r. regina* of eastern Australia, *P. r. ewingii* of Northern Territory, Kimberley and Lesser Sunda Islands, and *P. r. xanthogaster* of the Banda and Kei Islands; four in the Torres Strait Pigeon, *D. b. bicolor* from India to northwest New Guinea, *D. b. luctuosa* of Sulawesi, *D. b. spilorrhoa* of Australia and mainland New Guinea and *D. b. subflavescens* of the Bismarck Archipelago and Admiralty Islands.

INTRODUCTION

This paper is the first of a series on Kimberley pigeons. Thirteen native species of pigeon inhabit Western Australia; only one of them, the Brush Bronzewing (*Phaps elegans*), does not occur in the Kimberley. Five species, namely the Red-crowned Pigeon (*Ptilinopus regina*), Torres Strait Pigeon (*Ducula bicolor*), Green-winged Pigeon (*Chalcophaps indica*), White-quilled Rock Pigeon (*Petrophassa albipennis*) and the Partridge Pigeon (*Geophaps smithii*) are in Western Australia restricted to the Kimberley Division.

Sir George Grey was the first to record the Torres Strait Pigeon in Western Australia. On 17 December 1837 he collected two specimens at Hanover Bay (near the mouth of Prince Regent River) which he presented to the British Museum in 1840. G.F. Hill, who recorded and collected birds at Napier Broome Bay from August 1909 to July 1910, was the first to observe and collect a specimen of the Red-crowned Pigeon in Western Australia. He was

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also informed by Aborigines that a large white pigeon occurred there, and he often heard birds which he believed were Torres Strait Pigeons. Nothing more was learnt of these two pigeons in this State until the early 1970s when the Department of Ornithology and Herpetology of the Western Australian Museum, often in conjunction with the Department of Fisheries and Wildlife, began extensive survey work in the Kimberley. Much of the data presented in this paper resulted from these surveys. I am grateful for additional unpublished data from Mr W.H. Butler and Mrs H.B. Gill.

In both the Red-crowned and Torres Strait Pigeons it has been necessary to study specimens from other parts of Australia, New Guinea and southeast Asia to determine the taxonomic status of Western Australian populations.

MATERIALS AND METHODS

Ninety-six Red-crowned and 53 Torres Strait Pigeon specimens held in the Western Australian Museum, Australian National Wildlife Collection, National Museum of Victoria, British Museum (Natural History) and Rijksmuseum van Natuurlijke Histoire, Netherlands, were examined. Measurements of specimens were taken as follows: length of chord of flattened wing, length of tail to the outside base of central rectrix, length of tarsus and length of entire culmen.

RED-CROWNED PIGEON
Ptilinopus regina

Distribution

Storr (1980) gives the distribution in Kimberley as the subhumid northwest sector of the Kimberley Division from Napier Broome Bay southwest to Kunmunya, including several islands in the Bonaparte Archipelago, with an isolated population on the far north of Dampier Land (see **Fig. 1**).

Fig. 1: Distribution of *Ptilonopus regina regina* (north of Cardwell, Queensland), *P. r. ewingii* in Northern Territory and Western Australia and *P. r. ewingii*, *P. r. 'roseipileum'* and *P. r. xanthogaster* in Lesser Sunda Islands.
P. r. regina: 1 Cardwell, Rockingham Bay, Hinchinbrook Island, South Brook Island; 2 Dunk Island; 3 Innisfail, Mission Beach; 4 Yungaburra; 5 Cairns, Yarrabah; 6 Port Douglas; 7 Bloomfield River; 8 Cooktown; 9 Claudie River, Iron Range; 10 Somerset; 11 Prince of Wales, Booby, Thursday and Horn Islands; 12 Banks Island; 13 Darnley Island; 14 Edward River.
P. r. ewingii: 15 Sir Edward Pellew Group; 16 Groote Eylandt; 17 Port Bradshaw, Yirrkala; 18 Cobourg Peninsula (Reef Point, Black Point, Smith Point, Point Priest, Port Bremer); 19 Nourlangie; 20 South Alligator River; 21 Melville Island; 22 Darwin (East Point, Thring Creek, Cannon Hill, Mica Beach, Buffalo Point, Howard Springs, Shoal Bay); 23 Quail Island (Port Patterson); 24 Daly River; 25 Port Keats; 26 Kalumburu, Napier Broome Bay; 27 South West Osborne Island; 28 Hunter River; 29 St Andrew Island; 30 Kunmunya; 31 Cygnet Bay.

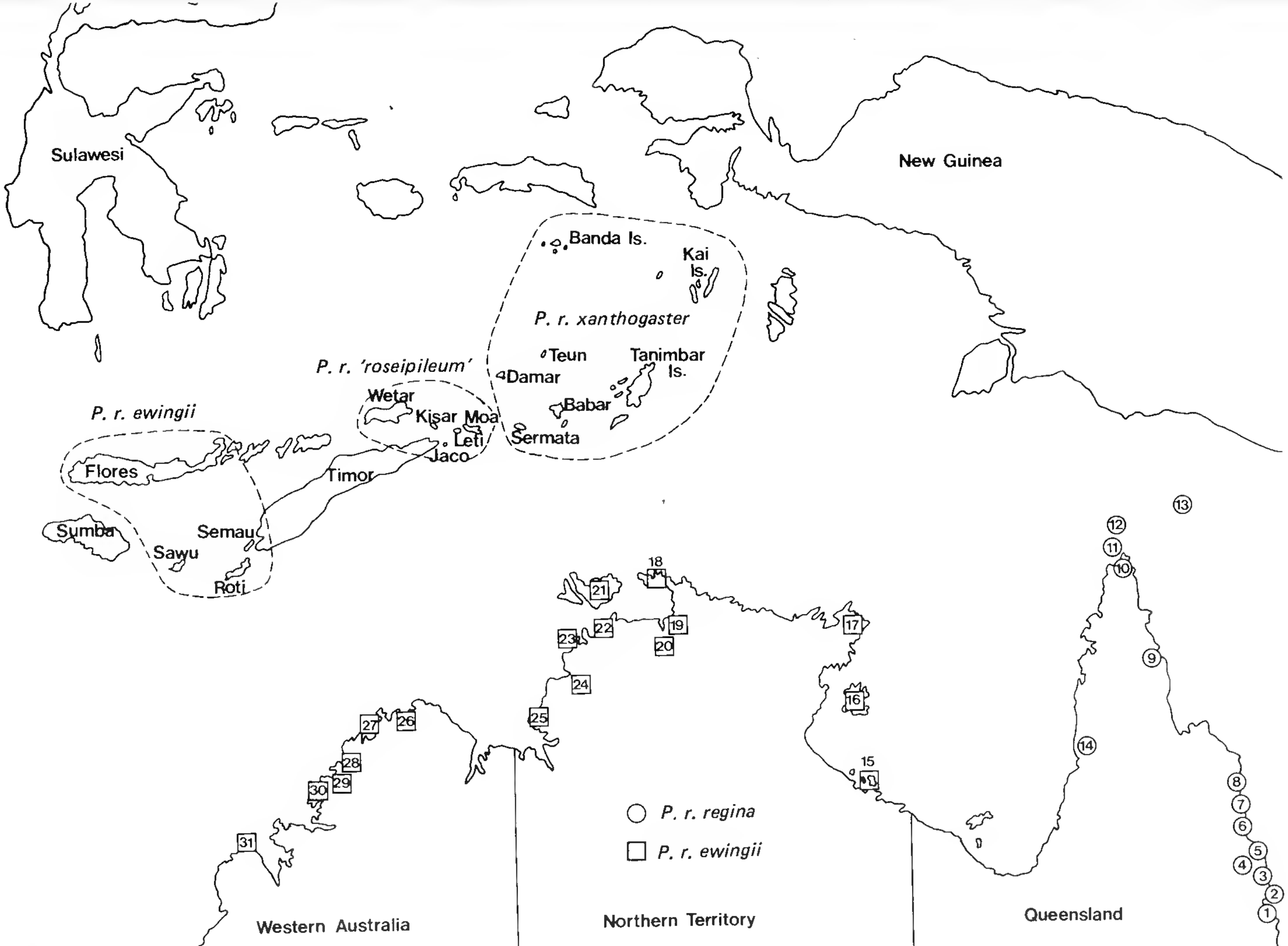
Sulawesi
New Guinea
Banda Is.
Kai Is.
P. r. xanthogaster
Teun
Tanimbar Is.
Damar
Babar
Sermata
P. r. 'roseipileum'
Wetar
Kisar
Moa
Leti
Jaco
P. r. ewingii
Flores
Timor
Sumba
Semau
Sawu
Roti
P. r. regina
P. r. ewingii
Western Australia
Northern Territory
Queensland
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Fig. 1

Status

Scarce, in ones, twos and threes on the northwestern mainland and islands. Uncommon to moderately common in flocks of up to five in northern Dampier Land.

Ecology

This pigeon is restricted to coastal semi-deciduous vine forest and thicket, mangal and tall melaleuca forest and woodland. The semi-deciduous vine forests, thickets and scrubs are best developed on coastal basalts where mean annual rainfall exceeds 1200 mm. The forests on the Osborne Islands are the richest in Kimberley; here and at the mouth of the Hunter River the vine forests are contiguous with closed mangrove forests which this pigeon also frequents. In the semi-deciduous vine forests the canopy closes at 3-9 m; the emergents (mostly deciduous) rise to 15 m and include *Bombax ceiba*, *Albizia lebbek*, *Celtis philippensis*, *Randia cochinchinensis*, *Ficus* spp., *Eugenia* spp., and *Zizyphus quadrilocularis*. The middle level consists mostly of slender trees and shrubs, and the lowest level is dominated by vines and spiny shrubs. On Dampier Land the Red-crowned Pigeon occurs in more open vine forests and scrubs growing on the landward side of coastal dunes and in near-coastal melaleuca thickets and forests (*Melaleuca leucadendron* and *M. acacioides*). The vine forests here consist of *Celtis*, *Ficus virens*, *Ficus dasycarpa*, *Ficus opposita*, *Terminalia*, *Cassine melanocarpa*, *Diospyros ferrea*, *Melaleuca* and often scattered *Eucalyptus*.

During the day the pigeons seldom leave the canopy and if disturbed prefer to fly below the canopy rather than above it. In flight the wings make a silky swishing noise. The call consists of about three short coos followed by a laughing sound, the coos commencing slowly and increasing in volume and the laughing sound decreasing in volume and descending in pitch.

The crops of two specimens collected on South West Osborne Island contained the fruits of *Zizyphus quadrilocularis*. Birds have been observed feeding on the fruit of *Mimusops elengi*.

Breeding

Two males and one female were collected on 28 June 1973 on South West Osborne Island. The female weighed 85 g and had a well-developed ovary (largest follicle 4 x 4 mm) and highly convoluted oviduct. The males weighed 85 and 86 g and had enlarged testes. It seems that these birds had recently bred.

Soft Parts

Bill green, iris yellowish orange (some specimens light brown), legs dark greenish grey and mouth greenish grey.

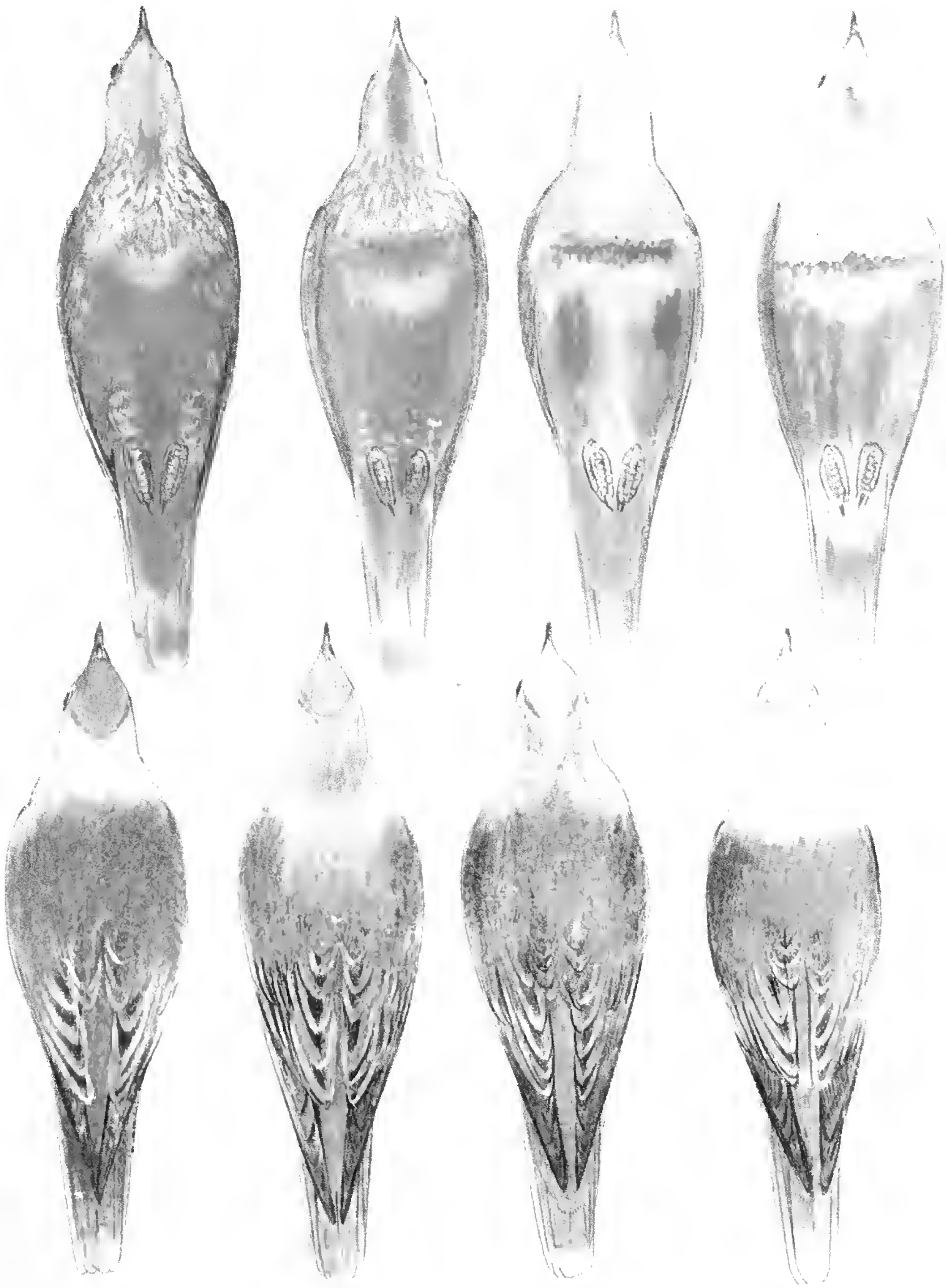

Fig. 2: Ventral and dorsal coloration in subspecies of *Ptilonopus regina*. Left to right: *P. regina regina* (CSIRO 5398 ♂ NSW); *P. r. ewingii* (CSIRO 6508 ♂ NT); *P. r. 'roseipileum'* (CSIRO 30202 ♂ Timor) and *P. r. xanthogaster* (CSIRO 14269 Taam Island [Kai Islands]).

Geographic Variation

The nominate subspecies *Ptilinopus regina regina* occurs in eastern Australia. Its distribution in Queensland is outlined by Storr (1973). In New South Wales it extends south to about Port Stephens. As a vagrant it has been recorded in Victoria and even as far south as Tasmania. New South Wales birds are described as follows: cap reddish purple, finely edged behind with yellow to above the eye (some specimens have little or no yellow edging); lore whitish; mantle greyish green in male, green (same as back colour) in female; rest of upper parts green, wing coverts and secondaries edged yellow and tertials and some coverts with dark blue spots, and tail broadly tipped yellow or yellowish white; chin whitish yellow; throat dull yellowish white; breast dark green (the bifid feathers tipped with silver-grey); belly patch pale reddish purple (often reduced to a few feathers); rest of belly and flanks reddish orange, becoming more yellow towards vent; under tail coverts reddish orange in male, yellow or yellowish orange in female; under tail grey; tip of tail yellowish white.

Although the range of *regina* on the eastern side of Cape York Peninsula is broken, birds show little geographic variation. Specimens from Cape York and Cairns and the Cape York bird pictured by Mathews (*Birds of Australia* 1: 105, pl. 22) are all large and dark, like those from New South Wales. The most distinctive specimens that I have seen from the east coast are those from Mission Beach (near Innisfail, Queensland); these birds are larger than other *regina* and have more white in the lore/supercilium and a larger pink belly patch; they are slightly more yellowish on the upper surface, and the undertail coverts of the males have a large reddish spot near the tip (as in several New South Wales specimens).

Frith (1952) indicated that *regina* has strong nomadic or migratory tendencies. It is therefore possible that the dark birds from Cape York are migrants from the south. Living on the wettest coast of Australia, the Mission Beach population has a good food supply all year, whereas New South Wales birds need to disperse northwards.

Storr (1973) listed an isolated population (of unknown subspecies) about the lower Edward River on the midwest coast of Cape York Peninsula. Four specimens were collected there in September-October 1928 by D.F. Thomson. These specimens are similar in size to nominate *regina*, but in coloration the males in particular are most like the Kimberley and Northern Territory subspecies *ewingii*. They have more yellow on the chin and throat than typical *regina*, the breast is paler (the bifid silver-grey tipped feathers on the breast have a lighter green base), the belly patch is pinkish, and the feathers above the belly patch are tipped yellow forming a pectoral band

TABLE 1
Showing measurements (mm) of *Ptilinopus regina*.

Subspecies	Locality	Number		Wing	Tail	Tarsus	Culmen (entire)	Weight
regina	New South Wales	♂	15	121-135	69-82	14-23	18-21	100-118
		♀	9	114-132	68-80	16-21	18-20	75-110
regina	Cape York, Cairns, and Mission Beach, Queensland	♂	4	130-135	78-85	20-23	18-20	112-120
		♀	2	126,127	77,81		18,21	103
regina	Edward River, Queensland	♂	2	125,132	74,88	19,22	18,20	
		♀	3	115,122	68-70	19	17-19	
ewingii	Northern Territory	♂	19	115-128	66-79	19-20	17-20	73-95
		♀	20	112-121	65-75	15-21	17-21	57-86
ewingii	Kimberley, Western Australia	♂	3	116-119	75-78		17-18	84-86
		♀	1	121	74		17	85
ewingii	Sawu and Roti	♂	3	116-120	69-75	16-17.5	17-18	
		♀	3	110-120	68-75		16-17.5	
'roseipileum'	Timor, Kisar,	♂	3	112-118	68-76	17-20	17-19	89
xanthogaster	Kai Is, Taam, Teun, Babar, Banda	♂	5	116-129	70-77	18-20	19-20.5	84-114
		♀	3	117-122	69-75	16-19	18.5-19	
		0	2	124,126	79	19,21		

(more pronounced in males). The band is not as bright or as broad as in *ewingii* (typical *regina* has no trace of breast band). The cap at Edward River is pinkish edged yellow; although the yellow edging is not as bright as in *ewingii* it is better defined than in typical *regina* and remains yellow above the eye. The males are also more greyish on the mantle than other Cape York Peninsula specimens. The paler coloration of the Edward River birds is correlated with climate; the rainfall here is similar to Kimberley and Northern Territory which is lower and more seasonal than within the range of typical *regina*. It is also noteworthy that Mathews included Cape York within the range of *ewingii*, thus separating a northern population (*ewingii*) from a southern (*regina*).

In the Northern Territory *ewingii* is confined to northern islands and coasts from Port Keats to the Sir Edward Pellew Group (see Fig. 1 and Storr 1973). *P. r. ewingii* is smaller than nominate *regina* (see Table 1) and differs considerably in colour (see Fig. 2). The cap in *ewingii* is pale reddish pink edged yellow, whereas *regina* has a reddish purple cap edged yellow (which sometimes becomes white above the eye). The throat in *ewingii* is more yellowish; the breast is paler (the bifid breast feathers are basally greyish green or lime green rather than dark green); the belly patch is pink, slightly paler than cap rather than pale reddish purple. In *regina* there is little or no trace of a bright band above the belly patch; in *ewingii* this band is orange below, yellow above (see Fig. 2). The flanks and lower abdomen in *ewingii* are orange, rather than reddish or reddish orange. In *ewingii* both males and females have the undertail coverts yellowish orange, whereas *regina* males are darker orange and females all yellow. Adult males of both *ewingii* and *regina* have a pale mantle (greyish, bluish grey or bluish grey-green) but this is more distinctive in male *ewingii.* Females of both races have the mantle a uniform green, the same as the back.

Mathews (1912) named the race *melvillensis* from Melville Island; it supposedly differed from *ewingii* in its paler head and back and in its light grey mantle. This however describes the difference between adult male and female *ewingii.* It appears that Mathews was unaware of sexual dimorphism in *ewingii* or *regina.* It is interesting that in a series of seven adult *ewingii* from Centre Island (Sir Edward Pellew Group), Northern Territory, three specimens (CSIRO 5717, 19536 and 19535) have dark backs (more bluish green) and are less yellow on the throat and breast and more whitish on the tail than in normally coloured *ewingii* from the same island. In back and throat colour they are tending towards *regina*, which may indicate some gene flow between northern populations of *regina* and eastern populations of *ewingii.* The Pellew Islands are at the eastern limit of *ewingii* and about 500 km west of the Edward River population of *regina* (see Fig. 1).

Goodwin (1967) included birds from the lesser Sunda Island, Flores, Sawu, Semau, Roti and Timor within the race *flavicollis*, which he stated was similar to *ewingii* except for a strong yellow-green suffusion on the neck and breast. Specimens from Savu and Roti Islands are in size and coloration almost identical with Kimberley and Northern Territory specimens. As a series they are slightly paler on the breast and flanks; however many *ewingii* are more yellowish on the throat and neck than the Sawu and Roti Island specimens. Mathews (1911) also concluded that birds from Sawu Island did not differ from those of the Northern Territory.

Hartert (1904) described the race *roseipileum* from the lesser Sunda Islands, mainly because of its rosy crown (see Fig. 2). It occurs on the islands of Timor, Wetar, Roma, Kisar, Moa and Leti (see Fig. 1). Hartert compared it with *P. r. xanthogaster* (Wagler) of the Banda and Kai Islands and Damar, Sermata, Babar, Teun, Nila and Tanimbar (see Fig. 1). *Xanthogaster* is described as follows:

Crown: light grey to dark grey, several specimens with a trace of reddish orange around the yellow edging (compared to light cream tinged with rosy in *roseipileum*, and reddish pink in *ewingii*);

Mantle: pure grey in male, grey tinged greenish in female (more bluish grey or greenish grey in *roseipileum* and *ewingii*);

Back and wings: dark green — darkest in Banda Island specimens (paler, more yellowish green in *roseipileum* and *ewingii*);

Tertials and coverts: with more extensive dark blue spotting in *xanthogaster* than in *roseipileum* and *ewingii*;

Tail: dark green — iridescent green in Banda Island males, with more white in tip (pale green with more yellow in tip in *roseipileum* and *ewingii*);

Belly patch: grey (pale grey in *roseipileum* and pink in most *ewingii*);

Belly and flanks: yellowish orange (yellowish orange in *ewingii*, yellowish in *roseipileum*);

Breast band: yellow or pale yellow (yellow in *roseipileum*, yellow and orange in *ewingii*);

Breast feathers: wholly pale grey in male, basally pale olive-green in female tipped pale grey.

Subspecies Recognized

In size and coloration *roseipileum* is very similar to *ewingii*, differing only slightly in crown, belly and flank colour. However some adult *ewingii* (in new plumage) resemble *roseipileum* in having the reddish pink of the crown and belly partly replaced with greyish pink. Birds with pale and dark pink crowns (respectively *roseipileum* and *ewingii*) have been collected on Timor, but little is known of the distribution of each form on the island. The single Timor *roseipileum* from Baucau matches perfectly with birds from Kisar and Letti Islands. In several characters, especially crown and belly colour, *roseipileum* is intermediate between *xanthogaster* and *ewingii*.

The easternmost population of *ewingii* (Pellew Islands) and westernmost *regina* (Edward River) also show some intermediacy in back, throat and breast colour. Further work is necessary in the Lesser Sunda Islands and in northeastern Australia to clarify the status of both *xanthogaster* and *ewingii*.

Meanwhile I propose recognition of three subspecies: *Ptilinopus regina regina* Swainson, *P. r. ewingii* Gould (including *flavicollis* Bonaparte, *roseipileum* Hartert and *melvillensis* Mathews), and *P. r. xanthogaster* (Wagler).

TORRES STRAIT PIGEON
Ducula bicolor spilorrhoa

Distribution

In Western Australia it is confined to subhumid northwest Kimberley from Cape Londonderry southwest to Kunmunya (see Fig. 3). There is an unconfirmed report of this species further south; in his book *Land of Opportunities* E.J. Stuart describes 'two beautiful black and white pigeons as big

Fig. 3: Distribution of *Ducula bicolor* in Kimberley, Western Australia: 1 Cape Londonderry; 2 Drysdale River (National Park); 3 Morgan River; 4 Napier Broome Bay; 5 Sir Graham Moore Island; 6 South West Osborne, Carlia and Borda Islands; 7 Admiralty Gulf; 8 Lawley River; 9 Mitchell River; 10 Bigge Island; 11 Roe River; 12 Prince Frederick Harbour, Hunter River mouth and Boongaree Island; 13 Coronation Island; 14 Prince Regent River; 15 St George Basin, St Andrew Island and Byam Martin Island; 16 Kunmunya; 17 Augustus Island.

as magpies', which were no doubt Torres Strait Pigeons but the precise locality where he shot the birds is uncertain.

Status

In Kimberley it is moderately common, mainly occurring in small flocks of up to 25. Unlike the Northern Territory and Queensland populations, which arrive from southern New Guinea between August and October and leave in March-April (Storr 1973, 1977), the Kimberley population is resident. Small flocks are present throughout the year, and breeding has been recorded in August, the earliest month for Australia.

Ecology and Habitat

This pigeon is mainly found in semi-deciduous vine forests rich in fruiting trees and shrubs, including *Ficus* spp., *Randia, Terminalia, Eugenia, Zizyphus* and *Celtis.* It also occurs in mangrove forests, evergreen thickets of *Ficus* at the foot of cliffs and along gullies, and waterside vegetation (especially tall *Melaleuca leucadendron*).

No single block of forest in Kimberley is big enough to support large flocks of Torres Strait Pigeons throughout the year. Moreover the amount of fruit available at any one place fluctuates widely from season to season, so that this species (and many other frugivorous birds) must search a large area for food. During the dry season there is a tendency for birds to disperse from the forest areas to offshore islands, riverside vegetation and eucalypt woodland. This movement and the consequent dispersal of seeds is probably instrumental in the establishment of new vine forests.

The rich lowland forests of southern New Guinea support huge wintering flocks from the Northern Territory and Queensland. Western Australia however has no large land mass rich in forests to the immediate north where Kimberley birds could spend the winter. This explains the small numbers in Western Australia and their relatively sedentary way of life. Predation by Aborigines may also have kept numbers down in certain areas. Hill, who spent 11 months at Napier Broome Bay between August 1909 and July 1910, did not record the Torres Strait Pigeon. Two were shot at Parry Harbour by mission Aborigines prior to his arrival and he heard pigeons that he believed were referable to this species. They were certainly not as common in this area as they are now.

Although mostly feeding in the canopy this species will venture close to the ground when feeding in low thickets or in isolated fruiting trees. Their flight is fast and direct, but not fast enough to elude Peregrine Falcons on South West Osborne Island; here the open space between the cliffs and the vine forest below the falcons' roost was thickly carpeted with bones and white feathers.

Food

The crop of a specimen collected in mangal on Augustus Island in May 1972 contained seeds of *Randia cochinchinensis* and mangrove buds. They also feed on the fruits of *Ficus platypoda*, *F. virens* and *Eugenia* spp.

Breeding

For details of the only nest found in Kimberley see Dell (1978). A female collected on 2 February 1972 at Mitchell Plateau had a well-developed ovary and a highly convoluted oviduct; another female collected on 24 October 1976 at the same place had a large ovary with two developing egg follicles. Two males collected on 30 September 1978 at Mitchell Plateau had large testes which indicated breeding.

Soft Parts

Bill greenish yellow (N 15), iris dark brown, legs lead grey or bluish grey and mouth pink to grey.

Weight

Adult males (N 5) 400-550 g, adult females (N 5) 371-510 g.

Geographic Variation

Previous authors have treated the Torres Strait Pigeon as a full species (*Ducula spilorrhoa*), distinct from the Pied Imperial Pigeon (*Ducula bicolor*).

Rand (1941) recognised four subspecies within *Ducula spilorrhoa*: the nominate form *D. s. spilorrhoa*, which occurs in scattered isolated populations on the islands and mainland of New Guinea; *D. s. subflavescens* (Finsch) of the Bismarck Archipelago and Admiralty Islands; *D. s. tarara* Rand of southern New Guinea from the Fly River west to at least Merauke; and *D. s. melvillensis* Mathews of northern and eastern Australia and the Hall Sound region of New Guinea. *D. s. melvillensis* was characterized by having the head distinctly grey-tinged. However Australian birds show considerable variation in the greyness of the head and back, the amount of black on the outer tail feathers, the amount of black spotting under the tail, and the degree of yellow tinging to plumage. All adult Kimberley specimens have a grey head. The amount of black on the outer tail feathers ranges from 5 to 32 mm (measured along the shaft). Kimberley birds are also well spotted on the under tail coverts. An adult male from Mitchell Plateau has a silver grey bloom on the dark wing feathers. An immature from the same place has the head whitish, the upper-parts and breast tinged grey, black on the outer tail feathers reduced, and pale greyish brown blotches under the tail finely peppered with black.

Not all Northern Territory birds have the head grey. In fact in his description of *melvillensis* (from Melville Island) Mathews states that it differs from *spilorrhoa* in having the base of the feathers 'much more yellow' and the bill 'more robust'; he does not mention any grey on the head or body. In a small series of four birds from the Alligator River, Northern Territory, two are white-headed and two grey-headed.

Most Queensland specimens have little or no grey tinge on the back, a white head and reduced black on the outer tail feathers.

Rand (1941) in his diagnosis of *tarara* stated that it differed from *melvillensis* in having the head deeper grey and the body plumage above and below grey-tinged. He also stated that though there was considerable variation in the depth of the grey on the body, no specimen lacked a grey head. Of the 24 New Guinea birds I studied, four were from the Gulf of Papua (near the range of *tarara*), three from the upper Sepik drainage, and 17 from south-eastern New Guinea (Port Moresby district and Grange Islands); four of them were collected in February, two in March, three in May, one in June, three in November and 11 in December. At least 18 of these (the November to February birds) would have been New Guinea breeders; however only one shows the *tarara* characters of grey head and grey tinge to back (but wings white); one other has a good grey head but has the rest of the plumage pure white; two have the head tinged grey similar to Western Australian and Northern Territory birds; seven have a slight tinge of grey on the head; and seven have pure white heads with no trace of grey.

Mayr (1941) also recognised two races in southern New Guinea, *D. s. tarara* the resident subspecies, and *D. s. spilorrhoa* a non-breeding migrant from Australia, restricted in New Guinea to Hall Sound.

Almost all Queensland and Northern Territory birds leave Australia in March-April, presumably for New Guinea. I believe that many, if not most, of the birds winter in the Fly River delta, where Bell (1967) recorded flocks of thousands in July 1965; in October of the same year constant aerial observation by him, showed greatly diminished numbers in the delta. At any rate it is very unlikely that the large number of birds in Australia could all winter in the Hall Sound region, as the current classification implies.

I believe that Rand's sample of *tarara* was biased, and that New Guinea breeding birds like those from Australia comprise grey and white variants. I accordingly treat *tarara* and *melvillensis* as synonyms of *spilorrhoa*. This does not deny that there is geographic variation in Australo-Papuan Torres Strait Pigeons. I have already indicated that from Kimberley to Queensland there is a decrease in the amount of grey in the plumage. Even birds from the small Grange Islands are distinctive in having reduced black on the outermost tail feather. Much more distinctive are the birds from the Admiralty Islands and the Bismarck Archipelago (*subflavescens*); they are characterized by a distinct yellow tinge to the white plumage and large black spots under the tail. This population is also sedentary.

The Pied Imperial Pigeon *Ducula bicolor bicolor* seems to vary little in its huge distribution from the Bay of Bengal eastwards to the Philippines and the islands off northwest New Guinea. Compared with the Torres Strait Pigeon it is purer white with no grey tinge (except for juveniles) and little or no black spotting under the tail and on the vent. Goodwin (1967) treats *melanura* of the Moluccas, which always has some black on the under tail coverts and slightly more black on the tail, as a race of *bicolor*, and *D. luctuosa* of Sulawesi, Peling, Banggai and the Sula Islands as a full species. *Ducula luctuosa* differs from *bicolor* in having the dark primaries silver grey edged with black, and slightly more black spotting under the tail (see Fig. 4). A Kimberley specimen of *spilorrhoa* also has a silver grey bloom on the

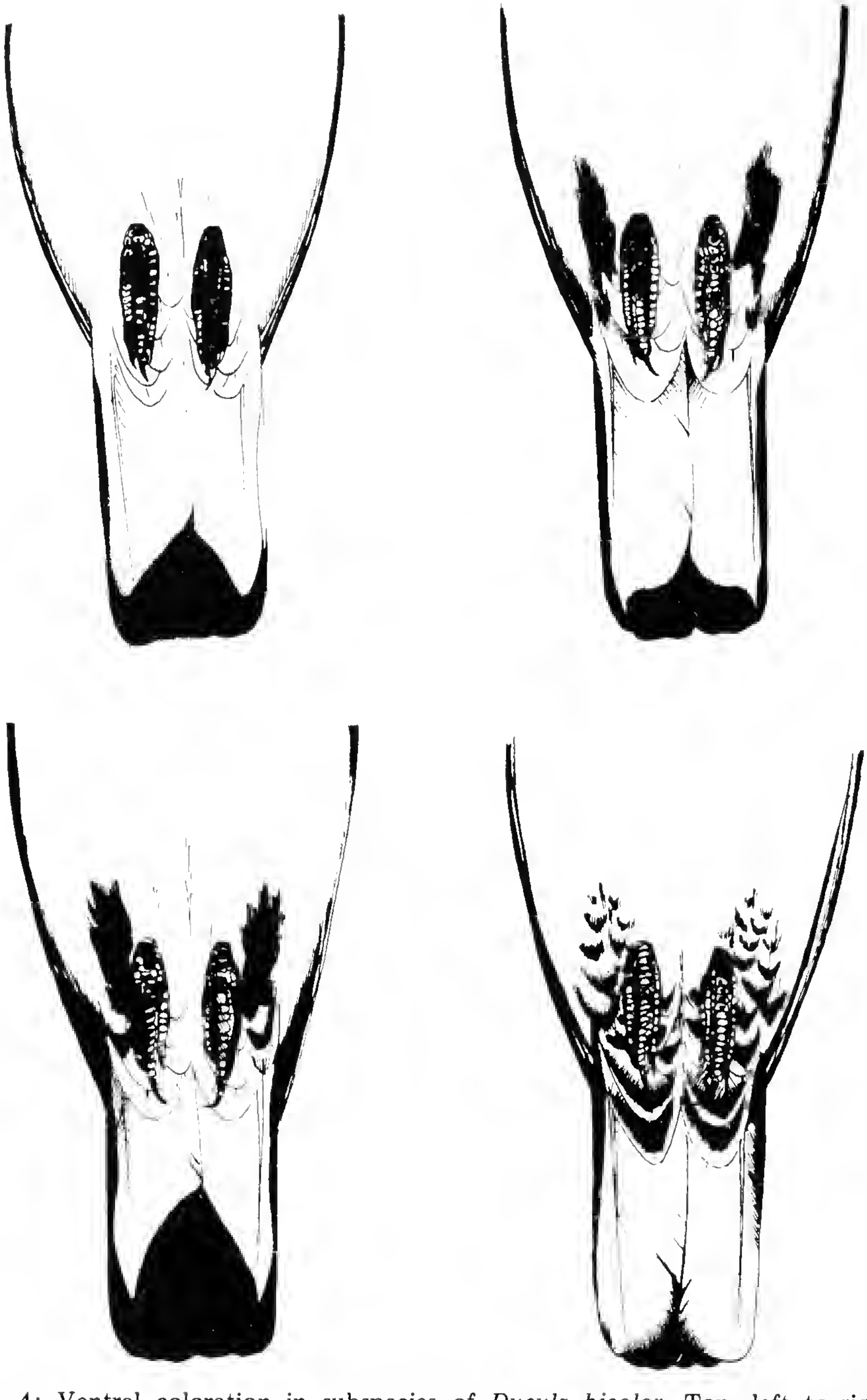

Fig. 4: Ventral coloration in subspecies of *Ducula bicolor*. Top, left to right: *D. bicolor bicolor*, *D. b. luctuosa*, *D. b. 'melanura'* and *D. b. spilorrhoa*.

dark primaries; and as a group *spilorrhoa* has only a little more black spotting under the tail than *luctuosa.*

Subspecies Recognized

Generally *melanura* and *luctuosa* are intermediate between *D. bicolor* and *D. spilorrhoa* (see **Fig. 4** and **Table 2**). Both specimens of *luctuosa* have spotting under the tail but less than in *spilorrhoa.* However one *bicolor* specimen from Borneo and one from Sanghir Island off Sulawesi have several blackish spots on the vent and under the tail. Both *luctuosa* specimens have the silver grey bloom on the black primaries, but this is also present in some *melanura* and *spilorrhoa*, although slightly less marked. It appears that the Sulawesi and Moluccan breeding populations are augmented by visitors of *D. b. bicolor* during the northern wet season.

In summary this group of pigeons is best treated as one widespread species. I propose the following nomenclature: *Ducula bicolor bicolor* (Scopoli), *D. bicolor luctuosa* (Temminck) (including *D. b. melanura* [Gray]), *D. bicolor spilorrhoa* (Gray) (including *melvillensis* Mathews and *tarara* Rand) and *D. bicolor subflavescens* (Finsch).

As a result of my conclusions on the taxonomic status of *bicolor*, *luctuosa* and *melanura* more work is required to elucidate the distribution, local movements and ecological requirements of these subspecies in Sulawesi and the Moluccas.

TABLE 2

Showing measurements (mm) of *Ducula bicolor.*

Subspecies	Locality		Number	Wing	Tail	Tarsus	Culmen
bicolor	Sulawesi, Borneo	♂	1	232	128	29	31.5
		♀	1	219	111	32	29
		0	1	221	121	31	28.5
luctuosa	Sulawesi, Lombar	♂	1	230	129		35.5
		♀	1	243	142		34
'melanura'	Seran, Batjan and Ambon	♂	2	233,234	121,122	32,32	31,32
		0	2	217,225	117,123	33,33	30,30
spilorrhoa	Kimberley, Western Australia	♂	9	231-248	137-147	22-29	28-32
		♀	6	217-240	129-140	22-29	28-32
spilorrhoa	Northern Territory and Queensland	♂	3	227-232	124-136	25-26	28-32
		♀	1	233	125	28	32
		0	1	220	122	32	30
spilorrhoa	New Guinea	♂	11	229-249	125-144	26-33	30-33.5
		♀	13	223-236	121-130	25-33	31-34

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HERPETOFAUNA OF THE SHORES AND HINTERLAND OF THE GREAT AUSTRALIAN BIGHT, WESTERN AUSTRALIA

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ABSTRACT

This paper is essentially an annotated list of the 10 families, 35 genera and 71 species and subspecies of frogs, turtles, lizards and snakes inhabiting the far southeast of Western Australia. Most of the region is arid or semi-arid, and surface water is ordinarily confined to granite outcrops in the far west of the area. Regional endemism and patterns of distribution are briefly discussed.

INTRODUCTION

The area covered in this report lies entirely within the Eucla Land Division. It is bounded in the north by the vicinity of the Eyre Highway, and in the west by the road running south from the Balladonia Hotel towards Israelite Bay (see **Fig. 1**).

Environment

Mean annual rainfall ranges from 22 cm in the north to about 45 cm in the extreme southwest. In the latter area much the wettest season is winter; the amount and proportion of winter rainfall decreases rapidly northwards and eastwards.

Owing to the proximity of the Southern Ocean, temperatures are mild throughout the year except for a few days in summer when hot northerly winds may raise the temperature to over 45°C.

On climatic, physiographic and vegetational criteria the study area is divisible into four subregions.

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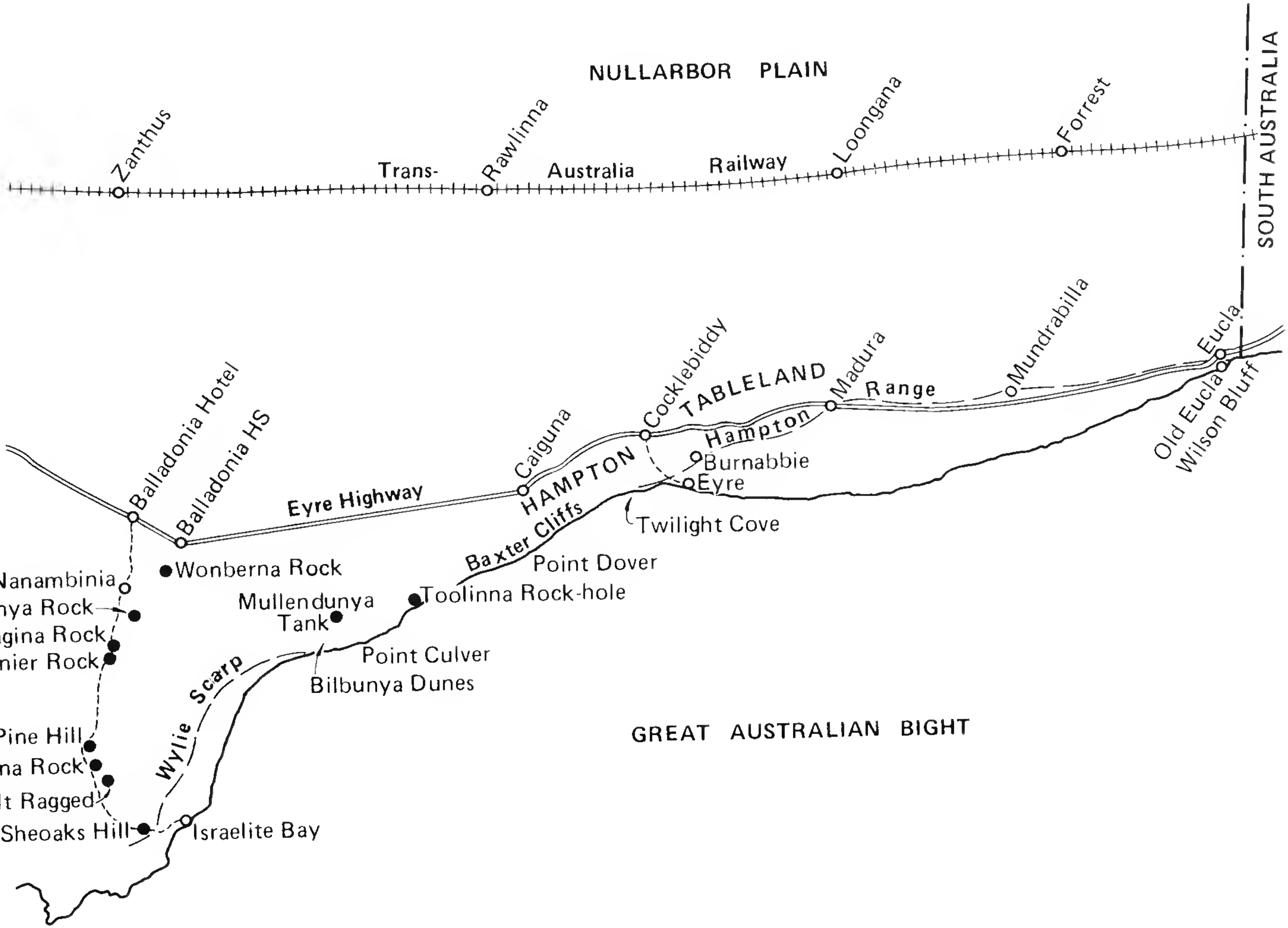

Fig. 1: Map of southeastern Western Australia.

Israelite Bay

The small area of white coastal dunes and sandplains in the extreme southwest of the region alone receives reliable winter rains. Its vegetation represents in depauperate form the south coast heaths and scrubs at their eastern limit. It is separated from the next subregion by the low Wylie Scarp.

Far western interior

This subregion is located on the eastern edge of the Western Australian Precambrian Shield. Apart from the herpetologically unexplored Russell Range, which culminates in Mt Ragged (585 m), the land slopes gently from about 50 m above sea-level in the south to 180 m in the north. The vegetation is dominated by open to moderately dense, semi-arid eucalypt woodlands and scrubs. Outcrops of granitic rocks provide some surface water. To the east it gradually merges with the next subregion.

Hampton Tableland

This, the southern fringe of the Nullarbor Plain, is a limestone plateau 50-140 m above the sea. Its southern boundary in the west is marked by the Baxter Cliffs and in the east by the escarpment known as the Hampton Range. The limestone is mostly covered with shallow clays and loams. Large areas carry a succulent steppe of bluebush (*Maireana sedifolia*), saltbush (*Atriplex* spp.) and other chenopods, with or without tussock grasses and scattered low trees, especially myall (*Acacia sowdenii*) and sugarwood (*Myoporum platycarpum*). Towards the south eucalypts and melaleucas become more plentiful. Mallee-*Triodia* grows on sandy areas southeast of Cocklebiddy.

Eastern coastal areas

East of Twilight Cove and south of the Hampton Range there is a large area of coastal plain. The vegetation is much the same as immediately above the escarpment, i.e. succulent steppe with scattered myall and copses of mallee on the heavier soils, and denser mallee and melaleuca on the lighter soils. Additionally there are extensive areas of dunes, some with little or no vegetation, others with thickets of mallee and wattle.

For a detailed account of the climate, geology, soils and vegetation of the region see Beard (1975). Much of the coastal strip is reserved in the Nuytsland Wildlife Sanctuary.

Herpetological exploration

Nothing was known of the herpetofauna until 1914 when the celebrated naturalist W.B. Alexander made small collections at Balladonia, Cardanumbi, Madura and Eucla. The next 40 years yielded only odd specimens donated by the public to the Museum.

In December 1953 A.R. Main collected frogs between Balladonia and Israelite Bay. The same area was visited by G.M. Storr in December 1959 and December 1962. In October 1964 G.M. Storr and A.M. Douglas collected along Eyre Highway and the Cocklebiddy-Eyre track. In March 1968 A. Baynes and J.L. Bannister worked around Israelite Bay. In August-September 1969 A. Baynes and W.K. Youngson visited the country south of Madura and south-east of Cocklebiddy. In October 1973 M.G. Brooker collected at Twilight Cove, Point Culver, Toolinna Rock-hole and Mullendunya Tank.

In April 1976 G. Harold, G. Barron and M. Peterson collected along the Eyre Highway between Balladonia and Cocklebiddy and down the track towards Twilight Cove; their substantial collection contained no taxa new to the area, indicating that the regional list was close to being complete. This was confirmed in September-October 1979 when G. Harold and T.M.S. Hanlon visited most parts of the region and collected 672 specimens, among which only *Neobatrachus pelobatoides, Caretta caretta, Ctenotus impar, Lerista p. picturata* and *Ramphotyphlops australis* were new for the area.

Other people whose specimens have contributed to this report are N.T. Allen, M. Archer, A. Baesjou, W.H. Butler, J. Bywater, A.J. Carlisle, I.C. Carnaby, B.T. Clay, T. Cleland, A. Chapman, A.E. Cockbain, R.J. Congdon, M. DeGraaf, J. Douglas, J.R. Ford, P. Griffin, J. Hickman, M. Hutchinson, G.W. Kendrick, D. King, M. King, K. Lance, A.K. Lee, J.C. LeSouef, J. Lowry, J. Martindale, E.R. Pianka, H.L. Pianka, W.D.L. Ride, A.J. Saar, R.K. Saar, J.D. Sandow, V.N. Serventy, M. Thomas, J.C. Wombey and B. Wykes. We are grateful to P. Griffin for checking the identification of many specimens and to Mrs and Mr W.H. Butler, whose grant to the Western Australian Museum financed Harold and Hanlon's field work in spring 1979.

ANNOTATED LIST

In this list we briefly describe the local distribution, relative abundance and habitat preferences of each species and subspecies. Unless otherwise indicated, registered numbers are of specimens lodged in the R series of the Western Australian Museum.

Leptodactylidae

Limnodynastes dorsalis (Gray)

Restricted to far western interior from Nanambinia south to Pine Hill. Plentiful in dam at Emu Soak (6 km S of Nanambinia HS); less numerous at waterholes and small dams at granite outcrops (Coragina Rock, Juranda Rock-hole and Pine Hill).

Neobatrachus centralis (Parker)

One record from far western interior: a specimen (19697) collected by G.M. Storr at Coragina Rock in evening of 5 December 1959.

Neobatrachus pelobatoides (Werner)

One record from far western interior: two specimens (66894-5) collected by G. Harold and T.M.S. Hanlon at Sheoaks Hill on 8 October 1979.

Pseudophryne guentheri Boulenger

One record from far western interior: a specimen (14497) collected by A.M. and J. Douglas at 28 km N of Mt Ragged on 25 April 1962.

Pseudophryne occidentalis Parker

Confined to far western interior from Booanya Rock south to Sheoaks Hill. Common in pools, rock-holes and small dams at granite outcrops, e.g. Coragina Rock, Ponier Rock, Juranda Rock-hole, Pine Hill and Junana Rock. Possibly occurring further north; W.B. Alexander collected a *Pseudophryne* at Balladonia in 1914, but the specimen (308) could not be found for specific identification.

Ranidella pseudinsignifera (Main)

Only recorded from Pine Hill in far western interior. Moderately common at small dam.

Hylidae

Litoria adelaidensis (Gray)

Only recorded from Pine Hill in far western interior. Common at small dam.

Litoria cyclorhynchus (Boulenger)

Confined to far west, north to Coragina Rock. Very plentiful in small dam at Pine Hill. Moderately common at granite outcrops (Coragina Rock, Juranda Rock-hole and Junana Rock). Also in slightly brackish water in holes dug by campers at inland foot of Israelite Bay sandhills.

Cheloniidae

Caretta caretta (Linnaeus)

One record: a recently dead juvenile (66505) found on beach at Twilight Cove by T.M.S. Hanlon and G. Harold on 30 September 1979.

Gekkonidae

Crenadactylus ocellatus ocellatus (Gray)

One record: a specimen collected at Israelite Bay by A.M. and J. Douglas on 25 April 1962.

Diplodactylus granariensis Storr

Northern and eastern, west to 7 km W of Balladonia HS and 11 km WSW of Toolinna Rock-hole. Very common. Mainly open eucalypt woodland (including mallee) over chenopods or *Triodia*.

Diplodactylus intermedius Ogilby

Evidently widespread but rare. Single specimens collected at Balladonia, Coragina Rock (in a bush), 37 km W of Caiguna (in a low shrub in sparse *Eucalyptus-Myoporum* woodland), and at Abrakurrie Cave (37 km W of Eucla).

Diplodactylus maini Kluge

Only certainly known from extreme northwest. G. Harold, G. Barron and M. Peterson collected seven specimens on evening of 22 April 1976 in open eucalypt woodland over chenopods at 7 km W of Balladonia HS. Kluge (1967) lists a specimen from between Balladonia and Cocklebiddy.

Diplodactylus spinigerus Gray

Single specimens collected at three western, near-coastal localities: 8 km W of Israelite Bay, 7 km NE of Toolinna Rock-hole, and 20 km W of Point Culver. Evidently rare in this the easternmost part of its range. Low shrubbery in or near coastal dunes.

Gehyra variegata (Duméril & Bibron)

Extreme north, south to Meelina Rock-hole (23 km S of Balladonia HS), 37 km W of Caiguna, Madura airstrip, and 7 km E of Wilson Bluff. Moderately common. Mainly under bark and leaf litter and in trees of open woodlands (*Eucalyptus, Myoporum* and *Acacia sowdenii*) over chenopods.

Heteronotia binoei (Gray)

Northern, south to Booanya Rock (12 km S of Nanambinia), Burnabbie and 23 km SE of Madura, and east to Mundrabilla. Moderately common about granite outcrops in northwest; further east mainly among stones of limestone escarpment (Hampton Range).

Phyllodactylus marmoratus (Gray)

Occurring in most of region but not the northwest corner, north and west of a line through Junana Rock, Mullendunya Tank (32°53′S, 124°35′E), and 70 km E of Balladonia HS (its absence from this area seems not to be due simply to distance from coast; further east it extends north across the Nullarbor Plain almost to the Trans-Australia Railway [23 km S of Reid]). Very common. Mainly in woodlands, scrubs and coastal heaths; also in sparsely wooded country where limestone rocks and holes provide shelter.

Phyllurus milii Bory

Northern and eastern, south and west to Balladonia HS and Toolinna Rock-hole; also at Israelite Bay. Common. Mainly beneath mallees and melaleucas and in holes and under rocks in limestone.

Pygopodidae

Aprasia inaurita Kluge

Only known from vicinity of Eyre. In 1935 A.J. Carlisle collected one (5280) at Eyre. A specimen in the Eyre Bird Observatory was found on 26 December 1978 dead on track through melaleuca woodland on grey sand 1 km E of Eyre. On 30 September 1979 G. Harold and T.M.S. Hanlon dug one (67474) from white beach sand in coastal dunes 13 km W of Eyre.

Delma australis Kluge

Only recorded from western half of region, viz. at Coragina Rock, Pine Hill, Toolinna Rock-hole, 11 km SSE of Cocklebiddy, 13 km W of Eyre, and Burnabbie. Moderately common. Eucalypt woodlands and open scrubs on sandy loam.

Delma fraseri Gray

Restricted to extreme southwest (Israelite Bay). One specimen was dug from an abandoned 'stick ant nest' in coastal dunes; the other five were found under sheets of iron at the ruins of the former telegraph station.

Lialis burtonis Gray

One record from extreme northwest: a specimen from Balladonia in the United States National Museum (Kluge 1974).

Pygopus lepidopodus (Lacépède)

Patchily distributed in near-coastal areas: recorded from Israelite Bay, Junana Rock, 3 km WSW of Toolinna Rock-hole, Twilight Cove, *ca* 25 km SE of Cocklebiddy, and Eucla (it has been found much further inland on the Nullarbor Plain, viz. at 36 km S of Forrest). Uncommon. Recorded in a wide variety of habitats, e.g. in open tall eucalypt woodland with much leaf litter, on a samphire flat, in low mallee at top of sea-cliffs, and in an abandoned 'stick ant nest' in coastal dunes.

Agamidae

Amphibolurus adelaidensis chapmani Storr

Southern, north to 32 km WSW of Balladonia Hotel just west of our region, 25 km NW of Toolinna Rock-hole, 21 km S of Caiguna, 11 km SSE of Cocklebiddy, Madura and Eucla, but not far southwest (south of Pine Hill). Moderately common. Open to fairly dense woodlands and scrubs of *Eucalyptus, Melaleuca* and *Callitris.*

Amphibolurus cristatus Gray

One record from extreme northwest: a juvenile (17465) collected on 15 December 1962 by G.M. Storr in eucalypt woodland 7 km S of Balladonia Hotel.

Amphibolurus maculatus dualis Storr

Near-coastal areas, west certainly to the Bilbunya Dunes (32°53'S, 124°32'E) and north to 8 km NE of Point Culver, 7 km NE of Toolinna Rock-hole, 37 km S of Caiguna, 11 km SSE of Cocklebiddy, 44 km S of Madura, 33 km S of Mundrabilla, and Old Eucla. Common. Well-wooded country, especially mallee (with or without *Triodia*); also *Callitris, Hakea, Banksia* and other shrubbery. Copulation observed in late September and early October.

This or another subspecies of *A. maculatus* probably occurs in far southwest: small grey *Amphibolurus* have been observed along the track 9-12 km NW of Sheoaks Hill, and a badly damaged specimen (31101) apparently of *A. maculatus* has been collected at 8 km west of Israelite Bay.

Amphibolurus muricatus (Shaw)

Near-coastal areas from Israelite Bay to Eucla, inland to 5 km S of Mt Ragged, Toolinna Rock-hole, 21 km S of Caiguna, 11 km SSE of Cocklebiddy, 34 km S of Madura, and the Eyre Highway at South Australian border. Moderately common. Open to fairly dense mallee, with or without *Triodia* or *Melaleuca.*

Amphibolurus nullarbor Badham

Single specimens collected in eastern half at Cocklebiddy (open *Eucalyptus-Myoporum* woodland), Madura and 33 km NE (Mullamullang Cave), 40 km

SW of Eucla (among low shrubs on a consolidated dune) and Wilson Bluff.

Amphibolurus pictus Peters

Far north, west to 70 km E of Balladonia HS and south to Burnabbie, Mundrabilla and Old Eucla. Moderately common. Succulent steppe, with or without scattered trees.

Amphibolurus salinarum Storr

Two records from far northwest: a specimen collected by W.B. Alexander at Balladonia in 1914, and two collected by the Fisheries and Wildlife Department on Ponier Rock in February 1978.

Tympanocryptis lineata lineata Peters

Northern, south to Wonberna Rock (19 km SW of Balladonia HS), Toolinna Rock-hole, 41 km SW of Caiguna, Cocklebiddy, Madura, Mundrabilla, and 7 km NW of Eucla. Common. Usually among limestone slabs and rocks in open or sparsely wooded country.

Scincidae

Cryptoblepharus plagiocephalus (Cocteau)

Two records from far north: on 13 December 1962 G.M. Storr collected one running on granite at Wonberna Rock (19 km SW of Balladonia HS), and on 26 September 1979 G. Harold and T.M.S. Hanlon collected two on a log in open eucalypt woodland at top of Madura Pass.

Cryptoblepharus virgatus clarus (Storr)

Throughout the region. Common. Eucalypt woodland, granite outcrops and limestone cliffs. In far northwest it overlaps the closely related *C. plagiocephalus* with no apparent ecological differentiation, e.g. the latter was found on granite at Wonberna Rock, and *C. v. clarus* on granite at Balladonia Rock, 18 km to northeast.

Ctenotus brooksi euclae Storr

Coastal and near-coastal dunes and sandplains in eastern half, west to 17 km W of Eyre. Locally common. Mainly on consolidated sands with open mallee and low shrubs; also low unconsolidated white dunes beside sea.

Ctenotus gemmula Storr

Single specimens from three near-coastal localities in western half: 8 km W of Israelite Bay, 20 km W of Point Culver, and 7 km NE of Toolinna Rock-hole (on greyish white sandy rise with low heath). Evidently rare in this the easternmost part of its range.

Ctenotus impar Storr

Only known from collections made by G. Harold and T.M.S. Hanlon in two near-coastal localities in western half: one specimen from an abandoned 'stick ant nest' in low open mallee-heath 12 km W of Israelite Bay, and two specimens from *Banksia* shrubland on greyish white sand 11 km WSW of Toolinna Rock-hole. Evidently rare in this the easternmost part of its range.

Ctenotus schomburgkii (Peters)

Single specimens from two western localities: Coragina Rock and 8 km N of Point Culver.

Egernia carinata H.M. Smith

Confined to extreme west, between Ponier Rock and Junana Rock. Uncommon. Open *Eucalyptus-Melaleuca* woodland, sheltering under logs and granite.

Egernia multiscutata bos Storr

Near-coastal sandplains and dunes in western half, east to 14 km W of Eyre and inland as far as 14 km SSE of Cocklebiddy. Common around Israelite Bay; moderately common in far east of range; only one record from intermediate area (a specimen from a sandy rise 7 km NE of Toolinna Rock-hole). Mainly in heath growing on whitish sand. (Provenance of specimen [29423] taken 'under limestone around rock-hole 32 km N of Madura' requires confirmation.)

Egernia napoleonis (Gray)

Confined to the Baxter Cliffs from Twilight Cove west to at least 3 km SW of Toolinna Rock-hole. Common. Among rocks at top of limestone cliffs, 50-75 m above sea. One specimen was taken from the mouth of a Death Adder (*Acanthophis antarcticus*).

Hemiergis initialis brookeri Storr

Widespread but absent from northwest (north of Coragina Rock and west of 40 km WSW of Caiguna) and apparently also from coastal plains, except at Old Eucla. Very common. Mainly in leaf litter beneath eucalypt woodlands on loamy soils; also under litter in *Banksia* shrubland on greyish white sand.

Hemiergis peronii peronii (Fitzinger)

Southwestern, north to Juranda Rock-hole (33 km N of Mt Ragged) and east to Toolinna Rock-hole. Moderately common. In leaf litter or under rocks at granite and limestone outcrops. Generally seeming to prefer damper situations than *H. i. brookeri* in their zone of overlap, but both species found under one slab of limestone at Toolinna Rock-hole.

Leiolopisma baudini Greer

The unique specimen (44969) of this skink was collected on 28 October 1973 by M.G. Brooker in low wattle scrub in the Bilbunya Dunes, 20 km W of Point Culver.

Leiolopisma trilineatum (Gray)

One record from extreme southwest: a specimen (18165) collected on 7 December 1959 by G.M. Storr in leaf litter at Israelite Bay.

Lerista distinguenda (Werner)

Coastal and near-coastal dunes and sandplains in western half, east to 25 km ESE of Cocklebiddy. Uncommon. Usually in leaf litter beneath mallee, *Callitris* or *Banksia* on white or yellowish sands; one specimen was dug from an abandoned 'stick ant nest'.

Lerista frosti (Zietz)

Greater part of region but not far southwest (south of Junana Rock). Very common. Under leaf litter beneath *Acacia sowdenii, Melaleuca* and *Eucalyptus-Myoporum* woodlands and scrubs and succulent steppe, and under slabs of limestone.

Lerista microtis arenicola Storr

Coastal dunes in eastern half, west to 13 km W of Eyre. Apparently common at 13 km W of Eyre, where T.M.S. Hanlon and G. Harold dug ten from sandy hillocks beside the beach on 30 September 1979; otherwise only known from single specimens taken at Eyre and Old Eucla.

Lerista microtis microtis (Gray)

Confined to extreme southwest (Israelite Bay and 8 km NE). Three specimens were obtained under sheets of iron at the ruins of the former telegraph station; one was found on an outcrop of gneiss; and one was dug from an abandoned 'stick ant nest'.

Lerista muelleri (Fischer)

Only known from far northwest (single specimens collected at Balladonia HS and 2, 7 and 12 km S of Balladonia Hotel) and from a specimen collected at 11 km SSE of Cocklebiddy. In leaf litter and under exfoliating granite.

Lerista picturata baynesi Storr

Eastern half, west to Madura Pass, Burnabbie and Twilight Cove. Very common. In leaf litter and top-soil beneath mallee, acacias and other shrubs.

Lerista picturata picturata (Fry)

Confined to northwest. G. Harold and T.M.S. Hanlon collected it at two localities in September-October 1979: Coragina Rock (five specimens under litter at base of eucalypts) and 37 km W of Caiguna (two specimens under litter in sparse *Eucalyptus-Myoporum* woodland); and G. Harold, P. Griffin and G. Barron collected three specimens under litter beneath open *Eucalyptus-Acacia* woodland 2 km S of Balladonia Hotel on 4 April 1980.

Lerista terdigitata (Parker)

Confined to far northwest, south to Coragina Rock and east to Wonberna Rock (19 km SW of Balladonia HS). Rare. Under logs and rocks.

Menetia greyii Gray

Throughout the region. Very common. In leaf litter and under logs and rocks; one was dug from an abandoned 'stick ant nest'.

Morethia adelaidensis (Boulenger)

Extreme north, west to Wonberna Rock (19 km SW of Balladonia HS) and south to Meelina Outcamp (22 km S of Balladonia HS), 37 km W and 21 km ENE of Caiguna, 10 km SSE of Cocklebiddy, Madura, Mundrabilla and Old Eucla. Common. In leaf litter and under limestone in sparsely wooded country.

Morethia butleri (Storr)

Two records from northwest: a specimen (24673) collected on 9 October 1964 by G.M. Storr and A.M. Douglas under leaf litter at 40 km W of Caiguna, and a specimen (59789) collected by the Fisheries and Wildlife Department under exfoliating granite at Ponier Rock on 28 February 1978.

Morethia obscura Storr

Most of the region but not the northwest (north of Coragina Rock and west of 40 km W of Caiguna). Very common (the most numerous reptile in collections from the region). Mainly under leaf litter in relatively well-wooded country; occasionally under limestone and granite.

Omolepida branchialis (Günther)

Two records from extreme north: a specimen (36165) collected by M. Archer at Cave N59 (38 km NE of Madura Pass) in February 1970, and one (36719) collected by J. Lowry at 13 km N of Madura on 17 October 1966. As mentioned in Storr (1976), this peculiar cave-inhabiting population could prove worthy of subspecific recognition.

Tiliqua occipitalis (Peters)

Two records from extreme southwest: A.M. and J. Douglas collected one (14173) at Israelite Bay on 25 April 1962, and A. Baynes and J.L. Bannister trapped one (31087) at 8 km W of Israelite Bay on 31 March 1968.

Tiliqua rugosa rugosa (Gray)

Extreme north, west to Balladonia HS. Judging from the number of regional specimens in the Museum (16) one would have to rate it as uncommon; however G.M. Storr and A.M. Douglas collected seven specimens on one day (8 October 1964) along an 85-kilometre stretch of the Eyre Highway between Madura and Cocklebiddy; this and other large species are probably under-collected. Mainly open or sparsely wooded country on the Hampton Tableland; only one record from coastal plain (a specimen collected on a consolidated dune 40 km SW of Eucla).

Varanidae

Varanus gouldii (Gray)

One record from northwest: an observation of a subadult by T.M.S. Hanlon and G. Harold at 58 km E of Balladonia HS on 6 October 1979; the lizard ran down a rabbit burrow in pale brown clay loam vegetated with succulent steppe and scattered eucalypts.

Varanus rosenbergi Mertens

Three widespread, near-coastal records: a specimen (17626) shot by G.M. Storr in *Banksia speciosa* sandplain 13 km SW of Israelite Bay on 19 December 1962; one observed by J. Martindale (pers. comm.) at Eyre on 27 December 1978; and one (18481) collected by A.M. Douglas at Eucla on 6 January 1963.

Typhlopidae

Ramphotyphlops australis (Gray)

Collected at four localities: Israelite Bay, Pine Hill, 20 km W of Point Culver and Madura. In coastal dunes at Israelite Bay two specimens were dug from beneath an old stump in mallee-heath, and one was dug from an abandoned 'stick ant nest'. Also found by G.W. Kendrick and V.A. Ryland under a log 5 km S of Balladonia Hotel (photograph identified by G.M. Storr).

Ramphotyphlops bituberculatus (Peters)

Two records from extreme north: a specimen (37048) collected by J. Bywater on surface near entrance to Cocklebiddy Cave on 3 January 1970; one in Eyre Bird Observatory collected at Eucla on 23 January 1979.

Elapidae

Acanthophis antarcticus (Shaw)

Northern and eastern, south and west to Booanya (11 km SSE of Nanambinia) and Toolinna Rock-hole. Scarce. Cliffs along the coast and the escarpment of the Hampton Tableland seem to be a favoured habitat.

Brachyaspis curta (Schlegel)

One record: a specimen (45351) collected by M.G. Brooker in a small hole in rock at top of cliff near Toolinna Rock-hole on 24 October 1973.

Denisonia coronata (Schlegel)

Known from three specimens collected in two western coastal localities: two specimens from Israelite Bay (14205, 67413) and one from 20 km W of Point Culver (44973). Evidently rare in this the easternmost part of its range.

Denisonia mastersii (Krefft)

Eastern coastal areas from Eyre east to Old Eucla, inland as far as the Eyre Highway at 33 km E of Cocklebiddy. Common. Mainly mallee-*Triodia;* also sparsely vegetated coastal dunes.

Denisonia nigriceps (Günther)

Two records: a specimen (45360) collected at Mullendunya Tank by M.G. Brooker on 27 October 1973, and one (66497) collected by T.M.S. Hanlon and G. Harold beneath rubbish on an open grassy flat with scattered eucalypts at Cocklebiddy on 29 September 1979.

Denisonia spectabilis nullarbor Storr

Three records from far east: a specimen from 10 km NNW of Eucla and two from Old Eucla, one of which had swallowed a *Morethia adelaidensis.*

Notechis scutatus occidentalis Glauert

One record from extreme southwest: a specimen (31090) collected by A. Baynes and J.L. Bannister at 16 km W of Israelite Bay on 27 March 1968.

Pseudonaja affinis Günther

Far north, west to Balladonia HS and south to 2 km NE of Toolinna Rockhole, 7 km SSE of Cocklebiddy, and 43 km S of Madura. Common. Mainly open myall or mallee over succulent steppe; also coastal heath.

Also one record from extreme southwest: a specimen (31115) collected by A. Baynes and J.L. Bannister at Israelite Bay on 29 March 1968.

These two apparently isolated populations possibly represent two subspecies: *P. a. affinis* in the southwest, and *P. a. inframacula* (Waite) or intergrades between it and *P. a. affinis* in the north. A revision of the species is planned.

DISCUSSION

The herpetofauna comprises 10 families, 35 genera and 69 species (two represented by two subspecies) distributed as follows.

Leptodactylidae: 4 genera, 6 species
Hylidae: 1 genus, 2 species
Cheloniidae: 1 genus, 1 species
Gekkonidae: 6 genera, 9 species
Pygopodidae: 4 genera, 5 species
Agamidae: 2 genera, 8 species
Scincidae: 10 genera, 28 species and subspecies
Varanidae: 1 genus, 2 species
Typhlopidae: 1 genus, 2 species
Elapidae: 5 genera, 8 species.

Compared to similar or even smaller areas on the west coast of Western Australia, e.g. Shark Bay (Storr & Harold 1978, 1980), the present region seems impoverished. However, compared with other regions in the south of the State its herpetofauna is seen to be moderately rich. In the region to our immediate north Brooker & Wombey (1978) list one frog and 27 reptiles. In the region immediately west of our western interior subregion N.L. McKenzie and his colleagues in the Department of Fisheries and Wildlife have collected six species of frogs and 43 reptiles. In the region immediately west of our Israelite Bay subregion, Chapman & Dell (1975) record six species of frogs and 36 reptiles.

None of the results of these comparisons are surprising. First, the west-coastal areas of Western Australia are extraordinarily rich in fossorial reptiles. In the country between Shark Bay and the lower Murchison, for instance, there occur five members of the *Lerista bipes* group and six of the genus *Vermicella;* neither of these taxa is represented in the present region, despite the abundance of sandy country.

On the other hand the present region is environmentally much more diversified than the country to north and west. In addition to extensive areas of succulent steppe (as on the Nullarbor Plain) and of semi-arid woodlands and scrubs (as in N.L. McKenzie's study area) the present region contains large tracts of coastal and near-coastal dunes and sandplains. Moreover these tracts are broadly interrupted by the Hampton Tableland and Baxter Cliffs, resulting in isolated southwestern and eastern coastal plains, each with distinctive elements.

Four southwest Australian reptiles reach their eastern limit in the Israelite Bay area: *Delma fraseri*, *Leiolopisma trilineatum*, *Lerista m. microtis* and *Notechis scutatus occidentalis*. A further six southwestern endemics, *Diplodactylus spinigerus*, *Ctenotus gemmula*, *C. impar*, *Egernia napoleonis* and *Denisonia coronata*, extend along the coast to the Baxter Cliffs or the Bilbunya Dunes. The latter area is also notable for the endemic skink *Leiolopisma baudini*.

Two lizards, *Ctenotus brooksi euclae* and *Lerista microtis arenicola*, are endemic to eastern coastal areas (and similar country in far western South Australia). A third lizard, *Lerista picturata baynesi*, is almost confined to this subregion.

Certain lizards characteristic of the semi-arid interior of southern Western Australia have their eastern limit in the western interior of the present region, namely *Diplodactylus maini*, *Amphibolurus salinarum* and *Lerista p. picturata*. The eastern limits of six southwest Australian frogs coincide with the eastern limit of granitic outcrops in this subregion: *Limnodynastes dorsalis*, *Neobatrachus pelobatoides*, *Pseudophryne guentheri*, *Ranidella pseudinsignifera*, *Litoria adelaidensis* and *L. cyclorhynchus*.

The Hampton Tableland contributes to the region what could be called a Nullarbor component, viz. *Amphibolurus nullarbor* and *Denisonia spectabilis nullarbor*. It and the Nullarbor Plain are also the stronghold in Western Australia of three lizards characteristic of east Australian succulent steppes, namely *Amphibolurus pictus*, *Tympanocryptis l. lineata* and *Morethia adelaidensis*.

Finally there are five lizards which are not confined to any one subregion but are endemic to the general vicinity of the Great Australian Bight. They are *Aprasia inaurita*, *Amphibolurus maculatus dualis*, *Hemiergis initialis brookeri*, *Lerista terdigitata* and *L. frosti* (apart from relict populations of the last-named in the mountains of northwestern and central Australia).

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A NEW SPECIES OF DEMODICID MITE (ACARI: PROSTIGMATA) FROM WESTERN AUSTRALIA PARASITIC ON *MACROGLOSSUS MINIMUS* (CHIROPTERA: PTEROPODIDAE)

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ABSTRACT

Demodex macroglossi sp. nov. from *Macroglossus minimus* is described and compared with the related species *D. carolliae* (Desch *et al.* 1971) from *Carollia perspicillata.* Specimens of *D. macroglossi* were found to reside in hair follicles of the eyelids and in a large dermal cyst on the neck. Two total-length size groups are recognized in nymphs representing possible sexual dimorphism.

This new species from a megachiropteran host most closely matching a demodicid from a microchiropteran reinforces the view that hair follicle-dwelling species of the Demodicidae are evolutionarily very conservative when compared with glandular invading species; thus, more precisely mirroring mammalian evolution.

INTRODUCTION

At present, demodicids are known from 11 mammalian orders including the Chiroptera (Nutting 1979). Within this order, six species of *Demodex* have been described from five host species of the suborder Microchiroptera, but none has been recorded from the Megachiroptera. The following report describes a new demodicid, *Demodex macroglossi* sp. nov. from the megachiropteran *Macroglossus minimus* Geoffrey, 1810 (Pteropodidae).

SYSTEMATICS

Demodex macroglossi sp. nov.

(All measurements below are in microns)

Holotype

Male; WAM 80-743; Plate I, 1.

Allotype

Female; WAM 80-744; Plate I, 2.

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Paratypes

Deposited in: Field Museum of Natural History, Chicago; U.S. National Museum of Natural History (Smithsonian Institution), Washington, D.C.; The Acarology Laboratory, Columbus, Ohio; Department of Zoology, University of Massachusetts, Amherst; Department of Aquatic Ecology, Catholic University, Nijmegen, The Netherlands.

Diagnosis

Demodex macroglossi is a medium-sized member of the genus; the longest adult specimen, a male, measured 189 μm. It is most similar to *D. carolliae* (Desch *et al.* 1971) of the Leaf-nosed Fruit Bat, *Carollia perspicillata.* Differences include:

1 *Demodcx macroglossi* males longer (175.7 ± 5.6 μm) than *D. carolliae* males (128.5 ± 2.6 μm).

2 *Demodex macroglossi* males longer than females; *D. carolliae* females longer than males.

3 Immatures of *D. macroglossi* lack supracoxal spines; present in corresponding stages of *D. carolliae* as minute, peg-like spines.

4 Ventral scutes (= epimeral scutes) present in protonymph and nymph of *D. macroglossi*; absent in all immature stages of *D. carolliae.*

Description

Male (Plate I, 1): Mean body length 175 μm (167-189 μm) (N = 20) with opisthosoma comprising two-thirds of this value. Other measurements in Table 1.

Gnathosoma trapezoidal, length less than basal width. Subgnathosomal setae (pits) lateral to anterior region of horseshoe-shaped pharyngeal pump (Fig. 2). Supracoxal spines 0.8 μm diameter at base flaring to 2.4 μm distally (Fig. 3). They are spaced 11 μm apart and are partially embedded in the gnathosomal cuticle. Palpal tarsus with two 2-tined spines and one minute, single-tined spine.

Legs evenly spaced along podosoma; terminal segment with pair of claws. Claws bifid distally and with a large, posteriorly directed spur. Solenidion anterodorsal to dorsal claw of legs I and II; absent on legs III and IV. Coxal plates meet at midline.

Genital orifice a simple longitudinal slit 5-6 μm long at level of legs I (Fig. 1). Dorsal podosomal tubercles faint. Anterior pair oblong with posterior end angled toward midline; spaced 16-18 μm apart at level of legs I. Posterior pair figure 8-shaped; spaced 12 μm apart at level of between legs I and II. Spaced 1.5 μm apart from front to back. Aedeagus 18 μm long with

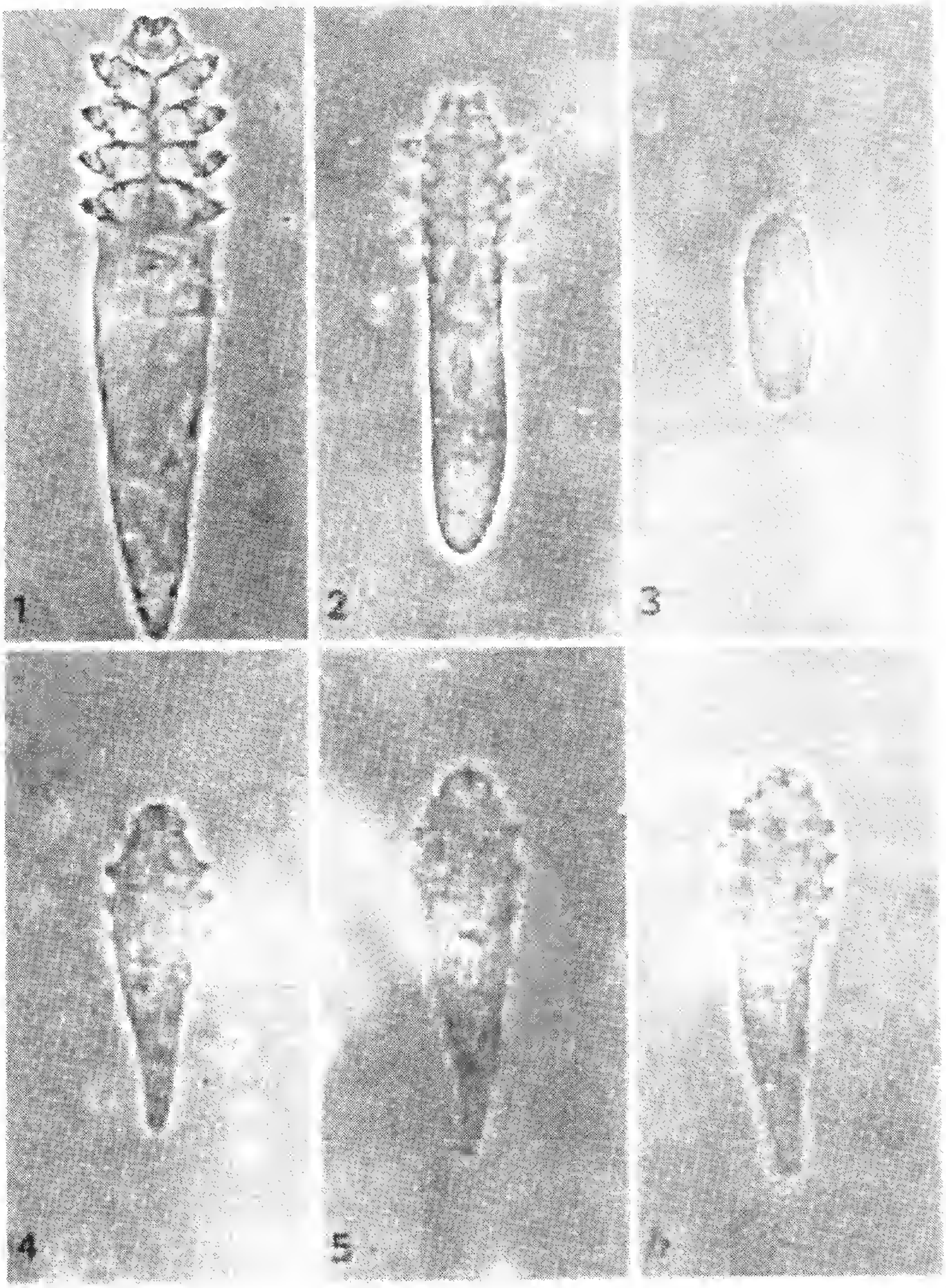

Plate I: Life stages of *Demodex macroglossi*. All X425. 1—Male (holotype). 2—Female (allotype). 3—Ovum. 4—Larva. 5—Protonymph. 6—Nymph.

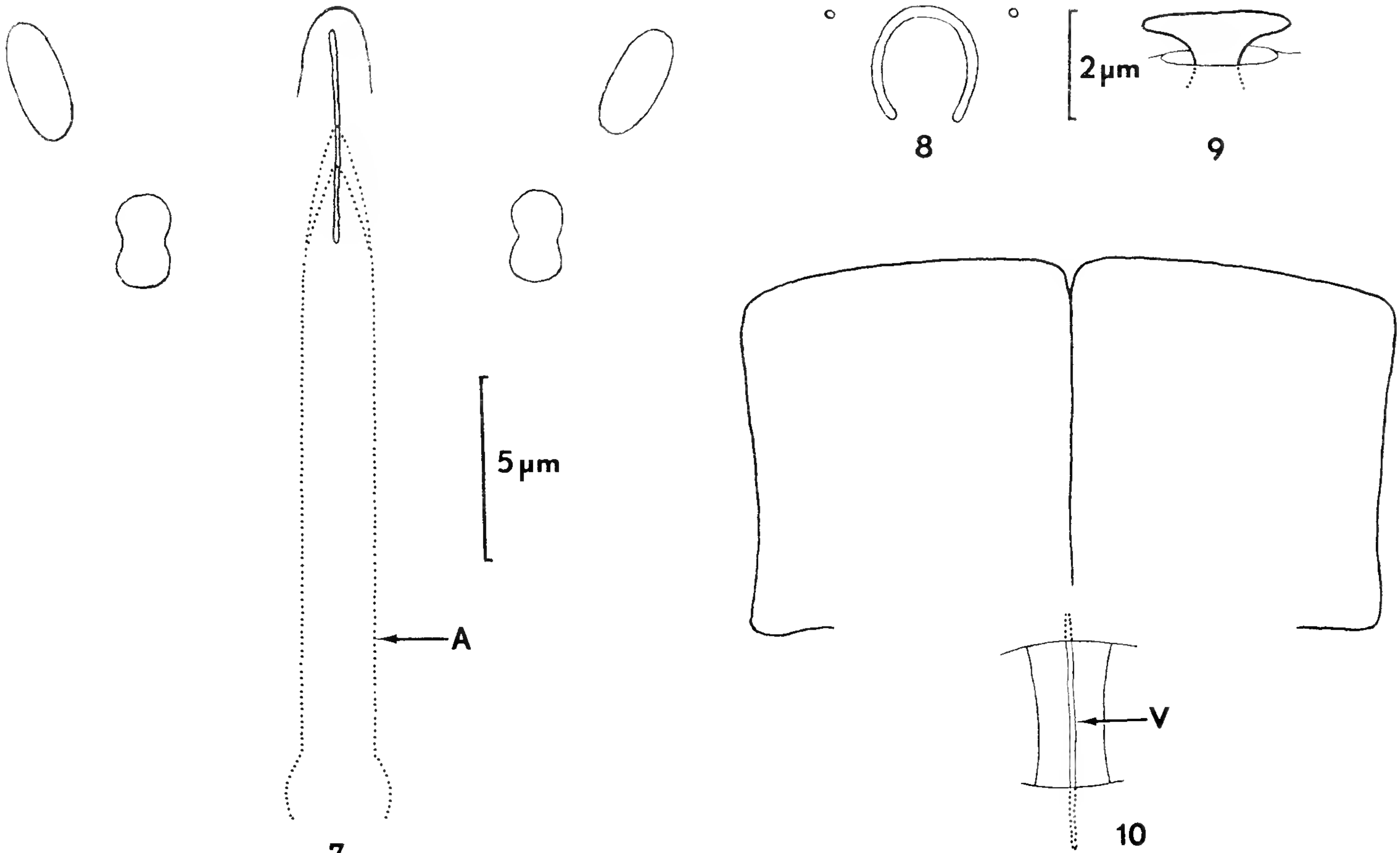

Fig. 1: Male genitalia and dorsal podosomal tubercles. A = aedeagus. Fig. 2: Pharyngeal bulb (pump) and lateral subgnathosomal setae (pits). Fig. 3: Left supracoxal spine. Fig. 4: Female external genitalia and coxal plates IV. V = vulva.

a narrow sheath. Posterior margin of dorsal podosomal shield at level of legs III.

Opisthosoma 108-125 μm long tapering to a blunt point. Transverse cuticular striations faint. Opisthosomal organ absent.

Female (Plate I, 2): Mean body length 141 μm (136-150 μm) (N = 20) with opisthosoma comprising nearly three-fifths of this value.

Gnathosoma and associated structures as in male but average width and length about 1 μm smaller. Supracoxal spines set 10 μm apart.

Legs and coxal plates as in male. Dorsal podosomal tubercles faint. Anterior pair as in male, 10 μm apart. Posterior small, round and 13 μm apart at level of legs II. Spaced 10 μm apart from front to back.

Vulva a simple longitudinal slit 4.4 μm long. Its anterior edge lies about 2 μm behind the posterior margin of coxal plate IV (Fig. 4).

Opisthosoma 76-89 μm long with round terminus. Transverse cuticular striations well-defined. Opisthosomal organ absent.

Ovum (Plate I, 3): Non-operculate, 48-54 μm long and broadly rounded at both ends. Anterior half with greatest width, 22-27 μm.

Larva (Plate I, 4): Spindle-shaped; 66-86 μm long with opisthosoma comprising just over one-half this value. Greatest width at legs III 21-29 μm.

Gnathosoma similar to adult but smaller and lacking subgnathosomal setae and supracoxal spines. Non-segmented legs positioned laterally projecting 4 μm from the body wall. Each leg with a large, short three-tined claw; tines spaced 3 μm apart. Ventral (sternal) scutes absent.

Protonymph (Plate I, 5): Spindle-shaped; 90-121 μm long with opisthosoma comprising two-thirds of this value. Greatest width at legs III 23-33 μm.

Gnathosoma and associated structures as in larva. Legs as in larva each with a pair of short trifid claws. Two pairs of ventral scutes at level of legs II and III; appear oval in ventral view and mamma-like in lateral view.

Nymph (Plate I, 6): Elongate, spindle-shaped; 114-156 μm with opisthosoma comprising two-thirds of this value. Greatest width at legs III 27-34 μm.

Gnathosoma and associated structures as in larva. Four leg pairs, each leg with a pair of short trifid claws. A pair of ventral scutes between each leg pair; anterior scute pair very small. Scutes shaped as in protonymph.

Host

Macroglossus minimus (Geoffrey, 1810) collected by F.S. Lukoschus at Camp Creek near Aluminium Camp on Mitchell Plateau (14°50'S, 125°49'E) on 19.X.1976. The holotype, allotype and all paratypes were taken from the single host specimen; WAM M15725.

Locus on host: Over one thousand mites were expressed from a single papule on the neck region. Mites were also recovered from hair follicles of the eyelids. Tissue was not available for histological examination.

Population structure: Of the 839 mites examined 57.7 per cent were immatures; 95 ova and embryos (11.3%); 163 larvae (19.4%); 88 protonymphs (10.5%) and 139 nymphs (16.6%). In the adult group, females outnumber males nearly two to one.

Frequency distribution plots of nymphal length (N = 83) reveal two size groups; one peaking at 121 μm and the other at 143 μm. This size distribution may indicate nymphal sexual dimorphism although no other morphological differences are distinguishable between nymphs.

TABLE 1

Means and standard deviations of 20 specimens of each stage and sex of *Demodex macroglossi*.
(All measurements in microns.)

		Male	Female
Gnathosoma	Length	13.3 ± 0.7	12.9 ± 0.6
	Width	18.4 ± 1.1	17.2 ± 0.9
Podosoma	Length	48.6 ± 0.9	46.4 ± 1.1
	Width	31.2 ± 1.8	28.0 ± 1.7
Opisthosoma	Length	113.8 ± 5.1	82.1 ± 3.2
	Width	29 5 ± 3.1	25.4 ± 3.2
Total length		175.7 ± 5.6	141.4 ± 3.0
Aedeagus		19.9 ± 1.2	
Vulva			4.4 ± 0.0

	Ovum			
Length	51.6 ± 1.6	74.1 ± 5.0	108.1 ± 8.9	136.8 ± 14.9
Width	24.2 ± 1.4	24.3 ± 2.4	28.0 ± 2.8	29 3 ± 2.5

DISCUSSION

Although all specimens of *D. macroglossi* examined in this study were obtained from a single papule on the neck of a *M. minimus*, additional mites were found infesting swollen hair follicles of the eyelids of this same host specimen (Lukoschus, pers. comm.). It is possible that follicles in other body regions are also inhabited by *D. macroglossi*, except the Meibomian glands which harbour another species of *Demodex* (Kniest & Lukoschus, in prep.). Of 12 host specimens surveyed for *D macroglossi* by F.S. Lukoschus, only the above-mentioned individual proved positive.

The morphological similarities of *D. macroglossi* and *D. carolliae* (Desch *et al.* 1971) and their similar pathology and distribution on their distantly related hosts, *Macroglossus minimus* (Megachiroptera) and *C. perspicillata* (Microchiroptera), respectively, indicate the evolutionary conservative nature of these mites that utilise the host hair follicle as habitat.

The bimodal size distribution of nymphs noted in *D. macroglossi* is observed in one other demodicid, *Demodex marsupialis* (Nutting *et al.*, 1980). Total length is the only external morphological manifestation so far observed to indicate possible sexual dimorphism in the nymphs of these two species. Additional meristic data from other demodicids may reveal similar results.

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NOTES ON THE DISTRIBUTION, ECOLOGY AND TAXONOMY OF THE PARTRIDGE PIGEON (*GEOPHAPS SMITHII*) AND SPINIFEX PIGEON (*GEOPHAPS PLUMIFERA*) IN WESTERN AUSTRALIA

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ABSTRACT

Data on distribution, abundance, habitat, food, breeding and colour of soft parts are given for the Partridge Pigeon and Spinifex Pigeon in Western Australia. Geographic variation in both species is analysed. Two subspecies are recognised in the Partridge Pigeon, *G. s. smithii* of Northern Territory (and formerly eastern Kimberley) and *G. s. blaauwi* of northwest Kimberley, Western Australia. No subspecies are recognised in the Spinifex Pigeon; the complex distribution and variation within this species make it difficult and artificial to recognise subspecies and I treat most of the variation as clinal. In morphology and behaviour the Spinifex Pigeon is close enough to the Partridge and Squatter Pigeons (*Geophaps*) not to require a genus of its own *(Lophophaps)*.

INTRODUCTION

The Partridge Pigeon was once widespread in the Northern Territory and Western Australia, but since the early nineteen-hundreds it has steadily declined in both States. Prior to 1960 little was known about the Partridge Pigeon in the Kimberley. It was first recorded in Kimberley near the Isdell River in 1901 by F.M. House who was the medical officer, naturalist and botanist on the Brockman Expedition. In 1902 Tunney collected a male and female at Cockatoo Springs, and at the same place in 1904 Kilgour saw great numbers of them and found a nest with eggs; these records are the last for east Kimberley. Rogers collected three males from the Townsend River in 1902, and Hill collected four males and four females around Napier Broome Bay from August 1909 to July 1910. In 1960 Mees collected a specimen at Kalumburu and in 1968 drew attention to the fact that Mathews' Kimberley subspecies *blaauwi* was distinct. Between 1970 and 1978 the Department of Ornithology and Herpetology of the Western Australian Museum, often in conjunction with the Department of Fisheries and Wildlife, carried out extensive fieldwork in the Kimberley, and much of the data presented here resulted from these surveys.

The Spinifex Pigeon is widespread in arid and semiarid regions of Australia (except sandy deserts), but its distribution, especially in Western Australia, is fragmented. Western Australia is the only State in which both the white-

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bellied ('*plumifera*') and red-bellied ('*ferruginea*') forms occur. Many previous writers have treated these forms as species or subspecies. Recent collections from problematical areas help solve the taxonomic status of western birds and show that most of the variation within "*plumifera*" is clinal. The Spinifex Pigeon has been variously placed by recent authors in *Lophophaps, Geophaps* and *Petrophassa*.

MATERIALS AND METHODS

I examined 130 Partridge Pigeons and 119 Spinifex Pigeons held in the Western Australian Museum, Australian National Wildlife Collection (Canberra), Australian Museum (Sydney), American Museum of Natural History and Queensland Museum. Measurements were taken as follows: length of chord of flattened wing, length of tail to outside base of central rectrix, length of tarsus and length of entire culmen. A series of standards were chosen in the Spinifex Pigeon to represent the full range of variation in colour (these are figured); a scale of one to six scored the amount of white and the amount and intensity of reddish brown on the belly.

PARTRIDGE PIGEON
(*Geophaps smithii*)

Distribution

Storr (1980) gives the distribution in Kimberley, Western Australia, as northwestern subhumid zone from Napier Broome Bay southwest to the Yampi Peninsula, inland to the lower Drysdale, Mitchell Plateau, Wulumara Creek, the middle Charnley and the lower Isdell. Formerly occurring in the Keep River drainage in far northeast of Kimberley Division but now extinct in this area (see **Fig. 1**). The present and former distribution in the Northern Territory is outlined in **Fig. 1** and by Storr (1977).

Status

Locally common but generally scarce or uncommon, usually occurring in pairs or small flocks of up to twenty.

Ecology

In Kimberley this pigeon favours the ecotone between the rugged King Leopold Sandstones and alluvial flats. The vegetation in these areas is mainly low woodland, tall shrubland and tall open shrubland. The trees and shrubs include *Eucalyptus miniata, E. apodophylla, E. latifolia, E. bigalerita, E. polycarpa*, bloodwoods (*Eucalyptus* spp.), *Acacia* spp. (including *A. holosericea* and *A. kelleri*), *Terminalia fitzgeraldii* and *Adansonia gregorii*. The ground cover is

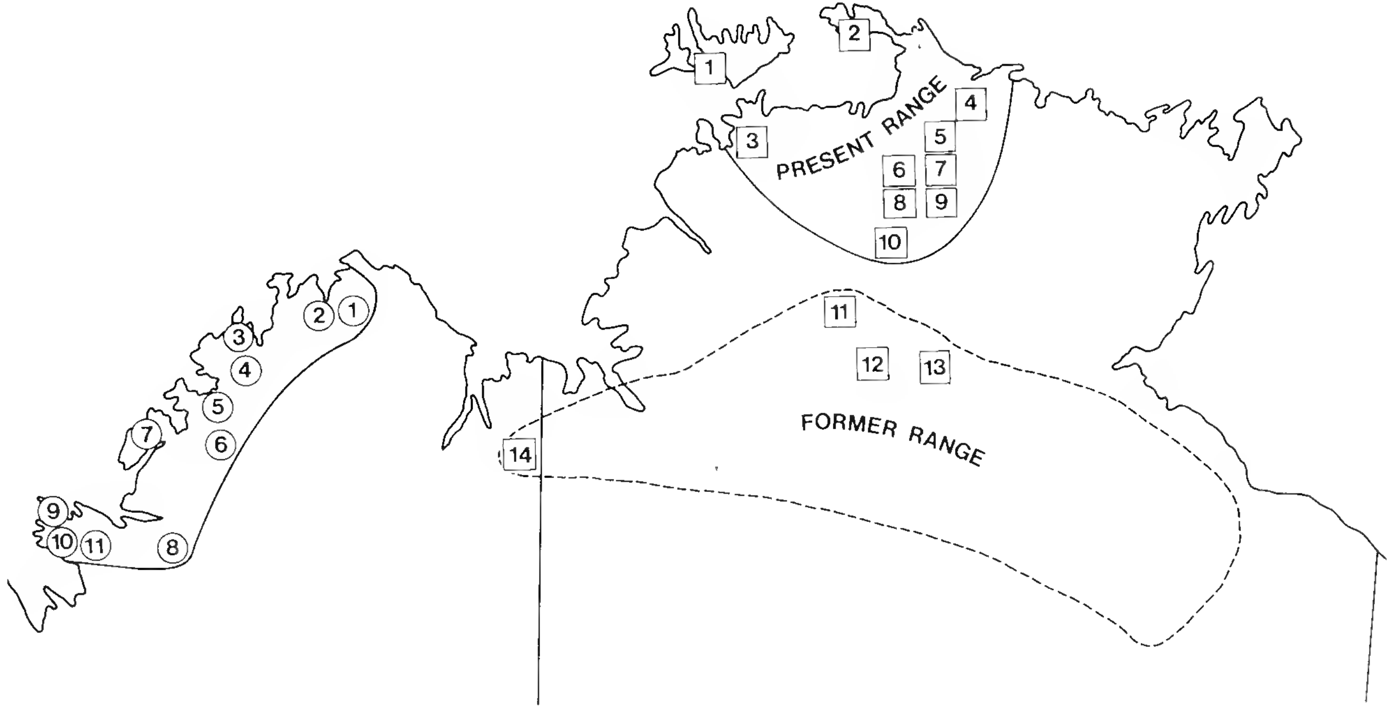

Fig. 1: Map of Northern Territory and Kimberley, Western Australia, showing distribution of *Geophaps s. smithii* (squares) and *G. s. blaauwi* (circles). *G. s. smithii:* 1 Melville Island, 2 Cobourg Peninsula, 3 Darwin, 4 Oenpelli, 5-9 East and South Alligator River drainages, 10 El Sherana, 11 Katherine River, 12 King River, 13 Roper River, 14 Cockatoo Springs. *G. s. blaauwi:* 1 Mumbo Jumbo, 2 Napier Broome Bay, 3 Crystal Head, 4 Mitchell Plateau, 5 lower Roe River, 6 Prince Regent River, 7 Kunmunya, 8 lower Isdell River, 9 Wotjulum, 10 Kimbolton, 11 Townsend River.

mostly a tall dense layer of grasses (*Sorghum* and *Eriachne* spp.). Pigeons are often seen feeding in grassland along creeks, especially in areas regenerating after fire. During the wet season on Mitchell Plateau many birds (mostly in pairs) feed on the roads and grid lines through a woodland of *Eucalyptus tetrodonta* and *E. miniata* with scattered *E. nesophila* and *E. latifolia* and a dense lower storey of *Livistona eastonii*. Grasses in this area include *Sorghum plumosum*, *Themeda australis*, *Chrysopogon latifolius* and *Plectrachne pungens*.

When approached this species will often squat or freeze like a quail, taking flight only when the observer is very close. The flight is similar to that of the Spinifex Pigeon, with a noisy flap then a glide on stiff wings. When flushed they often perch in trees. The call is a soft 'woop woo'. The bowing or courtship display is similar to that of the Spinifex Pigeon: the head and breast are lowered, the partly open wings are stiffly extended nearly to the ground, the tail is erect and fanned, and the bird coos rapidly. If the male is not close enough to the female to mount her immediately he walks to her with a limping gait. During some courtship displays and occasionally when perched, Partridge Pigeons will raise the lengthened nape feathers to form a short rounded crest.

Breeding

Kilgour found a nest with two eggs at Cockatoo Springs on 14 April 1904 (he wrongly ascribed them to *Petrophassa*). Hill observed young at Napier Broome Bay at the end of March and took eggs from 7 May to 28 June. P. Bindon (pers. comm.) found two nests on a grassy creekside flat on the northeast side of Yampi Peninsula on 7 and 8 July 1977, each with one pin-feathered nestling.

Soft Parts and Weights

The northwest Kimberley subspecies *Geophaps smithii blaauwi* has the iris brown to dark brown (in nine specimens), whitish grey (3) or cream (1), the last an immature. The facial skin is bright yellow (see **Fig. 2**), the bill black and the legs usually purplish brown (sometimes light greenish grey). Weights of seven males ranged from 160 to 217 g (mean 195 g) and five females 188 to 200 g (mean 194 g).

The Northern Territory subspecies *Geophaps smithii smithii* has the iris white or silvery white (79), greenish (3), yellow (2), mauve (1) and brown (1). The few birds that varied in iris colour may have been looked at some time after death. The facial skin in *G. s. smithii* is bright red (see **Fig. 2**), the bill black and the legs purplish grey, purplish brown or purple mauve. Weights of 59 males ranged from 167 to 230 g (mean 195 g) and 48 females 150 to 210 g (mean 180 g).

Fig. 2: Head pattern of *G. s. blaauwi* (left) and *G. s. smithii.*

Geographic Variation and Nomenclature

The Partridge Pigeon can be divided into two distinct subspecies, *Geophaps smithii smithii* (Jardine & Selby) of the Northern Territory and *Geophaps smithii blaauwi* Mathews from northwest Kimberley, Western Australia. Mathews (1912) described *blaauwi* from Napier Broome Bay on the basis of the naked eye-space or orbital skin being yellow rather than scarlet. Mathews' subspecies however has not been generally accepted. Peters (1937) regarded it as very doubtfully distinct. Deignan (1964) rejected it, suspecting that Mathews was misled by the red orbital skin rapidly becoming yellow in the dried skin. Condon (1975) listed it as a synomyn of *G. s. smithii,* despite the fact that Mees (1968) had collected a specimen and observed many individuals around the type locality of *blaauwi* all with the orbital skin ochre-yellow. I have also collected many specimens and observed numerous individuals in Kimberley, all with bright yellow orbital skin.

Another good character is the lack in *blaauwi* of a white supercilium. In *G. s. smithii* the white supercilium (white line above the black line) extends the full length of the orbital or facial skin and meets the white suborbital line behind the ear (**Fig. 2**). In *G. s. blaauwi* the white line above the lore extends at most to the front of the eye; it then becomes a broad all-black supercilium that meets the white suborbital line behind the ear (**Fig. 2**).

Hartert (1905), writing on Tunney's collection, listed a male and a female from Cockatoo Springs (near Kununurra, east Kimberley) collected on 20 June 1902. Tunney did not record the orbital skin colour of his specimens and, as the Partridge Pigeon is now extinct in east Kimberley (not recorded here since 1904), their subspecific identity was unknown. The easternmost population of *blaauwi* (at Mumbo Jumbo on the lower Drysdale River) is about 300 km to the northwest of Cockatoo Springs (**Fig. 1**). Only one of Tunney's specimens has been located, the male (no. 616113 in the American Museum of Natural History). This specimen has the complete white supercilium of the nominate race. Tunney labelled the iris colour of this bird as silvery grey, which is the same as in most Northern Territory birds (in *G. s. blaauwi* it is usually dark).

Table 1 gives the measurements of the two races. It will be seen that *G. s. blaauwi* has a slightly longer wing and bill than *G. s. smithii*.

TABLE 1

			Wing	Tail	Tarsus	Culmen
G. s. smithii	N.T.	♂	127-140 (133, N64	76-101 (89, N65)	26-32 (28, N65)	18.0-23.5 (22.0, N62)
		♀	124-135 (130, N50)	75-97 (87, N50)	25-31 (28, N50)	19.5-24.0 (21.5, N50)
	W.A.	♂	132	90	30	21.5
G. s. blaauwi	W.A.	♂	132-143 (137, N9)	85-95 (90, N9)	24-29 (27, N9)	21.0-25.0 (22.8, N9)
		♀	131-138 (135, N6)	82-89 (85, N6)	25-27 (26, N6)	21.0-23.0 (21.8, N6)

Table 1: Measurements (mm) of *Geophaps smithii* with means and sample size in parentheses.

DISCUSSION

Storr (1977) gives the status of the Partridge Pigeon in the Northern Territory as 'formerly common in well-watered but well-drained grassy woodlands and open forests, but now either greatly reduced in numbers or extinct in much of former range. Still locally common in rough country about the East and South Alligator and east of Pine Creek; scarce on Cobourg Peninsula; rare in Darwin district. No recent records from the Keep, Victoria, lower Daly, Katherine, King, Roper and McArthur drainages'.

There is little doubt that the great decline in numbers in the Northern Territory and east Kimberley is due to over-grazing by domestic stock. This is not only evident with the Partridge Pigeon but also with its close relative the Squatter Pigeon (*Geophaps scripta scripta*) and other grassland species, such as the Paradise Parrot (*Platycercus pulcherrimus*) and the Black-throated Finch (*Poephila cincta cincta*), in eastern Queensland. All are species which favour woodland savannah especially in broad river valleys; this habitat, often the first taken up by pastoralists, is vulnerable to degradation by over-grazing. All four species are now extinct over most of their former range, and all declined rapidly between 1860 and 1920.

SPINIFEX PIGEON
(*Geophaps plumifera*)

Distribution

Storr (1980) gives the distribution in the Kimberley as arid and semiarid zones, north to Beverley Springs, the Phillips Range, the sources of the Durack River, the New York Range, the lower Pentecost, Wyndham and Kununurra; west to Inglis Gap, the Napier Range, Mt Anderson, Grant Range and Logues Springs (Dampier Downs); and south to the Edgar Ranges, Mt Arthur, St George Ranges, Wattle Spring (56 km southeast of Christmas Creek HS), Mt Bannerman and the Gardiner Range (**Fig. 3**).

In the Northwest Division of Western Australia it ranges north to the DeGrey River, east to the Rudall River and Carnarvon Range, and south to Cape Range, the Wooramel River and Meekatharra. There is also an isolated population in the far east of the Eastern Division (Rawlinson Range and Walter James Range).

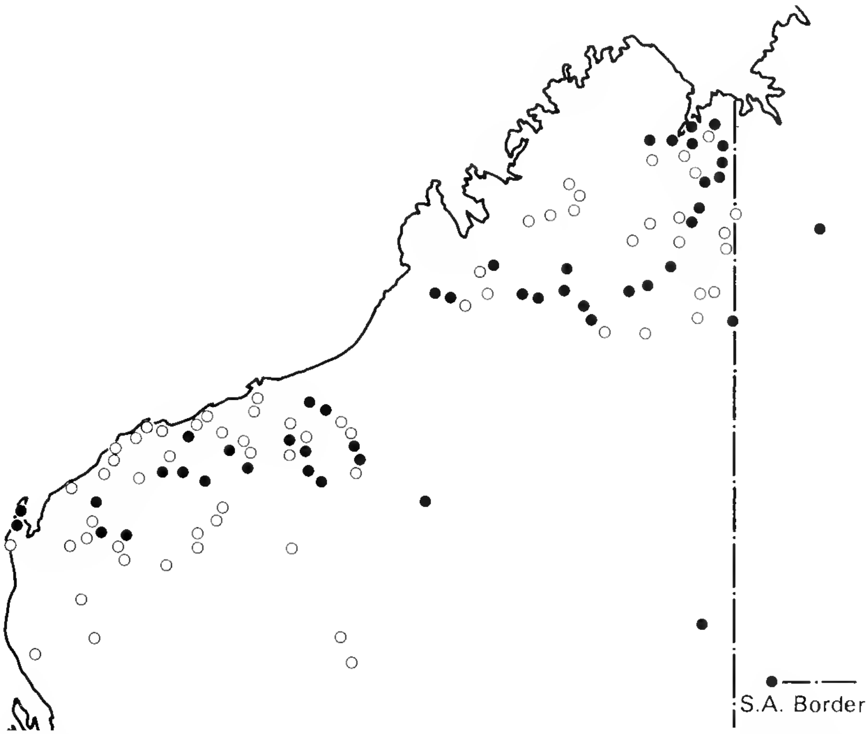

Fig. 3: Map of north Western Australia, showing location of specimens (solid circles) and sight records (hollow circles) of *Geophaps plumifera*.

Status

This pigeon is common throughout most of its range but may be uncommon to moderately common in isolated populations such as those of the Cape Range, Rawlinson Range and Walter James Range. It is usually found in pairs or small parties, occasionally in large flocks of up to 100 at water.

Ecology

The Spinifex Pigeon generally frequents rocky or stony country with permanent water. It is absent from sandy deserts. Although strongly associated with spinifex (*Triodia* and *Plectrachne*), Spinifex Pigeons are not completely dependent on it as a food source, feeding also on the seeds of other grasses and herbs. Water is an important factor in determining their distribution.

The flight is similar to that of the Partridge Pigeon, the birds rising with a clatter of wings then a glide, but when landing they often make a few slow flaps. The Spinifex Pigeon is very agile on the ground, being able to make short jumps from rock to rock and walk and run quickly. The bowing display is similar to that of the Partridge Pigeon (see above). The call is a short 'coo oor'.

Breeding

Twenty-one two-egg clutches have been recorded for Western Australia; eight in Kimberley in the following months, January (1), April (2), May (1), July (3), October (1), and thirteen in the Northwest Division in the following months, January (1), May (2), June (1), August (4), September (2), October (1) and December (2).

Nomenclature

Gould believed that the Spinifex Pigeon comprised three species, namely *Lophophaps plumifera* (which he described in 1842 with specimens from the Victoria River, Northern Territory), *L. ferruginea* (described in 1865 from Shark Bay, Western Australia) and *L. leucogaster* (described in 1869 from Machrihanish Station, South Australia). Mathews (1912) reduced the number of species to two, a white-bellied *plumifera* and a red-bellied *ferruginea* and named two new Western Australian subspecies: *Lophophaps plumifera pallida* from Parry Creek, and *L. ferruginea mungi* from 13 km southeast of Mt Alexander.

Mayr (1951) went further and treated all forms as a single species and described a new subspecies (*proxima*) from central-south Kimberley, and synonymised *pallida* with *plumifera*. Condon (1975) followed Mayr in treating *ferruginea* as a race of *plumifera* and recognising all five subspecies, but placed *Lophophaps* and *Geophaps* in *Petrophassa*.

The small head and bill, the reduced bronze on wing, the presence of a wing speculum, the barring on nape (and other parts of plumage), the immature plumages and the absence of a crest link *Petrophassa* more to *Geopelia* than to *Geophaps*. The main similarities between *Lophophaps* and *Geophaps* are the stout bill, shape and extent of orbital and facial skin, iridescent wing patches (on inner secondaries in *Lophophaps* and upper wing coverts in *Geophaps*), colour pattern of breast feathers, and crest (incipient in *Geophaps smithii*). The colour of the flesh also separates *Geophaps* from *Petrophassa*. In the Spinifex and Partridge Pigeons the flesh is pale pinkish white, whereas in the White-quilled Rock Pigeon *Petrophassa albipennis* and presumably the Rufous-quilled Rock Pigeon *P. rufipennis* it is dark reddish brown.

Geographic Variation

This subject is dealt with by comparing the more distinctive populations, beginning with those in the west.

1. Cape Range

The isolated population in the Cape Range is the palest of all red-bellied populations (**Figs 4, 5**). The breast and belly is very pale reddish brown; the breast band is ill-defined with the feathers pale bluish-grey at base, a blackish or dark brown narrow indistinct subterminal bar and a pale reddish brown tip. The forehead is pale bluish grey, the nape pale reddish brown (one specimen greyish brown), the mantle buffy brown, the lower back and tail pale reddish brown, the feathers with indistinct light brown rather than blackish brown bars. The wing coverts have a washed-out appearance, being pale bluish grey, tipped pale reddish brown. The Cape Range birds are separated from the Pilbara population by a broad belt of unsuitable sandy country south and east of Exmouth Gulf.

2. Pilbara *('ferruginea')*

These are characterised by being a rich reddish brown above and below. The breast is reddish brown; the individual feathers of the dark breast band (as with the feathers on the wing coverts and mantle) are bluish grey except for a blackish subterminal bar and pale tip; the rest of the under parts are reddish brown. The forehead is bluish grey; the crown is dark reddish brown; the mantle feathers are pale grey with an indistinct dark brown subterminal bar and reddish brown tip; the wing coverts are bluish grey with a distinct black subterminal bar and dark reddish brown tip; the lower back, rump and tail are dark reddish brown (**Fig. 4**). The iris is orange-brown or reddish brown. These populations are isolated from the Central Australian (Rawlinson Range etc.) by the Gibson Desert and from the Kimberley populations by the Great Sandy Desert.

'Fig. 4: Ventral coloration of *Geophaps plumifera*. Top, left to right: Cape Range W.A., Carawine Pool W.A., Edgar Ranges W.A. and Christmas Creek W.A.
Bottom, left to right: Wyndham W.A., Wave Hill N.T., Newcastle Range Qld. and Rawlinson Range W.A.

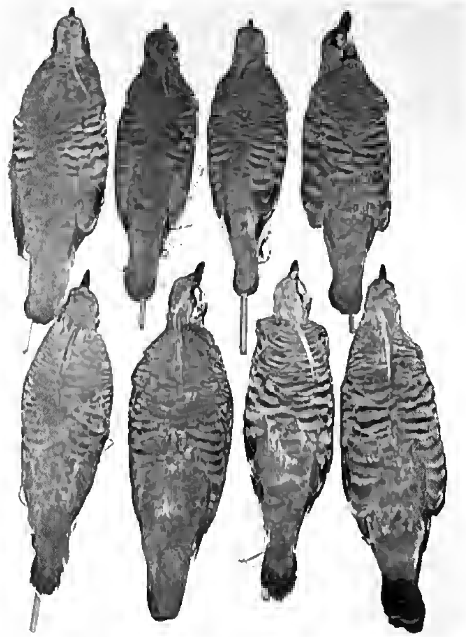

Fig. 5: Dorsal coloration of *Geophaps plumifera*.
Top, left to right: Cape Range W.A., Carawine Pool W.A., Edgar Ranges W.A. and Christmas Creek W.A. **Bottom, left to right:** Wyndham W.A., Wave Hill N.T., Newcastle Range Qld. and Rawlinson Range W.A.

3. Southwest Kimberley (*"mungi"*)

At Mt Anderson, Grant Range, Logues Springs, Edgar Ranges and Mt Arthur occur 'red-bellied' birds which match well with Cape Range specimens. Although the Grant and Edgar Ranges and Mt Arthur are all separated by unsuitable habitat, specimens from these localities are almost identical. It is of interest here to point out that Mayr (1951) unwittingly included specimens from Yardie Creek (Cape Range) with *'mungi'*. He apparently believed that Yardie Creek was near Derby. Cape Range specimens are in fact slightly paler on the belly and back than *'mungi'*. A description of *'mungi'* is as follows: the breast and belly are pale reddish brown (buffy brown); the breast band feathers are basally bluish grey and have a blackish subterminal bar and pale tip. The forehead is bluish grey and the crown reddish brown; the mantle feathers have a pale greyish brown base, a dark brown subterminal bar and a sandy brown tip; the wing coverts are bluish grey, with a black subterminal bar and a broad sandy brown tip; the lower back, rump and tail are pale reddish brown (**Figs 4, 5**).

The population *'mungi'* is important for interpreting the variation within the species. *Mungi* is in fact a primary intergrade. There is a slight break of 90 km between red-bellied birds in the Grant Range and white-bellied birds in the St George Ranges. The alluvial flats separating these two populations are unsuitable for Spinifex Pigeons. Although there is now little or no contact between white-bellied and red-bellied birds in this area, there is a definite cline in colour of back and to a lesser extent in belly colour (**Figs 4, 5**). In iris colour, too, *'mungi'* bridges the gap between white-bellied and red-bellied birds. White-bellied birds have a yellow iris ('chrome yellow' or 'yellowish'), whereas in Pilbara birds (*'ferruginea'*) it ranges from orange and reddish orange to light brown. Eighteen *'mungi'* from the Grant Range (which are nearest geographically to white-bellied birds) have the iris recorded as yellow, whereas eight *'mungi'* from the Edgar Ranges have the iris recorded as orange (1), reddish orange (5), brick red (1) and reddish brown (1).

4. Central-south Kimberley (*'proxima'*).

At St George Ranges, Fitzroy Crossing, Go Go, Cherrabun, Christmas Creek and the Margaret River occur white-bellied birds which Mayr (1951) named *'proxima'*. They differ from *'mungi'* in having a white breast band and white belly. A description of these birds is as follows: the breast is dark reddish brown with a well-defined white breast band above the dark band; the bluish grey feathers of the dark breast band are tipped dark reddish brown; the upper belly is mostly white, some feathers with a light reddish brown wash particularly on the flanks; the lower belly is pale sandy brown with some feathers washed or tipped whitish. The upper parts are almost the same as in *'mungi'*.

The entire series seen by Mayr was collected by Tunney in April 1902 from the middle Fitzroy River (320 km upstream) and the Margaret River (420 km from Derby). Mees (1961), with additional specimens from Moola Bulla, Margaret River and Fitzroy Crossing, agreed that '*proxima*' was distinct, but he wondered if it was desirable to separate it. Contrary to Mayr, however, he placed Margaret River specimens with the nominate race. As the variation here is clinal, no two authors could be expected to agree on where to draw the line between these 'subspecies'.

There is no break in the range of white-bellied birds in Kimberley. Birds from the Margaret River and middle Fitzroy are slightly more reddish brown (less greyish brown) on the upper parts than those from northeast Kimberley; this cline in back colouration ends in the Grant and Edgar Ranges, i.e. it extends through three 'subspecies'. The amount of rufous on the belly also decreases east of Christmas Creek. Most of the 34 specimens from between Christmas Creek and Noonkanbah had decidedly more white than pale reddish brown on the belly. However five specimens have more pale reddish brown than white; they are from Christmas Creek, Cherrabun and Fitzroy Crossing and not, surprisingly, from further west.

Birds from the Gardiner Range match well with Christmas Creek specimens, being more reddish brown on the upper parts than birds from Halls Creek.

5. East Kimberley, north of Northern Territory ('*plumifera*') and northwestern interior of Queensland

As mentioned above populations 4 and 5 are continuous. However birds from north of Halls Creek become more greyish brown (less reddish) on the upper parts, especially on the lower back and rump. The breast is reddish brown; the white and dark breast bands are broad, and the rest of the under parts are almost pure white with some reddish brown on the flanks.

Storr (1977) delimits three isolated populations of the Spinifex Pigeon in the Northern Territory; one in the west (Ord and Victoria drainages), a second in the northeastern semiarid zone (Carpentaria drainage), and a third in the hills and ranges of the central and southern arid zone (**Fig. 6**). Specimens from northeastern and northwestern Northern Territory and east Kimberley are similar. A specimen from Wave Hill in the Northern Territory is the most boldly patterned of all Spinifex Pigeons I have seen. It has the breast dark reddish brown with broad white and dark breast bands (the subterminal black bars on the breast feathers are much wider than in Halls Creek specimens). The belly is white with scattered reddish brown feathers, and the lower belly and vent are pale buffy brown. The cap is chestnut (light reddish brown in Halls Creek specimens) and the upper parts are more reddish than Halls Creek birds.

Most birds from the western interior of Queensland match well with birds from the north of the Northern Territory and northeast Kimberley.

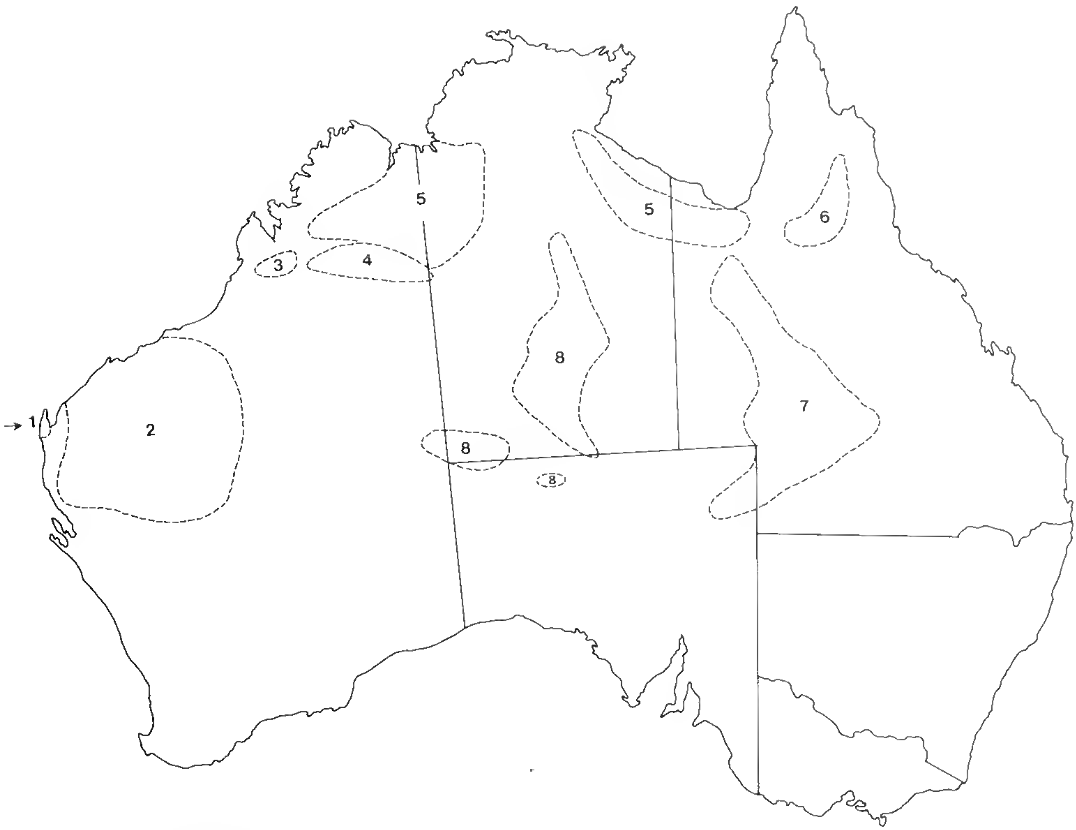

Fig. 6: Map of Australia showing the distribution of *Geophaps plumifera*. Numbers correspond to populations treated in text.

6. Southern interior of Cape York Peninsula

Birds from the Newcastle Range are isolated from those of western Queensland and are quite distinctive. The breast is buffy brown (or pale yellowish brown); the white and dark breast bands are broad and distinct; the belly is pure white, the flanks with a faint buffy wash. The crown is pale buffy brown (becoming almost white on the crest); the mantle feathers are bluish grey with a blackish subterminal bar and buffy brown tip; the back and rump are brownish grey (greyish brown in one specimen); the wing coverts are bluish grey with black subterminal bars and broad pale yellowish brown tips. This dark barring on the wing coverts gives a dark appearance to the upper parts (**Figs 4, 5**). The breast has a very washed-out appearance. These are the palest of all white-bellied specimens that I have seen.

7. Southwestern interior of Queensland and northeastern South Australia (*'leucogaster'*)

Gould characterised the race *'leucogaster'* from northeastern South Australia as agreeing in colour with *'plumifera'* but having a longer wing. Specimens from Coopers Creek are in fact slightly smaller than the measurements given by Mayr for *'leucogaster'*, being more like the white-bellied populations to the north. Mayr however loosely applied the name *'leucogaster'* to the Central Australian populations rather than to birds from the southwestern interior of Queensland and northeastern South Australia. Birds from southwestern Queensland are slightly paler than white-bellied birds to the north and there is a trend from north to south in reduced white on the belly. Two Coopers Creek birds have only a few white feathers below the dark breast band, and the rest of the belly is pale buffy brown.

8. Central Australia

The most interesting aspect of birds from Central Australia is the reduction in white on the belly. This is most evident in birds from the MacDonnell Ranges, Ayers Rock and Rawlinson and Mann Ranges. In this respect and in back coloration these birds, especially those from the Mann and Rawlinson Ranges, show a tendency towards *'ferruginea'*. The Mann and Rawlinson Range birds have the breast reddish brown, the white breast band narrow, and the belly pale buffy brown. The two specimens from these areas only score 1 out of 6 for white on the belly (**Fig. 4**). They are also large (**Table 2**). In back coloration and in reduced white on the belly these specimens are most like the red-belied populations; however they have some white on the belly and a white breast band.

In the past there may have been a connection between the Central Australian and Pilbara populations. There are many low ranges and hills between the Rawlinson and Carnarvon Ranges, but water is now scarce in this region. The Bowerbird (*Ptilinorhynchus maculatus guttatus*) is similarly disjunct between the Carnarvon Ranges and the Central Australian Highlands and likewise depends on water.

TABLE 2

		Wing	Tail	Culmen	Weight
1 Cape Range W.A.	♂	105-114 (N3)	59-70 (N3)	19.5-21.0 (N3)	
	♀	111	61	19.5	112
2 Pilbara W.A.	♂	103-110 (106, N12)	55-69 (64, N12)	19.0-22.5 (20.6, N12)	80-114 (99, N6)
	♀	106-115 (110, N13)	59-67 (63, N13)	18.0-21.0 (19.6, N13)	80-89 (83, N7)
3 Southwest Kimberley W.A.	♂	104-109 (106, N9)	54-69 (63, N9)	18.0-21.0 (19.5, N9)	73-96 (88, N9)
	♀	97-106 (102, N7)	52-64 (58, N7)	17.0-19.5 (18.4, N7)	70-83 (76, N7)
4 Central-south Kimberley	♂	104-112 (108, N18)	61-75 (67, N18)	18.0-22.0 (19.8, N18)	80-104 (91, N18)
	♀	102-108 (105, N15)	62-72 (67, N18)	18.5-20.0 (19.0, N18)	72-96 (81, N14)
5 East Kimberley, north of N.T. and northwestern interior of Qld.	♂	106-112 (109, N12)	63-75 (70, N12)	18.0-20.5 (19.4, N12)	90-128 (102, N9)
	♀	101-114 (106, N15)	65-74 (69, N15)	18.0-21.0 (19.5, N15)	67-96 (85, N9)
6 Southern interior of Cape York Peninsula	♂	106-111 (109, N5)	71, 79 (N2)	20.0-22.0 (21.0, N5)	
	♀	103-108 (105, N5)	67, 73 (N2)	18.5-21.5 (19.2, N5)	
7 Southwestern interior of Qld and northeastern S.A	♂	103	67	18.0	
	0	104, 110	69, 73	20.5	
8 Central Australia	♂	113	75	20.5	113
	♀	109	67	20.0	100

Table 2: Measurements (mm) of *Geophaps plumifera* with means and sample size in parentheses.

DISCUSSION

In view of the clinal and discordant variation within the Spinifex Pigeon it becomes artificial to recognise subspecies. Geographic variation within this species can be summarised as follows:

1. The red-bellied *'ferruginea'* appears to be the most distinct in belly, back and iris colour as compared to white-bellied birds; however the Edgar and Grant Range populations (*'mungi'*) are intermediate between these forms. Birds of the Cape, Edgar and Grant Range are in back coloration most like *'plumifera'* but in the colour of the underparts most like *'ferruginea'*. One could group these populations as a polytopic subspecies; however the pale coloration of the Cape Range birds must have evolved independantly.

2. No line can be drawn between *'proxima'* and *'plumifera'* or between *'plumifera'* and *'leucogaster'*. I can find little difference between some *'plumifera'* from southeastern Kimberley and some specimens of *'leucogaster'* from southwestern Queensland.

3. The Mann and Rawlinson Range birds are also difficult to place; they have the back and, to some extent, belly colour as in *'ferruginea'* but retain some white on the belly and have a white breast like *'plumifera'* and *'leucogaster'*.

This demonstrates the difficulty in recognising races within this species. If *'ferruginea'* is recognised the Cape Range, Newcastle Range and other populations should also be named.

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BIRDS OF THE NORTHEASTERN INTERIOR OF WESTERN AUSTRALIA

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ABSTRACT

This paper is essentially an annotated list of the 148 species of birds recorded from the tropical portion of the Eastern Division of Western Australia. The region consists largely of deserts (the Great Sandy, Tanami and Gibson).

INTRODUCTION

The area covered by this paper is the tropical portion of the Eastern Land Division of Western Australia. It is bounded in the north by the southern boundary of the Kimberley Division (lat. 19°30′S), in the south by the Tropic of Capricorn (lat. 23°26′30″S), in the east by the Northern Territory border (long. 129°00′E), and in the west by the eastern boundary of the North-West Division (which in the north follows long. 121°24′E and in the centre and south the long-abandoned No. 1 Rabbit-proof Fence) (see **Fig. 1**).

As in the 'Birds of the Kimberley Division, Western Australia' (Storr 1980, *Spec. Publs West. Aust. Mus.* No. 11) information is given on local distribution, ecological status, relative abundance, habitat preferences, movements, breeding season (defined by the months in which eggs are laid) and clutch size (prefixed by C for eggs and nestlings, and B for broods that have left the nest but are still dependent, e.g. C/2(3) denotes three records of nests with two eggs or nestlings).

Environment

The region lies entirely within the arid zone. Mean annual rainfall ranges from 32 cm in the northwest to 23 cm in the southeast, 75-90% of it falling from December to May. By the criterion of land-use all of the region is desert except for pastoral holdings in the far northwest (Anna Plains), far northeast (Billiluna, Lake Gregory and Balgo) and far southwest (Talawana). The far east is mostly Aboriginal Reserve.

Much of the region consists of the Great Sandy Desert, which is bordered on the southwest by the Little Sandy Desert, the central south by the Gibson Desert and the east by the Tanami Desert. The prevailing sandplains and

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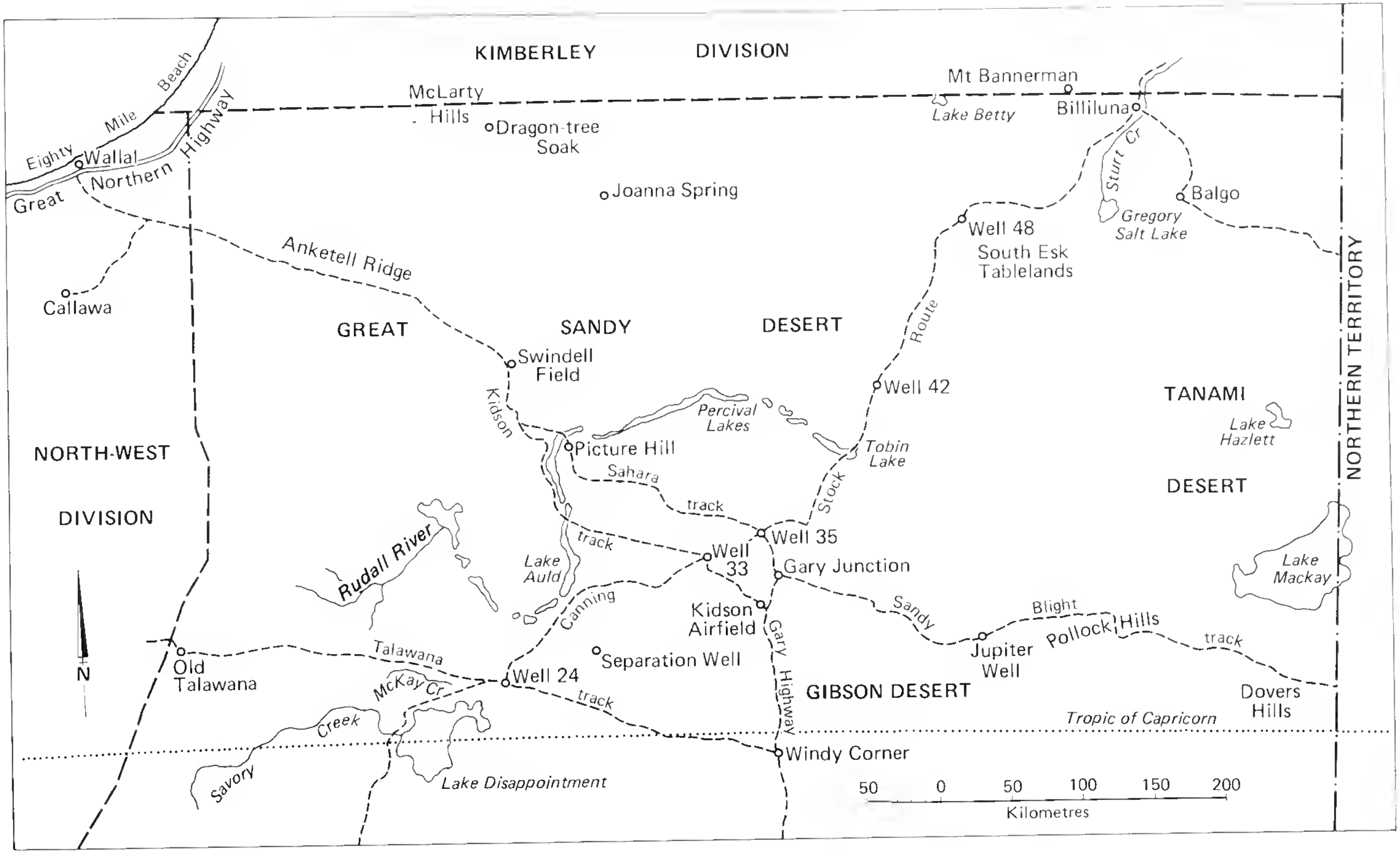

Fig. 1: Map of northeastern interior of Western Australia.

sandridges are interrupted by gravelly uplands such as the South Esk Tablelands, the Anketell Ridge and the Gibson Desert, by numerous saltpans, by the stony ranges of the southwest and the streams that flow out of them (essentially an eastward extension of the Pilbara), and by Sturt Creek and Gregory Salt Lake (in effect a southward extension of the Kimberley).

The vegetation is predominantly a hummock grassland of spinifex (*Triodia* and *Plectrachne* spp.) with scattered shrubs and low trees, especially of the genera *Acacia, Hakea, Grevillea* and *Eucalyptus*. Locally the trees are denser, as in groves of desert oak (*Casuarina decaisneana*) on interdunal sands or bloodwoods (*Eucalyptus dichromophloia*) along the upper slopes of sandridges. Mulga (*Acacia aneura*) scrubs are largely confined to the Gibson Desert, and teatree thickets (*Melaleuca glomerata* and *M. lasiandra*) to low-lying places. Along the few watercourses of the region the dominant tree is the river gum (*Eucalyptus camaldulensis*). Samphires and other halophytic herbage grow on and around the saltpans.

For a detailed account of the climate, physiography, soils and vegetation of the region see Beard & Webb (1974).

Sources of data

Until recently most of the region was inaccessible except to large expeditions equipped with camels. Only a little information on birds can be gleaned from the accounts of explorers. A.C. Gregory followed Sturt Creek down to Gregory Salt Lake in March 1856, and his brother F.T. Gregory penetrated the Great Sandy Desert for a few kilometres east of the Gregory Range in September 1861; they published their journals in 1884. P.E. Warburton crossed the northern part of the region from east to west in August-December 1872 (Warburton 1875). D.W. Carnegie crossed the eastern part of the region from south to north in September-November 1896 (Carnegie 1898).

The disastrous Calvert Expedition crossed the western part of the region from south to north in October 1896. The ornithologist G.A. Keartland accompanied them but had to abandon his collections in the desert. Extracts from Keartland's field notes and descriptions of the birds he obtained at Joanna Spring in April 1897 were published by North (1898).

Western Australian Museum preparator O.H. Lipfert collected along the Canning Stock Route from April 1930 to April 1931; his bird skins were shared between the Western Australian and South Australian Museums. From April 1943 to March 1944 ornithologist K.G. Buller worked on the Canning Stock Route between Old Billiluna and Well 23; his collection of bird skins and a copy of his diary are lodged in the Western Australian Museum. Naturalist J.H. Calaby visited the Rudall River in September 1955; he kindly gave me a copy of his bird notes. Anthropologist D.F. Thomson visited the far east of the region in 1957 but seldom mentioned the birds (Thomson 1962).

In the last 15 years the numerous roads and tracks made by surveyors and oil-prospectors have enabled several ornithologists to visit the region. In September 1966 J.R. Ford and G.M. Storr travelled north along the Gary Highway to Well 35, returning via the Talawana track. In early December 1970 T. Fletcher visited the Rudall River (Fletcher 1971). In May-June 1971 J.R. Ford, J. Dell and G. Chapman traversed the entire south of the region via the Sandy Blight and Talawana tracks. In August-September 1972 W.H. Butler collected birds in the far southwest for the American Museum of Natural History. In July 1973 S.J.J.F. Davies travelled to Well 35 via the Talawana track, returning via the Kidson track; Dr Davies also gave me a copy of the notes made by the late Noel Ives along the Sahara track and around Kidson Airfield in August 1974. In August 1973 J.R. Ford, R.E. Johnstone and G. Lodge worked along the Sandy Blight track and Gary Highway. In August 1976 P. de Rebeira visited Well 34 via the Talawana track and Gary Highway; on the return journey he visited the Rudall River. In August 1977 N.L. McKenzie and P.J. Fuller visited by helicopter the McLarty Hills, Dragon-tree Soak and a point on the Kidson track (*ca* 20°25′S, 122°10′E). In September 1977 P. de Rebeira and I. Rook travelled north along the Gary Highway to Well 35 and returned via the Sahara track. In November 1977 L.A. Smith and R.E. Johnstone visited Gregory Salt Lake (Smith & Johnstone 1978). In September 1978 D.A. Saunders and P. de Rebeira crossed the region from south to north via the Gary Highway and Billiluna track. In April-May 1979 A.N. Start, N.L. McKenzie, W.K. Youngson and A.A.E. Williams visited the Rudall River and worked along the Talawana track, Gary Highway and Kidson track. In the same period R.E. Johnstone, L.A. Smith, A.A. Burbidge and P.J. Fuller worked the country around Balgo and Gregory Salt Lake and along the Billiluna and Kidson tracks. A.A. Burbidge and P.J. Fuller revisited Gregory Salt Lake in late May and early June 1980, when the lake was half full; they also visited the country between Balgo and Point Moody. I am very grateful to all these gentlemen for their notes, which were almost entirely unpublished.

LIST OF BIRDS

Casuariidae

Dromaius novaehollandiae (Latham) **Emu**

Almost entirely southern and eastern, i.e. absent from most of Great Sandy Desert (only recorded in extreme north at Dragon-tree soak and near Lake Betty). Uncommon in southwest (north to the Rudall and east to McKay Creek), scarce elsewhere; in ones, twos or small parties (up to five). Mainly vicinity of fresh water (claypans, river pools, desert soaks) but also mulga country of Gibson Desert; absent from waterless sandy deserts.

Podicipedidae

Podiceps novaehollandiae novaehollandiae Stephens **Black-throated Grebe**

Only recorded in far northeast (Gregory Salt Lake) and southwest (Rudall River). Scarce; in ones, twos or small flocks (up to 10). One breeding report: two pairs with chicks observed by J.H. Calaby on the Rudall in mid-September 1955.

Podiceps poliocephalus Jardine & Selby **Hoary-headed Grebe**

Two records: one observed by P.J. Fuller, R.E. Johnstone *et al.* at mouth of Djaluwon Creek, Gregory Salt Lake, on 26 April 1979; and one observed by A.N. Start *et al.* at Coondegoon Pool, Rudall River, on 30 April 1979.

Pelecanidae

Pelecanus conspicillatus Temminck **Australian Pelican**

Only recorded in far northeast. The explorer D.W. Carnegie (1898: 371) noted pelicans on Gregory Salt Lake in April 1897. L.A. Smith and R.E. Johnstone found them common on Gregory Salt Lake in November 1977 in flocks of up to 200 but saw none here in April 1979 when the Lake was nearly dry. They were very plentiful on Gregory Salt Lake in early winter 1980, when A.A. Burbidge and P.J. Fuller saw flocks of *ca* 1000 and 5000 towards the south end of the lake.

Phalacrocoracidae

Phalacrocorax sulcirostris (Brandt) **Little Black Cormorant**

One record from far northeast: in November 1977 L.A. Smith and R.E. Johnstone found it plentiful in scattered flocks (up to 100) on Gregory Salt Lake when it was half full. They also saw hundreds of old cormorant nests in dead wattles about a kilometre back from the water edge; unfortunately they could find no remains of the birds to identify the species that built them.

Phalacrocorax melanoleucos melanoleucos (Vieillot) **Little Pied Cormorant**

Only recorded from far northeast and southwest. L.A. Smith and R.E. Johnstone saw a few at Gregory Salt Lake on 6 November 1977, and T. Fletcher saw one on a pool in the Rudall in early December 1970.

Anhinga melanogaster novaehollandiae (Gould) **Darter**

Two records from far northeast: several seen by L.A. Smith and R.E. Johnstone at Gregory Salt Lake on 7 November 1977, mostly single birds but also small parties (up to 6); and one seen there by A.A. Burbidge and P.J. Fuller on 3 June 1980.

Ardeidae

Ardea pacifica Latham **Pacific Heron**

Uncommon visitor to relatively well-watered northeast (e.g. a claypan at Billiluna, lower Sturt Creek, Gregory Salt Lake, mouth of Djaluwon Creek, Bulbi Plain and a gully pool near Breaden Valley) and southwest (Coondegoon Pool, Rudall River); usually single, occasionally in twos or threes.

Ardea novaehollandiae Latham **White-faced Heron**

Scarce visitor to relatively well-watered northeast (lower Sturt Creek, Gregory Salt Lake and freshwater lagoons near Lake Betty) and southwest (Coondegoon Pool and Talbot Soak, Rudall River); in ones, twos or small flocks (7).

Egretta alba alba (Linnaeus) **Great Egret**

Visitor to far northeast. In November 1977 L.A. Smith and R.E. Johnstone observed four single birds and a flock of 17 on Gregory Salt Lake; in April 1979 they saw one on Sturt Creek 11 km upstream from its mouth. In June 1980 A.A. Burbidge and P.J. Fuller saw 8 at Gregory Salt Lake.

Nycticorax caledonicus hilli Mathews **Rufous Night Heron**

Vagrant. On 7 May 1979 an adult was flushed by A.N. Start and N.L. McKenzie from a dense clump of bloodwoods at Well 30.

Ciconiidae

Ephippiorhynchus asiaticus (Latham) **Black-necked Stork**

Rare visitor to far northeast. L.A. Smith and R.E. Johnstone saw one on lower Sturt Creek and one at Gregory Salt Lake on 6-7 November 1977.

Threskiornithidae

Threskiornis spinicollis (Jameson) **Straw-necked Ibis**

Rare visitor to far northeast: A.A. Burbidge and P.J. Fuller saw two at Gregory Salt Lake on 1 June 1980. Vagrant elsewhere: on 4 August 1977 N.L. McKenzie observed a flock of nine in a dead mulga on the Kidson track (*ca* 20°25′S, 122°10′E); the birds remained in the area for about three hours.

Platalea regia Gould **Royal Spoonbill**

Scarce visitor to far northeast. L.A. Smith and R.E. Johnstone saw two at Gregory Salt Lake on 7 November 1977; and A.A. Burbidge and P.J. Fuller saw one there on 1 June 1980.

Platalea flavipes Gould **Yellow-billed Spoonbill**

Scarce visitor to far northeast. On 8 November 1977 L.A. Smith and R.E. Johnstone saw four at a pool on Sturt Creek 18 km SSW of Billiluna; and on 1 June 1980 A.A. Burbidge and P.J. Fuller saw seven at edge of Gregory Salt Lake.

Anatidae

Dendrocygna spp.

Visitor to far northeast. Whistling Ducks were among the abundant wild-fowl on Gregory Salt Lake when Carnegie visited it in April 1896. After dark on 21 April 1979 several Whistling Ducks flew over L.A. Smith and R.E. Johnstone's camp at 24 km W of Balgo; there was much thunderstorm activity to the north.

Cygnus atratus (Latham) **Black Swan**

Visitor to far northeast. In early November 1977 L.A. Smith and R.E. Johnstone saw about 400 on Gregory Salt Lake; in late April 1979 when the lake was almost dry, they only found a few birds in the mouths of creeks entering the lake (10 on Sturt Creek and 14 on Djaluwon Creek). Up to 15 birds were observed by A.A. Burbidge and P.J. Fuller on Gregory Salt Lake in early June 1980. Breeding in small numbers at Gregory Salt Lake in October 1977: C/4(1); B/3(1), 6(1). These observations provide another example of the recent spread of this swan into northern Australia. Just south of the region J.H. Calaby (1958, *West. Aust. Nat.* **6:** 184) found it breeding on Savory Creek in September 1955.

Tadorna tadornoides (Jardine & Selby) **Mountain Duck**

Visitor to far northeast. J. McGuire (1967) reported a few in the Balgo area for the quarter ending March 1967. On 26 April 1979 L.A. Smith and R.E. Johnstone saw eight on Sturt Creek 11 km N of its mouth. Just south of our region J.H. Calaby (1958, *West. Aust. Nat.* **6:** 184) observed it on Savory Creek in September 1955.

Anas superciliosa Gmelin **Black Duck**

Visitor to relatively well-watered northeast (lower Sturt Creek and Gregory

Salt Lake) and southwest (Rudall River and, just south of our region, Savory Creek); small parties or flocks (up to 200). Breeding at Coondegoon Pool (Rudall River) in March 1979; B/3(1), 8(1).

Anas gibberifrons gracilis Buller **Grey Teal**

Common visitor to relatively well-watered northeast (Gregory Salt Lake and lagoons near Lake Betty) and southwest (Rudall River and, just south of our region, Savory Creek); in flocks (sometimes many thousands). Much the most abundant duck in the region. Breeding on the Rudall in July and August 1955.

Malacorhynchus membranaceus (Latham) **Pink-eared Duck**

Visitor to relatively well-watered northeast and southwest. In January 1969 P. McDonald (1969) reported that Gregory Salt Lake was full of water (30 × 15 miles) and that the abundant waterfowl included Pink-eared Ducks. On 26 April 1979 L.A. Smith and R.E. Johnstone saw two flocks (*ca* 100 and 20) on lower Sturt Creek. On 31 May 1980 A.A. Burbidge and P.J. Fuller saw *ca* 50 at Gregory Salt Lake. On 30 April 1979 A.N. Start *et al.* saw two at Coondegoon Pool, Rudall River.

Aythya australis (Eyton) **Hardhead**

Two records from far northeast: a flock of six observed by L.A. Smith and R.E. Johnstone at Gregory Salt Lake on 7 November 1977, and a flock of six observed there by A.A. Burbidge and P.J. Fuller on 1 June 1980.

Chenonetta jubata (Latham) **Wood Duck**

Visitor to relatively well-watered northeast and southwest. J. McGuire (1967) reported them as common in the Balgo area during the quarter ending March 1967. A.A. Burbidge and P.J. Fuller observed four at Gregory Salt Lake on 1 June 1980. J.H. Calaby noted it on the Rudall in mid-September 1955, and T. Fletcher in December 1970. J.R. Ford heard them flying over Old Talawana on the night of 7 June 1971.

Accipitridae

Elanus caeruleus notatus Gould **Black-shouldered Kite**

Rare visitor or transient. A.A. Burbidge and P.J. Fuller saw one in spinifex country 14 km S of Balgo on 9 June 1980. On the Canning Stock Route in 1943 K.G. Buller found a mummified specimen south of Well 43 on 28 September and collected a solitary male near Well 33 on 17 December. P. de Rebeira observed one at 35 km W of Windy corner on 16 August 1976 and one in the Breaden Valley on 19 September 1978. A.N. Start *et al.* saw one on the Anketell Ridge (20°24′S, 122°07′E) on 15 May 1979.

Hamirostra melanosternon (Gould) **Black-breasted Kite**

Scarce. A few widespread sightings of single birds in April, May, June, August and November.

Haliastur sphenurus (Vieillot) **Whistling Kite**

Uncommon in northeast about water (recorded at a lagoon near Lake Betty, Old Billiluna, lower Sturt Creek and Djaluwon Creek); scarce or absent elsewhere; in ones or twos.

Milvus migrans affinis Gould **Black Kite**

Moderately common in northeastern pastoral country (Billiluna, Lake Gregory and Balgo Stations), usually in small flocks, occasionally in large flocks (e.g. about 200 counted in a paddock by P. de Rebeira at 9 km S of Billiluna HS on 20 August 1978), from which it extends in small numbers to the relatively well-watered South Esk Tablelands. When the Canning Stock Route was operational the kites followed the cattle further south; K.G. Buller observed them in ones and twos at Wells 45 and 43 in September and October 1943, and was told by a drover that they sometimes followed the cattle right to Wiluna. Also recorded from southwest: three birds observed by T. Fletcher on the Rudall River in December 1970.

Accipiter fasciatus fasciatus (Vigors & Horsfield) **Brown Goshawk**

Largely confined to relatively well-watered northeast and southwest. Moderately common, at least in winter, on the South Esk Tablelands (e.g. K.G. Buller found many of them on 13 August 1943 preying on the thousands of finches watering at Kunningarra Rock-hole) but generally scarce; usually single, occasionally in twos or more. Almost invariably at freshwater: rock-holes, river pools and even desert soaks (Keartland shot one at Joanna Spring).

The only extant specimen from the region is a female (WAM A16058) collected by L.A. Smith and R.E. Johnstone as it preyed on lizards (*Lophognathus longirostris*) on the trunks of eucalypts around a freshwater lagoon near Lake Betty (19°39′S, 126°13′E); it, and presumably all the other birds recorded in the region, belonged to the nominate race.

Accipiter cirrocephalus cirrocephalus (Vieillot) **Collared Sparrowhawk**

Status uncertain. Four autumn-winter sight records including observation by J.R. Ford and G.A. Lodge of two birds on 21 August 1973 near a rock-hole in the Pollock Hills; they were presumably preying on finches.

Aquila morphnoides morphnoides Gould **Little Eagle**

Status uncertain. Several observations of single birds, mainly in better-watered country, none in sandy deserts.

Aquila audax (Latham) **Wedge-tailed Eagle**

Widespread but now scarce; usually single. On 29 May 1971 J.R. Ford observed a bird sitting on a nest near Well 35. On 13 May 1979 A.N. Start *et al.* found a nest, presumably of this species, on the Anketell Ridge (20°24′S, 122°07′E); no birds were seen, but there were green leaves in the nest. In April 1979 L.A. Smith and R.E. Johnstone saw an old nest on Sturt Creek 12 km upstream from its mouth.

Before the catastrophic decline of hare and nail-tailed wallabies these eagles were evidently much more plentiful; G.A. Keartland (*in* North, 1898: 166) wrote 'in crossing the desert they were frequently seen pursuing the little wallabies so common in the sandhills'. Moreover, the introduced rabbit is scarce or absent in these northern deserts (at Well 42 in October 1943 K.G. Buller saw an eagle over a grassy flat 'apparently on the lookout for a rabbit').

Circus assimilis Jardine & Selby **Spotted Harrier**

Widespread but uncommon; usually single, occasionally in twos. Possibly a little south of our region, L.A. Wells collected two slightly incubated eggs on 25 September 1896 (G.A. Keartland, *in* North, 1898: 127).

Circus aeruginosus approximans Peale **Marsh Harrier**

One record from far northeast: on 2 June 1980 A.A. Burbidge and P.J. Fuller saw one flying low over the trees and scrub fringing Gregory Salt Lake.

Falconidae

Falco peregrinus macropus Swainson **Peregrine Falcon**

Status uncertain. Three records of single birds from the vicinity of water: on 26 April 1979 L.A. Smith and R.E. Johnstone saw a female on Sturt Creek 11 km upstream from its mouth; on 13 July 1943 K.G. Buller collected a female (WAM A5825) at Kunningarra Rock-hole (South Esk Tablelands); and on 12-13 September 1966 J.R. Ford and G.M. Storr observed one at a small pool on McKay Creek 56 km W of Well 23 (it had been feeding on galahs for some time, judging from the pile of feathers below its perch in a dead gum).

Falco longipennis longipennis Swainson **Australian Hobby**

Rare resident, possibly augmented by winter visitors. On 4 May 1979 L.A. Smith and R.E. Johnstone saw one pursuing a budgerigar over Tobin Lake. In December 1970 T. Fletcher regularly saw two at the Rudall River. On 20 August 1973 R.E. Johnstone and J.R. Ford found a pair attending a nest at the top of a bloodwood on the Sandy Blight track 19 km W of the Northern Territory border; these birds were preying on *Turnix velox;* on the same day a single bird was noted 28 km further west. On 2 June 1971 J.R. Ford found one defending its nest in a river gum on McKay Creek 58 km W of Well 23; two days later he observed one at 64 km E of Old Talawana, and one feeding in flight on a dragonfly 25 km further west.

Falco berigora berigora Vigors & Horsfield **Brown Falcon**

Moderately common (among diurnal raptors second in abundance to *F. cenchroides*); usually single, occasionally in twos. All kinds of country including sandy deserts. On 23 August 1948 K.G. Buller saw two pale-phase birds investigating an old nest near Well 48.

Most birds are pale, but a substantial minority are very dark. Extreme colour variants are probably the basis of most, if not all, records of *Falco subniger* Gray and *F. hypoleucos* Gould from the region.

Falco cenchroides cenchroides Vigors & Horsfield **Australian Kestrel**

Common in autumn and early winter; much less numerous after June; usually single, occasionally in twos or small parties. All kinds of open or lightly wooded country. In mid-September 1955 J.H. Calaby found a nest in a hollow tree on the Rudall. On 16 September 1977 P. de Rebeira found a nest and three eggs on a ledge above a cave between Well 35 and Picture Hill.

Turnicidae

Turnix velox (Gould) **Little Button-quail**

Very common in good years (e.g. 1955 and 1973), but generally uncommon to moderately common; usually single, occasionally in twos or small parties. Open or sparsely wooded country, especially with *Triodia* and other grasses. Breeding from early April to late August; C/3(1), B/1(1), 2(2), 3(1).

Gruidae

Grus rubicundus (Perry) **Brolga**

Confined to far northeast. At Gregory Salt Lake very common in wet years (e.g. 1977) in flocks of up to 150, moderately common in dry years (e.g. 1979); also observed in claypans in the Lake Betty district and at pools on lower Sturt Creek.

Rallidae

Gallinula ventralis Gould **Black-tailed Native Hen**

Only recorded in relatively well-watered northeast (single specimens collected by O.H. Lipfert at Sturt Creek and Well 48 in January and March 1931) and southwest (one observed in April 1979 by A.N. Start *et al.* at Coondegoon Pool, Rudall River).

Fulica atra australis Gould **Coot**

Confined to relatively well-watered northeast (Gregory Salt Lake, lower Sturt Creek and freshwater lagoons near Lake Betty) and southwest (fresh waters along the Telfer access road and, just south of our region, pools on Savory Creek). Non-breeding visitor, sometimes in large numbers. In November 1977, when Gregory Salt Lake was half full, L.A. Smith and R.E. Johnstone saw a flock of *ca* 5000; in April 1979 when the lake was almost dry they only counted 12 birds.

Otididae

Otis australis Gray **Australian Bustard**

Locally and seasonally common (e.g. Balgo area in early 1967 and the Rudall River in December 1970) when abundant green herbage builds up numbers of grasshoppers and other insects, but generally uncommon to moderately common; usually in ones or twos, occasionally in threes or small flocks (up to 21). Widespread but preferring better-watered country (e.g. the northeast and southwest) to sandy deserts. Breeding in July and August; B/1(2).

Charadriidae

Vanellus miles miles (Boddaert) **Masked Plover**

Visitor to far northeast in good seasons, e.g. early November 1977 when L.A. Smith and R.E. Johnstone saw four single birds and parties of five and eleven at Gregory Salt Lake.

Vanellus tricolor (Vieillot) **Banded Plover**

Two winter records from far south: on 20 August 1973 R.E. Johnstone and J.R. Ford found a pair with two small young on a grassy flat beside the Sandy Blight track 70 km W of Northern Territory border; in early June 1971 J.R. Ford heard and saw single birds near Old Talawana.

Charadrius ruficapillus Temminck **Red-capped Plover**

Three records from far northeast. On 6 November 1977 L.A. Smith and R.E. Johnstone found it fairly common at Gregory Salt Lake; on 17 April 1979 they saw a flock of about 50, including five immatures, at the edge of a freshwater lagoon near Lake Betty (19°39′S, 126°13′E) and collected one of them. On 3 June 1980 A.A. Burbidge and P.J. Fuller saw *ca* 250 at Gregory Salt Lake.

Charadrius melanops Vieillot **Black-fronted Plover**

Common in the limited habitat available to it; in pairs or small parties. Recorded at a freshwater lagoon near Lake Betty, a claypan at Billiluna, a bore-overflow near Balgo, Sturt Creek, Gregory Salt Lake, Gravity Lakes, and pools and rock-holes in the Rudall. One breeding report: December; C/3(1).

Charadrius veredus Gould **Oriental Plover**

Possibly a regular summer visitor to Gregory Salt Lake and its vicinity, where L.A. Smith and R.E. Johnstone observed flocks of 3-40 in early November 1977. At Well 31 O.H. Lipfert collected a solitary bird on 30 September 1930.

Charadrius cinctus (Gould) **Red-kneed Plover**

Two records from far northeast: on 18 April 1979 L.A. Smith and R.E. Johnstone collected a lone bird at the edge of a freshwater lagoon near Lake Betty (19°39′S, 126°13′E), and on 1 June 1980 A.A. Burbidge and P.J. Fuller saw a party of five at the edge of Gregory Salt Lake.

Peltohyas australis (Gould) **Australian Dotterel**

Three records from southwest. On 1 May 1979 A.N. Start *et al.* observed three birds on a sparsely vegetated, stony ridge north of the McKay Range; two days later they saw three and five birds on an almost bare, gravelly ridge at Well 24. In December 1970 T. Fletcher saw seven birds on a burnt-out plain near the Rudall River.

Scolopacidae

Tringa nebularia (Gunnerus) **Greenshank**

Probably a regular summer visitor to far northeast: single birds and small parties (2-4) observed in mid-April and early November at shallow freshwater lagoons near Lake Betty and at Gregory Salt Lake.

Tringa glareola Linnaeus **Wood Sandpiper**

One record from far northeast: on 7 November 1977 L.A. Smith and R.E. Johnstone observed eight feeding on a mat of floating aquatic plants at Gregory Salt Lake.

Tringa hypoleucos Linnaeus **Common Sandpiper**

One record from far northeast: on 25 April 1979 L.A. Smith and R.E. Johnstone observed three at a shallow lagoon near the mouth of Sturt Creek.

Calidris ruficollis (Pallas) **Red-necked Stint**

Two records from far northeast: on 17 April 1979 L.A. Smith and R.E. Johnstone collected one of 15 birds at the edge of a small freshwater lagoon near

Lake Betty (19°39′S, 126°13′E); nine days later they collected one of three birds at a lagoon near the mouth of Sturt Creek.

Calidris acuminata (Horsfield) **Sharp-tailed Sandpiper**

One record from far northeast: on 7 November 1977 L.A. Smith and R.E. Johnstone saw flocks of 6, 10 and 20 at Gregory Salt Lake.

Recurvirostridae

Himantopus himantopus leucocephalus Gould **Black-winged Stilt**

Four records from Gregory Salt Lake (far northeast): on 14 January 1931 O.H. Lipfert collected a specimen (SAM B15260) at the 'Sturt overflow'; on 7 November 1977 L.A. Smith and R.E. Johnstone saw flocks of four and 30 on the lake; on 25 April 1979 P.J. Fuller *et al.* observed one on a pool; and on 1 and 3 June 1980 A.A. Burbidge and P.J. Fuller saw two.

Cladorhynchus leucocephala (Vieillot) **Banded Stilt**

In mid-1975 the Geological Survey of Western Australia collected pigmented fragments of a few subfossil egg-shells at the Percival Lakes (21°22′S, 124°44′E); they are lodged in the Western Australian Museum (A14440).

Recurvirostra novaehollandiae Vieillot **Red-necked Avocet**

Four records from far northeast. O.H. Lipfert collected one on lower Sturt Creek *ca* January 1931. On 17 April 1979 L.A. Smith and R.E. Johnstone observed six on a small freshwater lagoon near Lake Betty (19°39′S, 126°13′E); eight days later they saw three on a shallow lagoon near the mouth of Sturt Creek. On 1 June 1980 A.A. Burbidge and P.J. Fuller saw a flock of 25 at the edge of Gregory Salt Lake.

Burhinidae

Burhinus grallarius (Latham) **Bush Stone-curlew**

Only recorded from the southwest: in December 1970 T. Fletcher heard them calling each night at the Rudall River.

Glareolidae

Stiltia isabella (Vieillot) **Australian Pratincole**

Three records from far northeast: on 6-7 November 1977 L.A. Smith and R.E. Johnstone saw a few single birds and flocks of four, 10 and 15 at Gregory

Salt Lake; on 23 April 1979 they saw a party of three at 20 km W of Balgo and on 1 June 1980 A.A. Burbidge and P.J. Fuller saw a flock of 16 on a green flat beside Gregory Salt Lake.

Laridae

Larus novaehollandiae novaehollandiae Stephens **Silver Gull**

Possibly an uncommon visitor to Gregory Salt Lake from southeastern Australia. On 25 April 1979 L.A. Smith and R.E. Johnstone collected two from a flock of 20 at the edge of Lera Waterhole. On 3 June 1980 A.A. Burbidge and P.J. Fuller observed 60 birds scattered along the southeastern shore of Gregory Salt Lake.

Sterna nilotica macrotarsa Gould **Gull-billed Tern**

Visitor to far northeast (Gregory Salt Lake). On 6-7 November 1977 L.A. Smith and R.E. Johnstone observed three single birds and five parties of 2-30 and collected one specimen; on 25-26 April 1979 they saw parties of six and 15 and collected a specimen. On 1 June 1980 A.A. Burbidge and P.J. Fuller saw a party of nine.

Sterna caspia Pallas **Caspian Tern**

Visitor to far northeast (Gregory Salt Lake). On 6-7 November 1977 L.A. Smith and R.E. Johnstone observed a single bird and five parties of 2-20. On 26 April 1979 they observed a party of seven. On 1 June 1980 A.A. Burbidge and P.J. Fuller observed two birds and a flock of 60.

Sterna hybrida javanica Horsfield **Whiskered Tern**

Visitor to far northeast (Gregory Salt Lake). On 6-7 November 1977 L.A. Smith and R.E. Johnstone observed three flocks of 10-50, some of which were resting on a floating mat of aquatic herbage. On 25 April 1979 they observed a flock of 30. On 31 May 1980 A.A. Burbidge and P.J. Fuller observed a flock of *ca* 2000 roosting on inundated samphires near the south-western shore of the lake; they believed that the terns would breed here.

Columbidae

Geopelia cuneata (Latham) **Diamond Dove**

Nomadic. Scarce to common, numbers varying locally with seasonal conditions (e.g. in August 1973 J.R. Ford *et al.* saw a total of 120 birds at 22 different places along the Sandy Blight track; in May 1971 they saw none); in ones, twos and small flocks (up to 30). Lightly wooded grasslands (mainly of *Triodia*) in vicinity of water. Two breeding reports: July and August; C/2(1).

Phaps chalcoptera (Latham) **Common Bronzewing**

Uncommon; usually single, occasionally in twos. Vicinity of river pools (Sturt Creek, Rudall River and McKay Creek), rock-holes and desert springs (Dragon-tree Soak).

Phaps histrionica (Gould) **Flock Pigeon**

Three records from northeast: on 2 March 1856 A.C. and F.T. Gregory (1884) observed large flocks of pigeons, presumably of this species, feeding on the plains beside Sturt Creek between 19°40′ and 19°51′S; on 28 August 1872 P.E. Warburton (1875) recorded a flock on a large black-soil plain about 40 km NE of Bishops Dell; two days later he saw them drinking at Lady Edith Lagoon. Warburton's observation on 1 October 1872 of an immense number of bronzewings coming in to drink at Joanna Spring surely refers to this species, as does Keartland's observation (*in* North 1898: 183) of 30 bronzewings feeding on a patch of bare ground at Joanna Spring.

Geophaps plumifera Gould **Spinifex Pigeon**

Confined to far southwest, north to the Gregory Range and east to the Harbutt Range. Uncommon; in small parties. Rocky country in vicinity of water.

Ocyphaps lophotes (Temminck) **Crested Pigeon**

Common in relatively well-watered country; in ones, twos or small parties, larger flocks aggregating at water in early morning or late afternoon. Lightly wooded country.

Psittacidae

Trichoglossus versicolor Lear **Varied Lorikeet**

One record from far northeast: on 6 November 1977 L.A. Smith and R.E. Johnstone observed parties of four and six in flowering eucalypts 6 km N of Billiluna (i.e. 2 km S of the Kimberley boundary).

Polytelis alexandrae Gould **Princess Parrot**

Patchily distributed in family parties and small flocks in the Great Sandy Desert. In April 1897 G.A. Keartland (*in* North 1898: 130-1, and *in* Mathews, *Bds Aust.* 6: 275) observed a pair and a flock of 20 near Joanna Spring; the stomach contents of the two birds he collected consisted mainly of *Triodia* seeds. On 6 November 1943 K.G. Buller collected three birds (WAM A5831-3) in a grove of desert oaks (*Casuarina decaisneana*) at Tobin Lake; their stomach contents consisted entirely of wattle seeds. Buller also observed a few at Well

37 on 27 November 1943, large flocks between Wells 37 and 36 on 30 November 1943 and, when returning northwards on 4 January 1944, some flocks near Tobin Lake. On 6 May 1979 L.A. Smith saw a party of five fly into a desert oak near Tobin Lake; they then flew to the ground where Smith watched them feeding for some time; this could have been at the same patch of desert oaks as Buller's observations 36 years earlier; like Buller, Smith compared their chattering to that of budgerigars, though the notes were deeper and uttered more slowly.

The new parrot seen on 3 September 1861 by F.T. Gregory (Gregory & Gregory 1884: 80) in sandridge country east of the Gregory Range (*ca* 21°25′S, 121°25′E) was more likely to be this species than, as H.M. Whittell (1946: 295) suggested, the Mulga Parrot (*Platycercus varius*).

Platycercus zonarius zonarius (Shaw) **Ring-necked Parrot**

Moderately common in relatively well-watered southwest, especially in river gums along watercourses, e.g. Rudall River and Talawana Creek; usually in pairs. Also in southwestern sector of Great Sandy Desert: on 1 January 1944 K.G. Buller saw a party of five feeding among desert oaks at Well 35; in 1896 G.A. Keartland (*in* North 1898: 170) found them in pairs and small flocks feeding on the ground or eating the green shoots of small plants around waterholes north to Separation Well, north of which none was seen.

Melopsittacus undulatus (Shaw) **Budgerigar**

Common to very common; usually in small parties, occasionally in flocks of many hundreds. Mainly in better-watered country, but also in ordinarily waterless deserts when ephemeral water and *Triodia* and other grass seeds are available after good rains. Two breeding reports: J.H. Calaby found them nesting in tree-hollows on the Rudall in mid-September 1955; P. de Rebeira saw them entering eucalypt spouts at Wormys Well and at 38 km NE of Well 42 in mid-September 1978.

Nymphicus hollandicus (Kerr) **Cockatiel**

Moderately common in relatively well-watered southwest, usually in pairs and small flocks; but generally scarce, and not recorded at all from east of Gregory Salt Lake, Well 41 and Kidson Airfield.

Calyptorhynchus magnificus (Shaw) **Red-tailed Black Cockatoo**

Confined to extreme southwest. On 6 and 7 June 1971 J.R. Ford observed flocks of five and six near Old Talawana.

Cacatua roseicapilla Vieillot **Galah**

Common in relatively well-watered southwest and along the Canning Stock

Route, usually in pairs or small flocks; rare in Gibson Desert; absent from northwestern sector of Great Sandy Desert, i.e. west of Joanna Spring and north of Callawa. Breeding in August and September: C/4(1); B/3(1).

Cacatua tenuirostris sanguinea Gould **Corella**

In far northeast moderately common in flocks (up to 100) on lower Sturt Creek, around Gregory Salt Lake and at Balgo. Also recorded by K.G. Buller at Well 48 (a small flock flew over on 19 August 1943), and by J.H. Calaby on the Rudall in mid-September 1955.

Cacatua leadbeateri (Vigors) **Major Mitchell's Cockatoo**

Mainly northeastern (not recorded from west of the McLarty Hills or south of Tobin Lake and Lake Mackay). Uncommon to moderately common near water; usually in pairs or small flocks (up to 15). At Labbi-labbi Rock-hole (southeast of Lake Hazlett) D.F. Thomson (1962: 151) found them feeding on native figs (*Ficus platypoda*). Near Godfrey Tank L.A. Smith and R.E. Johnstone watched them eat the fleshy centres of bloodwood galls. On 19 September 1978 P. de Rebeira saw one searching trees for a nesting spout at Well 45.

Cuculidae

Cuculus pallidus (Latham) **Pallid Cuckoo**

Status uncertain (only one breeding record). Moderately common; usually single, occasionally in twos. Mulga and other arid scrubs. On 21 August 1973 R.E. Johnstone found an almost fledged juvenile in the nest of a *Meliphaga virescens* on the Sandy Blight track at 26 km W of Pollock Hills.

Chrysococcyx basalis (Horsfield) **Horsfield's Bronze Cuckoo**

Status uncertain (no breeding records). Moderately common; usually single. Recorded in all kinds of woody vegetation from bloodwoods down to low shrubbery.

Strigidae

Tyto alba delicatula (Gould) **Barn Owl**

Status uncertain, but evidently scarce. Between July and December 1943 K.G. Buller observed three single birds and a pair on the Canning Stock Route (Wells 48, 42, 41 and 35). In April 1979 L.A. Smith and R.E. Johnstone saw one on Aitchison Creek 9 km N of Pussycat Bore. In August 1976 P. de Rebeira found the remains of one at a pool on the Rudall.

Ninox novaeseelandiae boobook (Latham) **Boobook Owl**

Status uncertain (no breeding records) but moderately common and apparently resident (judging from calling) in relatively well-watered and well-wooded northeast (Mt Bannerman, Sturt Creek, Gregory Salt Lake and Godfrey Tank) and southwest (Rudall River, Talawana, Coondra Coondra Spring and McKay Creek). Less plentiful and possibly only a winter visitor or passage migrant in more arid parts of region. A female (WAM A11756) collected by J.R. Ford at 24 km N of Windy Corner on 30 May 1971 was very fat; its stomach was crammed with grasshoppers.

Podargidae

Podargus strigoides (Latham) **Tawny Frogmouth**

Status uncertain, but clearly rare; possibly resident in far southwest (J.R. Ford heard two calling at Old Talawana on night of 6 June 1971, and W.H. Butler collected a pair at 20 km SE of Jiggalong on 16 September 1972). The only other records are a specimen (WAM A3963) collected by O.H. Lipfert at Well 30 on 5 September 1930 and two seen in mulga on the Sahara track (21°30′S, 123°21′E) by P. de Rebeira and I. Rook on 17 August 1977.

Aegothelidae

Aegotheles cristatus cristatus (White) **Australian Owlet-nightjar**

Confined to southern third of region, north to the Rudall, Well 24 and nearly to Lake Mackay. Moderately common in relatively well-wooded and well-watered southwest (Rudall River and Talawana). Uncommon elsewhere.

Two specimens from the vicinity of the Rudall belong to the dark southern race.

Caprimulgidae

Eurostopodus guttatus (Vigors & Horsfield) **Spotted Nightjar**

Common and widespread. Open or sparsely wooded country, especially vicinity of stony areas suitable for daytime roosts and nesting. Attracted to fires and in hot weather to water (K.G. Buller watched them drinking on the wing like swallows on the Canning Stock Route in October and January). One breeding record: a small downy juvenile found by K.G. Buller near Well 42 on 4 October 1943. Calling reported in May and September.

Apodidae

Apus pacificus pacificus (Latham) **Fork-tailed Swift**

Rare summer visitor. Two records: a specimen (WAM A3972) collected by O.H. Lipfert at Well 34 on 19 October 1930, and one collected by him at Well 48 on 15 March 1931 (SAM B15306).

Alcedinidae

Halcyon pyrrhopygia Gould **Red-backed Kingfisher**

Common on heavier soils and in better-wooded country; scarce in sandy deserts. Breeding in August; C/4(1), 5(1).

Halcyon sancta sancta Vigors & Horsfield **Sacred Kingfisher**

Restricted to southwestern watercourses (Rudall River and Talawana Creek). Observed in April, June and September. Scarce.

Meropidae

Merops ornatus Latham **Rainbow Bee-eater**

Recorded at water in far north (Dragon-tree Soak, Gregory Salt Lake and Balgo Hill) and southwest (Rudall River and Talawana Creek). Presumably breeding at Gregory Salt Lake (recorded in April and November); status uncertain elsewhere (recorded in April, June and August). Common on the Rudall; scarce elsewhere.

Alaudidae

Mirafra javanica Horsfield **Horsfield's Bushlark**

Confined to northeast (Lake Betty area, Gregory Salt Lake, Balgo and vicinity of Well 48), the Anketell Ridge (eastwards along the Kidson track to 146 km E of the Callawa turnoff) and the Rudall River; these populations are extensions of those of the Kimberley and Pilbara. Common; usually in ones or twos. Open short grasslands (Mitchell and other 'soft' grasses and *Triodia*); also samphire flats.

Hirundinidae

Cheramoeca leucosterna (Gould) **White-backed Swallow**

Moderately common and presumably resident in south, north to the Sahara track, Tobin Lake and Sandy Blight track; usually in ones and twos. Uncommon in north and possibly only a non-breeding visitor (May-July). Breeding reported from McKay Creek and Sandy Blight track (69 km W of Northern Territory border); August.

Hirundo neoxena Gould **Welcome Swallow**

Status uncertain; apparently a rare autumn-winter visitor to far northeast. Only records are sightings by K.G. Buller at Old Billiluna in 1943: on 29 May he noted some around his camp; two days later he saw two at a claypan, and on the following day he observed one roosting on a case of food at his camp.

Hirundo nigricans nigricans Vieillot **Tree Martin**

Confined to relatively well-watered and well-wooded southwest (Rudall and Oakover Rivers and Talawana Creek). Moderately common; usually in small parties. Vicinity of river gums along watercourses. On 5 June 1971 J.R. Ford saw seven entering hollows in river gums on Talawana Creek.

Hirundo ariel (Gould) **Fairy Martin**

Widespread in spring and summer, judging from observations of old nests, but the birds themselves have only been reported on two occasions (late August and mid-September). One breeding record (September); nests located in groups of 12 to *ca* 200 in cliffs along breakaways and watercourses and in rocky hills.

Motacillidae

Anthus novaeseelandiae australis Vieillot **Richard's Pipit**

Moderately common to common in relatively well-watered northeast and southwest; less plentiful in more arid parts of region, and especially scarce in sandy deserts; usually in ones or twos, occasionally in small parties. Samphire flats, grassy flats and edge of saltlakes and saltpans. On 7 June 1971 J.R. Ford observed several display flights over flats at Old Talawana.

Campephagidae

Coracina maxima (Rüppell) **Ground Cuckoo-shrike**

Status uncertain; perhaps only a rare autumn-winter visitor. Four records: on 25 July 1943 K.G. Buller collected one of a party feeding on a stony rise near Well 48; on 7 June 1980 A.A. Burbidge and P.J. Fuller saw four in low open woodland over open short grass at 28 km N of Point Moody; on 27 May 1971 J.R. Ford saw one at Jupiter Well, and on 6 and 8 June 1971 he saw three at Old Talawana.

Coracina novaehollandiae subpallida Mathews **Black-faced Cuckoo-shrike**

Confined to relatively well-watered and well-wooded southwest, north to the Rudall (specimens from Coondegoon Pool and Talbot Soak) and east to McKay Creek (observations by J.R. Ford and G.M. Storr on 13 September 1966 at 56 and 76 km W of Well 23). Moderately common; usually in ones or twos. Mainly river gums.

Coracina novaehollandiae novaehollandiae (Gmelin)

Apparently resident in far northeast, judging by November observations on lower Sturt Creek and around Gregory Salt Lake. Elsewhere a moderately common passage migrant or winter visitor (April-September); in ones, twos or small parties (up to seven).

Lalage sueurii tricolor (Swainson) **White-winged Triller**

Moderately common to common passage migrant, moving north in April and early May and south in August and early September. Also a scarce resident or breeding visitor, judging from observations on lower Sturt Creek and at Gregory Salt Lake, Well 41 and Well 35 between mid-October and mid-January, and at 48 km SW of Well 39 (where P. de Rebeira watched a female carrying food on 17 September 1978).

Pachycephalidae

Petroica goodenovii (Vigors & Horsfield) **Red-capped Robin**

Status uncertain (no breeding records). Moderately common and presumably resident in south, north to about the Rudall, Separation Well, Jupiter Well and Dovers Hills; usually in ones or twos; mainly dense mulga, also thickets of wattle and teatree and groves of desert oak. Scarce and presumably only a non-breeding visitor (May-August) in north.

Petroica cucullata (Latham) **Hooded Robin**

Mainly eastern, north and west to the Canning Stock Route; also southwest around the Rudall River, Talawana and Jiggalong. Moderately common in south, less plentiful in north; usually in ones or twos. Lightly wooded country (mulga, corkwood and wattle). One breeding report (G.A. Keartland *in* North, 1898: 175): nest and two eggs on 26 October 1896; however, the season probably begins much earlier in view of J.R. Ford's observation of a pair displaying and carrying food near Old Talawana on 9 June 1971.

Pachycephala rufiventris rufiventris (Latham) **Rufous Whistler**

Moderately common in better-wooded country (i.e. far northeast, southwest and south), usually single; absent from sandy deserts. Mainly tall mulga; also thickets of *Grevillea stenobotrya* and *G. wickhami,* teatrees and eucalypts.

Colluricincla harmonica harmonica (Latham) **Grey Shrike-thrush**

Restricted to far northeast (lower Sturt Creek and Aitchison Creek). Scarce. The holotype of *C. brunnea julietae* Mathews came from this population; it (and *brunnea*) were synonymized by Ford & Parker (1974, Emu **74**: 187) with the nominate race.

Colluricincla harmonica rufiventris Gould

Only recorded from three areas: (1) the Rudall River, (2) around Jiggalong, and (3) northwestern corner of Gibson Desert, north to Kidson Bluff and west to 40 km W of Windy Corner. Common in river gums and adjacent thickets of mulga on the Rudall; elsewhere uncommon and mainly in dense mulga; in ones or twos.

Oreoica gutturalis (Vigors & Horsfield) **Crested Bellbird**

Greater part of region but no records from far northeast (north of Well 48). Common to moderately common in south (north to the Rudall and Well 35); much less plentiful in north; usually in ones or twos. Mulga and other thickets.

Psophodes occidentalis (Mathews) **Western Wedgebill**

Gibson and Tanami Deserts, north to Well 48 and west to Well 24. Moderately common in south (north to Well 35), scarce in north; usually in ones or twos. Thickets of mulga, wattle, teatree and *Grevillea* spp.

Monarchidae

Rhipidura fuliginosa alisteri Mathews **Grey Fantail**

One record: a specimen collected by J.R. Ford (1971, *Emu* **71**: 109) in a teatree thicket at Well 35 on 9 September 1966. The bird was presumably on its way back to south-eastern Australia after wintering in the Kimberley.

Rhipidura leucophrys leucophrys (Latham) **Willie Wagtail**

Status uncertain (no breeding records). Apparently a very common passage migrant and winter visitor (April to early September); usually single, occasionally in small parties (up to six). Also an uncommon resident, judging by a few October-February records from Lake Gregory HS, Well 50, Well 49, Well 37, Bungabinni Well (10 km W of Well 36), Well 34 and the Rudall River.

Orthonychidae

Cinclosoma castaneothorax marginatum Sharpe

Chestnut-breasted Quail-thrush

Far west of Gibson Desert between Windy Corner and Well 24; also further west in the Throssel Range and around Talawana. Common; usually in pairs. Stony country with thickets of *Acacia* (especially mulga), *Eremophila, Grevillea* and *Cassia.*

The Chestnut Quail-thrush (*C. castanotum* Gould) possibly occurs in the region too. G.A. Keartland (*in* North 1898: 180) claims to have shot several birds about 40 miles south of Separation Well in September 1896 (Keartland evidently knew *C. c. marginatum* well; it was numerous in the rough stony country around the camel depot near Carnegie). On 23 August 1973 J.R. Ford and R.E. Johnstone flushed a bird with a bright chestnut back from beside the Sandy Blight track 22 km E of Gary Junction where the vegetation consisted of wattle and spinifex; the bird flew towards dunes clothed with *Thryptomene, Grevillea stenobotrya* and *Triodia* but could not be found again.

Pomatostomus temporalis rubeculus (Gould) **Grey-crowned Babbler**

Far northeast (lower Sturt Creek and Gregory Salt Lake) and extreme southwest (around Talawana). Scarce; in small parties. Apparently breeding in winter; a female, one of three birds at a nest in a river gum on the Oakover, had large ova and a large oviduct on 9 June 1971 (J.R. Ford, pers. comm.).

Pomatostomus superciliosus (Vigors & Horsfield) **White-browed Babbler**

Far southeast and central south, i.e. Gibson Desert north to Well 35 and west to 48 km W of Windy Corner. Moderately common around Windy Corner; uncommon elsewhere; in pairs or small parties (up to eight). Mainly copses of tall dense mulga, also thickets of wattle and teatree (*Melaleuca glomerata*).

Acanthizidae

Aphelocephala nigricincta (North) **Banded Whiteface**

Eastern and southern, north to Gregory Salt Lake and west to Well 48, 49 km NW of Swindell Field and Old Talawana. Common in Gibson Desert, scarce or uncommon elsewhere; usually in pairs or small parties (up to 10). Open shrubbery (including samphire) mainly on heavy soils. Breeding from April to September: C/1(3), 2(5), 3(1); nesting mostly in corkwoods (*Hakea* spp.).

Gerygone fusca mungi Mathews **Western Flyeater**

Southeastern, i.e. Gibson Desert west to Jupiter Well. Scarce; in ones or twos. Mallee (including *Eucalyptus kingsmillii*) and desert oaks. Apparently breeding in winter; on 27 May 1971 J.R. Ford collected a pair at Jupiter Well that were engaged in display and copulation.

Gerygone fusca fusca (Gould)

Only certainly recorded from far southwest; identification based on a specimen collected on 23 August 1972 by W.H. Butler in sparse mulga at Curran Curran Rock-hole, on two specimens collected on 24 April 1979 by A.N. Start *et al.* in a mulga thicket 86 km E of Old Talawana, and on birds heard and seen by J.R. Ford in acacias and river gums along Talawana Creek on 7 and 8 June 1971. Status uncertain; perhaps only an uncommon autumn-winter visitor.

Smicrornis brevirostris (Gould) **Weebill**

One record from far northeast: two birds observed on 27 April 1979 by P.J. Fuller *et al.* at Lens Bore, Gregory Salt Lake. Two records from far southwest: a single bird observed on 3 June 1971 by J.R. Ford in a white gum near the Emu Range, 116 km E of Old Talawana, and three observed by W.H. Butler at 20 km SE of Jiggalong on 14 September 1972.

Pyrrholaemus brunneus Gould **Redthroat**

Southern, north to Well 35 and west to the Talawana track (72 km W of Well 23). Uncommon; usually in pairs. Thickets of mulga, wattle and teatree. Apparently breeding in winter; on 31 May 1971 J.R. Ford observed a male displaying.

Acanthiza apicalis Gould **Broad-tailed Thornbill**

Eastern and southern, north to Well 41 and west to Lake Auld and Hanging Rock. Uncommon; usually in pairs. Mainly thickets of teatree (*Melaleuca lasiandra* and *M. glomerata*).

Acanthiza robustirostris Milligan **Slaty-backed Thornbill**

Far south, west to Well 24. Moderately common; usually in pairs or family parties. Thickets of mulga and other acacias.

Acanthiza uropygialis Gould **Chestnut-rumped Thornbill**

Only reported from two areas in extreme south: (1) around Old Talawana and Jiggalong and (2) at 42 km W of Windy Corner. Uncommon; in pairs or family parties. Thickets of mulga and other acacias. Apparently breeding in winter: on 8 June 1971 J.R. Ford watched a pair displaying and a bird collecting spider web for a nest in a hole in a mulga at 6 km W of Old Talawana.

Sericornis fuliginosus campestris (Gould) **Calamanthus**

Patchily distributed in southwest, northeast to Lake Auld (22°30′S, 123°51′E). Uncommon; in ones, twos or small parties (up to five). Low dense shrubbery (including samphire) and spinifex.

Maluridae

Amytornis striatus whitei Mathews **Striated Grasswren**

Southern and eastern, north to the Sahara track and Well 48. Common in southeast, scarce to moderately common elsewhere; usually in pairs or family parties. Spinifex, especially dense hummocks intermixed with herbage and low shrubs. Breeding reported in July and October; C/2(2).

Malurus lamberti assimilis North **Variegated Fairy-wren**

Common; in pairs or small parties (up to five). All kinds of thicket and shrubbery. Breeding in July and August.

Malurus leucopterus leuconotus Gould **White-winged Fairy-wren**

Greater part of region but not far northwest, west of Joanna Spring and the Anketell Ridge (20°53′S, 122°04′E). Very common; usually in small parties (up to six). Low vegetation: spinifex, herbage, shrubbery and samphire. Breeding in August and September; C/3(1).

Stipiturus ruficeps ruficeps Campbell **Rufous-crowned Emu-wren**

Southern and eastern, north to Lake Auld (22°27′S, 123°53′E) and Well 48. Uncommon in south, scarce in north; usually in pairs or small parties. Spinifex and low shrubbery.

Sylviidae

Acrocephalus stentoreus australis (Gould) **Clamorous Reed Warbler**

One record: at least four were noted by N.L. McKenzie at Dragon-tree Soak on 10 August 1977; one of them was collected (WAM A15106).

Eremiornis carteri North **Spinifex-bird**

Five records from central west. On 16 May 1979 A.N. Start *et al.* saw one in spinifex and shrubbery (*Grevillea* and *Acacia*) along a drainage line on the Anketell Ridge (20°15′S, 121°44′E); on 10 May 1979 they collected a specimen (WAM A16144) in rank spinifex with scattered shrubs (*Hakea* and *Acacia*) on sand near Lake Auld (22°27′S, 123°56′E). On 2 August 1974 N. Ives found it nesting on the 'Sahara track, about 150 miles southeast of the Great Northern

Highway'; on the following day he saw one near Kidson Airfield. On 13 August 1976 P. de Rebeira saw one in spinifex on a gravelly ridge 8 km SW of Well 33.

Cincloramphus mathewsi Iredale **Rufous Songlark**

Status uncertain; perhaps mainly a passage migrant (April-May and August-September). Moderately common in good years, e.g. along the Sandy Blight track in August 1973, but generally rare.

Cincloramphus cruralis (Vigors & Horsfield) **Brown Songlark**

Moderately common; usually single. Short open grasses (occasionally including spinifex), low shrubbery regenerating after fire, and samphire. Song and display noted in early June.

Daphoenosittidae

Daphoenositta chrysoptera pileata (Gould) **Australian Sittella**

Far south, north to Well 35. Uncommon; usually in small parties (up to 12). Mainly tall mulga; also desert oaks. Breeding in July, judging from fledgelings observed on 20 August 1973 by R.E. Johnstone near Dovers Hills.

Dicaeidae

Dicaeum hirundinaceum hirundinaceum (Shaw) **Mistletoebird**

Moderately common in relatively well-wooded northeast and southwest, scarce or absent in sandy deserts; usually single, occasionally in twos.

Pardalotidae

Pardalotus rubricatus Gould **Red-browed Pardalote**

Uncommon to moderately common in relatively well-watered and well-wooded northeast (e.g. Gregory Salt Lake and South Esk Tablelands) and southwest (e.g. Talawana and McKay Creeks, but strangely not recorded from the Rudall), scarce or uncommon elsewhere; usually in ones or twos. Mainly river gums and other eucalypts along watercourses and drainage lines; also bloodwoods on dunes. One breeding report; August.

Pardalotus striatus substriatus Mathews **Striated Pardalote**

Autumn-winter visitor (May-September). Uncommon in southwest, north to the Rudall and east to Well 24; rare elsewhere (recorded at Well 45 and Dovers Hills); usually single, one party of six. River gums along watercourses and bloodwoods on dunes.

Meliphagidae

Lichmera indistincta indistincta (Vigors & Horsfield) **Brown Honeyeater**

Patchily distributed (largely confined to gullies in hills and breakaways). Locally common, but generally scarce; in ones, twos or small parties. Thickets in relatively well-watered places; attracted to flowering shrubs and trees (*Grevillea wickhami, G. refracta, G. eriostachya,* bloodwoods and *Melaleuca lasiandra*). Apparently breeding in winter.

Certhionyx niger (Gould) **Black Honeyeater**

Nomadic. Locally and seasonally common (e.g. at Well 41 in late October 1943 and in parts of the Anketell Ridge in mid-May 1979), but generally uncomon; in ones, twos or small parties. Attracted to flowering shrubs and trees (*Grevillea wickhami, G. refracta, Hakea lorea, Acacia* spp. and bloodwoods). Two breeding reports: August and September; C/1(1).

Certhionyx variegatus Lesson **Pied Honeyeater**

Nomadic. Locally and seasonally common, e.g. at Well 41 in October 1943, but generally uncommon; in ones, twos or small flocks (up to 16). Attracted to flowering trees and shrubs (bloodwoods, *Grevillea wickhami, G. refracta* and *Acacia* spp.).

Meliphaga virescens (Vieillot) **Singing Honeyeater**

Widespread and very common; usually in ones or twos, occasionally aggregating in small flocks (up to eight) at extraordinary sources of nectar. Small thickets of shrubs and copses of trees in otherwise lightly wooded country; attracted to flowering shrubs and trees (*H. lorea* and other hakeas, *Melaleuca glomerata, Grevillea wickhami, G. refracta* and bloodwoods). Breeding from June to August; C/2(1); parasitized by *Cuculus pallidus.*

Meliphaga keartlandi (North) **Grey-headed Honeyeater**

Widespread and common; in ones, twos or small flocks (up to 12). Mainly eucalypt scrubs and woodlands (bloodwoods, *E. kingsmillii* and other mallees, *E. papuana* and *E. aspera*) but attracted to other shrubs and trees when flowering (e.g. *Grevillea wickhami, G. refracta, Hakea lorea* and *Melaleuca glomerata*). Breeding in July and August; B/2(2).

Four records of the Yellow-fronted Honeyeater, *M. plumula* (Gould), were possibly based on imperfect sightings of this species.

Meliphaga penicillata Gould **White-plumed Honeyeater**

Northeastern, west to Lake Betty and south to South Esk Tablelands (Mt

Ernest and Well 50); southwestern, north to the Rudall and east to McKay Creek; and patchily distributed in Gibson Desert (recorded at Wormys Well and vicinity and on the Sandy Blight track 69 km W of Northern Territory border). Common in relatively well-watered northeast and southwest; usually in small parties. Mainly river gums; attracted to flowering bloodwoods, *Hakea lorea* and *Grevillea wickhami*. One breeding report; May.

Melithreptus gularis laetior Gould **Black-chinned Honeyeater**

Mainly northeastern, south and west to Well 45; also patchily distributed further south (92 km E of Old Talawana, Well 30 and 39 km W of Pollock Hills). Uncommon; usually in pairs and small parties. Mostly river gums and other waterside vegetation; also other eucalypts (bloodwoods and mallees) and attracted to flowering *Grevillea refracta*.

Phylidonyris albifrons (Gould) **White-fronted Honeyeater**

Widespread, but no records from northeast, i.e. north and east of Well 35 (however, it has been recorded in adjacent parts of southeast Kimberley). Winter visitor (April-September) in highly variable numbers. Very common in some winters, e.g. along the Sandy Blight and Talawana tracks in 1971, but generally uncommon to moderately common; in ones, twos or small flocks (up to 20). Attracted to flowering shrubs and trees: *G. wickhami*, *G. refracta*, *G. stenobotrya*, *G. eriostachya* and other grevilleas, *H. lorea* and other hakeas, *E. kingsmillii* and other eucalypts (especially bloodwoods), *M. glomerata* and other melaleucas, and *Acacia* spp. Breeding in July and August; C/2(1).

Manorina flavigula (Gould) **Yellow-throated Miner**

Widespread, but no records from northeast, i.e. north of lat. 21°S (however, it has been recorded in adjacent parts of southeast Kimberley). Common in relatively well-watered and well-wooded southwest, north to the Rudall and east to Well 24; uncommon elsewhere; usually in pairs or small flocks (up to 20). Mainly eucalypt woodland (river gums, bloodwoods, *E. kingsmillii* and *E. papuana*); also desert oaks, mulga and other acacias, and cajaputs; attracted to flowering *Grevillea refracta*, *G. wickhami* and *Hakea lorea*.

Acanthagenys rufogularis Gould **Spiny-cheeked Honeyeater**

Uncommon to moderately common in south, scarce or absent in north; usually in ones, twos or small parties (up to 16 birds observed drinking together). Mainly mulga and other acacia scrubs, also bloodwoods and melaleuca thickets; attracted to flowering hakeas and grevilleas.

Epthianura aurifrons Gould **Orange Chat**

Patchily distributed: recorded from Gregory Salt Lake, Lake Auld and claypans 14 km SSW of Well 25. Common (at least around Gregory Salt Lake); usually in small parties. Samphire.

Epthianura tricolor Gould **Crimson Chat**

Nomadic. Moderately common to very common–more numerous in wet years (e.g. 1971) than dry, and in south than north; usually in ones, twos or small parties, occasionally in flocks of 80 or more. Lightly wooded country, especially post-fire regeneration and flats with fresh grass and herbage; attracted to flowering *Grevillea wickhami, G. refracta, G. eriostachya* and *Hakea lorea*. Breeding north to Kidson Airfield; June to September.

Ploceidae

Emblema pictum Gould **Painted Finch**

Widespread but patchily distributed. Moderately common; usually in pairs or small parties, sometimes in hundreds at water. Mainly spinifex in stony gullies and hills; also locally in sandy deserts, e.g. Joanna Spring. Breeding from May to August.

Poephila guttata castanotis (Gould) **Zebra Finch**

Very common in relatively well-watered northeast and southwest, moderately common to common elsewhere; usually in small flocks, sometimes in thousands at water. Lightly wooded country with spinifex and other grasses in vicinity of water. Breeding from March to September; C/1(1), 2(3), 3(3), 4(2), 5(2), 6(1), 7(1).

Grallinidae

Grallina cyanoleuca (Latham) **Magpie-lark**

Confined to relatively well-watered northeast (Lake Betty area, lower Sturt Creek, Gregory Salt Lake and Balgo) and southwest (Rudall River and Talawana). Common; usually in pairs. Lightly wooded country in vicinity of water. Two breeding records from the Rudall; August.

Artamidae

Artamus personatus (Gould) **Masked Woodswallow**

Nomadic. Widespread. Moderately common to very common; usually in small flocks, occasionally in thousands. Lightly wooded country; attracted to flowering trees and shrubs, especially bloodwoods, but also *Grevillea wickhami, G. refracta, G. eriostachya* and *Hakea lorea*. Breeding in August.

G.A. Keartland (*in* North 1898: 172) also noted the White-browed Woodswallow, *Artamus superciliosus* (Gould), in the desert but it is uncertain whether this was north or south of the Tropic.

Artamus cinereus melanops Gould **Black-faced Woodswallow**

Very common (the widest-spread and most abundant bird in the region); usually in ones, twos or small parties, occasionally in small flocks (up to 40). Lightly wooded country. Breeding in August and September; C/3(2).

Artamus minor Vieillot **Little Woodswallow**

Patchily distributed in west, north to the Anketell Ridge (107 km WNW of Swindell Field) and east to the Rudall River and Emu Range. Scarce; usually in small parties. About cliffs and breakaways.

Cracticidae

Cracticus torquatus torquatus (Latham) **Grey Butcherbird**

Patchily distributed in western part of extreme south: recorded from Old Talawana, Well 24, and 24 and 42 km N of Windy Corner. Scarce; in ones or twos. Tall dense mulga.

Cracticus nigrogularis (Gould) **Pied Butcherbird**

Northeastern, south and west to South Esk Tablelands (Breaden Valley). Western and southern, north to the Anketell Ridge, Kidson Bluff, Pollock Hills and Dovers Hills. Moderately common; in ones or twos. Mainly hard country where runoff from hills and breakaways favours scattered tall eucalypts; absent from sandy deserts. One breeding report: October; C/2.

Cracticus tibicen tibicen (Latham) **Australian Magpie**

Only recorded from two small areas in far south: (1) the Buck Hills (Sandy Blight track at 11 and 19 km W of Northern Territory border), and (2) the Harbutt and McKay Ranges (Talawana track at 21, 58 and 68 km W of Well 23). Scarce.

Corvidae

Corvus orru salvadorii Finsch **Australian Crow**

Southern and eastern, i.e. absent from most of Great Sandy Desert. Moderately common in relatively well-watered and well-wooded northeast (southwest to South Esk Tablelands) and southwest (north to the Rudall and east to McKay Creek), scarce or uncommon elsewhere; in ones, twos or small parties. Wooded country in vicinity of water with moderately tall eucalypts suitable for nesting in. One breeding report: July; C/4.

Not much can be said about the two *Corvus* spp., for most crows are not identified to species. *C. orru* has been collected at Well 48 and Talbot Soak (Rudall River), and *C. bennetti* at Wells 47, 44 and 39.

Corvus bennetti North **Little Crow**

Southern and eastern, i.e. absent from most of Great Sandy Desert. Uncommon to moderately common; in ones, twos or small flocks (up to 30). Wooded country in vicinity of water. One breeding report: August.

DISCUSSION

In the table below, the birds of the region are enumerated according to ecological status.

	non-passerine	passerine	total
residents	31	56	87
breeding visitors	7	0	7
non-breeding visitors	46	4	50
passage migrants	1	2	3
vagrants	1	0	1
total	86	62	148

148 species is a very low total for a region that has an area (480,000 sq. km) more than twice that of the State of Victoria. Even so, the total would have been much less but for the inclusion within the region of certain peripheral areas.

The well-watered far northeast, especially Gregory Salt Lake, contributed 28 non-passerines and 2 passerines that are not recorded from elsewhere in the region. The relatively well-wooded and well-watered southwest contributed 3 non-passerines and 2 passerines unrecorded elsewhere. A further 13 non-passerines and 6 passerines, shared by the far northeast and far southwest, do not extend to the more arid parts of the region.

The far northeast and far southwest are essentially extensions of the Kimberley and Pilbara regions. If we subtract the 43 non-passerines and 6 passerines regionally confined to them, we are left with the 43 non-passerines and 56 passerines that inhabit or visit the truly desert country. Of these, 4 non-passerines and 9 passerines are restricted to the far south, especially the mulga thickets of the Gibson Desert.

The Great Sandy Desert, which constitutes the major part of the region, thus has an avifauna of fewer than 90 species. This poverty reflects the extreme harshness of the environment. No other part of Australia is so inimical to birdlife as this land of great summer heat and little or no surface water.

GAZETTEER

Co-ordinates for watercourses are taken at their termination, sheep and cattle stations at their homestead, other features at their centre.

Aitchison Creek 20°21′S, 128°36′E
Anketell Ridge 20°30′S, 122°30′E

Balgo Mission Station 20°09′S, 127°57′E
Billiluna Station 19°34′S, 127°40′E
Bishops Dell 20°41′S, 127°33′E
Breaden Valley 20°17′S, 126°32′E
Buck Hills 23°09′S, 128°54′E
Bulbi Plain 20°16′S, 127°20′E

Callawa Station 20°38′S, 120°30′E
Callawa turnoff 20°06′S, 121°09′E
Carnegie Station 25°47′S, 122°58′E
Coondegoon Pool 22°28′S, 122°31′E
Coondra Coondra Spring 23°07′S, 121°02′E
Curran Curran Rock-hole 22°32′S, 121°56′E

Djaluwon Creek 20°17′S, 127°26′E
Dovers Hills 23°07′S, 128°40′E
Dragon-tree Soak 19°40′S, 123°21′E

Emu Range 22°57′S, 122°12′E

Gary Junction 22°30′S, 125°15′E
Godfrey Tank 20°14′S, 126°35′E
Gravity Lakes 20°52′S, 126°05′E
Gregory Range 21°25′S, 121°14′E
Gregory Salt Lake 20°13′S, 127°27′E

Hanging Rock 22°30′S, 121°40′E
Harbutt Range 22°55′S, 122°50′E

Jiggalong 23°21′S, 120°47′E
Joanna Spring 20°06′S, 124°11′E
Jupiter Well 22°53′S, 126°36′E

Kidson Airfield 22°43′S, 125°08′E
Kidson Bluff 22°15′S, 125°04′E
Kunningarra Rock-hole 20°15′S, 126°34′E

Labbi-labbi Rock-hole 21°34′S, 128°49′E
Lady Edith Lagoon 20°36′S, 127°14′E
Lake Auld 22°35′S, 123°45′E
Lake Betty 19°32′S, 126°20′E
Lake Hazlett 21°30′S, 128°38′E
Lake Gregory Station 20°09′S, 127°35′E
Lake Mackay 22°25′S, 128°50′E
Lens Bore 20°15′S, 127°30′E
Lera Waterhole 20°10′S, 127°24′E

McKay Creek 23°04′S, 122°52′E
McKay Range 23°00′S, 122°30′E
McLarty Hills 19°28′S, 123°33′E
Mt Bannerman 19°28′S, 127°11′E
Mt Ernest 20°10′S, 126°34′E

Oakover River 20°42′S, 120°33′E
Old Billiluna 19°40′S, 127°35′E
Old Talawana 22°50′S, 121°10′E

Percival Lakes 21°20′S, 124°40′E
Picture Hill 21°40′S, 123°50′E
Point Moody 21°15′S, 127°47′E
Poisonbush Range 22°48′S, 121°39′E
Pollock Hills 22°50′S, 127°33′E
Pussycat Bore 20°21′S, 128°36′E

Rudall River 22°10′S, 123°00′E

Savory Creek 23°21′S, 122°40′E
Separation Well 22°52′S, 124°00′E
South Esk Tablelands 20°30′S, 126°35′E
Sturt Creek 20°13′S, 127°23′E
Swindell Field 21°07′S, 123°27′E

Talawana Creek 22°45′S, 121°08′E
Talawana Station 22°57′S, 121°12′E
Talbot Soak 22°32′S, 122°24′E
Telfer 21°43′S, 122°14′E

Throssel Range 21°55′S, 121°45′E
Tobin Lake 21°45′S, 125°40′E

Well 23 23°05′S, 123°13′E
Well 24 23°07′S, 123°20′E
Well 25 22°59′S, 123°24′E
Well 30 22°30′S, 124°08′E
Well 31 22°32′S, 124°24′E
Well 33 22°20′S, 124°44′E
Well 34 22°16′S, 124°54′E
Well 35 22°13′S, 125°03′E
Well 36 22°09′S, 125°16′E
Well 37 22°09′S, 125°27′E
Well 39 21°46′S, 125°38′E
Well 40 21°40′S, 125°48′E
Well 41 21°34′S, 125°51′E
Well 42 21°19′S, 125°53′E
Well 43 21°12′S, 125°58′E
Well 45 20°48′S, 126°11′E
Well 48 20°15′S, 126°31′E
Well 50 20°13′S, 126°59′E
Wiluna 26°35′S, 120°14′E
Windy Corner 23°34′S, 125°11′E
Wormys Well 23°02′S, 125°11′E

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FURTHER LARGE AUSTRALITES FROM WESTERN AUSTRALIA

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ABSTRACT

Australites which weigh individually more than 100 g and have become known since 1974 have been listed and described if that has not already been done. The sites of find conform to the previously established pattern which may have significance in terms of australite origins and dispersal.

INTRODUCTION

In an earlier paper (Cleverly 1974), the 32 known Western Australian australites which each weighed more than 100 g were described or references were given if adequate published descriptions already existed. Eight further specimens are now known. Two are in the Western Australian Museum (WAM), one in the Geology Department, W.A. School of Mines, and five in private collections. The purpose of the present paper is to up-date the earlier one according to the same general plan. Some physical details of the additional specimens are given in **Table 1** and their sites of find are shown in **Fig. 1.** Notes on individuals follow in the numerical sequence of the table.

DESCRIPTIVE NOTES

1 Private collection of Mr A. McConnell of South Australia. For a detailed description and illustrations see Scrymgour (1978).

2 **Fig. 2A-D.** Owned by Mr L.G. Lewis of Corrigin, who found it in a dry creek bed on Avon Location 21 846 (property of Mr H. Button) on 3 August 1977.

The posterior surface of flight shows a number of smooth flow cells separated by narrow widths of highly vesicular glass with strong flow

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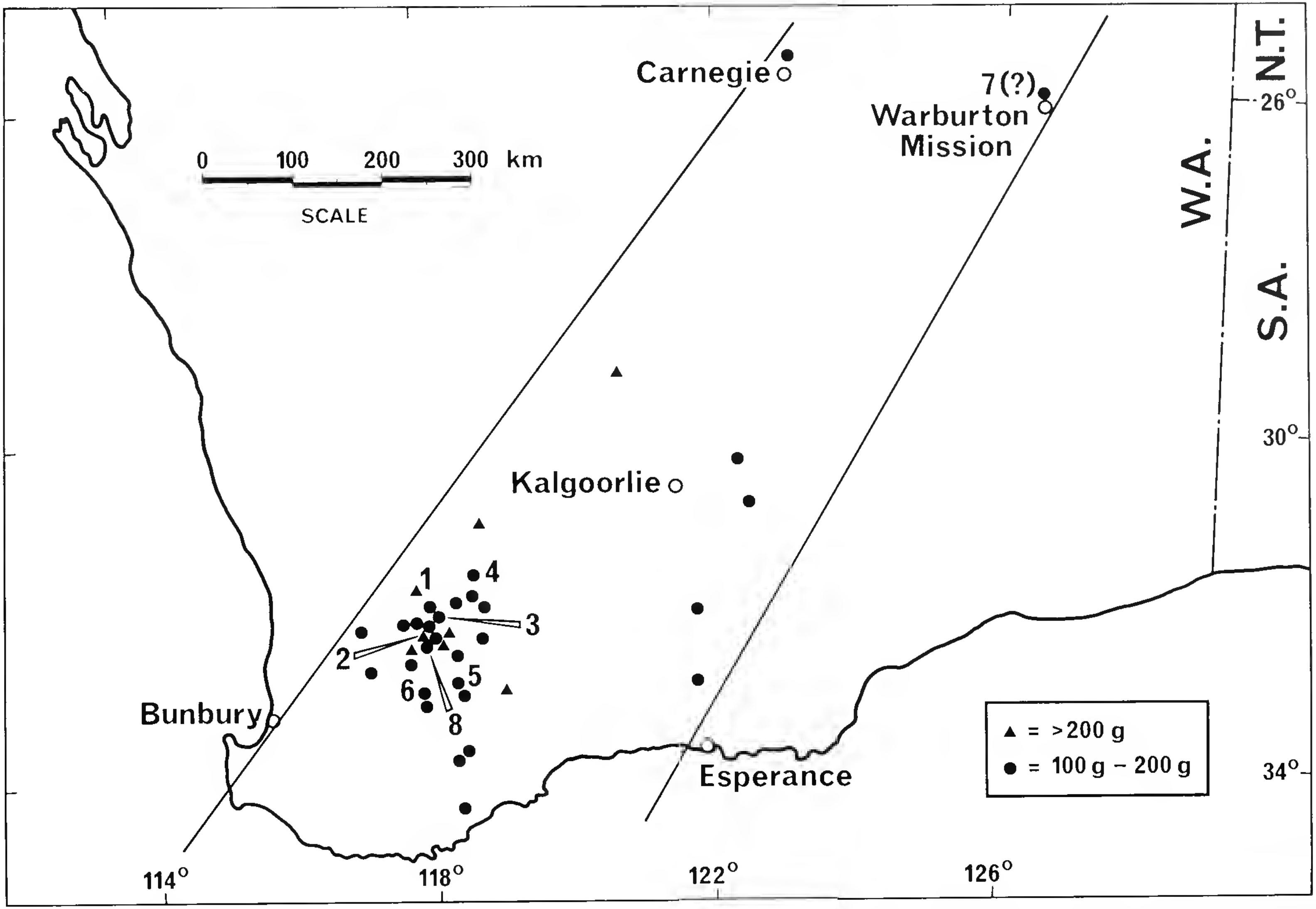

Fig. 1: Map of southern Western Australia showing the sector containing sites of find of australites weighing more than 100 g. Numbers refer to the australites of Table 1.

TABLE 1

Masses and dimensions of some large australite cores from Western Australia and their primary bodies.

			Australite					Primary body		% Losses	
No.	Core shape	Site of find	Long. E	Lat. S	Mass g	Dimensions mm	G	Dimensions mm	Mass g	Mass	Depth
1	[1]Teardrop	Near Shackleton	117°15'	31°56'	225.07	66.0 x 57.0 x 50.1	2.42	—	-	-	-
2	Round	7 km S of W of Gorge Rock	117°55'	32°28'	200.53	(60.0-57.7) x 51.2	2.375	66 diameter	365	45	23
3	Round	10.5 km SE of Babakin	118°07'	32°11'	197.35	(58.7-57.0) x 48.6	2.426	66 diameter	375	47	27
4	[2]Broad oval	6 km E of Muntadgin	118°37'	31°46'	167.98	69.9 x 56.9 x 35.2	2.428	77 x 62 x 40	245	31	12
5	Round	Lake Grace	118°28'	33°06'	132.73	(53.8-52.7) x 39.1	2.424	—	—	—	—
6	Round	*ca* 16 km SSE of Harris-mith	*ca* 117°56'	*ca* 33°04'	121.40	(49.6-48.6) x 39.9	2.423	*ca* 55 diameter	210	42	27
7	Narrow oval	Warburton Range area (?)	*ca* 126.5°	*ca* 26°	110.12	67.4 x 39.5 x 30.1	—	—	—	—	—
8	[3]Fragment	6 km SW of Gorge Rock	117°57'	32°31'	80.09	55.2 x 40.3 x 29.6	2.428	—	—	—	—

[1] Data from Scrymgour (1978).

[2] Data from Cleverly (1979).

[3] Of round or broad oval core initially weighing more than 100 g.

structure (Fig. 2A). The rim is somewhat rounded by weathering and is irregular in the plan view, though quite planar (Fig. 2A-C). The equatorial zone shows a few shallow, spiky-outlined depressions from which thin flakes have been lost as described below for the anterior surface. The main anterior surface is very oblique to the line of flight (Fig. 2C), evidently as the result of an old loss of some tens of grams of material. The scar is now characterized by a roughly concentric system of cracks and by small depressions, not generally more than 0.5 mm deep, resulting from the loss of small flakes with spiky outline. The origins of those minor features are unknown. Rather similarly-shaped small depressions are present along the course of U-grooves on the anterior surface of a large round core from Lake Yealering, Western Australia (Chapman 1964, Fig. 6A), but they appear to be the result of corrosion rather than of flake loss.

The specific gravity is only 2.375, the lowest value found for any of the large cores from southwestern Australia. For 31 such cores (Cleverly 1974 and this paper), the mean specific gravity is 2.426 with standard deviation 0.008; the very small standard deviation is noteworthy. All the values except the one under consideration are in the narrow range 2.409 to 2.439. The most likely explanation for the unusually low specific gravity of this specimen is the presence of a bubble cavity or cavities. An australite of this size and of average specific gravity 2.426 would need a bubble cavity of volume 1.8 cm^3 (diameter 15 mm) to reduce the bulk specific gravity to 2.375. For stability in flight, such a large cavity would have to be centred, at least approximately, upon the line of flight and closer to the posterior than to the original anterior surface of flight. No cavity could be detected using strong lamps but that is not surprising in view of the extremely large size of the australite. The dimensions of the specimen are such that a 15 mm bubble could be enveloped in glass as much as 18 mm thick. Complete australites which are known to contain a cavity as large as 15 mm diameter are extremely rare (Baker 1966, Table 1), but specimens with breached cavities of that size and fragments of such specimens are occasionally found. The presence of a bubble cavity, even if of unusually large size, is still a more likely explanation than that the specimen should be radically different in its chemistry and hence in its specific gravity from others found in the same general area, or that it should be an import to the area.

3 **Fig. 3A & B.** WAM 13 364. Found by Mr Tony Hobson some years prior to 1975 on Avon Location 18 941 about 1.2 km in direction 120° from its northwestern corner. Donated by Mrs L. Robins.

The specimen is classed as a round core but has considerable irregularity of shape arising from peculiarities of the detached stress shell. In one area (**Fig. 3A**) a tongue of glass remains anterior to the rim where it would normally have been detached as stress shell; in another area distant about 120° around the rim (**Fig. 3B**), spalling has extended far posterior to rim level, almost to the posterior pole.

The most prominent minor sculpture is the grooves of U-shaped cross section on the equatorial zone and anterior surface. Grooves near the rim have their usual orientation approximately normal to it and are present also around the outside of the tongue of persistent stress shell and around the inside of the spalled embayment on the posterior surface. This distribution of grooves supports the interpretation that those features are parts of the outline of a stress shell of unusual shape.

The estimates of the form of the primary body and losses from it (**Table 1**) are necessarily not of the highest quality for such an irregularly shaped specimen.

4 WAM 13 396. For a detailed description and illustrations, see Cleverly (1979a).

5 Private collection of Mrs A. Clarke of Cottesloe, Western Australia.

As in the case of no. 3 above, there are imperfections of shape arising from peculiarities of the stress shell. The rim is recognisable and regular for most of the circumference, though very much reduced and affected by solution etching. Around rather more than half the circumference, thin flake losses extend from c. 5 mm to c. 20 mm posterior to rim level (**Fig. 3C & D**). The flaked zone, like the anterior surface (**Fig. 3E**), shows a very abundant development of U-grooves. Curves could not be fitted sufficiently closely to the posterior surface to warrant the calculation of a primary body.

This specimen is one of those cores found especially in south-western Australia which 'exhibit a base surface that is irregularly contoured, often somewhat faceted in shape' (Chapman 1964, p. 852). Specimen no. 3

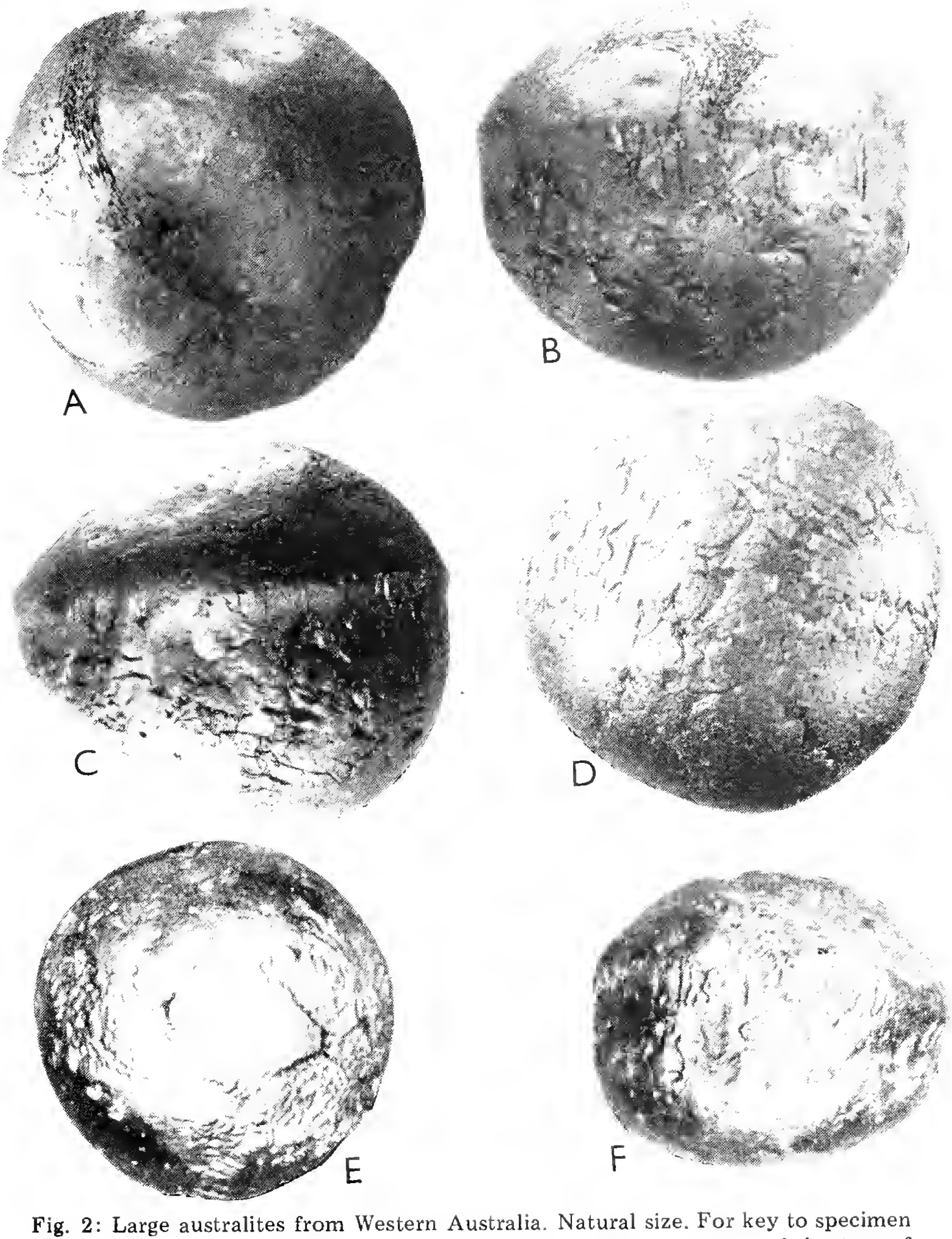

Fig. 2: Large australites from Western Australia. Natural size. For key to specimen numbers, see Table 1. In elevational views, direction of flight is towards bottom of page. A: No. 2, posterior surface of flight. B: No. 2, elevation. C: No. 2, elevation showing obliquity of part of anterior surface to line of flight. D: No. 2, as seen in a direction normal to the oblique part of the anterior surface, rim at top. E: No. 6, posterior surface showing abundance of minor sculpture where thin flakes have been lost. F: No. 6, elevation.

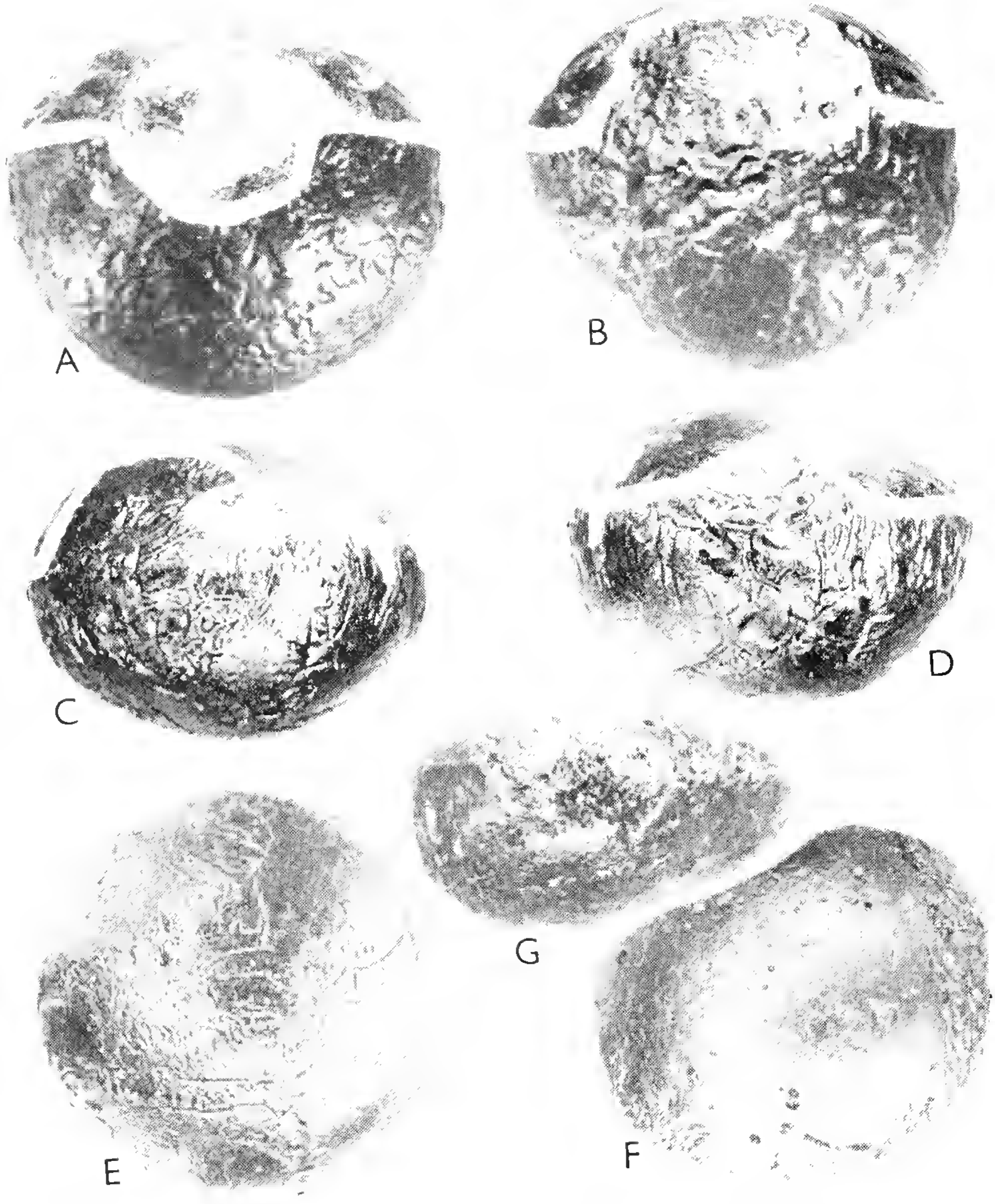

Fig. 3: Large australites from Western Australia. Natural size. For key to specimen numbers see Table 1. In elevational views, direction of flight is towards bottom of page. A: No. 3, elevation. White line marking rearward limit of spalling coincides with rim at left and right. B: No. 3, a second elevational view. C: No. 5, elevation. White line marking rearward limit of spalling coincides with rim only at extreme left. Rim faintly visible across middle of photograph. D: No. 5, elevation to right of C (arrow is common to both views). White line, descends to rim level only at point of disappearance on far right. E: No. 5, anterior surface. F: No. 8, posterior surface. G: No. 8, elevation showing from left to right, old flake scar, highly vesicular area, rim.

above and no. 6 below are further examples. The abundant occurrence of U-grooves on the flaked zone posterior to the rim as well as on the anterior surface illustrates the relationship of the grooves to surface exposed by loss of stress shell as first pointed out by Chapman (*op. cit.*).

6 **Fig. 2E & F.** W.A. School of Mines Geology Department collection 12 030. Found in 1978 by Mr P.H. Davidson of Kukerin on Avon Location 11 996 which is located 16 km SSE of Harrismith towards Moulyinning.

The posterior surface of flight is extensively affected by old shallow flake losses (Fig. 2E & F). Estimates of the radius of curvature of that surface (i.e. of the primary body) show a considerable variation from 52.5 to 57.2 mm, and a rounded mean figure of 55 mm was used for the calculation of the primary body and the losses from it. The anterior surface is oblique to the line of flight because of a considerable loss of material.

The surface of the core is brighter anterior to the rim. This suggests that it was embedded in the soil for some time to the level of the rim with the posterior surface exposed to abrasion by blown sand whilst the balance of the surface was subject to etching by the chemical constituents of soil water.

7 Obtained from Aborigines at Warburton Mission by Mr S. Bridgeman, but it might have been brought into the Mission from a considerable distance. Enquiries continue regarding the specific provenance. The specimen could be examined only very briefly and the details shown in Table 1 were the only observations possible.

8 **Fig. 3F & G.** Private collection of Mr L.G. Lewis of Corrigin. Found by Mr M. Winmar on a stony ridge on Avon Location 19 800 (property of Lewis Bros) in March 1979.

This fragment is the major part of a large core but is insufficiently complete for determination of original shape and mass with certainty. The core could have been round, of diameter *ca* 52 mm and mass *ca* 105 g or possibly broad oval *ca* 58 x 55 mm and mass *ca* 119 g. These are the limits of a number of attempted reconstructions which differ according to whether small differences in radii of curvature are regarded as original or attributed to weathering. The mass was probably more than 100 g and might have approached 120 g.

The rear surface is dominated by smooth flow cells with bordering glass having strong flow structure shown by etched schlieren, and numerous bubble pits including a small, highly vesicular area which interrupts the rim (**Fig. 3F & G**). The rim is well-defined, reasonably regular and planar. There is no defined equatorial zone. The anterior surface shows a few etch pits and shallow (i.e. abraded) U-grooves including some which are approximately normal to the rim.

Portion of an old fracture scar is etched quite as deeply as the major surfaces; it evidently dates from early in the terrestrial history of the core. The much larger fracture surface shows minute pits and lightly etched schlieren giving it a matte appearance. It is clearly a much younger fracture, yet appears too weathered to have been caused by man. There is no defined cone of percussion or other feature to suggest that the fragment is other than a natural one.

DISCUSSION

Two examples (nos 3 & 5) of extensive shallow flaking of posterior surfaces and one less evident example (no. 6) are present amongst the eight specimens; for other examples see Chapman (1964), who has offered an explanation. Three specimens (nos 2, 6 & 8) have lost large pieces from the anterior leaving the surface very oblique to the line of flight; another example is a round core of 92.9 g from Avon Location 19 123 between Muntadgin and Tandagin owned by Mr Brett Hooper of Muntadgin. No reason for these losses is known.

The criticism that too much attention has been paid to very large australites and too little to very small ones is defensible in Western Australia on two counts. Firstly because, with the possible exception of some specimens from Menangina, few small specimens from Western Australia are sufficiently well-preserved to warrant study (Cleverly 1979b). Secondly, because all australites weighing more than 100 g known to 1977 were found in two sectors divergent from northern Australia, the heaviest ones towards the southern ends and western sides of the sectors (Cleverly & Scrymgour 1978, Fig. 3); the specimens which have since become known conform to the pattern (Scrymgour 1978, Fig. 2; this paper, Fig. 1) with the possible exception of no. 7, the provenance of which is unknown. The pattern might well have significance in regard to australite origins and dispersal. For example, the heaviest australites (say, greater than 200 g) might be at the southern ends because of a mass grading effect, and if their mode of dispersal was such that the heaviest ones arrived last, rotation of the earth could leave them distributed along the western sides of the sectors. The peculiar grouping of large australites at the southern end (Fig. 1) is likely to be, at least in part, an effect arising from the distribution of human population. The western group is in the wheat belt whilst the eastern is in the narrow strip of country running north and south from Kalgoorlie and associated with mining; the intervening country is uninhabited (Cleverly 1976). A round core of 95.7 g found at Lake King within the gap by an itinerant worker lends support to the supposition that the gap in australite occurrence will cease to exist when the area is inhabited. The continued recording of the distribution of not only the unusually massive australites, but of all australites is desirable.

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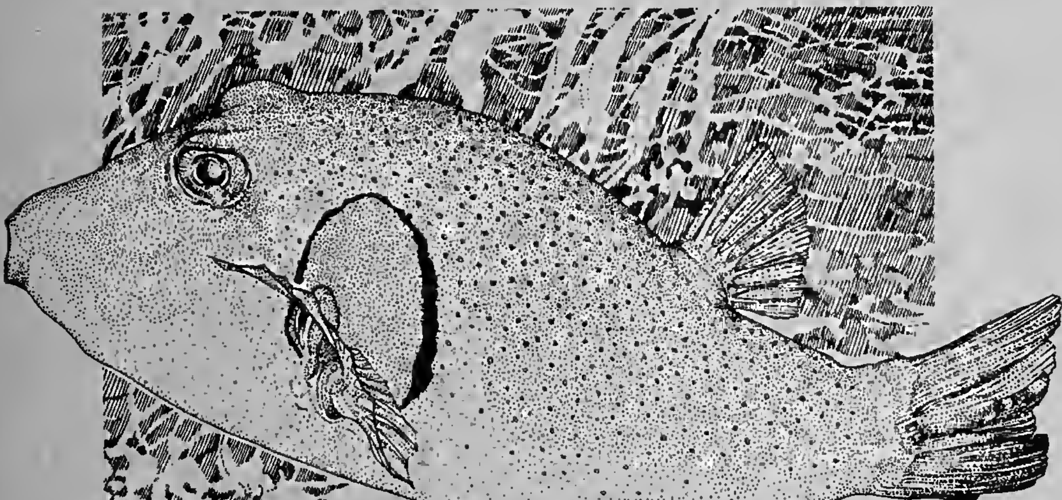

Volume 9, Part 2, 1981

RECORDS OF THE WESTERN AUSTRALIAN MUSEUM

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Cover: A Ringed Toadfish (*Omegophora armilla*) drawn by Gaye Roberts.

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PARASITES OF WESTERN AUSTRALIA
XIII
A NEW SPECIES OF DEMODICID MITE FROM THE MEIBOMIAN GLANDS OF THE BAT *MACROGLOSSUS MINIMUS*

F.M. KNIEST* and F.S. LUKOSCHUS*

ABSTRACT

Demodex bicaudatus sp. nov. is described from the Meibomian glands of the blossom-visiting bat *Macroglossus minimus* Geoffrey, 1910. Holdfast adaptations to maintain the mites in the Meibomian gland against the secretion flow are compared with those of other species.

INTRODUCTION

Species of the genus *Demodex* Owen, elongate to worm-like mites, live in the pilo-sebaceous complex of mammals. Those inhabiting the Meibomian glands show special adaptations, mostly in immatures, against the secretion flow.

During the Western Australian Field Programme expedition to Mitchell Plateau, in the Kimberley Division of Western Australia in 1976-77, involving the Chicago Field Museum of Natural History and the Western Australian Museum, F.S.L. investigated the Meibomian glands of *Macroglossus minimus*. Contents of the glands were expressed by watchmakers' forceps and spread in Hoyer's medium. Some included small numbers of a new species of *Demodex* described below. All measurements are in microns.

SYSTEMATICS

Demodex bicaudatus sp. nov.

Figs 1-12

Holotype

WAM 80-311; male; from Meibomian glands of *Macroglossus minimus*, Camp Creek, near Aluminium Camp, Mitchell Plateau (14°50'S, 125°19'E); 19 October 1976. Host in Field Museum of Natural History, Chicago.

Allotype

WAM 80-315; female; host, locality and date as for holotype.

* Department of Aquatic Ecology, Catholic University of Nijmegen, The Netherlands.

Paratypes

WAM 80-312; egg and larva. WAM 80-313; egg, nymph. WAM 80-314; protonymph. Other paratypes are in the Field Museum of Natural History, Chicago; Department of Zoology, University of Massachusetts, Amhurst, and in the collections of the authors. Host, locality and date as in holotype.

Diagnosis

A medium-sized, broad species with the characteristics of the genus and narrow opisthosomal annulations. Largest adult, a female, 293 long overall. Opisthosoma relatively variable in length in all stages, occupying a third to a half of the body length. They are strikingly different from all known demodicids in that adults show an annulated dorsal, tail-like appendage on the opisthosoma, and developmental stages have a pronounced broadening of the podosoma.

Description

Male (holotype): Total length 196, width 65 and opisthosoma 57. Venter (Fig. 1): Legs evenly spaced on podosoma with coxal plates not touching in midline. Coxae I-IV with tooth-like elevations exteriorly and coxae II-III with cuticular excrescences midposterior. Femora (second movable segment) with rounded posteroventral spur. Genua-tarsi (third movable segment) fused with only 1 segmentation line ventrally. Claws straight, flattened from side to side, with 2 short apical and 3 longer midventral spines (Fig. 4). Genua-tarsi I-II with solenidion (*so*). Gnathosoma broader than long, with 2-segmented palp, oval pharyngeal bulb (pump) (*pb*) and subgnathosomal setae (*sg*); dorsally with 2 sclerotized cones identical with the larval egg teeth (possibly modified fixed digits of chelicerae) and conical supracoxal spines (*scx*). Opisthosoma with rounded terminus; opisthosomal organ absent. Dorsum (Fig. 2): Prodorsal shield with indistinct borders, 2 pairs of podosomal tubercles (*pt*) and 5 spots of irregular texture (these are probably muscle attachments). Opisthosoma with dorsal, tail-like appendage, unknown in any other demodicid and variable in shape and size (Fig. 3), other measurements are given in Table 1.

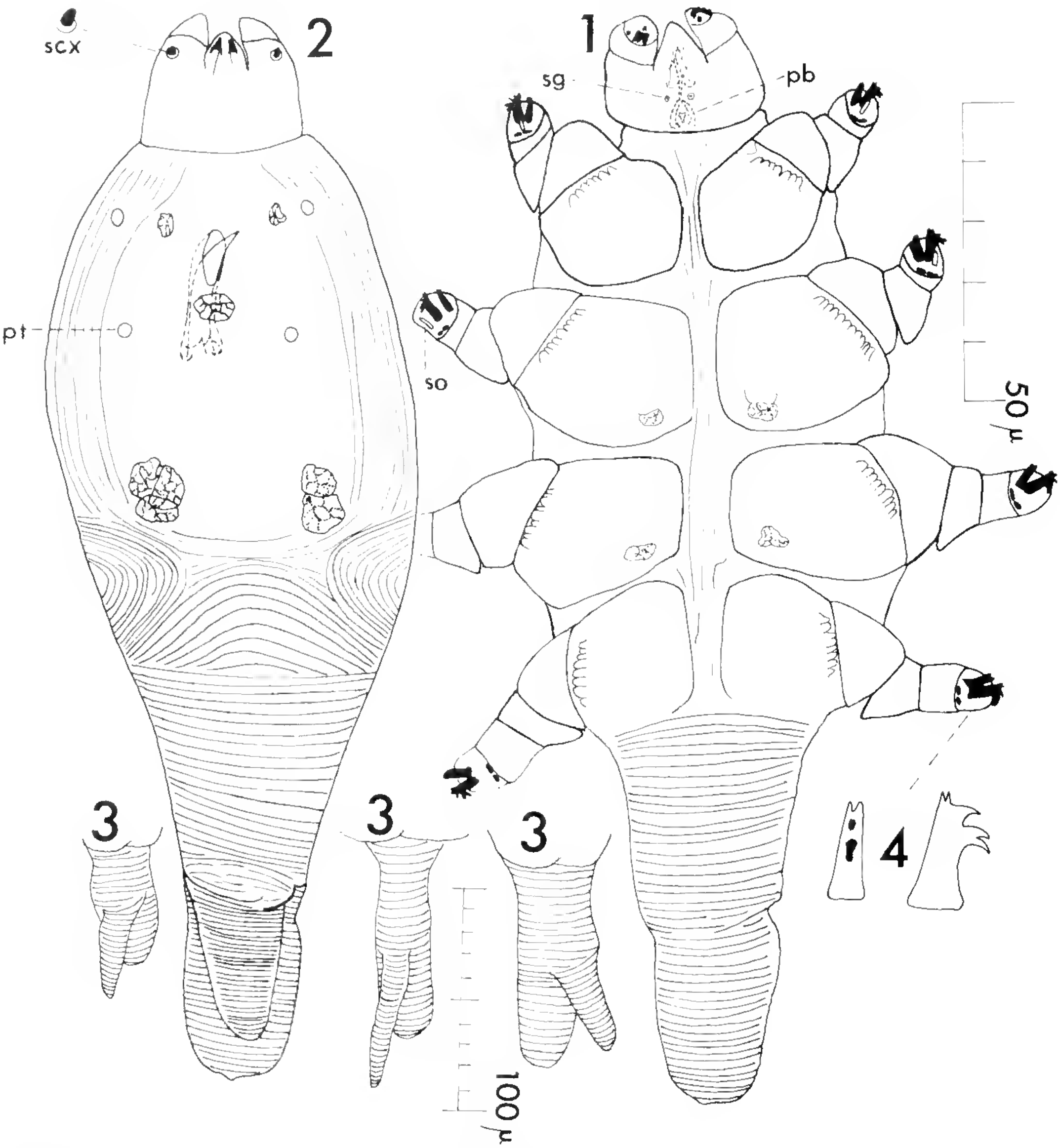
Female (allotype): Length 241, width 170 and opisthosma 102. Venter (Fig. 5): Similar to that of male, genital opening (20) behind coxal fields IV, separated by several striations. Vulva protuberant. Cuticular pattern on coxal fields II-III different from male on the midposterior border of coxal fields. Dorsum (Fig. 6): Prodorsal shield weak, with 8 muscle attachments. Opisthosomal appendage somewhat smaller than in male, very variable in paratypes (Fig. 7). Podosomal tubercle not apparent.

Late Nymph (Fig. 12): Four pairs of unsegmented, bilobed, laterally inserted legs; leg IV with additional broad posterolateral lobe. Solenidia on legs I and II not observed. Greatest width at level of legs IV (between legs II and III in adults). Gnathosoma similar to that of adults; other characteristics similar to that of protonymph and larva.

TABLE 1

Meristic data (average and range) for stages of the life cycle of *Demodex bicaudatus* sp. nov. All measurements are in microns.

N =	Male 8	Female 13	Nymph 3	Protonymph 5	Larva 1	Ovum 23
gnathosoma						
length $\overline{X}$	23	27	26	23	23	123
length range	20-29	26-32	24-29	20-26	—	119-127
width $\overline{X}$	28	30	32	22	20	59
width range	26-29	26-32	29-34	17-29	—	52-64
podosoma						
length $\overline{X}$	110	105	136	114	102	
length range	105-119	99-113	131-145	102-131	—	
width $\overline{X}$	66	69	94	61	67	
width range	61-70	58-81	84-110	44-75	—	
opisthosoma						
length $\overline{X}$	74	107	102	82	75	
length range	52-99	75-160	73-116	44-102	—	
width $\overline{X}$	29	54	34	30	29	
width range	26-35	44-61	23-44	20-46	—	
total body						
length $\overline{X}$	208	239	264	218	200	
length range	182-233	200-293	228-290	198-246	—	
penis/vulva						
length $\overline{X}$	27	21				
length range	23-30	17-25				
dorsal shield						
length $\overline{X}$	51	55				
length range	44-61	44-60				
width $\overline{X}$	41	48				
width range	41	44-58				
'second' tail						
length $\overline{X}$	41	32				
length range	26-61	23-58				
end podosoma/ begin 2 tail						
length $\overline{X}$	39	51				
length range	23-55	44-73				

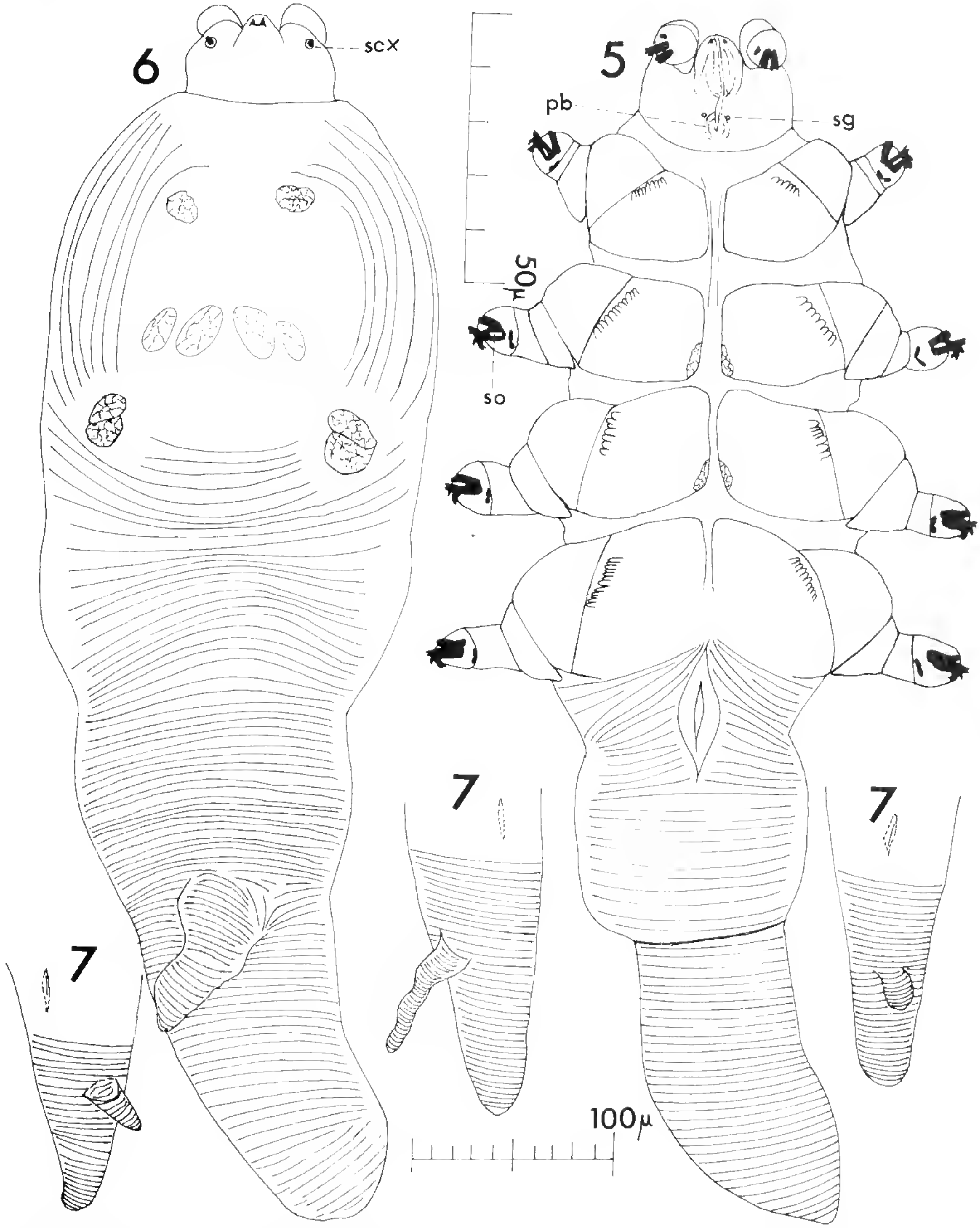


Figs 1-4: *Demodex bicaudatus* sp. nov., male: (1) holotype, venter; (2) holotype, dorsum; (3) opisthosoma dorsal view of paratypes; (4) claws in lateral and ventral view.

Protonymph (Fig. 11): Opisthosoma inserted dorsally, widest behind legs III. Legs and gnathosoma similar to that of larva.

Larva (Fig. 9) (Pressed out of egg-shell during mounting): Three pairs of unsegmented, bilobed legs, each lobe carrying a broad spatulate 5-7-pointed claw. Solenidia on legs I and II not observed. Opisthosoma inserted postero-dorsally, widest at legs II. Gnathosoma similar to that of adults, but supra-coxal spines smaller and single-tined spine on palpal tarsus not observed.

Egg teeth longer than in nymphs and adults. Ventral scutes absent; no appendage dorsally on opisthosoma. Annulation distinct only on opisthosoma.



Figs 5-7: *Demodex bicaudatus* sp. nov., female: (5) allotype, venter; (6) allotype, dorsum; (7) opisthosoma dorsal view of paratypes.

Figs 8-12: *Demodex bicaudatus* sp. nov., developing stages: (8) egg; (9) larva, laterally; (10) gnathosoma larva, dorsally; (11) protonymph, venter; (12) nymph, venter.

Ovum (Fig. 8): Pear-like, bulbous anterior. Length less variable than in other stages. Operculate groove distinct. Oriented in glands with posterior end towards aperture.

DISCUSSION

Species of *Demodex* living in the narrow ducts of the sebaceous glands of hair follicles are adapted to the habitat and the flow of secretions not only by the worm-like shape of the adults, but also by holdfast mechanisms in the developmental stages, especially during the non-active moulting periods. Larvae and nymphs have short, one or two-segmented legs and posteriorly directed ventral scutes serving to anchor the mites in the wall of the duct. Species living in the Meibomian glands with greater secretion flow and wider duct diameter have developed further adaptations in the eggs and developmental stages.

The family Demodicidae, highly adapted to parasitic life in all stages in very small niches, have not replaced oviparity (the egg is the most sensitive stage to loss by secretion flow) by viviparity as did other endo- and ectoparasitic mites, e.g. Spinturnicidae, Rhinonyssidae, Dermanyssidae, Ereynetidae, Teinocoptidae, Laminosioptidae and Chirodiscidae. Particularly, elimination of eggs is prevented by their shape, e.g. the Y-shaped eggs in *D. gapperi* (Nutting *et al.*, 1968) and *D. molossi* (Desch *et al.*, 1972), and the bulbous eggs with a spine-like or narrow posterior end in *D. melanopteri* Lukoschus *et al.*, 1972 and *D. lacrimalis* Lukoschus and Jongman, 1974. Operculate eggs and larval egg teeth enable rapid emergence of larvae (*D. melanopteri*).

In larvae and nymphs of *D. molossi* and *D. longissimus* (Desch *et al.*, 1972), the unusual, elongated leg III and dorsal, propodosomal 'wings' (*D. molossi* only) anchor these species in wide ducts, while elongate, laterally directed palps and long, unsegmented legs with broad, spatulate, multiple-tined claws give reaction in the narrow ducts inhabited by *D. lacrimalis* and *D. melanopteri*. In what is believed to be the most primitive species of *Demodex* known, *D. marsupiali* (Nutting *et al.*, 1980), elongate supracoxal spines serve this purpose.

Demodex bicaudatus, living in wide Meibomian ducts, shows operculate bulbous eggs, egg teeth (possible fixed digits of chelicerae, present in all stages, see Figs 2 and 10), large segmented legs with multiple-tined claws, and exceptional broadening of the podosoma in the developmental stages. The posterodorsally inserted and dorsally arched opisthosoma is an additional anchoring mechanism in very wide ducts, as is the unusual dorsal opisthosomal appendage in adults, seemingly a second tail which probably acts as a holdfast barb.

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THE GENUS *FURINA* (SERPENTES: ELAPIDAE) IN WESTERN AUSTRALIA

G.M. STORR*

ABSTRACT

Furina ornata (Gray) is the only member of the genus occurring in Western Australia. It is redescribed.

INTRODUCTION

Furina is one of several Australian elapid genera whose limits are ill-defined. As the genus is centred in eastern Queensland, the problem of its definition is beyond the scope of this paper. For present purposes *Furina* is assumed to comprise *F. diadema* (Schlegel), *F. ornata* (Gray), *F. barnardi* (Kinghorn), *F. tristis* (Günther) and *F. warro* (DeVis).

This revision is based on the herpetological collection (R series) of the Western Australian Museum; registered numbers of specimens are cited without prefix.

SYSTEMATICS

Genus *Furina* Duméril

Brachysoma Fitzinger, 1843, Systema reptilium, p. 25. Type-species (by original designation): *Calamaria diadema* Schlegel. Not *Brachysoma* Brandt, 1835 (Coelenterata).

Furina Duméril, 1853, Mém. Acad. Sci., Paris 23: 517. Type-species (by designation of Jan, 1859, Rev. Mag. Zool. (2) 11: 124): *Calamaria diadema* Schlegel.

Glyphodon Günther, 1858, Catalogue of colubrine snakes in the collection of the British Museum, p. 228. Type-species (by designation of Boulenger, 1896, Catalogue of the snakes in the British Museum (Natural History) 3: 313): *Glyphodon tristis* Günther.

Lunelaps Worrell, 1961, West. Aust. Nat. 8: 22. Type-species (by monotypy): *Pseudelaps christieanus* Fry.

Diagnosis

Small to medium-sized, slender, nocturnal elapid snakes with eye about as large as its distance from lip; no canthus rostralis; head wide and slightly depressed; neck slightly to moderately narrower than head; midbody scale rows 15 or 17; anal divided; subcaudals in pairs. Distinguishable from *Vermicella* by nasal widely separated from preocular, temporals normally 2 + 2, and body and tail not cross-banded.

Distribution

Southern New Guinea and northern three-quarters of Australia.

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Furina ornata (Gray, 1842)
Fig. 1

Elaps ornatus Gray, 1842, Zoological miscellany, p. 55. Western Australia.

Brachysoma simile Macleay, 1878, Proc. Linn. Soc. N.S.W. 2: 221. Port Darwin, N.T.

Denisonia bancrofti DeVis, 1911, Ann. Qd Mus. no. 10: 23. Stannary Hills, Qld. For corrections to original description, see Mack & Gunn (1953: 59).

Pseudelaps christieanus Fry, 1915, Proc. R. Soc. Qd 27: 91. Point Charles, N.T.

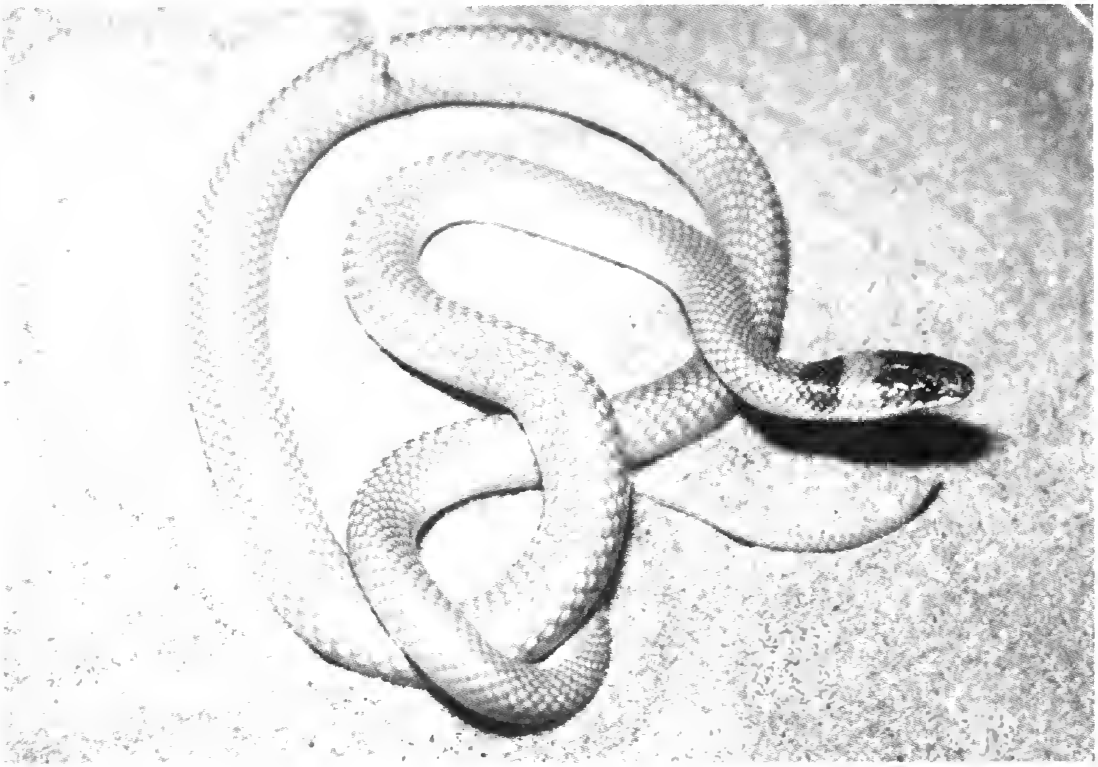

Fig. 1: A *Furina ornata* from Woodie Woodie. Photographed by R.E. Johnstone.

Diagnosis

Very like *F. diadema* (Schlegel) of eastern Australia, but larger and with wide orange occipital bar completely separating dark brown head and nuchal blotches (in *F. diadema* the black of head and neck are usually continuous below the small orange crescent on occiput).

Description

Snout-vent length (mm): 128-508 (N 100, mean 304.7). Tail (% SVL): 14.1-26.8 (N 98, mean 19.8).

Rostral 1.8-2.5 times as wide as high. Internasals very much smaller than prefrontals. Frontal 1.1-1.8 times as long as wide, and 1.5-2.3 times as wide

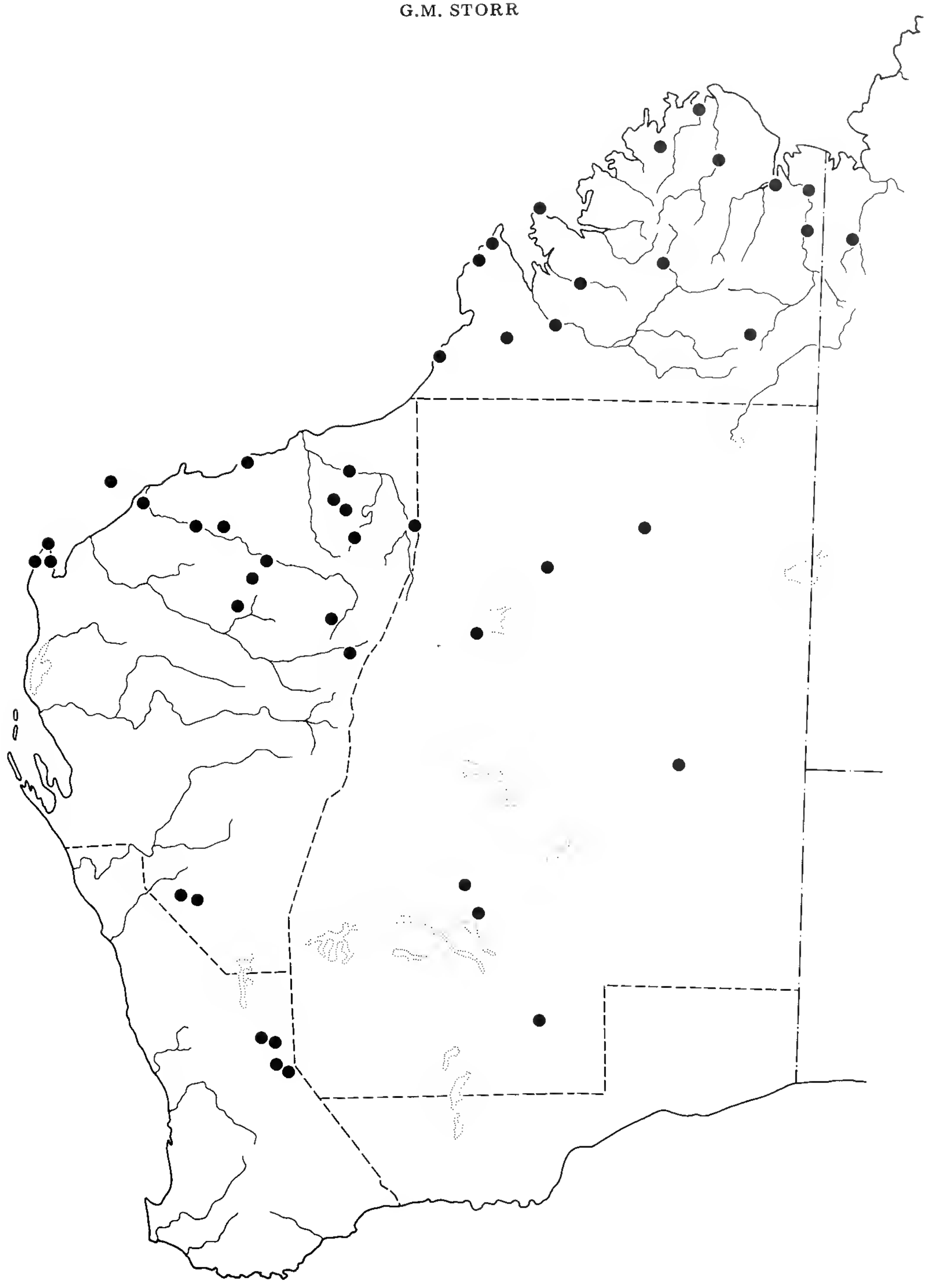

Fig. 2: Map of Western Australia showing location of specimens of *Furina ornata*.

as supraoculars. Parietals much longer than frontal. Nasal widely separated from preocular, which is in contact with frontal (N 80) or narrowly separated from it (16) or fused to it (1). Postoculars 2. Temporals: primaries 2 (N 93) or 3 (5); secondaries 2 (N 91) or 3 (7); lower primary not reaching lip (N 95) or in broad contact with it (3). Upper labials 6 (N 95) or 7 (2); latter count due to division of fifth. Dorsal scale rows: 15 (N 45) or 17 (58) at midbody; 17-23 (N 87, mean 19.4) on neck; 13-17 (N 78, mean 15.0) just before vent. Ventrals 163-235 (N 52, mean 197.5). Subcaudals 40-65 (N 58, mean 52.8). Ventrals plus subcaudals 212-291 (N 49, mean 250.0).

Head blotch dark brown or blackish-brown, usually extending back to a little before end of parietals (sometimes a little past them in adults) and down to top of upper labials; occasionally broken by small whitish areas, especially in front of eyes. Occipital bar orange-red (whitish in alcohol), 1½-6 dorsal scales wide and usually extending a little on to parietals. Nuchal blotch same colour as head blotch, extending back furthest (2-9 dorsal scales) on midline. Back and tail whitish, buffy, pale brown or pale reddish-brown, each scale (except usually the first 1 or 2 rows nearest to ventrals) narrowly edged with dark brown or reddish-brown; with age, edges thickening and pigment invading remainder of each scale, at first only the longitudinal rows nearest to midline, finally back and sometimes sides entirely dark. With age, dark pigment of head and nuchal blotches invading occipital bar. Lower surfaces whitish, except occasionally for dark lateral edge to ventrals.

Distribution

Greater part of Western Australia, south in the interior to the central Wheat Belt and Eastern Goldfields (Fig. 2). Also Northern Territory and north Queensland.

Geographic Variation

Specimens from north Kimberley and far north of Northern Territory tend to be darker than those from further south. Ventral and subcaudal counts are highest in the Pilbara and Central Australian highlands (sums of 244-291 v. 212-262 elsewhere). Pilbara specimens are also notable for the dorsal scale rows usually increasing by 4-6 on neck (usually 2-4 elsewhere). Dorsal scale rows are fewest in the Eastern and South West Divisions of Western Australia, all 14 specimens having only 15 rows at midbody.

Material

Kimberley Division (W.A.): Kalumburu (28053, 34077); Mitchell Plateau (56255); Drysdale River National Park (15°16′S, 127°12′E) (50553); Wyndham (13329, 31519); Kimberley Research Station (12214-5, 13604-5, 22349-51, 22364-5); 23 km W of Kununurra (70024); Lake Argyle (52267, 70716); Koolan I. (67331); Lombadina (46417); Beagle Bay (22649); Moll Gorge (17°00′S, 125°59′E) (32289); Kimberley Downs (13878); Mt Anderson (32093); near Halls Creek (26637); McHugh Bore, Dampier Downs (54198); Lagrange (28051).

North West Division (W.A.): Muccan (10750); Mundabullangana (15089-90); Barrow I. (28695, 48954-5, 51633); Mardie (13421); Marble Bar (11338); Mt Edgar (15087-8, 36680); Woodie Woodie (67892); Nullagine (39081) and 5 km E (51720); Tambrey (6478); Millstream (22040); Vlaming Head (19672) and 16 km S (28052, 70715); Yardie Creek (13117); 8 km N of Learmonth (21350); Wittenoom (11843, 18489); Wittenoom Gorge (31368); Marandoo (51100, 52709, 56069); Paraburdoo (58933, 68160); Newman (23992, 29637); 10 km S of Mundiwindi (13879); Marloo (16 km NW of Wurarga) (3782); Yalgoo (4942).

Eastern Division (W.A.): Tobin Lake (63466); 12 km NNE of Well 29 (63949-51); Durba Spring (40354); Warburton Range (31357); 6 km NNW of Erlistoun (62872); Laverton (23912); Cundeelee (58714).

South West Division (W.A.): Bencubbin (31155); Mukinbudin (31998, 32037); Mangowine via Nungarin (7841); 7 km E of Merredin (25568).

Northern Territory: Yirrkala (13500*a-d*); Oenpelli (32449); Darwin, including Parap and Stuart Park (21977, 26222-3, 28412, 30950); Howard Springs (23628-9); Katherine (23891-2, 24941) and 35 km SW (47598); Jasper Gorge (60182); Kildurk (40992-3); Renner Springs (74070); Tennant Creek (21502) and 11 km E (21503); Palm Valley (20865).

ACKNOWLEDGEMENTS

I am grateful to Mr A.F. Stimson of the British Museum (Natural History) for the loan of the holotype of *Elaps ornatus* Gray (BMNH 1946.1.21.76), to Ms J. Covacevich (Queensland Museum) for the loan of the syntypes of *Denisonia bancrofti* DeVis (QM J195, 12881) and to Dr A.E. Greer for the loan of specimens of *Furina diadema* from the Sydney area.

REFERENCE

MACK, G. and GUNN, S.G. (1953). DeVis' types of Australian snakes. *Mem. Qd Mus.* 13: 58-70.

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TEN NEW *CTENOTUS* (LACERTILIA: SCINCIDAE) FROM AUSTRALIA

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ABSTRACT

Seven new species and three new subspecies of *Ctenotus* are described: *C. arnhemensis* from extreme north of Northern Territory, *C. eutaenius* from north-east Queensland, *C. essingtonii brevipes* from north Queensland, *C. capricorni* from central Queensland, *C. xenopleura* from the southern interior of Western Australia, *C. zebrilla* from north Queensland, *C. strauchii varius* from the eastern deserts, *C. allotropis* from south Queensland and northern New South Wales and *C. brooksi iridis* from south-eastern South Australia and western Victoria. *C. s. strauchii* is redescribed.

INTRODUCTION

Eight of the new taxa belong to five species-groups that have been described elsewhere (Storr *et al.*, in press):

1 *C. lesueurii* group. Size typically large; habit typically robust; digits not or only slightly compressed; subdigital lamellae bearing wide calli; second supraocular usually wider than first and much wider than third; supraciliaries very disparate in size (third or fourth to penultimate much smaller than others); ear lobules large and graded in size; colour pattern usually including a wide, black, white-edged vertebral stripe and a black upper lateral zone enclosing a series of pale spots. The *C. inornatus* subgroup is further characterized by having nasals normally separated, prefrontals normally in contact, nuchals mostly 2 or 3 (never more than 4), upper labials usually 8, and midbody scale rows 26-34 (mostly 28-32).

2 *C. essingtonii* group. Size small to medium; habit slender; digits compressed; subdigital lamellae bearing wide to moderately narrow calli; second supraocular usually wider than first and much wider than third; ear lobules absent, small or very disparate in size; dark vertebral stripe narrow or absent, seldom pale-edged; dark upper lateral zone usually unspotted.

3 *C. atlas* group. Size small to medium; habit moderately slender; digits compressed; subdigital lamellae with an obtuse keel or a narrow to moderately wide callus; supraoculars and supraciliaries not so disparate in size as in *lesueurii* and *essingtonii* groups; colour pattern consisting almost entirely of alternating dark and pale longitudinal stripes (upper lateral zone spotted in a few taxa). Formerly known as the *C. taeniolatus* group,

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but it is becoming increasingly doubtful whether *C. taeniolatus* is a member of it.

4 *C. colletti* group. Size very small; habit slender; snout long and narrow; toes compressed; subdigital lamellae with a fine sharp keel ending in a mucron or small spine; colour pattern consisting of alternating black and white longitudinal stripes.

5 *C. schomburgkii* group. Size very small; habit slender; subdigital lamellae with a fine sharp keel ending in a mucron or small spine; dark vertebral

Fig. 1: Map of Australia showing type localities of *Ctenotus arnhemensis* (1), *C. eutaenius* (2), *C. essingtonii brevipes* (3), *C. monticola* (4), *C. capricorni* (5), *C. xenopleura* (6), *C. zebrilla* (7), *C. strauchii strauchii* (8), *C. strauchii varius* (9), *C. allotropis* (10) and *C. brooksi iridis* (11).

stripe narrow or absent; usually a dark laterodorsal stripe enclosing (or interrupted by) pale spots, short dashes or transverse bars; dark upper lateral zone enclosing pale dots, spots or short dashes or interrupted by pale, squarish, window-like marks.

Two of the new species, *C. monticola* and *C. capricorni*, both from east Queensland, are more similar to each other than to other species of *Ctenotus*. They combine certain characteristics of the *lesueurii* and *leonhardii* groups. When more is known of the Queensland fauna it may prove feasible to describe a species-group for them.

A spot map (Fig. 10) is provided for the closely related *C. strauchii* and *C. allotropis*. The other species are known from too few localities to warrant separate maps, and I have contented myself (in Fig. 1) with locating their type-localities.

This paper is based on specimens in the Australian Museum (registered numbers prefixed with AM), Queensland Museum (QM), National Museum of Victoria (NMV), South Australian Museum (SAM) and Western Australian Museum (WAM).

SYSTEMATICS

Ctenotus arnhemensis sp. nov.

Fig. 2

Holotype

R88613 in Australian Museum, collected on 10 August 1979 by R. Sadlier at Jabiluka, Northern Territory, in 12°33′S, 132°55′E.

Paratypes

Northern Territory: Jabiluka (AM R88596, 88602, 88651-2, 88669, 88672, 88944, 88946); Island Billabong (12°33′S, 132°53′E) (AM R88937-40).

Diagnosis

A very small, strongly patterned member of the *Ctenotus lesueurii* group with seven upper labials and separated nasals and prefrontals.

Description

Snout-vent length (mm): 46-55 (N 13, mean 51.0). Length of appendages (% SVL): foreleg 24-29 (N 13, mean 25.4), hindleg 40-48 (N 13, mean 43.0), tail 191-237 (N 6, mean 207.0).

Nasals separated (N 13). Prefrontals separated (N 13). Supraoculars 4, first 3 in contact with frontal, second much wider than first and third. Supraciliaries 9-10, third (occasionally fourth) to penultimate much smaller than others. Upper ciliaries 10-14 (N 13, mean 11.5). Second loreal 1.1-1.6 times as wide as high (N 13, mean 1.27). Presuboculars 2. Upper labials 7 (N 13). Ear lobules 5-7 (N 13, mean 5.5), mostly subacute, third from top usually largest. Nuchals 3-5 (N 12, mean 3.6). Midbody scale rows 23-27 (N 13, mean 24.8). Toes slightly compressed; 20-23 (N 13, mean 21.4) lamellae under fourth, each with a moderately wide callus.

Dorsal ground colour brown, palest on tail. Moderately wide, black, white-edged vertebral stripe from nape to base of tail. Narrow black latero-dorsal stripe from orbit to tail, on which it becomes brown. White dorso-lateral stripe from orbit to tail, on which it becomes brownish-white. Black upper lateral zone from orbit to level of hindleg, enclosing a series of white spots; represented on tail by a brown stripe. White midlateral stripe from ear aperture to tail; represented anteriorly by 2 white spots on temple and by a white line curving beneath eye up on to lore. Limbs brownish-white longitudinally streaked with blackish-brown.

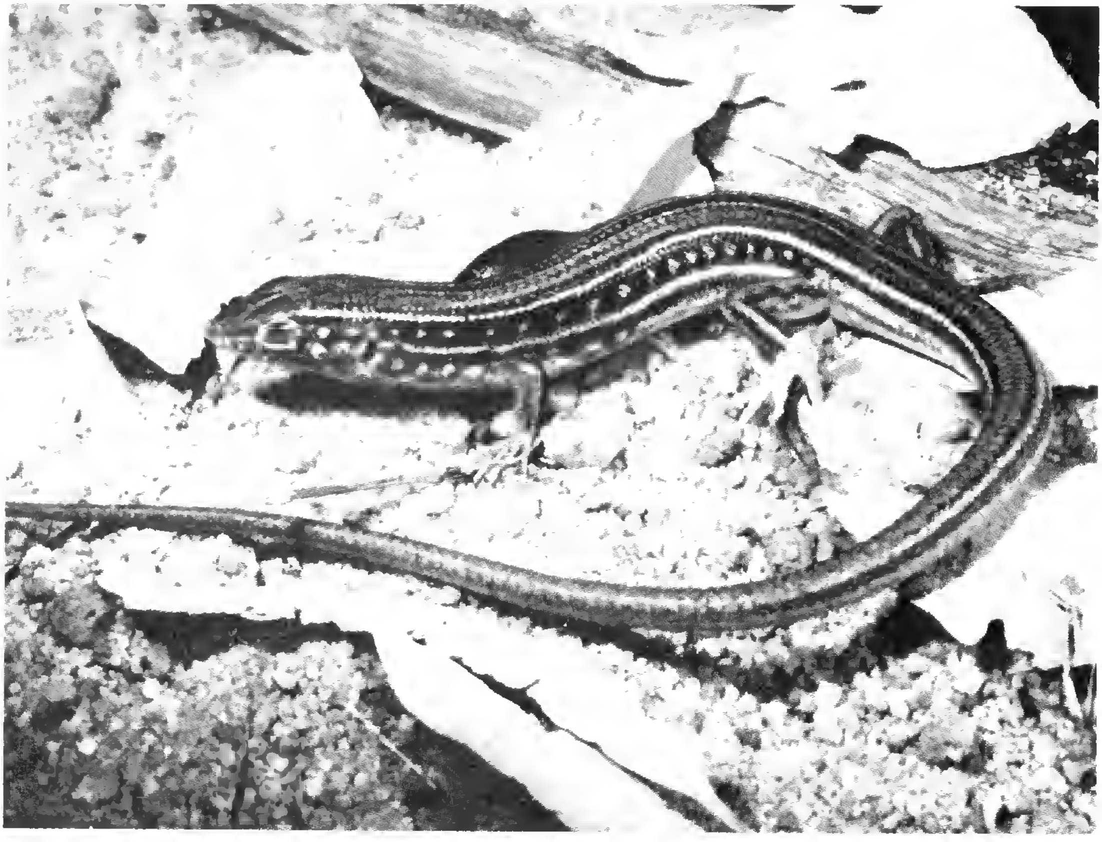

Fig. 2: A *Ctenotus arnhemensis* from Jabiluka, N.T., photographed in life by R.W.G. Jenkins.

Distribution

Only known from one small area in Arnhem Land (far north of Northern Territory).

Ctenotus eutaenius sp. nov.

Fig. 3

Holotype

R93408 in Australian Museum, collected on 30 July 1977 by A.E. and P. Greer at Charters Towers, Queensland, in 20°05′S, 146°16′E.

Paratype

Queensland: Picnic Bay, Magnetic I. (AM R93407).

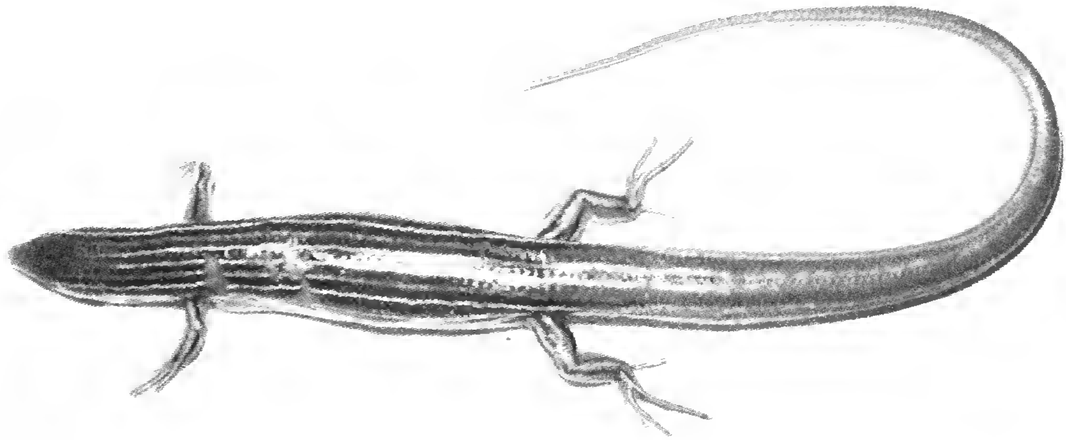

Fig. 3: Holotype of *Ctenotus eutaenius.*

Diagnosis

A member of the *C. lesueurii* group, *inornatus* subgroup, differing from all others by back and sides black with 10 white stripes. Similar in coloration to members of the *atlas* and *colletti* groups, but distinguishable by wide subdigital calli and large second supraocular.

Description (based on holotype and paratype)

Snout-vent length (mm): 82, 46.5. Length of appendages (% SVL): foreleg 24, 28; hindleg 40, 51; tail 221, 209.

Nasals separated or just touching. Prefrontals forming a short or long suture. Supraoculars 4, first 3 in contact with frontal, second much wider than first and third. Supraciliaries 9, fourth to penultimate much smaller than others. Upper ciliaries 10-12. Second loreal 1.2-1.5 times as wide as high. Presuboculars 2. Upper labials 8. Ear lobules 4 or 5; obtuse in juvenile, subacute in adult; second or third largest. Nuchals 2 or 3. Midbody scale rows 30. Toes not compressed; 20-22 lamellae under fourth, each with a wide callus.

Back and sides black with 5 white stripes on each side: a narrow paravertebral from nape to tail (on which it becomes buffy-brown), a narrow dorsal from nape to rump, a narrow dorsolateral from last supraocular to tail (on which it is brownish-white), a narrow upper lateral from temple to tail (on which it is wider and buffy-brown), and a wide midlateral from below eye to tail (on which it is brownish-white). Also some indication anteriorly of a wide white lower lateral stripe.

Distribution

North-east Queensland.

Derivation of Name

Greek for 'well-striped'.

Ctenotus essingtonii brevipes subsp. nov.

Fig. 4

Holotype

R63611 in Australian Museum, collected on 24 June 1977 by A.E. and P. Greer at Venture Creek, 62 km E of Croydon, Queensland, in 18°13′S, 142°49′E.

Paratypes

Queensland: Coen (AM R16529); Strathgordon (NMV D13169); 16 km N of Edward River HS (AM R27285); Hann River, Kennedy Road (AM R26904); Wrotham Park (WAM R55858); Muldiva, W of Chillagoe (AM R70939); Tate River, near Ootann (AM R54642); 47 km WNW of Croydon (WAM R55850); Croydon (AM R63334-6); Venture Creek (AM R63610); Rifle Creek, 28 km S of Mt Isa (WAM R58266-7).

Fig. 4: Holotype of *Ctenotus essingtonii brevipes.*

Diagnosis

A member of the *C. essingtonii* group, distinguishable from *C. e. essingtonii* (Gray, 1842) by having little or no indication of ear lobules; it is also slightly smaller and has shorter appendages, fewer midbody scale rows and fewer subdigital lamellae.

Distribution

Semi-arid and arid north Queensland (Gulf of Carpentaria and Princess Charlotte Bay drainages) from Coen south-west to Mt Isa.

Description

Snout-vent length (mm): 43-52 (N 14, mean 48.0). Length of appendages (% SVL): foreleg 21-26 (N 14, mean 22.7), hindleg 36-44 (N 14, mean 39.8), tail 193-211 (N 8, mean 201.4).

Nasals usually narrowly separated, occasionally in short contact. Prefrontals separated (usually widely, occasionally narrowly). Supraoculars 4, first 3 in contact with frontal; second much wider than first and third. Supraciliaries 7-10 (mostly 8, N 13, mean 8.2), third to penultimate much smaller than others. Upper ciliaries 7-11 (N 15, mean 8.5). Second loreal 1.3-1.9 (N 14, mean 1.65) times as wide as high. Presuboculars 2. Upper labials 7 (N 13) or 6 (1). Ear lobules absent, unless a small slat-like preauricular scale partly covering upper anterior sector of aperture is construed as a lobule. Nuchals 3-5 (N 15, mean 3.7). Midbody scale rows 21-26 (N 15, mean 24.7). Toes slightly compressed; 17-21 (N 15, mean 18.8) lamellae under fourth, each with a narrow to moderately wide callus.

Upper surface brown, tinged with olive on head, red on tail and sometimes yellow on back. Usually no dorsal pattern, but one specimen (27285) has a white-edged, narrow, blackish-brown vertebral stripe on nape. Narrow but conspicuous white dorsolateral stripe from orbit to tail (on which it is suffused with reddish-brown), edged above by narrow, sharply defined, blackish-brown laterodorsal stripe. Blackish-brown upper lateral zone, continuing forward through orbit as a loreal stripe to nasal, and back on to tail (on which it becomes reddish-brown with dark edges). White midlateral stripe extending forward above ear aperture and below eye to bottom of first loreal, and back on to tail, where it is suffused with pink. Blackish-brown lower lateral stripe extending forward to lips. Some indication of a dark brown ventrolateral stripe in front of and behind arm. Lips pale brown, longitudinally striped with dark brown.

Remarks

For description of *Ctenotus e. essingtonii* see Storr (1970: 104).

Derivation of Name

Latin for 'short-footed'.

Ctenotus monticola sp. nov.

Fig. 5

Holotype

R70937 in Australian Museum, collected on 16 June 1976 by A.E. and P. Greer at 11 km W of Mareeba, Queensland, in 17°02'S, 145°20'E.

Paratypes

Queensland: 11 km W of Mareeba (AM R70936, 70938); Herberton (AM R63863-4).

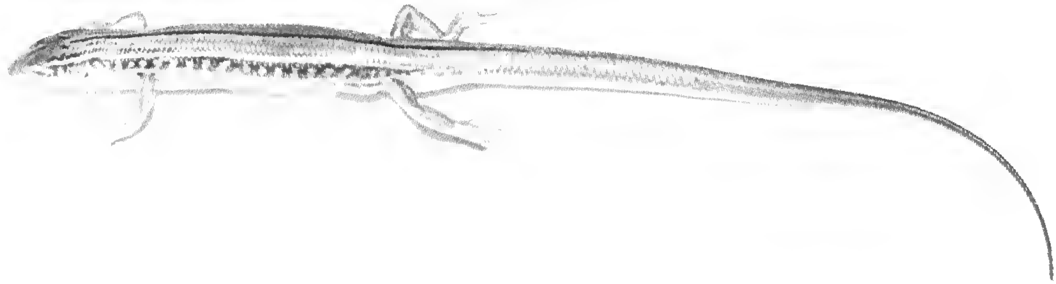

Fig. 5: Holotype of *Ctenotus monticola.*

Diagnosis

A moderately small *Ctenotus* with coloration as in *C. leonhardii* group, e.g. vertebral stripe narrow and upper lateral zone enclosing rows of pale dots, but having only 7 upper labials, shorter limbs, and fewer and more widely callose subdigital lamellae.

Description

Snout-vent length (mm): 52-61 (N 5, mean 56.4). Length of appendages (% SVL): foreleg 22-25 (N 5, mean 23.2), hindleg 39-45 (N 5, mean 42.8), tail 211-220 (N 2).

Nasals separated (usually narrowly). Prefrontals separated. Supraoculars 4, first 3 in contact with frontal. Supraciliaries 7 or 8 (N 5, mean 7.8), fourth to penultimate considerably smaller than others. Upper ciliaries 9-11 (N 5, mean 9.6). Second loreal 1.2-1.6 (N 5, mean 1.36) times as wide as high. Presuboculars 2 (3 on one side of one specimen). Upper labials 7. Ear lobules 2-4 (N 5, mean 2.4) obtuse or subacute, first usually largest. Nuchals 3-5 (N 5, mean 4.3). Midbody scale rows 24-28 (N 5, mean 25.6). Toes compressed; 17-19 lamellae (N 5, mean 17.9) under fourth, each with a narrow to moderately wide callus.

Upper surface brownish, tinged with olive on back and red on tail. Narrow blackish vertebral stripe from nape to proximal fifth of tail, narrowly and indistinctly edged with white. Occasionally some indication of a narrow dark dorsal stripe. Narrow white dorsolateral stripe from orbit to level of vent, narrowly to moderately widely edged above with blackish (laterodorsal stripe). Blackish or dark brown upper lateral zone enclosing 1-3 longitudinal series of brownish-white dots which tend to align vertically. Narrow white midlateral stripe from below eye to level of vent. Lower lateral zone dark brown irregularly spotted with brownish-white. Upper lips barred with dark brown.

Distribution

Subhumid highlands of north-east Queensland.

Derivation of Name

Latin for 'inhabiting highlands'.

Ctenotus capricorni sp. nov.

Fig. 6

Holotype

R65946 in Australian Museum, collected on 28 November 1976 by R. Wells and D. Metcalfe at 33 km W of Jericho, Queensland, in 23°34'S, 145°48'E.

Paratype

Queensland: 33 km W of Jericho (AM R65945).

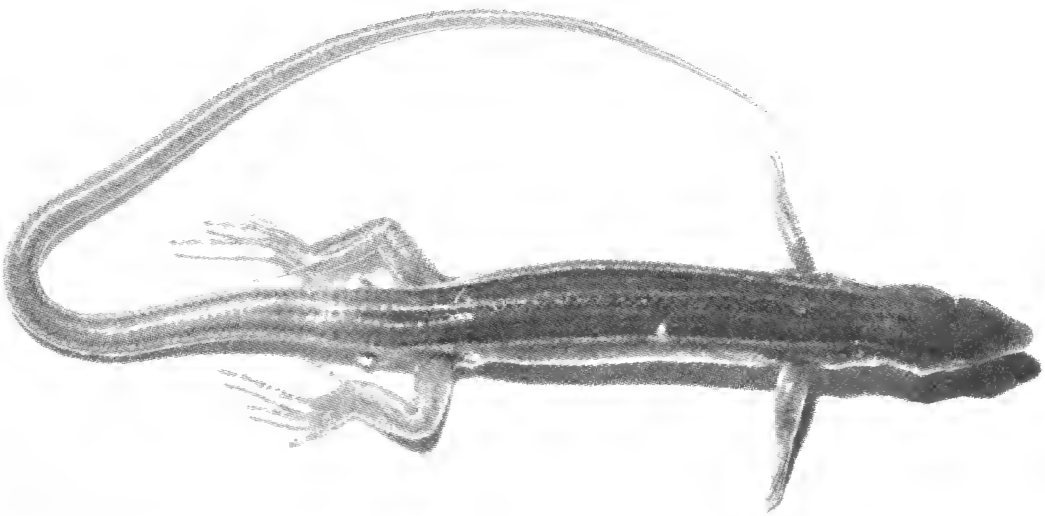

Fig. 6: Holotype of *Ctenotus capricorni*.

Diagnosis

A moderately small *Ctenotus* with coloration as in *C. leonhardii* group, e.g. vertebral stripe narrow or absent and upper lateral zone enclosing rows of pale dots, but with wide subdigital calli and wide second supraocular as in *C. lesueurii* group. Further distinguishable from *C. monticola* by more numerous midbody scale rows, subdigital lamellae and ear lobules but fewer nuchals.

Description (based on holotype and paratype)

Snout-vent length (mm): 58.5, 53. Length of appendages (% SVL): foreleg 25, 28; hindleg 43, 38; tail 215, 202.

Nasals very narrowly separated. Prefrontals in short contact or very narrowly separated. Supraoculars 4, first 3 in contact with frontal, second wider than first and third. Supraciliaries 6-9. Upper ciliaries 11-12. Second loreal 1.2-1.8 times as wide as high. Presuboculars 2. Upper labials 8. Ear lobules 4 or 5, second or third largest, subacute or obtuse. Nuchals 2 or 3. Midbody scale rows 30 or 32. Lamellae under fourth toe 21-23, each with a moderately wide callus.

Head olive-brown. Tail buffy-brown. Back brown with narrow blackish vertebral stripe from nape to base of tail, edged with pale brown or brownish-white. Narrow, indistinct, pale brown dorsal stripe. Narrow blackish laterodorsal stripe from nape to base of tail. Narrow white dorsolateral stripe from above temple to tail (on which it becomes wider and buffy). Brown upper lateral zone enclosing a series of white dots and short dashes (2 series in front of foreleg). White midlateral stripe well developed posteriorly but disappearing at or behind foreleg. Lower lateral zone pale greyish-brown.

Distribution

Central Queensland.

Remarks

Three specimens from Yeppoon (AM R16662, 16664, 16681) are similar in size, proportions and scutellation to *C. capricorni* but, differing considerably in coloration, are tentatively excluded from that species. They are described as follows.

Snout-vent length (mm): 51-59. Length of appendages (% SVL): foreleg 25-27, hindleg 48-49, tail 202.

Nasals very narrowly to moderately separated. Prefrontals in contact or very narrowly separated. Supraoculars 4, first 3 in contact with frontal, second wider than first and third. Supraciliaries 8-10, fourth to penultimate much smaller than others. Upper ciliaries 9-11. Second loreal 1.2-1.7 times as wide as high. Presuboculars 2. Upper labials 7 or 8. Ear lobules 4-6, obtuse or subacute. Nuchals 3. Midbody scale rows 30 or 32. Lamellae under fourth toe 21-23, each with a moderately wide callus.

Upper surface greyish-brown, tinged reddish on tail. With or without a narrow, faintly pale-edged, dark vertebral stripe. Narrow white dorsolateral stripe sometimes broken into short dashes, extending back to proximal third of tail, with or without a narrow brown edge above (laterodorsal stripe). Blackish or dark brown upper lateral zone enclosing 2 series of white dots. With or without a narrow white midlateral stripe from ear aperture to proximal third of tail, represented anteriorly by a curving white line under eye. Lower lateral zone greyish-brown with or without variegations.

Derivation of Name

Latin for 'of Capricorn', in allusion to its known range being close to that Tropic.

Ctenotus xenopleura sp. nov.

Fig. 7

Holotype

R72212 in Western Australian Museum, pit-trapped by R.A. How *et al.* on 23 April 1980 at 15 km NE of Bungalbin Hill, Western Australia, in 30°17'S, 119°44'E.

Paratypes

Eastern Division (W.A.): 15 km NE of Bungalbin Hill (WAM R67097, 67104-5, 67116, 67118, 67140, 67143, 72123-4, 72139, 72149-50, 72181-2, 72198-9, 72205-9).

Eucla Division (W.A.): McDermid Rock (32°01'S, 120°44'E) (WAM R65290, 65304, 66153).

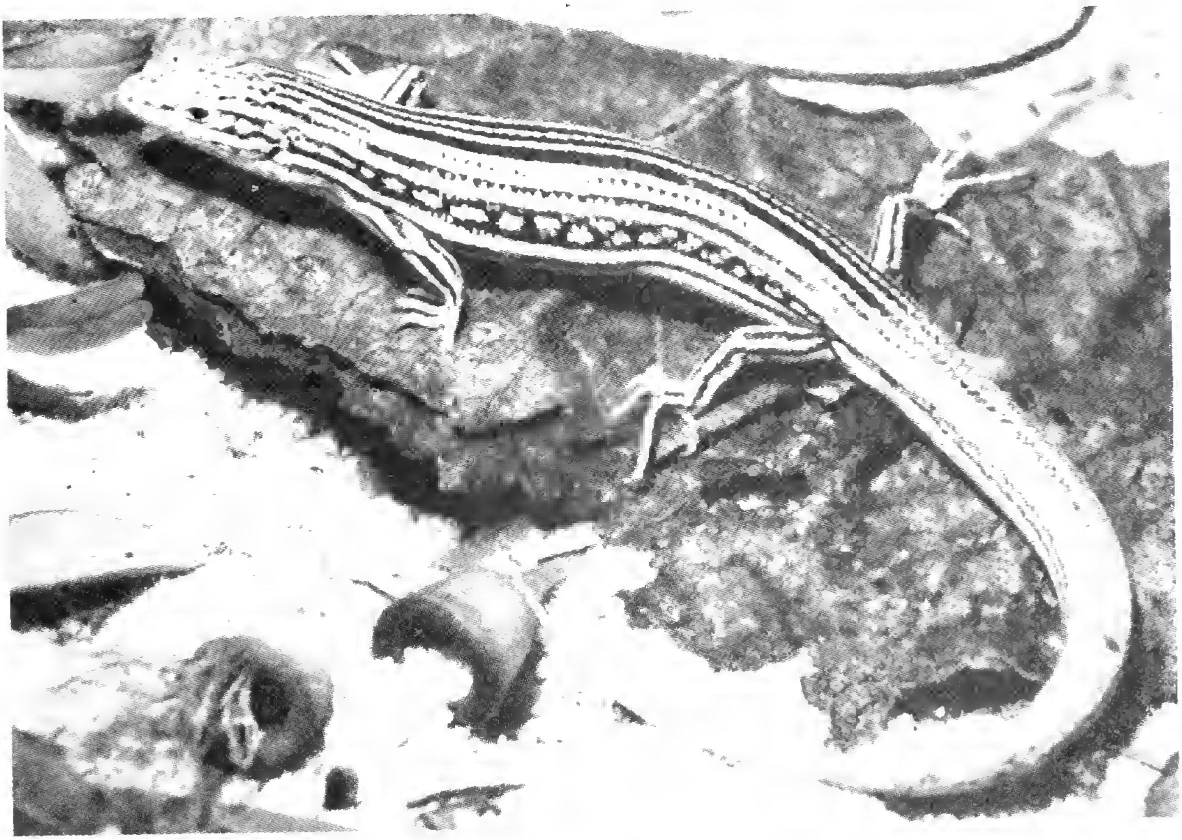

Fig. 7: Holotype of *Ctenotus xenopleura*, photographed in life by R.E. Johnstone.

Diagnosis

A small member of the *C. atlas* group with 10 pale stripes on a black ground and upper lateral zone spotted. Most like *C. alacer* Storr of east Kimberley and Central Australia, but smaller and having fewer upper labials, midbody scale rows and subdigital lamellae.

Description

Snout-vent length (mm): 27-49 (N 24, mean 38.4). Length of appendages (% SVL): foreleg 26-33 (N 24, mean 29.6), hindleg 43-51 (N 24, mean 45.8), tail 145-195 (N 12, mean 171.8).

Nasals separated (usually narrowly). Prefrontals narrowly separated or in contact (usually short). Supraoculars 4, first 3 in contact with frontal. Supraciliaries 6 (N 1) or 7 (23), fourth to penultimate considerably smaller than others. Upper ciliaries 7-11 (N 23, mean 8.7). Second loreal 1.1-1.8 times as wide as high (N 22, mean 1.50). Presuboculars 1 (N 2) or 2 (22). Upper labials 6 8 (7 except in 2 specimens). Ear lobules 2-6 (N 23, mean 4.6), obtuse or subacute. Nuchals 2-4 (N 22, mean 2.9). Midbody scale rows 26-30 (N 24, mean 27.6). Lamellae under fourth toe 20-26 (N 24, mean 22.9), each with a weak obtuse keel.

Head pale brown, pale olive or brownish-white, spotted (sparsely towards snout) with blackish-brown; narrow black stripe through lore. Back and sides black, marked with white (pale coppery in life) as follows: on each side a narrow paravertebral, dorsal and dorsolateral stripe, 1 (occasionally 2) upper lateral series of small, usually elongate spots, a wide midlateral (which passes over top of ear aperture) and ventrolateral stripe; white stripes suffused with brown on nape and foreback. Tail brownish-white (pale coppery in life) with some indication (especially anteriorly) of dark hollow vertebral, laterodorsal and upper lateral stripes. Upper surface of limbs brownish-white (pale coppery-brown in life) with 3 black stripes.

Distribution

Only known from 2 localities in the semi-arid southern interior of Western Australia. At both localities it was confined to patches of sandy soil with low shrubs over *Triodia*.

Derivation of Name

Greek for 'strange-sided', in allusion to the pale upper lateral spots, rare in the *C. atlas* group.

Ctenotus zebrilla sp. nov.

Fig. 8

Holotype

R63316 in Australian Museum, collected on 24 June 1977 by A.E. and P. Greer at Venture Creek, 62 km E of Croydon, Queensland, in 18°13′S, 142°49′E.

Paratypes

Queensland: Lappa (AM R16478, 16672).

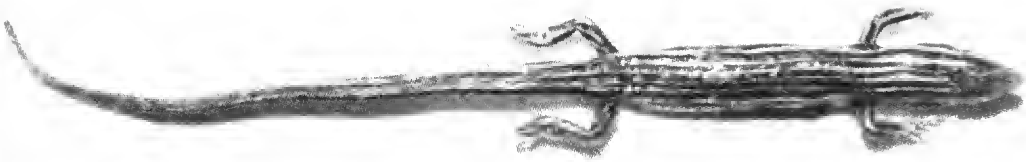

Fig. 8: Holotype of *Ctenotus zebrilla.*

Diagnosis

A member of the *C. colletti* group with 8 white stripes on a black ground. Agreeing with *C. striaticeps* Storr of north-west Queensland in having widely separated prefrontals but differing in failure of paravertebral stripe to extend on to head, presence of dorsal stripe, absence of ventrolateral stripe, fewer subdigital lamellae, and more numerous but smaller ear lobules.

Description

Snout-vent length (mm): 31-40 (N 3, mean 36.3). Length of appendages (% SVL): foreleg 25-28 (N 3, mean 27.0), hindleg 42-47 (N 3, mean 45.0), tail 177 (N 1). Nasals in moderately long contact. Prefrontals very widely separated. Supraoculars 4, first 3 in contact with frontal. Supraciliaries 7, fourth to penultimate considerably smaller than others. Upper ciliaries 8 or 9. Second loreal 1.3-1.4 times as wide as high. Presuboculars 2. Upper labials 6 or 7. Ear lobules 3-7 (N 3, mean 5.3), first never largest; obtuse in smallest specimen, subacute in others. Nuchals 3 or 4. Midbody scale rows 29 or 30. Toes compressed; 17-21 (N 3, mean 19.2) lamellae under fourth, each with a fine dark mucronate keel.

Upper and lateral surfaces black with 4 white stripes on each side: a narrow paravertebral, a narrow dorsal, a narrow dorsolateral from first supraocular nearly to end of tail, and a midlateral extending forward to first labial after bending above ear aperture.

Distribution

Southern interior of Cape York Peninsula, north Queensland.

Derivation of Name

Neo-Latin for 'little zebra', in allusion to its black and white stripes.

Ctenotus strauchii strauchii (Boulenger, 1887)

Fig. 10

Lygosoma strauchii Boulenger, 1887, Catalogue of the lizards in the British Museum (Natural History), 3: 229. Gayndah, Queensland (Godeffroy Museum).

Diagnosis

A sharply patterned member of the *C. schomburgkii* group with nasals in contact, prefrontals widely separated, second supraocular usually narrower than third, ear lobules very small, and subdigital keels fine and mucronate.

Description

Snout-vent length (mm): 30-52 (N 19, mean 41.8). Length of appendages (% SVL): foreleg 22-29 (N 18, mean 25.8), hindleg 33-48 (N 18, mean 40.4), tail 135-187 (N 7, mean 159.0).

Nasals in short to moderately long contact. Prefrontals widely to very widely separated. Supraoculars 4, first 3 in contact with frontal; second narrower than third (N 13) or about as wide (3) or slightly wider (2). Supraciliaries 6 (N 2) or 7 (16), fourth to penultimate usually much smaller than others. Upper ciliaries 9 or 10 (N 15, mean 9.5). Second loreal 1.2-1.8 times as wide as high (N 17, mean 1.47). Presuboculars 2. Upper labials 7 (N 16) or 8 (3). Ear lobules 2-5 (N 18, mean 3.2), obtuse, very small. Nuchals 3-5 (N 17, mean 3.5). Midbody scale rows 26-32 (N 18, mean 28.5). Lamellae under fourth toe 14-22 (N 18, mean 18.1), each with a fine, mucronate, greyish-brown keel.

Head dark olive-brown (paler in far west of range) and tail pale brown. Back brown with or without a narrow, black, pale-edged vertebral stripe from nape to base of tail. Narrow or wide black laterodorsal stripe from above eye to base of tail, enclosing a series of pale spots, dots or short dashes. Narrow white dorsolateral stripe from above eye to tail (on which it becomes wider and suffused with brown; except in AM R62861 where it is replaced by a series of short white oblique dashes). Black upper lateral zone from orbit to base of tail, enclosing a series of small whitish spots or 1-3 series of whitish dots that tend to align vertically; represented on tail and sometimes on lore by a dark brown stripe. White midlateral stripe from bottom of loreals to base of tail, branches encircling ear aperture. Narrow black or greyish-brown lower lateral zone, sometimes enclosing small irregular white spots; represented on upper and lower lips by a dark stripe. Upper surface of limbs pale brown, streaked or mottled with black. Plantar scales wholly white.

Distribution

Subhumid, semi-arid and arid zones of eastern and mid-western Queensland, west to about long. 144°E (where it begins to intergrade with *C. s. varius*); and arid and semi-arid northern interior of New South Wales, south to about lat. 31°S and west to the Barrier Range (where it again begins to intergrade with *C. s. varius*) (see Fig. 10).

Geographic Variation

In the north-east of its range, i.e. Queensland east of the Great Dividing Range, there is usually no vertebral stripe, the black laterodorsal stripe is very wide, and the appendages are considerably longer and the subdigital lamellae more numerous than in the south and west. When more material is available from Queensland it may prove desirable to recognise an additional subspecies in eastern Australia. Another consequence of this geographic variation is discussed under *C. allotropis*.

Material

Queensland: north Queensland (NMV D2035); Charters Towers (WAM R21467-9) and 35 km SSW (AM R63106); Telemon, 50 km WNW of Hughenden (QM J5818); 80 km NNW of Muttaburra (AM R62861); 48 km NNW of Marlborough (QM J24922); Arcadia Valley, 66 km NNE of Injune (QM J30814); road west of Charleville (AM R57597); Dynevor Downs (AM R59260-2).

New South Wales: 30 km WSW of Brewarrina (AM R47387-8, 68296); Quambone (AM R64907); Darling River between Bourke and Wilcannia (AM R6467); Fowlers Gap, 110 km N of Broken Hill (AM R52929).

Ctenotus strauchii varius subsp. nov.

Figs 9 and 10

Holotype

R49507 in Australian Museum, collected on 14 October 1975 by H.G. Cogger and P. Webber at Charlotte Waters, Northern Territory, in 25°54′S, 134°56′E.

Paratypes

For details of 29 specimens from Queensland, Northern Territory, South Australia and New South Wales, see Material.

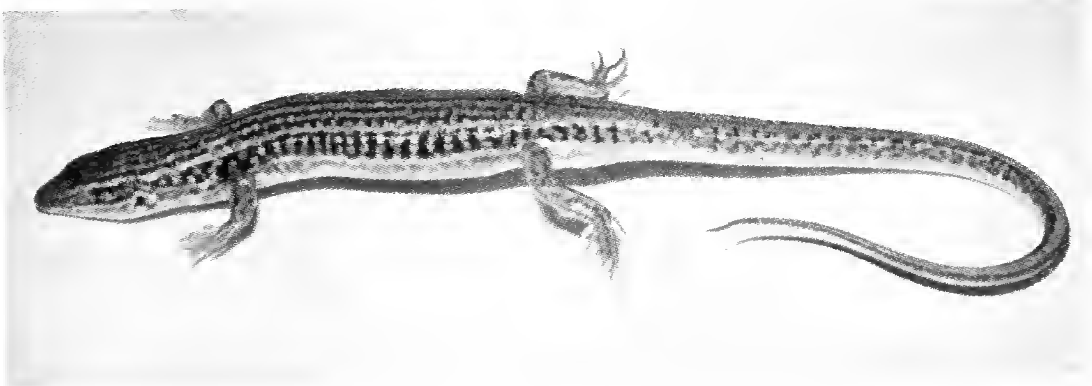

Fig. 9: Holotype of *Ctenotus strauchii varius*.

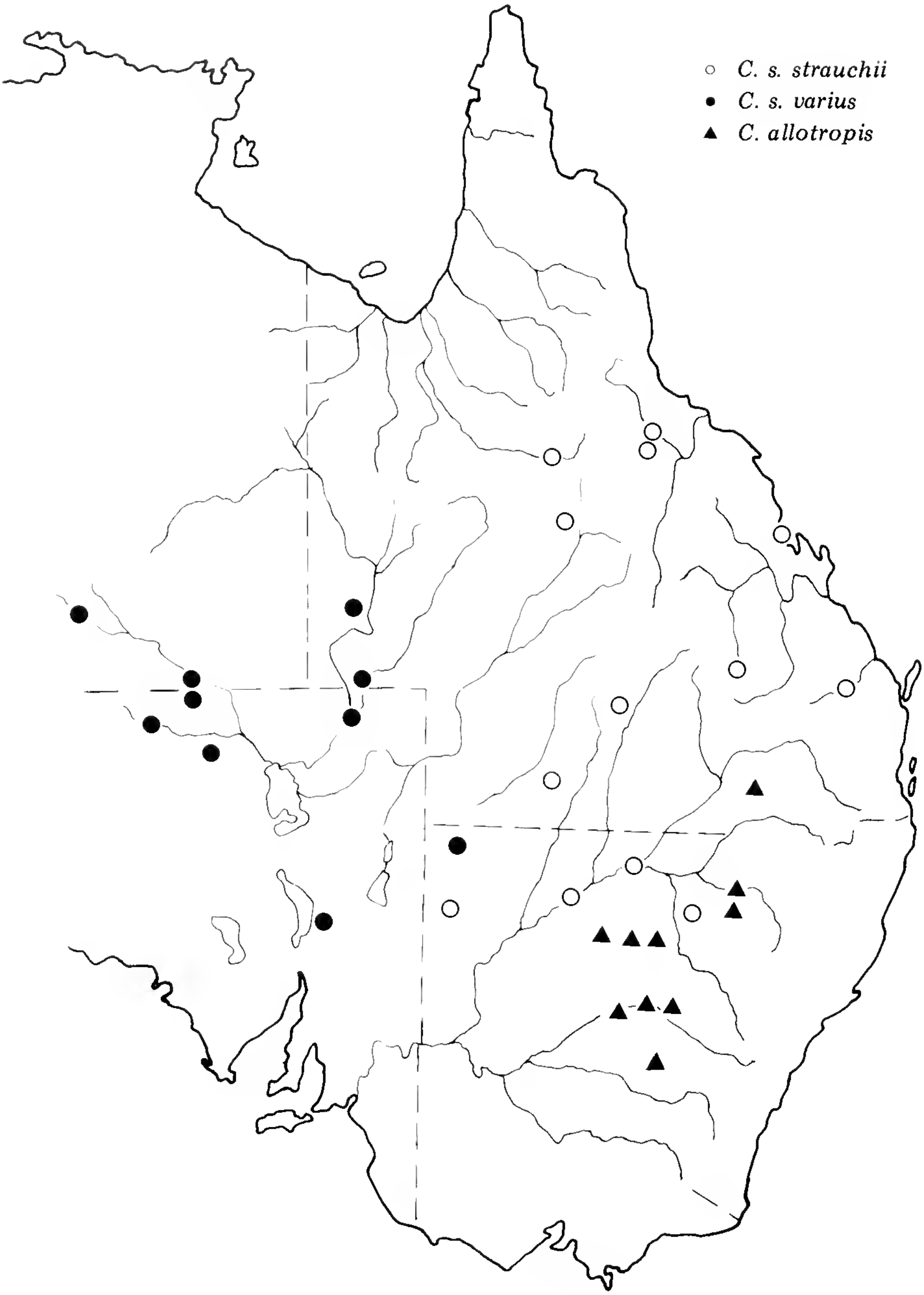

Fig. 10: Map of eastern Australia showing locality of specimens of *Ctenotus strauchii strauchii*, *C. strauchii varius* and *C. allotropis*.

Diagnosis

Distinguished from *C. s. strauchii* and *C. allotropis* by its pale coloration, diffuse colour pattern, more numerous presuboculars and upper labials, supraciliaries decreasing gradually in size from first to penultimate, and ear lobules more disparate in size. Further distinguishable from *C. allotropis* by its sharply keeled subdigital lamellae.

Description

Snout-vent length (mm): 33-56 (N 30, mean 46.7). Length of appendages (% SVL): foreleg 21-29 (N 29, mean 24.4), hindleg 32-42 (N 29, mean 36.8), tail 126-173 (N 15, mean 148.4).

Nasals in short to moderately long contact (N 31) or narrowly separated (1). Prefrontals moderately to widely separated. Supraoculars 4 with first 3 in contact with frontal (N 29) or 5 with first 4 in contact with frontal (2), second usually much narrower than first. Supraciliaries 6-9 (seldom more than 7, N 30, mean 6.6). Upper ciliaries 8-13 (N 28, mean 9.4). Second loreal 1.1-1.9 times as wide as high (N 30, mean 1.60). Presuboculars usually 3 (with second small and wedged in between top of first and top of third), occasionally 2, rarely 1. Upper labials 7-9 (N 30, mean 8.0). Ear lobules 2-4 (N 30, mean 2.8), short, obtuse or subacute, first or second much larger than others. Nuchals 1-5 (N 29, mean 3.2). Midbody scale rows 25-32 (N 29, mean 28.4). Lamellae under fourth toe 16-21 (N 30, mean 18.1), each with a fine mucronate keel.

Ground colour of head and back pale olive-grey, pale reddish-brown or pale buffy-brown, of tail pale reddish-brown. Black dorsal markings highly variable: occasionally a narrow vertebral stripe and on each side a narrow dorsal stripe; usually a laterodorsal series of irregular spots or short transverse bars. White dorsolateral stripe from above lore or eye to base of tail, usually narrow and continuous. Upper lateral zone black, occasionally enclosing 1-3 series of small pale spots, but usually broken up into a series of narrowly vertical bars or approximately rectangular blotches, alternating with bars of dorsal ground colour similar in size and shape to black bars; represented on lore by narrow black stripe, and on tail by a series of squarish brown spots. Narrow white midlateral stripe. Narrow grey lower lateral zone usually present.

Distribution

Arid eastern interior of Australia: far western Queensland, south-eastern Northern Territory, north-eastern South Australia and far north-western New South Wales (see Fig. 10).

Material

Queensland: Sandringham, 54 km NW of Bedourie (AM R93006-7, 93010); Birdsville (QM J9743).

Northern Territory: Tempe Downs (NMV D280); Charlotte Waters (NMV D946; AM R49731, 70933-4); Central Australia (AM R2094); '39 km N of Neale Junction, W.A.' (AM R49741).

South Australia: 15 km S of Charlotte Waters (AM R70935); Lambina (NTM 1548); Oodnadatta (AM R60023-4); 16 km N of Clifton Hills (SAM R10345); Mern Merna (SAM R2611, 2646, 10018-23).

New South Wales: Milparinka (SAM R9930, 10042-3; AM R42714-5).

Ctenotus allotropis sp. nov.
Figs 10 and 11

Holotype

R27832 in Australian Museum, collected in August 1967 by H.G. Cogger in the Round Hill Fauna Reserve, near Euabalong, New South Wales.

Paratypes

Queensland: Moombah, 70 km E of St George (QM J34770).

New South Wales: 32 km SW of Wee Waa (AM R69621); Pilliga East State Forest (AM R69620); Nyngan (AM R58700-1); 13 km E of Hermidale (AM R17164) and 11 km W (AM R45877); Cobar (AM R58702-3); Round Hill Fauna Reserve (AM R26986, 27829, 27910, 30413, 45569-73, 57905, 92294); Condobolin (QM J31847-8); 3 km N of Bogan Gate (AM R59263); Ingalba Nature Reserve, Temora (AM R85252).

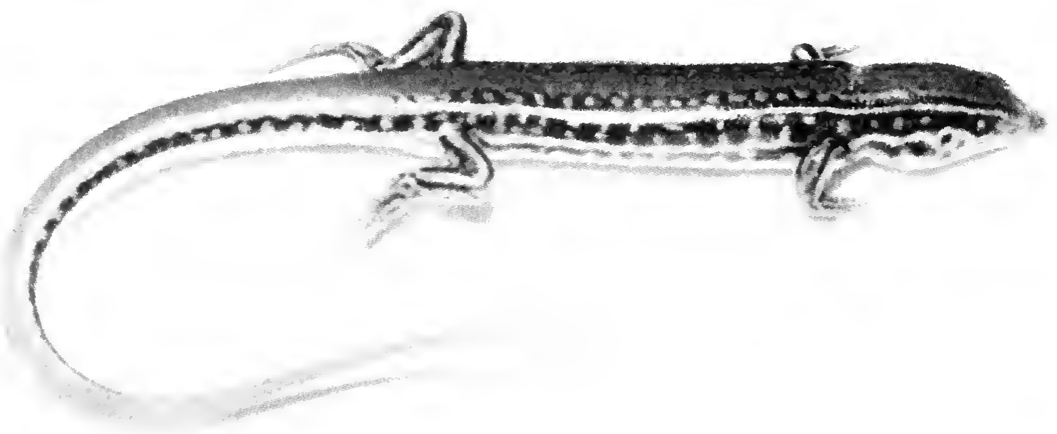

Fig. 11: Holotype of *Ctenotus allotropis.*

Diagnosis

A sharply patterned member of the *C. schomburgkii* group with nasals in contact and prefrontals widely separated, distinguishable from all other members of the group by the blackish, relatively wide keels of the proximal subdigital lamellae. Further distinguishable from *C. s. strauchii* by second supraocular not narrower than third. For other differences between *C. allotropis* and sympatric *C. s. strauchii*, see under Remarks.

Description

Snout-vent length (mm): 29-54 (N 25, mean 43.9). Length of appendages (% SVL): foreleg 22-29 (N 25, mean 25.6), hindleg 40-49 (N 25, mean 44.7), tail 130-182 (N 14, mean 161.9).

Nasals in very short to moderately long contact. Prefrontals widely to very widely separated. Supraoculars 4, first 3 in contact with frontal; second as wide as third (N 3) or wider (22). Supraciliaries 6 (N 5) or 7 (19), fourth to penultimate much smaller than others. Upper ciliaries 7-10 (N 21, mean 9.0). Second loreal 1.3-2.1 times as wide as high (N 24, mean 1.76). Presuboculars 2. Upper labials 7 (N 22) or 8 (2). Ear lobules 3-6 (N 24, mean 3.5), obtuse or subacute, small. Nuchals 3 or 4 (N 24, mean 3.7). Midbody scale rows 26-32 (N 25, mean 28.2). Lamellae under fourth toe 17-22 (N 24, mean 19.6), each with a blackish-brown keel (proximal keels obtuse, distal keels fine and mucronate).

Dorsally brown, paler and more reddish on tail. Black laterodorsal stripe from orbit to base of tail, enclosing a series of pale reddish-brown or brownish-white spots. Narrow white dorsolateral stripe from orbit to base of tail; on tail wider and pale reddish-brown. Upper lateral zone black, enclosing 2 or 3 series of pale reddish-brown or brownish-white dots that tend to align vertically; represented anteriorly by black loreal stripe, and on tail by black stripe enclosing a series of small brownish-white spots or broken by a series of irregular white vertical bars. Upper surface of limbs pale brown, streaked with blackish-brown. Apices of larger (outer) plantar scales blackish-brown.

Distribution

Semi-arid lowlands of southern Queensland and northern New South Wales, west of the Great Dividing Range and between lat. 28° and 34° 30'S (see **Fig. 10**).

Remarks

This species is very similar to *C. s. strauchii* and not easily distinguished from it except by the nature and colour of the subdigital keels and plantar scales. However, in the zone of overlap they are more different than one would suppose after comparing their descriptions. Within the range of *C. allotropis*, *C. s. strauchii* has a vertebral stripe, much shorter appendages (e.g. hindleg 35-43% of SVL, N 4, mean 37.0), and less numerous lamellae under fourth toe (14-17, N 4, mean 16.0).

Derivation of Name

From Greek *allos* (different or strange) and *tropis* (keel), in allusion to the obtuse keels of the proximal subdigital lamellae, unique in the *C. schomburgkii* group.

Ctenotus brooksi iridis subsp. nov.

Fig. 12

Holotype

D53837 in National Museum of Victoria, pit-trapped by A.J. Coventry and D. Ashwell on 18 February 1980 at 6.6 km ENE of Chinaman Well, Victoria, in 35°52'S, 141°43'E.

Paratypes

For details of 59 specimens from South Australia and Victoria, see Material.

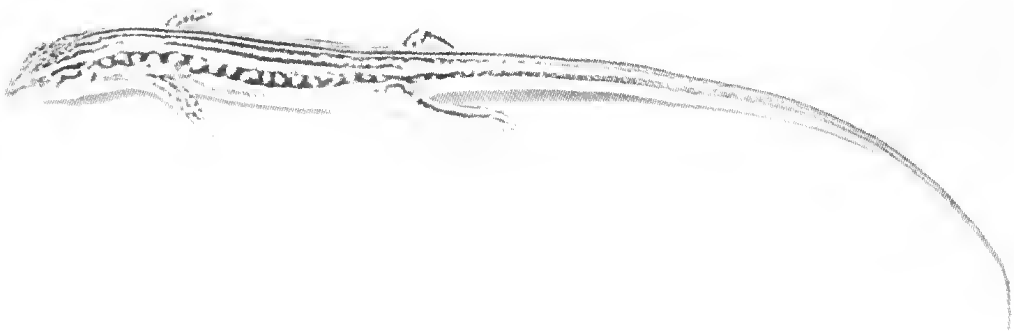

Fig. 12: Holotype of *Ctenotus brooksi iridis*.

Diagnosis

A member of the *Ctenotus schomburgkii* group distinguishable from other subspecies of *C. brooksi* by its dark coloration and strong pattern, especially the 5 well-defined black stripes on back. Further distinguishable from *C. b. aranda* and *C. b. taeniatus* by black upper lateral zone enclosing a series of white spots (rather than being broken by a series of white rectangular marks) and by presence of white midlateral stripe.

Description

Snout-vent length (mm): 25-50 (N 60, mean 39.9). Length of appendages (% SVL): foreleg 24-33 (N 53, mean 27.8), hindleg 40-53 (N 53, mean 47.1), tail 143-178 (N 31, mean 159.3).

Nasals narrowly separated (N 38) or in short contact (8). Prefrontals in contact (N 38) or narrowly separated (8). Supraoculars 4, first 3 in contact with frontal, second and third usually narrower than first. Supraciliaries 6 (N 25) or 7 (15), third to penultimate smallest. Upper ciliaries 8 (N 5), 9 (14) or 10 (15). Second loreal 1.3-2.3 times as wide as high (N 40, mean 1.72). Presuboculars 1 (N 44) or 2 (1). Upper labials 7 (N 40) or 8 (2). Ear lobules 3-6 (N 40, mean 4.4), acute or subacute in adults, obtuse in juveniles. Nuchals 1-6 (N 43, mean 2.7). Midbody scale rows 26-30 (N 43, mean 27.0). Lamellae under fourth toe 17-23 (N 43, mean 20.5), each with a fine, dark, mucronate keel. First few plantar scales opposite fourth toe enlarged and bearing a fine pale keel.

Ground colour (in alcohol) of head and tail pale brown, of back very pale green or very pale brown (pale pink in life). Head streaked with black. Back with five black stripes: vertebral and on each side a dorsal and laterodorsal; vertebral extending for furthest on tail (but for not more than half its length); dorsal and dorsolateral merging at base of tail and soon disappearing. Narrow white dorsolateral stripe from above eye to base of tail. Black upper lateral zone from eye to base of tail, enclosing an irregular series of whitish spots; represented on lore by a narrow black stripe and on tail by a blackish-brown stripe. White midlateral stripe from upper lips to base of tail, broad on body. Narrow lower lateral zone blackish-grey, sometimes interrupted by or enclosing small white spots. Limbs pale brown, longitudinally striped with black.

Distribution

South-eastern interior of South Australia (the Murray Mallee and Upper South-East) and western interior of Victoria (the Big Desert).

Remarks

Of all the subspecies of *Ctenotus brooksi*, *euclae* from the northern shores of the Great Australian Bight is most like *iridis*. Yet these taxa are separated by 700 km of seas, mountain ranges and other country unsuitable for the species. On the other hand *C. b. aranda* occurs only 300 km to the north of *iridis*, with the Olary Spur alone hindering the dispersal of the species. Thus on geographic grounds one would have to derive *iridis* from the north, which would imply that the similarities between *iridis* and *euclae* were examples of convergence or the shared retention of ancestral characters.

Two things support the derivation of *iridis* from a northern rather than a western stock. First, the northernmost specimens of *iridis* (SAM R11183, 14601) tend towards *aranda* in that the white spots are not enclosed by the black of the upper lateral zone but interrupt it. Second, the population of *C. brooksi* on Eyre Peninsula, judging from specimens from Wirrulla (SAM R15210) and Sceale Bay (SAM R15124), though geographically intermediate between *euclae* and *iridis*, is in no way morphologically intermediate. Indeed this population is unique in having the upper lateral zone almost entirely black.

The name of this subspecies comes from Latin *iris*, in allusion to the proximity of the type locality to the town of Rainbow. For descriptions of previously named subspecies of *Ctenotus brooksi* see Storr (1971).

Material

South Australia: Calperum South (34°07′S, 140°37′E) (SAM R14601); 20 km NE of Blanchetown (SAM R11183); Billiatt Conservation Park (34°55′S, 140°20′E) (SAM

R15796, 16682); 'S.E. County Chandos' (SAM R9003); 48 km S of Pinnaroo (SAM R14480*a-d*, 15193); Naracoorte (SAM R9299).

Victoria: 28-30 km NW of Wyperfield (NMV D51675, 51724) and 5-18 km W (NMV D51658, 51662, 51664, 51666, 51681, 51685, 51689, 52160) and 11 km E (NMV D51734); 10 km S of Moonlight Tank (NMV D48296); 2-5 km NNW of Chinaman Well (NMV D52623, 52643, 52655, 52683, 53023-4, 53452, 53512-4, 53520, 53830, 53895, 53914, 53969, 54066) and 1-2 km N (NMV D52602, 53074, 54121) and 0.2-5 km NE (NMV D52642, 52661, 52676, 53483, 53819-20, 53859, 53899, 53951) and 4-7 km NE (NMV D52978, 53461, 53848, 53865-6, 53922, 53939).

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NEW AND REDISCOVERED SPECIES OF FROGS FROM THE DERBY-BROOME AREA OF WESTERN AUSTRALIA

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and ANGUS A. MARTIN†

ABSTRACT

Three new species of frogs are described from localities in the Derby-Broome area. One is a member of the Hylidae (*Cyclorana vagitus* sp. nov.) and the others represent the Leptodactylidae (*Neobatrachus aquilonius* sp. nov. and *Uperoleia aspera* sp. nov.). Rediscovery of *U. mjobergi* (Andersson) permits a redefinition of the species.

INTRODUCTION

In each wet season from 1977 to 1980 we have undertaken surveys of the frog fauna in various parts of the Kimberley Division, Western Australia. These surveys have led to the description of 10 new species: Martin, Tyler and Davies (1980), Tyler and Davies (1979) and Tyler, Davies and Martin (1977, 1979, 1981).

In February 1980 we visited Derby, Broome and adjacent areas seeking to establish the position and nature of barriers to the southern dispersal of the Kimberley frog fauna, and the nature of that fauna. Here we describe three new species collected during that survey, and redescribe *Uperoleia mjobergi* (Andersson, 1913), formerly known from the two types. A manuscript synthesizing the ecology and biogeography of the Kimberley frog fauna is in preparation.

MATERIALS AND METHODS

The specimens reported here have been deposited in the following collections: Australian Museum, Sydney (AM), American Museum of Natural History, New York (AMNH), British Museum (Natural History), London (BMNH), Department of Zoology, University of Adelaide (AUZ), Museum of Natural History, University of Kansas, Lawrence (KU), Naturhistoriska Riksmuseet, Stockholm (NR), South Australian Museum, Adelaide (SAM), Western Australian Museum, Perth (WAM).

Methods of measurements follow Tyler (1968). Abbreviations used in the text are: E (eye diameter), E-N (eye to naris distance), HL (head length),

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HW (head width), IN (internarial span), S-V (snout to vent length), T (tympanum diameter), TL (tibia length). In *Neobatrachus* we introduce an additional measurement as an overall quantification of foot length. The length of the foot (FL) was measured from the proximal end of the outer metatarsal tubercle to the tip of the fourth toe.

Osteological data were obtained from cleared and Alizarin Red stained preparations using the technique described by Davis and Gore (1947). Differential Alizarin Red/Alcian Blue staining of bone and cartilage followed enzymic digestion of soft tissues employing the method of Dingerkus and Uhler (1977). Osteological descriptions follow Trueb (1979).

Mating calls were recorded with a Sony TC-510-2 tape recorder and a Beyer M-88 dynamic microphone, at a tape speed of 19 cm/sec. Appropriate temperatures (water or air wet-bulb) were measured close to the calling sites of males, using a Schultheis quick-reading thermometer. Calls were analysed using a sound spectrograph (Kay Model 6061-B Sona-Graph) with the response curve set in the FL-1 mode. Temporal characteristics of calls were determined from wide-band (300 Hz bandpass) and spectral characteristics of calls from narrow-band (45 Hz bandpass) spectrograms. Audiospectrograms were analysed using dividers and calibrated paper.

For *Uperoleia* species three calls of each of three individuals were analysed and mean values were calculated. Only one individual of *Neobatrachus* was recorded, and the recording is of poor quality; however the calls are judged to be representative of the many individuals whose calls were heard but not recorded.

SYSTEMATICS

Family Hylidae Hallowell

Cyclorana vagitus sp. nov.

Figs 1-5

Cyclorana cultripes: Tyler and Martin, 1977, p. 267 (part.)

Holotype

WAM R71037, an adult male of 46.8 mm S-V length collected by the roadside at the junction of the Great Northern Highway and the road to Derby, 41 km S of Derby, 124°38'E, 17°44'S, Kimberley Division, W.A. by A.H. Cross, M. Davies, A.A. Martin and M.J. Tyler on 14 February 1980.

Paratypes

There are 26 paratypes all of which are adults: WAM R71030-36, SAM R18008-10, KU 186039, AMNH 106555, BMNH 1980.4, AM R95415 taken at the type locality 14-21 February 1980; WAM R27251 Duncan Highway, 17 km N of Lake Argyle turnoff, near Kununurra, 8 June 1966, A.M. Douglas and G.W. Kendrick; SAM R16535, WAM R58836-37, 71039, Parry Creek Road, Kununurra, 25 January 1978, Davies, Martin and Tyler; WAM R71038, 29 km S of Northern Highway/Duncan Highway junction, 24 January 1978, Martin and Tyler; WAM R71029, Camballin, 18 February 1980, Davies, Martin and Tyler.

Diagnosis

A moderate-sized, robust species with a large and roughly triangular head, bearing diffuse dark grey and dark green mottling. Males 42-48 mm; females 44-48 mm S-V. Of species within the size range of *C. vagitus*, *C. cultripes* shares similar proportions, but has a short (370-375 msec) mating call, whereas in *C. vagitus* it is of approximately 1 sec. duration, and resembles the crying of a young baby.

Description of Holotype

Head high and distinctly broader (HW 18.4 mm) than long (HL 17.2 mm, HL/HW 0.93), angular but rounded terminally when viewed from above; rounded in profile; eye large and prominent (Fig. 1), its diameter (5.5 mm) more than one and one-quarter of eye to naris distance (4.0 mm). Canthus rostralis not prominent and very slightly curved. Nostrils inclined dorsolaterally and separated from one another by distance (3.2 mm) slightly more than three-quarters of internarial span (E-N/IN 1.25). Tympanum entirely visible, its diameter (3.6 mm) three-fifths of eye diameter (Fig. 2).

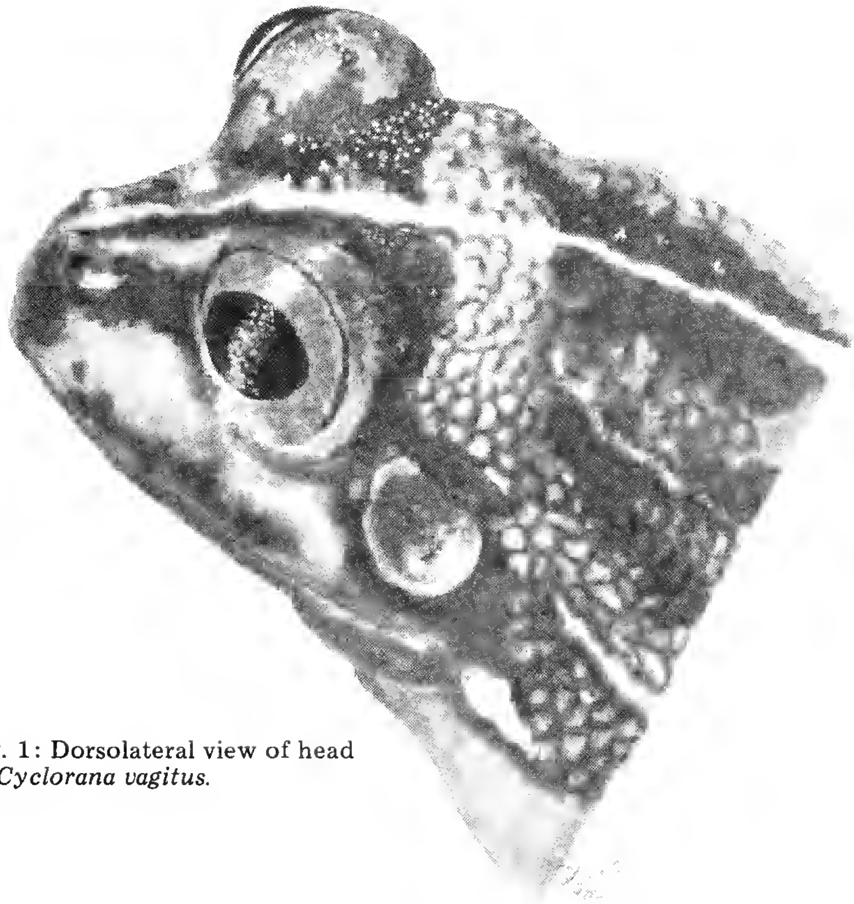

Fig. 1: Dorsolateral view of head of *Cyclorana vagitus*.

Fig. 2: *Cyclorana vagitus* in life. Paratype from Parry Creek Road, Kununurra. This individual has a snout to vent length of 45 mm.

Tongue broad, circular and slightly free behind. Choanae small and oval, and vomerine teeth on two converging elevations principally behind choanae.

Fingers rather broad and slightly flattened, with narrow, lateral fringes. Fingers in decreasing order of length 3 > 4 > 1 > 2. Subarticular tubercles extremely prominent; palmar tubercles large and prominent (Fig. 3a). Foot short, and toes have broad lateral fringes. Webbing on medial surface of fifth and third toes reaches subarticular tubercle at base of penultimate phalanx. Toes in decreasing order of length 4 > 3 > 5 > 2 > 1. Subarticular tubercles extremely prominent, large oval inner but no outer metatarsal tubercle (Fig. 3b). Hindlimbs very short (TL 17.5 mm, TL/S-V 0.37). Skin of dorsal surface smooth but for a few, small, scattered tubercles between eyes. Abdomen and lateral body surfaces uniformly and coarsely granular. A poorly developed supratympanic fold and a narrow tarsal fold.

Dorsal surface dull grey with extensive, irregular, darker mottling, and bearing a narrow, white mid-vertebral stripe. A narrow, dark, canthorostral stripe extends from nostril to eye, and continues behind eye as a broader stripe to above insertion of forearm. Throat heavily suffused with grey; remainder of undersurface is white.

Single, elongate, nuptial pad on medial surface of second finger.

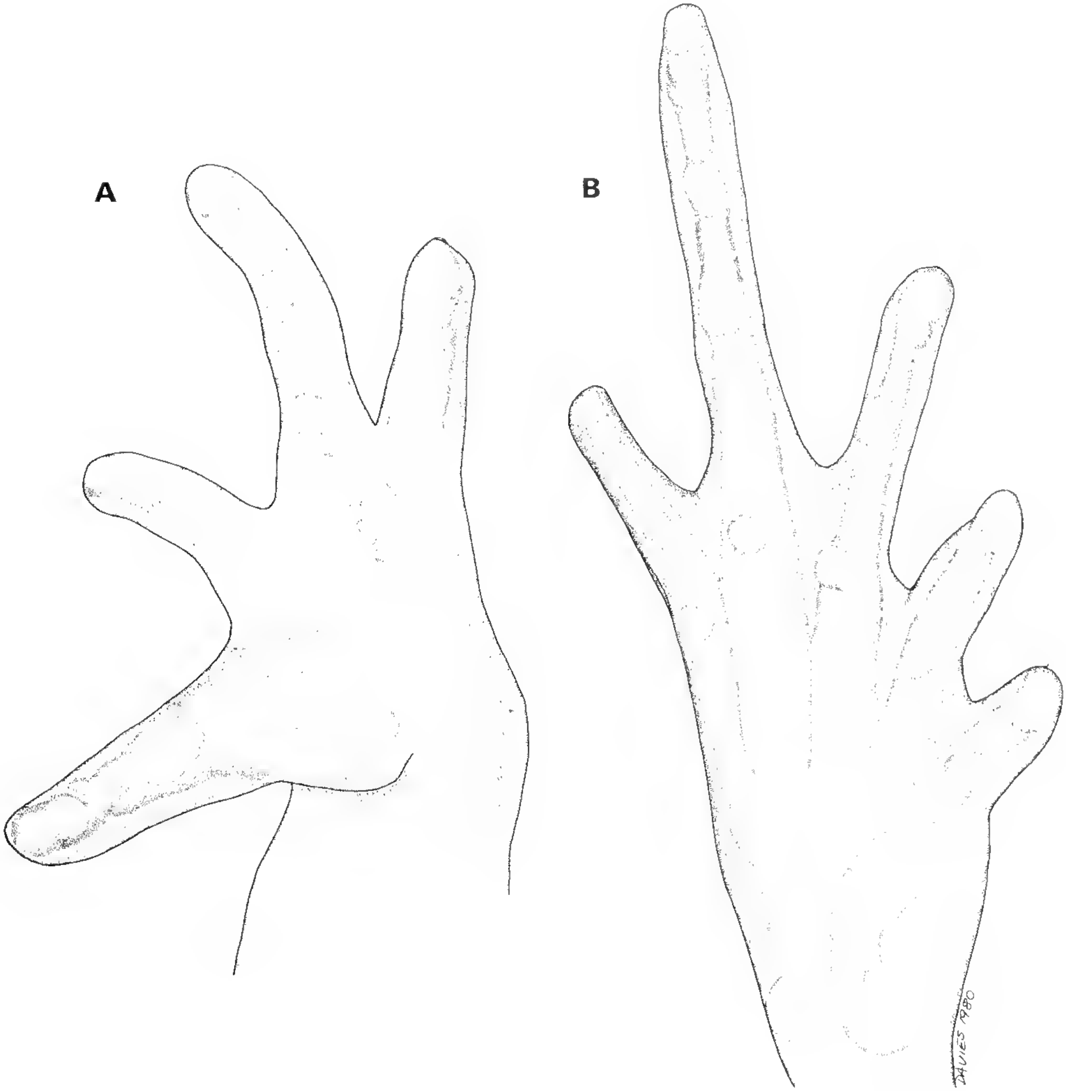

Fig. 3: (a) Palmar view of hand of *Cyclorana vagitus*; (b) Plantar view of foot of *C. vagitus*.

Variation

Males 41.8-47.8 mm S-V; females 43.8-47.6 mm. All are robust specimens in breeding condition, but none was observed in amplexus. Variation in proportions: E-N/IN 1.13-1.41, TL/S-V 0.36-0.44, HL/HW 0.85-0.96, HL/S-V 0.33-0.38.

The coloration is remarkably uniform. In life the frogs exhibit small and irregularly shaped patches of lichen green upon a dull grey-slate background, but in preservative these green markings are lost. The throat of males is slate.

Osteology

Skull robust with moderately ossified neurocranium. Sphenethmoid well ossified, extending anteriorly in a rhomboidal projection between and anteriorly to nasals to level of alary processes of premaxillaries. Sphenethmoid overlapped laterally by nasals. Prootic completely fused with exoccipitals dorsally, but ossification reduced ventromedially. Crista parotica well developed, moderately long and slender; short stocky otic ramus of squamosal lies alongside lateral extremities (Fig. 4a). Frontoparietal fontanelle slender and barely exposed for middle one third of orbital length. Frontoparietal elements well developed, extending about two-thirds length of orbit; orbital edges straight. Nasals triangular, moderately large with robust maxillary processes that articulate with well developed preorbital processes of deep pars facialis of maxillaries. Palatines robust, expanded laterally, blunt medially, ridged, extending to level of centre of dentigerous processes of prevomers. Parasphenoid robust, cultriform process extending to level of anterior extremity of pterygoid; alary processes long, moderately broad, at right angles to cultriform process and overlapped laterally by medial rami of pterygoids (Fig. 4b).

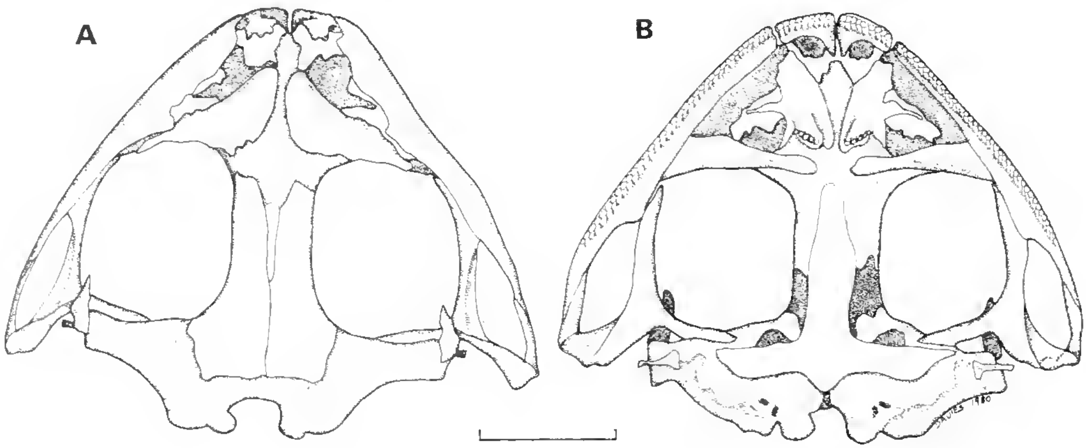

Fig. 4: (a) Dorsal view of skull of *Cyclorana vagitus*; (b) Ventral view of skull of *C. vagitus*. Scale bar = 5 mm.

Pterygoid well developed with robust posterior process, long, acuminate anterior process and long robust medial ramus; anterior ramus in long contact with pterygoid process of palatal shelf of maxillary, reaching to palatines. Quadratojugal robust and in firm contact with maxillary. Squamosal robust with short zygomatic ramus and slightly longer otic ramus. Maxillary and premaxillary dentate. Alary processes of premaxillaries inclined posteromedially. Palatine processes of premaxillaries long, almost abutting medially.

Prevomers entire, moderately short dentigerous processes inclined at an angle of approx. 45° to midline; alae forming margins of choanae. Bony columella present.

Pectoral girdle arciferal and robust; omosternum and xiphisternum present, clavicles robust and abutting medially; coracoids robust and widely separated medially; scapula bicapitate, longer than clavicles; suprascapula one-half to two-thirds ossified.

Humeral crest moderately well developed. Eight procoelous non-imbricate presacral vertebrae. Relative widths of transverse processes: III > sacrum > IV > II > V = VI = VII = VIII. Sacral diapophyses moderately expanded, ilia extend half way along their length. Urostyle bicondylar with long dorsal crest extending for posterior seven-eighths of urostyle. Phalangeal formula of hand: 2,2,3,3; distal tips of terminal phalanges knobbed. Well developed bony prepollex. Phalangeal formula of foot 2,2,3,4,3; well developed bony prehallux.

Comparison with Other Species

Smaller adult size is sufficient to distinguish *C. vagitus* from *C. australis* (males 71-79 mm; females 71-105 mm) and *C. novaehollandiae* (males 61-81 mm; females 75-101 mm). Subadult *C. australis* proportions are similar to those of *C. vagitus*, but lack the intense dorsal mottling of that species, and have a more clearly demarcated lateral head stripe.

The size range of *C. platycephalus* (males 45-55 mm; females 53-66 mm) just overlaps the upper limit of *C. vagitus*. It is further distinguished by its fully webbed toes and flattened head.

The dorsal patterns of markings of *C. brevipes*, *C. longipes* and *C. maculosus* are variable, but all exhibit dark islands of pigmentation upon a lighter background, whereas the dorsum of *C. vagitus* is irregularly mottled, without clear demarcation of dark from light areas.

Cyclorana cryptotis is generally brown upon an orange background, and hence coloured differently to *C. vagitus*. *Cyclorana cryptotis* is smaller than *C. vagitus* (males 34-44 mm; females 36-46 mm), and the tympanum is usually hidden beneath the skin, whereas the tympanum is large and prominent in *C. vagitus*.

Cyclorana maini is a diffusely marked species of a similar size to *C. vagitus*. Limb length possibly is slightly longer in the new species (TL/S-V 0.36-0.44 compared with 0.33-0.41 in *C. maini*) but the most distinctive difference is in the shape of the head as demonstrated by the more narrowly spaced nostrils (E-N/IN 0.97-1.23 in *C. maini*; 1.13-1.41 in *C. vagitus*). Although we lack a recording of the mating call of *C. vagitus*, we believe it to be of longer duration than that of *C. maini* (775-882 msec in *C. maini*: Tyler and Martin 1977, p. 276).

Cyclorana verrucosus is confined to south-eastern Queensland and northern and central New South Wales. Its habitus is similar to that of *C. vagitus*, but it is distinguished by its extremely tubercular dorsal skin, and in particular by the development of elongate ridges along the back. In *C. vagitus* the skin tubercles are small, round and confined to the head.

Finally there is *C. cultripes* which morphologically resembles *C. vagitus* in several features. They differ in that *C. cultripes* has a broad, pale post-ocular bar lacked by *C. vagitus*, and *C. vagitus* lacks the dark canthal stripe of *C. cultripes*. The species are distinguished readily in mating call characteristics. *Cyclorana cultripes* (Tyler and Martin 1977, p. 267) has a short mating call (370-375 msec), whereas the call of *C. vagitus* has a duration of at least one second.

Mating Call

An irregularly repeated, quavering, crying sound which we estimate to have a duration of about one second.

Distribution

Confined to the Kimberley Division, Western Australia, south to the Fitzroy River.

Habitat

Found in flooded grassland at the type locality (Fig. 5) and on a flooded spinifex plain at Camballin. Specimens from the Kununurra area also were taken at or near inundated grasslands.

Fig. 5: Type locality of *Cyclorana vagitus* 41 km S of Derby, W.A. The entire area was inundated to a depth of 20 cm at the time of collection of the holotype. The bush in the centre foreground is approximately 2 metres high.

Etymology

From the Latin *vagitus*, 'crying or squalling' and referring to the mating call which resembles the plaintive crying of a young baby.

Family Leptodactylidae Berg

Neobatrachus aquilonius sp. nov.

Figs 6 and 7

Holotype

WAM R71005, an adult male of 51.3 mm S-V collected by the roadside during a transect 22-41 km S of Derby, Kimberley Division, W.A. by A.H. Cross, M. Davies, A.A. Martin and M.J. Tyler on 14 February 1980.

Paratypes

There are 17 paratypes: BM 1979.729; SAM R18012-14, 18032-33, 18101-02; WAM R71001-04, 71006-09, collected on or adjacent to the road 10-41 km S of Derby by Davies, Martin and Tyler on 13-19 February 1980, and WAM R62195 taken 32 km S of Derby by the same collectors on 13 February 1979. The series SAM R18032-33, 18101-02 has been cleared and stained with Alcian Blue and Alizarin Red, or Alizarin Red alone.

Diagnosis

A relatively large species (males 48-54 mm; females 52-59 mm S-V) with a diffuse dorsal pattern of mustard variegated with dark brown to black, and a mating call consisting of a short trill. Most closely related to *N. centralis* which is a slightly smaller species (males 42-51 mm) with a longer foot (FL/S-V 0.38-0.44, compared with 0.33-0.40 in *N. aquilonius*).

Description of Holotype

Head high and semi-circular when viewed from above, and rounded in profile. Snout high. Eye large and prominent, its diameter (5.9 mm) equivalent to one and one-half times eye to naris distance (4.0 mm). Pupil a vertical slit (Fig. 6). Canthus rostralis very poorly defined and straight. Nostrils inclined superiorly and separated from one another by a distance (3.3 mm) equivalent to three-quarters of eye to naris distance (E-N/IN 1.21). Tympanum not visible.

Tongue broad and circular. Choanae small and oval and vomerine teeth in two relatively long rows directly between choanae.

Fingers cylindrical, unwebbed and lacking lateral fringes. Subarticular and palmar tubercles moderately developed. Fingers in decreasing order of length $3 > 1 > 2 > 4$ (Fig. 7a). Foot long (FL 19.8 mm) with prominent, black, inner metatarsal tubercle but no outer metatarsal tubercle. Toes flattened slightly and with very small subarticular tubercles and approximately one-half webbed (Fig. 7b). Toes in decreasing order of length $4 > 5 = 3 > 2 > 1$. Hind limbs very short (TL 16.3 mm, TL/S-V 0.32).

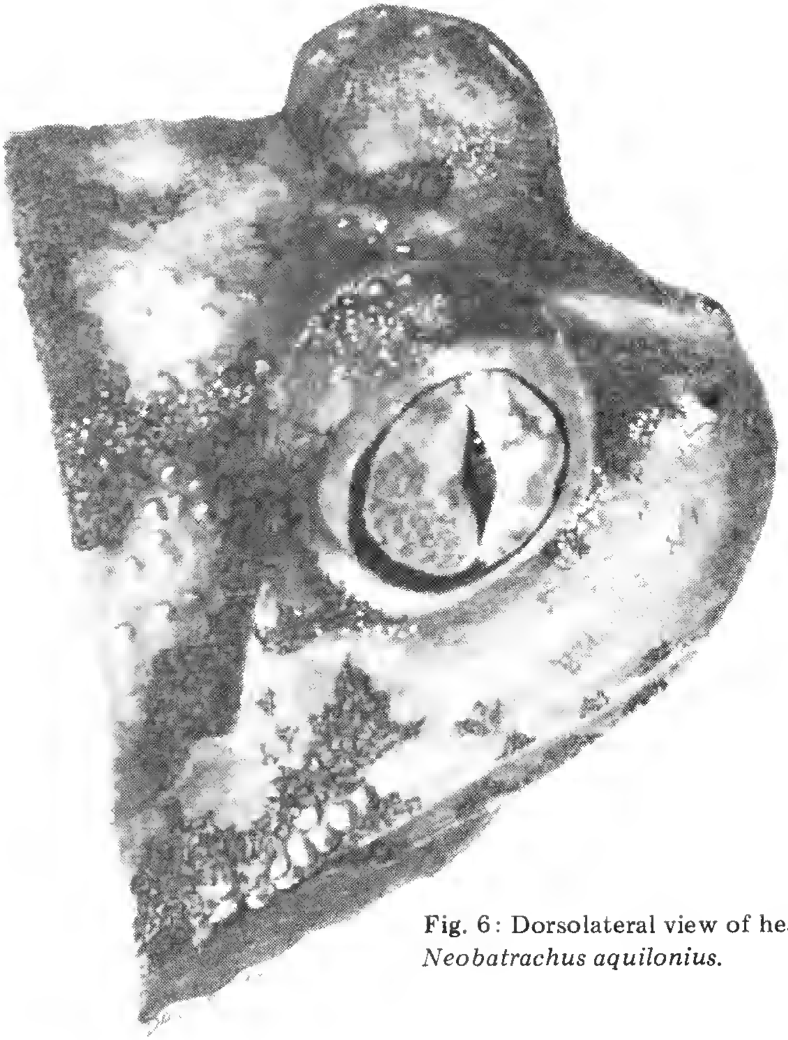

Fig. 6: Dorsolateral view of head of *Neobatrachus aquilonius.*

Skin of dorsal surface finely and evenly tubercular. From posterior half of upper eyelids many of these tubercles bearing minute, conical, black spines only visible microscopically. Ventral surface of body and limbs entirely smooth.

Dorsal surface pale grey with darker slate pattern including a narrow trans-ocular bar and single postocular stripes extending along the flanks, and a broad butterfly-shaped mark in the post-scapular area. Posteriorly the dark markings merge into a series of small, irregular patches. Back of thighs pale slate. Ventral surface of body white but for grey patches beneath angles of mandibular articulation.

Elongate nuptial pads on the medial surfaces of the first and second fingers.

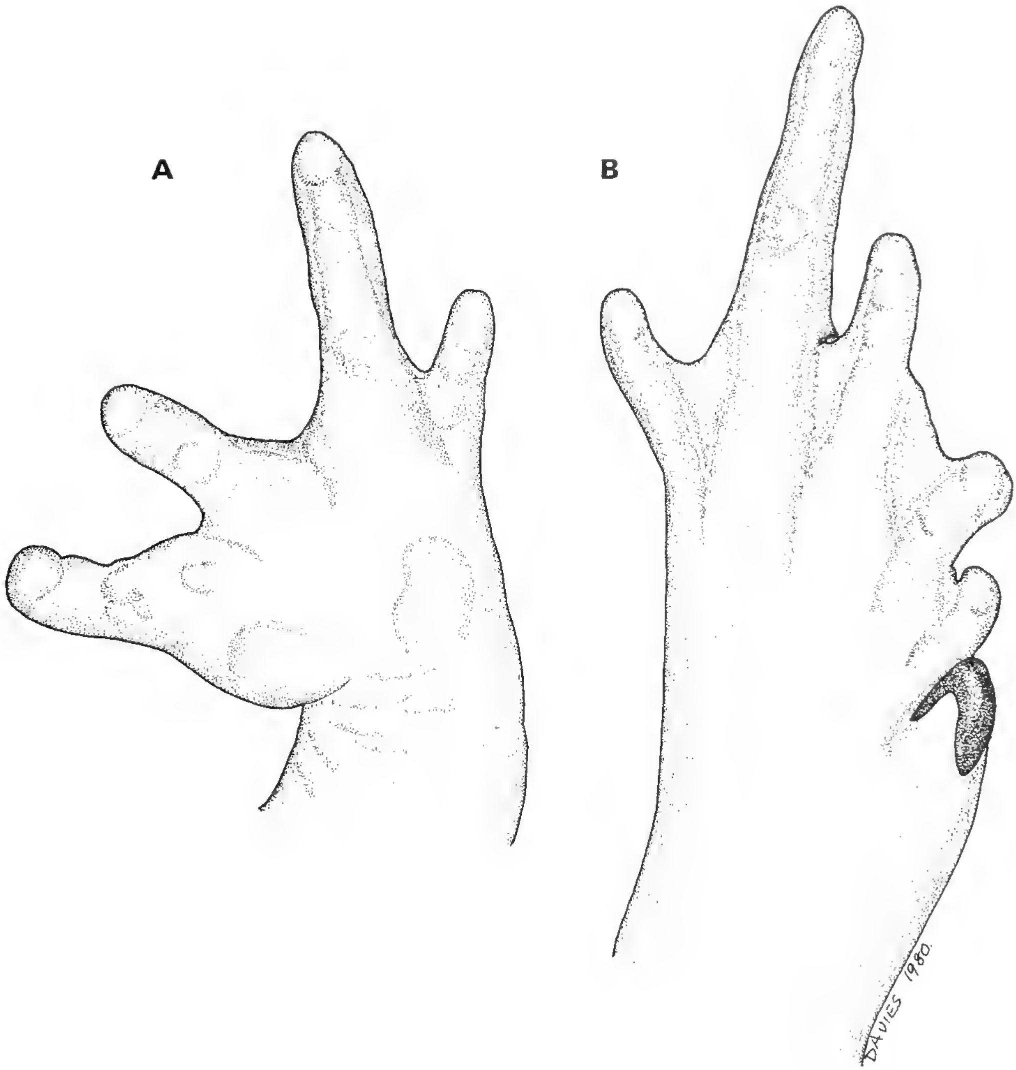

Fig. 7: (a) Palmar view of hand of *Neobatrachus aquilonius*; (b) Plantar view of foot of *N. aquilonius.*

Variation

S-V length of adult males 47.9 -53.9 mm, in females 52.2-59.0 mm.

Head exhibiting minimal variation in proportions. Eye consistently large and prominent. E-N/IN 0.93-1.31. Body large and robust and hindlegs very short (TL/S-V 0.29-0.35).

Five of the 17 paratypes have pale, narrow mid-vertebral stripes. Dark markings on dorsum vary in position and intensity.

In life ground colour of dorsal surface mustard yellow, variegated dark brown to black. Top of head light brown; bright yellow band bordering superior edge of nictitating membrane. Undersurface of limbs plum, dorsal surface variegated with mustard yellow and brown. Ventral surface of body white.

Comparison with Other Species

There are currently four congeners recorded from Western Australia: *N. pelobatoides* (Werner), *N. sutor* Main, *N. wilsmorei* (Parker) and *N. centralis* (Parker).

Neobatrachus pelobatoides has a much longer call than *N. aquilonius* (approx. 3.6 sec.; Littlejohn and Main 1959), and has a significantly shorter S-V length: 45 mm compared with 59 mm. Its head is flatter and when present, its mid-vertebral stripe is red (yellow or green in *N. aquilonius*).

Neobatrachus sutor is up to 51 mm in length and is gold with black markings. Its distinctive mating call is a short tap repeated at approximately 0.4 sec. intervals (Littlejohn and Main 1959). It is therefore also a smaller species with a call unlike the trill of *N. aquilonius.*

Neobatrachus wilsmorei is a highly distinctive species characterised by its chocolate brown colour with, on each side, a pair of diverging, bright yellow stripes commencing behind the eye. Its call is a single pulse of about 0.04 sec. duration, repeated at approximately 1.4 sec. intervals. *Neobatrachus centralis* is a poorly defined species because little is known of the population at the type locality near Lake Eyre in South Australia. Data derived from specimens collected at South Australian localities, east, south and west of the type locality suggest that *N. centralis* is a slightly smaller species than *N. aquilonius* (males 42-51 mm in *N. centralis*, compared with 48-54 mm in *N. aquilonius*), and *N. centralis* has a longer foot (FL/S-V 0.38-0.44, compared with 0.33-0.40 in *N. aquilonius*). The populations of *Neobatrachus* from the west and south-east of the continent reported as *N. centralis* by various authors do not appear to represent *N. aquilonius.*

Neobatrachus sudelli was resurrected from the synonymy of *N. pictus* by Roberts (1978) who suggested that this species might prove a senior synonym of *N. centralis.* The holotype of *N. sudelli* from Warwick, Queensland, is reported by Moore (1961) to have an S-V length of 41.4 mm. Two adult males collected at St George, 340 km west of Warwick (SAM R3717, 3440A) have S-V lengths of 36.8 mm and 43.3 mm respectively, and a gravid female measures 42.0 mm. These sizes are substantially less than the size ranges of *N. aquilonius* cited above. *Neobatrachus pictus* includes individuals with a pattern of markings similar to *N. aquilonius*, but has a substantially longer foot (FL/S-V 0.42-0.54).

Mating Call

The mating call can be described as a soft, slow rattle. The call of the one individual recorded consists of 11 pulses repeated at a rate of 18.33 pulses/ sec., with a total call duration of 565 msec. Each pulse has a duration of approximately 25 msec, and the dominant frequency of the call lies at about 1500 Hz.

The trilled call structure of *N. aquilonius* distinguishes it from *N. sutor* and *N. wilsmorei*, whose calls consist of short, single notes (Littlejohn and Main 1959). From *N. pictus* and *N. pelobatoides*, which have pulsed calls, it is clearly distinguishable by its lower pulse number (11, compared with about 33 in *N. pictus* and 70 in *N. pelobatoides*: Roberts 1978; Littlejohn and Main 1959); its call duration is also lower. The call structure is similar to that of *N. sudelli* in eastern Australia (Roberts 1978) and of the population in south-western Australia called *N. centralis* by Littlejohn and Main (1959).

Distribution

We collected this species 22-41 km south of Derby. A few individuals were heard calling on the inundated Roebuck Plains approximately 25 km east of Broome, but at no other sites, on a 200 km transect from Derby to Broome. It is possible that Andersson's (1913) report of *Heleioporus pictus* from Mowla Downs about 110 km south of the Fitzroy River is a record of this species, but that individual was a male 44 mm in length, and thus was 4 mm smaller than any adult male in the series taken by us.

Breeding Biology

One of the paratype females laid 1426 eggs on 14 February 1980. The developing spawn perished during transit to Adelaide and so was preserved upon arrival. The diameter of a sample of 10 fertile ova averaged 1.9 mm and the capsule diameters averaged 2.7 mm.

Etymology

From the Latin *aquilonius* meaning 'northern'. This species is the most northern member of *Neobatrachus* yet described.

Uperoleia aspera sp. nov.

Figs 8-12

Holotype

WAM R69648, an adult male of 26.8 mm S-V collected by the roadside 28 km S of Derby (123°43'S, 17°30'E), Kimberley Division, W.A. by M. Davies, A.A. Martin and M.J. Tyler on 14 February 1980.

Paratypes

There are 19 paratypes, consisting of 13 adult males and six adult females (five gravid): WAM R69649, SAM R18093-97, AM R95416, AMNH 106556, KU 186040 collected with the holotype. WAM R69655-58, SAM R18098, Great Northern Highway, 8 km NE of Broome, 15 February 1980; WAM R69653-54, Great Northern Highway, 167 km E of Broome, 17 February 1980; WAM R69651-52, 41 km S of Derby at Great Northern

Highway junction; WAM R69650, 20-41 km S of Derby, 14 February 1980. The entire series was collected by M. Davies, A.A. Martin and M.J. Tyler.

Diagnosis

A moderate-sized species (males 24-30 mm, females 29-34 mm S-V), lacking maxillary teeth. Toes webbed only at base. Dorsal surface commonly covered with large tubercles. Mating call a repetitive click. Frontoparietal foramen scarcely detectable.

Description of Holotype

Maxillary teeth absent. Vomerine teeth absent. Snout short, broadly rounded when viewed from above and in profile. Eye diameter 3.4 mm; eye to naris distance (2.15 mm) considerably greater than internarial span (IN 1.4 mm, E-N/IN 1.54). Canthus rostralis straight. Tympanum not visible externally (Fig. 8).

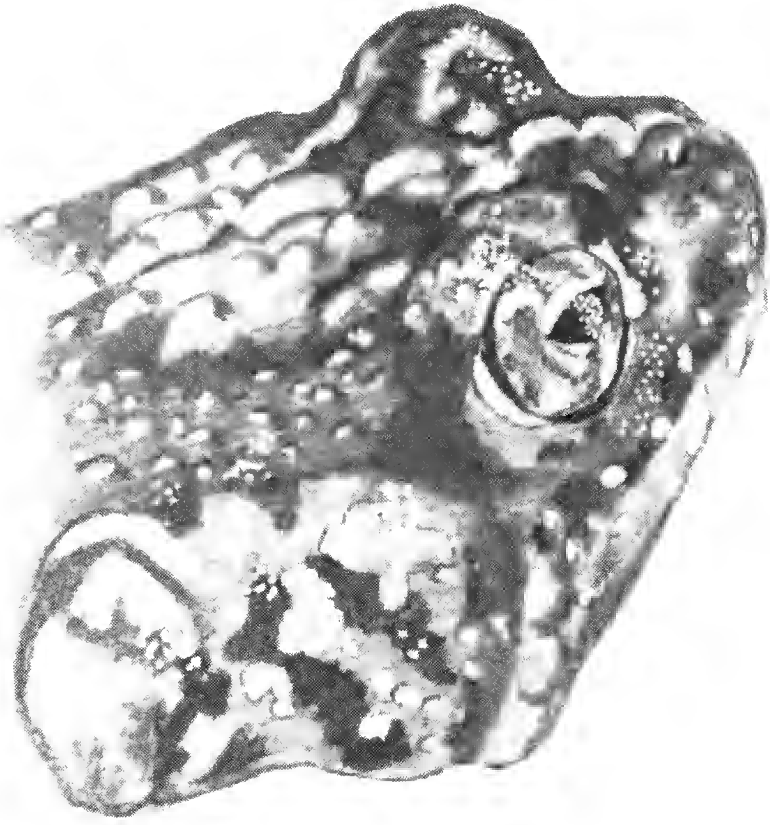

Fig. 8: Dorsolateral view of head of *Uperoleia aspera*.

Fingers short, slender, unwebbed, with a trace of lateral fringes, and with prominent subarticular tubercles; in order of length 3 > 4 > 2 > 1. Palmar tubercles large and prominent (Fig. 9a). Hindlimbs short (TL 8.9 mm, TL/S-V 0.33). Toes long, narrowly fringed and with trace of basal webbing (Fig. 9b); in order of length 4 > 3 > 2 > 5 > 1. Metatarsal tubercles very large. Subarticular tubercles prominent.

Dorsal surface coarsely tubercular. Parotoid and coccygeal glands well developed; inguinal glands not visible externally. Trace of narrow skin fold in

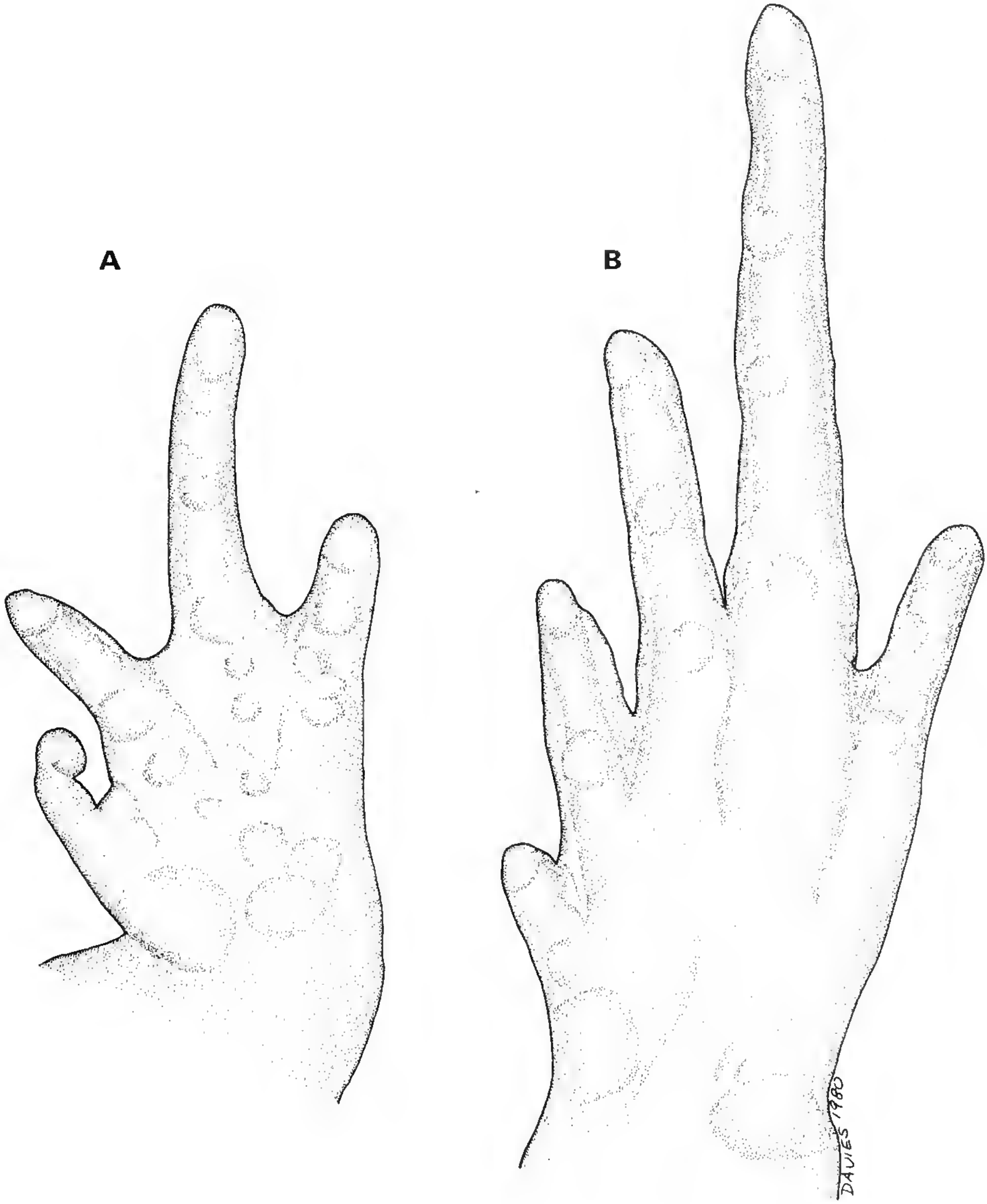

Fig. 9: (a) Palmar view of hand of *Uperoleia aspera*; (b) Plantar view of foot of *U. aspera*.

mid-dorsal region of head, and a group of tubercles around jaw articulation. Ventral surface irregularly granular, most conspicuously so on submandibular area and flanks. Cloacal flap well developed.

Unilobular, submandibular vocal sac.

Dorsal surface dull brown, bearing numerous, very small and diffuse darker patches. Dermal glands creamish with small black spots. Tubercles at posterior angle of mouth white. Ventral surface dull cream, throat stippled with greyish. Unpigmented patches in inguinal and on post-femoral areas.

Variation

A species of moderate size when compared with congeners. Males 23.8-30.3 mm S-V, females 29.0-33.8 mm. Limbs consistently short (TL/S-V 0.28-0.34). Nostrils narrowly spaced in comparison with distance separating each from eye (E-N/IN 1.25-1.92).

Glandular development consistent — inguinal glands scarcely detectable externally in most specimens, whereas coccygeal and parotoid glands readily discernible. Toe webbing restricted to base of toes in all specimens. One specimen has an abnormal right foot.

In life pale brown mottled with darker brown. Top of head and dermal glands pale yellow marked with brown. Ventral surface white, with submandibular area of males dull grey or slate.

Mating Call

To the ear the mating call is a sharp, loud click, repeated at a rate of about 3 calls/sec. However analysis shows the call to consist of 5-6 pulses produced at a rate too high for the ear to resolve (about 170 pulses/sec.) (**Fig. 10**). Call duration is 30-35 msec and the dominant frequency is centred at about 2800 Hz (Table 1).

Of the other species of *Uperoleia* whose calls are known, only *U. lithomoda* and *U. minima* produce 'click' calls (short calls of Tyler, Davies and Martin 1981). The call of *U. lithomoda* is a single pulse of 26-29 msec duration, and that of *U. minima* consists of 2-3 pulses, with a call duration of 17-23 msec. In both these species the dominant frequency is higher than in *U. aspera* (*U. lithomoda* 3420 Hz; *U. minima* 3517 Hz: Tyler, Davies and Martin 1981).

Osteology

Skull moderately ossified, sloping anteroventrally. Sphenethmoid poorly ossified in two portions just anteriorly to anterior extremities of frontoparietals, ventrally to position about one-quarter posteriorly of length of orbit. Sphenethmoid not making bony contact with nasals. Prootic incompletely fused with exoccipital. Crista parotica poorly ossified, short and stocky; not articulating with long, unexpanded otic ramus of squamosal

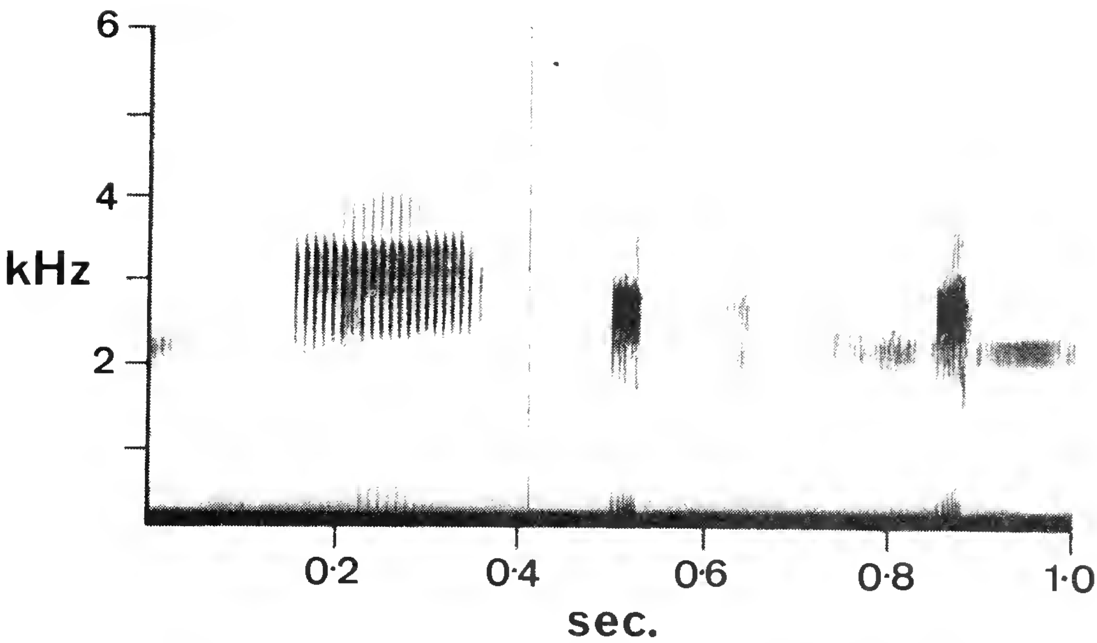

Fig. 10: Audiospectrograms (300 Hz bandpass) of left, a call of *Uperoleia mjobergi*; right, two calls of *U. aspera*; both recorded 28 km S of Derby, W.A.

TABLE 1

Characteristics of mating calls of *Uperoleia aspera* and *U. mjobergi* at a site 28 km S of Derby, W.A., recorded on 14 February 1980 at a wet-bulb air temperature of 25.6°C. Mean values are given with ranges in parentheses.

	N	No. of pulses	Call duration (msec)	Pulse repetition rate (pulses/sec)	Dominant frequency (Hz)
U. aspera	3	5.67 (5-6)	33.33 (30-35)	169.84 (166.67-171.43)	2778 (2650-2900)
U. mjobergi	3	22.11 (20-25)	225 (210-240)	98.12 (94.49-102.09)	3272 (3166-3350)

laterally. Frontoparietal fontanelle poorly exposed in form of narrow slit anteriorly with slight medial expansion at level of posterior extremity of orbit, returning to narrow slit posteriorly (Fig. 11a). Frontoparietal elements well ossified, orbital edges angled slightly posterolaterally. Carotid canal groove absent. Nasals approximately triangular, well ossified, poorly separated anteromedially, widely posteromedially. Maxillary processes moderately blunt, widely separated from poorly developed preorbital processes of shallow pars facialis of maxillary. Palatines reduced laterally, expanded medially and articulating with and slightly overlapping ventrally ossified portion of sphenethmoid at about 45° (Fig. 11b).

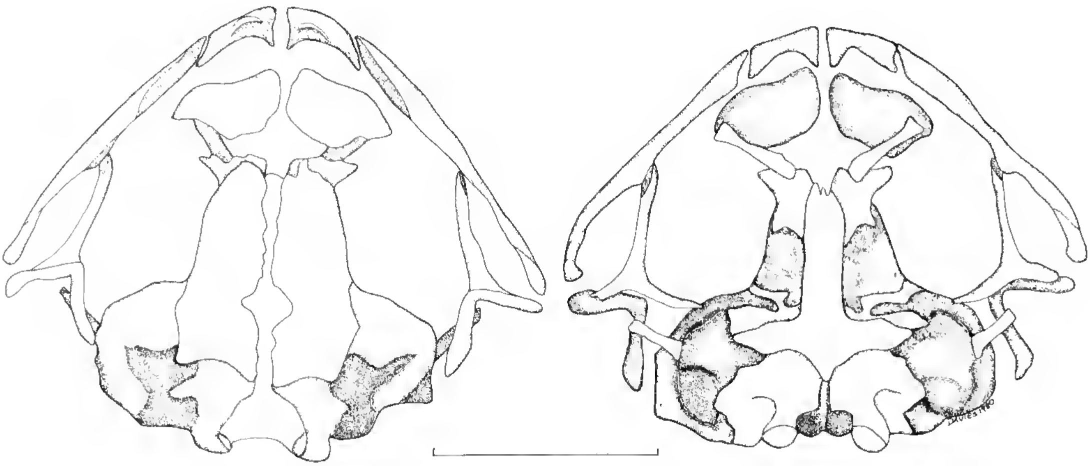

Fig. 11: (a) Dorsal view of skull of *Uperoleia aspera*; (b) Ventral view of skull of *U. aspera*. Scale bar = 5 mm.

Parasphenoid robust, cultriform process broad with serrated extremity; alary processes moderately short at right angles to cultriform process and not overlapped laterally by medial arms of pterygoids.

Pterygoid moderately developed; long anterior arm in short contact with pterygoid process of pars palatina at level about three-quarters anteriorly along the length of the orbit; posterior arm short and robust, anterior arm long and acuminate.

Cartilaginous quadrate present between base of squamosal and quadratojugal. Squamosal moderately robust with no zygomatic ramus and long unexpanded otic ramus.

Maxillary and premaxillary edentate. Alary processes of premaxillary perpendicular and inclined medially; palatine processes well developed, not abutting medially; pterygoid processes small. Prevomers absent; bony columella present.

Pectoral girdle arciferal and robust. Tiny cartilaginous omosternum, well developed xiphisternum; sternum cartilaginous. Clavicles slender, curved, moderately applied medially; coracoids robust, widely separated medially. Scapula bicapitate, slightly longer than clavicles. Suprascapula about one-half ossified.

Eight procoelous non-imbricate presacral vertebrae. Relative widths of transverse processes III > sacrum > IV > II = V = VI = VII = VIII. Sacral diapophyses poorly expanded; ilia extending two-thirds of their length. Bicondylar sacrococcygeal articulation. Coccygeal crest extending along anterior one-third of urostyle.

Humerus with well developed anteroproximal crest; phalangeal formula of hand: 2,2,3,3; distal tip of terminal phalanges knobbed. Small bony prepollex; palmar sesamoid. Phalangeal formula of foot: 2,2,3,4,3. Well developed bony prehallux.

Comparison with Other Species

Of the species currently recognised, three may be distinguished from *U. aspera* by possession of conspicuous maxillary teeth (*U. laevigata*, *U. marmorata* and *U. mjobergi*). Some individuals of *U. micromeles* exhibit vestigial teeth, but that species is readily distinguished by its very low E-N/IN ratio (0.83-0.90, compared with 1.25-1.92 in *U. aspera*).

The minimal degree of exposure of the frontoparietal fontanelle is a feature shared or approached by each of the above species and by *U. fimbrianus*, *U. variegata*, *U. minima* and *U. lithomoda*. Adult size and mating call distinguished *U. minima*: males of that species have an S-V range of 16-21 mm (compared with 24-30 mm in *U. aspera*), and whereas *U. minima* has a 'short' call sounding like a single click, *U. aspera* emits a series of clicks. *Uperoleia lithomoda* also produces a 'short' call. Its size range (21-25 mm S-V) overlaps that of *U. aspera* but it is evidently similar to that species in a number of respects, indicating a close relationship.

Uperoleia borealis has a 'long' mating call and more extensive webbing between the toes.

Uperoleia variegata is consistently smaller than *U. aspera* (19-23 mm S-V in 17 adult males in the type series). The call of that species is not known.

Data on *U. fimbrianus* are restricted to the description of the holotype (a 28 mm female) and our supplementary description. This size is only just below the range of *U. aspera*. Differences noted are the similarity of the lengths of the second and fourth toes in *U. fimbrianus* (fourth longer than second in *U. aspera*) and the conspicuous fimbriated supra-anal flap of *U. fimbrianus*. Additionally, the species are geographically remote: *U. fimbrianus* is known only from southern Queensland, and *U. aspera* from the southern limit of the Kimberley — a geographic separation of 2700 km.

Habitat

We collected specimens at several sites where flooding following heavy rain had created temporary pools in shallow, excavated gravel scrapes adjacent to roads. In each case the surrounding area was grassland with isolated tussocks reaching a height of 1 m (Fig. 12).

Fig. 12: Type locality of *Uperoleia aspera* 28 km S of Derby, W.A. Inundated grassland. The bush slightly to the left of the centre of the photograph is approximately 1.5 m high.

Distribution

The type series was taken at sites extending from 8 km north-east of Broome to 28 km south of Derby. We located specimens beside the Gibb River Road 54 km east of Derby. The species may occur further east in the vicinity of the Fitzroy River, but we did not collect this species (or any congener) on a night transect extending approximately 90 km south of Broome.

Etymology

Derived from Latin *aspera* (rough in relation to texture) describing the texture of the skin of the dorsum.

Uperoleia mjobergi (Andersson, 1913)

Figs 13-16

When Tyler *et al.* (1981) redefined this species only the holotype and the single paratype were available. However we found the species to be reasonably abundant in the Derby-Broome area, with the result that we now are able to provide considerably more morphological and biological detail.

Description

The redescription of Tyler *et al.* (1981) can be supplemented as follows. This is a small species in which males range 20.1-25.1 mm in S-V and females 21.0-23.0 mm. Hindlimbs are short to very short (TL/S-V 0.28-0.36).

Two morphological features are unique to this species: presence of a large heel papilla, and vast lateral extent of the parotoid and inguinal glands. These glands may be confluent, or slightly separated as in Fig. 13. Individuals not exhibiting this hypertrophy externally were at dissection found to exhibit hypertrophy subcutaneously.

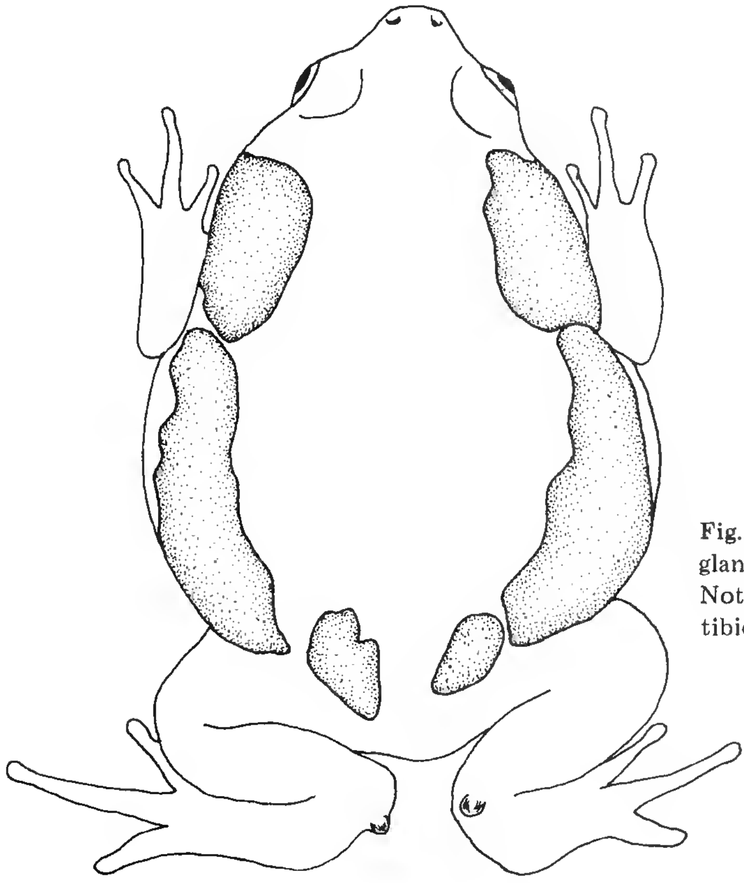

Fig. 13: Disposition of dermal glands of *Uperoleia mjobergi*. Note also the position of the tibio-tarsal papilla.

Dorsal surface is very weakly to coarsely tubercular. In its most extreme form plicae and tubercles are particularly prominent upon the head (**Fig. 14**).

Fig. 14: *Uperoleia mjobergi* in life. Collected 18 km S of Derby, W.A. This individual has a snout to vent length of about 22 mm. Note the hypertrophied parotoid and inguinal glands.

Variation in coloration involves relative extent, rather than presence or absence, of markings upon the dorsum. In preservative the back is pale grey, commonly with five discrete markings as follows: a pair of reniform markings commences behind the eyes, passes posteriorly and occasionally coalesces medially over part of their length. There is a smaller, oval or circular patch in the pre-sacral area, and a pair of large and roughly circular or oval patches above the inguinal area. The dorsolateral edges of the inguinal glands are creamish or golden. The axillary and post-femoral areas are pale pink (two months after preservation). The tibiae are cross-barred with narrow dark stripes.

In life the ground colour is light brown and the patches upon it are dark brown. The light markings upon the inguinal glands are a pale silvery-yellow. The groin and post-femoral patches are scarlet-orange. The ventral surface is off-white and the submandibular area of males is greyish-brown.

Habitat

We found this species in areas of relatively dense, low-growing vegetation. At a site 83 km east of Broome adult specimens were recovered in the day-time from beneath a small log. This is unusual within our experience of

Uperoleia because individuals of most species pass the daytime beneath the surface of the ground. However we note that the types of *U. mjobergi* were collected beneath debris (Andersson 1913).

Osteology

Skull moderately ossified and sloping anteroventrally; small lateral portions of sphenethmoid ossified posteriorly to palatines extending for about half length of orbit in ventral view. Sphenethmoid not making bony contact with nasals. Prootic fused with exoccipital; lack of ossification medially, ventrolaterally and ventromedially. Crista parotica well developed, short and stocky; not articulating with long otic ramus of squamosal laterally. Frontoparietal fontanelle elongate, very narrow with slight medial expansion. Extremities of fontanelle difficult to define due to lack of ossification of sphenethmoid anteriorly and exoccipital posteriorly. Frontoparietals well ossified, very shallow groove of carotid canal present posterolaterally (Fig. 15a). Nasals triangular and moderately well ossified, moderately separated medially; maxillary processes blunt, widely separated from preorbital processes of shallow pars facialis of maxillary. Palatines short, reduced laterally, angled at about 45° to anterior, ventral extremities of sphenethmoid where they articulate. Parasphenoid robust; cultriform process moderately broad with serrated anterior extremity; alae moderately short and broad, at right angles to cultriform process, not overlapped by medial arm of pterygoid.

Pterygoid moderately developed; anterior arm in long contact with pterygoid process of maxillary; medial arm slender and acuminate, not in bony contact with prootic region; posterior arm robust, articulating with base of squamosal and cartilaginous quadrate.

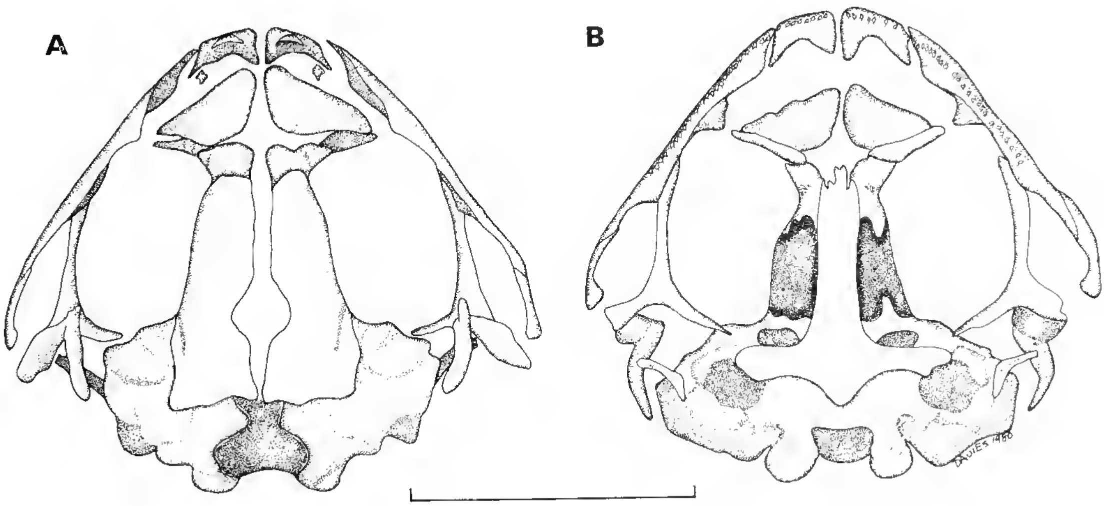

Fig. 15: (a) Dorsal view of skull of *Uperoleia mjobergi*; (b) Ventral view of skull of *U. mjobergi*. Scale bar = 5 mm.

Cartilaginous quadrate present between base of squamosal and quadratojugal. Squamosal moderately robust with tiny knobbed zygomatic ramus and long unexpanded otic ramus.

Maxillary and premaxillary dentate (Fig. 15b). Alary processes of premaxillaries bifurcate, perpendicular to dentigerous processes. Palatine processes well developed, not abutting medially. Prevomers absent; bony columella present.

Pectoral girdle arciferal and robust. Very small omosternum; xiphisternum present; sternum cartilaginous. Clavicles slender, curved, moderately separated medially; coracoids robust, widely separated medially. Scapular bicapitate, about same length as clavicles; suprascapula about one-half ossified.

Eight procoelous non-imbricate presacral vertebrae. Relative widths of transverse processes: III > sacrum > IV > II = V = VI = VII = VIII. Ilia extend to anterior extremity of sacrum. Sacral diapophyses poorly expanded. Sacrococcygeal articulation bicondylar; urostyle crest extending one-half to two-thirds length of urostyle.

Humerus with well developed anteroproximal crest; phalangeal formula of hand: 2,2,3,3; distal tip of terminal phalanges knobbed. Small bony prepollex; palmar sesamoid. Phalangeal formula of foot: 2,2,3,4,3. Well developed bony prehallux.

Mating Call

The mating call is a short 'rasp' or 'creak', consisting of 20-25 pulses produced at a rate of about 98 pulses/sec. (Table 1). Call duration is 210-240 msec and the dominant frequency lies at about 3300 Hz (Fig. 10).

'Rasp' calls (long calls of Tyler, Davies and Martin 1981) characterize many species of *Uperoleia*, including *U. arenicola*, *U. borealis*, *U. crassa*, *U. inundata* and *U. talpa*. However calls of all species are distinguishable by the combination of pulse number, pulse repetition rate, call duration and dominant frequency. *U. mjobergi* has a longer call duration, higher pulse number and faster pulse repetition rate than all Western Australian species except *U. borealis*. From *U. borealis* it is distinguished by its higher dominant frequency (3300 Hz as against 2600 Hz) (Tyler, Davies and Martin 1981).

Distribution

Uperoleia mjobergi is common and widely distributed on the Fitzroy River plains and surrounding area (Fig. 16).

Material Examined

Twenty-three adult specimens (18 males, 5 gravid females): AM R95417, AMNH 106557, BM 1980.5, KU 186041, WAM R71041, AUZ A582-583, NR AM2050; SAM R18020-21, 18 km S of Derby, 13 February 1980; SAM R18022-28, 22-41 km S of Derby, 14 February 1980; WAM R71043, SAM R18029, Great Northern Highway, 83 km E of Broome, 17 February 1980; SAM R18030-31, WAM R71042, Great Northern Highway, 160 km E of Broome, 17 February 1980; WAM R71040, Camballin, 18 February 1980.

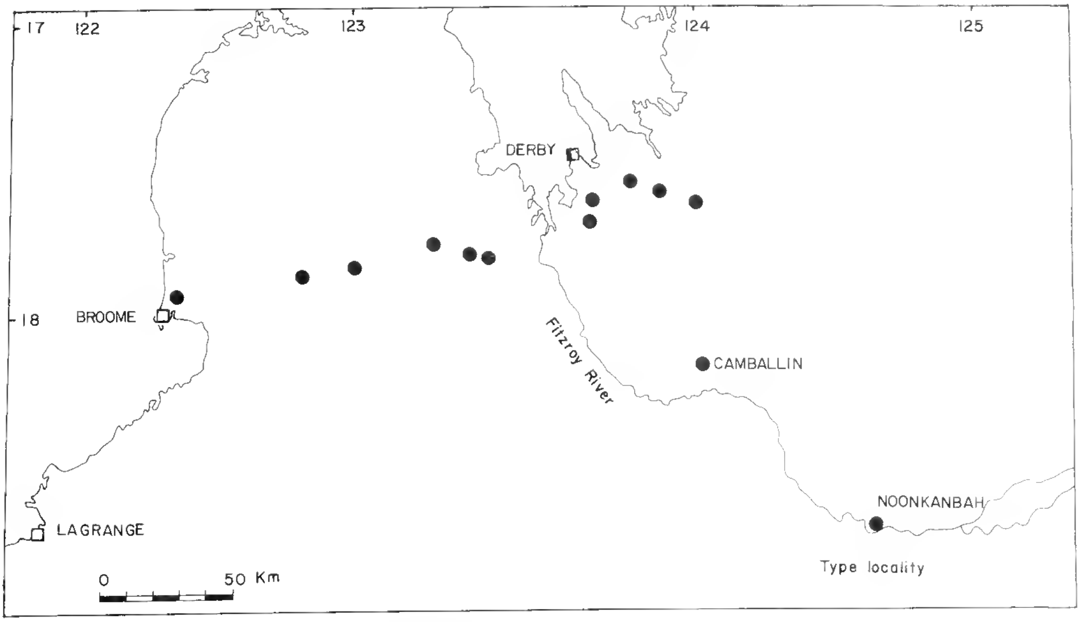

Fig. 16: Distribution of *Uperoleia mjobergi.*

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Figs 2 and **14** are the work of Bohdan Stankewytsch-Janusch.

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BREEDING, DIET AND HABITAT PREFERENCE OF *PHASCOGALE CALURA* (GOULD, 1844) (MARSUPIALIA: DASYURIDAE) IN THE SOUTHERN WHEAT BELT, WESTERN AUSTRALIA

D.J. KITCHENER*

ABSTRACT

Phascogale calura, once widely distributed in Australia, is now confined to the southern Wheat Belt where it is considered an endangered species. Information, based on trapping surveys and Museum records, is presented on its breeding, diet and relative abundance in different habitats.

Phascogale calura is an opportunistic feeder taking a wide range of insects with a preference for those $<$ 10 mm in length, small birds and small mammals, particularly *Mus musculus*. It appears to feed extensively on the ground. Females usually give birth to eight young between mid-June and mid-August. Young are weaned before the end of October. There appears to be a post-mating mortality in males. They were most abundant in denser and taller climax vegetation communities within the frequently adjacent *Eucalyptus wandoo* and *Casuarina huegeliana* alliances. The former alliance has abundant *Gastrolobium* and *Oxylobium* species of poison plants.

Phascogale calura probably survives in nature reserves in the Western Australian Wheat Belt and in Dryandra State Forest because poison plants in these reserves buffer vegetation from effects of domestic stock and feral animals. These reserves, being nature sanctuaries, are also protected to some extent from frequent burning.

INTRODUCTION

The Red-tailed Wambenger *Phascogale calura* (Gould, 1844), a small dasyurid marsupial, originally had a wide but apparently patchy distribution in Australia. It has been collected from the Canning Stock Route, Western Australia; 16 km from Darling Junction, Victoria; Alice Springs, Barrow Creek and Tennant Creek, Northern Territory and Adelaide, South Australia (Krefft 1866, Thomas 1888, Wood Jones 1923, Parker 1973). Its present distribution is restricted to south-western Western Australia.

Despite its inclusion in the International Union for the Conservation of Nature and Natural Resources 'Red Book' of rare species, little published information is available on any aspects of the biology of *P. calura*, save for Krefft's (1866) comments that the species is nocturnal, generally found by natives in hollow limbs of trees and eats mice and small birds in captivity. McKenzie *et al.* (1973), Kitchener and Chapman (1977, 1978) and Morris

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and Kitchener (1979) provide some brief notes on specimens collected by them in the Wheat Belt.

Extensive mammal surveys have been conducted in Western Australia in the last decade in regions where *P. calura* is known to have occurred: the Wheat Belt (Kitchener *et al.* 1980) and desert (Burbidge *et al.* 1976, Burbidge and Fuller 1980) as well as in the Goldfields region (R. How and

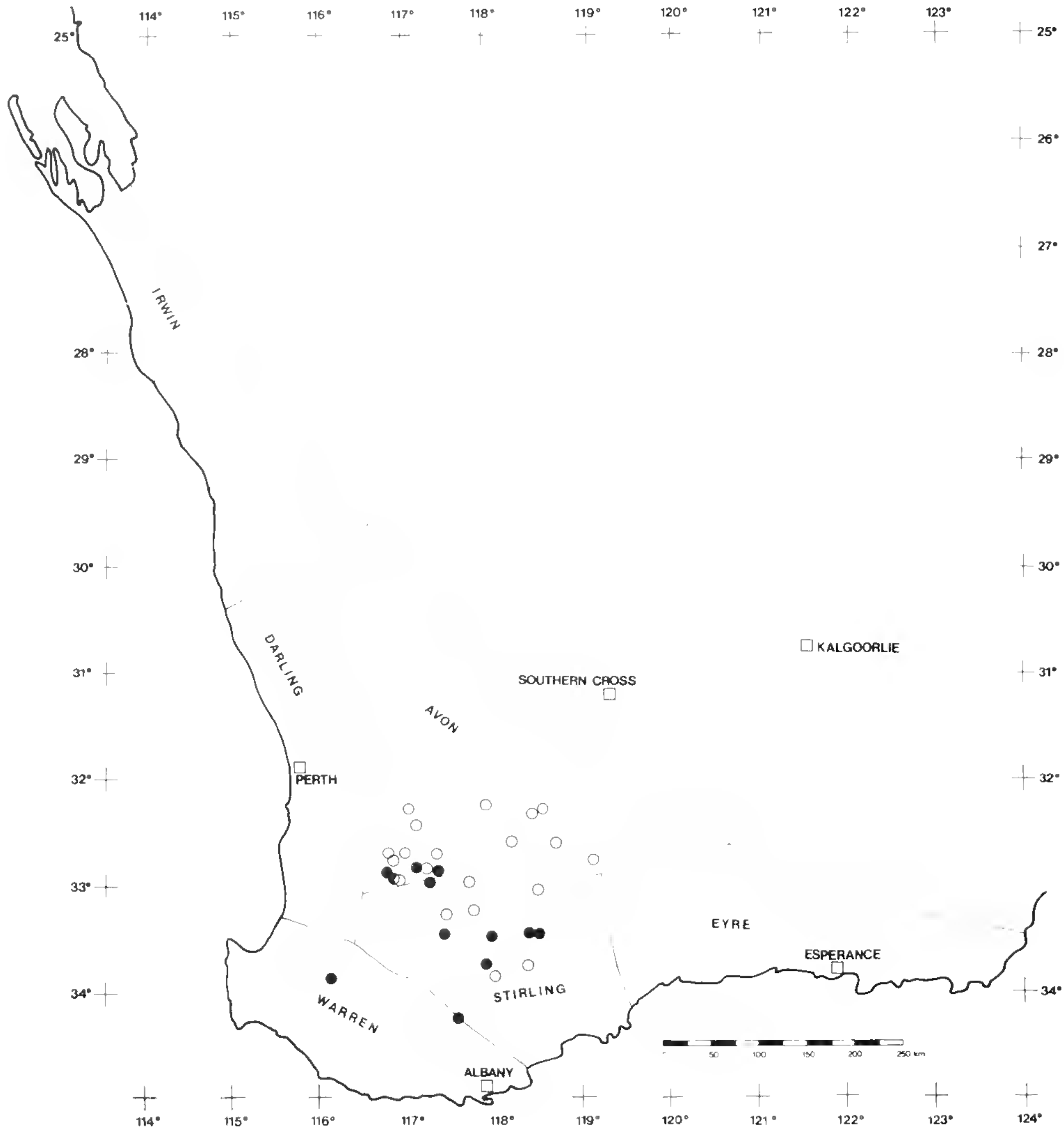

Fig. 1: Localities of *Phascogale calura* from modern records in the Western Australian Museum, shown in relation to the vegetation sub-provinces of Gardner and Bennetts (1956). The unshaded circles are for specimens collected since 1960.

N.L. McKenzie pers. comms) and coastal regions (Bannister 1969, Kitchener and Chapman 1975, Chapman and Kitchener 1976, Burbidge *et al.* 1980) where it could be expected to occur.

These surveys allow for a reasonably accurate definition of the species' present distribution in Western Australia (see Fig. 1).

This paper presents additional information on this little-studied species, particularly its diet, habitat preference and reproduction. Use is made of the data in the above-mentioned reports, specimens in the Western Australian Museum and personal communications, to suggest possible reasons for its range contraction.

OBSERVATIONS

Size and Age

Adult males are significantly larger than adult females (Table 1). These measurements and weights are from females collected between August to September and judged to be parous from condition of uteri, teats, mammary glands, pouch, or from presence of young in pouch; and males collected immediately prior to the breeding season (March-April), when estimated to be at least eight months old and with greatest diameter of the scrotum exceeding 12 mm.

Individuals smaller than the minimum values given for each sex in Table 1, but with approximate adult body proportions are categorized as subadults; others were classed as juveniles.

TABLE 1

Mean, standard error, and range for tail, body and pes lengths and weights of adult male and adult female *Phascogale calura*. t — test values comparing male and female values shows males to be significantly larger and heavier than females.

	Tail length (mm)	Body length (mm)	Pes length (mm)	Weight (gm)
♂♂	N = 9 140.6±1.3 (134.0-145.0)	N = 9 113.3±2.14 (104.6-122.0)	N = 9 23.7±0.4 (22.3-25.1)	N = 6 60.0±4.4 (39.0-68.0)
♀♀	N = 8 131.5±2.86 (119.2-144.0)	N = 8 101.0±1.8 (92.9-104.7)	N = 8 21.8±0.3 (20.8-22.9)	N = 6 42.5±1.6 (37.5-48.0)
t	3.04	4.32	4.27	3.74
Significance	.010>p>.005	p<.001	p<.001	.005>p>.001

Seasonal Captures

Results of trapping are compared for four reserves in the Wheat Belt which were trapped using the same methods and approximately equal effort (Kitchener and Chapman 1977, 1978; Morris and Kitchener 1979). These data are presented in Table 2 and show that about equal numbers of adult females were caught in autumn and spring. Slightly more adult males than females were caught in autumn and no males were caught in spring. Sub-adults were caught only in autumn.

TABLE 2

Number of adult (A) and subadult (S) male and female *Phascogale calura* trapped in four Wheat Belt reserves during autumn and spring. Number of trapnights is recorded.

Nature reserve	March-April			September-November		
	No. trapnights	♂♂	♀♀	No. trapnights	♂♂	♀♀
Yornaning	1526	8 A	5 A, 1 S	1200	0	7 A
Dongolocking	1800	2 A	2 A	1732	0	1 A
Bendering	940	5 A	1 S	840	0	0
West Bendering	1300	1 A	4 A, 2 S	1640	0	2 A
Totals	5566	16 A	11 A, 4 S	5412	0	10 A

Additional adults (11 ♂♂, 19 ♀♀) have been collected in other months from different localities (A.A. Burbidge, N.L. McKenzie and A. Bradley, and WAM records). No adult males are recorded from August to January, although one juvenile male was collected in September and four subadult males in December; 10 adult females were collected in August and one in November.

These few captures may indicate either a differential seasonal trapability between sexes, or a post-mating mortality of males such as occurs in at least six *Antechinus* species (Lee *et al.* 1977).

Period of Births

There are few records of females with pouch young; these are listed in **Appendix I.** These observations indicate that females normally give birth to eight young between mid-June and mid-August. This period of births tends to be confirmed, first by the observation that the reproductive tracts of four females, collected between 27 March and 28 April, showed no indication of reproductive activity (from the appearance of uteri and teats only one of these appeared to be parous), and second, because seven females collected between 7 September and 21 October were, from appearance of mammary glands, teats and uteri, still weaning young or had recently done so when collected.

Diet

Stomach contents of 26 *P. calura* were examined for arthropods by M.C. Calver and J.N. Dunlop, Murdoch University; the mammal hairs were identified by W.K. Youngson, Department of Fisheries and Wildlife. Mastication is thorough and most arthropod remains are too fragmented for detailed identification. However, 94 individual prey items were allocated to nine arthropod orders. These orders, followed by the number of stomachs in which they occurred, are as follows: Myriapoda (2), Araneida (4), Isoptera (1), Blattodea (8), Hemiptera (3), Orthoptera (4), Coleoptera (8), Hymenoptera — wasps (1) and Formicidae (1) and Diptera (2). These observations suggest that cockroaches and beetles are favoured food items. The range of items eaten indicates that they are not specialized feeders. Most of the identified invertebrates were small, with more than half less than 10 mm in length. Six of the stomachs had clumps of hair which seemed to be too large to have been swallowed merely from grooming. In five of these stomachs there were hairs of feral mice *Mus musculus*. The other stomach contained only hairs of the European Rabbit *Oryctolagus cuniculus*, which from the length and thickness of guard hairs were thought to be from a juvenile. One stomach also contained a bird feather. Kitchener and Chapman (1978) also suggest that the species is an opportunistic feeder: separately, termites and cockroaches formed a large proportion of stomach contents of two specimens and lepidopteran larvae appeared in the diet only during spring. It occasionally eats birds. Culver and Dunlop report that most stomachs contain only a single or several individuals of a range of prey items. For example, one stomach contained two spiders, one myriapod, one beetle and two cockroaches which further suggest that the species is an opportunistic feeder.

Of particular interest is the observation that cockroaches, grasshoppers, myriapods and beetles make up 31 of the 94 invertebrate individuals recorded, suggesting that *P. calura* feeds extensively on the ground. This is supported by the observation that phascogales apparently predate heavily on the ground-dwelling *M. musculus*. The occurrence of juvenile rabbit fur in a stomach suggests that *P. calura* may take carrion.

Relative Abundance

The relative abundance of this species in different habitats was evaluated from trapping data from the four reserves listed earlier in **Table 1**. Because these reserves were trapped between November 1972 and March 1976 using different trapping efforts, population numbers between reserves and number of individuals captured in particular habitat types are not directly comparable. Instead, after grouping spring and autumn trapping data for each trapline, abundance of individuals between sampled habitats was compared using an abundance index (AI):

$$AI = 10^4 \sum_{n=1}^{4} Pi \Big/ \sum_{n=1}^{4} Ti$$

where P = proportion of individuals caught in a habitat in reserve i.
T = total number of trapnights in a habitat in all reserves.
i = number of reserves when i = one to four.

Habitat is used here to denote any structural, floristic or pedological character considered.

The vegetation classification used throughout is that of Muir (1977b) and the descriptions of the vegetation and soils in all traplines are in Muir (1977a and b, 1978, and 1979). Nomenclature for plants follows Beard (1970).

Vegetation Structure: AI values and trapping effort in each of the vegetation life form/height classes and corresponding canopy cover density groupings (LFD) in the appendix were compiled by treating each vegetation stratum in each trapline separately. These values show that although *P. calura* was captured in 60 per cent of the LFDs trapped (in 17 of the 47 traplines) a restricted habitat preference is suggested.

Total AI values for the life form/height class in **Appendix II** suggest that low trees were preferred to mallees and shrubs, with tall shrubs preferred to lower (< 1.5 m high) shrubs. Of the ground covers, low bunch grass was favoured relative to mat plants, sedges and herbaceous species. Canopy cover totals in this appendix indicate a preference towards denser vegetation. This trend is supported by the grouped data for shrubs, mallees and trees, which have AI values and number of trapnights (in brackets) as follows: dense 9.2 (960), mid-dense 4.6 (8384), sparse 2.3 (8982) and very sparse 1.5 (5900) — although there is one LFD grouping, sparse trees < 5 m high, which notably reverses this trend. In this instance, this LFD (*Acacia lasiocalyx*) is associated with a mid-dense understratum of *Casuarina campestris* which is almost certainly the stratum being used by phascogales.

With the ground covers there is no trend towards denser vegetation. When values for mat plants, grasses, herbaceous species, sedges, ferns and mosses are grouped, the AI values are as follows: dense 0 (720), mid-dense 6.9 (2400), 3.8 (1780) and 5.9 (660).

Floristics: AI values were calculated for each dominant plant genus in the upper stratum and lower stratum (where present), and for both strata combined (Table 3). These values suggest that *Casuarina* spp. (*C. huegeliana*, *C. campestris* and *C. acutivalvis* in that order) were a most important habitat, whether present in either the upper or lower stratum. *Acacia* (*A. lasiocalyx*) was only dominant in the upper stratum and this appeared equally preferred to *Eucalyptus* spp. (*E. wandoo* favoured). Interestingly, no captures were recorded in *Eucalyptus* when it formed an understory only. Mixed shrub assemblages were little favoured and none were captured in vegetation associations dominated by a mixed shrub assemblage < 1.0 m high. Associations dominated by *Dryandra* spp., *Banksia* sp. or *Melaleuca* sp. were not favoured.

Associations with a shrub layer dominated by the poison bushes *Gastrolobium* spp. (*G. crassifolium*, *G. spinosum* most favoured) had the highest AI value (8.8) of the shrubs and trees. Of the ground cover, the grass *Spartochloa scirpoides* was most favoured, followed by the mat plants Cyperaceae gen. nov. and *Wilsonia* sp., mixed sedges, the herb *Borya nitida* and the sedges *Lepidosperma angustatum* and *Lomandra effusa*.

TABLE 3

Phascogale calura abundance indices and number of trapnights (in brackets) for vegetation floristic groupings on Wheat Belt reserves (for explanation see text).

	Vegetation stratum		
Dominant plant genera/structure	upper	lower	upper and lower
Casuarina (> 2 m)	6.5 (2406)	6.2 (1750)	6.4 (4156)
Acacia (> 2 m)	6.0 (820)	—	6.0 (820)
Eucalyptus (> 2 m)	3.4 (5380)	0 (660)	3.1 (6040)
Melaleuca (> 0.5 m)	0 (60)	3.2 (740)	3.0 (800)
Low mixed shrubs (< 1.0 m)	0 (772)	2.3 (5328)	2.0 (6100)
Tall mixed shrubs (1.0-1.5 m)	1.5 (740)	1.5 (3720)	1.5 (4460)
Dryandra (0.1-4.0 m)	0.4 (1260)	—	0.4 (1260)
Banksia (2.0-4.0 m)	0 (360)	—	0 (360)
Gastrolobium (1.0-2.0 m)	—	8.8 (510)	8.8 (510)
Olearia (< 0.5 m)	—	0 (240)	0 (240)
Blackboys (*Xanthorrhoea*)	—	0 (280)	0 (280)
Mat plants (Cyperaceae, *Wilsonia*)	—	4.1 (580)	4.1 (580)
Grass (*Spartochloa*)	—	13.4 (500)	13.4 (500)
Sedges (*Lomandra*)	—	1.3 (80)	1.3 (80)
(*Lepidosperma*)	—	1.2 (640)	1.2 (640)
(Mixed)	—	4.7 (1280)	4.7 (1280)
Herbs (*Borya*)	—	3.3 (1800)	3.3 (1800)

Soils: The AI values, followed by trapping effort, for the soil texture groupings were as follows: sand 0 (1632), loamy sand 11.5 (62), clayey sand 9.4 (576), loam (> 80% gravel content) 1.8 (280), sandy loam 2.3 (3220), fine sandy loam 3.0 (2770), light sandy clay loam 0 (260), sandy clay loam 8.2 (1020), sandy clay loam (> 80% gravel content) 0 (240), silty clay loam 14.2 (120), heavy clay 4.6 (240).

There was no clear preference for soil groupings, although silty clay loams had the highest AI value followed by loamy sand and clayey sand. None were collected on sand and relatively few on loam except where the clay content was high.

DISCUSSION

The contraction in the distribution of *P. calura* following European settlement of Australia would not appear to involve dietary specialization because of the wide range of prey items taken by the species.

Limited data presented suggest that habitat preference may be an important factor in this contraction. From Museum trapping records the species appears to prefer a denser vegetation or vegetation with a continuous foliage stratum of the following species: *Eucalyptus wandoo*, *E. accedens*, *E. gardneri*, *E. falcata* and *Gastrolobium* spp. (*E. wandoo* alliance of Aplin, 1979) and the *Casuarina huegeliana* alliance of Aplin (1979). These plant species frequently occur together as adjacent associations or as a community. Apart from the capture by McKenzie *et al.* (1975) of a single *P. calura* in a different, but structurally similar vegetation type, all the additional captures (Appendix III) were in vegetation which was both structurally and floristically similar to that of the Museum records. In all instances surveyed by me, captures of *P. calura* were in climax vegetation: Yornaning Nature Reserve has not been burnt for about 40 years; and the youngest association in which they were captured in Dongolocking, West Bendering and Bendering Nature Reserves is about 40, 25 and 10-20 years, respectively. Further, the captures in Tutanning Nature Reserve were in an association which had not been burnt for about 40 years (N.L. McKenzie, pers. comm.). They were, however, captured at Dryandra State Forest Reserve in associations burnt as recently as one year previous to the trapping, although these were controlled prescribed burns and as such were 'cool' fires which left much of the vegetation in the middle and upper strata intact (A.A. Burbidge, pers. comm.).

On release in the field *P. calura* have been tracked to a hollow limb of a mallee and hollows of fallen logs (A. Chapman and A.A. Burbidge, pers. comms). These observations, taken in conjunction with those of Krefft (1866), suggest that hollow logs and trunks are probably the natural rest sites of the species. Certainly climax (and senescent) vegetation afford more opportunities for such rest sites and a continuous vegetation canopy would assist its movement through foliage as suggested by Kitchener and Chapman (1978).

The high abundance index of *P. calura* with the poison plants (*Gastrolobium* spp.) warrants further investigation. Aplin (1973) states that mortalities in sheep and goats, probably attributable to *Gastrolobium oxylobioides*, was first recorded in 1837 from Guildford, Western Australia. It is now known that all species of domestic animals are susceptible to monosodium fluoroacetate, the toxic element in *Gastrolobium* and *Oxylobium* (Papilionaceae), following ingestion of the plant. Death usually occurs within a few hours of eating the plant. Only three of the 34 species of poison plants in these two genera are found outside the South Western Vegetation Province (Aplin 1973). Interestingly, unlike their close eastern Australian relatives, the South-West vertebrate species which have been examined (*P. calura* not included) have evolved methods for detoxifying monosodium fluoroacetate (Oliver, King and Mead 1977). Christensen (1980) speculates that foxes and other exotic predators on native mammals may also suffer secondary poisoning after eating native fauna which have fed on these plants. It is for these reasons that Main (1979) states that areas with concentrations of poison plants 'have never been invaded by wandering domestic stock nor occupied by feral animals . . . As a consequence the plant assemblages and animal communities that are present (in areas with abundant poison plants) are singularly free from unwanted alien weeds or pest species.'

It is, then, unlikely to be coincidental that the recent distribution of *P. calura* (since 1960 — see Fig. 1) encompasses the southern part of the Avon and the northern part of the Stirling sub-provinces of Gardner and Bennetts (1956) (or western part of the Roe sub-province of Beard [1979]).

Numbers of poison plant species in each of the vegetation sub-provinces of Gardner and Bennetts (1956) are available from Aplin (1973). The expected number of species of poison plants in these sub-provinces was estimated, first, by converting the area of each sub-province to the power 0.15, to accord with the expression of the relationship between species richness and area for mainland situations (see MacArthur and Wilson 1967). The expected number for each sub-province was, then, obtained by multiplying the sum of the species of poison plants in each sub-province by the proportion of the transformed sub-province area over the sum of transformed areas for each sub-province. The observed followed by expected values of poison plants in each sub-province is: Avon (23, 14.8), Stirling (18, 14.0), Darling (13, 13.3), Eyre (12, 14.0), Irwin (12, 14.5) and Warren (6, 13.4). These values show that only the Avon and Stirling sub-provinces have more species than expected, indicating that these two sub-regions are particularly rich in poison plant species. The difference between the observed and expected values are significant for the Avon ($X^2 = +4.57$, $0.05 > p > 0.025$) and Warren ($X^2 = -4.07$, $0.05 > p > 0.025$) sub-provinces.

Relative to other small mammals in the South-West *P. calura* appears to be relatively fecund (Baynes 1980) with most females having from 6-8 young per year. However, if *P. calura* males are semelparous then this may conceivably be a factor in the decline of the species because its distribution encompassed semi-arid and sub-tropical habitat with unpredictable climate. As noted by Lee *et al.* (1977) the success of this mode of reproduction depends on the species being able to reliably time, as well as maximize, its reproductive effort to coincide with the period when most young survive. Lee *et al.* (1977) state that in all *Antechinus* species with semelparous males, mating is in winter or early spring with litters being weaned between November and January to correspond with the spring flush of insects. These *Antechinus* species occur only in areas receiving reliable rainfall of at least 600 mm annually. These authors state that unpredictable environments would militate against semelparity because 'the only insurance against reproductive failure is the capacity of some females to breed in a second and very occasionally a third year.'

In conclusion, *P. calura* may persist in Western Australian Wheat Belt nature reserves because some of these reserves are protected from too frequent burning. Also they are protected by poison plants from direct and indirect effects on vegetation of grazing and browsing by exotic fauna that has been noted elsewhere in Australia (Wilcox 1960, Gentilli 1961, Newsome 1975). Thus these reserves favour the retention of floristically and structurally rich climax vegetation communities which would appear to favour the species resting site requirements and aerial capabilities. Wilcox (1960) has shown that grazing on the Wandarrie grass associations of the sandier soils of the mulga (*Acacia aneura*) zone has resulted in the loss of the tree and shrub-layers in many areas. Such changes would be inimical to *P. calura* and probably played a role in the extinction of this species in the arid and semi-arid parts of its range.

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APPENDIX I

Records of *Phascogale calura* with pouch young.

Reference	Locality	No. adults	Date collected	No. young	Crown-rump length (mm)	Notes
WAM No. 9907	Dragon Rocks Nature Reserve	1	3 August 1972	8	7.2	teats slender, 2.9 mm long, uteri only partially involuted, pouch and mammaries moderately developed
WAM No. 8069	Dumbleyung	1	22 August 1967	8	8.9	as above
A.A. Burbidge (pers. comm.)	Dryandra State Forest	4	22-25 June 1971	6-8	small unfurred	—
A. Bradley (pers. comm.)	Yornaning Nature Reserve	5	2 August 1980	8	<6.0	two other females had no pouch young
Krefft (1866)	Victoria	1	early June	8	small	—

APPENDIX II

Phascogale calura abundance indices and trapping efforts (in brackets) for vegetation structural groupings on four Wheat Belt reserves (see text for explanation). The total and sub-total values for the broad life form/height and canopy cover groups were calculated as for the values within the matrix.

Life form/height class	Canopy cover				
	Dense 70-100%	Mid-dense 30-70%	Sparse 10-30%	Very sparse 2-10%	Totals
Trees > 30 m					
Trees 15-30 m		0 (360)		0 (380)	4.8 (6426)
Trees 5-15 m		8.8 (3296)	0 (1780)	0 (280)	
Trees < 5 m			0 (230)	17.0 (100)	
Mallee tree form			13.8 (80)		2.6 (2200)
Mallee shrub form	12.1 (140)	0 (620)	2.2 (1300)	0 (60)	
Shrubs > 2 m	9.5 (760)	2.4 (700)	4.7 (600)	1.7 (1000)	
Shrubs 1.5-2.0 m		7.1 (240)	3.1 (1100)	1.3 (1360)	
Shrubs 1.0-1.5 m		0 (720)	0.6 (800)	1.4 (800)	2.2 (15600)
Shrubs 0.5-1.0 m		0 (940)	0 (892)	3.4 (500)	
Shrubs 0.0-0.5 m	0 (60)	4.0 (1508)	2.0 (2200)	0.4 (1420)	
Sub-totals	9.2 (960)	4.6 (8384)	2.3 (8982)	1.5 (5900)	2.9 (24226)
Mat plants				4.8 (580)	4.8 (580)
Hummock grass					
Bunch grass > 0.5 m					13.4 (500)
Bunch grass < 0.5 m			13.4 (500)		
Herbaceous spp.	0 (360)	6.5 (920)	0 (480)		3.4 (1760)
Sedges > 0.5 m		8.0 (560)	0 (280)		5.3 (2200)
Sedges < 0.5 m	0 (360)	9.4 (640)	0 (280)	13.8 (80)	
Ferns			0 (240)		0 (520)
Mosses, Liverworts		0 (280)			
Sub-totals	0 (720)	6.9 (2400)	3.8 (1780)	5.9 (660)	4.9 (5560)
Totals	5.3 (1680)	5.1 (10784)	2.0 (10762)	1.9 (6560)	

APPENDIX III

Other habitat observations for *Phascogale calura*.

Reference	Locality	Date	Vegetation		No. *P. calura* captured	Notes
			Floristics	Structure		
A.A. Burbidge (pers. comm.)	Dryandra State Forest	22-25 June 1971	*Eucalyptus accedens* *E. wandoo* *Gastrolobium microcarpum* *Bossiaea eriocarpa* *Casuarina huegeliana*	'Woodland'	5	Burnt 1-8½ years previously
N. McKenzie (pers. comm.)	Tutanning Nature Reserve	22-24 May 1975	*E. wandoo* *C. huegeliana* *Oxylobium parvifolium* *Astroloma prostratum* *A. epacridis* *Dryandra ferruginea*	Low woodland A Low scrub B Mixed dwarf scrub D	3	Not burnt for at least 40 years
As above	As above	As above	*E. wandoo* *C. huegeliana* *D. sessilis* *Xanthorrhoea reflexa* *G. spinosum* *Banksia sphaerocarpa* *D. ferruginea*	Open low woodland A Scrub Heath A Dwarf scrub D	2	As above
WAM Nos 7134-5, 7137	Near Mooterdine	28-29 April 1964	*Casuarina* sp.	'Thicket'	3	—
7140			Mallet (*Eucalyptus* spp.) and *G. trilobum*	'Woodland'	2	—
WAM Nos 7136, 7139	Near Contine	30 November and 7 December 1964	*E. wandoo* and mallet Mallet and *Dryandra* sp.	'Woodland' 'Woodland'	1 1	—
McKenzie *et al.* 1975	Dragon Rocks Nature Reserve	3 August 1972	*E. salmonophloia* *Acacia merrallii*	Forest Shrub mallee	1	Not burnt for at least 20 years

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ON THE VALIDITY OF THE PUFFERFISH GENUS *OMEGOPHORA* WHITLEY (TETRAODONTIFORMES: TETRAODONTIDAE) WITH THE DESCRIPTION OF A NEW SPECIES

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ABSTRACT

Omegophora Whitley, 1934 is considered a valid generic name for two species from temperate Australian waters, and is redefined. The genus differs significantly in dorsal craniology from *Arothron*, particularly in the shape of frontals and prefrontals. *Omegophora armilla* (Waite and McCulloch) is redescribed, and *O. cyanopunctata* sp. nov. is described, being distinct from it on the basis of both morphology and osteology. Full synonymy is provided for *O. armilla*.

INTRODUCTION

Omegophora armilla (Waite and McCulloch, 1915) is a moderately common inhabitant of temperate Australian seas, where it has been recorded from southern Western Australia to southern New South Wales. Although some degree of sexual dimorphism is apparent in the colouring of *O. armilla* (Scott 1962), the species is easily distinguished from all other Australian pufferfishes by virtue of a thin, black ring, which encloses the upper half of, and on occasions completely encircles, the pectoral fin base.

Alternative generic allocations have been few since the original description (as *Tetraodon armilla*) by Waite and McCulloch (1915). In 1934, Whitley proposed a new name, *Omegophora*, but this has not been accepted by subsequent authors, despite Whitley's continued usage.

In this paper, validity of the genus *Omegophora* Whitley is reconsidered, and the type species, *O. armilla*, redescribed. In addition, examples of *Omegophora* representing a new species apparently restricted to the south-western coastline of Western Australia, are described.

METHODS AND ABBREVIATIONS

Measurements were taken by dial caliper and millimetre rule (to the nearest 0.1 mm for measurements less than 10 mm), in a manner similar to that outlined by Dekkers (1975).

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Fin ray counts include all visible rays, both branched and unbranched. Fin ray lengths were determined by measurement from the embedded base.

One example of each species was cleared and stained, and all others X-rayed, for the examination of osteology.

All measurements are from preserved specimens.

The following abbreviations are used in the text: SL — standard length; HL — head length; TL — total length; N — number of specimens examined; AMS — Australian Museum, Sydney; CSIRO — Commonwealth Scientific & Industrial Research Organisation, Fisheries & Oceanography Division, Cronulla; MAGNT — Museums and Art Galleries of the Northern Territory, Darwin; NMV — National Museum of Victoria, Melbourne; QVM — Queen Victoria Museum & Art Gallery, Launceston; SAM — South Australian Museum, Adelaide; WAM — Western Australian Museum, Perth.

SYSTEMATICS

Subsequent to its original description, *Tetraodon armilla* had three further generic allocations. Of these, neither *Sphoeroides* Anon. (see Shipp 1974; Tyler and Paxton 1979) nor *Arothron* Muller, 1841 (see Fraser-Brunner 1943; Hardy 1980; Tyler 1980) exhibit some of the characters considered herein to be diagnostic of *Omegophora*. Le Danois' (1959) referral of *Tetraodon armilla* to *Catophororhynchus scaber* (Eydoux and Souleyet, 1841) (in part) was without any valid reason, and cannot be seriously entertained.

Tyler (1980), who examined also *Arothron hispidus*, *A. nigropunctatus*, and *A. stellatus*, found that while some external features of *T. armilla* are suggestive of *Arothron*, others including aspects of the skull osteology are not. He concluded that comparison with further *Arothron* species may confirm the validity or otherwise of the name *Omegophora* Whitley. Morphological examination during this study of *Arothron immaculatus* (Bloch and Schneider, 1801) and *A. reticularis* (Bloch and Schneider, 1801) and osteological examination of *A. firmamentum* (Temminck and Schlegel, 1850), have confirmed the generic distinctiveness of *T. armilla* compared with various *Arothron* species. This disparity is further enhanced by the finding of a second *armilla*-like species.

In defining the genus *Omegophora*, Whitley (1934) considered it to be markedly different from *Tetraodon* Linnaeus, but referred for comparison only to Boulenger's (1916) figure of *T. lineatus* Linnaeus. However, Fraser-Brunner (1943) noted the characteristics of *Tetraodon* in more detail. Such characters as a nasal sac with two thick tentacles, a supra-anal branch of the lateral line, prefrontals separated by the ethmoid and in contact with the palatines, and the frontal notched anteriorly to the sphenotic, do not match those in *Omegophora*. In fact the combination of generically significant characters seen in *Omegophora* species has not been recorded for any other genus.

We recognise therefore, the validity of *Omegophora* Whitley for *armilla* and the new species described herein.

Genus *Omegophora* Whitley, 1934

Type-species: *Tetraodon armilla* Waite and McCulloch, 1915, by monotypy.

Diagnosis

Form robust; snout elongate; interorbital convex; nasal organ a single, distally expanded flap; eye completely adnate; pectoral fins bilobed, median rays shorter than those above or below; other fins rounded; no ventrolateral skinfold; anterior margin of gill opening lacking projecting spur or papillae; small spines densely cover back, sides, and belly, usually extending on to caudal peduncle; lateral line encircling eye with anterodorsal branch arising posterior to nasal organ; no lateral line posterior to pectoral fin on ventrolateral surface.

Prefrontals meet in midline immediately anterior to frontals, separating the latter from ethmoid; orbital margin of frontal concave; frontal extended towards pterotic by short, posterolateral wing; parasphenoid with dorsal extension in orbit; dorsal myodome represented by medial prongs of prootic extending to midline; distinct trituration teeth replaced more or less by raised, unevenly surfaced plates; no interhyal; single hypohyal; well developed first dorsal and anal fin rays; posterior prongs absent from last basal pterygiophores; several abdominal vertebrae with complete haemal arches.

Comparison with Other Genera of Tetraodontidae

Tyler and Paxton (1979) have discussed in some detail the relationships of several tetraodontid genera. While it is here considered unnecessary to reiterate in detail the generic characteristics, the following points can be made. *Omegophora*, being neither especially elongate, nor streamlined, is in this regard similar to *Sphoeroides* species. However, the possession of a single flap nasal organ not only distinguishes *Omegophora* from *Sphoeroides* and its nearest relatives (see Tyler and Paxton 1979), but also from *Arothron* and *Chelonodon*. Furthermore, the bilobed appearance of the pectoral fin is more suggestive of the genus *Canthigaster* (Subfamily Canthigasterinae).

The lateral line of *Omegophora* essentially follows the generalized pattern seen in most *Sphoeroides* species and *Arothron*. However, a variation in *Omegophora*, the anterodorsal extensions arising from the supraocular branch posterior to the nasal organ, is seen in neither *Sphoeroides* nor *Arothron*, or in any other of the tetraodontid genera represented by Australian species. The possession of abdominal vertebrae with complete haemal arches is a feature recorded for several genera as well as *Omegophora*; similarly for the oblique epural position (the somewhat horizontal placement in *O. cyanopunctata* cannot be reasonably compared with the horizontal placement in *Lagocephalus*, owing to the anteroposterior elongation of the epural in the latter — Tyler 1970). The absence of distinct trituration teeth in *Omegophora* is perhaps less significant than it may at first appear, considering the raised, uneven inner surfaces of the premaxillary in *O. armilla* and to a lesser extent in *O. cyanopunctata*.

Omegophora essentially differs little from *Pelagocephalus*, *Sphoeroides*, *Fugu*, *Torquigener*, and *Amblyrhynchotes* (see Tyler and Paxton 1979), with regard to presence of first pharyngobranchial teeth, presence of a dorsal extension of the parasphenoid in the orbit, absence of an interhyal, absence of last basal pterygiophore posterior prongs, absence of a dorsal hypohyal, well developed first dorsal and anal fin rays, and absence of a ventrolateral skin fold on the caudal peduncle. However, medial prongs from the prootic are more strongly developed in *Omegophora* than in the above genera (as well as in *Arothron*), except in some species of *Sphoeroides*. In addition, the dorsal extension of the parasphenoid in the orbit in *Omegophora* is considerably more strongly developed than in *Arothron*.

Omegophora differs markedly from *Arothron* species in the shape of the frontals and prefrontals. The frontals of *Arothron* are greatly expanded over the orbit, whereas those in *Omegophora* (see **Fig. 3A, B**), particularly in *O. armilla*, are not much wider over the orbit than more posteriorly. In addition, the frontals of *Omegophora* are anteriorly tapered instead of ending abruptly in their articulation with the prefrontals and ethmoid (see Fraser-Brunner 1943, Fig. 2; Hardy 1980, Fig. 4). Furthermore, the exclusion of the ethmoid from the frontals by the prefrontals in *Omegophora* differs from the situation in *Arothron*, wherein the prefrontals are separated mostly by the ethmoid, which makes broad contact with the frontals. The prefrontals in *Omegophora* enclose the olfactory foramen, as is the case in *Arothron*, but are not as strongly down-turned anterior to the orbit.

Omegophora armilla (Waite and McCulloch, 1915)
(Ringed Toadfish or Pufferfish)
Figs 1A, B; 3A

Tetraodon armilla Waite and McCulloch, 1915: 457-458, 475, pl. 15 (Type locality: Great Australian Bight, between 22-140 fathoms); Waite, 1921: 196, fig. 328; McCulloch, 1921-22: 128; Waite, 1923: 227, fig. on 227; McCulloch, 1927: 102; Waite, 1928: 10; McCulloch, 1929: 427; Whitley, 1934: 160; Scott, 1963: 26; — 1965: 64; — 1971: 119, 141.

Omegophora armilla: Whitley, 1934: 160-161; — 1943: 144; — 1948: 32; — 1965: 59.

Sphaeroides armilla: Fraser-Brunner, 1943: 11; Scott, T.D., 1962: 296, pl. on 296; Halstead, 1967; Baslow, 1969: 197; Scott, Glover and Southcott, 1974: 327, 330, pl. on 330.

Catophororhynchus scaber (Eydoux and Souleyet): Le Danois, 1959: 208, 246, 252, 255 (in part).

Arothron armilla: Thomson, 1977: 63; Hutchins, 1979: 89, 100, pl. 79; Tyler, 1980.

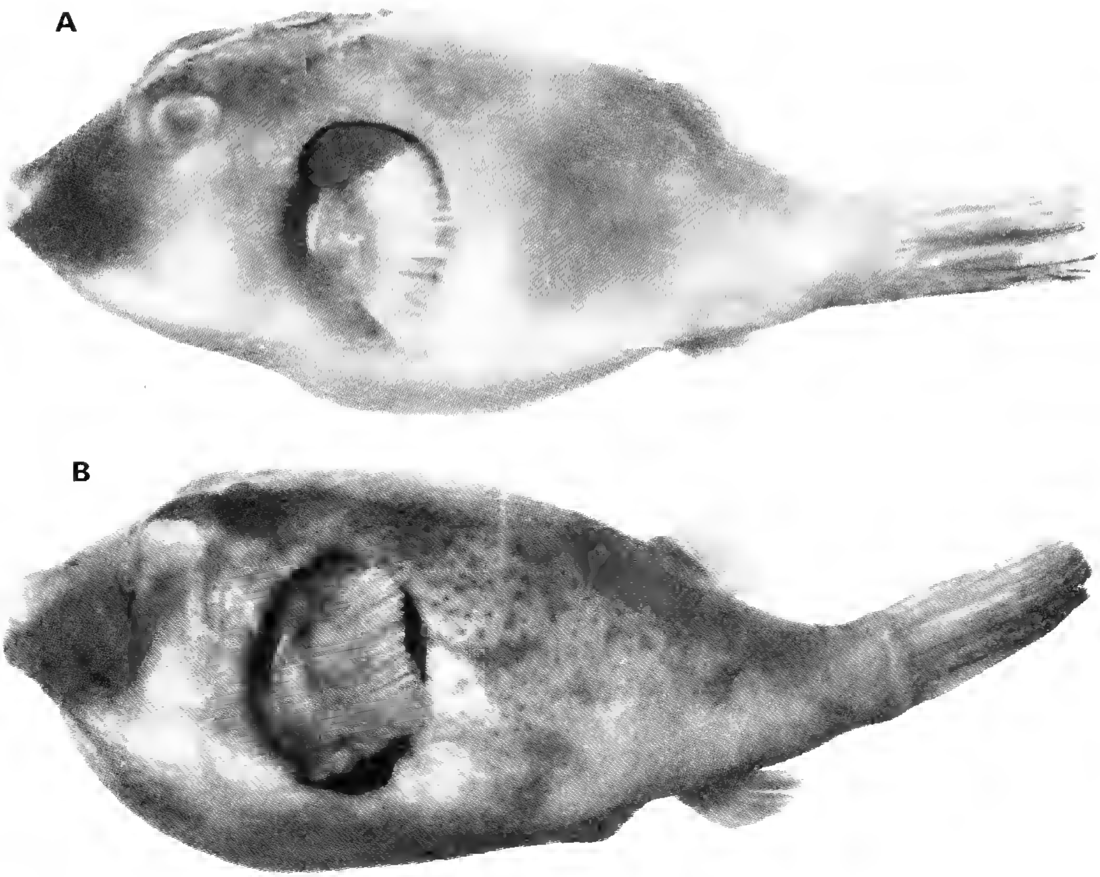

Fig. 1: (a) *Omegophora armilla*, WAM P.25754-001, 101 mm SL, showing the usual condition of the black ring, partially encircling the pectoral fin; (b) *Omegophora armilla*, AMS I.20234-012, 181 mm SL, showing the extreme condition of the black ring, completely encircling the pectoral fin.

Diagnosis

Distinguished from the only other known species in the genus by the thin, black ring enclosing the greater part or all of the pectoral fin base; broader ethmoid and maxillary; frontals more deeply concave over the orbit; deeper interorbital septum formed by the dorsal extension of the parasphenoid contacting the frontal and prefrontal.

Description

The proportions given below are based on the holotype, 10 paratypes, and 21 additional specimens, 71-200 mm SL (the range for paratypes and additional specimens appears in parentheses):

Dorsal rays 12 (11-13); anal rays 11 (9-11); pectoral rays 22 (20-23[1]); caudal rays 11 (11); vertebrae 8 + 11 (8 + 11, 8 + 12, 9 + 11 or 10 + 11).

Body elongate, somewhat bulky about head and pectoral region, rounded dorsally and flattened ventrally, tapering to the moderately thickened caudal peduncle; head length 3.1 (2.7-3.2) in SL; snout to anterior of vent 1.6 (1.3-1.6) in SL, to origin of dorsal fin 1.5 (1.3-1.5) in SL, to origin of anal fin 1.4 (1.3-1.4) in SL, to origin of pectoral fin 2.9 (2.4-2.9) in SL; width at base of pectoral fin 3.3 (2.5-3.5) in SL; depth from dorsal fin origin to anal fin origin 3.7 (3.3-4.2) in SL; depth at posterior of dorsal fin 4.4 (4.4-5.7) in SL; caudal peduncle length 4.7 (4.7-5.5) in SL; least depth of caudal peduncle 9.5 (7.5-9.5) in SL.

Mouth small, terminal on a protruding snout, width 3.9 (3.2-5.4) in HL; lips moderately thick, covered with numerous short papillae; chin lacking; nasal organ a small, single tentacle, slightly expanded distally, length 18.9 (15.7-29.1) in HL; snout to anterior edge of nasal organ 1.7 (1.6-2.1) in HL; posterior edge of nasal organ to anterior edge of eye 5.7 (5.7-8.2) in HL.

Eye smallish, round, completely adnate, slightly interrupts dorsal profile, lower border well above level of mouth corner, horizontal diameter 4.6 (3.7-5.9) in HL; least fleshy interorbital distance 3.0 (2.7-3.8) in HL and 9.5 (8.3-10.8) in SL; margin of gill opening without lobules; posterior of eye to anterior edge of gill opening 2.8 (2.4-3.1) in HL.

Pectoral fins more or less bilobed, the median rays shorter than those above or below, maximum length of pectoral fin from base 7.5 (6.5-8.2) in SL; top of base well below lower margin of eye; first ray about one-third length of second; dorsal fin wide and rounded, based slightly forward of vent, first ray (9.3-12.7) in SL (anteriormost 3 rays malformed in holotype); longest ray 8.2 (6.5-8.2) in SL; base 14.0 (11.4-14.4) in SL and 1.7 (1.5-2.2) in longest ray; anal fin wide and rounded, based almost posterior to dorsal fin base, first ray 11.3 (9.4-12.8) in SL; longest ray 8.9 (7.0-8.9) in SL; base 18.6 (14.8-18.6) in SL and 2.1 (1.8-2.6) in longest ray; caudal fin rounded, maximum length 4.6 (3.5-4.6) in SL (upper second and third rays malformed in holotype).

Ventrolateral skin fold absent; lateral line often indistinct in adults (indistinct in holotype), associated with small papillae, encircles eye with anterodorsal branch arising posterior to nasal organ and meeting in midline and preopercular branch extending almost to belly, continuing to caudal fin base, dropping sharply between pectoral and anal fins; dorsal branches of lateral line may meet in midline; second lateral line bridging middle of snout, almost meeting anterior part of eye encircling line, before dropping antero-ventrally behind mouth on to belly, along lateral region of which it passes, curving towards but failing to meet pectoral fin base.

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1 Fifteen pectoral fin rays on one side in SAM F1605; pectoral fin ray counts include the rudimentary uppermost ray.

Body spines short, multi-rooted, densely scattered over body from mid-snout to caudal peduncle though more sparse on ventral aspect of latter.

Colour of holotype in alcohol: after long preservation, dull brown over body and fins, slightly darker on snout and with paler patches on belly; darker brown band borders posterior of lower lip; clearly delineated, black semicircle curves posteriorly from upper anterior edge of gill opening almost to level of pectoral fin base.

Colour in life (based on colour transparencies of live fish under water): dorsal base colour light to medium brown or grey, sometimes with pale patches about mid-dorsum; two brown bars extend down each side of body, first passing obliquely through eye to lower jaw, joining with corresponding bar from other side, second just posterior to pectoral fin; interspaces on sides pale; ventral surface white; a thin, black ring, sometimes open ventrally, encircles pectoral fin base; area enclosed by ring medium brown or greyish; adult males with blue spots on the head and sides, and a thin, blue ring outside and encircling black ring; fins yellow, caudal more dusky with lowermost rays blackish.

Distribution

Relatively common around south-western Western Australia, from west of Lancelin Island (31°01'S, 115°19'E) and extending around the coasts of South Australia, Victoria, and New South Wales to Botany Bay (34°00'S, 151°11'E); uncommon in Tasmanian waters, although recorded from north-western Bass Strait (P. Last, pers. comm.), and several recorded off Flinders Island and one off King Island; also recorded (extralimital?) from York Sound, north-western Western Australia. Known from depths of up to 146 m.

Remarks

For their description of *Tetraodon armilla*, Waite and McCulloch (1915) referred to 12 specimens, and nominated one held in the South Australian Museum as type (holotype). Of the remaining 11 specimens, 10 are held in the Australian Museum, Sydney, being labelled 'cotypes'. We are unaware of the repository for the remaining specimen. Whitley's (1934) proposal of *Omegophora* for *Tetraodon armilla* referred to paratypes in the Australian Museum, but gave no indication of number present. There is little doubt regarding the identity of the types. The holotype (SAM F168), though previously unlabelled as such, corresponds in length (TL = 195 mm; c.f. 200 mm reported by Waite and McCulloch), in the malformation of the uppermost caudal fin ray, which was represented in the figure of the type, and in time of acquisition, which corresponds to the cruise of the trawler *Simplon* (the report of the latter formed the basis of the paper in which *Tetraodon armilla* was described).

Of the 10 paratypes located, nine have locality data corresponding exactly to those listed by Waite and McCulloch. The locality of the tenth (AMS

E.725) is missing from the description, apparently an oversight on the part of the authors.

Because of the extreme latitudinal range between York Sound and the next most northern Western Australian record for *O. armilla*, some doubt was initially cast on the authenticity of the northernmost record. However, the registration data for this specimen (MAGNT S.0232) is unambiguous, and the collector known for accuracy in collection details (G.F. Gow, pers. comm.).

Material Examined

(N = 67, two or more specimens in a lot indicated by number in parenthesis.)

Holotype: SAM F.168, 160 mm SL, *Simplon* trawling cruise, 16-30 September 1914, Great Australian Bight.

Paratypes (N = 10): AMS E.478, 94 mm SL, east coast of Flinders I., 73 m; AMS E.725, 109 mm SL, 16 August 1909, 66 km W of Kingston, S.A., 55 m; AMS E.953, 159 mm SL, Flinders I., AMS E.978, 126 mm SL, off St Francis I., Investigator Group, S.A.; AMS E.2304-5(2), 71-80 mm SL, Doubtful I. Bay, south-west W.A., 37-46 m; AMS I.10193, 106 mm SL, E of Flinders I., 73 m; AMS I.10344, 100 mm SL, 19 August 1905, Marsden Point, Kangaroo I.; AMS I.10388, 162 mm SL, 30 August 1909, Flinders I., 68 m; AMS I.12300, 111 mm SL, 30 November 1911, Doubtful I. Bay, south-west W.A., 37-46 m. (All specimens collected by F.I.S. *Endeavour.*)

Additional: Western Australia: York Sound, MAGNT S.0232; 31°05'S, 114°55'E, WAM P.9366; Rottnest I., WAM P.4154; WAM P.25754-001; due west of Rottnest I., WAM P.5651 (146 m), WAM P.7407-08 (2); Cockburn Sound, WAM P.5649 (skeletonized), WAM P.22183, WAM P.23294 (18 m), WAM P.24515 (14 m), WAM P.25713-001; Bunbury, CSIRO C.2585, WAM P.10481; Eagle Bay, Geographe Bay, AMS I.20234-012; King George Sound, Frenchmans Bay, WAM P.5052; Michaelmas I., WAM P.5041; Cheynes Beach, WAM P.5040; Leighton, WAM P.5667; south Western Australia, CSIRO C.1442.

South Australia: Off Port Lincoln, SAM F.3108; Outer Harbour, SAM F.1877, SAM F.2749; Sellicks Beach, SAM F.1976; St Vincents Gulf, AMS I.14; Glenelg, SAM F.3050; Investigator Strait, AMS I.20194-008; Corney Pt, Yorke Peninsula, SAM F.2145.

Victoria: 5 km SSE of Cape Woolomai, NMV A.744 (3); Bass Strait, NMV A.746 (2); off Phillip I., 38°32'S, 145°15'E, NMV A.627; Sorrento Ocean Beach, NMV A.747; Portsea Ocean Beach, NMV A.288; 27 km SSW of Lakes Entrance, 29-37 m, NMV A.745 (2), NMV A.748.

New South Wales: Off Botany Bay, 91 m, AMS I.14994; Wollongong, AMS IA.1837; off Eden, 119 m, AMS I.13789.

King Island, Bass Strait: Porky Beach, QVM 1970/5/22.

Great Australian Bight: CSIRO C.3504.

No data: WAM P.717; SAM F.1601 (3), SAM F.1602, SAM F.1605 (2), SAM F.1608, SAM F.1609 (3), SAM F.1610 (2).

Omegophora cyanopunctata sp. nov.
(Blue-spotted Pufferfish)
Figs 2, 3B; Table 1

Arothron sp.: Hutchins 1979: 100.

Holotype

WAM P.26942-001, 123 mm SL, female, B.C. Russell, 1 April 1978, Canal Rocks, Cape Naturaliste, W.A.

Paratypes

Eighteen specimens from Western Australia, AMS I.20219-012 (2 specimens), 55-101 mm SL, B.C. Russell, 20 March 1978, Rob I., Recherche Archipelago; AMS I.20220-013 (2 specimens), 88-96 mm SL, B.C. Russell, 20 March 1978, Lucky Bay, Recherche Archipelago; AMS I.20231-009, 146 mm SL, B.C. Russell, 27 March 1978, 0.5 km S of Carnac I., Cockburn Sound; AMS I.20233-016, 112 mm SL, collection data as for holotype; AMS I.20236-012, 99 mm SL, B.C. Russell, 4 April 1978, South Point, Two People Bay; AMS I.20243-005, 93 mm SL, B.C. Russell, 11 April 1978, Rottnest I.; AMS I.21732-001, 114 mm SL, G.S. Hardy, 23 December 1979, Busselton jetty, 2 m (skeletonized); WAM P.5648, 121 mm SL, off Middleton Beach; WAM P.24540, 87 mm SL, D. Parker, 28 November 1971, Carnac I., Cockburn Sound; WAM P.25763-001, 85 mm SL, J.B. Hutchins, 8 April 1977, Sandy Hook I., Recherche Archipelago; WAM P.25769-001, 112 mm SL, J.B. Hutchins, 2 April 1977, Sandy Hook I., Recherche Archipelago; WAM P.26003-004 (2 specimens), 79-86 mm SL, J.B. Hutchins, R. Steene, 16 March 1978, Lucky Bay, Recherche Archipelago; WAM P. 26564-001, 133 mm SL, Quarry Bay Beach, 1.5 km N of Cape Leeuwin; SAM F.4549 (ex WAM P.26602-001), 74 mm SL, N. Sinclair, 14 April 1980, Michaelmas I. (35°03'S, 118°02'E); WAM P.26928-001, 120 mm SL, N. Coleman, 7 April 1971, Busselton, 7.5 m.

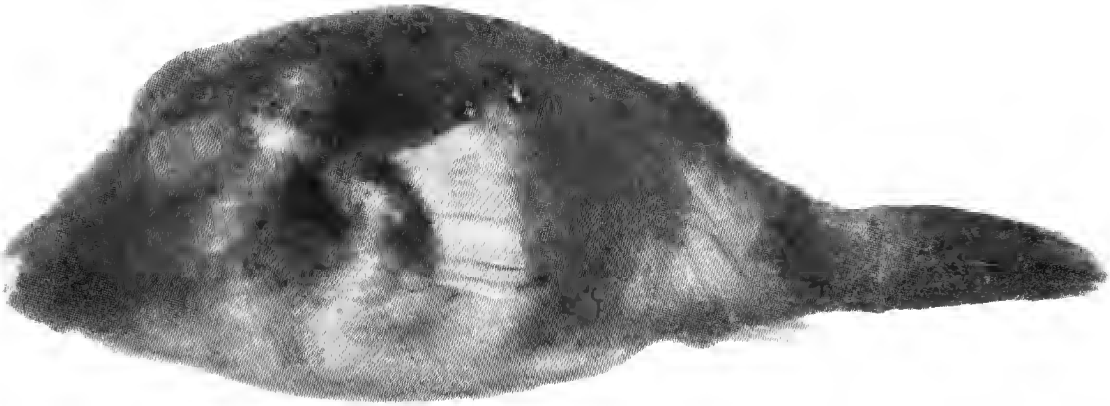

Fig. 2: *Omegophora cyanopunctata* sp. nov., holotype, WAM P.26942-001, 123 mm SL.

Diagnosis

Distinguished from *O. armilla* by the iridescent blue spots on cheeks and flanks, and lack of a thin, black ring over or surrounding pectoral fin base; narrower ethmoid and maxillary; shallower interorbital septum formed by the dorsal extension of the parasphenoid contacting the frontal and prefrontal.

Description

Measurements and counts of the holotype and five paratypes are presented in Table 1.

The following counts and proportions are based on 19 type specimens, 55-146 mm SL: dorsal rays 10-12; anal rays 9-11; pectoral rays 19-22; caudal rays 11; vertebrae 8 + 11 or 8 + 10.

Body elongate, somewhat bulky about the head and pectoral region, rounded dorsally and flattened ventrally, tapering to the moderately thickened caudal peduncle; head length 2.4-2.9 in SL; snout to anterior of vent 1.3-1.5 in SL, to origin of dorsal fin 1.3-1.4 in SL, to origin of anal fin 1.2-1.4 in SL, to origin of pectoral fin 2.1-2.6 in SL; width at base of pectoral fin 2.3-2.7 in SL; depth from dorsal fin origin to anal fin origin 3.5-4.0 in SL; depth at posterior of dorsal fin 4.6-5.9 in SL; caudal peduncle length 5.2-6.7 in SL; least depth of caudal peduncle 7.2-9.0 in SL.

Mouth small, terminal on a protruding snout, width 3.1-5.6 in HL; lips moderately thick, covered with numerous short papillae; chin lacking; nasal organ a small, simple tentacle, slightly expanded distally, length 13.3-34.4 in HL; snout to anterior edge of nasal organ 1.8-2.1 in HL; posterior edge of nasal organ to anterior edge of eye 5.5-8.9 in HL.

Eye smallish, round, completely adnate, slightly interrupts dorsal profile, lower border well above level of mouth corner, horizontal diameter 3.6-5.1 in HL; least fleshy interorbital distance 2.5-3.9 in HL and 6.8-10.4 in SL; margin of gill openings without lobules; posterior of eye to anterior edge of gill opening 2.5-3.5 in HL.

Pectoral fins more or less bilobed, the median rays shorter than those above or below; maximum length of pectoral fin from base 6.2-7.0 in SL; top of base just below lower margin of eye; first ray one-third length or shorter than second; dorsal fin wide and rounded, based slightly forward of vent, first ray 8.8-10.9 in SL; longest ray 6.0-7.4 in SL; base 11.4-13.6 in SL and 1.8-2.0 in longest ray; anal fin wide and rounded, based almost posterior to dorsal fin base, first ray 9.4-11.0 in SL; longest ray 7.1-8.3 in SL; base 14.0-17.5 in SL and 1.7-2.5 in longest ray; caudal fin rounded, maximum length 3.3-4.5 in SL.

Ventrolateral skin fold absent; lateral line may be indistinct in adults, associated with small papillae, encircles eye with traces of an anterodorsal branch posterior to nasal organ and a preopercular branch extending almost to lateral limit of belly, continues to caudal fin base, dropping sharply between pectoral and anal fins; dorsal branch of lateral line not meeting in midline; traces of second lateral line dorsally in middle of snout, continuous behind mouth on to belly, along the lateral region of which it passes, curving towards but failing to meet the pectoral fin base.

Body spines short, multi-rooted, densely scattered over body from mid-snout to dorsal fin, sometimes continuing sparsely on anterior part of caudal peduncle.

TABLE 1

Measurements (mm) and fin ray counts of selected type specimens of *Omegophora cyanopunctata*.

	Holotype WAM P.26942-001	Paratypes AMS I.20231-009	WAM P.26564-001	AMS I.20233-016	AMS I.20236-012	WAM P.25763-001
Standard length	123	146	133	112	99	85
Head length	48	53	47	44	38	31
Snout-vent length	86	100	94	78	72	61
Snout to origin of dorsal fin	92	106	96	84	74	63
Snout to origin of anal fin	93	107	105	88	78	65
Snout to origin of pectoral fin	52	60	52	48	48	34
Body width at base of pectoral fin	52	63	55	49	37	34
Dorsal fin origin to anal fin origin	34	43	33	32	28	22
Depth at posterior of dorsal fin	24	31	23	22	20	16
Caudal peduncle length	22	27	23	20	16	15
Caudal peduncle least depth	14	20	16	13	12	11
Snout to anterior edge of nasal organ	24	30	26	22	20	16
Posterior edge of nasal organ to eye	8.2	8.6	5.3*	6.3	5.3	5.1
Nasal organ length	3.6	1.7*	2.4	2.0	1.5	0.9
Eye horizontal diameter	11	11	11	9.5	8.7	7.8
Least fleshy interorbital width	16	21	15	13	12	9.2
Posterior of eye to anterior of gill opening	16	21	15	14	13	12
First dorsal ray length	12	12	13	11	10	9.3
Longest dorsal ray length	18	20	19	15	15	14
Base of dorsal fin	10	12	10	8.8	7.8	6.8
First anal ray length	12	11	13	11	10	8.5
Longest anal ray length	17	18	17	14	13	11
Base of anal fin	7.4	9.7	8.4	7.0	6.6	5.3
Maximum pectoral fin length	19	21	20	16	16	13
Maximum caudal fin length	29	33	32	25	27	22
Dorsal ray count	11	11	10	11	11	12
Anal ray count	9	10	10	10	10	10
Pectoral ray count	21/21	20/20	21/21	21/21	19/21	21/21
Sex	Female	Female	?	Female	Female	?

* Measurement affected by distortion.

Colour of holotype in alcohol (Fig. 2): dorsal surface of snout and head dark, grading into paler regions on cheek; further dark area anterior to gill opening; remaining dorsal and lateral surfaces consist of large mottled light and dark areas, with small, dark spots superimposed on flanks between pectoral and dorsal fins; bases of pectoral and dorsal fins dark; upper lip pale; middle of lower lip similarly pale, bordered on sides and behind by a broad, dark band; belly pale; caudal fin dark, other fins pale.

Colour in life: dorsal base colour brown to dark brown with numerous iridescent blue spots; three brown to dark-brown bars extend down each side of body, first passing obliquely through eye to lower jaw, joining with corresponding bar from other side, second enveloping gill slit and pectoral base and bifurcating ventrally, and the third just posterior to pectoral fin; interspaces on side pale brown to cream; ventral surface white with ventro-lateral surface lined with yellow; adult males possess a black to brown circular blotch above pectoral base, surrounded or partly surrounded by an iridescent blue line or series of spots; fins yellow to orange, caudal more dusky with lowermost rays blackish.

Distribution

South-west corner of Western Australia, from Rottnest Island (32°00′S, 115°30′E) off Fremantle to the Recherche Archipelago (34°10′S, 122°15′E). Recorded from depths to 25 metres.

Osteological Comparisons of *Omegophora armilla* and *O. cyanopunctata*

The most noticeable difference between the two species lies in the distinctly heavier build of many of the skull and axial skeleton bones of *O. armilla* compared with *O. cyanopunctata*. This can be seen particularly in the broader ethmoid and wider maxillary in the former species (see **Fig. 3A, B**). In both species, the ethmoid is anteriorly fused extensively with the underlying vomer, and is overlain posteriorly by the prefrontals which meet in the midline. The orbital margin of the frontal is weakly concave in its postero-lateral extension to the sphenotics in *O. cyanopunctata*, and more deeply so in *O. armilla*.

A further distinction between the species is the depth of the interorbital septum, formed by the dorsal extension of the parasphenoid contacting the frontal and prefrontal; the septum is deeper in *O. armilla*, and is reflected morphologically in the lower edge of the eye being markedly higher in relation to the pectoral fin base in that species.

In both species, the frontal is extended posterolaterally as a short wing towards the pterotic, leaving a moderately broad fossa between the lateral extensions of the frontal. Medial prongs extend from the prootic to the midline. In some other tetraodontids, these represent the remains of the dorsal myodome (Tyler 1963). A further anteromedial projection from the prootics in *O. cyanopunctata* is not so well developed in *O. armilla*.

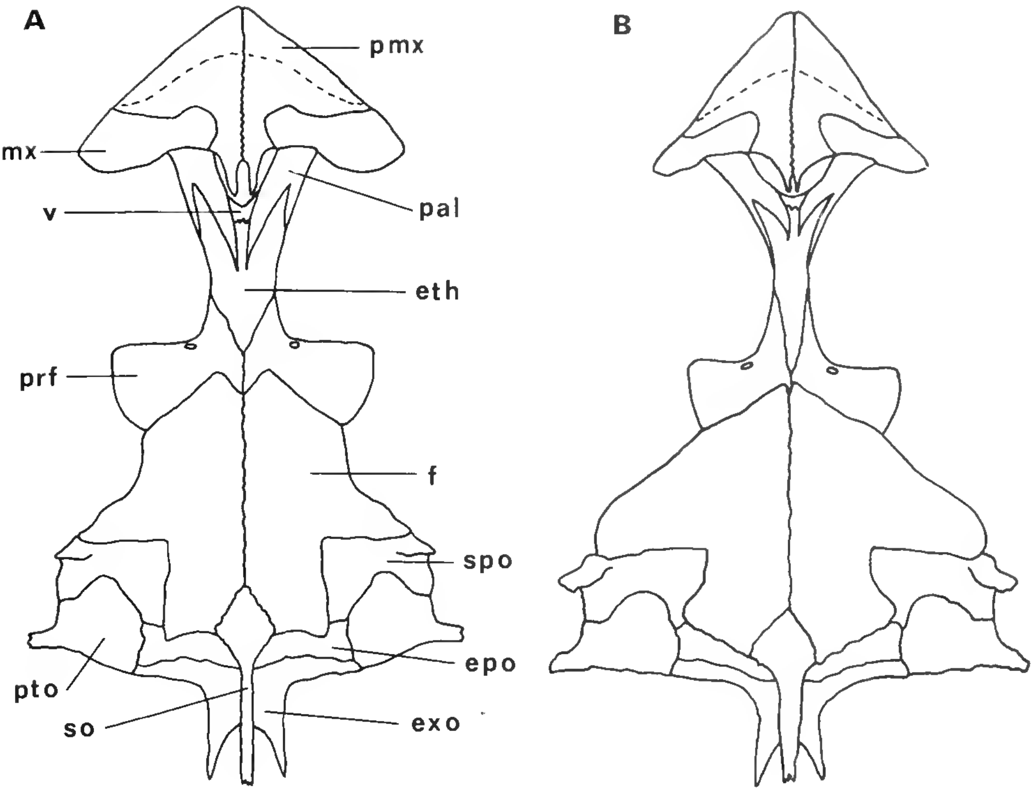

Fig. 3: (a) Skull osteology of *Omegophora armilla* (skull length 60 mm). Abbreviations: epo, eipotic; eth, ethmoid; exo, exoccipital; f, frontal; mx, maxillary; pal, palatine; pmx, premaxillary; prf, prefrontal; pto, pterotic; so, supra-occipital, spo, sphenotic; v, vomer; (b) Skull osteology of *Omegophora cyanopunctata* (skull length 54 mm).

The inner surface of the upper jaw, while lacking distinctly formed trituration teeth, has a raised, somewhat uneven surface, particularly in *O. armilla*, in which species the inner surface of the lower jaw is similarly uneven. In both species the pharyngobranchials all possess a number of small but distinct teeth. The first pharyngobranchial bears about 30 teeth (both species), the second pharyngobranchial bears about 20 teeth in *O. cyanopunctata* and about 25 teeth in *O. armilla*, and the third pharyngobranchial bears about 12 teeth in *O. cyanopunctata* and about 15 teeth in *O. armilla*. There is no interhyal and only a single hypohyal in both species.

The modal vertebral formula 8 + 11 = 19 is common to both species, as are the complete haemal arches of the four posteriormost abdominal vertebrae. However, variation in vertebral formula is greater in *O. armilla*. The haemal arch of the first caudal vertebra is not especially expanded laterally, though more so than those adjacent to it on either side. A similar, moderate laterial expansion occurs in the proximal articulating surface of the first basal pterygiophore of the anal fin. In both species, the posteriormost dorsal and anal fin basal pterygiophores are distally comprised of several fused columnar elements.

The caudal skeleton is essentially typical of tetraodontids (Tyler 1964), with an autogenous haemal spine of the penultimate vertebra, a free parhypural, a lower hypural plate fused to the centrum, an upper free hypural plate, and a free epural, somewhat horizontally placed in *O. cyanopunctata*, and more obliquely placed in *O. armilla*. Both species however, lack an elongate urostyler projection from the centrum of the last vertebra, which in many other members of the family, separates for the most part the epural from the free upper hyprual plate (Tyler 1964).

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THE GENUS *ACANTHOPHIS* (SERPENTES: ELAPIDAE) IN WESTERN AUSTRALIA

G.M. STORR*

ABSTRACT

Three species of death adder are recognised in Western Australia, namely *Acanthophis antarcticus* (Shaw) in the far south, *A. praelongus* Ramsay in the far north, and *A. pyrrhus* Boulenger in the intervening arid regions. Descriptions and a key are provided.

INTRODUCTION

Differences between the various forms of *Acanthophis* are slight compared to the striking differences between them and other elapid snakes; hence the tendency to lump them as subspecies of a single species, *A. antarcticus*. However, in the Western Australian Wheat Belt the known range of *A. pyrrhus* (at Bunjil) comes within 150 km of that of *A. antarcticus* (at Cadoux) without the slightest indication of gene flow between them. Nor is there any evidence of gene flow between *A. pyrrhus* and *A. praelongus*, despite the proximity of their ranges in southern Kimberley. It therefore seems best to treat the three taxa tentatively as allospecies. The names of these taxa will also remain tentative until an Australia-wide revision is undertaken.

All the material studied in this revision is lodged in the herpetological collection (R series) of the Western Australian Museum.

SYSTEMATICS

Genus *Acanthophis* Daudin, 1803

Description

Moderately large, stout elapid snakes (total length up to 74 cm), remarkably similar in habit to viperid snakes. Head wide, deep and sharply marked off from very narrow neck. Forebody slender but rapidly broadening towards midbody. Tail slender, the distal portion laterally compressed and terminating in a soft slender spine.

Head scales smooth to strongly rugose, usually entire (most frequently the prefrontals are longitudinally divided; occasionally the preocular and

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rarely the lowest primary temporal are transversely divided). Rostral 2.5-4.0 times as wide as high. Internasals considerably smaller than prefrontals, except when latter divided. Frontal much longer than wide and narrower than supraoculars. Parietals about as long as wide. Nasal large, rarely semi-divided, in contact with preocular and third labial. Preocular usually single. Postoculars usually 2. Suboculars 2 or 3. Temporals usually 3 + 3 or 4, lowest primary largest but seldom completely separating fifth and sixth labials. Upper labials 6, last 2 much the largest, third and fourth higher than wide. Dorsal scale rows 17-23 at midbody, usually reducing to 17 before vent but increasing or reducing on neck according to species; the few rows nearest to ventrals always smooth; other rows smooth to strongly keeled (keeling strongest in adults and on neck and forebody, with keels often terminating in a spine). Ventrals 110-152. Anal single. Subcaudals 36-63, anteriorly single, posteriorly paired.

Dorsally various shades of brownish-grey to reddish-brown, with 40-70 diffuse pale bands across body and tail; bands usually about as wide as interspaces and often marked posteriorly by black spots. Compressed tip of tail blackish or whitish and contrasting more or less sharply with rest of tail. Lips more or less boldly patterned (scales usually pale-edged and dark-centred).

Distribution

Ranging widely in Australia (except far south-east and far south-west) and eastern half of Indo-Australian Archipelago (Ceram and Tanimbar east to New Guinea).

Key to Western Australian Species

1 Head scales smooth or weakly rugose; anterior dorsals weakly keeled or smooth; upper lips boldly patterned with white and black or dark brown . . . . *A. antarcticus*

Head scales moderately or strongly rugose; anterior dorsals strongly keeled (except in juveniles); upper lips not boldly patterned 2

2 Head and body bright reddish-brown; head scales strongly rugose; midbody scale rows usually 19 or 21 . . . . *A. pyrrhus*

Head and body dark brown or dark reddish-brown; head scales moderately rugose; midbody scale rows usually 23 . . . . *A. praelongus*

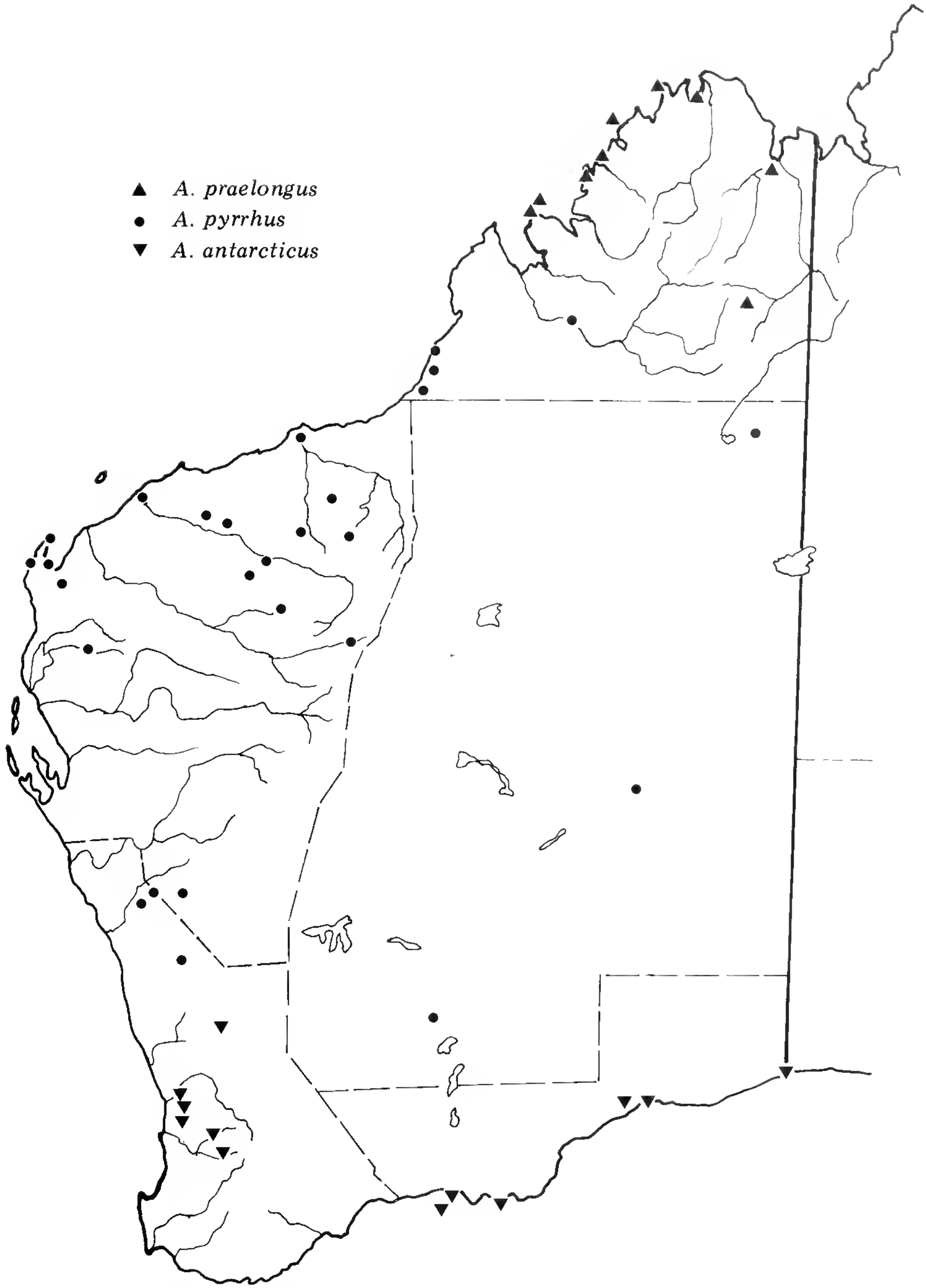

Fig. 1: Map of Western Australia showing location of specimens of *Acanthophis praelongus*, *A. pyrrhus* and *A. antarcticus*.

Acanthophis antarcticus Shaw, 1794

Fig. 2

Boa antarctica Shaw, 1794, The Naturalist's Miscellany, pl. 535. Type locality presumably vicinity of Sydney, N.S.W.

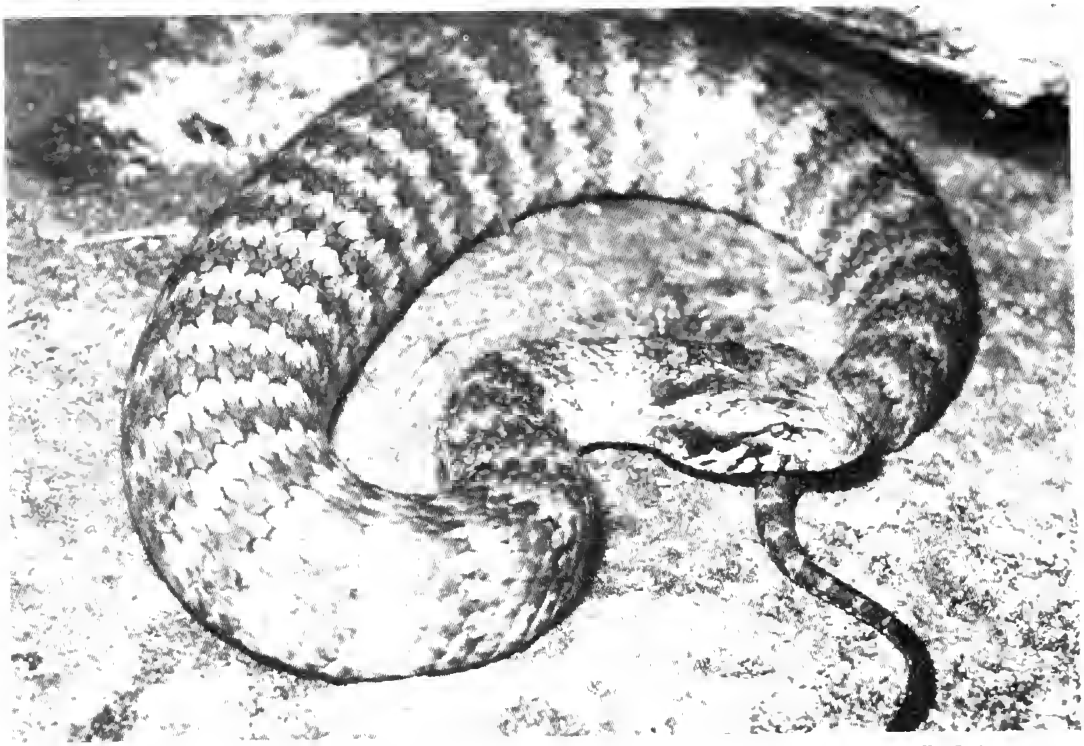

Fig. 2: An *Acanthophis antarcticus* from Canning Dam photographed by R.E. Johnstone.

Diagnosis

A very stout *Acanthophis* with upper head shields smooth or slightly rugose, anterior dorsal scales weakly keeled or smooth, posterior dorsal scales smooth or very weakly keeled, head deeper than in other species and upper lips more boldly patterned.

Description

Snout-vent length (mm): 132-585 (N 34, mean 414.8). Length of tail (% SVL): 14.7-25.2 (N 33, mean 20.3).

Prefrontals 2 (N 16), 3 (3) or 4 (3). Preoculars 1 (N 28) or 2 (3). Postoculars 2 (N 30) or 3 (1). Suboculars 2 (N 17) or 3 (14). Upper labials 6 (N 32). Temporals: primaries 3 (N 33); secondaries 3 (N 26), 4 (5) or 5 (1). Dorsal scale rows: 21 (N 34) or 23 (1) at midbody; seldom reducing on neck, i.e. usually not changing or increasing by 2 rows; usually reducing to 17 before vent. Ventrals 110-124 (N 25, mean 116.6). Subcaudals 36-50 (N 33, mean 45.4), 16-31 single (mean 23.6), 17-26 paired (mean 21.8).

Dorsal ground colour dark greyish-brown or dark brownish-grey. Back and tail with 40-50 pale grey or pale brown cross-bands; on posterior edge of bands usually a series of black spots (apices and posterior edges of scales). On back of head 1 or 2 pale oblique streaks, converging anteriorly. Snout pale brown peppered with blackish-brown. Often a broad blackish streak from orbit back through lower temples. Lips whitish barred with black or brown. Rest of lower surfaces whitish except for black or dark brown centres to gulars, anterior ventrolaterals (dorsals nearest to ventrals) and subcaudals, and occasionally for brown flecks on ventrals.

Distribution

Patchily distributed in southern Western Australia: the northern Darling Range, central Wheat Belt, Esperance district (including the Archipelago of the Recherche) and southern edge of Nullarbor Plain (Fig. 1).

Material

South-West Division (W.A.): Cadoux (19124); Lion Mill (248); Crystal Falls, Lesmurdie (28160); Maddington (12267); Pickering Brook (58779); Bartons Mill (8823); Karragullen (9643); Araluen (10393, 26689); Kelmscott (7402); Canning Dam (5948, 19804, 26803, 58080, 64698); Armadale (1523) and 10 km SE (26688); Byford (13693, 20577) and 5 km E (22332, 26351); Jarrahdale (5619, 9576, 34068); Congelin (8646); 14-mile Brook, 33 km W of Narrogin (2820).

Eucla Division (W.A.): Esperance (28096); Boxer I. (10102-3); North Twin Peak I. (53096); Caiguna (40197) and 22 km S (51814); Twilight Cove (44975); Eucla (2160).

Acanthophis pyrrhus Boulenger, 1898

Fig. 3

Acanthophis pyrrhus Boulenger, 1898, Ann. Mag. nat. Hist. (7) 2: 75. Station Point, N.T.

Diagnosis

A relatively slender, reddish *Acanthophis* with upper head shields strongly rugose, prefrontals often divided, anterior dorsal scales very strongly keeled, and posterior dorsals strongly keeled in adults (weakly or moderately keeled in juveniles).

Description

Snout-vent length (mm): 141-634 (N 40, mean 352.0). Length of tail (% SVL): 16.2-25.4 (N 28, mean 20.6).

Prefrontals 2 (N 11) or 4 (22). Preocular single (N 30). Suboculars 2 (N 30). Temporals: primaries 3 (N 31) or 4 (1); secondaries 3 (N 14), 4 (17) or 5 (1). Upper labials 6 (N 29). Dorsal scale rows: 17 (N 1), 19 (23), 20 (1) or 21 (24) at midbody; seldom reducing on neck, i.e. usually increasing by 2 rows or not changing; usually reducing to 17 before vent. Ventrals 126-152 (N 22, mean 139.3). Subcaudals 42-63 (N 25, mean 51.4), 11-39 single (mean 26.6), 6-37 paired (mean 24.8).

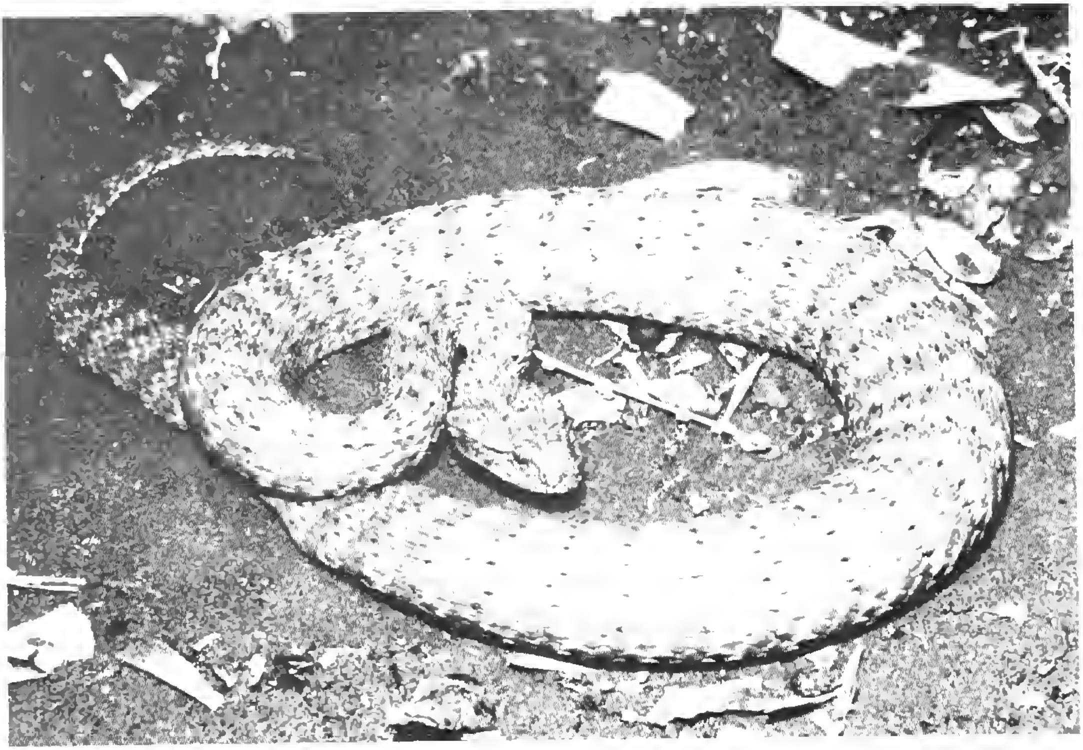

Fig. 3: An *Acanthophis pyrrhus* from Giralia photographed by T.M.S. Hanlon.

Dorsal ground colour reddish-brown. Body and tail with 50-70 pale reddish-brown or brownish-white cross-bands; on posterior edge of bands usually a series of black or dark brown spots. Lips and lower surfaces whitish.

Distribution

Arid zone of Western Australia from south Kimberley south to the northern Wheat Belt and Eastern Goldfields (**Fig. 1**). Also arid interior of eastern Australia.

Material

Kimberley Division (W.A.): Mt Wynne (2138); Lagrange and vicinity (3437, 28097, 28100-7, 70701); Frazier Downs (28098, 46079); Anna Plains (28099).

North-West Division (W.A.): DeGrey (2130); Marble Bar (438, 12674, 14061) and 10 km N (12672); Mardie (13873, 26822); Woodstock (13870); Mt Herbert (20239); Tambrey (4550); Nullagine (9335); Vlaming Head (2999, 19674); Neds Well (28325); Exmouth (26759); mouth of Yardie Creek (61495); Exmouth Gulf (8658); 5 km E of Giralia (61357); Wittenoom (17121, 18493) and 11 km E (15100); Wittenoom Gorge (8886, 21538); Marandoo (56097); 31 km SE of Mt Meharry (67921); Mundiwindi (12280); near Middalya (49985); Wurarga (7868, 10033).

South-West Division (W.A.): Tallering (9996); Mullewa (70700); Bunjil (1767).

Eastern Division (W.A.): Balgo (69975); Gahnda Rockhole (15101); Kalgoorlie (70699).

Acanthophis praelongus Ramsay, 1877
Fig. 4

Acanthophis praelongus Ramsay, 1877, Proc. Linn. Soc. N.S.W. 2: 72. Cape York, Qld.
Acanthophis antarcticus rugosus Loveridge, 1948, Bull. Mus. Comp. Zool. 101: 392. Merauke, south-eastern West Irian.

Fig. 4: An *Acanthophis praelongus* from 45 km NNE of Halls Creek photographed by G. Harold.

Diagnosis

A moderately stout *Acanthophis*, intermediate between *A. antarcticus* and *A. pyrrhus* in several respects (coloration, habit, rugosity of head shields, keeling of dorsals and number of ventrals and subcaudals). Distinguishable from *A. pyrrhus* by darker coloration, stronger colour pattern, smooth or nearly smooth posterior dorsals, undivided prefrontals, and more numerous midbody scales (usually 23, v. usually 19 or 21). Distinguishable from *A. antarcticus* by head shields more rugose, strongly keeled anterior dorsals, free edge of supraocular often raised, lower fourth labial (not much higher than wide), and dorsal scale rows usually fewer on neck than at midbody.

Description

Snout-vent length (mm): 166-482 (N 14, mean 361.1). Length of tail (% SVL): 19.0-25.2 (N 13, mean 21.5).

Prefrontals 2 (N 13). Preocular single (N 13). Postoculars 2 (N 11) or 3 (2). Suboculars 2 (N 9) or 3 (4). Temporals: primaries 3 (N 13) or 4 (1); secondaries 3 (N 11), 4 (2) or 5 (1). Upper labials 6 (N 14). Dorsal scale rows: 21 (N 2) or 23 (12) at midbody; usually reducing by 2 or 4 rows on neck; usually reducing to 17 before vent. Ventrals 122-134 (N 12, mean 126.9). Subcaudals 47-57 (N 15, mean 50.5), 19-39 single (mean 28.3), 14-29 paired (mean 22.2).

Dorsal ground colour dark brown to dark reddish-brown. Body and tail with about 50 cross-bands; scales mostly pale reddish-brown but sometimes intermixed with brownish-white scales; bands occasionally edged with very dark brown. Upper lips dark brown or dark reddish-brown, the lower halves of scales sometimes edged with brownish-white. Lower surfaces whitish except for black, blackish-brown or dark reddish-brown spot on mental, lower labials, two or three lowest scale rows on side of neck, lowest scale row on body and lateral edge of each ventral and subcaudal.

Distribution

Subhumid and semi-arid zones of Kimberley Division, south to the Yampi Peninsula and nearly to Halls Creek (Fig. 1). Also north of Northern Territory, northern Queensland and southern New Guinea.

Remarks

A. praelongus has hitherto been considered conspecific with *A. antarcticus*. However, *A. praelongus* appears to be no closer to *A. antarcticus* than to *A. pyrrhus*. As the latter is almost certainly a full species, it seems advisable to treat *A. praelongus* too as a full species until hybrids or intergrades are found between it and other species.

Material

Kimberley Division (W.A.): Gibson Point, Parry Harbour (70968); Kalumburu (34078-9); Bigge I. (41457); Prince Regent River Reserve in 15°20'S, 124°56'E (46836); Kunmunya (5709); Koolan I. (37761-4); Wotjulum (11241); Wyndham (10628); 45 km NNE of Halls Creek (70690).

Northern Territory: Yirrkala (13517*a-b*); Ranken River (21519).

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A REVISION OF THE PYTHON GENERA *ASPIDITES* AND *PYTHON* (SERPENTES: BOIDAE) IN WESTERN AUSTRALIA

L.A. SMITH*

ABSTRACT

The five species and subspecies representing *Aspidites* and *Python* in Western Australia, namely *A. melanocephalus* (Krefft), *A. ramsayi* (Macleay), *P. spilotus variegatus* (Gray), *P. spilotus imbricatus* subsp. nov. and *P. carinatus* sp. nov. are described and their distribution is mapped.

It is demonstrated that populations of two taxa in south-western Western Australia (*A. ramsayi* and *P. spilotus imbricatus*) have been greatly reduced in the last few decades.

INTRODUCTION

Pythons are large, conspicuous and easily captured. Consequently most of the Australian species were described before the end of last century and generally they number among our best known reptiles. However, the problems of preserving and storing large specimens, such as pythons, has delayed the accumulation of long series in collections and thus an understanding of intraspecific variation and the detection of obscure species and subspecies.

Although a good deal has been published on Australian pythons much of it is of a popular and uncritical nature. Simple facts such as accurate measurements of the various species have until recently been difficult to obtain.

Worrell (1951) attempted to summarize what was known about Australian pythons by combining his field observations with data from specimens in the Australian Museum. Otherwise no one has worked their way systematically through large collections of Australian pythons.

When I began revising the pythons of Western Australia it was my intention to publish all results in one paper. However, it became clear that even in Western Australia '*Liasis childreni*' comprised two (and possibly three) species and that resolution of the *Liasis childreni* complex would be best accomplished by an Australia-wide revision.

This is the first of two papers dealing with species in which study was restricted to Western Australian taxa and populations. The second will deal with the *Liasis olivaceus* species-group.

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This paper is based on 110 specimens in the Western Australian Museum herpetological collection (R series): *Aspidites melanocephalus* (25), *A. ramsayi* (33), *Python spilotus imbricatus* (47), *P. spilotus variegatus* (4) and *P. carinatus* (1).

Width of head was measured at its widest point; length of head from snout to posterior end of the lower jaw.

To minimize error midbody scale rows were counted at the dorsal row opposite the middle ventral. Scale rows at neck were counted two head lengths back from the snout. Scale rows at tail were counted one head length forward of the vent. With bilateral characters such as labials which can vary even in an individual, both counts were recorded for each specimen.

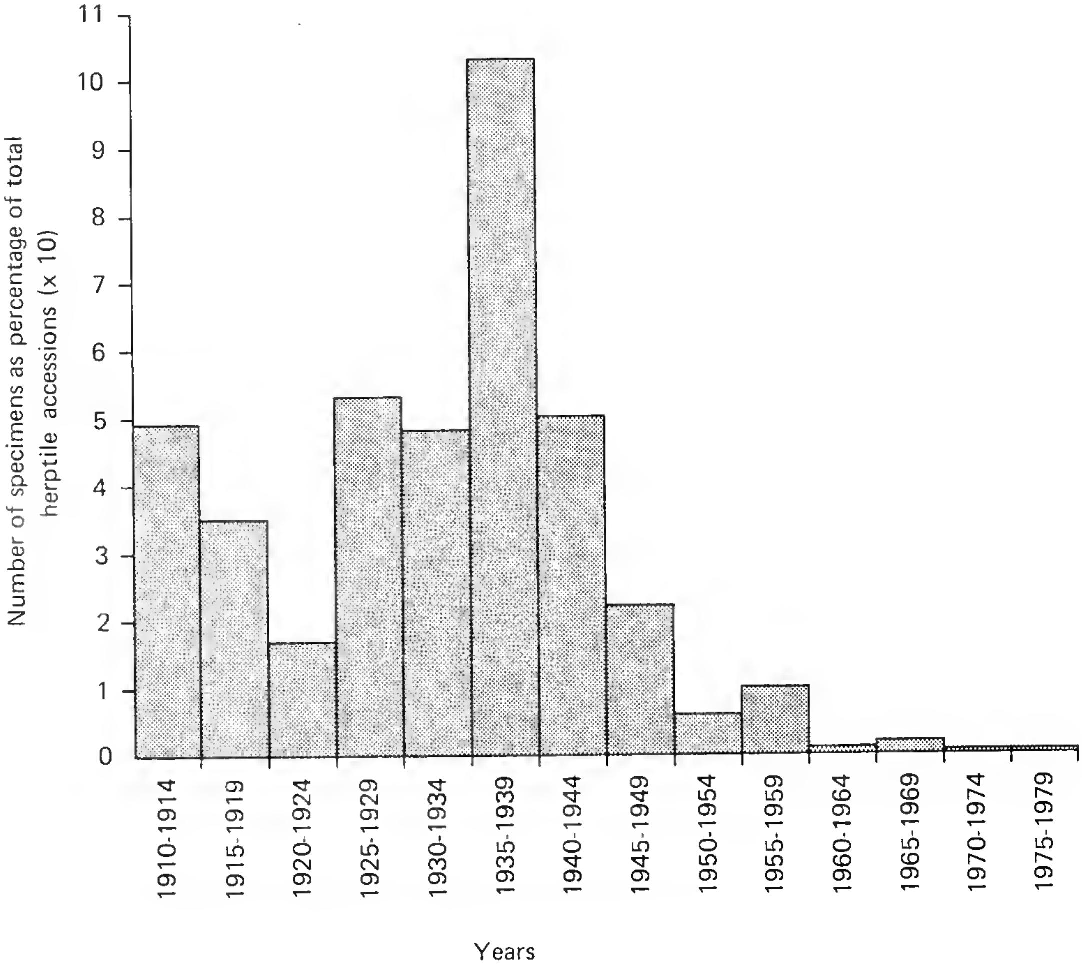

Fig. 1: Western Australian Museum accessions of *Aspidites ramsayi* from south-western Western Australia.

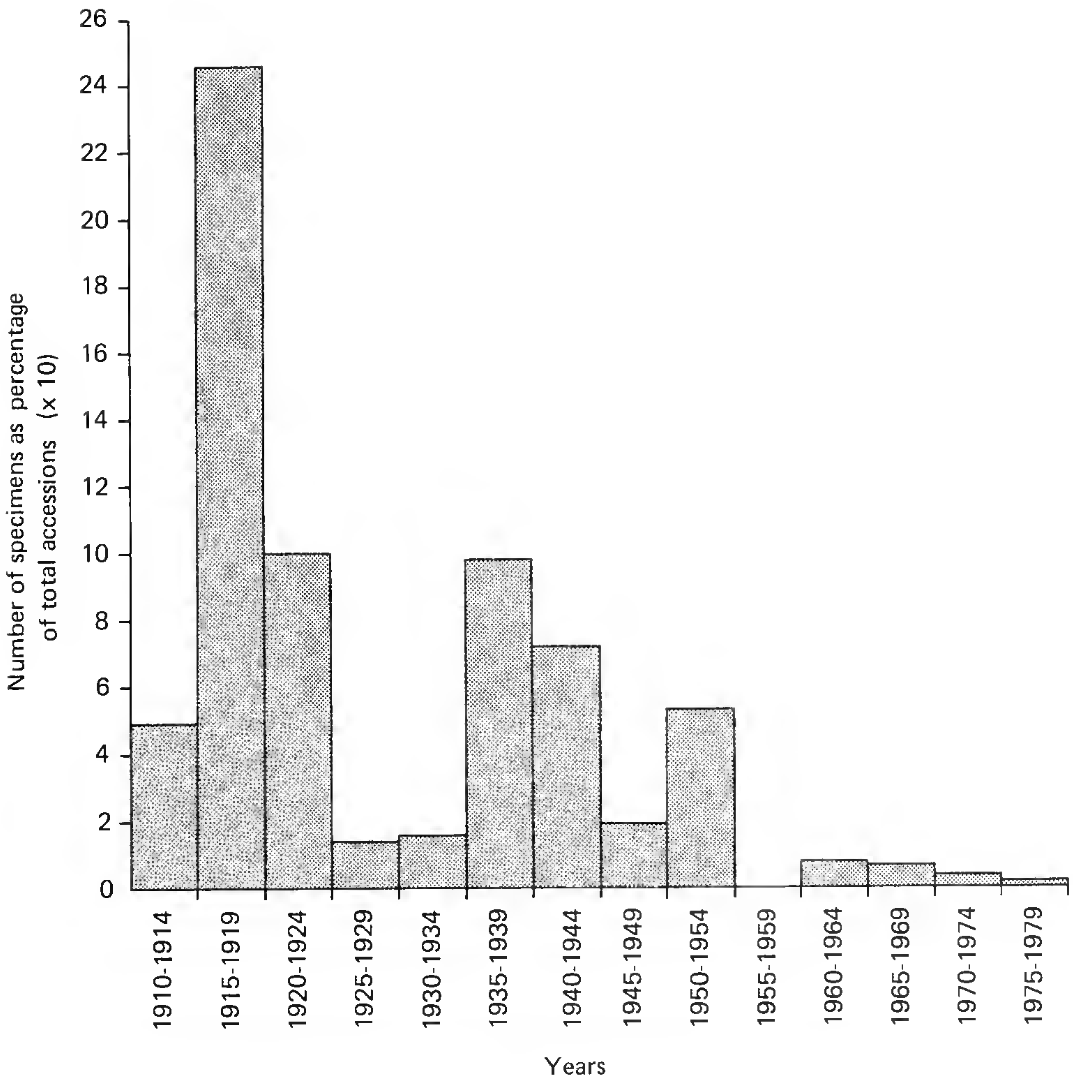

Fig. 2: Western Australian Museum accessions of *Python spilotus imbricatus*.

SYSTEMATICS

Genus *Aspidites* Peters, 1876

Aspidiotes Krefft, 1864.(non Bouché, 1834), *Proc. zool. Soc. London* 1864: 20. Type-species (by monotypy) *Aspidiotes melanocephalus* Krefft.

Aspidites Peters, 1876. *M. Ber. K. preuss. Akad. Wiss.* Berlin 1876: 914. Type-species (by monotypy) *Aspidiotes melanocephalus* Krefft.

Diagnosis

Premaxillary teeth absent. Majority of subcaudals single. Also distinguished from *Liasis* and *Python* by absence of sensory pits on labials and rostral.

Description

Head shields symmetrical. Nasal entire. Parietals fragmented but discernible, usually two symmetrical lobate fragments, sometimes in contact but usually separated by small scales.

Ventrals 273-359. Subcaudals 43-69. Anal scale entire. Midbody scale rows 43-63. Dorsal scales smooth, moderately imbricate, apically rounded.

Juveniles strongly banded and compressed.

Aspidites melanocephalus (Krefft, 1864)

Aspidiotes melanocephalus Krefft, 1864. *Proc. zool. Soc. London* **1864**: 20. Type locality: Port Denison, Queensland.

Aspidites melanocephalus Peters, 1876. *M. Ber. K. preuss. Akad, Wiss. Berlin* **1876**:533, 914.

Diagnosis

Distinguished from *A. ramsayi* by its glossy black or deep reddish-brown hood.

Description

Largest specimen 3023 mm (Smith and Johnstone 1981). Head 1.5-2.1 times as long as wide (N 17, mean 1.6). Neck distinct from head, but not prominently so.

Rostral 1.5-2.0 times as wide as high. Two pairs of prefrontals, anterior pair always and posterior pair almost always in contact. One loreal (N 38). Preoculars 2 (N 38). Postoculars 3 (11% of specimens) or 4 (89% of specimens) (N 36, mean 3.9). Anterior temporals 3 (18% of specimens), 4 (65% of specimens), 5 (11% of specimens) or 6 (6% of specimens) (N 36, mean 4.1). Upper labials 10 (47% of specimens), 11 (47% of specimens) or 12 (6% of specimens) (N 36, mean 10.5), usually fifth and sixth entering orbit, sometimes the sixth (once sixth and seventh). Lower labials 14 (12% of specimens), 15 (18% of specimens), 16 (35% of specimens), 17 (26% of specimens) or 18 (9% of specimens) (N 34, mean 16.1).

Ventrals 315-359 (N 18, mean 330.4). Subcaudals 63-69 (N 18, mean 66.1), mostly entire. Ventrals plus subcaudals 380-427 (N 16, mean 395.9). Scale rows at midbody 50-60 (N 14, mean 53.2), at neck 37-46 (N 13, mean 47.1, decreasing by 6-17), at tail 35-37 (N 8, mean 36.1, decreasing by 15-20).

Coloration of adult. Head with glossy black or deep reddish-brown hood, extending 16-26 scales beyond the parietals. Back light brown to reddish-brown with many irregular dark brown to black bands 2-4 scales wide on flanks, usually increasing in width on back, often to extent of coalescing along vertebral line and sometimes extending on to creamish ventrals and subcaudals as vague blotches and smudges. Bands discernible at all ages. In juveniles contrast between ground colour and bands is more pronounced and the black or dark reddish-brown of the head extends back on to the anterior ventrals.

Distribution

In Western Australia the Kimberley Division south to Lake Argyle, St George Ranges and Broome. Also western part of Great Sandy Desert (Anketell Ridge) and North-West Division (from Port Hedland south to Yardie Creek and east to Warrawagine and Jiggalong) (Fig. 3).

Material Examined

Kimberley Division: Kalumburu (42795); Wyndham (51208); 8 km S of Wyndham (17115-17); 7 km NE Thompson Spring (44785); 8 km N of Lake Argyle Village (60610); Lake Argyle (44786, 59946-48, 60109); 4 km S of Beverley Springs HS (64978); Mt Hart HS (24065); Derby (14940); Broome (58841); Broome (31210); St George Ranges (51292).

Eastern Division: Anketell Ridge road in 20°13′S, 121°24′E (64694).

North-West Division: Port Hedland (12268); Warrawagine (14599); Pannawonica (49888); Tom Price (46170); presumably Learmonth (36566); Yardie Creek (22622).

Northern Territory: Katherine (13732); Kildurk (40008); Tennant Creek (21499); 32 km S of Tennant Creek (21498).

Aspidites ramsayi (Macleay, 1882)

Aspidiotes ramsayi Macleay, 1881. *Proc. Linn. Soc. N.S.W.* 6: 813. Type locality: Fort Burke, New South Wales.

Aspidites collaris Longman, 1913. *Mem. Qd Mus.* 2: 40. Type locality: Avondale Station near Cunnamulla.

Diagnosis

Distinguished from *A. melanocephalus* by absence of dark hood.

Description

Largest specimen 2260 mm. Head 1.2-2.0 times as long as wide (N 23, mean 1.5). Neck distinct from head but not prominently so.

Rostral 1.0-2.0 (mostly 1.5) times as wide as high. Two pairs of prefrontals; anterior pair always, posterior pair almost always in contact. Two (rarely 3) loreals. Preoculars 1 (4% of specimens), 2 (91% of specimens) or 3 (5% of specimens) (N 56, mean 2.0). Postoculars 3 (4% of specimens), 4 (48% of specimens), 5 (39% of specimens) or 6 (9% of specimens) (N 56, mean 4.5). Anterior temporals 4 (4% of specimens), 5 (44% of specimens), 6 (33% of specimens), 7 (15% of specimens), 8 (2% of specimens) or 9 (2% of specimens) (N 46, mean 5.7). Upper labials 11 (9% of specimens), 12

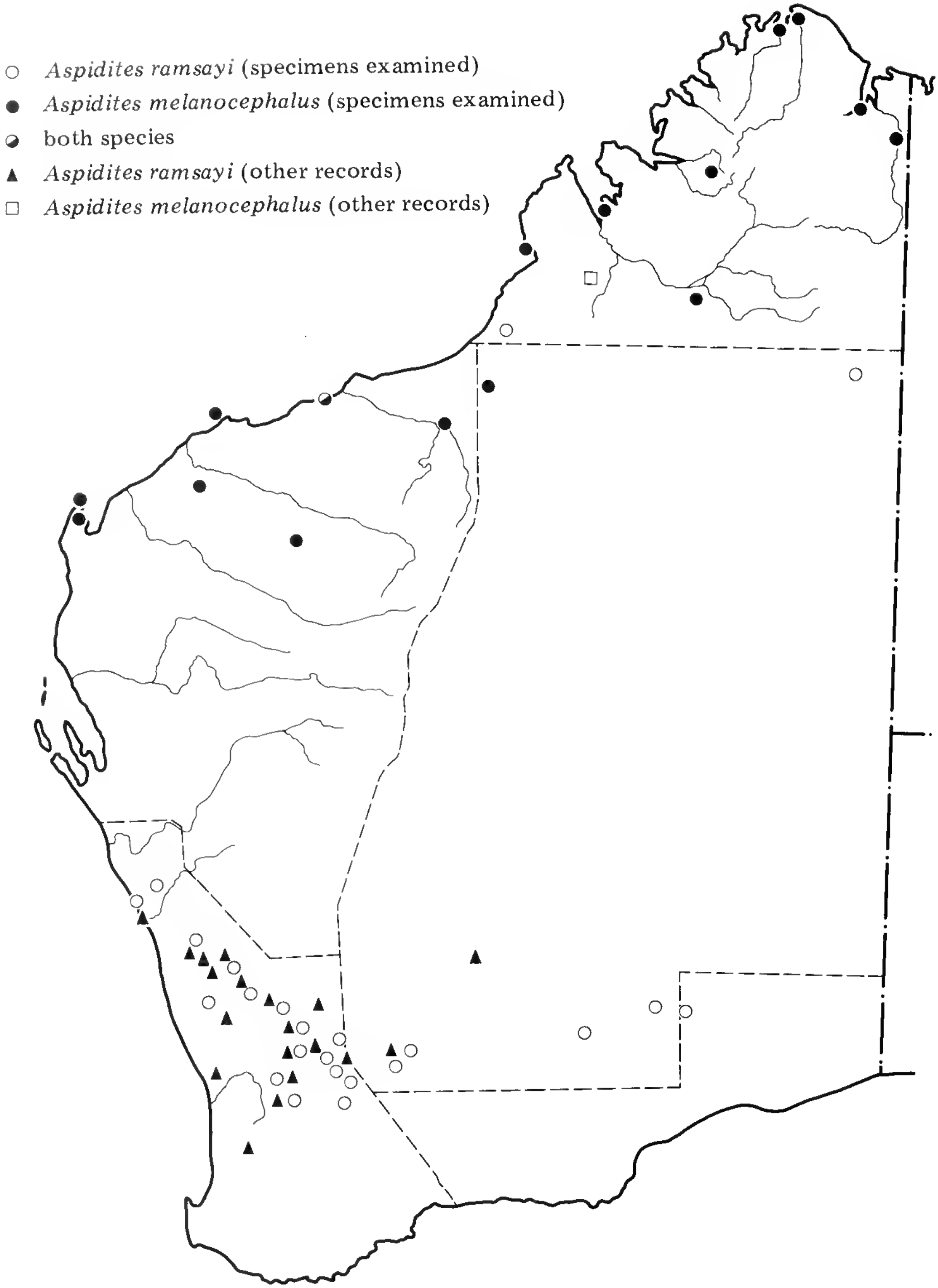

Fig. 3: Location of specimens examined and catalogue records of *Aspidites*.

(46% of specimens), 13 (32% of specimens) or 14 (13% of specimens) (N 54, mean 12.5), usually sixth and seventh entering orbit. Lower labials 14 (2% of specimens) (N 54, mean 16.6).

Ventrals 273-304 (N 27, mean 286.4). Subcaudals 43-53 (N 28, mean 47.5), mostly entire. Ventrals plus subcaudals 317-346 (N 26, mean 332.4). Scale rows at midbody 43-63 (N 26, mean 53.2), at neck 32-42 (N 21, mean 43.5, decreasing by 3-16), before vent 33-51 (N 19, mean 37.8, decreasing by 6-21).

Coloration of adult. Head, body and tail uniform brown except for vague darker bands along vertebral column (remnants of juvenile bands). Ventrals yellow with irregular pinkish-brown markings.

Coloration of juveniles. Supraoculars and tip of snout dark brownish-black. Back and top of tail pale brown with many dark brown bands of regular width (4-6 scales), nearly always coalescing along vertebral line, always wider than interspaces. Scales at edge of bands solid brown, inner scales of bands only edged darker brown. Ventrals (but not throat) brown.

Distribution

The specimens examined are from three areas: (1) the fringe of the Great Sandy Desert from near Balgo west and south to Mt Phire and Port Hedland; (2) the Nullarbor Plain and its vicinity (Zanthus east to near Rawlinna); and (3) the south-west from Yuna south to Boddington and east to Karalee and near Menzies (**Fig.** 3).

The first population is almost certainly continuous with the central Australian population which in turn is presumably continuous with the Nullarbor and near Nullarbor population. If the sight record 19 km S of Menzies is taken as bridging the gap between the Karalee and Zanthus specimens a case for there being a single, more or less continuous population in Western Australia could be made.

However, the sandplains with which this species appear to be associated in the south-west are discontinuous with the arid sandy deserts of the interior. To the north and east they are separated by heavy soils dominated by *Acacia*, particularly mulga. Until there are specimens from these intervening areas with heavy soils to prove the contrary the south-west population is best considered as being separated from the inland population.

Remarks

Pythons, like other large animals, have always posed problems of preservation and storage for museums. In the first half of this century a number of pythons presented to the Western Australian Museum were identified, catalogued, sometimes measured, then discarded.

Two species of python in the south-west of Western Australia (*A. ramsayi* and *P. spilotus*) are easily identified and catalogue records of discarded specimens are considered reliable. Registered numbers of these records are listed under Material Examined in square brackets.

An analysis of all records of *A. ramsayi* records in south-west Western Australia indicates a marked reduction in accessions over the last 40 years, indicating declining numbers of the species in that region (see Fig. 1). About 80% of the Western Australian Museum's accessions of *A. ramsayi* are between 1925 and 1944. There have only been two (3% of total *A. ramsayi* accessions for the area) in the last 10 years. There seems little doubt that the south-western population is close to extinction.

Material Examined

Kimberley Division: Mt Phire (28043).

North-West Division: Port Hedland (34070).

South-West Division: Yuna (5830); between Geraldton and Northampton (5237); Eradu (24849); Newmarracarra (5808); 21 km E of Yandanooka (29578); Arrino [5902]; Caron [5916]; Latham (5804), [8304]; Winchester [9740]; Coorow [8515]; Buntine [9548]; Wubin [7772]; Dalwallinu (1149); 8 km N of Badgingarra (26465); 26 km E of Watheroo (11557); Kalannie [5083]; Pithara [6506]; Kulja (4740); Wialki [8018]; Damboring [6902, 7304]; Walebing [10700]; Gabbin (3318, 5179, 8079); Cowcowing [7517]; Campion (2254); Trayning [4346]; Yelbini (7203); Korrelocking (708); Nukarni (1621, 5831); Boralanning via Noonijin (5979); Burrakoppin (43459); Merredin (17662), [5153]; Norpa (7118); Meckering [213]; Cunderdin (4310), Muntagin (20599); Balkuling [5127, 5131]; near Quairading (2499); Dulbelling [5092]; Narembeen (52102), [7209]; Boddington [8263].

Eastern Division: 40 km N of Balgo Mission (63270); 64 km NNW of Naretha (21969); Zanthus (31152); Karalee (2000); Yellowdine (5072), [5714]; Ghooli [5713], Marvel Loch (4602).

Eucla Division: 48 km NW of Rawlinna (34100).

Other records: Loveridge (1934: 271) lists two Western Australian specimens: MCZ32806 (near Burracoppin) and MCZ32807 (?Merredin). Recorded in the Toodyay district until 1950 by members of Toodyay Naturalists' Club (Storr and Chapman 1979). One seen dead on road 19 km S of Menzies on 11 February 1966 in mixed acacia-mallee scrub, including some mulga (Storr and Smith MS diary).

Genus *Python* Daudin, 1803

See McDowell 1975: 49 for diagnostic characters and synonomy.

Remarks

Until 1977 two species of *Python* were known from Australia, *P. amethystinus* (see McDowell *supra cit.* pp. 31 and 59) from north-eastern Queensland and *P. spilotus* which comprised two subspecies: *P. spilotus spilotus*, which occurs east of the Great Dividing Range from Byron Bay in the north almost to the Victorian border in the south (Gow 1976), and *P. spilotus variegatus*, found across Australia generally west of the Great Dividing Range.

Gow (1977a) described *P. oenpelliensis* from western Arnhem Land, a species apparently restricted to that region.

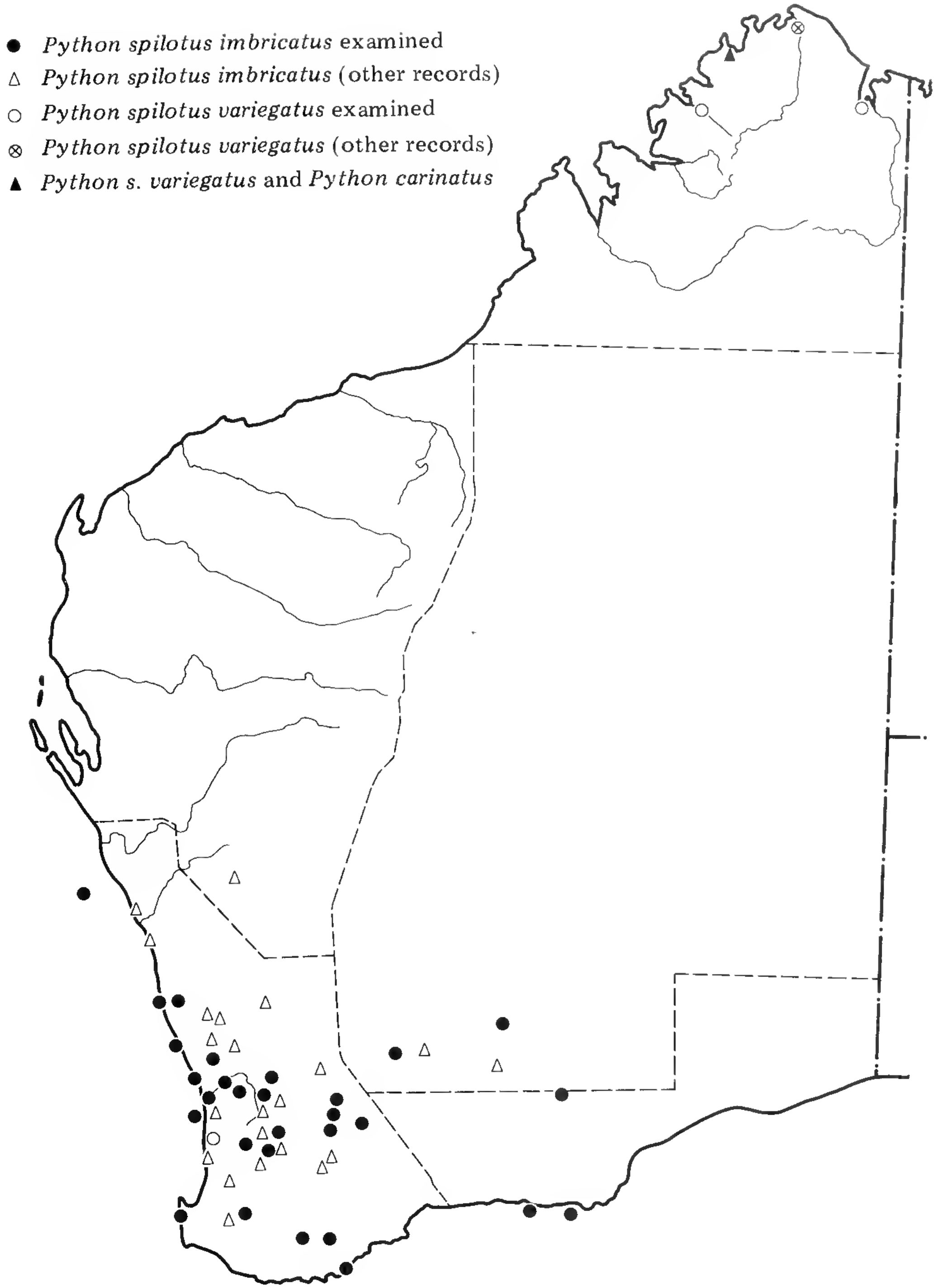

Fig. 4: Location of specimens examined and catalogue records of *Python*.

Similarly, *P. carinatus* (described below) has only been found at one locality on one of the sandstone plateaux of north-west Kimberley and is probably confined to them. It is yet another example illustrating the high degree of endemism in north-west Kimberley reptiles (see Smith and Johnstone 1981).

The distribution of *P. spilotus variegatus* is not as widespread as indicated in general texts. In Western Australia the distinctive south-western population (described below) is completely isolated from *P. spilotus variegatus*. Examination of other *P. spilotus* west of the Great Dividing Range may indicate a similar disjunct distribution. For example, the distinctive reddish central Australian population is probably isolated.

Python carinatus sp. nov.

Figs 5 and 6

Holotype

R45352 in Western Australian Museum; collected at Mitchell River Falls, Western Australia (14°50'S, 125°42'E) on 14 January 1973 by L.A. Smith, R.E. Johnstone and J.A. Smith.

Diagnosis

Distinguished from other species of *Python* by having keeled dorsal scales (Fig. 5).

Description of Holotype (the only available specimen)

Total length 1975 mm (SVL 1760, tail 215). Tail 12.2% of SVL; not prehensile. Cloacal spurs present.

Rostral with angular apex, and a pair of oblique sensory pits; almost as wide as high, penetrating deeply between the internasals which are separated by 2 small median scales. Anterior prefrontals broken into 4 symmetric parts, anterior pair of fragments in contact, posterior pair separated by a scale. Frontal oval (9 x 8 mm). Four supraoculars (third largest) separated from frontal by a row of small scales. Remainder of head shields asymmetrically divided. Loreals small, numerous, sharply differentiated from other scales. Upper labials 14 and 15, seventh and eighth entering orbit (both sides), first 3 on each side with an oblique pit. Lower labials 16 and 17 with pits in labials 9-14, and 10-14. Mental groove deep, bordered on each side by first lower labial and about 15 scales, all much smaller than adjacent gular scales.

Ventrals 298. Anal scale entire. Subcaudals 83, all but numbers 4-6 and 73-80 divided. Scale rows at midbody 45; at neck 41 and at tail 30.

Dorsals imbricate, scales in first and last 4 or 5 rows smooth, remainder with a short, blunt keel (keels strongest on mid-dorsal scales).

Fig. 5: Holotype of *Python carinatus*.

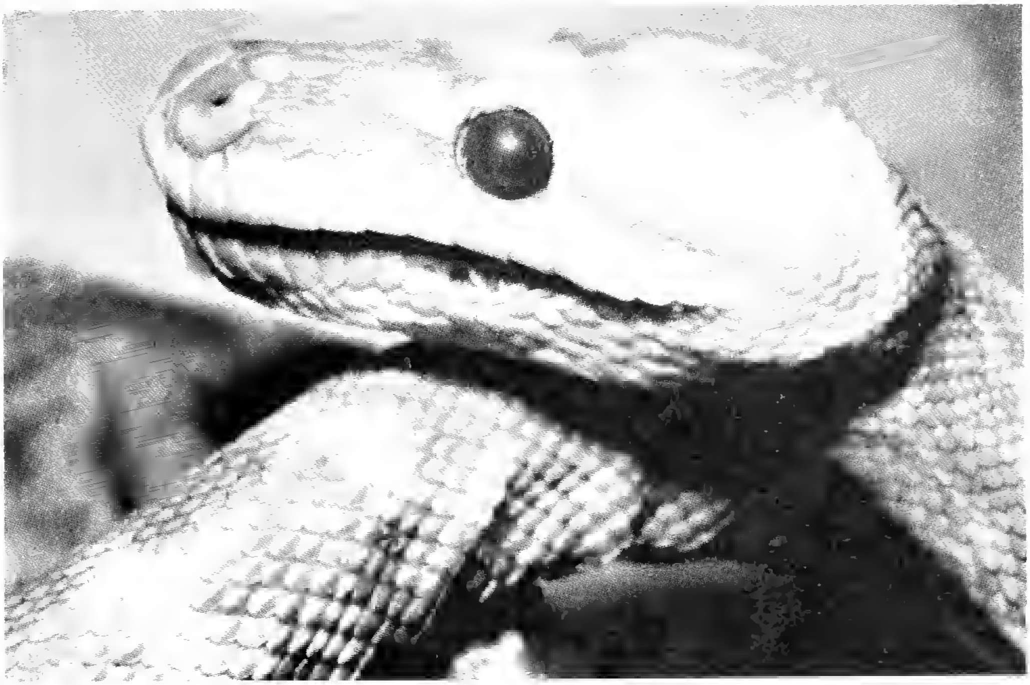

Fig. 6: Head of holotype of *Python carinatus*.

Head brownish, unpatterned except for 2 vague whitish streaks on the temporals. Ground colour of dorsum brownish-white with dark brown variegation and blotches. Ground colour becoming paler and blotches darker posteriorly, thus increasing contrast in pattern. Ventrals mostly off-white, every second to fifth smudged brown.

Distribution

Admiralty Gulf on north-west coast of Kimberley, Western Australia (Fig. 4).

Python spilotus imbricatus subsp. nov.

Fig. 7

Holotype

R54340 in Western Australian Museum; collected at Jurien Bay, Western Australia in 30°18′S, 115°02′E by Mrs N. Lang on 22 February 1976.

Paratypes

See Material Examined.

Diagnosis

Distinguished from *P. spilotus variegatus* by having strongly imbricate, lanceolate (not rhomboidal) posterior dorsals, fewer ventrals (239-276 v. 259-294) and fewer subcaudals (63-82 v. 75-89).

Description

Tail 14.2-19.4% of SVL (N 4, mean 16.9%). Head 1.2-1.8 times as long as wide (N 29, mean 1.6).

Rostral with an angular apex and a pair of oblique sensory pits; as wide as or slightly wider than high. Prefrontals (1 or 2 pairs) and supraoculars discernible, other head shields fragmented into small irregular scales. Upper labials 11 (5% of specimens), 12 (32% of specimens), 13 (40% of specimens), 14 (21% of specimens) or 15 (2% of specimens) (N 72, mean 12.8). An oblique crease on first to fourth (usually first 3), sixth and seventh entering orbit (41.0% of specimens), sixth to eighth (31% of specimens), seventh to eighth (15% of specimens) and seventh to ninth (13% of specimens). Lower labials 16 (7% of specimens), 17 (37% of specimens), 18 (22% of specimens), 19 (28% of specimens) or 20 (6% of specimens) (N 68, mean 17.8). Six to eight (mostly 7) pits on labials 8-16 commencing on labials 8 or 9 in 73.8% of specimens.

Ventrals 239-276 (N 39, mean 260.6). Anal scale entire. Subcaudals 63-82 (N 39, mean 75.3), mostly divided. Ventrals plus subcaudals 312-351 (N 37, mean 336.3). Dorsals smooth, strongly imbricate and lanceolate posteriorly, in 41-49 rows (N 36, mean 44.8) at midbody; at neck 35-40

Fig. 7: A *Python spilotus imbricatus* from Serpentine.

(N 30, mean 36.8, decreasing by 5-18) and at tail 22-30 (N 34, mean 26.3, decreasing by 14-23).

Colour pattern extremely variable. Ground colour of back brownish with numerous irregular pale fawn blotches or transverse bars edged with 1 or 2 rows of black scales. Scales within ocelli paler than ground colour and immaculate. Scales outside ocelli with varying amounts of black on tips of scales. Ocelli on flanks longitudinally elongate and often coalescing to form irregular black-edged ventrolateral stripes.

When the black on tips of scales on back encroaches to cover all scales outside ocelli (often the case anteriorly) pattern is two-toned (ground colour black with pale fawn blotches). Belly usually with 3 strong black longitudinal stripes, especially on posterior two-thirds; otherwise belly yellowish.

Live specimens give the overall impression of being greenish-black.

Distribution

The south-west of Western Australia, north to Geraldton and Yalgoo, and east to Kalgoorlie, Norseman and Mt Le Grand; also West Wallabi, Garden, North Twin Peak and Mondrain Islands (Fig. 4).

Remarks

Ms A. Edwards of the South Australian Museum (*in litt.*, 4 September 1979) informs me that the South Australian Museum has specimen '*P. spilotus variegatus*' from as far west as Denial Bay, Eyre Peninsula. If an early dubious record of *P. spilotus* is ignored (it was part of a small collection which contained two other species not known from Eucla) the western population is separated from the South Australian population by about 1000 km.

As with *A. ramsayi* a number of *P. spilotus imbricatus* were discarded by the Museum. Their numbers are listed below in square brackets.

An analysis of *P. spilotus imbricatus* accessions suggests a decline in the numbers of this subspecies (at least on the mainland) similar to *Aspidites ramsayi* in south-western Western Australia.

Material Examined

Paratypes

South-West Division: West Wallabi I. (18558, 18583-85); Geraldton [6297]; Dongara [12029]; 10 km E of Badgingarra (27968); Moora [8090]; Walebing [768]; Mogumber [12032]; Ledge Point (31040, 49889); Calcarra [8030]; Bindoon Hill (14939); Merredin [51537]; Yanchep (19912); North Baandee [586]; Cunderdin (5765), [375, 7605, 11309]; Clackline [6369, 7639]; Bakers Hill [8401]; Gidgiegannup (22993); Wooroloo [10440]; Chidlows [671]; 13 km E of York (21844); 20 km W of York (3815); Yoting [700]; Balkuling [5127, 5131]; Hemsley [10071]; Middle Swan [5199]; Midland [10914]; Maida Vale [6169]; North Beach [585]; Perth [448, 695, 1105]; Perth District [619], (29822); Wembley [5938]; Cottesloe [10099]; Mt Hawthorn (615); Darlington [6712]; Kelmscott [1505]; Armadale [7227]; Roleystone [6253]; Lesmurdie (5316); Mundaring [6129]; Kalamunda [8918]; Gooseberry Hill (5738); Quairading [605], (5978); Dulbelling [517, 5092]; Narembeen (5647); Beverley [4570]; Garden I. (29394, 44716, 58926-27); Mundijong [11812]; 5 km E of Bendering (42615); Hyden District (34027); Karlgarin (10185), [10884]; Kondinin (46172); 32 km W of Pingelly (34953); Fairbridge N of Pinjarra (5931); Marrinup [10632]; 13 km E of Crossman (70724); Cuballing [6310]; Contine (70723); Hamel [6331]; Buniche [4544]; Williams [1323]; Kukerin [10138]; Boyup Brook (31979); Bridgetown [8495]; Cowaramup Bay (41920); Monigup Pass (824); 13 km SW of Witchcliffe (24850); Cranbrook (788); Two Peoples Bay (36348).

Eastern Division: Yellowdine (6550); Kalgoorlie district (29162); 20 km E of Kalgoorlie (25102); 10 km E of Karalee [10992]; Spargoville [5859].

North-West Division: Yalgoo [4312].

Eucla Division: 104 km E of Norseman (R45775); Mt Le Grand (47671); North Twin Peak I. (54341); Mondrain I. (68278-79).

Python spilotus variegatus (Gray, 1842)

Morelia variegata Gray, 1842. Zool misc. 43. Type locality: Port Essington [Northern Territory].

Diagnosis

Distinguished from *P. spilotus imbricatus* by having less imbricate posterior dorsals which are rhomboidal (not lanceolate) and more ventrals and subcaudals 259-294 (N 14, mean 280) v. 239-276 and 75-89 (N 14, mean 84.1)

v. 63-82 respectively. Sum of ventrals plus subcaudals 336-385 (N 14, mean 364) v. 312-351. See Remarks.

Description

Largest specimen 1431 mm in total length. Tail 17.1% of SVL. Head 1.5-1.7 times as long as wide (N 4, mean 1.6).

Rostral with an angular apex and a pair of oblique sensory pits; as wide as or slightly wider than high. Internasals, prefrontals (1 or 2 pairs) and supraoculars discernible, other head shields fragmented into small irregular scales. Upper labials 12 (37% of specimens) or 13 (N 8, mean 12.6), an oblique crease on first to third, sixth to eighth (50% of specimens), fifth to seventh (25% of specimens) and sixth to seventh entering orbit.

Ventrals 280-290 (N 4, mean 285.2). Anal scale entire. Subcaudals 81-89 (N 4, mean 83.2), mostly divided. Ventrals plus subcaudals 362-379 (N 4, 368.5). Dorsals smooth, weakly imbricate becoming almost juxtaposed, rhomboidal posteriorly, in 45-47 rows (N 4, mean 45.7) at midbody; at neck 34-40 (N 4, mean 37.2, decreasing by 6-10) and at tail 26-28 (N 4, mean 26.7, decreasing by 18-20).

Colour pattern not as complex and variable as *P. spilotus imbricatus*. All but one of the specimens has the ground colour of back tan on reddish-brown with fairly regular pale fawn or whitish black-edged bands 3-4 scales wide (as in photograph in Gow 1977b: 12) with little or no tendency to form longitudinal blotches on lower flanks. Ventrals whitish without black marks.

Pale bands on 32364 have broken to form 3 lines of ocelli: a vertebral and 1 on either flank; the vertebral ocelli tending to coalesce.

Distribution

In Western Australia only in the northern Kimberley.

Remarks

The ranges given in the diagnosis for ventrals, subcaudals and their sums include data from Boulenger (1896: 83) and Mitchell (1964: 310). New Guinea specimens are excluded because of their lower counts (see McDowell 1975: 65). The description is based on the four Western Australian specimens.

All Western Australian specimens show a high degree of compression. Only one of several *P. spilotus imbricatus* of similar size showed the same tendency. It is possible that compression is characteristic of juveniles (as in *Aspidites*). On the other hand it is possible that *P. spilotus variegatus* is smaller and more compressed than *P. spilotus imbricatus*.

Material Examined

Kimberley Division: Mitchell Plateau (61730); Prince Regent River Reserve in 15°28′S, 125°29′E and 15°17′S, 125°04′E (46694, 47038); Wyndham (32364); Pago [1569].

Queensland: Moggill (47673).

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A REVISION OF THE *LIASIS OLIVACEUS* SPECIES-GROUP (SERPENTES: BOIDAE) IN WESTERN AUSTRALIA

L.A. SMITH*

ABSTRACT

Three species and subspecies representing the *Liasis olivaceus* species-group in Western Australia, namely *Liasis mackloti* (Duméril and Bibron), *L. olivaceus olivaceus* Gray and *L. olivaceus barroni* subsp. nov., are described and their distribution is mapped.

INTRODUCTION

This is the second of three papers dealing with the pythons of Western Australia. The first (Smith 1981) revised the genera *Aspidites* and *Python*. This revision of the *Liasis olivaceus* species-group is based on 36 specimens in the Western Australian Museum: *Liasis mackloti* (8), *L. olivaceus olivaceus* (20) and *L. olivaceus barroni* (8). The third paper (Smith in prep.), will be expanded to provide an Australia-wide revision of the *Liasis childreni* species-group.

Methods of obtaining counts and measurements are as in Smith (1981).

Nomenclature follows McDowell (1975).

SYSTEMATICS

Genus *Liasis* Gray, 1842

See McDowell (1975: 31) for synonomy and diagnostic characters.

Remarks

After transferring the Amethyst Python to *Python*, McDowell (*supra cit.* pp. 31 and 59) divided *Liasis* into two species-groups: the *Liasis olivaceus* species-group comprising *L. olivaceus* Gray, 1842, *L. mackloti* (Duméril and Bibron, 1844) and *L. papuensis* Peters and Doria, 1878; and the *Liasis boa* group comprising *L. albertisii* Peters and Doria, 1878, *L. boa* (Schlegel, 1837) and *L. childreni* Gray, 1842 (McDowell *supra cit.* p. 32), although later (p. 33) he wrote, 'the Australian *Liasis childreni* is a highly peculiar form, perhaps worthy of being placed in a third group of the genus'. I agree that *L. childreni* warrants a group of its own; moreover it comprises at least two species (Smith in prep.).

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Australian mainland *Liasis* can thus be placed in one or other of two species-groups: the *Liasis olivaceus* group comprising *L. olivaceus olivaceus*, *L. olivaceus barroni* and *L. mackloti* which are large pythons (up to 550 cm total length), lack dorsal pattern and have one (occasionally two) loreals. McDowell (*supra cit.* pp. 32 and 33) discusses cranial, dental and other scale characters for this group. Species in the *Liasis childreni* (*recte gilberti*) group are relatively small (up to 150 cm total length) and have at least some indication of dorsal colour pattern and more numerous (up to about 20) irregular-shaped loreals.

Liasis mackloti (Duméril and Bibron, 1844)

See McDowell 1975: 34 for synonomy.

Diagnosis

Distinguished from *Liasis olivaceus* by having fewer midbody scale rows (45-48 v. 58-72), fewer ventrals (271-286 v. 321-411) and fewer subcaudals (72-89 v. 96-119).

Description

Largest accurately measured specimen (R14138) has a total length of 1240 mm (tail 24.0% of SVL). Cogger (1979) gives its length as up to about 3 m. Head 1.7-2.2 times as long as wide (N 5, mean 1.95).

Rostral 1.1-2.0 as wide as high (mostly about 1.25). Two pairs of prefrontals, anterior pair always in contact; posterior pair separated, usually by the larger anterior prefrontals. One loreal. One preocular. Postoculars 2 (50% of specimens), 3 (33% of specimens) or 4 (17% of specimens) (N 14, mean 2.7). Anterior temporals 3 (58% of specimens), 4 (33% of specimens) or 5 (9% of specimens) (N 14, mean 3.4). Upper labials 11 (66.6% of specimens) or 12 (33.4% of specimens) (N 14, mean 11.5), usually fifth and sixth entering orbit, always an oblique pit on the first and sometimes the second. Lower labials 15 (17% of specimens), 16 (50% of specimens) or 17 (33% of specimens) (N 12, mean 16.2), with 3-5 pits on labials 8-13.

Ventrals 271-286 (N 6, mean 279.2), subcaudals 72-89 (N 6, mean 80.8), mostly divided. Ventrals plus subcaudals 346-375 (N 5, mean 360.4). Scale rows at midbody 45-48 (N 6, mean 45.6), at neck 39.42 (N 6, mean 40.2, decreasing by 4-9), and at tail 27-30 (N 6, mean 28.3, decreasing by 16-19).

Back with an oily blue-grey sheen. Belly yellow, especially anteriorly. Contrast between dorsal and ventral coloration more distinct than in forms of *L. olivaceus*.

Distribution

In Western Australia only in the Kimberley Division.

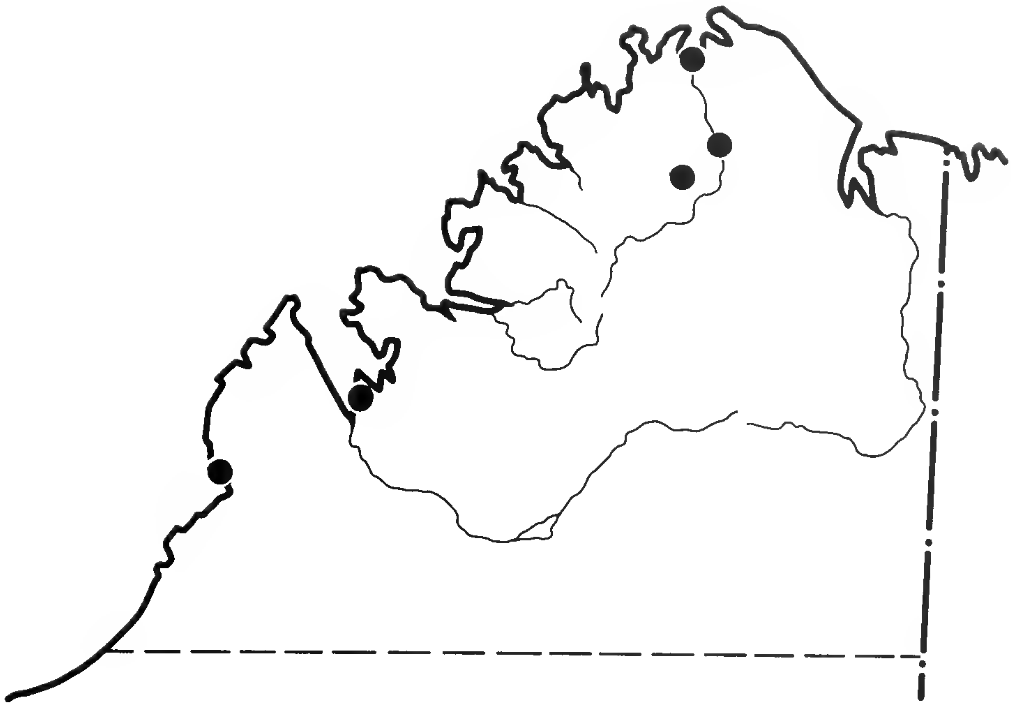

Fig. 1: Location of specimens of *Liasis mackloti* examined.

Remarks

The *Liasis mackloti* listed for St Andrew Island (Smith and Johnstone 1979) is an *L. olivaceus olivaceus.*

Material Examined

Kimberley Division: Kalumburu (13882, 42796); Drysdale River National Park in 15°16′S, 126°43′E and 15°03′S, 126°44′E (50699, 50550); 5 km E of Old Doongan HS (50979); Point Torment (58559); Derby (52132); Broome (14138).

Northern Territory: Darwin (10477); Fogg Dam, Darwin (47687-88); Rapid Creek, Darwin (53777); 32 km NW of Mt Roper (32059); Millingimbi (13529-30); Oenpelli (52111).

Queensland: Cairns (10695).

Liasis olivaceus olivaceus Gray, 1842

Liasis olivaceus Gray, 1842, Zool. Misc.: 45. Type locality: Port Essington (Northern Territory).

Diagnosis

Distinguished from *L. mackloti* by having more midbody scale rows (61-72 v. 45-48) and more ventrals (321-377 v. 271-286). Distinguished from

L. olivaceus barroni by having more midbody scale rows (61-72 v. 58-63) and fewer ventrals (321-377 v. 374-411).

Description

Largest accurately measured specimen 2515 mm in total length (tail 15.4% of SVL). Head 1.6-2.1 times as long as wide (N 18, mean 1.9).

Rostral 1.1-2.0 (mostly about 1.25) as wide as high. Two pairs of prefrontals, anterior pair the larger and always in contact. Posterior pair usually separated by a small scale, sometimes in contact, occasionally separated by the frontal. One (89.5% of specimens) or 2 loreals. One preocular. Postoculars 3 (5% of specimens), 4 (42% of specimens), 5 (42% of specimens) or 6 (11% of specimens) (N 36, mean 4.6). Anterior temporals 4 (3% of specimens), 5 (25% of specimens), 6 (33% of specimens), 7 (3% of specimens) or 8 (3% of specimens) (N 24, mean 4.6). Six specimens had the anterior temporals fragmented into many small scales. Upper labials 12 (12% of specimens), 13 (26% of specimens), 14 (47% of specimens) or 15 (15% of specimens) (N 34, mean 13.6), always an oblique pit on the first and sometimes the second, seventh to ninth entering orbit (29% of specimens), sixth and seventh (25% of specimens), seventh and eighth (21% of specimens), sixth to eighth (18% of specimens) and the seventh (7% of specimens), the last condition caused by the pinching off of the top of the eighth labial, this fragment being counted as a postocular. Lower labials 18 (12% of specimens), 19 (9% of specimens), 20 (32% of specimens), 21 (35% of specimens) or 22 (12% of specimens) (N 34, mean 20.2), with 4-7 (mostly 5 or 6) pits in labials 9-19 commencing in labials 12 or 13 in 63.0% of specimens.

Ventrals 321-377 (N 19, mean 361; only 1 specimen with fewer than 355). Subcaudals 96-119 (N 18, mean 106.5), mostly divided. Ventrals plus subcaudals 420-483 (N 17, mean 468.5); only 1 specimen with fewer than 461). Scale rows at midbody 61-72 (N 19, mean 66.0), at neck 48-59 (N 14, mean 53.5, decreasing by 3-18), and at tail 31-38 (N 15, mean 34.9, decreasing by 26-41).

Distribution

In Western Australia the Kimberley Division south to Lake Argyle in the east and Mt Anderson in the west.

Remarks

The only conclusive data for the '*Liasis olivaceus?*' listed by Fry (1914: 190) are the ventral and subcaudal counts (357 + 101) and scale rows (56-64) which places the specimen with *L. olivaceus olivaceus*. The other characters used have been shown, in this paper and elsewhere, to be too variable for diagnosis. I cannot locate the specimen.

Material Examined

Kalumburu (28044-46, 28048, 54334); Crystal Creek (56233); Mitchell Plateau (51043); Kimberley Research Station (11978); Lake Argyle (59974-75, 60108); Prince

Regent River Reserve in 15°28'S, 124°29'E (47274); Heywood I. (41507-08); St Andrew I. (54463); Augustus I. (64944); 11 km S of Lombadina (58816); Coulomb Point (40280); Mt Anderson (R28047).

Northern Territory: Katherine (24934-35); 27 km W of Katherine (53767).

Liasis olivaceus barroni subsp. nov.

Holotype

R55384, a juvenile collected at Tambrey, Western Australia, in 21°35'S, 117°34'E by W.H. Butler on 7 July 1964.

Paratypes

North-west Division: Bamboo Creek (33420); Woodstock (54378); Marandoo (60708); 16 km from Nanutarra (24920); Paraburdoo (58935); Pipe Springs, 16 km W of Newman (54617); Prairie Downs (17694).

Diagnosis

Distinguished from nominate *Liasis olivaceus* by having fewer midbody scale rows (58-63 v. 61-72) and more ventrals (374-411 v. 355-377).

Description

Head 1.5-2.3 times as long as wide (N 17, mean 1.7).

Rostral 1.25-2.0 times as wide as high. Internasals sometimes separated by a small median scale. Two pairs of prefrontals, anterior pair always the larger, posterior pair either in contact or separated by a small median scale or the frontal. Loreals 1 (50% of specimens) or 2 (N 16). Preoculars 1 (34% of specimens) or 2 (N 14, mean 1.7). Postoculars 3 (21% of specimens), 4 (36% of specimens), 5 (36% of specimens) or 6 (7% of specimens) (N 14, mean 4.2). Anterior temporals 5, or divided into many small scales. Upper labials 12 (17% of specimens), 13 (17% of specimens), 14 (58% of specimens) or 15 (8% of specimens) (N 12, mean 13.5) with an oblique pit on the first and sometimes the second. Seventh to ninth labials entering orbit (37.5% of specimens), sixth to eighth (25%) and seventh and eighth (25%) and ninth and tenth (12.5%). Lower labials 20 (8% of specimens), 21 (50% of specimens), 22 (25% of specimens) or 23 (17% of specimens) (N 12, mean 18.3) with 5 or 6 pits on labials 10-18 commencing on labials 12 or 13 in 66% of specimens.

Ventrals 374-411 (N 8, mean 392.2). Subcaudals 99-112 (N 7, mean 105), mostly divided. Ventrals plus subcaudals 486-515 (N 7, mean 496). Scale rows at midbody 58-63 (N 8, mean 60.6); at neck 46-55 (N 4, mean 53, decreasing by 5-13) and at tail 33-36 (N 5, mean 34.2, decreasing by 26-30).

Specimens preserved in alcohol show no differences in colour between nominate *L. olivaceus* and *L. olivaceus barroni.*

Distribution

The Pilbara Region from Tambrey in the north to Paraburdoo in the south and Newman in the east to Nanutarra in the west.

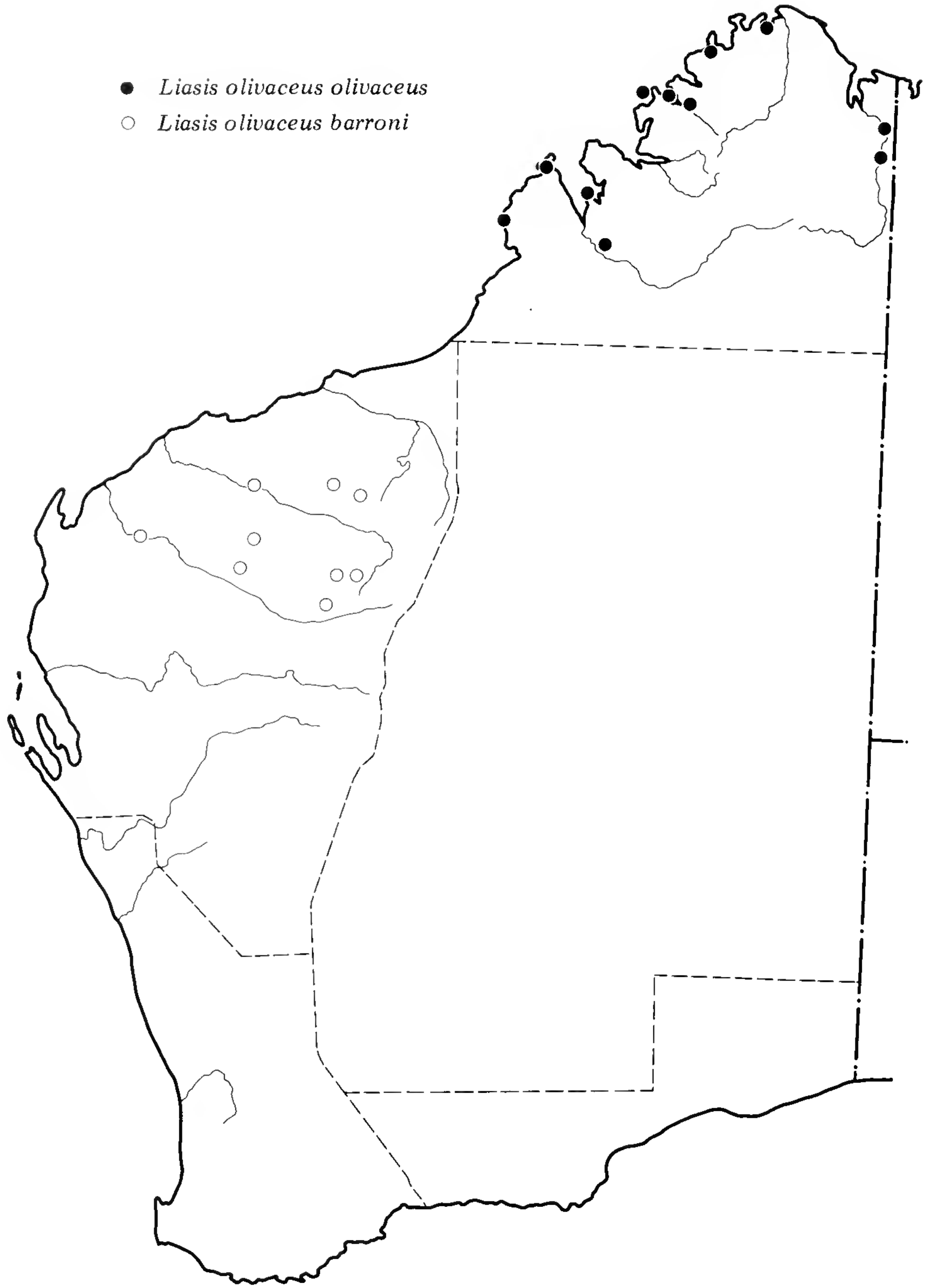

Fig. 2: Location of specimens of *Liasis olivaceus* and *Liasis olivaceus barroni* examined.

Remarks

Glauert's (1957) record of *L. olivaceus* from the Murchison district was presumably based on R2760 (a specimen from the South Perth Zoological Gardens purported to have come from Cue). However it has 355 ventrals and 68 midbody scale rows and could only have come from within the range of *L. o. olivaceus.*

Serventy (1952) measured a specimen of *L. o. barroni* from Hooley with a total length of 370 cm and weight of 9.3 kg. Whitlock (1923) reports specimens up to 550 cm.

This subspecies is named after Mr Gregory Barron of the Western Australian Museum in recognition of his services to Western Australian herpetology.

ACKNOWLEDGEMENTS

I thank Dr G.M. Storr, Head, Department of Ornithology and Herpetology, Western Australian Museum, for his guidance and comments on the manuscript.

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GUIDE TO AUTHORS

Subject Matter

Reviews and papers reporting results of research in all branches of natural science and human studies will be considered for publication. However, emphasis is placed on studies pertaining to Western Australia. Material must be original and not have been published elsewhere.

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Authors are advised to follow the layout and style in the most recent issue of the *Rec. West. Aust. Mus.* including headings, tables, illustrations and references.

The title should be concise, informative and contain key words necessary for retrieval by modern searching techniques. Names of new taxa must not be included. An abridged title (not exceeding 50 letter spaces) should be included for use as a running head.

An abstract must be given, summarizing the scope of the work and principal findings. It should normally not exceed 2% of the paper and should be suitable for reprinting in reference periodicals. Contrary to Recommendation 23 of the International Code of Zoological Nomenclature it may include names of new taxa.

Footnotes are to be avoided, except in papers dealing with historical subjects.

The International System of units should be used.

Numbers should be spelled out from one to nine in descriptive text; figures used for 10 or more. For associated groups, figures should be used consistently, e.g. 5 to 10, not five to 10.

Spelling should follow the *Concise Oxford Dictionary.*

Systematic papers must conform with the International Codes of Botanical and Zoological Nomenclature and, as far as possible, with their recommendations.

Synonymies should be given in the short form (taxon, author, date, page) and the full reference cited at the end of the paper.

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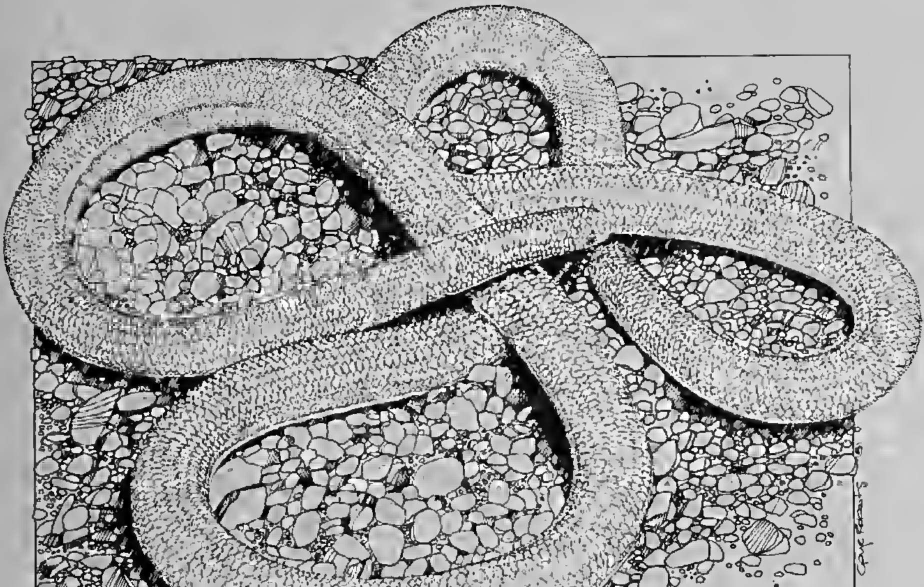

Volume 9, Part 3, 1981

RECORDS OF THE WESTERN AUSTRALIAN MUSEUM

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Cover: Waite's Blind-snake, *Ramphotyphlops waitii*, a species endemic to Western Australia. Drawn by Gaye Roberts.

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THE GENUS *RAMPHOTYPHLOPS* (SERPENTES: TYPHLOPIDAE) IN WESTERN AUSTRALIA

G.M. STORR*

ABSTRACT

The 18 species and subspecies of blind-snakes inhabiting Western Australia are described and keyed out. They are *R. australis* (Gray), *R. bituberculatus* (Peters), *R. diversus ammodytes* (Montague), *R. diversus diversus* (Waite), *R. endoterus* (Waite), *R. grypus* (Waite), *R. guentheri* (Peters), *R. hamatus* sp. nov., *R. kimberleyensis* sp. nov., *R. leptosoma* Robb, *R. ligatus* (Peters), *R. margaretae* sp. nov., *R. micromma* sp. nov., *R. pinguis* (Waite), *R. troglodytes* sp. nov., *R. unguirostris* (Peters), *R. waitii* (Boulenger) and *R. yampiensis* sp. nov.

INTRODUCTION

In 1918 E.R. Waite revised the blind-snakes of Australia. His material was scanty and often poorly or wrongly localised. Nevertheless his achievement was remarkable, and he set new standards for systematic herpetology in Australia.

In his revision of the blind-snakes of the New Guinea region, McDowell (1974) placed all the species in species-groups, which were based on anatomic as well as scale characters. Because little or nothing is known of the anatomy of Australian blind-snakes, I have not attempted to locate the Western Australian species in species-groups but have dealt with them in alphabetic sequence. However, most of our blind-snakes can be grouped into clusters of superficially similar species. For example *R. unguirostris*, *R. australis*, *R. hamatus* and *R. endoterus* make up a close-knit group. *R. bituberculatus* and *R. margaretae* constitute a vicariant pair. *R. waitii*, *R. grypus* and *R. leptosoma* are much alike and largely replace each other geographically. *R. diversus* and *R. yampiensis* (and *R. tovelli* of the Northern Territory) form another group, in which it may prove possible to include *R. braminus*. *R. kimberleyensis* is perhaps nearest to a group of extra-limital species including *R. polygrammicus*, *R. torresianus* and *R. nigrescens*. The remaining western species, *R. guentheri*, *R. ligatus*, *R. micromma*, *R. pinguis* and *R. troglodytes*, seem to have no close allies, at least in Western Australia.

The present revision is based on the collections (R series) of the Western Australian Museum (registered numbers cited without prefix) and selected specimens in the National Museum of Victoria (specimens prefixed with NMV), South Australian Museum (SAM), British Museum (Natural History) (BMNH), Rijksmuseum van Natuurlijke Historie (RMNH) and Museum für

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Naturkunde der Humboldt-Universitàt, Berlin (ZMB). Ventrals are construed as all the scales between the mental and the anals. Subcaudal counts do not include the terminal spine-bearing scale. The prefrontal and frontal are respectively the first and second median dorsal scales behind the rostral.

Five blind-snakes, viz. *Ramphotyphlops affinis* (Boulenger), *R. broomi* (Boulenger), *R. polygrammicus* (Schlegel), *R. wiedii* (Peters) and *Typhlops labialis* Waite (= *T. diardi* Schlegel, *fide* McDowell 1974) have been erroneously reported from Western Australia. A description of *Ramphotyphlops braminus* (Daudin) is given in the **Appendix**; this vagile snake may well become established in Western Australia, where it could easily be mistaken for *R. diversus*.

I am grateful to Mr A.J. Coventry (NMV), Dr T.D. Schwaner (SAM), Mr A.F. Stimson (BMNH), Dr M.S. Hoogmoed (RMNH) and Dr G. Peters (ZMB) for the loan of specimens in their care.

SYSTEMATICS

Genus *Ramphotyphlops*

Typhlina Wagler, 1830, Naturliches System der Amphibien . . . p. 196. Not available for this genus (Stimson *et al.*, 1977: 204).

Pseudotyphlops Fitzinger, 1843, Systema reptilium, p. 24. Type-species (by original designation): *Typhlops polygrammicus* Schlegel. Not *Pseudo-Typhlops* Schlegel, 1839.

Ramphotyphlops Fitzinger, *ibid.* Type-species (by original designation): *Typhlops multilineatus* Schlegel.

Pilidion Duméril and Bibron, 1844, Erpétologie générale 6: 257. Type-species (by original designation): *P. lineatum* Duméril and Bibron [= *Typhlops lineatus* Boie].

Typhlinalis Gray, 1845, Catalogue of the specimens of lizards in the collection of the British Museum, p. 134. Type-species (by monotypy): *T. lineatum* (Boie).

Diagnosis

Blind-snakes of the family Typhlopidae (as restricted by McDowell 1974), differing from *Typhlops* only in characters of the male genitalia (Robb 1966).

Distribution

From Malaya and the Philippines south-east to Australia and the Loyalty Islands (excluding the range of the widespread parthenogenetic species *braminus*, which does not certainly belong to *Ramphotyphlops*).

Key to Western Species

1 Midbody scale rows 24 2
Midbody scale rows fewer 3

2 Snout rounded in profile . . . . *ligatus*
Snout tipped with a transverse cutting edge . . . . *unguirostris*

3 Midbody scale rows 22 4

Midbody scale rows fewer 8

4 Snout rounded in profile 5

Snout tipped with a transverse cutting edge 7

5 Rostral (from above) a little longer than wide; nostrils inferior; ventrals fewer than 400; inhabiting south of W.A. . . . . *australis*

Rostral (from above) much longer than wide; nostrils lateral; ventrals more than 400; inhabiting far north of W.A. 6

6 Nasal cleft extending upwards and slightly backwards to about midway between nostril and top of nasal scale; nostril a little nearer to rostral than preocular; ventrals fewer than 550 . . . . *kimberleyensis*

Nasal cleft extending upwards and forwards from nostril to rostral; nostril much nearer to rostral than preocular; ventrals more than 600 . . . . *troglodytes*

7 Rostral (from above) a little longer than wide; nasal cleft usually proceeding from second labial (rarely from preocular); ventrals fewer than 400 . . . . *hamatus*

Rostral (from above) not longer than wide; nasal cleft proceeding from preocular; ventrals more than 400 . . . . *endoterus*

8 Midbody scale rows 20 9

Midbody scale rows fewer 12

9 Snout tipped with a transverse cutting edge . . . . *waitii*

Snout without a cutting edge 10

10 Nasal cleft proceeding from second labial; snout obtusely angular in profile 11

Nasal cleft proceeding from preocular; snout rounded in profile . . . . *diversus*

11 Snout(from above) rounded in outline; body stout; ventrals fewer than 350 . . . . *pinguis*

Snout (from above) trilobed in outline; body slender; ventrals more than 400 . . . . *bituberculatus*

12 Midbody scale rows 18 13

Midbody scale rows 16 . . . . *leptosoma* (part)

13 Snout tipped with a transverse cutting edge 14

Snout not tipped with a cutting edge 15

14 Tail black . . . . *grypus*

Tail not black . . . . *leptosoma* (part)

15 Tail black . . . . *guentheri*

Tail not black 16

16 Snout weakly trilobed from above and angular in profile . . . . *margaretae*

Snout rounded from above and in profile 17

17 Nasal cleft proceeding from preocular; eye larger than nostril . . . . *yampiensis*

Nasal cleft proceeding from second labial; eye not larger than nostril . . . . *micromma*

Ramphotyphlops australis (Gray, 1845)

Figs 1 and 2

Anilios australis Gray, 1845, Catalogue of the specimens of lizards in the collection of the British Museum, p. 135. Western Australia.

Onychocephalus verticalis Smith, 1846, Illustrations of the zoology of South Africa, pl. 54. 'Interior of South Africa'. (Synonymy *fide* D.G. Broadley, *in litt.*).

Typhlops preissi Jan, 1860, Iconographie générale des ophidiens **1** (1): 1; Pl. 5, Fig. 2. Australia.

Diagnosis

A dark, moderately large, stout blind-snake with snout rounded in profile, 22 midbody scale rows, nasal cleft usually proceeding from second labial and extending up to about midway between nostril and rostral, the top of cleft curving forwards.

Description

Total length (mm): 86-417 (N 312, mean 196.6). Length of tail (% of total length): 1.6-5.2 (N 79, mean 3.4).

Rostral (from above) elliptic, a little longer than wide, about two-thirds as wide as head and extending back to well short of level of eyes. Nasals narrowly separated behind rostral. Frontal smaller than prefrontal. Snout usually rounded in profile (very slightly angular in a few specimens). Nostrils inferior, slightly to much nearer to rostral than preocular. Nasal cleft proceeding from second labial (N 248), junction of first and second (14), junction of second and preocular (5) or preocular (5), and extending vertically from nostril and terminating about midway between nostril and rostral after curving forwards for a short distance.

Midbody scale rows 22 (N 282). Ventrals 278-357 (N 50, mean 311.5). Subcaudals 10-18 (N 50, mean 14.1).

Dorsal and dorsolateral surfaces purplish-black in adults (purplish-pink in juveniles), lower surfaces whitish; boundary between dark and pale coloration jagged, owing to lateral scales being either wholly dark or wholly pale.

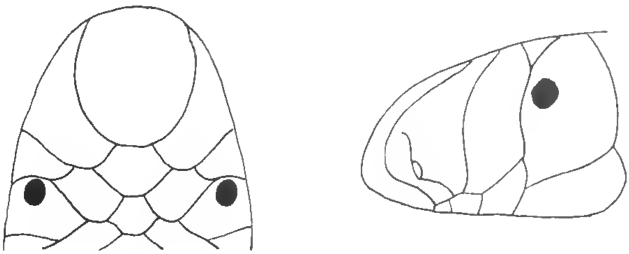

Fig. 1: Head of *Ramphotyphlops australis*.

Fig. 2: A *Ramphotyphlops australis* from Wongan Hills, W.A., photographed by R.E. Johnstone.

Distribution

Southern Western Australia north generally to Irwin, Badgingarra, Wialki, the Eastern Goldfields and Madura, and south to Augusta, Bridgetown, Narrikup and Esperance. An apparently isolated population considerably further north in Edel Land (Shark Bay). See **Fig. 3.**

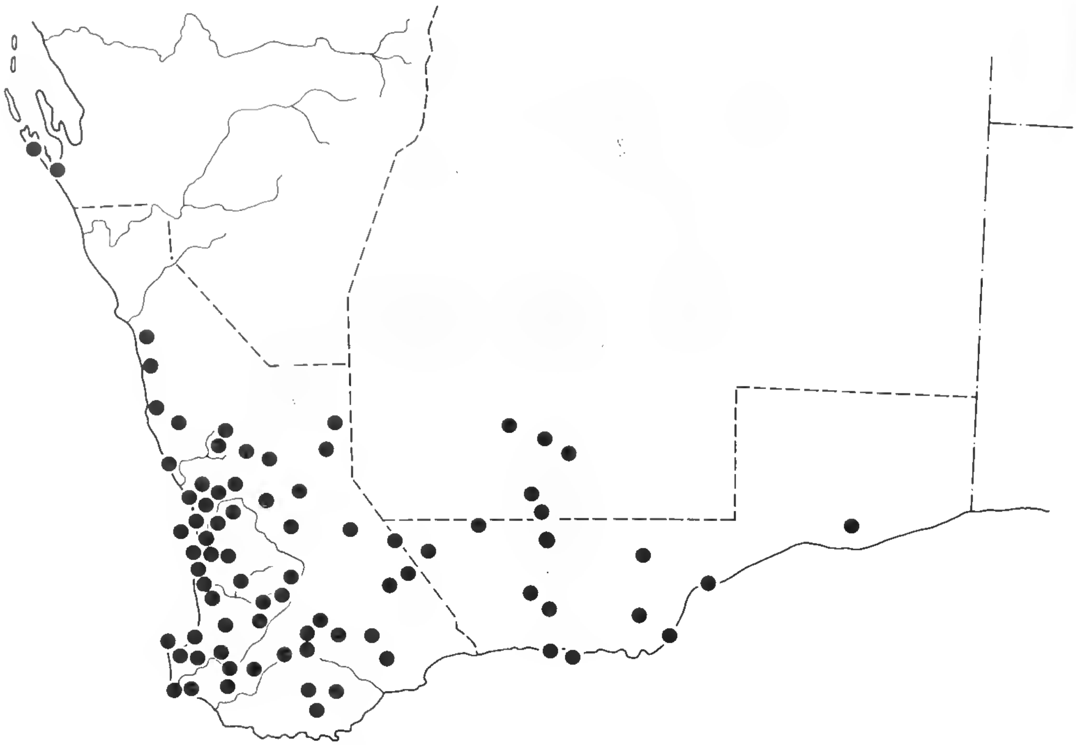

Fig. 3: Map of southern Western Australia showing location of specimens of *Ramphotyphlops australis.*

Geographic Variation

The specimens from Edel Land are notable for their low ventral counts (278, 283).

Material

North-West Division (W.A.): False Entrance Well (66216); 1 km S of Tamala (64351).

South-West Division (W.A.): Irwin House (29°13'S, 115°06'E) (5688); Arrowsmith (21856); 5 km W of Padbury (49111); 5 km E of Mt Peron (49164); 9 km NE of Jurien Bay (46596-8) and 16 km SE (46589); Badgingarra (34274); Badgingarra National Park (68932-9); Wialki (6819); Bindi Bindi (31478); Gabalong (21599); Mukinbudin (4669); 29 km N of New Norcia (31529) and 11 km N (26056-7); Wongan Hills (50989); Lancelin (15114) and 6 km N (61772-3) and 3 km S (49972-3); Ejanding (2374); Culham (3872, 15115); Gingin (2257, 8460); proposed reserve south of Gingin (59222); 17 km N of Yanchep (59219); 17 km NW of Kellerberrin (52373); Muchea (456); Neerabup (31557); Bullsbrook (34344); Twin Swamps Reserve (59505-6); Meckering (212); Wanneroo (32031); 3 km NE of Upper Swan (69876); Wundowie (26409) and 3 km W (33433); Woorooloo (21337); Gidgiegannup (29053); Herne Hill (861); Mussel Pool (51565); Sawyers Valley (3072); Stoneville (40313, 46243); Mundaring (507); Mahogany

Creek (4886); Glen Forrest (52135, 61616); Darlington (16497, 29306, 47844); West Midland (36122); Guildford (1252, 22859); Beechboro (620); Morley (54222); Hamersley (51297); Doubleview (21877); Wembley Downs (36313); City Beach (40963); Reabold Hill (28395); Wembley (29785); Rottnest Island (3758, 47778); Quairading (34118); 13 km SSE of Chidlow (57258; NMV R7181); Mundaring Weir (49957-8, 60475); 10 km E of Kalamunda (14541-2, 22774-7); Kalamunda (770, 13230, 31997, 31997*a*, 39699, 48178, 56100); Gooseberry Hill (28346, 28419, 30933, 45620-1); High Wycombe (37976); Maylands (1524, 3405, 4162); Perth (792, 1369, 2317, 2605, 5249, 8973, 69477-8); Swan River (BMNH 1946.1.10.61 holotype); Shenton Park (5912); Hollywood (3844); Nedlands (4404-5); Mt Claremont (39985); South Perth (3335, 10136); Como (2775, 26754); Forrestfield (66277); Bickley (3829); Lesmurdie (40971-2, 56098); Kenwick (13426, 20565); Beckenham (47750); Cannington (10068-9); Wilson (42970); Riverton (13557, 13824, 52136); Karawara (52088); Attadale (40967, 40974); Bicton (14243); Coolbellup (39071); Gosnells (47783); Roleystone (5895); Karragullen (9425); Narembeen (1161); North Jandakot (410*a-g*); Thompson Reserve (36561); Jandakot (62717); 24 km E of Armadale (57043); Naval Base (50021); Rockingham (47360); Karnup, Peel Estate (6959); Mundijong (25615); Jarrahdale (34405, 68242); Mt Randall (40208-9); 3 km SE of Mt Vincent (68122, 68131-4); Huntly (4397-9, 4631); Mandurah (49852-3); South Mandurah (26721); Miami, 8 km S of Mandurah (34545-6); Yundurup (36997, 37467); 8 km NE of Bendering (52603); 40 km NE of Hyden (31669); Lake Varley (29576); 16 km WSW of Holt Rock (58741-7); Dragon Rocks (43727, 43757-62); 25 km E of Yornaning (50181-3, 51312, 51319-26, 51373, 51383, 56184); Coolup (31676-7); Boddington (4938); Waroona (3863-4); Yarloop (2601); Williams (4706, 34329); Narrogin (12634, 25995) and 34 km ESE (56002); Wedin (5343); Darkan (1543, 13131); Collie (13481, 15124) and 8 km SW (15116); Dongolocking Reserve (49640*a-b*); 10 km E of Woodanilling (23354-6); Nyabing (56874); 27 km E of Pingrup (39836, 39845); mouth of Capel River (26558); Capel (46252); Cape Naturaliste (47788); Busselton (26060-1, 26614, 26690); 2 km NE of Yallingup (68243); Boscabel (33°40'S, 117°03'E) (5345); Katanning (6916); Kojonup (1280); Balingup (5772); Greenbushes (10229); Jarrahwood (39125); 13 km N Margaret River (64890); Nannup (26631, 47745, 52236, 56764-6); Bridgetown (7022, 31956); Jerramungup (15125); Tambellup (2427, 4289, 4986, 6777); Manjimup (37716); Kudardup (40734-5); Cranbrook (6562); Tenterden (1356); Stirling Range National Park (40117, 40130); Unicup Lake (40968); Perup (46609); between upper reaches of Perup and Tone Rivers (42577); near Mammoth Cave (47757-8); Scott River (36043, 49688); Augusta (11284, 21611); Mt Barker (36567); Narrikup (11583).

Eastern Division (W.A.): Grants Patch (30°27'S, 121°07'E) (7064); Bulong (3329, 3747, 34320); 'the Goldfields' (27); 67 km E of Kalgoorlie (43591); Widgiemooltha (318); 48 km N of Norseman (47256).

Eucla Division (W.A.): Madura (31171); McDermid Rock (65362); Norseman (9398; NMV R7066); Lake Cronin (65293); 17 km NE of Charlina Rock (58040); W of Point Culver (44968); 16 km W of Salmon Gums (33380); East Grass Patch (4968); Pine Hill (36230); Israelite Bay (66873-4, 66883); Mt LeGrand (42480); Esperance (27269, 47744).

Ramphotyphlops bituberculatus (Peters, 1863)

Fig. 4

Onychocephalus bituberculatus Peters, 1863, Monatsb. K. Preuss. Akad. Wiss. Berlin **1863**: 233 and (for illustration) **1867**: 708. Buchsfeld near Adelaide, South Australia.

Diagnosis

A moderately dark, moderately small, slender, long-snouted blind-snake with snout strongly trilobed (as seen from above) and slightly angular in profile, 20 midbody scale rows and nasal cleft proceeding from second labial.

Description

Total length (mm): 111-349 (N 31, mean 229.7). Tail (% total length): 1.5-3.3 (N 17, mean 2.3).

Rostral (from above) elliptic, very much longer than wide, almost two-thirds as wide as head and extending back nearly to level of eyes (occasionally to front edge of eyes). Nasals narrowly separated behind rostral. Frontal much smaller than prefrontal. Nostrils inferior, markedly swollen, much nearer to rostral than preocular. Nasal cleft proceeding from second labial (N 24) to nostril, thence obliquely upwards and forwards to midway between nostril and rostral or a little further.

Midbody scale rows 20 (N 30). Ventrals 414-485 (N 14, mean 447.7). Subcaudals 11-18 (N 10, mean 14.1).

Dorsal and upper lateral surfaces dark purplish-brown, gradually merging with whitish lower surfaces.

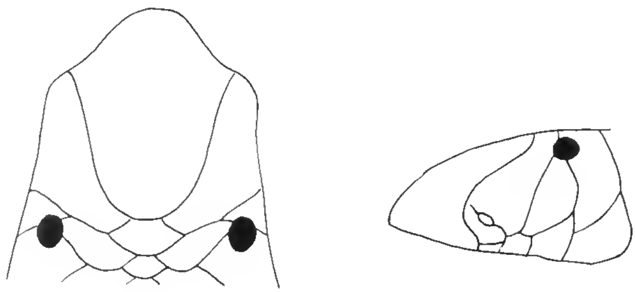

Fig. 4: Head of *Ramphotyphlops bituberculatus.*

Distribution

Southern interior of Western Australia, north to latitude 28° 30′S, west to the north-eastern Wheat Belt (Mukinbudin), and south to Norseman and Cocklebiddy (Fig. 5). Also eastern Australia.

Material

South-West Division (W.A.): Mukinbudin (5078, 10442, 32038); 'Parkerville' (5952); 'Karragullen' (6002); 'Narrogin' (509); 'Highbury' (7008).

Eastern Division (W.A): Yuinmery (69111); Menzies (4811); Broad Arrow (5317); Kurrawang (4721); 'the Goldfields' (26); Kanandah (39779-80); Coolgardie (NMV D4626); Woolgangie (21575); 29 km S of Yellowdine (37932); Buningonia Spring (65555).

Eucla Division (W.A.): 80 km N of Rawlinna (41230); Forrest (16914) and 5 km S (36471); Cocklebiddy (37048); Frazer Range (41630); Norseman (8219).

South Australia: Fowlers Bay (NMV D4687-8); Buchsfeld (syntypes ZMB 4723, 4724*a-b*).

Victoria: Cohuna (9862).

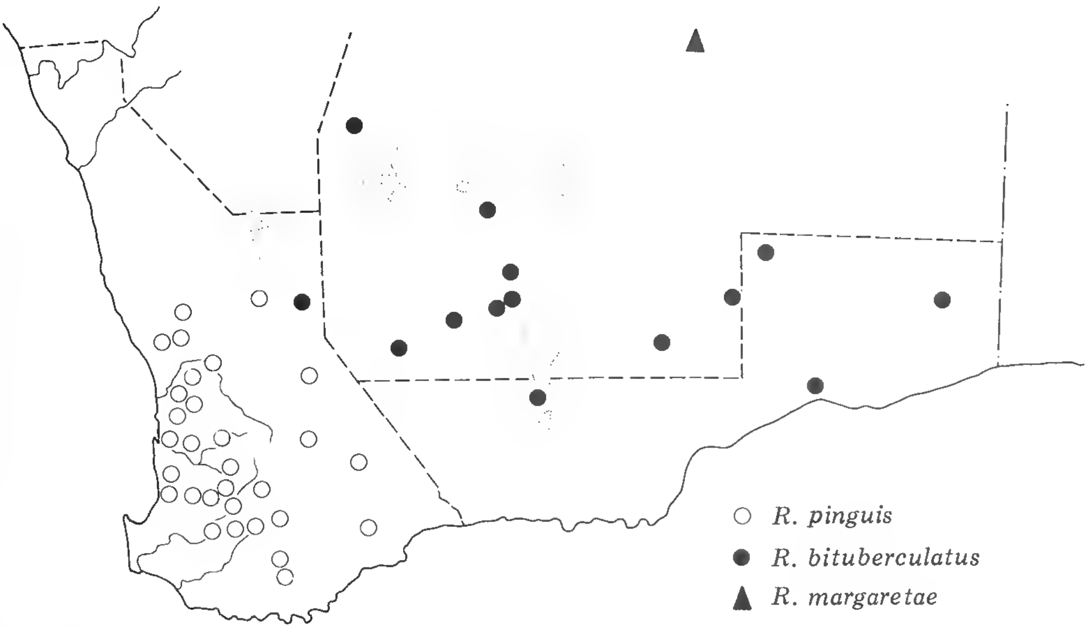

Fig. 5: Map of southern Western Australia showing location of specimens of *Ramphotyphlops bituberculatus, R. margaretae* and *R. pinguis.*

Ramphotyphlops diversus ammodytes (Montague, 1914)

Figs 6 and 7

Typhlops ammodytes Montague, 1914, Proc. zool. Soc. Lond. **1914**: 642. Hermite Island, Western Australia.

Diagnosis

A small, pale, moderately slender blind-snake with rounded snout, 20 mid-body scale rows and nasal cleft proceeding from preocular and usually dividing nasal scale. Differing from *R. d. diversus* mainly by narrower rostral (usually less than 0.4 times as wide as head, v. usually more than 0.4) and nasal cleft extending higher on to top of head.

Description

Total length (mm): 97-252 (N 14, mean 173.6). Length of tail (% total length): 1.6-5.1 (N 14, mean 2.8).

Rostral (from above) slightly to moderately constricted anteriorly so that sides are concave, about twice as long as wide, and extending back nearly to level of eyes. Nasals narrowly separated (N 11) or in point contact (2) behind rostral. Frontal smaller than prefrontal. Snout rounded in profile. Nostrils lateral or slightly superior, usually a little nearer to preocular than rostral. Nasal cleft proceeding from preocular (N 14) to nostril, thence upwards and slightly forwards to rostral or almost so.

Midbody scale rows 20 (N 14). Ventrals 387-416 (N 5, mean 401.2). Subcaudals 10-16 (N 8, mean 13.4).

Dorsal surfaces pinkish-purple, gradually becoming paler ventrally.

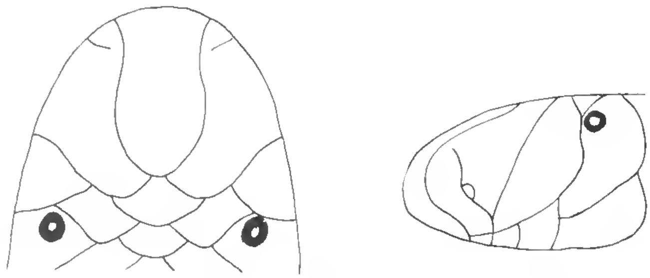

Fig. 6: Head of *Ramphotyphlops diversus ammodytes.*

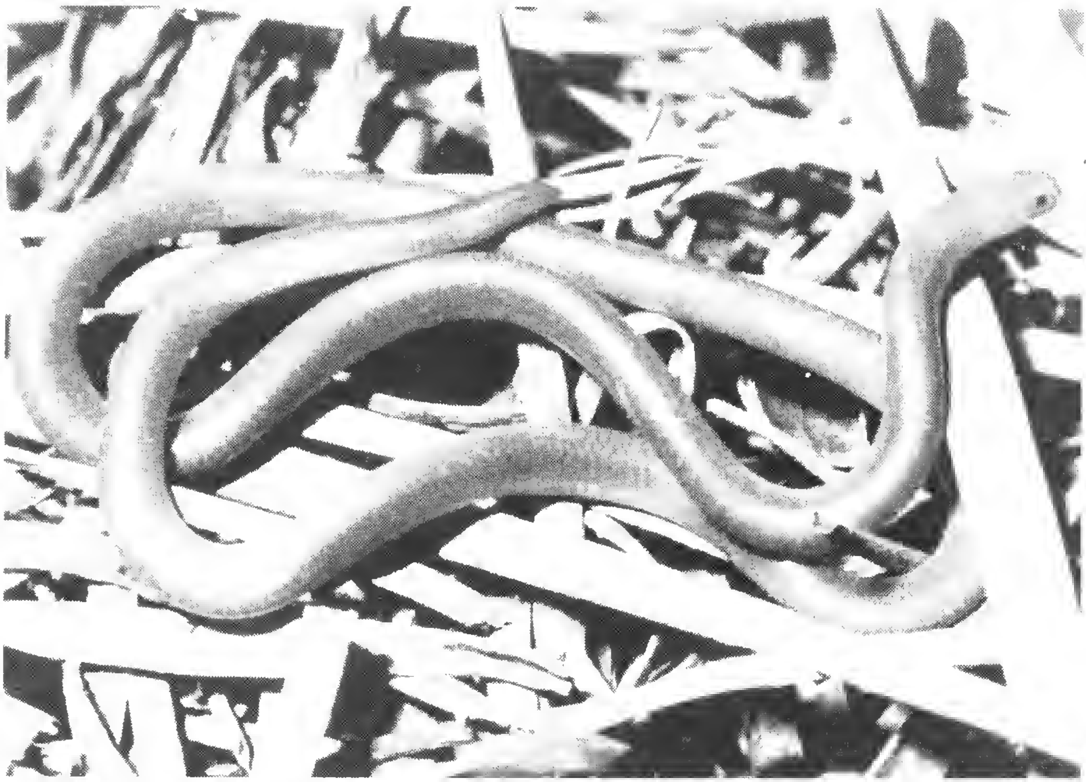

Fig. 7: A *Ramphotyphlops diversus ammodytes* from Yardie Creek, W.A., photographed by G. Harold.

Distribution

Pilbara region of Western Australia (including the Montebello and other islands off north-west coast), from the De Grey River south to the North West Cape peninsula and the Hamersley Range (**Fig. 8**).

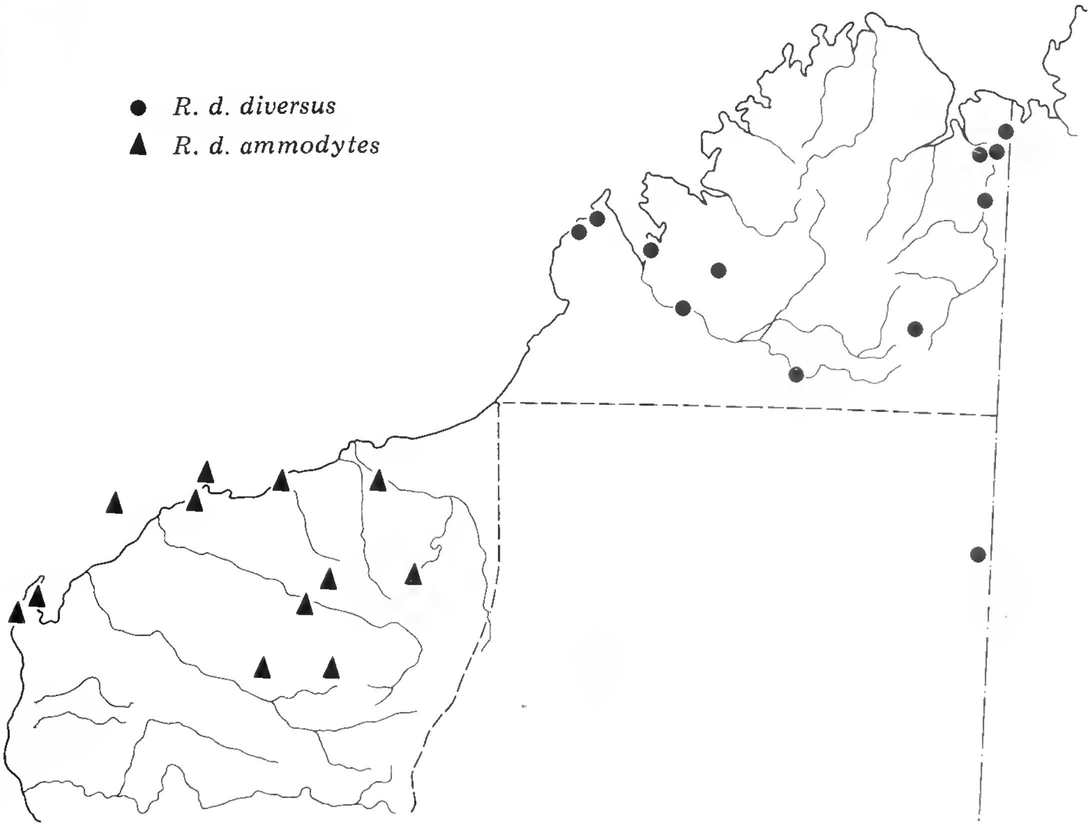

Fig. 8: Map of northern Western Australia showing location of specimens of *Rampho-typhlops d. diversus* and *R. d. ammodytes.*

Material

North-West Division (W.A.): Legendre I. (37327-8); Mulyie (62370); Mundabullangana (15117); Karratha (60317); Barrow I. (28039); Nullagine (29499); Cockeraga River (37065); 27 km S of Exmouth (61472); 2-4 km N of mouth of Yardie Creek (61120, 61493); Hancock Gorge, Wittenoom (39740); 31 km SE of Mt Meharry (67903); Paraburdoo (67336).

Ramphotyphlops diversus diversus (Waite, 1894)

Fig. 9

Typhlops diversus Waite, 1894, Proc. Linn. Soc. N.S.W. (2) 9: 10. 'Mowen' [= Morven], Queensland.

Diagnosis

A small, pale, moderately slender blind-snake with rounded snout, 20 midbody scale rows and nasal cleft proceeding from the preocular and usually dividing nasal. Distinguishable from *R. tovelli* (Loveridge) from far north of Northern Territory by shorter and wider rostral and more numerous ventrals (more than 380 v. fewer than 300).

Description

Total length (mm): 97-352 (N 22, mean 205.9). Length of tail (% total length): 1.4-3.5 (N 22, mean 2.2).

Rostral (from above) usually elliptic, occasionally constricted anteriorly so that sides are slightly concave, about one and one-half times as long as wide, about half as wide as head and not extending back to level of eyes. Nasals narrowly separated behind rostral. Frontal much smaller than prefrontal. Snout rounded in profile. Nostrils lateral or slightly inferior, a little nearer to rostral than preocular. Nasal cleft proceeding from preocular (N 21) to nostril, thence curving fowards to rostral or nearly so.

Midbody scale rows 20 (N 22). Ventrals 389-457 (N 10, mean 419.0). Subcaudals 8-18 (N 15, mean 13.5).

Dorsal surfaces purplish brown, becoming darker on head and gradually paler ventrally.

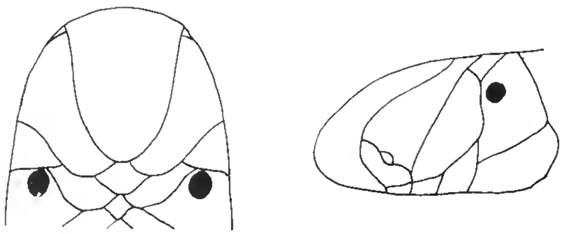

Fig. 9: Head of *Ramphotyphlops d. diversus.*

Distribution

East and south Kimberley and Tanami Desert, northern Western Australia (Fig. 8). Also Northern Territory and Queensland.

Material

Kimberley Division (W.A.): Point Springs, Weaber Range (28485); Kimberley Research Station (15 km N of Kununurra) (12111, 22353, 22356); Ivanhoe (10305); Lake Argyle (61350-1); Lombadina (46419); Beagle Bay (46482); Derby (41269, 60606); 7 km W of Mt North (17°29'S, 125°45'E) (70680); Liveringa (10363); Halls Creek (26636, 29575); Edgar Range in 18°21'S, 122°53'E (54027); Christmas Creek (63244).

Eastern Division (W.A.): Labbi-labbi Rock-hole (21°34'S, 128°49'E) (NMV DT-D1324).

Northern Territory: Timber Creek (24862); 6 km S of Coolibah (23141); Peko (12 km E of Tennant Creek) (21495-7).

Ramphotyphlops endoterus (Waite, 1918)
Fig. 10

Typhlops endoterus Waite, 1918, Rec. S. Aust. Mus. 1: 32. Hermannsburg, Northern Territory.

Typhlops leonhardii Sternfeld, 1919, Senckenbergiana 1: 77. Hermannsburg, Northern Territory.

Diagnosis

A dark, medium-sized, moderately slender blind-snake with snout angular in profile, 22 midbody scale rows and nasal cleft proceeding from preocular. Most like *R. hamatus* but with wider rostral and more numerous ventrals (more than 400 v. fewer than 400).

Description

Total length (mm): 109-376 (N 10, mean 227.7). Length of tail (% total length): 1.5-2.9 (N 10, mean 2.1).

Rostral (from above) as wide as long or a little wider, three-quarters as wide as head and extending back to well short of level of eyes. Nasals narrowly separated behind rostral. Frontal smaller than prefrontal. Snout angular in profile, with a weak transverse cutting edge. Nostrils inferior, slightly swollen and much nearer to rostral than preocular. Nasal cleft proceeding from preocular (N 10) to nostril, thence forwards and slightly upwards or slightly downwards to rostral or for various distances towards it; cleft not crossing slight ridge above nostril and thus not visible from above.

Midbody scale rows 22 (N 10). Ventrals 406-438 (N 7, mean 419.4). Subcaudals 9-16 (N 9, mean 12.7).

Snout pale; rest of dorsal and upper lateral surfaces dark purplish-brown, junction between upper surfaces and pale lower surfaces jagged (as in *R. australis* and *R. hamatus*).

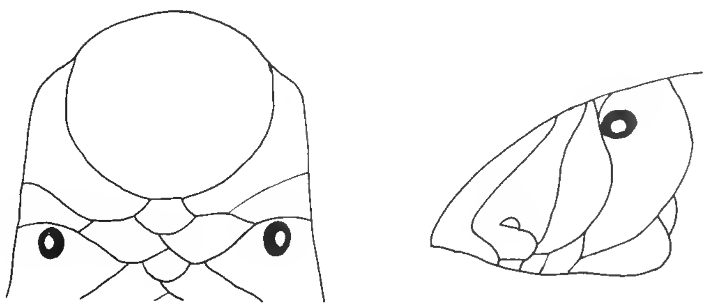

Fig. 10: Head of *Ramphotyphlops endoterus*.

Distribution

Arid eastern interior of Western Australia, west to Cosmo Newbery (Fig. 17). Also Northern Territory.

Material

Eastern Division (W.A.): between Wells 39 and 51 (SAM R1769); Warburton Range (15147, 17782, 22026, 22096-7, 22226); Skipper Knob (116 km S of Warburton Range) (22118); Cosmo Newbery (13855*a*-*b*).

Ramphotyphlops grypus (Waite, 1918)

Figs 11 and 12

Typhlops grypus Waite, 1918, Rec. S. Aust. Mus. 1: 17.

Typhlops nigroterminatus Parker, 1931, Ann. Mag. nat. Hist. (10) 8: 604. Roebuck Bay, Western Australia.

Diagnosis

A moderately large, very slender, black-tailed blind-snake with snout beaked in profile, 18 midbody scale rows and nasal cleft usually proceeding from second labial.

Description

Total length (mm): 124-415 (N 53, mean 271.2). Length of tail (% total length): 1.1-4.4 (N 49, mean 2.4).

Rostral (from above) much longer than wide, about three-quarters as wide as head and extending back to level of eyes or nearly so. Nasals narrowly separated behind rostral. Frontal smaller than prefrontal. Snout angular from above, weakly or strongly beaked in profile. Nostrils inferior, very slightly or not swollen and much nearer to rostral than preocular. Nasal cleft proceeding from second labial (N 36), preocular (4), junction between preocular and second labial (1) or first labial (2) to nostril, where it occasionally (N 7) terminates, but mostly it proceeds for varying distances obliquely upwards and forwards towards rostral (N 16) or reaches it (N 16).

Midbody scale rows 18 (N 51). Ventrals 525-677 (N 9, mean 614.2). Subcaudals 13-36 (N 20, mean 22.6).

Snout white; rest of head and neck blackish. Tail (sometimes wholly, but usually only distal 30-90%) blackish. Rest of dorsal and lateral surfaces pinkish-brown to moderately dark brown, gradually merging with greyish-white ventral surfaces.

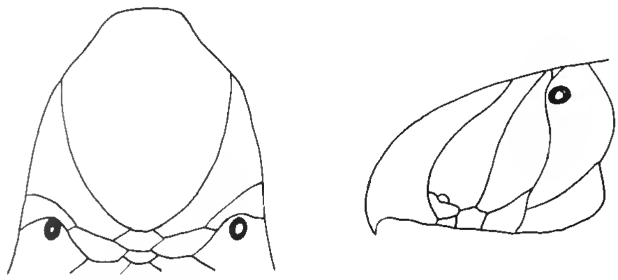

Fig. 11: Head of *Ramphotyphlops grypus*.

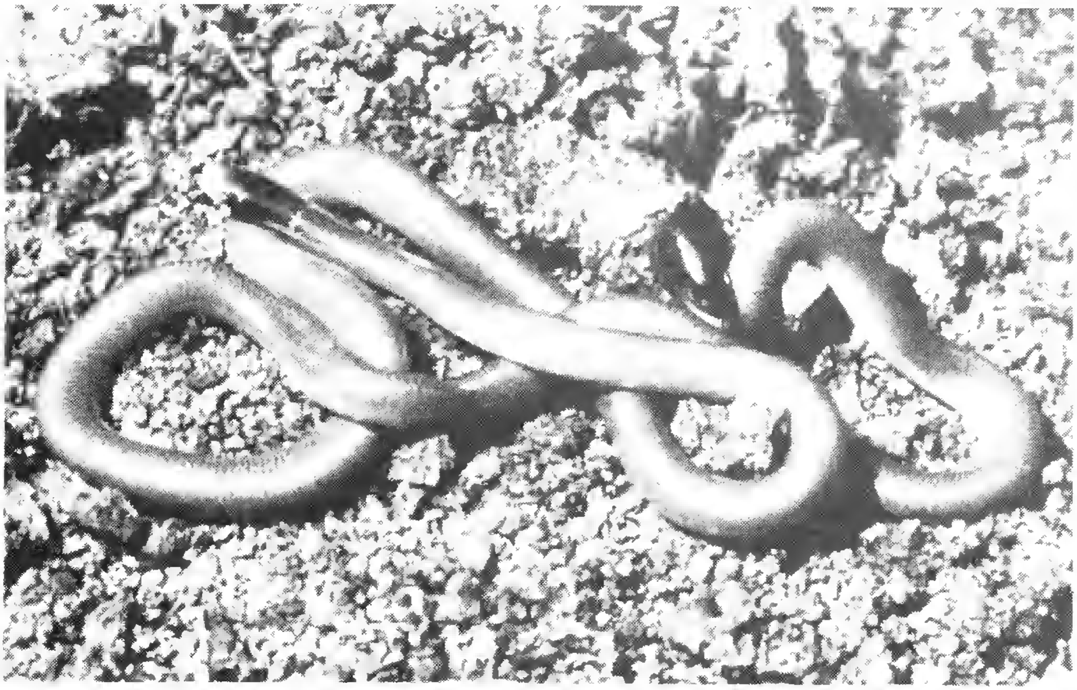

Fig. 12: A *Ramphotyphlops grypus* from Mt Herbert, W.A., photographed by G. Harold.

Distribution

Arid zone of Western Australia, from far south of Kimberley Division south to latitude 26°S (Fig. 21).

Remarks

The holotype of *grypus* has not been used in drawing up the above description. In view of its extremely high ventral count (790), it possibly comes from eastern Australia and represents a different subspecies.

Material

Kimberley Division (W.A.): Derby (145, 46660); Broome (29156; NMV R7187); near Wolf Creek meteorite crater (64035, 64054).

North-West Division (W.A.): Wallal (6582); DeGrey (5103-4); Point Samson (45631); Dampier (47781, 54385); Muccan (6582, 10981); Whim Creek (51041); Marble Bar (22887; paratype NMV D12358, formerly R7200); Mt Edgar (15121); 12 km SW of Woodstock (31227, 73520); Cane River (56105); North West Cape (28038); Vlaming Head (22506); Exmouth (31413, 31430, 50283); 2 km N of Cape Range No. 2 Well (25101); Learmonth (36677); Tambrey (2250, 6476, 7195, 8102); Wittenoom Gorge (13432); Marandoo (58753); Tom Price (44820); 27 km SE of Mt Meharry (66335) and 37 km SE (67904); Newman (28931); Middalya (NMV D4812); Callagiddy (36324); Karalundi (42662-71); Ejah Camp, Mileura (15122, 47631).

Eastern Division (W.A.): 34 km S of Boundary Hill (63262); Anketell Ridge in 20°22'S, 122°03'E (69523); Well 40 (64185); Well 39 (4073); Paterson Range (47784); Durba Hills (40368).

No locality: holotype (NMV D12351, formerly R7102).

Ramphotyphlops guentheri (Peters, 1865)

Figs 13 and 14

Typhlops (Onychocephalus) Güntheri Peters, 1865, Monatsb. k. Preuss. Akad. Wiss. Berlin 1865: 259. Northern Australia.

Typhlops nigricauda Boulenger, 1895, Proc. zool. Soc. Lond. **1895**: 867. Daly River, Northern Territory.

Diagnosis

A small, very slender, black-tailed blind-snake with 18 midbody scale rows and nasal cleft proceeding from second labial. Distinguishable from *R. grypus* by snout rounded (rather than beaked) in profile.

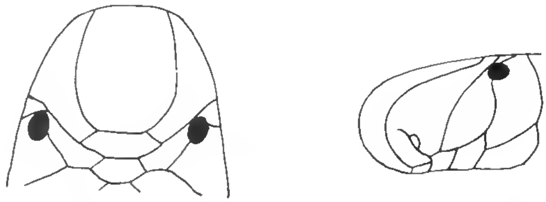

Fig. 13: Head of *Ramphotyphlops guentheri.*

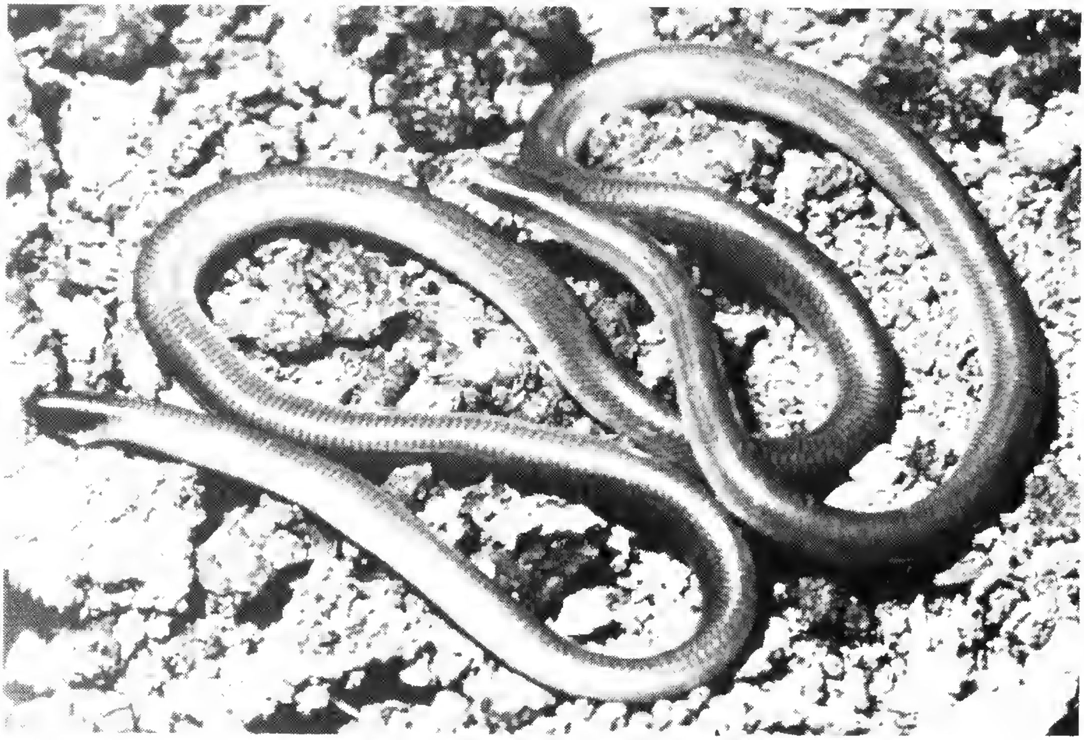

Fig. 14: A *Ramphotyphlops guentheri* from 13 km NW of Lissadell, W.A., photographed by G. Harold.

Description

Total length (mm): 120-288 (N 10, mean 210.8). Length of tail (% total length): 1.1-2.7 (N 9, mean 1.6).

Rostral (from above) truncate oval, a little longer than wide, a little more than half as wide as head and extending back to level of eyes or almost so. Nasals widely separated behind rostral. Frontal much smaller than prefrontal. Snout short, rounded in profile. Nostrils inferior, much nearer to rostral than preocular. Nasal cleft proceeding from second labial (N 8) to nostril, thence curving upwards and forwards for one-quarter to three-quarters of distance between nostril and rostral.

Midbody scale rows 18 (N 9). Ventrals 525-580 (N 5, mean 560.0). Subcaudals 10-15 (N 7, mean 13.7).

Tip of snout usually pale brown; rest of head and neck dark purplish-brown. Caudal spine and around vent whitish or pale grey; rest of tail (and often last few scale rows of body) brownish-black. Remaining dorsal surfaces purplish-brown, gradually becoming paler on lateral and ventral surfaces.

Distribution

East Kimberley (far north-east of Western Australia), south to Halls Creek and west to Fitzroy Crossing (**Fig. 19**). Also Northern Territory.

Material

Kimberley Division (W.A.): Wyndham (31520); Lake Argyle (61352-3); 13 km NW of [new] Lissadell (70361, 70368) and 12 km WSW (70322); Turkey Creek (NMV D4715); Elgie Cliffs (32283); near Halls Creek (26635); Fitzroy Crossing (28234).

Northern Territory: 12 km N of Adelaide River (24006); Katherine (21935).

Ramphotyphlops hamatus sp. nov.

Figs 15 and 16

Holotype

R69572 in Western Australian Museum, caught by Mr R.E. Johnstone on evening of 6 May 1980 in a garden at Marandoo, Western Australia, in 22°38′S, 118°06′E.

Paratypes

For details of 40 specimens from the North-West, South-West and Eastern Divisions of Western Australia, see Material.

Diagnosis

A moderately large, moderately stout, dark blind-snake with beaked snout, 22 midbody scale rows and nasal cleft usually proceeding from second labial. Distinguishable from *R. australis* by transverse cutting edge on tip of snout, nasal cleft not extending on to top of head and more numerous ventrals (usually more than 340 v. usually fewer than 340).

Description

Total length (mm): 113-418 (N 40, mean 246.5). Length of tail (% total length): 1.8-4.1 (N 33, mean 2.7).

Rostral (from above) elliptic, much longer than wide, about two-thirds as wide as head and extending back to well short of level of eyes. Nasals narrowly separated behind rostral. Frontal usually as large as prefrontal. Tip of snout with a weak to moderately strong, transverse cutting edge. Nostrils inferior, slightly swollen, slightly to much nearer to rostral than preocular. Nasal cleft proceeding from the preocular (N 2), second labial

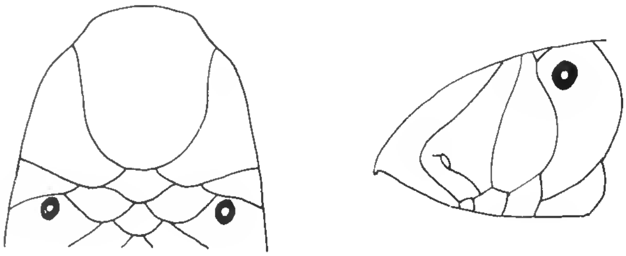

Fig. 15: Head of *Ramphotyphlops hamatus.*

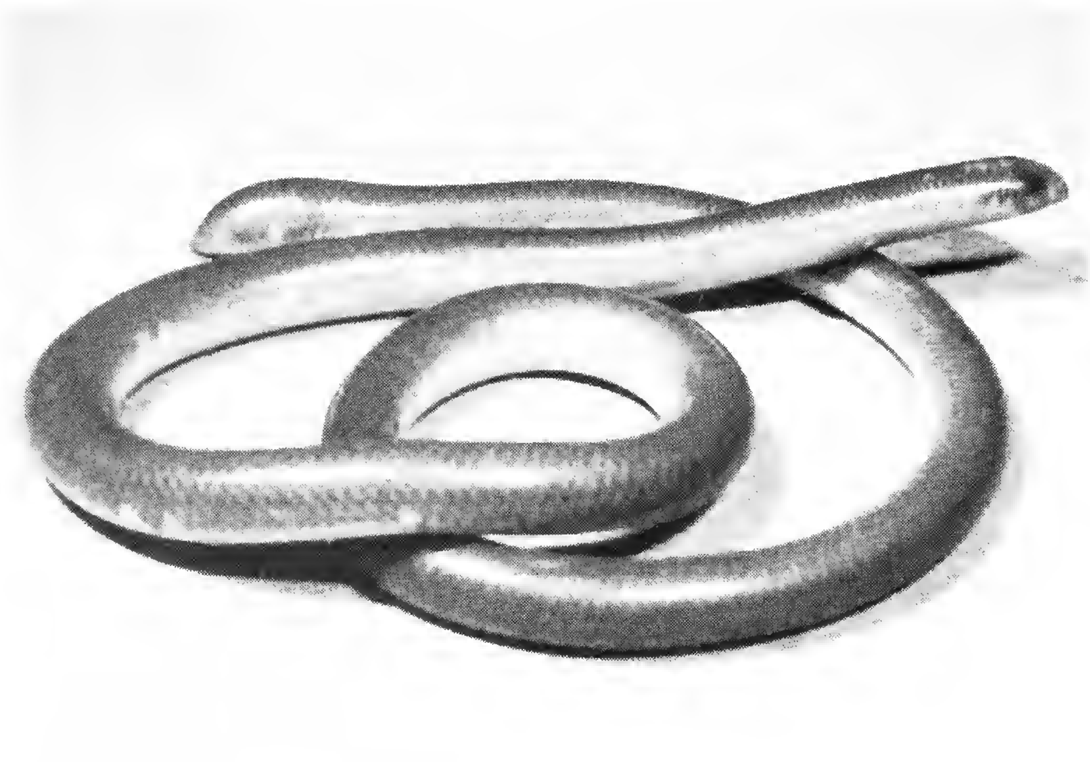

Fig. 16: A *Ramphotyphlops hamatus* from 40 km NNE of Yuin, W.A., photographed by P. Griffin.

(24), junction between first and second labials (5) or first labial (2) to nostril or a little forwards past it but never crossing obtuse ridge above nostril.

Midbody scale rows 22 (N 39). Ventrals 338-394 (N 32, mean 364.1). Subcaudals 11-22 (N 32, mean 14.4).

Dorsal and upper lateral surfaces brownish-black (paler in juveniles), lower surfaces whitish; boundary between dark and pale coloration jagged, owing to lateral scales being wholly dark or wholly pale (as in *R. australis*).

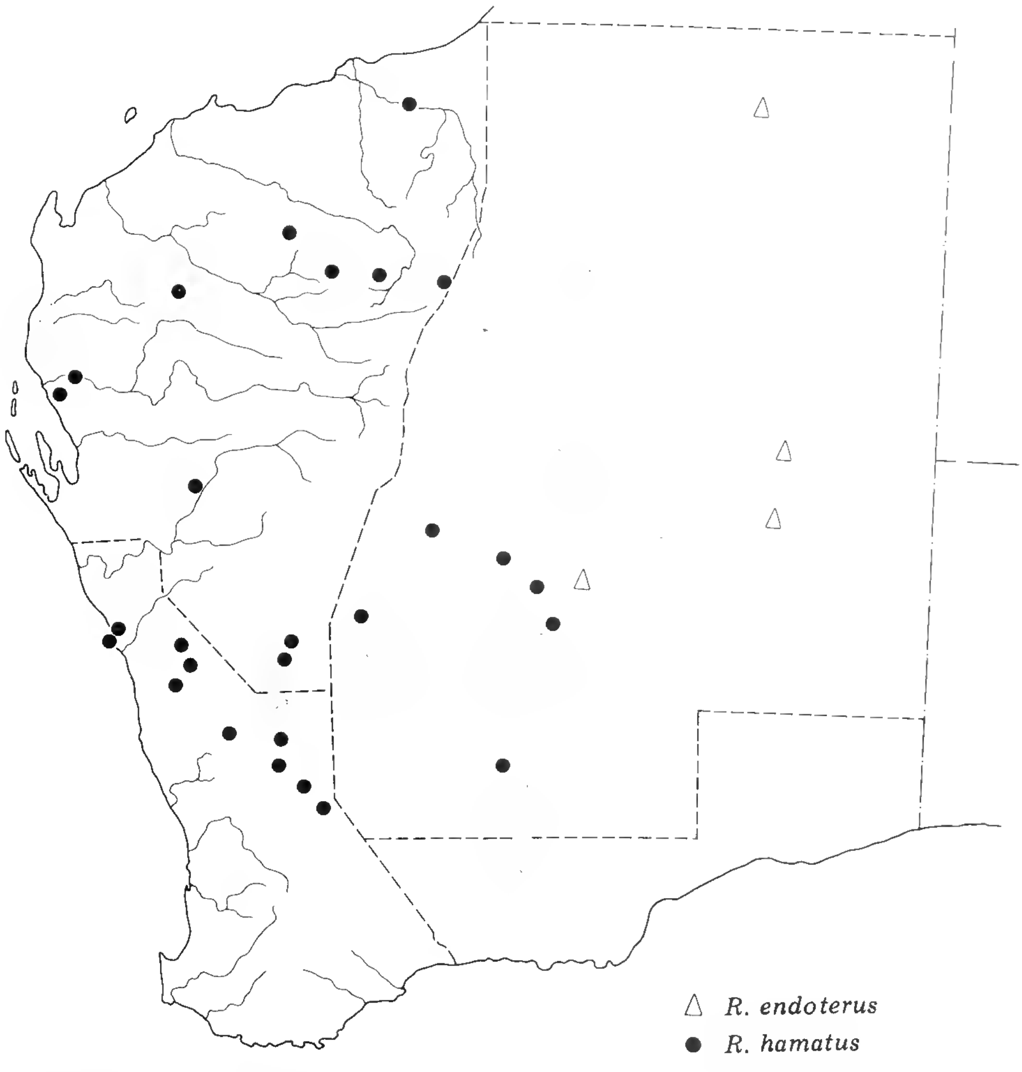

Fig. 17: Map of southern and central Western Australia showing location of specimens of *Ramphotyphlops endoterus* and *R. hamatus*.

Distribution

Western arid and semi-arid zones of Western Australia from the DeGrey south to the central Wheat Belt (Merredin), west to the lower Gascoyne, Geraldton and Three Springs, and east to Jiggalong, Banjawarn and Yuinmery (Fig. 17).

Material

North-West Division (W.A.): Muccan (10897); Woodstock (13055-6, 73521); Marandoo (58925, 56072); 27 km SE of Mt Meharry (65322-3) and 31 km SE (67920) and 36 km SE (67919); Newman (26304); Jiggalong (13359); Ullawarra (15113); 50 km E of Carnarvon (34570); Callagiddy (37049); Mt Narryer (62373); 7 km E of Oudabunna (34684); Paynes Find (12653).

South-West Division (W.A.): Newmarracarra (1733); Geraldton (32368); Canna (28312); Morawa (13686); Three Springs (45699); Caron (24789); Pithara (10044); Mollerin (24984); Koorda (3774); Kunnunoppin (13146); Merredin (21568).

Eastern Division (W.A.): Albion Downs (28291, 30979); Kathleen Valley (62870); Banjawarn (69226, 69242, 69294, 69306, 69329); 10 km NW of Erlistoun (62871); Yuinmery (69193); Laverton (12068); Boulder (7025).

Derivation of Name

Latin for 'hooked', in reference to tip of snout.

Ramphotyphlops kimberleyensis sp. nov.

Fig. 18

Holotype

R41456 in Western Australian Museum, collected by Mr J. VanRoon on 5 June 1972 on Bigge Island, Western Australia, in 14°32′S, 125°08′E.

Paratype

Kimberley Division (W.A.): Napier Broome Bay (69476).

Diagnosis

A slender, flat-headed blind-snake with rounded snout, 22 midbody scale rows and nasal cleft proceeding from second labial to high up on nasal scale.

Description

Total length (mm): 220-296 (N 2). Length of tail (% total length): 1.7-2.2 (N 2).

Rostral (from above) much longer than wide, about half as wide as head, widest anteriorly and not reaching back to level of eyes. Nasals narrowly separated. Frontal smaller than prefrontal. Snout rounded in profile. Nostrils lateral, a little nearer to rostral than preocular. Nasal cleft proceeding from second labial (N 2) to nostril, thence upwards and slightly backwards to about midway between nostril and top of nasal.

Midbody scale rows 22 (N 2). Ventrals 488-504 (N 2). Subcaudals 12-20 (N 2).

Snout pale, almost back to level of eyes. Dark upper surfaces gradually merging with pale lower surfaces.

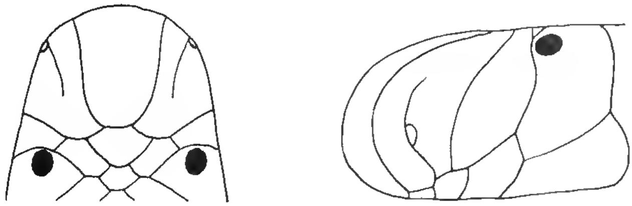

Fig. 18: Head of *Ramphotyphlops kimberleyensis.*

Distribution

Subhumid north-west Kimberley (far northern Western Australia). See **Fig. 19.**

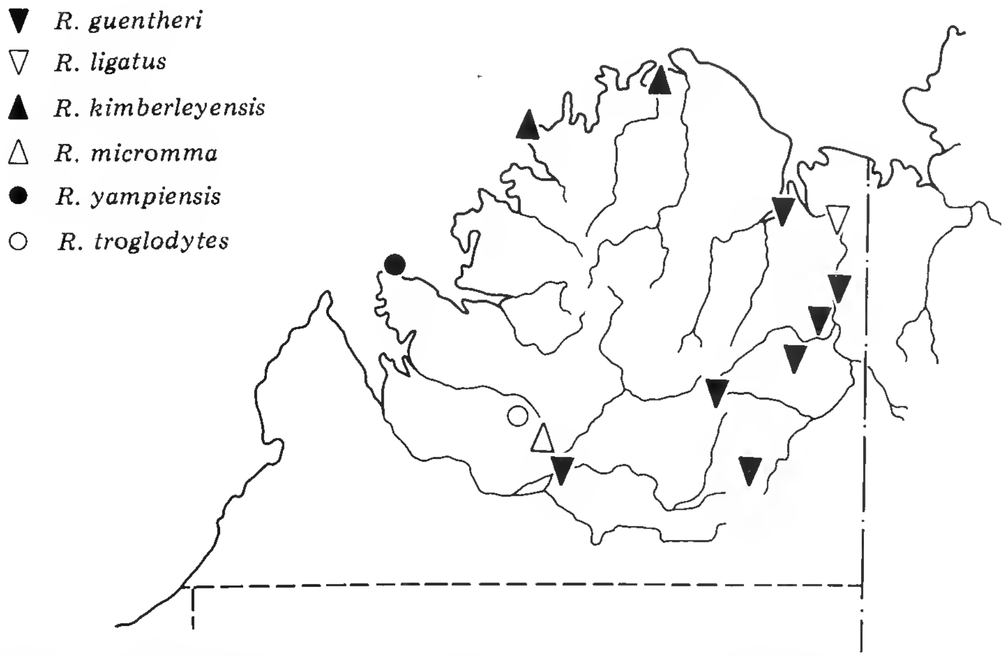

Fig. 19: Map of northern and central Western Australia showing location of specimens of *Ramphotyphlops guentheri, R. kimberleyensis, R. ligatus, R. micromma, R. troglodytes* and *R. yampiensis.*

Remarks

This species has been confused with *R. polygrammicus* (Schlegel) of the Lesser Sundas. After examining the holotype of *R. polygrammicus* (RMNH

3712; 1) and another specimen from Timor (RMNH 6895; 1) and two topotypes of *Typhlops soensis* de Jong (BMNH 1926.8.20.139-140) I find *R. kimberleyensis* to be quite distinct. *R. polygrammicus* is much darker and not flat-headed; its rostral is narrower and narrows (not widens) anteriorly; the nasal cleft proceeds vertically from the nostril and, after curving sharply forwards, terminates about one quarter of the way from nostril to top of nasal; and there are fewer ventrals (421-450).

In *R. torresianus* (Boulenger) of north Queensland and southern New Guinea the rostral similarly narrows anteriorly, but the ventrals are still fewer (c. 350).

Ramphotyphlops leptosoma Robb, 1972

Fig. 20

Ramphotyphlops leptosoma Robb, 1972, J. Proc. R. Soc. West. Aust. 55: 39. The Loop, lower Murchison River, Western Australia.

Diagnosis

A medium-sized, very slender, beaked blind-snake with 16 or 18 midbody scale rows and nasal cleft proceeding from second labial and often dividing nasal scale. Further distinguishable from *R. grypus* by its non-black tail, and from *R. waitii* by its unswollen nostrils.

Description

Total length (mm): 125-375 (N 18, mean 238.5). Length of tail (% total length): 1.5-3.8 (N 18, mean 2.3).

Rostral (from above) elliptic, about one and three-quarters times as long as wide, about three-quarters as wide as head and usually extending back to level of eyes. Nasals narrowly separated behind rostral. Frontal much smaller than prefrontal. Snout with a dark, weak to moderately strong transverse cutting edge. Nostrils inferior, very close to rostral. Nasal cleft proceeding from second labial (N 17) to nostril, thence obliquely upwards and forwards to rostral or nearly so. Eye small, not much larger than nostril.

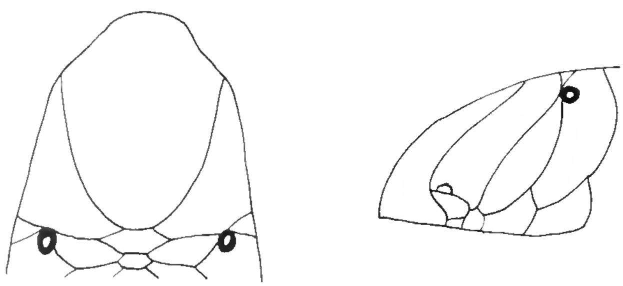

Fig. 20: Head of *Ramphotyphlops leptosoma*.

Midbody scale rows 16 (N 17) or 18 (1). Ventrals 558-720 (N 10, mean 617.3). Subcaudals 16-25 (N 13, mean 18.2).

Snout horn-coloured. Remaining dorsal surfaces purplish-brown, gradually becoming paler ventrally.

Distribution

Mid-west coast of Western Australia from Wooramel south to Geraldton and inland to Meeberrie (Fig. 21).

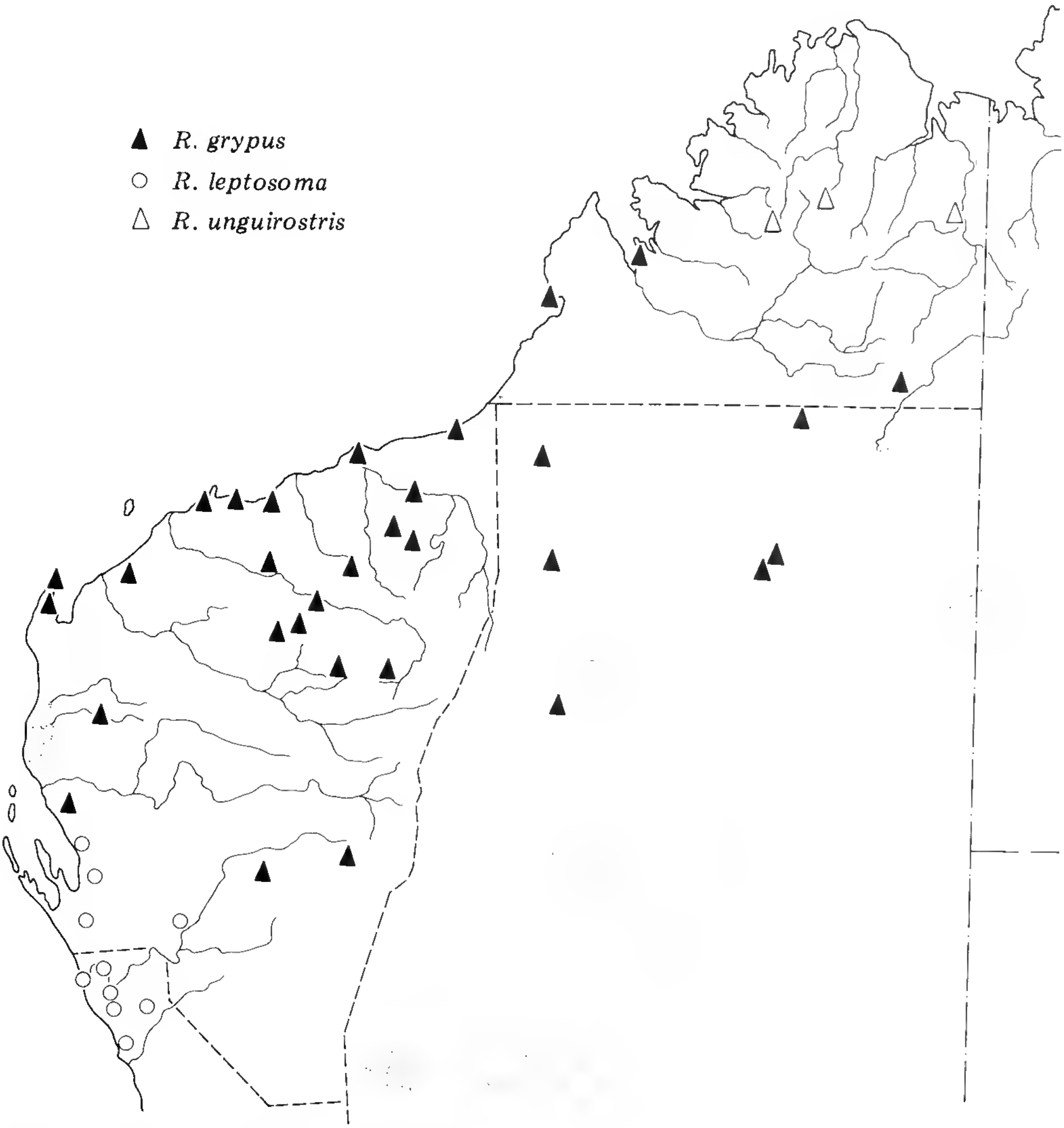

Fig. 21: Map of northern and central Western Australia showing location of specimens of *Ramphotyphlops unguirostris, R. grypus* and *R. leptosoma*.

Geographic Variation

Only the southernmost specimen (1734) has more than 16 midbody scale rows.

Material

North-West Division (W.A.): Wooramel (55038-9); Woodleigh (57392); 15 km WNW of Cooloomia (66343); Meeberrie (51097).

South-West Division (W.A.): The Loop, lower Murchison River (29624); Kalbarri (34580-1, 34649); Ajana (26012-3); Binnu (26014); 40 km NE of Yuna (57545); Bowes Station, Northampton (13642*a-d*); Newmarracarra (1734).

Ramphotyphlops ligatus (Peters, 1879)

Fig. 22

Typhlops ligatus Peters, 1879, Monatsb. k. Preuss. Akad. Wiss. Berlin 1879: 775. Mackay, Queensland.

Typhlops curtus Ogilby, 1892, Rec. Aust. Mus. 2: 23. Walsh River, Queensland.

Diagnosis

A moderately stout blind-snake with 24 midbody scale rows and nasal cleft proceeding from first labial well on to top of head. Further distinguishable from *R. unguirostris* by snout rounded in profile and much narrower rostral.

Description

Total length (mm): 111-319 (N 5, mean 198.0). Length of tail (% total length): 2.7-3.9 (N 5, mean 3.2).

Rostral (from above) about twice as long as wide, one-third or less as wide as head, widest posteriorly and not extending back to level of eyes. Nasals narrowly separated behind rostral. Frontal much smaller than prefrontal. Snout rounded in profile. Nostrils inferior, about equidistant form rostral and preocular. Nasal cleft proceeding from first labial (N 5) to nostril, thence upwards and slightly backwards and terminating after briefly curving forwards midway between nostril and top of nasal scale or higher.

Midbody scale rows 24 (N 5). Ventrals 335-435 (N 5, mean 397.4). Subcaudals 11-17 (N 5, mean 13.4).

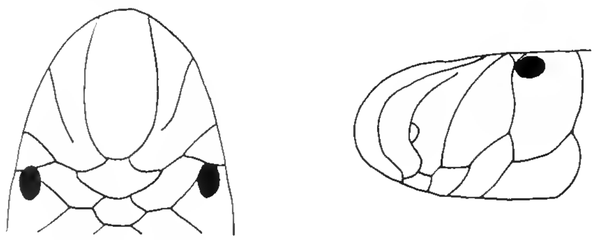

Fig. 22: Head of *Ramphotyphlops ligatus.*

Snout and around eye pale. Remaining dorsal and upper lateral surfaces dark purplish-brown, sharply demarcated from whitish lower surfaces.

Distribution

East Kimberley (far north-eastern Western Australia). Also Northern Territory and Queensland. See Fig. 19.

Material

Kimberley Division (W.A.): Kimberley Research Station (15 km N of Kununurra) (12110, 22357); 13 km NW of [new] Lissadell (75510).

Northern Territory: Katherine (24936). [For locality of specimens in Northern Territory Museum, Darwin, see Wells (1979).]

Queensland: Brisbane (11554).

Ramphotyphlops margaretae sp. nov.

Fig. 23

Holotype

R15710 in Western Australian Museum, collected by Mr W.H. Butler on 25 August 1962 at Lake Throssell, Western Australia, in 27°25′S, 124°18′E.

Diagnosis

A very slender blind-snake with 18 midbody scale rows and nasal cleft proceeding from second labial; most like *R. bituberculatus* but body more elongate and snout not so strongly trilobed.

Description (of holotype, the only available specimen)

Total length (mm): 306. Length of tail (% total length): 1.1.

Rostral (from above) one and three-quarters times as long as wide, two-thirds as wide as head and extending back to level of front of eyes. Nasals separated behind rostral. Frontal much smaller than greatly enlarged pre-frontal. Snout angular in profile. Nostrils inferior, swollen, and nearer to rostral than preocular.

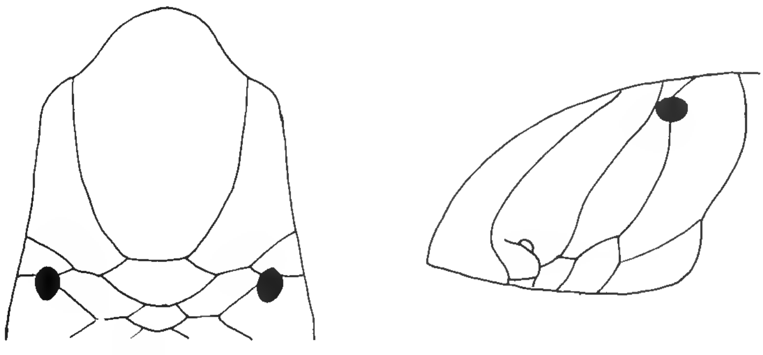

Fig. 23: Head of *Ramphotyphlops margaretae.*

Midbody scale rows 18. Ventrals 559. Subcaudals 12.

Snout pale horn. Remaining dorsal surfaces pinkish to purplish-grey. Ventral surfaces pale grey.

Distribution

Known from only one locality in the arid interior of Western Australia (Fig. 5).

Remarks

Named after Margaret Butler, wife of the collector of the holotype.

Ramphotyphlops micromma sp. nov.

Fig. 24

Holotype

R1341 in Western Australian Museum, collected in October 1924 by W.R. Richardson at Leopold Downs, Western Australia, in 17°52′S, 125°26′E.

Diagnosis

A slender, short-snouted blind-snake with very small eyes, 18 midbody scale rows and nasal cleft proceeding from second labial and completely dividing nasal scale. Further distinguishable from *guentheri* and *grypus* by non-black tail and less numerous ventrals (fewer than 500 v. more than 500).

Description (of holotype, the only available specimen)

Total length (mm): 205. Length of tail (% total length): 2.4.

Rostral (from above) widest posteriorly, one and three-quarters times as long as wide, a little more than half as wide as head and extending back to level of front edge of eyes. Nasals moderately widely separated behind rostral. Frontal much smaller than prefrontal. Snout very short, rounded in profile. Nostrils inferior, nearer to rostral than preocular. Nasal cleft proceeding from second labial to nostril, thence extending vertically well on to top of head and reaching rostral after curving forwards. Eye very small (no larger than nostril) and barely discernible.

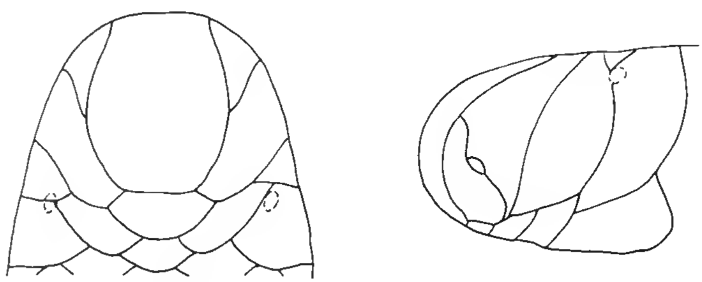

Fig. 24: Head of *Ramphotyphlops micromma*.

Midbody scale rows 18. Ventrals 478. Subcaudals 15.

No details of coloration remain.

Distribution

Only known from one locality in southern interior of Kimberley Division (far northern Western Australia). See Fig. 19.

Derivation of Name

Greek for 'small eye'.

Ramphotyphlops pinguis (Waite, 1897)

Figs 25 and 26

Typhlops pinguis Waite, 1897, Trans. R. Soc. S. Aust. 21: 25. 'South Australia'.

Typhlops opisthopachys Werner, 1917, Mitt. zool. Mus. Hamb. 34: 35. 'Tanga, German East Africa'.

Diagnosis

A large, very stout, moderately dark blind-snake with 20 midbody scale rows, snout slightly angular in profile and nasal cleft proceeding from second labial.

Description

Total length (mm): 131-445 (N 48, mean 335.4). Length of tail (% total length): 2.6-5.7 (N 46, mean 3.8).

Rostral (from above) urn-shaped, much longer than wide, about half as wide as head and not extending back to level of eyes. Nasals narrowly separated behind rostral. Frontal usually much smaller than prefrontal. Snout slightly angular in profile. Nostrils inferior, slightly swollen, equidistant from rostral and preocular. Nasal cleft proceeding from second labial (N 42) to nostril, thence curving upwards and forwards for one-fifth to one-half of distance to rostral.

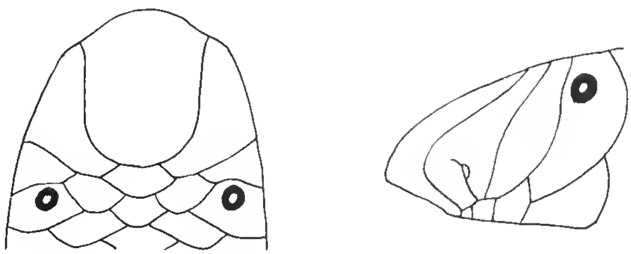

Fig. 25: Head of *Ramphotyphlops pinguis*.

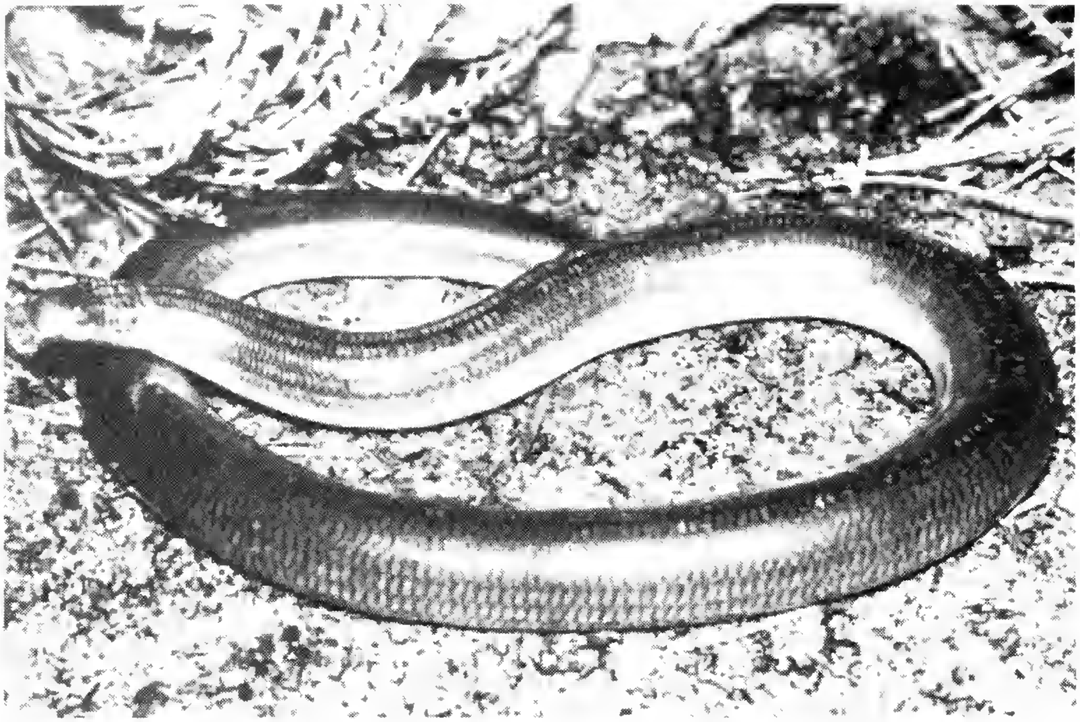

Fig. 26: A *Ramphotyphlops pinguis* from Canning Dam, W.A., photographed by T.M.S. Hanlon.

Midbody scale rows 20 (N 47). Ventrals 277-331 (N 41, mean 301.5). Subcaudals 12-19 (N 41, mean 14.8).

Dorsal and upper lateral surfaces dark brown, either merging gradually with or fairly sharply demarcated from whitish lower surfaces.

Distribution

South-western Western Australia, north to New Norcia, east to Koorda, Bruce Rock and Jerramungup, and south to Bunbury, Boyup Brook and Tenterden (Fig. 5).

Material

South-West Division (W.A.): 'Geraldton' (14204); Koorda (3774); New Norcia (28396); Gingin (3364); Bindoon (37465); Northam (4545); Muresk (22423); Bakers Hill (12920); Chidlow (2109, 26865); Bruce Rock (3401); Darlington (11326); Boya (55917); Kalamunda (26343, 29754); Karragullen (2591); Mt Dale (19133); Jarrahdale (64626); Pinjarra (747, 7078); head of South Dandalup River (31222); Wandering (4367); Kulin (34028); Yarloop (2602); Williams (17310); Lake Biddy (2779); Harvey (6372); Wokalup (NMV R7173); West Tarwongup (5347); Wagin (15123); Darkan (4391); Boolading (4951); Buckingham (1365); Burekup (854); Capercup (5207); Katanning (473, 859); Kojonup (590, 653, 28630); Narlungup (805); Boyup Brook (5352); Jerramungup (21879); Cranbrook (783, 5122); Tenterden (8231); no locality (291, 69519); holotype (SAM R803).

Ramphotyphlops troglodytes sp. nov.

Fig. 27

Holotype

R51043 in Western Australian Museum, collected on 1 September 1975 by Dr B.R. Wilson and Mrs S.M. Slack-Smith at Tunnel Cave, Napier Range, Western Australia, in 17°37'S, 125°14'E.

Diagnosis

A very slender, flat-headed, white-snouted blind-snake with snout rounded in profile, 22 midbody scale rows and nasal cleft proceeding from second labial and completely dividing nasal.

Description (based on holotype, the only available specimen)

Total length (mm): 402. Tail length (% total length): 1.3.

Rostral (from above) oval, widest anteriorly, nearly one and one-half times as long as wide, nearly three-quarters as wide as head and extending back to well short of level of eyes.

Head depressed. Snout rounded in profile. Nostrils lateral, much nearer to rostral than preocular. Nasal cleft proceeding from second labial to nostril, thence curving upwards and forwards to rostral. Eyes indistinct.

Midbody scale rows 22. Ventrals 641. Subcaudals 14.

Coloration in spirits. Snout whitish, back nearly to level of eyes. Tip of tail whitish. Remaining dorsal and upper lateral surfaces brown, gradually merging with pale lower surfaces.

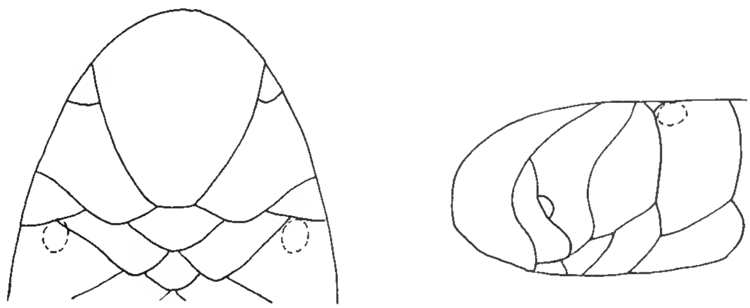

Fig. 27: Head of *Ramphotyphlops troglodytes*.

Distribution

Only known from one locality in the interior of the Kimberley Division, far northern Western Australia (**Fig. 19**).

Ramphotyphlops unguirostris (Peters, 1867)

Fig. 28

Typhlops (Onychocephalus) unguirostris Peters, 1867, Monatsb. K. Preuss. Akad. Wiss. 1867: 708. Rockhampton, Queensland.

Typhlops curvirostris Peters, 1879, Monatsb. K. Preuss. Akad. Wiss. Berlin 1879: 776. Port Bowen, Queensland.

Diagnosis

A moderately slender blind-snake with 24 midbody scale rows, nasal cleft proceeding from first labial, and snout tipped with cutting edge. Further distinguishable from *R. ligatus* by much wider rostral.

Description

Total length (mm): 268-490 (N 7, mean 357.0). Length of tail (% total length): 1.2-2.7 (N 7, mean 2.0).

Rostral (from above) elliptic, longer than wide, about two-thirds as wide as head, and extending back to well short of eyes. Nasals in short contact behind rostral or narrowly separated. Frontal smaller than prefrontal. Cutting edge at tip of snout extending back through nasal scale as a ridge. Nostrils inferior, much nearer to rostral than preocular. Nasal cleft proceeding from first labial to nostril, thence curving upwards and forwards to or towards rostral.

Midbody scale rows 24 (N 7). Ventrals 387-474 (N 5, mean 426.6). Subcaudals 11-16 (N 7, mean 13.1).

Dorsal and upper lateral surfaces dark olive-brown, fairly sharply demarcated from whitish lower surfaces.

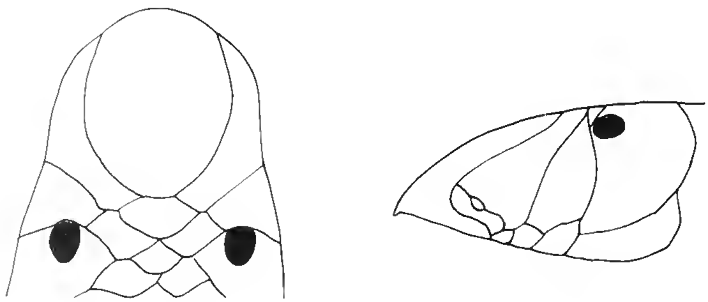

Fig. 28: Head of *Ramphotyphlops unguirostris*.

Distribution

Kimberley Division, far northern Western Australia (Fig. 21). Also Northern Territory and eastern Australia.

Remarks

Our first Western Australian specimen was obtained when Mr W.H. Butler saw one of two Pied Butcherbirds (*Cracticus nigrogularis*) with a snake in its bill. A well-aimed stone persuaded the bird to release the snake.

The five species of blind-snake recorded from north-west Kimberley, viz. *R. kimberleyensis*, *micromma*, *troglodytes*, *unguirostris* and *yampiensis*, are represented in our collection by only eight specimens. This and Mr Butler's experience demonstrate the difficulty of collecting blind-snakes in this rugged region and indicate the probability that several more species remain to be discovered there.

Material

Kimberley Division (W.A.): Gibb River HS (73513, 73538); Manning Creek in 16°38'S, 125°55'E (70725); 13 km NW of [new] Lissadell (75342, 75461, 75518).

Northern Territory: Katherine (13891).

Ramphotyphlops waitii (Boulenger, 1895)

Figs 29 and 30

Typhlops waitii Boulenger, 1895, Proc. Linn. Soc. N.S.W. (2) 9: 718. N.W. Australia.

Diagnosis

A large, very slender, strongly beaked blind-snake with 20 midbody scale rows and nasal cleft usually proceeding from second labial. Further distinguishable from *R. bituberculatus* by more numerous ventrals (more than 500 v. fewer than 500) and snout not strongly trilobed.

Description

Total length (mm): 127-614 (N 155, mean 341.2). Length of tail (% total length): 1.0-3.1 (N 76, mean 2.0).

Rostral (from above) elliptic, much longer than wide, about three-quarters as wide as head and usually extending back not as far as eyes (occasionally to level of front edge of eyes). Nasals narrowly separated behind rostral. Frontal smaller than prefrontal. Tip of snout with a strong, dark transverse cutting edge. Nostrils inferior, swollen, much nearer to rostral than preocular. Nasal cleft proceeding from second labial (N 121) or from junction between second labial and preocular (1) to nostril, thence obliquely upwards and forwards to about midway between nostril and rostral.

Midbody scale rows 20 (N 110). Ventrals 535-667 (N 30, mean 599.4). Subcaudals 13-26 (N 31, mean 18.6).

Dorsal and upper lateral surfaces moderately dark purplish-brown, gradually merging with whitish lower surfaces.

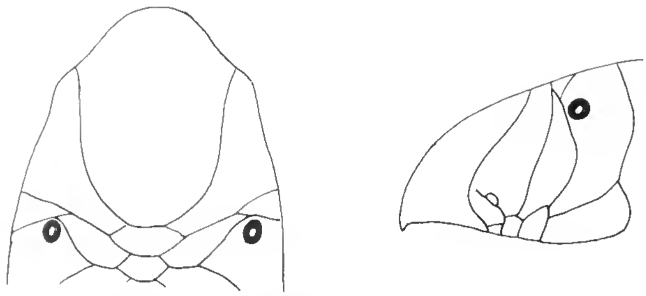

Fig. 29: Head of *Ramphotyphlops waitii*.

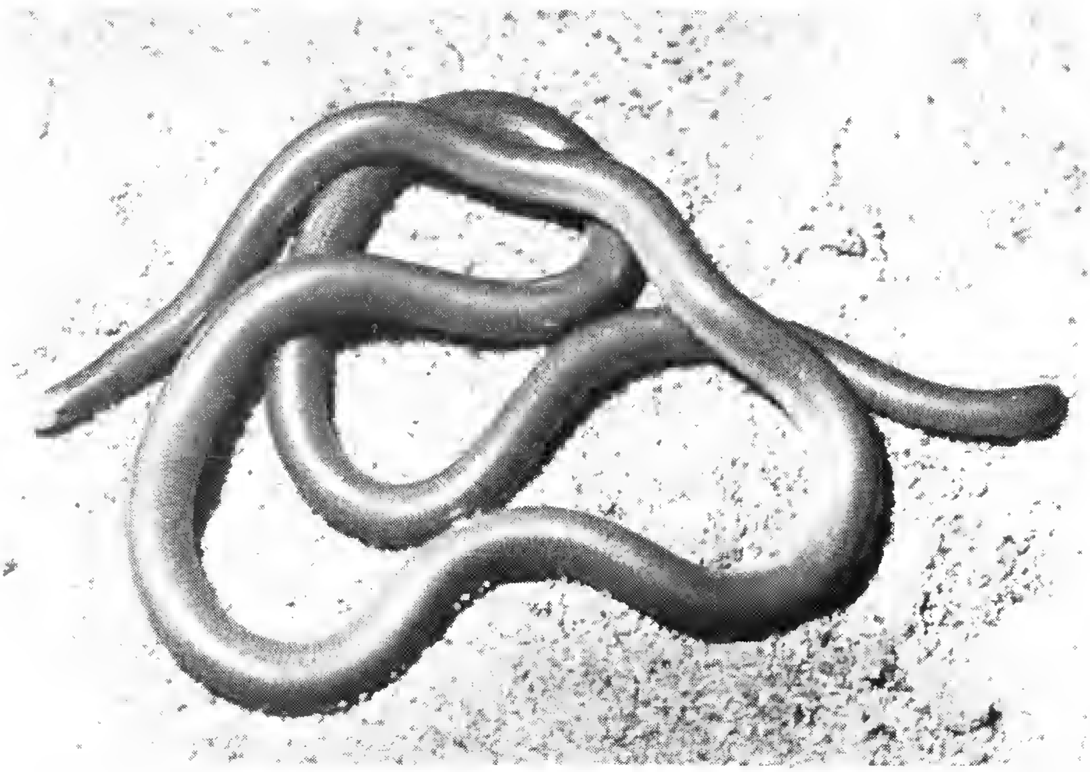

Fig. 30: A *Ramphotyphlops waitii* from 10 km S of Coorow, photographed by T.M.S. Hanlon.

Distribution

Western Australia from the Hamersley and Warburton Ranges south to Armadale, Dumbleyung, Holt Rock, the Eastern Goldfields and Cundeelee (Fig. 31).

Material

North-West Division (W.A.): 'N.W. Australia' (holotype BMNH 1946.1.11.74); Marandoo (52687-8, 68951); Marillana (31906); Roy Hill (13998); Kumarina (25214); 19 km S of Tamala (64382); Yalgoo (1743); Warriedar (1404).

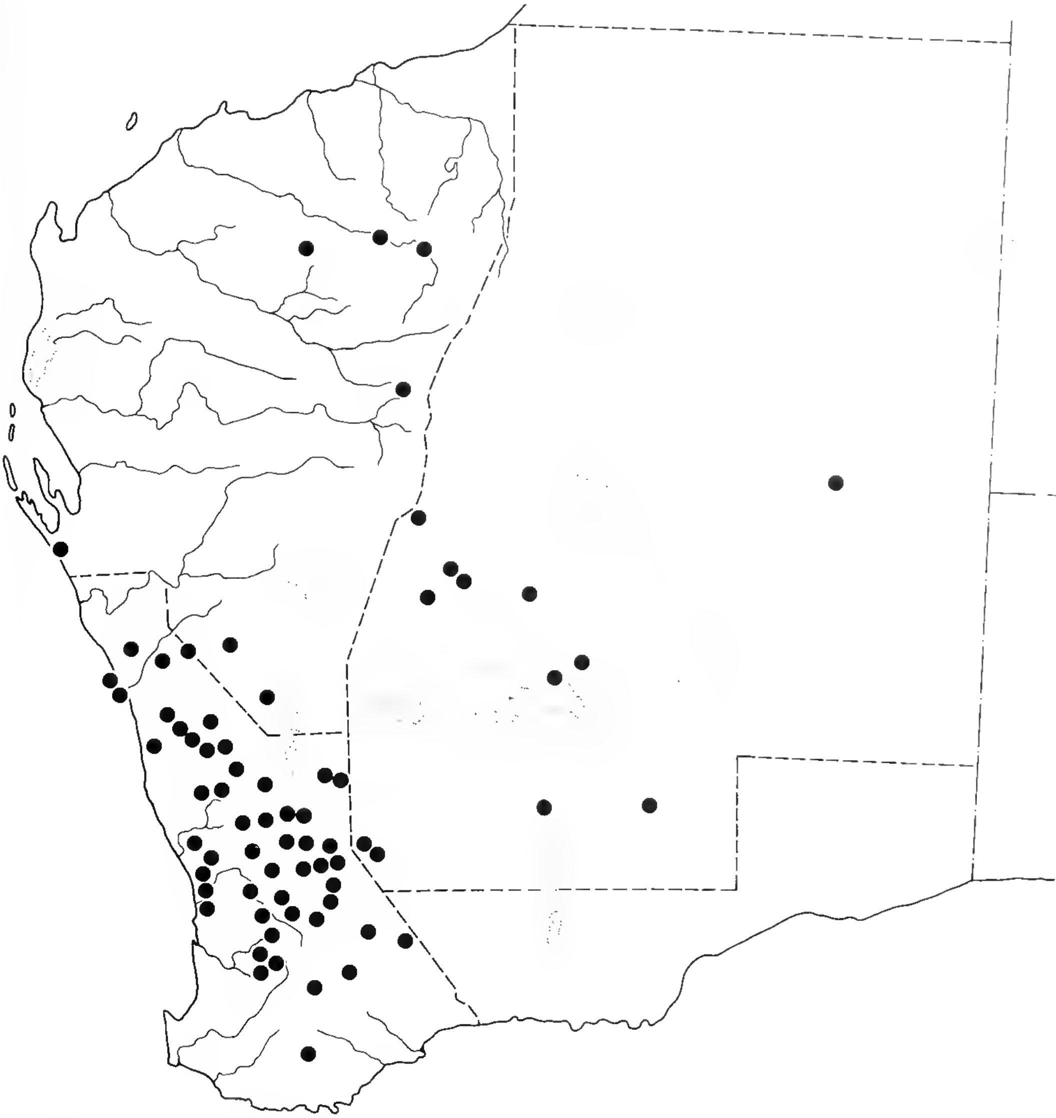

Fig. 31: Map of southern and central Western Australia showing location of specimens of *Ramphotyphlops waitii.*

South-West Division (W.A.): Yuna (26048); Mullewa (8447) and 32 km E (22769); Geraldton (8703-4, 34550) and 4 km S (41665); Greenough (7924); 13 km S of Mingenew (33382-3); Perenjori (24796); Three Springs (5192); Carnamah (403); Eneabba Spring (26761); Waddi Forest (8064); Maya (26407, 56106); 10 km S of Coorow (54485, 57801-7); Wubin (30913); Dalwallinu (9241, 28145); 30 km NE of Beacon (48403); 29 km NE of Wialki (47782); Kalannie (69497); Coomberdale (31157); Miling (48017-8); Bindi Bindi (12020); Moora (22864-5); Gabbin (13990); Koorda (19659-65); Wongan Hills (10057); Moonijin (32032, 37490); Ejanding (7105); Nalkain (4992); Korrelocking (26410); 14 km S of Trayning (25595); Nukarni (6312); Goomalling (12769); Beermullah (8613); Lower Chittering (24742); Merredin (1368); Doodlakine (5787); Kellerberrin (24093, 27266); Cunderdin (3854, 29305); East Bullsbrook (13865); Bullsbrook

(NMV R7199); Upper Swan (15118); Herne Hill (68275); Midland (2443); Guildford (31994); York (4246-9, 8973-8); Helena Valley (31992); Maida Vale (1554-5); Bruce Rock (29598) and 18 km S (22937-8); Shackleton (15119); Balkuling (5129); Quairading (2484-8, 14827, 52636); Dangin (4265); Gosnells (1381-2); Armadale (67334); Mt Kokeby (3794); Lake Mears (4319); Corrigin (12652); Pingelly (9175, 12633, 62504); Karlgarin (31055); 5 and 9 km NW of Holt Rock (54412-6); Congelin (39070); Contine (69528); Narrogin (25901); Williams (421); Lake Grace Reserve (44219-21); Dumbleyung (28948); 'Cranbrook' (NMV R7172, 7193); no locality (643, 1198, 4832, 7297, 8937, 29708-13).

Eastern Division (W.A.): Warburton Range (14659, 17780-1, 22004, 22027, 22095, 31358-9); Yandil (2228); Albion Downs (30978, 30980); Kathleen Valley (15120, 19778); Booylgoo Spring (1121, 1745); Banjawarn (69197, 69219); Laverton (21336, 23913); 8 km SW of Mt Morgans (69527); Cundeelee (32676); Bulong (4205); 'Goldfields' (448); Westonia (4988); Bodallin (22885).

Ramphotyphlops yampiensis sp. nov.

Fig. 32

Holotype

R26839 in Western Australian Museum, collected in March 1966 by Mr F.C. VanIngen on Koolan Island, Western Australia, in 16° 08'S, 123° 45'E.

Diagnosis

A slender blind-snake with rounded snout, 18 midbody scale rows and nasal cleft proceeding from preocular and completely dividing nasal scale. Further distinguishable from *R. diversus* by more numerous ventrals.

Description (based on holotype, the only available specimen)

Total length (mm): 128. Tail (% total length): 1.8.

Rostral (from above) elliptic, one and three-quarters times as long as wide, two-thirds as wide as head and extending back nearly to level of eyes. Nasals narrowly separated behind rostral. Frontal smaller than prefrontal. Snout rounded in profile. Nostrils slightly inferior (i.e. almost lateral), nearer to rostral than preocular. Nasal cleft proceeding from preocular to nostril, thence obliquely upwards and forwards to rostral.

Midbody scale rows 18. Ventrals 480. Subcaudals 11.

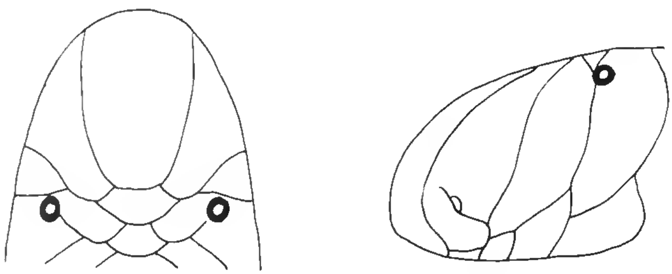

Fig. 32: Head of *Ramphotyphlops yampiensis.*

Coloration in spirits. Snout pale, rest of upper surface brown, becoming darker on head, neck and tail and paler on lower surfaces.

Distribution

Only known from one island in Yampi Sound, north-west Kimberley (far north of Western Australia). See **Fig. 19**.

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APPENDIX

Ramphotyphlops braminus (Daudin, 1803)

Fig. 34

Eryx braminus Daudin, 1803, Histoire naturelle, générale et particulière des reptiles 7: 279. Vizagapatam, India.

Diagnosis

A very small, dark blind-snake with rounded snout, 20 midbody scale rows, and nasal cleft proceeding from preocular and completely dividing nasal scale. Distinguishable from all Australian blind-snakes by ventrals dark and often only in point contact with adjacent scales of same longitudinal row (Fig. 33).

Fig. 33: Sketch showing ventral scales in Western Australian species of *Ramphotyphlops* (right) and in *R. braminus* (left).

Description

Total length (mm): 64-150 (N 9, mean 107.9). Length of tail (% total length): 1.5-2.7 (N 9, mean 2.1).

Rostral (from above) twice as long as wide, about one-third as wide as head, narrowing anteriorly, and usually not extending back to level of eyes. Nasals narrowly separated behind rostral. Frontal about as large as prefrontal. Snout short and rounded in profile. Nostrils lateral, usually just visible from above, equidistant from rostral and preocular or a little nearer to rostral. Nasal cleft proceeding from preocular (N 9) to nostril, thence upwards and curving forwards before joining rostral at its widest point.

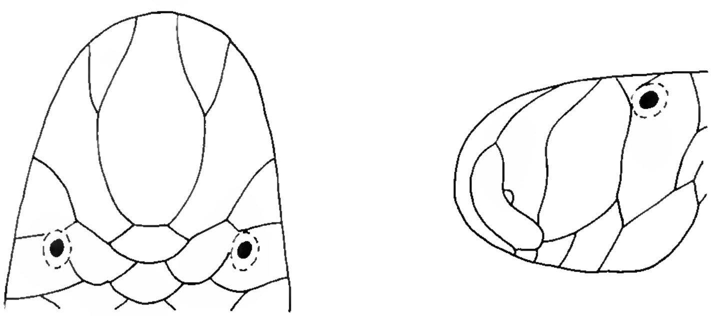

Fig. 34: Head of *Ramphotyphlops braminus*.

Midbody scale rows 20 (N 6). Ventrals 300-318 (N 4, mean 308.2). Subcaudals 8-12 (N 4, mean 10.2).

Tip of snout, lips and tip of lower jaw pale brown. Vent and tip of tail white. Rest of upper surface dark purplish-brown, gradually becoming paler on lower surfaces, anterior angle of all scales purplish-black.

Distribution

Original habitat presumably South-East Asia; now established in many parts of the world.

Remarks

At present *Ramphotyplops* and *Typhlops* can only be distinguished on characters of the male genitalia, which makes it impossible to place the parthenogenetic *braminus* with any certainty. I therefore follow McDowell (1974) in placing it in *Typhlina [=Ramphotyphlops]* to which it seems closer in details of head scalation.

Material

Malaya (6096-7); Christmas I. (37046); Cocos Keeling Is (26234); Darwin, Northern Territory (28735, 28413, 30946-8).

Rec. West. Aust. Mus. 1981, 9 (3): 273-277

TWO SPECIES OF LUMBRICID EARTHWORM NEWLY RECORDED FROM WESTERN AUSTRALIA

IAN ABBOTT*

ABSTRACT

Eisenia rosea (Sav.) and *Octolasion cyaneum* (Sav.) (Oligochaeta: Lumbricidae) are newly recorded from Western Australia. The distribution of *E. rosea* suggests that it may have arrived overland from South Australia. The mode of entry of *O. cyaneum* is unknown.

INTRODUCTION

Prior to European settlement, the only earthworms present in Western Australia belonged to the family Megascolecidae (*sensu* Jamieson 1971). With the trafficking of farm goods and other supplies, and the disposal of ballast at ports, it would not have taken long for lumbricid earthworms to have been accidently introduced, presumably from Britain. Unfortunately, none of the early naturalists collected earthworms, probably because there were too many novelties to be had with the flora and vertebrate fauna. It was not until the arrival of the Hamburg expedition in 1905 that an attempt to compile an inventory of invertebrates of this State was begun.

Michaelsen (1907) collected in nearly all of the then-settled districts in temperate Western Australia. He recorded five lumbricid earthworm species: *Allolobophora caliginosa*[1] (widespread), *Eiseniella tetraedra* (one locality), *Helodrilus parvus*[2] (one locality), *H. constrictus*[3] (two localities) and *Eisenia foetida*[4] (one locality).

Jackson (1931) did not add to this list of lumbricid species. I have examined the collection held in the Western Australian Museum, and found no previously unrecorded lumbricid species in Western Australia. In 1977-79, I attempted to add to our meagre knowledge of earthworm distribution in Western Australia. This resulted in an additional two species of lumbricid being recorded from Western Australia.

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1 I have identified Michaelsen's specimens (deposited in the Western Australian Museum) from selected localities as *Aporrectodea trapezoides* (Dugès, 1828).

2 This species is currently referred to as *Bimastos parvus* (Eisen, 1874).

3 This species is currently referred to as *Dendrodrilus rubidus* (Savigny, 1826).

4 This species is now correctly referred to as *Eisenia fetida* (Savigny, 1826).

SYSTEMATICS

Family Lumbricidae

Eisenia rosea (Savigny, 1826)

Enterion roseum Savigny, 1826, p. 182

Diagnosis

This is based on a composite of all the material collected. A very detailed description is given by Gates (1973).

Length of preserved specimens: to 75 mm; colour of preserved specimens: anterior pale flesh, rest fawn or fawn all over; male pore: on segment 15, between b and c lines of setae; in clitellate specimens the papillae spread on to segments 14 and 16. Clitellum: white, covering segments 23-, 24- or 25-32. Tuberculum pubertatis: on segments 29-30 or -31. Genital tumescences: may be present on setae a and b between segments 24 and 32. Setae: closely paired.

Distribution

Eisenia rosea has a sparse distribution in the Wheat Belt of Western Australia (Fig. 1). None was found elsewhere during an extensive search of an area of the Wheat Belt bounded by Merredin, Northam, Narrogin, Lake King and Hyden (Abbott and Parker 1980).

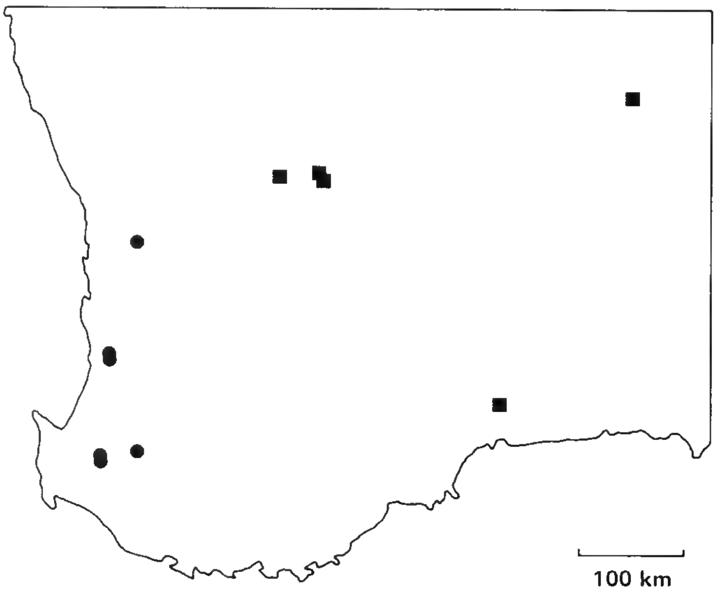

Fig. 1: Map of portion of south-western Australia showing the known distribution of *Eisenia rosea* (■) and *Octolasion cyaneum* (●).

Material Examined

WAM 9-81. Merredin Agricultural Research Station, August 1979. Collected by I. Abbott in clay soil on a creek bank (11 aclitellate specimens) and adjacent wheat crop (1 clitellate, 6 aclitellate). WAM 10-81. Great Eastern Highway, 31 km west of Hines Hill, August 1979. Collected by I. Abbott in a gutter containing clay loam soil, sparsely vegetated with Rye Grass and Double Gee (8 clitellate, 3 aclitellate). WAM 11-81. Forests Department Arboretum, Kalgoorlie, August 1980. Collected by I. Abbott in red clay loam, much overgrown with weeds (1 clitellate, 9 aclitellate). WAM 12-81. Hotel garden, Ravensthorpe, August 1980. Collected by I. Abbott in clay soil with Kikuyu grass (1 aclitellate).

Family Lumbricidae

Octolasion cyaneum (Savigny, 1826)

Enterion cyaneum Savigny, 1826, p. 181

Diagnosis

The following is based on a composite of all the material collected. For a detailed description, see Gates (1974).

Length of preserved specimens: to 105 mm; colour of preserved specimens: anterior segments pink, remainder light grey or fawn/light brown all over. Last few segments in life yellow. Male pore: on segment 15, with papillae only extending slightly to adjacent segments and lying between b and c lines of setae. Clitellum: a distinct saddle, no more ventral than the b setal line, coloured brown, cream or white. It covers segments 28- or 29-34 or -35. Tuberculum pubertatis: white, between b and c setal lines, and covering segments ½ 29- ½ 34, sometimes 30-33 or 30-34. Genital tumescences: variably developed and sometimes absent. On the specimens at hand the arrangement is segment 9 (pair), segment 19 (pair); 18 (pair), 19 (single), 21 (single); 18 (pair), 21 (RHS); 18 (pair), 20 (pair); 17 (RHS), 19 (RHS), 20 (RHS); 17 (RHS), 19 (RHS); 18 (LHS), 20 (RHS); 18 (RHS), 19 (RHS), 21 (LHS); 18 (RHS), 19 (RHS), 20 (LHS); 18 (LHS), 19 (RHS). It is the setae in the a and b lines that are usually modified on tumescences. The a and b setae on segments anterior to 16 are close (aa < 2ab), thereafter diverging so that ab (on segments posterior to 19) = 2ab (on segments anterior to 15). Generally cd < bc < ab < aa.

Distribution

All of the records of *O. cyaneum* are from the high rainfall zone of the south-west of Western Australia (Fig. 1).

Material Examined

WAM 13-81. Ale Farm, about 9 km south of Nannup, March 1979. Collected by I. Abbott in loam in garden and adjacent pasture (9 clitellate). WAM 14-81. Harvey townsite (Herbert Road), September 1979. Collected by E.H. Sedgwick in clayey garden and lawn soil (3 clitellate). WAM 15-81. Adjacent to Blackwood River near Bridgetown, June 1980. Collected by J. Conacher from alluvial soil (6 clitellate, 2 aclitellate). WAM 17-81. Carinyah forest settlement (abandoned), August 1980. Collected by I. Abbott in loamy soil under hardwood plantation (2 clitellate).

Remarks

As *Eisenia rosea* is not known from the Perth metropolitan area (personal observations), its possible point of entry into the State invites comment. This species occurs in South Australia, Victoria and New South Wales. The location of the Western Australian records, all close to major road links with the Eastern States, suggests that *E. rosea* may have been introduced from South Australia. This species probably originally came from Britain. Elsewhere in the Southern Hemisphere, it has been recorded from South Africa (Ljungström 1972), New Zealand (Martin 1977) and Argentina (Ljungstrom *et al.* 1973).

Carinyah forest settlement was established in 1921 and abandoned in 1970. This is consistent with the idea that *O. cyaneum* was indeed absent from the State when Michaelsen in 1905-06 collected extensively in the high rainfall sector of south-western Australia. This species also has not been recorded from the Perth metropolitan area (personal observations). Elsewhere in Australia, *O. cyaneum* has been recorded from Victoria and New South Wales. I have no useful speculations to offer as to its possible mode of entry into Western Australia. Apart from its occurrence in Australia, other Southern Hemisphere records are New Zealand (Martin 1977) and Argentina (Ljungström *et al.* 1973).

ACKNOWLEDGEMENTS

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A REVISION OF THE RAINBOWFISH GENUS *CHILATHERINA* (MELANOTAENIIDAE)

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ABSTRACT

The six species of *Chilatherina*, family Melanotaeniidae, are reviewed. The genus inhabits freshwater streams of northern New Guinea between the Markham and Mamberamo Rivers and also the central highlands of Papua New Guinea. The habitat consists mainly of exposed, sunlit sections of tributary streams, although two species have lacustrine populations. A brief diagnosis, illustrations, and tables of counts are presented for each of the following species (approximate distributions indicated in parentheses): *C. axelrodi* (Pual River system); *C. campsi* (Markham River system and headwater streams of Sepik and Purari River systems); *C. crassispinosa* (widespread northern New Guinea); *C. fasciata* (widespread northern New Guinea); *C. lorentzi* (Tawarin River, Irian Jaya); *C. sentaniensis* (Lake Sentani, Irian Jaya). A generic diagnosis and key to the species are also provided.

INTRODUCTION

The freshwater rainbowfishes (Melanotaeniidae) of Australia and New Guinea have received relatively little attention since the major works of Weber (1908), Regan (1914), and Weber and De Beaufort (1922). Aside from brief reviews of the Australian and New Guinea species by Munro (1958 and 1964, respectively) nothing of great significance has been published in the last several decades. The main reason for the lack of recent activity is the remote nature of the rainbowfish habitat. Most of the species inhabit the New Guinea interior, much of which remains unexplored even today, particularly the western half now known as Irian Jaya. The present author initiated a study of melanotaeniid taxonomy in 1974 and since that time has conducted six major fieldtrips to northern Australia and Papua New Guinea. This work has resulted in the discovery of 13 new species and a far better understanding of the biology and taxonomy of rainbowfishes. Seven genera were recognized in my recent review of taxonomic relationships within the family (see Allen 1980*a*).

The genus *Chilatherina* Regan is revised in the present paper. The only previous reviews of this genus are those of Regan (1914) and Weber and De Beaufort (1922). Two species were recognized in both of these works, *C. fasciata* (Weber) and *C. sentaniensis* (Weber). Munro (1964) gave a brief synopsis of generic characters and showed that *Anisocentrus campsi* Whitley

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also belonged to *Chilatherina.* He placed *C. fasciata* in the synonymy of *C. lorentzi* (Weber) a species originally described as a *Rhombatractus* Weber (= *Melanotaenia*). The present study reveals that *C. fasciata* and *C. lorentzi* are distinct. Allen (1980*a*) expanded the genus to encompass *C. crassispinosa* (Weber), a species previously assigned to the monotypic *Centratherina* Regan. The sixth member of the genus, *C. axelrodi* was described by Allen (1980*b*).

The genus is restricted primarily to northern New Guinea (see map) between the Markham and Mamberamo Rivers. The only exception is *C. campsi* which occurs in mountainous terrain on both sides of the central dividing range. *Chilatherina* are relatively small fishes, seldom exceeding 100 mm SL. They generally inhabit streams and small creeks although at least two species, *C. fasciata* and *C. sentaniensis*, have lacustrine populations. In stream habitats they frequent shallow pools usually where the flow is relatively gentle, although *C. crassispinosa* is sometimes found in steep gradient situations. Typically these fishes prefer sections of the stream which afford maximum exposure to sunlight. The substratum generally consists of gravel or sand, frequently littered with leaves or log debris. Food items include filamentous algae, small crustacea, terrestrial insects such as ants and beetles, and various aquatic insect larvae. Sexual maturation occurs in most species at a relatively small size, usually about 35-40 mm SL in females and 45-55 mm SL in males. Gravid females deposit several eggs each day which adhere to aquatic vegetation by means of a thread-like filament. Hatching occurs in about 15 days at 22°-24°C. The fry grow rapidly and may attain sexual maturity by the end of their first year.

During the present study *Chilatherina* were observed and collected in the field at Papua New Guinea in tributary streams of the Markham, Ramu, Sepik, and Pual Rivers. In addition, *Chilatherina campsi* was taken from the Upper Purari system of the Central Highlands. Specimens were also examined from the following institutions (abbreviations in parentheses are used in the subsequent text): American Museum of Natural History, New York (AMNH); Australian Museum, Sydney (AMS); Museum National d'Histoire Naturelle, Paris (MNHN); Kanudi Fisheries Research Laboratory, Port Moresby, Papua New Guinea (PNG); Rijksmuseum van Naturrlijke Historie (RMNH); U.S. National Museum of Natural History, Washington, D.C. (USNM); Western Australian Museum, Perth (WAM); and Zoologisch Museum, Amsterdam (ZMA). Lectotypes deposited at ZMA which are listed under the material examined sections were designated by Hoedeman (1960).

Proportions appearing in the text are expressed as percentage of the standard length unless stated otherwise. Selected fin-ray and scale counts are summarized in Tables 1-4.

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.

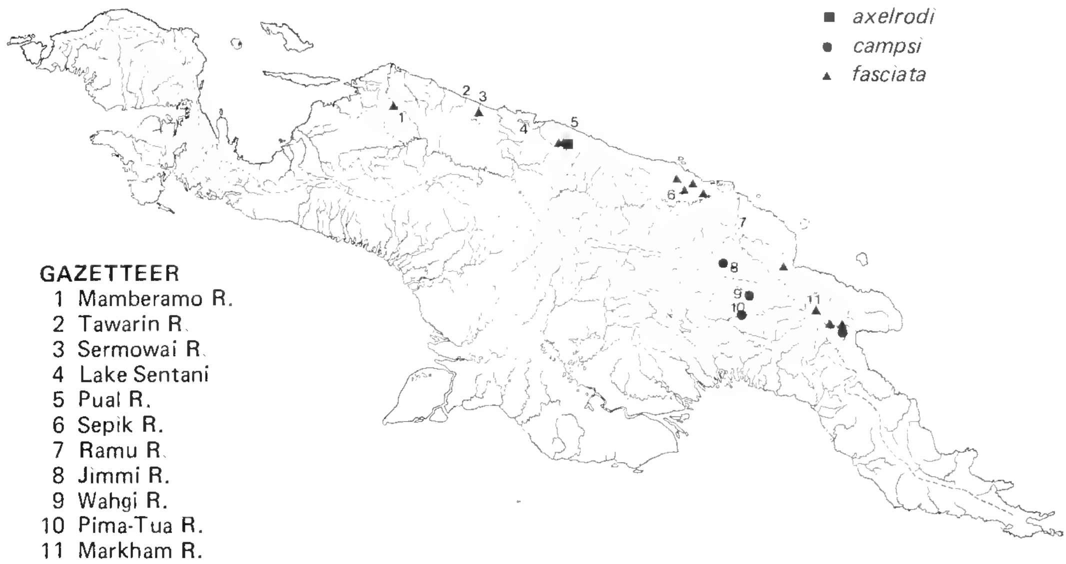

Fig. 1: Distribution of *Chilatherina axelrodi*, *C. campsi*, and *C. fasciata*. The gazetteer includes major river systems and lakes mentioned in the text.

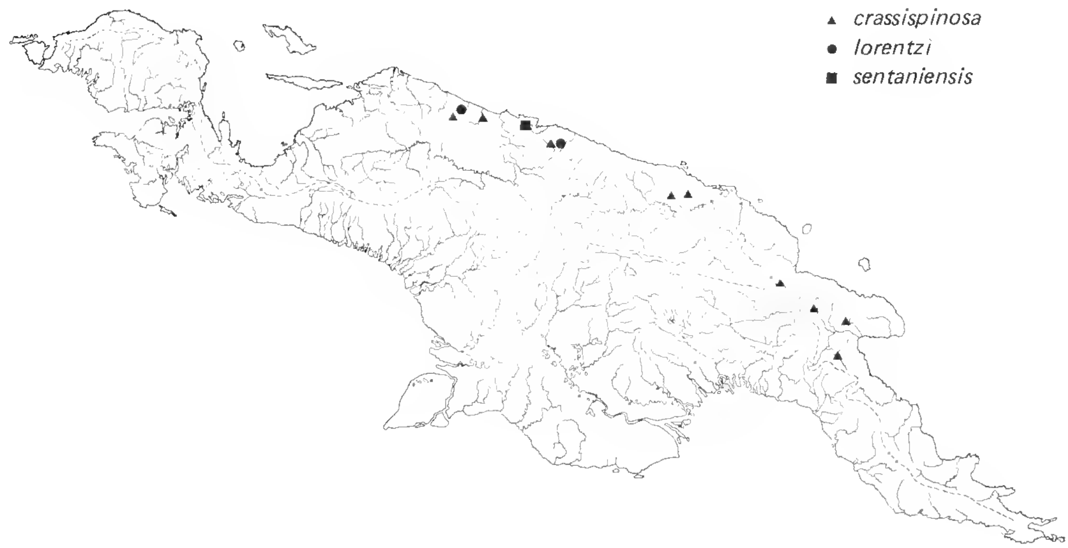

Fig. 2: Distribution of *Chilatherina crassispinosa*, *C. lorentzi*, and *C. sentaniensis*.

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. Horizontal scale rows are counted from the anus to the base of the first dorsal fin. Vertical scale rows are counted along the side from the scale immediatley above the upper edge of the gill opening to the middle of the caudal fin base. 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. Gill-raker counts include rudiments; the raker at the angle was incorporated into the lower-limb count.

TABLE 1

Dorsal fin-ray counts for species of *Chilatherina*.

	First dorsal spines					Second dorsal soft rays								
	IV	V	VI	VII	VIII	8	9	10	11	12	13	14	15	16
axelrodi		3	30	3					15	18	3			
campsi		8	18	3	2					1	13	9	6	1
crassispinosa	4	13	3			2	5	6	6	1				
fasciata	6	44	17	1					2	16	30	13	4	1
lorentzi	4	18	8							2	17	8	4	
sentaniensis	14	25	1				3	21	4	1				

TABLE 2

Anal and pectoral fin-ray counts for species of *Chilatherina*.

	Anal soft rays												Pectoral rays				
	19	20	21	22	23	24	25	26	27	28	29	30	12	13	14	15	16
axelrodi	2	1	12	13	6	2								4	28	4	
campsi			6	7	10	4	1	2						5	20	5	
crassispinosa	1	3	3	5	7	1									4	15	1
fasciata			1	5	8	22	12	7	2	2					13	32	3
lorentzi							1	5	10	8	4	2			16	15	
sentaniensis			3	10	16	7	3	1							7	31	2

TABLE 3

Predorsal scale counts for species of *Chilatherina*.

	No. of predorsal scales									
	16	17	18	19	20	21	22	23	24	25
axelrodi	5	10	2	1						
campsi		3	6	4	6	4	2	2		
crassispinosa					6	7	7			
fasciata			6	18	11	11	8	1		
lorentzi		10	14	4	2					
sentaniensis				1	4	10	14	6	3	1

TABLE 4
Preopercle-suborbital scale counts for species of *Chilatherina*.

	No. of preopercle-suborbital scales															
	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
axelrodi				2	1	1	3	6	2	1	2	3				
campsi	1		1	3	3	4	3	8	2	1						
crassispinosa						1	3	5	1	5	4	1				
fasciata			2		4	1	5	14	14	13	4	3	1			
lorentzi							1	3	2	3	7	4	2	1	2	1
sentaniensis				6	14	5	4	4	3							

SYSTEMATICS

Genus *Chilatherina*

Chilatherina Regan, 1914: 282 (type-species, *Rhombatractus fasciatus* Weber, 1913, by subsequent designation of Jordan 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; vomerine and palatine teeth present or absent; inter-dorsal pterygiophores 2 or 3; first dorsal fin with 4 to 7 spines, usually first spine rigid and others more slender and flexible, except all rays relatively stout in *C. crassispinosa*; second dorsal fin with a stout rigid spine and 8 to 16 segmented rays; anal fin with a stout rigid spine and 18 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 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; 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 10 to 13, 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 characterized mainly by deeper body and taller first dorsal fin 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 crassispinosa (Weber) was previously placed in the genus *Centratherina* (Regan, 1914; Weber and De Beaufort, 1922; and Munro, 1967). The traditional character used to separate these genera is the constitution of the first dorsal fin rays: they are supposedly segmented in *Chilatherina* and unsegmented in *Centratherina*. However, examination of numerous specimens of *Chilatherina* by Allen (1980*a*) failed to reveal segmentation (see Fig. 22 in Allen 1980*a*), although there is a pronounced difference in the rigidity of the dorsal rays. In *C. crassispinosa* all the rays of the first dorsal fin are relatively stout and pungent whereas this condition is restricted to the first ray in other members of the genus. The remaining rays are slender and flexible. In view of the overall morphological similarities between *crassispinosa* and other *Chilatherina* this difference appears significant only at the specific level.

Allen (1980*a*) indicated that *Chilatherina* possessed teeth on the vomer and palatine bones. This observation was based on limited material. A more detailed study of this feature during the present study reveals that three species lack vomerine teeth and palatine teeth are also absent in two of these.

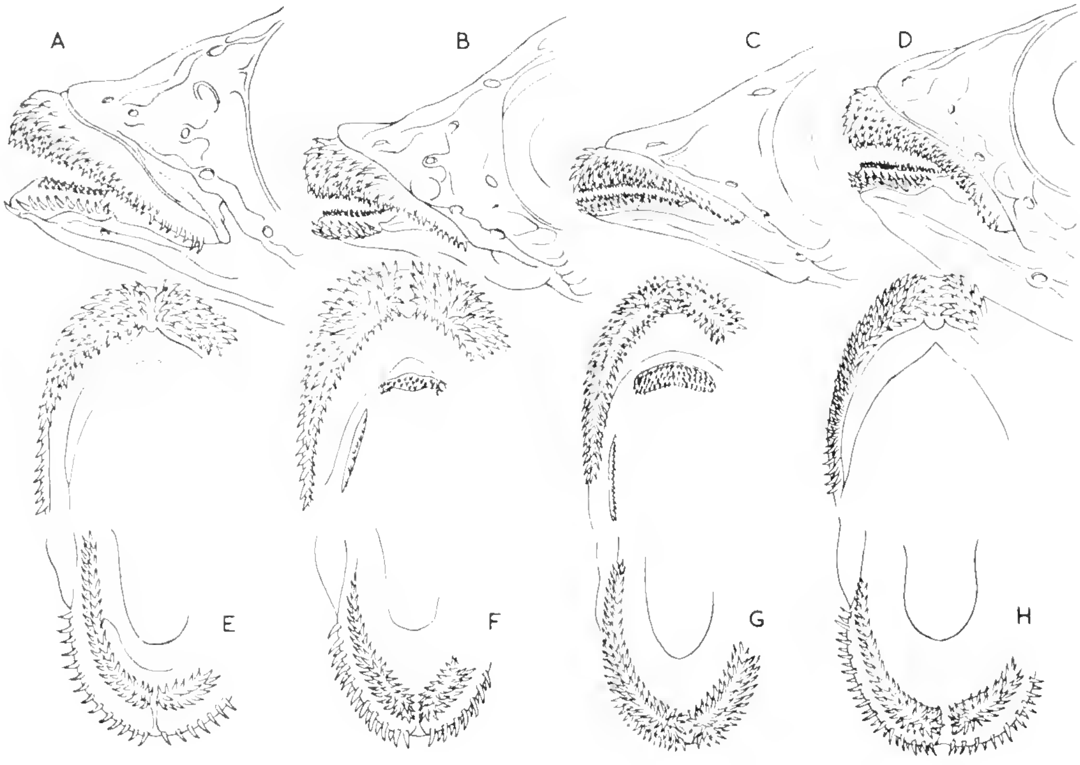

Fig. 3: Dentition of *Chilatherina:* (A and E) *C. campsi;* (B and F) *C. fasciata;* (C and G) *C. sentaniensis;* (D and H) *C. crassispinosa.* Drawings adapted from Munro 1964.

Chilatherina is closely related to *Melanotaenia*, the largest genus in the family. They differ chiefly with regard to jaw structure. In *Chilatherina* the lateral portion of the premaxillary is either straight or curved gently in a postero-ventral direction. The lower jaw is generally inferior to the upper jaw and the medial portion of the upper lip is swollen and profusely covered with teeth (Fig. 3). In addition, the head tends to be more slender and the snout relatively pointed compared with *Melanotaenia*. The latter genus by contrast, has a more or less abrupt downward bend in the lateral portion of the premaxillary with less swelling of the medial upper lip and fewer teeth on its surface. Moreover, the jaws are usually about even or the upper jaw is slightly inferior (i.e. lower jaw protruding). The external jaw features of *Chilatherina* and *Melanotaenia* were illustrated by Allen (1980*a*).

Key to the Species of *Chilatherina*

1a Vomerine teeth absent 2

1b Vomerine teeth present 4

2a All rays of first dorsal fin stiff and pungent (sometimes not evident in small specimens); soft rays in second dorsal fin usually 8 to 11, rarely 12; caudal fin with thin black margin on basal half (widespread northern New Guinea between Markham and Mamberamo Rivers) .... *C. crassispinosa*

2b Only first ray of first dorsal fin stiff and pungent, remaining rays relatively weak and flexible; soft rays in second dorsal fin 11 to 16; caudal fin without thin black margin on basal half 3

3a Palatine teeth well developed; soft rays in second dorsal fin usually 11 or 12, occasionally 13; midlateral dark stripe interrupted, forming series of blotches on anterior half of body; males deep-bodied, greatest depth frequently greater than 40% of SL in specimens exceeding 70 mm SL and averaging 37% of SL between 50-69 mm SL (Pual River system near Vanimo) .... *C. axelrodi*

3b Palatine teeth absent; soft rays in second dorsal fin usually 13 to 15, rarely 12 or 16; mid-lateral dark stripe, if present, not forming series of blotches; males relatively slender, greatest depth not exceeding 33% of SL and averaging 30% of SL in specimens over 50 mm SL (foothill streams of Markham River system and headwater streams of Sepik and Purari Rivers in Central Highlands) .... *C. campsi*

4a Rear edge of maxillary reaching to level of anterior edge of eye or beyond; dorsal fin origin noticeably behind level of anal fin origin, about level with base of fourth or fifth soft anal ray; soft rays in anal fin 25 to 30, usually 27 or 28 (Tawarin River, Irian Jaya) . . . . *C. lorentzi*

4b Rear edge of maxillary not reaching level of eye; dorsal fin origin either equal to or only slightly behind level of anal fin origin, about level with base of first or third soft anal ray if behind; soft rays in anal fin usually 25 or less except sometimes 26 to 28 in *C. fasciata* 5

5a Snout elongate, usually 2.5 to 2.9 in head length; soft rays in second dorsal fin usually 9 to 11, rarely 12 (Lake Sentani, Irian Jaya) . . . . *C. sentaniensis*

5b Snout shorter, usually 3.0 to 3.5 in head length; soft rays in second dorsal fin usually 12 to 15, rarely 11 or 16 (widespread northern New Guinea between Markham and Mamberamo Rivers) . . . . *C. fasciata*

Chilatherina axelrodi Allen

Fig. 4

Chilatherina axelrodi Allen, 1980*b*: 48 (type locality: Yungkiri Stream, Papua New Guinea).

Diagnosis

Dorsal rays V to VII-I,11 to 13; anal rays I,19 to 24; pectoral rays 13 to 15; horizontal scale rows 10; vertical scale rows 37 to 40; predorsal scales 16 to 19; preopercle-suborbital scales 15 to 22. Greatest body depth by sex and size class as follows: *males* — (a) 40-49 mm SL, 30.0-34.7 ($\overline{x}$ = 32.8, N = 5), (b) 50-69 mm SL, 34.0-39.1 mm SL ($\overline{x}$ = 37.2, N = 18), (c) 70+ mm SL, 36.1-41.3 ($\overline{x}$ = 39.3, N = 11); *females* — (a) under 50 mm SL, 32.6 (N = 1), (b) 50-63 mm SL, 31.1-36.1 ($\overline{x}$ = 33.4, N = 15); head length 23.9-25.8; snout length 6.7-8.8; eye diameter 7.5-9.3; interorbital width 7.2-8.2; caudal peduncle depth 10.1-11.7; caudal peduncle length 14.1-17.7; predorsal distance 45.1-48.9; preanal distance 46.8-52.4.

Colour in alcohol: generally brownish on back and whitish on lower two-thirds of body with dark markings similar to those shown in **Fig. 4**; dorsal and caudal fins dusky; anal fin whitish at base and dusky on distal half; pelvic and pectoral fins mainly translucent. Some specimens light brown or tan on back with darkly pigmented scale outlines; dark midbody stripe faint or absent on several specimens.

Colour in life: generally greenish-brown on upper half and whitish on lower half; a series of about 10 short bars along middle of side (approximately every two scales) these finally merging with more or less solid blackish stripe along middle of caudal peduncle; about 6-10 faint dusky bars on lower side, those on side of abdomen particularly evident; upper half with series of bluish stripes and lower half with series of faint yellow stripes, bordering each longitudinal scale row; dorsal fin dusky with yellow suffusion; caudal, anal, and pelvic fins yellow; pectoral fins translucent. The live coloration of a male specimen was illustrated by Allen (1980*b*).

Fig. 4: *Chilatherina axelrodi*, male holotype, 81 mm SL, Pual River system, Papua New Guinea (WAM P26739-001).

Comparisons

Chilatherina axelrodi is most closely related to *C. fasciata* and *C. sentaniensis*. These species share a similar body shape, jaw dentition, and general coloration. However, they are separable on the basis of head and snout length, modal dorsal ray counts (Table 1) and to a certain extent on the basis of colour pattern. *Chilatherina axelrodi* has a consistently shorter head and snout length; its head fits about 4 times in the standard length compared with about 3.2-3.8 for the others. The snout length of *C. axelrodi* is generally about equal to the horizontal eye diameter whereas it is slightly to considerably greater than the eye diameter in the other two species (at least in specimens in excess of about 55 mm SL). Furthermore, *C. axelrodi* differs significantly in lacking teeth on the vomer. The general coloration consisting of a brownish back with white on the lower sides is present in all three species, but *C. axelrodi* differs by usually having a series of 6-10 pronounced bars on the lower side. Similar bars are sometimes evident on the other species, but they are generally very faint and fewer in number.

Distribution

Chilatherina axelrodi is known only from the type locality, Yungkiri Stream which is a tributary of the Pual River (Nemayer River on some maps).

This site is situated near the Irian Jaya border approximately 37 km south-west of Vanimo.

Habitat

The only known specimens were collected from a small flowing stream in rainforest habitat. Most were taken from two large pools measuring about 3 x 10 m with a maximum depth of 1.5 m. Although situated in rainforest the stream-bed was relatively open and exposed to sunlight. The water was slightly turbid and a temperature of 28.5°C and pH of 7.8 were recorded. *Chilatherina axelrodi* was by far the most common fish in the stream which was also inhabited by two other rainbowfishes, *C. crassispinosa* and *Melanotaenia affinis.*

Material Examined (51 specimens, 35-81 mm SL, all types)

AMS I.21299-001 (7: 46-76 mm SL); MNHN 1979-671 (3: 61-66 mm SL); PNG F.4466-01 (5: 53-68 mm SL); RMNH 28152 (5: 57-72 mm SL); USNM 220909 (3: 43-75 mm SL); WAM P26739-001 (holotype, 81 mm SL); WAM P26739-002 (22: 35-85 mm SL); ZMA 115.400 (5: 41-62 mm SL).

Chilatherina campsi (Whitley)

Fig. 5

Anisocentrus campsi Whitley, 1956: 26 (type locality: small creek flowing into the middle Jimmi River, 53 km, 6°E of NE of Mount Hagen airstrip).

Centratherina tenuis Nichols, 1956: 1 (type locality: Kondiu, Wahgi Valley).

Diagnosis

Dorsal rays V to VII-I,12 to 16; anal rays I,21 to 26; pectoral rays 13 to 15; horizontal scale rows 11 or 12; vertical scale rows 39 to 42; predorsal scales 17 to 23; preopercle-suborbital scales 12 to 21. Greatest body depth by sex and size class as follows: *males* — (a) 30-49 mm SL, 26.5-29.7 ($\overline{x}$ = 27.6, N = 6), (b) 50-65 mm SL, 28.0-32.3 ($\overline{x}$ = 29.6, N = 15); *females* — (a) 30-49 mm SL, 23.7-27.9 ($\overline{x}$ = 26.0, N = 13), (b) 50-69 mm SL, 25.9-28.3 ($\overline{x}$ = 27.0, N = 7), (c) 70+ mm SL, 26.8 (N = 1); head length 23.2-25.8; snout length 6.3-8.0; eye diameter 7.0-8.5; interorbital width 7.1-8.0; caudal peduncle depth 9.1-10.4; caudal peduncle length 14.8-17.0; predorsal distance 43.4-47.1; preanal distance 45.4-51.3.

Colour in alcohol: brown or tan on upper half and whitish to pale yellow on lower half; a black mid-lateral stripe from rear edge of gill cover to base of caudal fin, this marking sometimes faint in females; a series of 6-8 faint dusky bars on lower sides from below pectoral fin to level of anterior anal rays, this marking apprently not evident in specimens from the Central Highlands; fins translucent to slightly dusky.

Color in life: generally pale bluish-white with silvery sheen; top of head and nape yellowish-brown; mid-lateral stripe blue, most prominent on posterior part of body; pale yellow to whitish longitudinal stripes frequently bordering scale rows; fins frost-white, soft dorsal and anal fins sometimes with yellow suffusion; pectoral fins translucent. Female colours are similar, but less intense, particularly the mid-lateral stripe. In addition, the fins of females are mainly translucent. Male specimens from the Markham River system exhibit faint dusky bars on the middle of the lower side. The live coloration of a male specimen from the Wahgi River was illustrated by Allen (1980*b*).

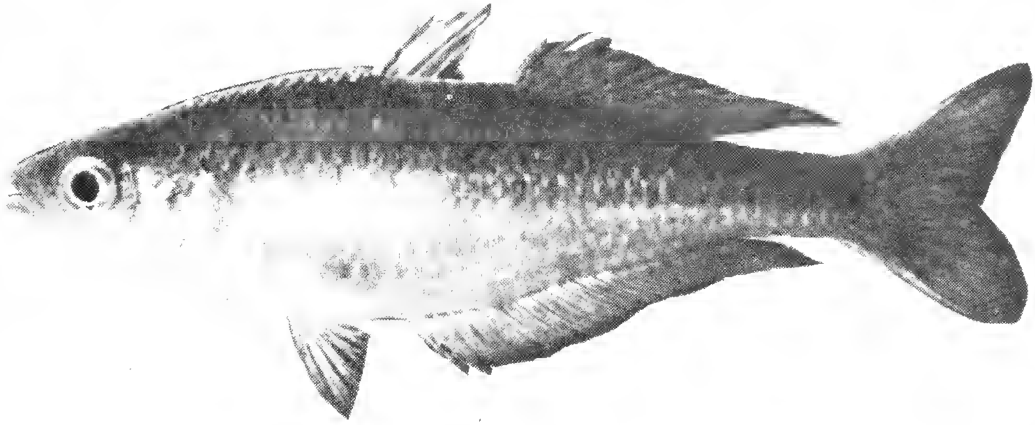

Fig. 5: *Chilatherina campsi*, male, 54 mm SL, Wahgi River, Papua New Guinea (WAM P26745-001).

Comparisons

Chilatherina campsi is most closely allied to *C. fasciata*. These species exhibit similar fin-ray and scale counts (Table 1), and small specimens of *C. fasciata* are easily confused with *C. campsi*. However, they possess vomerine teeth, a feature which is lacking in *C. campsi*. In addition, the premaxillary has a slight downward curve in *C. fasciata* compared with the straight premaxillary of *C. campsi*. The former species attains a much greater length, about 105 mm SL compared with 75 (usually under 65) mm SL for *C. campsi*. There is also a difference in the position of the first dorsal fin origin in relation to the anal fin origin; in *C. campsi* the dorsal origin is about even or slightly ahead of the anal origin, whereas the dorsal origin is noticeably behind the anal origin in *C. fasciata*. These species appear to have mainly allopatric distributions except they co-occur in some tributaries of the Markham River.

Distribution

Chilatherina campsi was formerly known only from the Central Highlands of Papua New Guinea in the Jimmi River (Sepik system) and Wahgi River (Purari system) at an elevation of approximately 1,525 m. It is the only melanotaeniid known to occur on both sides of the central dividing range.

Recent collections by the author have expanded the range considerably. It is now known from the Pima River at the junction of the Tua River, approximately 190 km downstream from the previous collection sites on the Wahgi River, and from two sites in the Markham River drainage near Lae, some 240 km east of the Highland collection sites.

Habitat

Chilatherina campsi inhabits foothill and mountain streams ranging in altitude from about 200 m to 1600 m. It appears to be most abundant in the smaller tributaries characterized by reduced flow and clear to moderately turbid water. Small schools are often seen over sand, mud or rock bottom in areas exposed to sunlight. Temperatures and pH values at several collection sites ranged from 21.0°-25.5°C and 7.6-7.8 respectively. In the Wahgi Valley *C. campsi* is the only rainbowfish present, but at the Pima River it co-occurs with *Melanotaenia pimaensis* and is sympatric with *M. affinis* and *Glossolepis maculosus* at the Omsis River near Lae.

Remarks

Two probable female hybrid crosses between *C. campsi* and *Melanotaenia affinis* were collected at the Omsis River. These specimens, 68 and 84 mm SL display a blend of features from the presumed parental species. They are deposited at WAM (P26976-005).

The smallest ripe female examined was 34.5 mm SL although immature eggs were detected in a specimen of 33.0 mm SL. Males begin to develop secondary sexual features (i.e. elongate fins and increased body depth) between 35-40 mm SL.

Material Examined (91 specimens, 18-71 mm SL)

AMNH 20211 (holotype of *Centratherina tenius*, 65 mm SL), Wahgi Valley; AMS IB.3337 (holotype, 56 mm SL) and AMS IB.3342 (paratype, 50 mm SL), both from tributary of middle Jimmi River; USNM 224787 (23: 34-59 mm SL), small tributary of Markham River about 105 km NW of Lae; WAM P26745-001 (43: 18-54 mm SL), Wahgi Valley near Minj; WAM P26971-003 (5: 27-49 mm SL), Pima River, upper Purari system, 78 km SW of Goroka; WAM P26976-001 (7: 29-71 mm SL), Omsis River, 22 km W of Lae; WAM P26977-002 (10: 29-65 mm SL), small tributary of Omsis River.

Chilatherina crassispinosa (Weber)

Fig. 6

Rhombatractus crassispinosus Weber, 1913: 567 (type locality: Tawarin and Upper Sermowai Rivers, northern New Guinea).

Diagnosis

Dorsal rays IV to VI-I,8 to 12; anal rays I,19 to 24; pectoral rays 14 to 16; horizontal scale rows 11 to 13; vertical scale rows 37 to 43; predorsal scales 20 to 22; preopercle-suborbital scales 17 to 23. Greatest body depth by sex and size class as follows: *males* — (a) 30-49 mm SL, 25.4-28.7 ($\overline{x}$ = 27.3, N = 6), (b) 50-69 mm SL, 27.0-36.5 ($\overline{x}$ = 31.4, N = 8), (c) 70+ mm SL, 29.7-34.3 ($\overline{x}$ = 32.1, N = 5); *females* — (a) 30-49 mm SL, 24.0-29.7 ($\overline{x}$ = 27.1, N = 6), (b) 50-69 mm SL, 27.0-32.3 ($\overline{x}$ = 29.6, N = 8), (c) 70+ mm SL, 27.2-32.5 ($\overline{x}$ = 28.9, N = 6); head length 24.2-27.7; snout length 6.9-9.3; eye diameter 7.0-9.6; interorbital width 6.8-8.8; caudal peduncle depth 8.2-11.4; caudal peduncle length 15.5-21.2; predorsal distance 46.9-53.4; pre-anal distance 48.1-53.5.

Colour in alcohol: brown on upper half with dense pattern of pepper-like pigmentation, lower half yellow-white; most specimens with thin black longitudinal stripe from upper edge of opercle to middle of caudal fin base; some specimens with faint series of 'herring-bone' markings along middle of sides; opercle silvery; dorsal fins dusky with translucent membrane; caudal, anal, pelvic, and pectoral fins translucent to pale yellow; dorsal and ventral edges of caudal fin and sometimes outer edge of anal fin with narrow black margin.

Colour in life: overall silvery, shading to brown or greenish on dorsal portion of side and white in breast region; fins mainly translucent with some

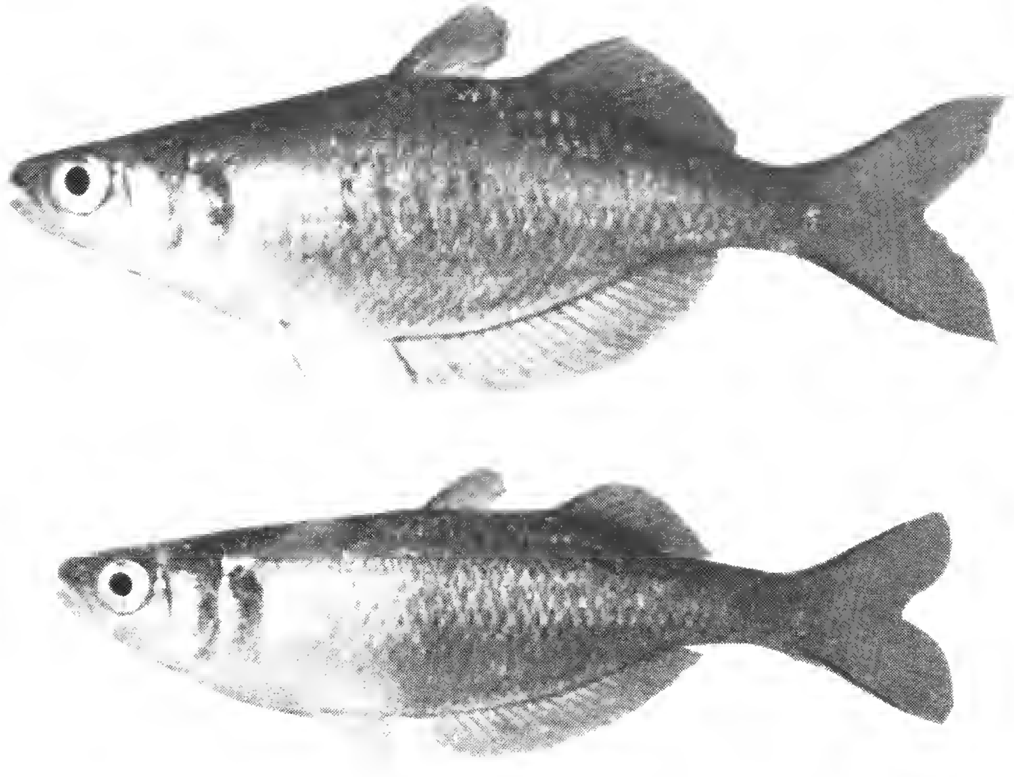

Fig. 6: *Chilatherina crassispinosa*, male (upper), 60 mm SL, and female, 51 mm SL, Markham River system, Papua New Guinea (WAM P26425-001).

duskiness, except anal and pelvic fins of adults, particularly males, often whitish or yellow-white and second dorsal fin sometimes yellow along base; dorsal and ventral edges of caudal fin with narrow black margin. The live coloration of a male specimen was illustrated by Allen (1980*b*).

Comparisons

Chilatherina crassispinosa differs from all other members of the genus in having the spines of the first dorsal fin, particularly the first three or four, stiff and pungent. There is a relatively gradual reduction posteriorly in the thickness of each spine. Other *Chilatherina*, to the contrary, have a greatly thickened first spine with the other spines much more slender in comparison. Only the first spine is stiff and pungent; the remainder are relatively flexible. In addition, *C. crassispinosa* lacks teeth on the vomer, a character shared only by *C. campsi* and *C. axelrodi*. The latter species are easily separable on the basis of soft dorsal ray counts and predorsal scalation respectively (see Tables 1 and 3).

Distribution

Chilatherina crassispinosa and *C. fasciata* are the most widely distributed members of the genus. The range for both species extends from the vicinity of Lae in Papua New Guinea westward to the Mamberamo River of Irian Jaya. Major river systems encompassed by the distribution include the Markham, Ramu, Sepik, and Mamberamo. In addition, it occurs in many of the smaller systems along the north coast.

Habitat

Chilatherina crassispinosa exhibits a broader tolerance to habitat conditions than other members of the genus. It is often found in the sunlit, relatively slow flowing pools favoured by other *Chilatherina*. In addition, it has been taken from rapid flowing, steep gradient streams in pools adjacent to waterfalls and cascades. Temperature and pH values recorded at various collection sites ranged from 26°-29°C and 7.7-8.5 respectively. This species is usually found in relatively hilly or mountainous terrain at elevations between 100-600 m. It sometimes co-occurs with *C. fasciata*, *C. axelrodi*, and *Melanotaenia affinis*.

Material Examined (163 specimens, 32-104 mm SL)

USNM 224785 (50: 34-86 mm SL), tributary of Ramu River; WAM P26425-001 (14: 34-64 mm SL), Erap River, 45 km NW of Lae; WAM P26427-001 (47: 17-50 mm SL), tributary of Ramu River, 5 km E of Usino on Madang Road; WAM P26428-001 (14: 32-75 mm SL), tributary of Ramu River, 13 km NE of Usino on Madang Road; WAM P26734-002 (4: 67-72 mm SL), tributary of Sepik River, 5 km beyond Maprik on Dreikikir Road; WAM P26736-003 (16: 36-84 mm SL), Trubum Stream on Maprik Road 79 km W of Wewak; WAM P26739-003 (17: 37-67 mm SL), Yungkiri Stream, 37 km inland from Vanimo on Bewani Road; ZMA 103.104 (lectotype, 104 mm SL), Mamberamo River, northern New Guinea.

Chilatherina fasciata (Weber)

Fig. 7

Rhombatractus fasciata Weber, 1913: 565 (type locality: Boearin River, tributary of Upper Sermowai River, Irian Jaya).

Diagnosis

Dorsal rays IV to VII-I,11 to 16; anal rays I,21 to 28; pectoral rays 14 to 16; horizontal scale rows 10 to 12; vertical scale rows 39 to 44; predorsal scales 18 to 23; preopercle-suborbital scales 14 to 24. Greatest body depth by sex and size class as follows: *males* — (a) 30-49 mm SL, 26.3-30.9 ($\overline{x}$ = 27.7, N = 16), (b) 50-69 mm SL, 26.1-33.1 ($\overline{x}$ = 29.3, N = 23), (c) 70+ mm SL, 30.3-38.8 ($\overline{x}$ = 33.6, N = 10); *females* — (a) 30-49 mm SL, 27.0-32.3 ($\overline{x}$ = 28.5, N = 6), (b) 50-69 mm SL, 26.5-30.6 ($\overline{x}$ = 29.4, N = 5), (c) 70+ mm SL, 29.9-33.4 ($\overline{x}$ = 31.1, N = 12); head length 23.2-27.5; snout length 6.3-8.6; eye diameter 7.2-8.8; interorbital width 7.4-9.6; caudal peduncle depth 7.8-11.3; caudal peduncle length 12.7-19.5; predorsal distance 44.6-55.0; preanal distance 46.5-53.0.

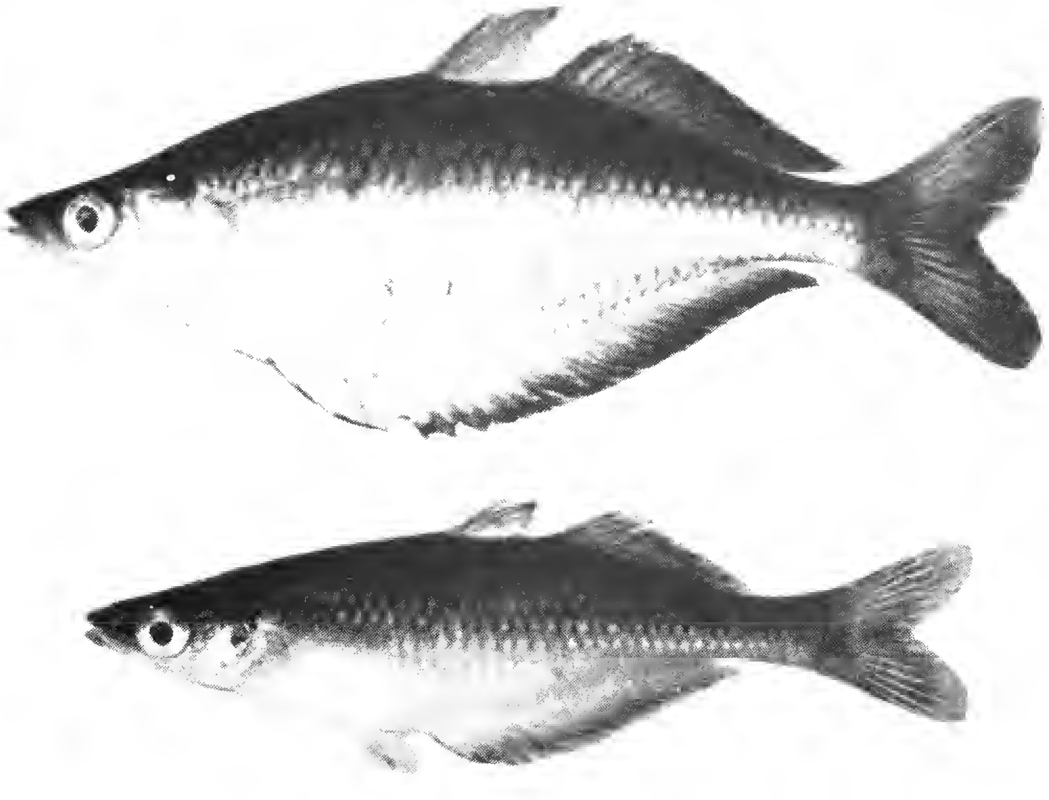

Fig. 7: *Chilatherina fasciata*, male (upper), 78 mm SL, and female, 65 mm SL, Lake Wanam, Papua New Guinea (WAM P26420-003).

Colour in alcohol: brownish on upper half and white or yellowish on lower half, frequently with a dusky or black mid-lateral stripe; 6-8 faint dusky bars sometimes present on middle of lower sides in male specimens; operculum silvery; fins translucent or dusky. Old specimens tend to be tan or pale brown, slightly darker on the dorsal half.

Colour in life: brown to bluish-green on upper half; white on lower half frequently with scales bordered with pale yellow: opercle silvery; dorsal fins and caudal fin dusky, particularly outer edge; pelvic fins and basal two-thirds of anal fin yellow-white in males, more or less translucent in females, outer edge of anal fin and anterior edge of pelvics dusky; pectoral fins with translucent membranes and dusky rays. The live coloration of a male specimen was illustrated by Allen (1980*b*, as *C. lorentzi*).

Comparisons

Chilatherina fasciata is closely allied to *C. campsi*, and also shares similarities with *C. axelrodi* and *C. sentaniensis*. The reader is referred to the comparisons section for *C. fasciata* and *C. axelrodi* for a discussion of the differences between these species. Munro (1964) considered *C. fasciata* to be a junior synonym of *C. lorentzi*, but comparison of the respective types at ZMA during the present study revealed important differences between these species. *Chilatherina fasciata* is a much more slender fish, males seldom exceed a maximum depth of 35% of the SL compared with frequent values exceeding this figure and sometimes over 40% in *C. lorentzi*. The caudal peduncle depth also reflects this difference with most specimens of *C. fasciata* under 11.3% whereas the values in *C. lorentzi* ranged from 11.3-13.6% SL. Counts for the anal rays and preopercle-suborbital scales are also useful for separating these species, although there is some overlap in the ranges (see Table 1). Additionally, the upper jaw of *lorentzi* is longer and reaches the level of the anterior edge of the eye, whereas that of *fasciata* fails to reach eye level.

Distribution

The known range of *C. fasciata* extends from the vicinity of Lae westward to the Mamberamo River. Major river systems encompassed by the distribution include the Markham, Ramu, Sepik, and Mamberamo. It possibly occurs farther westward, but this region of Irian Jaya remains uncollected.

Habitat

Chilatherina fasciata is generally found in clear rainforest streams, but in open clearings exposed to maximal sunlight. Flow conditions range from moderate to slow. I have also taken specimens from Lake Wanam near Lae. These were caught along the shore in an area of clean white sand with isolated clumps of aquatic vegetation. Temperature and pH measurements taken at various field localities ranged from 28°-32°C and 7.7-8.1 respectively. The species occurs both in the lowland tributaries of major rivers and in hilly terrain to an elevation of about 400-500 m. It often co-occurs with *C. crassispinosa* and *Melanotaenia affinis*, particularly the latter species.

Remarks

This is the only known species of melanotaeniid in which hermaphroditism occurs (at least in some individuals). Both male and female gonads were found in 12 specimens, 44-82 mm SL. The smallest female examined with ripe eggs was 35 mm SL.

Material Examined (175 specimens, 23-105 mm SL)

USNM 224786 (11: 39-97 mm SL), small tributary of Markham River about 25 km W of Lae; WAM P26420-003 (4: 65-89 mm SL), Lake Wanam, 25 km W of Lae; WAM P26421-001 (4: 64-92 mm SL), small stream 15 km W of Lae; WAM P26424-002 (6: 47-83 mm SL), Cleanwater Creek, 65 km W of Lae; WAM P26727-001 (78: 23-99 mm SL), small stream on Angoram Road, 73 km E of Wewak; WAM P26734-001 (10: 32-105 mm SL), small stream 5 km beyond Maprik on Dreikikir Road; WAM P26733-001 (42: 44-90 mm SL), Bagi Stream about 10 km W of Angoram; WAM P26735-001 (1: 81 mm SL), small stream on Maprik Road 113 km W of Wewak; WAM P26736-002 (7: 66-89 mm SL), Trubum Stream on Maprik Road 79 km W of Wewak; ZMA 103.104 (paralectotype, 104 mm SL), Boearin River, tributary of Upper Sermowai River, Irian Jaya; ZMA 103.047 (11: 51-57 mm SL), Mamberamo River at Pioniersbivak, Irian Jaya.

Chilatherina lorentzi (Weber)

Fig. 8

Rhombatractus lorentzi Weber, 1908: 236 (type locality: Tawarin River, northern New Guinea).

Diagnosis

Dorsal rays IV to VI-I,12 to 15; anal rays I,25 to 30; pectoral rays 14 or 15; horizontal scale rows 11 to 13; vertical scale rows 35 to 38; predorsal scales 17 to 20; preopercle-suborbital scales 18 to 27. Greatest body depth by sex and size class as follows: *males* — (a) 30-49 mm SL, 31.7-32.5 ($\overline{x}$ = 32.1, N = 2), (b) 50-69 mm SL, 32.4-37.3 ($\overline{x}$ = 34.9, N = 3), (c) 70+ mm SL, 34.0-40.8 ($\overline{x}$ = 38.3, N = 3); *females* — (a) 30-49 mm SL, 30.6-32.4 ($\overline{x}$ = 31.8, N = 4), (b) 50-69 mm SL, 32.7-33.8 ($\overline{x}$ = 33.8, N = 4), (c) 70+ mm SL, 33.7-36.7 ($\overline{x}$ = 35.3, N = 5); head length 26.5-28.7; snout length 7.9-9.8; eye diameter 6.3-9.7; interorbital width 8.5-10.1; caudal peduncle depth 11.3-13.6; caudal peduncle length 12.2-16.4; predorsal distance 50.4-55.6; preanal distance 48.0-53.9.

Colour in alcohol: overall yellowish-tan, scales on upper half with dusky outlines and a faint, dark mid-lateral band from eye to middle of caudal fin base; fins dusky grey except pelvics and pectorals mainly translucent. Several specimens from near Vanimo have 1-5 small intensely blackish spots on the anterior portion of the mid-lateral scale row. The type series show very little colour after 77 years in preservative. The body and fins are a bleached yellow-tan.

Colour in life: females brownish-green on back and silvery-white on lower half; a diffuse bluish mid-lateral band from eye to middle of caudal fin base (fades rapidly after death); dorsal, caudal, and anal fins dusky, anal fin with slight suffusion of yellow; pelvic fins white; pectoral fins translucent. The live coloration of males is unknown, but Weber (1908) stated that freshly preserved examples have a longitudinal blackish band, about two scales wide, extending from the upper edge of the opercle to the middle of the caudal fin base.

Fig. 8: *Chilatherina lorentzi*, female, 95 mm SL, Pual River system, Papua New Guinea (WAM P26741-001).

Comparisons

See comparison section for *C. fasciata.*

Distribution

Chilatherina lorentzi is thus far known from only two localities on the central north coast of New Guinea. The types were collected in the Tawarin River, Irian Jaya which is situated approximately 100 km west of Jayapura. A recent collection of 13 female specimens was made by the author at Puive Creek, a tributary of the Nemayer or Pual River system, in mountainous terrain near Vanimo, Papua New Guinea. This site is situated about 160 km east of the type locality and the species can be expected to occur in the intermediate area. The male and female *C. lorentzi* illustrated by Allen (1980*a* and *b*) from Lake Wanam near Lae represents a misidentification of *C. fasciata.*

Habitat

Specimens were collected by the author in 1979 from a relatively small (5-10 m width) clear, moderately flowing stream. The stream was enveloped by dense rainforest canopy with little direct sunlight reaching the surface.

The fishes were concentrated in the deeper (1-2 m) sections in the vicinity of aquatic plants and log debris. The elevation at this site is approximately 300 m above sea level.

Material Examined (37 specimens, 21-96 mm SL)

WAM P26741-001 (13: 39-95 mm SL), Puive Creek, Papua New Guinea; ZMA 103.146 (lectotype, 96 mm SL), Tawarin River, Irian Jaya; ZMA 110.157 (paralectotypes, 23: 21-86 mm SL), Tawarin River.

Chilatherina sentaniensis (Weber)

Fig. 9

Rhombatractus sentaniensis Weber, 1908: 235 (type locality: Lake Sentani, Irian Jaya).

Diagnosis

Dorsal rays IV to VI-I,9 to 12; anal rays I,21 to 26; pectoral rays 14 to 16; horizontal scale rows 11 to 13; vertical scale rows 38 to 41; predorsal scales 19 to 25; preopercle-suborbital scales 16 to 20. Greatest body depth by sex and size class as follows: *males* — (a) 50-69 mm SL, 32.3-34.8 ($\bar{x}$ = 33.6, N = 2), (b) 70+ mm SL, 35.2-39.5 ($\bar{x}$ = 36.9, N = 5); *females* — (a) 50-69 mm SL, 29.4-30.9 ($\bar{x}$ = 30.2, N = 3), (b) 70+ mm SL, 29.0-38.4 ($\bar{x}$ = 32.5, N = 10); head length 27.3-30.3; snout length 9.6-11.2; eye diameter 7.5-9.0; interorbital width 8.3-9.6; caudal peduncle depth 9.3-11.2; caudal peduncle length 13.8-17.4; predorsal distance 56.4-61.0; preanal distance 46.8-52.4.

Colour in alcohol: dark brown on upper half, whitish to tan on lower half; males with series of 6-8 faint bars in middle of lower half of body; opercle silvery and silvery sheen sometimes present on lower sides; dorsal fins and

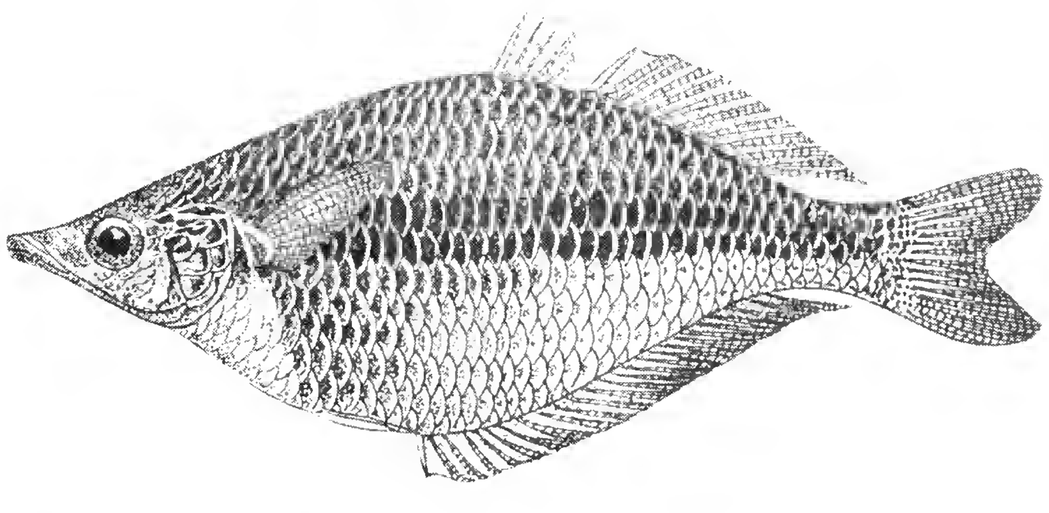

Fig. 9: *Chilatherina sentaniensis*, drawing of adult male, Lake Sentani, Irian Jaya (from Weber and De Beaufort, 1922).

caudal fin dusky; anal fin translucent or yellowish, dusky on outer edge; pectoral and pelvic fins translucent.

Colour in life: blue-grey on upper half, white with slight pink suffusion on lower half; males with 6-8 reddish-brown bars on lower sides between pectoral fin base and level of middle anal rays; dorsal fins and anal fin bluish-grey; anal and pelvic fins mainly whitish, blue-grey along distal margin; pectoral fins translucent. The live coloration of a male specimen was illustrated by Clasen (1976).

Comparisons

Chilatherina sentaniensis is a lacustrine species apparently derived from the ancestral stock of *C. fasciata*. It is similar in appearance to *C. fasciata*, but differs significantly in having a lower number of soft rays in the second dorsal fin (see Table 1). In addition, the snout of *C. sentaniensis* is longer, usually 2.5 to 2.9 in the head length compared with 3.0 to 3.6 for *C. fasciata*.

Distribution

Chilatherina sentaniensis is known only from Lake Sentani which lies about 12 km to the south-west of Jayapura, Irian Jaya.

Habitat

According to Boeseman (1963) Sentani Lake is situated in a hilly region at an altitude of 75 m. It has an approximate length of 30 km and widths varying between 2 and 5 km. The shores are generally steep, but low and swampy in a few places, generally covered with grasses, shrubs, and some forest. The water is clear and the bottom along shore consists of mud or sand covered with some aquatic vegetation which may be dense. The lake receives an annual average rainfall of 185 cm.

Material Examined (57 specimens, 48-96 mm SL)

RMNH unregistered (51: 48-81 mm SL), Lake Sentani; WAM P26789-001 (5: 69-76 mm SL), Lake Sentani; ZMA 103.093 (lectotype, 96 mm SL), Lake Sentani.

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A NEW SPECIES OF *GLOSSOLEPIS* (PISCES: MELANOTAENIIDAE) FROM FRESH WATERS OF PAPUA NEW GUINEA

GERALD R. ALLEN*

ABSTRACT

A new species of rainbowfish (Melanotaeniidae) belonging to the genus *Glossolepis* Weber is described from seven specimens from the Omsis River, a tributary of the Markham River near Lae, Papua New Guinea. *Glossolepis maculosus* sp. nov. differs from all other members of the genus on the basis of a combination of features which include colour pattern, a remarkably small size, reduced scalation, and a low number of gill rakers on the first branchial arch.

INTRODUCTION

The rainbowfishes of the family Melanotaeniidae are inhabitants of fresh and brackish waters of New Guinea and Australia. The group contains 47 known species, but future discoveries will no doubt increase this total. Fieldwork by the author over the past six years has resulted in the collection of 13 undescribed species and an additional six new species have surfaced in various museum collections. The most fertile area for new discoveries would appear to be the little explored interior of Irian Jaya (West New Guinea). The family is divisable into seven genera which were reviewed by Allen (1980).

The present paper describes a new species of *Glossolepis* Weber collected by the author near Lae, Papua New Guinea during September 1980. Methods of counting and measuring follow those explained in Allen and Cross (1980). Counts and measurements are summarized in Tables 1 and 2. Data in parenthesis indicate the range for paratypes when differing from the holotype.

TABLE 1

Fin-ray counts for type specimens of *Glossolepis maculosus*.

First dorsal fin spines

V	VI
4	4

Second dorsal fin soft rays

9	10
5	3

Anal fin soft rays

18	19	20
3	4	1

Pectoral fin rays

12	13
6	2

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Proportional measurements are presented as percentage of the standard length. These data are based on the holotype and 5 paratypes, 36.3-46.6 mm SL, unless stated otherwise. Type specimens are deposited at the Kanudi Fisheries Laboratory, Port Moresby, New Guinea (PNG); and the Western Australian Museum, Perth (WAM).

TABLE 2

Comparison of selected counts for species of *Glossolepis*.

	Gill rakers lower limb of first arch	Horizontal scale rows	Vertical scale rows	Predorsal scales	Total scales on preopercle-suborbital
incisus	26-32	16-20	50-60	30-36	26-38
maculosus	13-14	10	34-36	17-20	11-14
multisquamatus	19-23	12-16	38-43	24-31	20-26
pseudoincisus	26-30	12-16	38-43	27-34	21-29
wanamensis	19-23	15-17	39-44	23-35	21-30

SYSTEMATICS

Glossolepis maculosus sp. nov.

Fig. 1

Holotype

WAM P26976-001, male 46.2 mm SL, small tributary of Omsis River about 22 km west of Lae, Markham River System, Papua New Guinea (approximately 6°42′S, 146°47.5′E), seine net, G. Allen and B. Crockford, 27 September 1980.

Paratypes

PNG unregistered, 3 specimens, 36.3-42.2 mm SL, collected with holotype; WAM P26976-004, 3 specimens, 24.2-43.8 mm SL, collected with holotype; WAM P26976-003, 46.6 mm SL, collected from small side channel of Omsis River about 300 m upstream of type locality, seine net, G. Allen, B. Crockford, and B. Parkinson, 26 September 1980.

Diagnosis

A species of *Glossolepis* with the following combination of characters: dorsal rays V or VI-I,9 or 10; anal rays I,18 to 20; pectoral rays 12 or 13; horizontal scale rows 10; vertical scale rows 34 to 36; predorsal scales 17 to 20; preopercle-suborbital scales 11 to 14; gill rakers on first arch 2 or 3 + 13 or 14; colour generally brownish on upper half, white on lower half with series of 6-8 large dark spots along middle of sides.

Description

Dorsal rays VI-I,9 (V or VI-I,9 or 10); anal rays I,19 (I,18 to 20); pectoral rays 12 (12 or 13); horizontal scale rows 10; vertical scale rows 36 (34 to 36); predorsal scales 18 (17 to 20) (av. 16, N = 8); peropercle scales 14 (11 to 14) (av. 12, N = 8); gill rakers on first arch 2 + 13 (2 or 3 + 13 or 14).

Greatest body depth of holotype 30.7, greatest depth of paratypes by sex and size class as follows: *males* — (a) 35-40 mm SL, 27.5 (N = 1), (b) 41-47 mm SL, 28.9-30.7 (av. 29.8, N = 2); *females* — (a) 24-34 mm SL, 23.1-23.2 (av. 23.2, N = 2), (b) 35-40 mm SL, 26.4 (N = 1), (c) 41-47 mm SL, 28.5 (N = 1); head length 26.0 (25.5-27.3); snout length 6.9 (6.2-7.2); eye diameter 8.9 (8.6-10.1); interorbital width 8.2 (8.2-8.7); caudal peduncle depth 10.0 (9.1-10.2); caudal peduncle length 16.7 (15.7-19.1); predorsal distance 48.1 (46.6-50.6); preanal distance 48.1 (46.0-50.4); prepelvic distance 37.0 (35.8-37.9).

Jaws (Fig. 2) about equal, oblique, premaxilla without an abrupt bend between the anterior horizontal portion and lateral part; maxilla ends well forward of anterior edge of eye; lips thin except median portion of upper lip bulbous; teeth conical with slightly curved tips, those in outer row stouter; teeth in upper jaw arranged in 2 to 3 rows anteriorly, reduced to a single row posteriorly; teeth at front of lower jaw in 4 or 5 rows, tapering to a single row posteriorly; teeth of upper jaw and middle portion of lower jaw extending outside of mouth onto lip; vomer with a row of small, conical teeth (difficult to detect even under high magnification); palatines edentulous.

Scales relatively large, arranged in regular horizontal rows; body scales with slightly crenulate margins (Fig. 2); predorsal scales extending to posterior portion of interorbital; a single scale row on preopercle with 1-2 additional scales below posterior corner of eye.

First dorsal fin originates about opposite of anal fin origin; first dorsal spine is slightly (in females) to distinctly (in males) shorter than longest (usually third) spine; longest spine of first dorsal fin 21.6 (12.6-18.2), its tip reaching base of second or third soft ray of second dorsal fin in males and falling just short of second dorsal fin origin in females when depressed. Longest (usually first) soft ray of second dorsal fin 13.9 (14.2-16.0); depressed posterior rays of second dorsal fin extends back about one-third length of caudal peduncle in females and one-half length of caudal peduncle or more in males. Longest anal rays (middle rays in females, most rays uniform in males) 12.6 (10.7-16.3). Soft dorsal and anal fin rectangular in outline, the posterior rays somewhat elongate and pointed in males. Pelvic fin tips when depressed just reaching base of anal spine in females and extending to base of first or second soft anal ray in males; length of pelvic fin 14.9 (13.5-15.7). Pectoral fins pointed, the length 18.8 (15.7-18.3). Caudal fin moderately forked, its length 22.3 (18.7-22.3).

Colour in alcohol: brownish on upper half with slightly lighter scale centres; silvery or whitish on lower half; a row of 7-8 irregularly spaced spots (pupil size or smaller) along middle of side; fins dusky.

Colour in life: brownish-green dorsally grading to silvery-white on ventral half; lower portion of side with yellow suffusion posteriorly; spots along middle of side bluish-black; fins mainly translucent or slightly dusky; second dorsal fin yellowish basally and anal fin with broad median band of yellow. The yellow coloration of the fins and body is more pronounced in males.

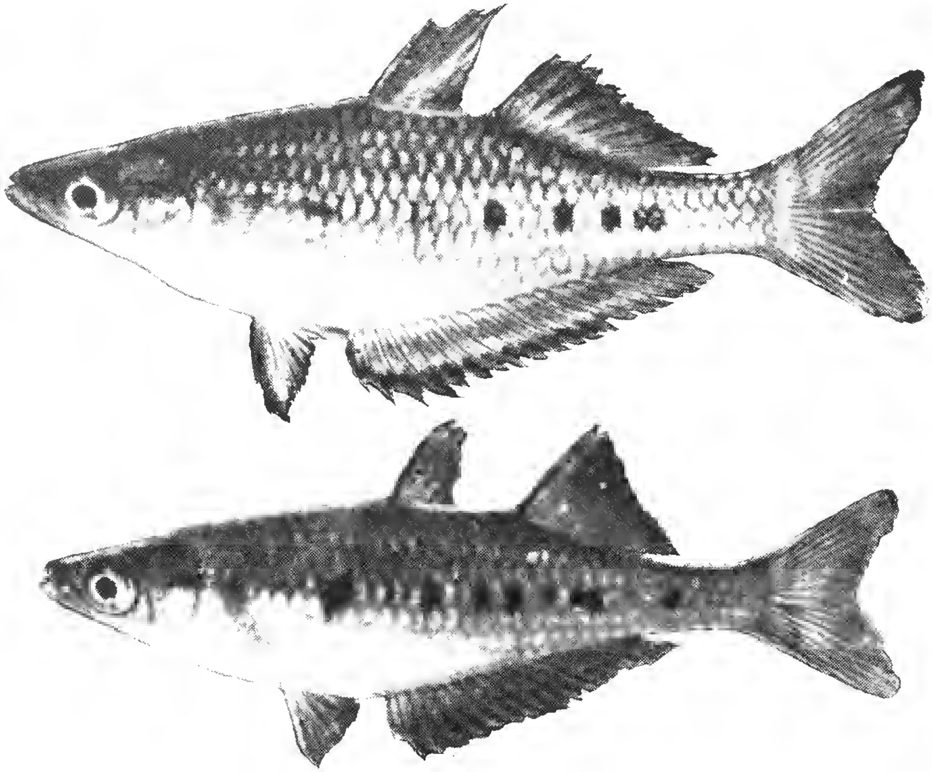

Fig. 1: *Glossolepis maculosus*, male holotype (upper), 46.2 mm SL and female paratype, 42.2 mm SL.

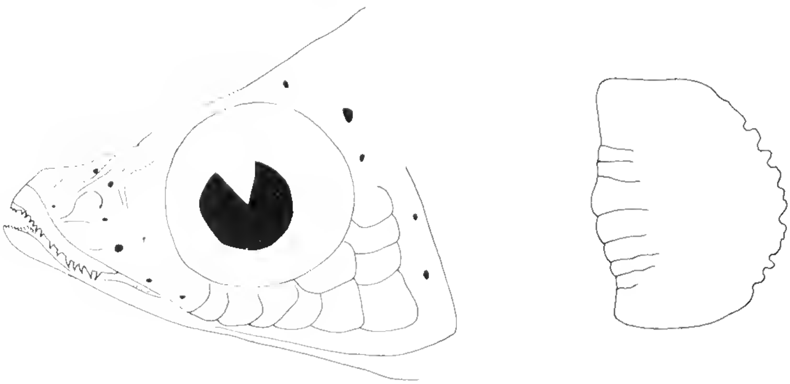

Fig. 2: Camera lucida drawings of head of holotype and body scale (x250, removed three scale rows below base of first dorsal fin). The crenulations on the posterior (right) margin of the scale are less distinct than in other *Glossolepis* (see Fig. 12, A-C, in Allen 1980).

Comparisons

The genus *Glossolepis* contains five species which are restricted to northern New Guinea between the drainage systems of the Markham and Mamberamo Rivers. All except *G. multisquamatus*, from the Sepik and Mamberamo, appear to have extremely limited distributions. *Glossolepis incisus* is known only from Lake Sentani near the Irian Jaya capital of Jayapura, and approximately 30 km west of the single collection site for *G. pseudoincisus* on the Tami River. *Glossolepis wanamensis* is known only from Lake Wanam, about 25 km west of Lae and just 5 km from the Omsis River where *G. maculosus* is found.

The diagnostic features of the genus *Glossolepis* were discussed in detail by Allen (1980), Allen and Cross (1980), and Allen and Kailola (1979).

Glossolepis maculosus exhibits crenulate scale margins and a small premaxillary with relatively few teeth, both typical features of the genus. However, it is noticeably aberrant compared to other *Glossolepis* with regard to its reduced number of gill rakers and scales. These differences are indicated in Table 2. The colour pattern of this species is very different to that of other *Glossolepis*, and although the sample size is small it appears to attain a very small size, only about 50 mm SL, compared with 80-115 mm SL for the other species.

Distribution

The species is known only from the type locality, a small stream flowing into the Omsis River about 500 m upstream from the Tablebirds Poultry Farm. This locality is situated about 22 km west of Lae. The Omsis is a tributary of the Markham River.

Habitat

All but one of the types were collected from a small, clear, slow flowing creek. The width ranged from about 0.5 to 3.0 m, and the depth from about 10 to 70 cm. The stream was bordered by tall grass and occasional patches of rainforest. The types were taken from a narrow (1.5 m) section containing a dense cover of aquatic vegetation. A pH of 7.8 and temperature of 25.0°C were recorded. The site is situated about 50 m upstream from the Omsis River. The remaining type was taken from a small side channel in the main stream-bed of the Omsis River. A number of seine hauls in the main river yielded two other rainbowfishes, *Melanotaenia affinis* (Weber) and *Chilatherina campsi* (Whitley). The type locality stream was also inhabited by these species, although they frequented the deeper sections in contrast to *G. maculosus*.

Remarks

The smallest gravid female among the type series is 36.7 mm SL.

The species is named *maculosus* (Latin: spotted) with reference to the colour pattern.

ACKNOWLEDGEMENTS

Special thanks are due B. Parkinson of Rabaul, Papua New Guinea and B. Crockford of Melbourne. Mr Parkinson accompanied the author throughout the 1980 visit and his assistance was instrumental to the success of the expedition. Mr Crockford is responsible for informing the author about the existence of *G. maculosus* prior to the 1980 New Guinea visit and kindly joined the expedition at Lae to assist with the capture of specimens. Dr H. Axelrod of T.F.H. Publications (U.S.A.) generously donated travel funds. Accommodation was provided by L. and J. Crossfield of Port Moresby, and J. Gollan and Ron Wilson of Lae. D. Dunham and N. Serafini assisted with the shipment of live specimens. Collection and exportation permits were provided by the Wildlife Division, Department of Lands and Environment, Government of Papua New Guinea under the auspices of N. Kwapena, First Assistant Director. Finally I thank C. Allen for her careful preparation of the typescript.

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Rec. West. Aust. Mus. 1981, 9 (3): 307-313

PARASITES OF WESTERN AUSTRALIA

XIV

TWO NEW SPECIES OF *OPHTHALMODEX* LUKOSCHUS AND NUTTING (ACARINA: PROSTIGMATA: DEMODICIDAE) FROM THE EYES OF BATS

A.G.W. WOELTJES* and F.S. LUKOSCHUS*

ABSTRACT

Two new species of *Ophthalmodex* Lukoschus and Nutting from bats are described from the Kimberley Division of Western Australia: *O. australiensis* from *Rhinonicteris aurantius* (Gray) (Hipposideridae) and *O. wilsoni* from *Eptesicus pumilus* (Gray) (Vespertilionidae).

INTRODUCTION

Species of *Ophthalmodex* Lukoschus and Nutting, 1979, tiny turtle-shaped mites of the family Demodicidae live on the corneal surface in the eyelid fornices and in the ducts of the lacrimary glands of mammals. They are morphologically adapted to these niches, where they consume epithelial cells. Only lightly infected hosts and low-grade pathology have been observed (Lukoschus and Nutting 1979, Lukoschus *et al.* 1980).

SYSTEMATICS

Key to Species of *Ophthalmodex*

Males

1 Opisthosoma strongly reduced, not prominent between legs IV, prodorsal shield with U or V-shaped elevation behind aedeagus 2

Opisthosoma in form of U or V-shaped prominence behind legs IV, prodorsal shield with or without inverted V-shaped elevation, covering aedeagus 3

2 Aedeagus slender, shield elevation in V-shape, inverted U-shaped striations on posterior part of dorsum, *ex Artibeus literatus* . . . *O. artibei* Lukoschus and Nutting, 1979

Aedeagus stout, shield elevation in U-shape, only few longitudinal striations on terminal region of dorsum, *ex Carollia perspicillata* . . . . *O. carolliae* Lukoschus *et al.*, 1980

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3 Claws with 6 points, *ex Molossus molossus* ...... *O. molossi* Lukoschus *et al.*, 1980

Claws with 5 points 4

4 Coxal fields II and III largely separated in midline, opisthosoma almost triangular, tapering to end, *ex Rhinonicteris aurantius* .... *O. australiensis* sp. nov.

Coxal fields II and III almost together in midline, opisthosoma with broad end, *ex Eptesicus pumilus* ... *O. wilsoni* sp. nov.

Females

1 Genital opening between coxal fields IV 2

Genital opening behind coxal fields IV 3

2 Opisthosoma a single U-shaped prominence. Dorsal shield covering anterior podosoma, *ex Artibeus literatus* ...... *O. artibei* Lukoschus *et al.*, 1980

Opisthosomal contours laterally bisinous. Dorsal shield demarked anteriorly from anterior poclosoma by single striation, *ex Carollia perspicillata* .... *O. carolliae* Lukoschus, *et al.*, 1980

3 Claws with 6 points, *ex Molossus molossus* ...... *O. molossi* Lukoschus *et al.*, 1980

Claws with 5 points 4

4 Coxal fields II and III small, widely separated in midline, *ex Rhinonicteris aurantius* .... *O. australiensis* sp. nov.

Coxal fields large trapezoid, close together in midline, *ex Eptesicus pumilus* .... *O. wilsoni* sp. nov.

Opthalmodex australiensis sp. nov.

Figs 1-5

Holotype

WAM 80-320; male; total length 125 μm, width 79 μm; host: *Rhinonicteris aurantius* (Gray): Hipposideridae (deposited in the Field Museum of Natural History, Chicago [FMNH]); locality: Geikie Gorge, 18°05′S, 125°43′E; 9 October 1976; coll. F.S. Lukoschus.

Allotype

WAM 80-319; female; total length 140 μm, width 85 μm. Other data as for the holotype.

Paratypes

WAM 80-321 (1 slide). Other paratypes are in FMNH (3 slides) and the Catholic University of Nijmegen (CU) (3 slides). Other data as for the holotype.

Diagnosis

Elongate-oval species with the characteristics of the genus. Axes in both sexes 1.6: 1, opisthosoma a quarter of total length. Largest adult, a female, 148 x 73 μm.

Description

Male (Figs 1, 2): Venter (Fig. 1) elongate, with pronounced opisthosoma. Gnathosoma and legs partly covered by overhanging carapace-like dorsum. Legs short and broad with large coxal plates touching one on the next in file, but widely separated in midline (except legs I). Length of coxal fields about subequal to their width. Femora with prominent ventroposterior spurs not remarkably sclerotised. Genua-tarsi fused into apical segment with two large five-tined claws, two point-like internal sclerotisations, and on legs I-II one free solenidion (so). Shaft of claws moderately recurved, apical tines smaller than lateral ones. Gnathosoma with two-segmented palps and styliform chelicerae. Small palptarsus attached ventrally to broad palptibia with lateral and dorsoanterior conical expansions. Palptarsus with two two-pointed claw-like spines and one small solenidion. Pharyngial bulb present, subgnathosomal setae absent. Supracoxal setae (scx) short in broad, relatively strongly sclerotised rings on dorsolateral side of gnathosomal base. Dorsum (Fig. 2): Prodorsal shield with triangular elevation, without sclerotised pattern or podosoma tubercles, 67 x 57 μm (holotype), covering most of width of podosoma. Large genital opening near anterior border of prodorsal shield. Aedeagus strong, 29 μm long (holotype), in penis sheath. Soft parts of metapodosoma transversely striated.

Female (Figs 3, 4): Total length in 10 paratypes measured 140.7 ± 4.8, width 85.1 ± 5.8. General shape of venter, legs and gnathosoma as in male, but palptibia with stronger dorsoanterior cone, and broader opisthosoma with tapering rounded end (33 μm long [allotype], in paratypes 34.3 ± 2.0). Total length/length opisthosoma 4.11 ± 0.12. Genital opening behind coxal plates IV. Dorsum with large prodorsal shield 67 μm long (allotype), paratypes 70.1 ± 7.3, almost wholly covering region of legs I-III. Soft parts to sides of shield with few longitudinal striae, behind shield with largely transverse striae.

Nymph (Fig. 5): Oval, with soft, smooth cuticle. Gnathosoma head-like as large as in adults, with palps, carrying two spines. Legs stubby, unsegmented, with two lobes, but without ventral segmentation line as in *Demodex*. Leg lobes each with one two-pointed claw with slender tines. Solenidia not observed. Ventral scutes and other anchoring organs absent.

Egg: With thin unsculptured shell, large in relation to female and genital opening: 61.1 ± 2.4 μm. As in all other demodicid and psorergatid genera egg-shell not observable within females mounted in Hoyer's medium.

Figs 1-5: *Ophthalmodex australiensis* sp. nov. (1) male holotype, venter; (2) male holotype, dorsum; (3) female allotype, venter; (4) female allotype dorsum; (5) nymph, venter.

Ophthalmodex wilsoni sp. nov.

Figs 6-9

Holotype

WAM 80-316; female; total length 148 mm, width 93 µm; host: *Eptesicus pumulis* (Gray): Vespertilionidae (deposited in FMNH); locality Geikie Gorge, 18°05'S, 125°43'E; 9 October 1976; coll. F.S. Lukoschus.

Allotype

WAM 80-317; male, total length 128 µm, width 93 µm. Other data as for the holotype.

Paratypes

WAM 80-318 (1 slide). Other paratypes are in FMNH (4 slides) and CU (3 slides). Other data as for holotype.

Diagnosis

With characteristics of the genus and closely related to *O. australiensis*. Largest adult, a female 157 x 102 µm. Opisthosoma less than a quarter of total length.

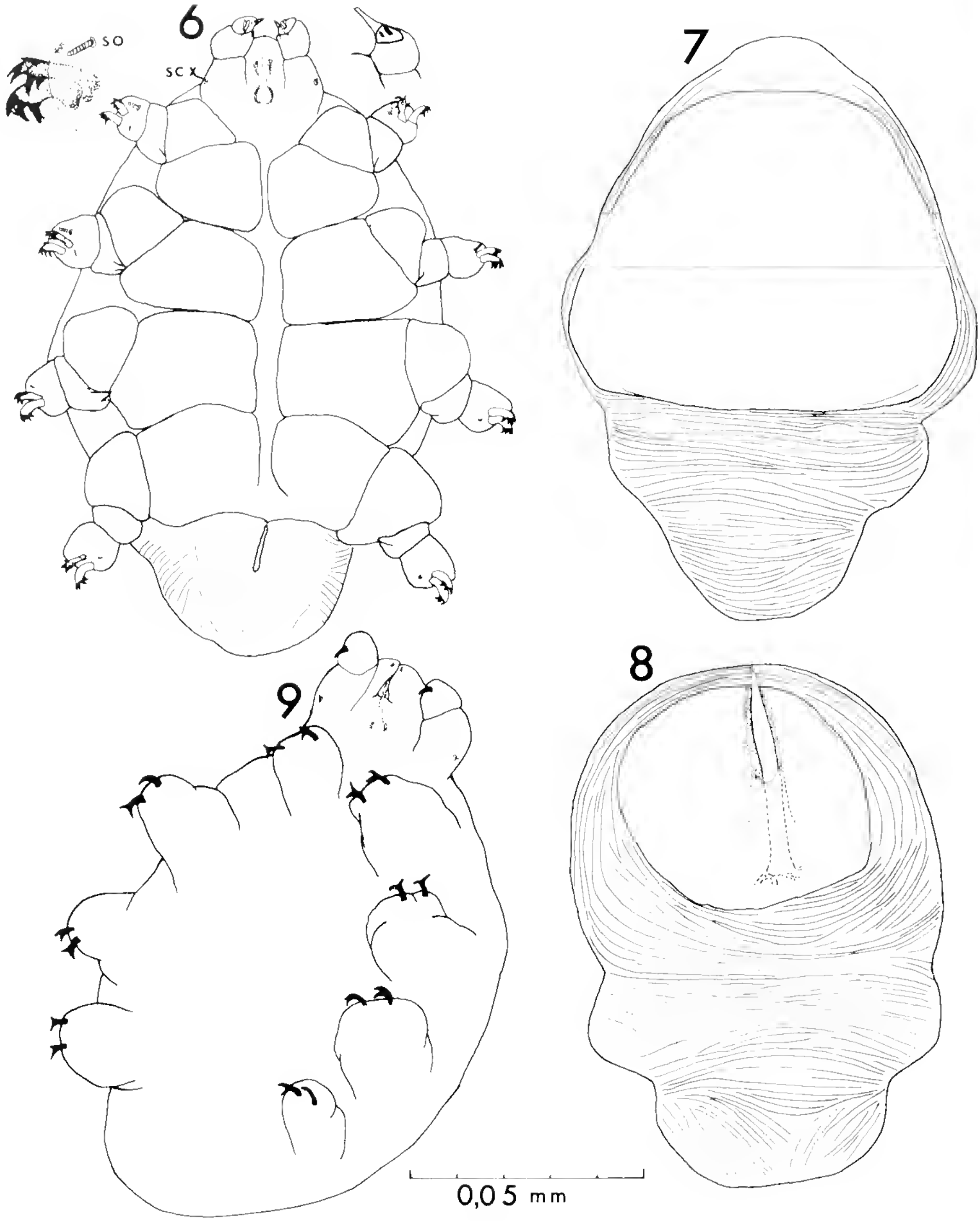
Description

Male (Fig. 8): Total length 125 µm, width 90 µm in single paratype. General shape of venter as in female. Dorsum with small prodorsal shield, lacking elevation covering aedeagus (49 x 49 µm) in allotype, falling well short of sides of propodosoma. Genital opening long, oval, near anterior border of shield. Aedeagus 24 µm long (allotype), relatively stout, within distinct penis sheath. Striations of soft parts as figured.

Female (Figs 5, 7): Total length in 13 paratypes measured 144.5 ± 8.6, width 92.7 ± 7.1. Opisthosoma of holotype 31 µm (29.7 ± 4.7) long, with broad rounded end, without distinct transverse striation. Total length/length opisthosoma 4.86 ± 0.76. Venter (Fig. 6) as in *O. australiensis*, but legs set more ventrally, and coxal plates I touching in midline, II-IV separated by small sternal region. Coxal plates distinctly larger in transverse than in longitudinal direction (contrary to *O. australiensis*). Claws with five subequal tines. Palptibia with long dorsodistal protrusion and rather strong sclerotisation (palptibial claw). Dorsum (Fig. 7) with broad prodorsal shield, covering propodosoma except for narrow strip at sides, 84 µm long in holotype (74.5 ± 5.0). Soft parts beside shield with longitudinal, behind shield with transverse striations.

Nymph (Fig. 9): General shape as in *O. australiensis* with gnathosoma prominent, as large as in adults. Palptarsus with only one spine. Legs stumpy, without distinct lobes; claws with stronger points.

Egg: Subspherical, 63.8 ± 3.2 µm, large in relation to female and genital opening.



Figs 6-9: *Ophthalmodex wilsoni* sp. nov. (6) female holotype, venter; (7) female holotype, dorsum; (8) male allotype, dorsum; (9) nymph, venter.

Etymology

The new species is dedicated to Dr Barry Wilson, Director, National Museum of Victoria, Melbourne, formerly Head of the Division of Natural Science, Western Australian Museum, Perth.

ACKNOWLEDGEMENTS

This paper results from the combined Western Australia Field Programme 1976-77 of the Field Museum of Natural History, Chicago and the Western Australian Museum, Perth. The participation of a mammal group was made possible by the generous gift of William S. and Janice Street, Ono, Washington, U.S.A., and with the aid of grant R 87-111 by Netherlands Organization for the Advancement of Pure Research (Z.W.O.). We are indebted to Dr D.J. Kitchener, Western Australian Museum, Perth, for identification of hosts, and to Dr R. Domrow, Queensland Institute of Medical Research, Brisbane, for critical review.

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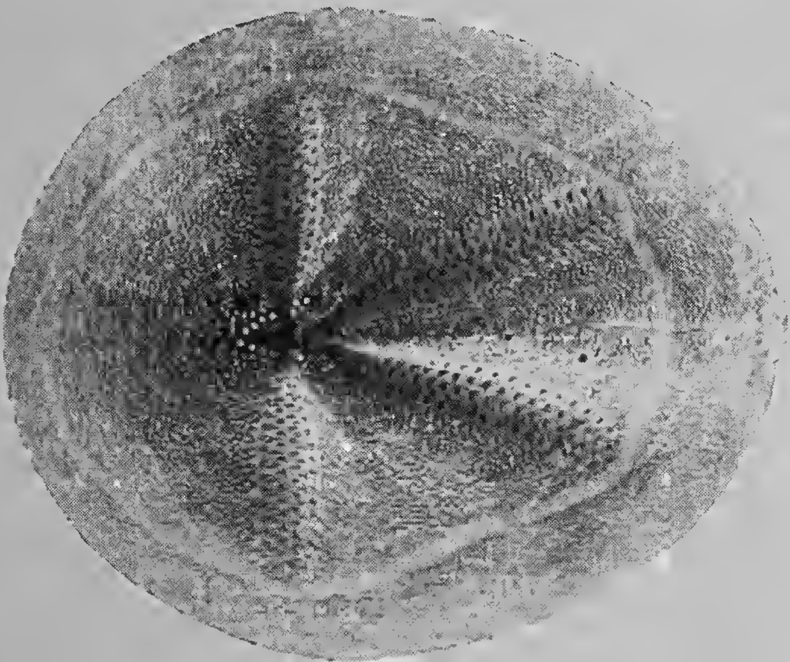

Volume 9, Part 4, 1982

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Cover The holotype specimen of *Rhinobrissus tumulus* sp. nov. from Barrow Island, Western Australia. Photograph by Val Ryland.

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Parasites of Western Australia

XV

A New Species of *Psorergatoides* (Acarina: Psorergatidae) from Australian Bats

K.M.T. Giesen,* F.S., Lukoschus*
and A. Fain†

Abstract

Psorergatoides australiensis sp. nov., parasitic on *Eptesicus pumilus*, is described, figured and compared with related species. Specimens from *Eptesicus douglasi*, *Nyctophilus arnhemensis* and *Nyctophilus walkeri* cannot be separated from those from the type host.

Introduction

Species of *Psorergatoides* Fain, 1959*b* live as minute, disc-shaped parasites beneath the stratum corneum of the wings or ears of bats. The genus has not previously been reported from Australia.

During the joint expedition of the Western Australian Museum (WAM)and the Field Museum of Natural History, Chicago (FMNH) to Mitchell Plateau, in the Kimberley Division of Western Australia in 1976-1977, F.S.L. collected a new species of *Psorergatoides* from four species of vespertilionid bats. This species shares four characters (two setae on femora I-III, a bifid spine and one-pointed claws on tarsi, no terminal body setae in males) with *P. kerivoulae* Fain, 1959*a*, *P. nycteris* Fain, 1959*a*, and a species to be described later (Giesen *et al.* in press; referred to subsequently as *P.* species A). The new species is compared with these three.

Measurements are tabulated in micrometers (μm).

* Department of Aquatic Ecology, Catholic University of Nijmegen, The Netherlands.
† Institut de Médecine Tropicale Prince Léopold, Antwerp, Belgium.

Systematics

Psorergatoides australiensis sp. nov.

Figures 1-9

Holotype

WAM 81-570; female; from *Eptesicus pumilus* (Gray, 1841); Geikie Gorge, Western Australia, 18°05'S, 125°43'E; 8 October 1976. Host in FMNH, no. 120153.

Allotype

WAM 81-571; male; host, locality and date as for holotype.

Paratypes

WAM 81-572, 81-643 (eight specimens); from *Eptesicus pumilus* (Gray, 1841); near Aluminium Camp, Mitchell Plateau, 14°50'S, 125°49'E; 23 October 1976. Host in WAM, field no. 3076; WAM M15756. Other paratypes are in FMNH; U.S. National Museum of Natural History (Smithsonian Institution), Washington; Acarology Laboratory, Ohio State University, Columbus; Rocky Mountain Laboratory, Hamilton; Rijksmuseum van Natuurlijke Historie, Leiden; Zoologisches Institut und Zoologisches Museum, Hamburg; British Museum (Natural History), London; and in collection of authors.

Diagnosis

Species with paired femoral setae IV, female with very long terminal body setae (78-108 μm), male without terminal body setae. Largest adult, a female, 167 x 152 μm.

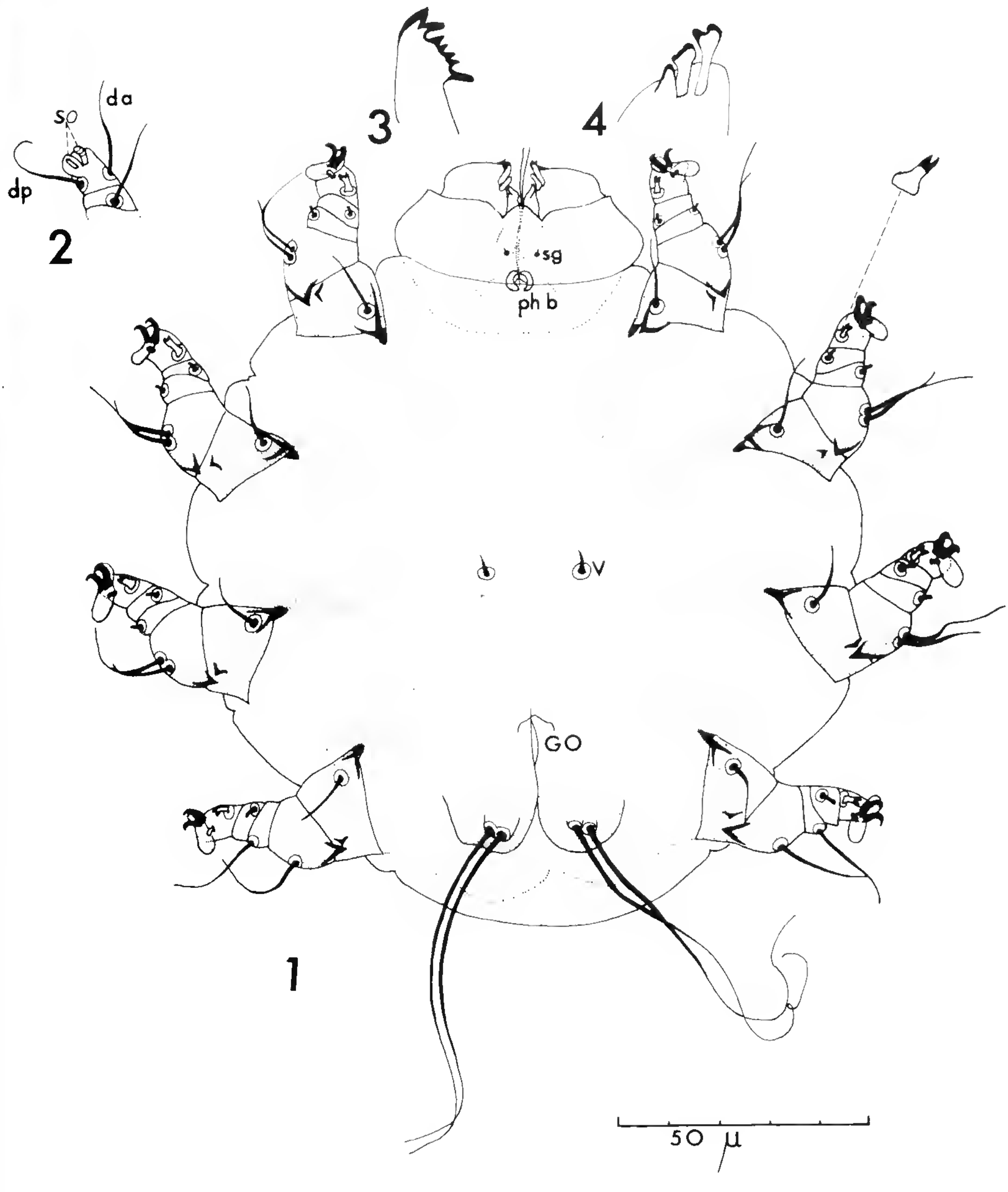
Description

Female (Figures 1-7)

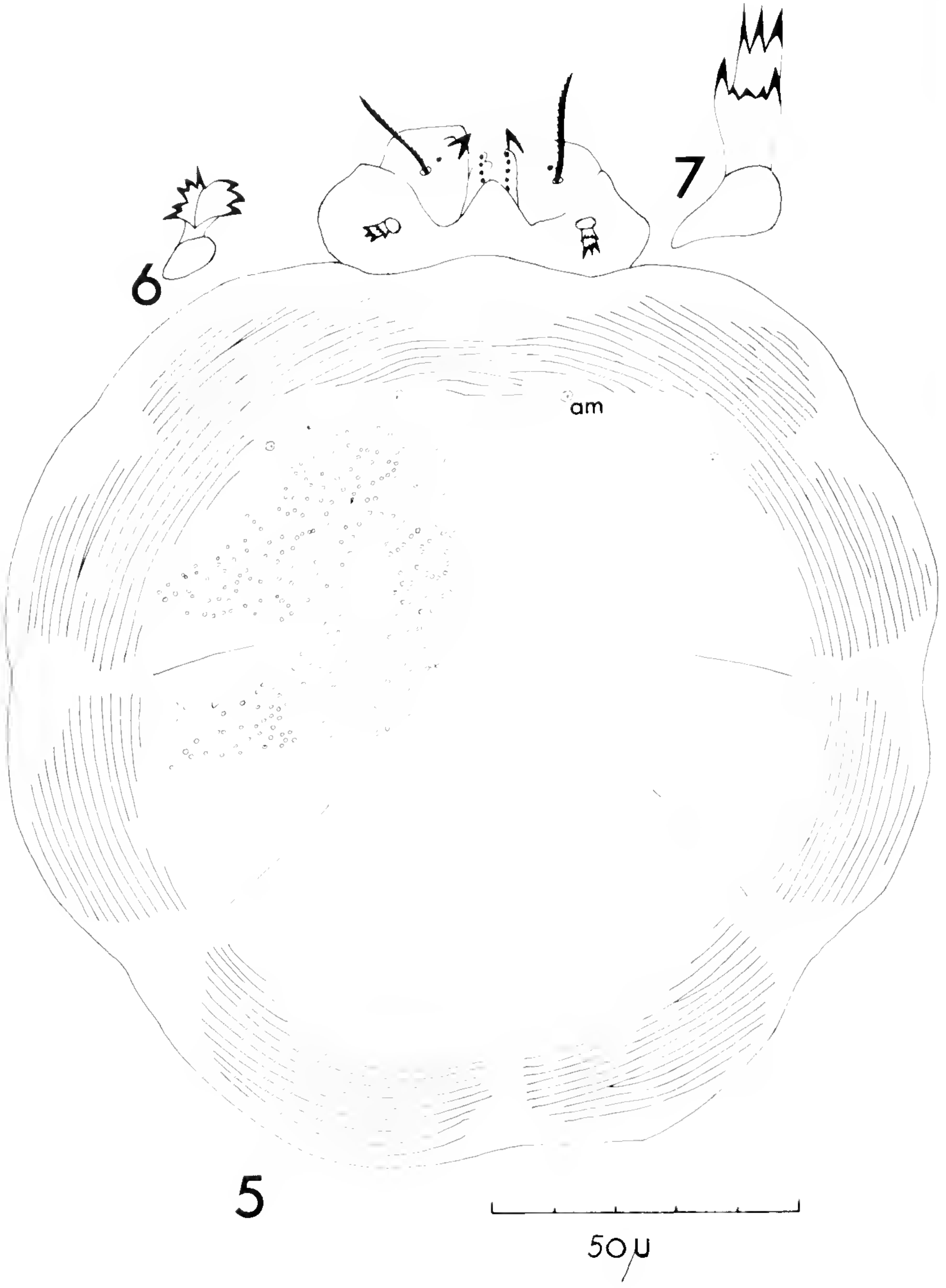
Whitish, medium-sized mites with a total length (including gnathosoma) in the holotype of 159 μm, width 142 μm. Venter (Figure 1): All epimera straight, directed towards centre. Genital opening (*GO*) between adanal lobes, each of which carries a pair of long terminal setae. Ventral setae (*V*) just anterior to epimera III. Cuticle smooth.

Legs subequal, short and stout, with five free segments, evenly spaced ventrolaterally. Tarsi with two equal one-tined claws, bilobed empodium with smaller lobes between claws, sclerotized condylophores inside tarsus, bifid ventroanterior spur, and two subequal dorsal setae (Figure 2, *d a*, *d p*). Two solenidia (*so*) on tarsi I-II. Seta *d p* lacking on tarsus IV. Tibiae with ventroanterior blunt spine and relatively long dorsal seta. Genua I-III with short posterolateral seta, genu IV with long seta (longer than femoral seta). Femora with strongly sclerotized posterior spur forming pincers with small spur on trochanters, a pair of unequal posterolateral setae on I-III, and a single seta on IV. Trochanters with a strongly sclerotized ventroanterior spur protruding to act as an anchor in skin of host, a relatively strong seta at base of this spur, and a small posterior spur.

Gnathosoma with two short subgnathosomal setae (*sg*) in front of pharyngeal bulb (*ph b*), two-segmented palps, and chelicerae with seven-dentate fixed



Figures 1-4 *Psorergatoides australiensis* sp. nov. (female): (1) venter of holotype; (2) dorsal view of tibia-tarsus I of holotype; (3) chelicera of squashed paratype; (4) palpal tarsus of squashed paratype.



Figures 5-7 *Psorergatoides australiensis* sp. nov. (female): (5) dorsum; (6-7) gnathosomal (supracoxal) seta enlarged.

digit (Figure 3) and stylet-like movable digit. Palpal tarsus with two ventromedially directed modified setae and a one-tined spine (Figure 4). Palpal tibia dorsally with a long servate posterior seta, a minute anterior seta, and a terminal anteriorly directed spur. Gnathosomal (supra-coxal) setae (Figures 6, 7) two-lobed, with dentate edges.

Dorsum (Figure 5). Dorsal shield almost round, weakly sclerotized, and distinctly punctate except for periphery and two pairs of sector-like furrows laterally at level of legs III-IV. Anteromedian pair of setae on shield (*a m*) and four pairs of lateral setae indistinct in most paratypes (second to fourth pair absent in Figure 5). Soft parts of dorsum striate as figured.

Measurements in Table 1.

Table 1 Measurements of females of *Psorergatoides australiensis* from four host species.

Host species	*Eptesicus pumilus*			*Eptesicus douglasi*		*Nyctophilus arnhemensis*		*Nyctophilus walkeri*	
	Holotype	X	min-max (n = 10)	X̄	min-max (n = 10)	X̄	min-max (n = 10)	X	min-max (n = 8)
body length	159	162	(159-167)	169	(154-176)	174	(168-184)	177	(161-188)
width	142	145	(140-152)	148	(139-155)	153	(149-157)	153	(142-159)
shield length	105	108	(105-112)	114	(107-120)	115	(110-120)	117	(113-130)
width	102	105	(100-110)	109	(105-113)	118	(114-122)	118	(110-123)
setal length									
terminal	80	94	(78-108)	91	(73-115)	101	(85-115)	99	(75-109)
trochanter	16	13	(10-16)	11	(10-13)	16	(10-21)	12	(11-15)
femora I-III	23	23	(20-27)	23	(21-25)	25	(23-27)	26	(21-30)
femur IV	18	19	(14-25)	17	(14-21)	21	(18-26)	20	(18-23)
genua I-III	2	2	(2-3)	2	(2-3)	2	(2-3)	3	(2-3)
genu IV	20	22	(17-29)	22	(20-30)	27	(21-30)	24	(19-28)
ventral	5	6	(4-8)	7	(5-9)	10	(6-15)	8	(7-10)
distance between ventral setae	18	16	(14-20)	20	(15-24)	17	(14-21)	14	(11-16)
length post. palpal tibial setae	17	17	(15-18)	16	(12-19)	20	(18-22)	23	(19-24)
length gnathosomal setae	7	7	(6-8)	7	(6-8)	8	(8-9)	8	(6-9)

Male (Figure 8)

Similar to female in the main. Venter with short slcerotized median lobe, without terminal setae.

Dorsal shield distinctly longer than broad, with a median longitudinal furrow, but without lateral furrows in areas at level of legs III-IV. Genital slit between anteromedian setae (*a m*). Penis short, with cone-shaped sheath. Genital setae (*g s*) closer to midline than *a m* setae. Lateral shield setae distinctly inserted to sides of pits.

Measurements in Table 2.

Developmental Stages

With gnathosoma of almost adult size; indistinguishable from those of *P. glossophagae* Lukoschus *et al.*, 1973 and *P. desmodus* Lukoschus *et al.*, 1979. Deutonymph 137 μm long x 123 μm wide; protonymph 108 μm x 97 μm; larva 105 μm x 91 μm; egg 98 μm x 93 μm, almost spherical, relatively large in relation to female.

Table 2 Measurements of males of *Psorergatoides australiensis* from four host species.

Host species	*Eptesicus pumilus*			*Eptesicus douglasi*		*Nyctophilus arnhemensis*		*Nyctophilus walkeri*
	Allo-type	X	min-max (n = 4)	X	min-max (n = 9)	X	min-max (n = 10)	min-max (n = 2)
body length	159	155	(146-159)	150	(135-166)	169	(159-179)	117-129
width	122	122	(115-129)	120	(108-130)	133	(125-140)	105-110
shield length	102	98	(90-102)	103	(88-120)	111	(105-120)	76-77
width	98	91	(84-98)	87	(77-101)	96	(88-115)	85-86
setal length								
trochanter	11	12	(11-12)	11	(10-13)	13	(11-17)	7
femora I-III	17	18	(17-19)	17	(14-23)	21	(18-26)	
femur IV	13	14	(13-16)	14	(12-16)	16	(11-20)	–
genua I-III	2	2		2		2		-
genu IV	18	17	(16-18)	14	(10-17)	19	(15-25)	–
ventral	6	5	(5-6)	6	(5-8)	8	(5-11)	4-11
distance between ventral setae	19	19	(16-21)	20	(13-30)	22	(19-26)	23-25
length post. palpal tibial setae	12	13	(12-14)	14	(10-17)	18	(16-18)	15-16
length gnathosomal setae	4	4		6	(5-7)	8	(6-9)	5-6
length penis	19	18	(15-22)	25	(21-30)	26	(23-32)	26-31
length penis sheath	16	16		17	(15-19)	18	(17-19)	16-17
distance between *a m* setae	12	12	(11-12)	12	(10-13)	12	(11-14)	19
distance between genital setae	9	9	(8-9)	9	(8-10)	9	(7-10)	11-13

Pathogenicity

The mites were found in the dactylopatagium between digits 3-4 on the dorsal side, living between the stratum granulosum and the stratum corneum and feeding on the cells of the stratum granulosum, causing hyperkeratosis. In infested regions, the stratum corneum is not melanized, and appears white to the naked eye. Both host specimens were only slightly infested, and only low-grade pathology was observed.

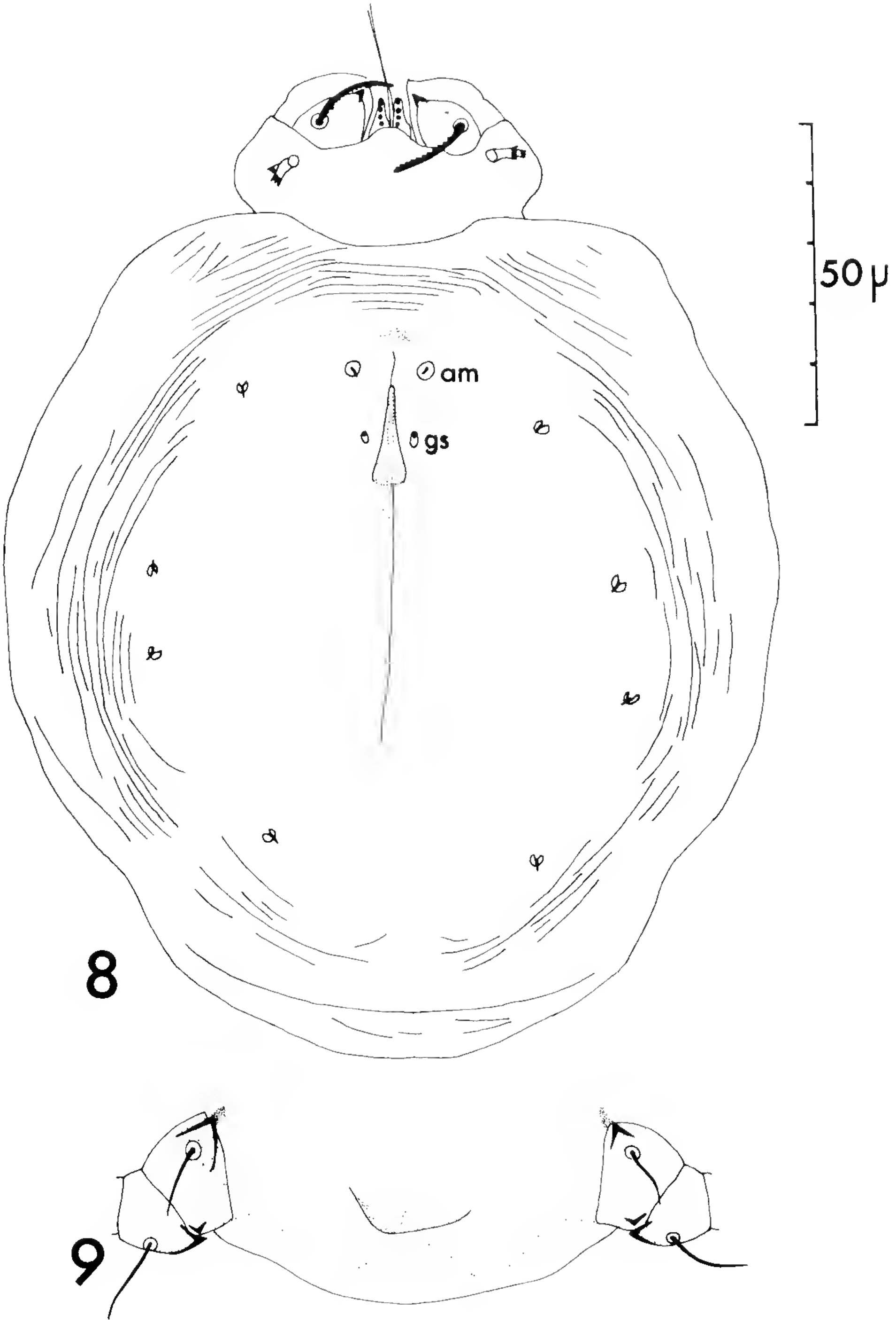
Comparison with Related Species

Of the six known species of *Psorergatoides*, four possess paired femoral setae on leg I-III: *P. kerivoulae*, *P. nycteris*, *P.* species A and *P. australiensis*. *P. kerivoulae* differs from *P. australiensis* in its longer trochanteral setae, subequal femoral setae, shorter genu IV, and shorter gnathosomal setae; *P. nycteris* in its very short femoral, genual, and terminal setae; and *P.* species A in its very small body size, short terminal setae, and gnathosomal setal shape.

For comparison, we add measurements of females and males of these species in Tables 3-4 (male of *P. nycteris* unknown).

Other Material Examined

Additional specimens of *P. australiensis* were collected from the following vespertilionid hosts: *Eptesicus douglasi* Kitchener, 1976, Geikie Gorge, 4 and 8 October 1976; fourteen specimens (WAM 81-579 to 81-584, 81-644), (hosts FMNH 120092, 120110). *Nyctophilus*



Figures 8-9 *Psorergatoides australiensis* sp. nov. (male): (8) dorsum; (9) venter; caudal part.

Table 3 Measurements of females for comparison with related *Psorergatoides* species.

Species	*Psorergatoides australiensis*		*Psorergatoides kerivoulae*		*Psorergatoides nycteris*		*Psorergatoides* species A	
	X	min-max	X	min-max	X	min-max	X	min-max
body length	162	(159-167)	178	(170-186)	188	(175-205)	111	(102-117)
width	145	(140-152)	156	(148-162)	169	(169-180)	98	(96-105)
shield length	108	(105-112)	130		135		78	(75-81)
width	105	(100-110)	126		130		74	(70-79)
setal length								
terminal	94	(78-108)		(75-80)		(8-10)	47	(45-50)
trochanter	13	(10-16)		(12-18)		(4-6)	6	(5-8)
femora I-III	23	(20-27)		(15-20)	6	(4-6)	15	(13-18)
femur IV	19	(14-25)		(12-15)		(4-5)	11	(10-13)
genua I-III	2	(2-3)		(1-2)		(1-2)	1	(1-2)
genu IV	22	(17-29)		(15-18)		(1-2)	20	(19-23)
ventral	6	(4-8)		(6-7)	3		4	(4-5)
distance between ventral setae	16	(14-20)	16	(16-18)	12		16	(16-18)
length post. palpal tibial setae	17	(15-18)	15	(13-17)		(8-10)	6	(5-8)
length gnathosomal setae	7	(6-8)		(3-4)	4	(2-4)	5	(4-6)

Table 4 Measurements of males for comparison with related *Psorergatoides* species.

Species	*Psorergatoides australiensis*		*Psorergatoides kerivoulae*		*Psorergatoides* species A	
	X	min-max	X	min-max	X	min-max
body length	155	(146-159)		(185-186)	98	(93-105)
width	122	(115-129)		(145-147)	82	(75-90)
shield length	98	(90-102)	120		71	(69-74)
width	91	(84-98)	90		62	(59-65)
setal length						
trochanter	12	(11-12)			5	(5-6)
femora I-III	18	(17-19)		(12-15)	10	(9-11)
femur IV	14	(13-16)			8	(8-9)
genua I-III	2			(1-2)	1	
genu IV	17	(16-18)		(8-9)	15	(13-16)
ventral	5	(5-6)			4	
distance between ventral setae	19	(16-21)	18		21	(19-26)
length post. palpal tibial setae	13	(12-14)	13		7	(6-8)
length gnathosomal setae	4		4		5	(4-8)
length penis	18	(15-22)	52		28	(25-29)
length penis sheath	16		22		12	(11-23)
distance between *a m* setae	12	(11-12)		(4-5)	10	(9-11)
distance between genital setae	9	(8-9)		(4-5)	6	

arnhemensis Johnson, 1959, Beverley Springs Station, 18°35′S, 125°29′E, 19 and 20 September 1976: eight specimens (WAM 81-573 to 81-578, 81-642); (hosts FMNH 120681, 120686). *Nyctophilus walkeri* Thomas, 1892, Camp Creek near Aluminium Camp on Mitchell Plateau, 18 October 1976 (host WAM M15768).

Remarks

The *Psorergatoides* collected from the other host species do not show distinct morphological differences from those from *Eptesicus pumilus,* although there are some meristic differences.

Measurements of the main characteristics are given in Tables 1-2. We believe *Psorergatoides* spp. are each specific to one host species, and it may be that the non-overlapping measurements in some characteristics (e.g. length of body, dorsal shield, and penis) indicate a very close species relationship. However, because of the lack of distinct morphological characteristics, we prefer to assign these specimens to *P. australiensis.*

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The Genus *Notechis* (Serpentes: Elapidae) in Western Australia

G.M. Storr*

Abstract

The concept of *Notechis* Boulenger is expanded to include *Brachyaspis* Boulenger, *Elapognathus* Boulenger, *Drysdalia* Worrell and *Austrelaps* Worrell. In Western Australia it is represented by *N. scutatus* (Peters), *N. curtus* (Schlegel), *N. minor* (Günther), *N. coronatus* (Schlegel) and *N. mastersii* (Krefft).

Introduction

In 1961 Worrell began the dismemberment of the elapid genus *Denisonia* Krefft as delimited by Boulenger (1896). Most of Worrell's new genera were only separated from each other by single characters, many of them of little or no phylogenetic value. *Suta,* for example, was distinguished from *Denisonia* (*sensu* Worrell) by its 19 rather than 17 midbody scale rows, despite the fact that both counts occur in *Denisonia fasciata* Rosén (Smith 1980). Contact between postfrontal and prefrontal bones served Worrell for separating *Cryptophis* from *Parasuta,* resulting in the members of the *Denisonia gouldii* species-group (Storr 1981) being spread over two genera; indeed *Parasuta gouldii* (Gray) and *Cryptophis dwyeri* Worrell were later considered by Cogger (1975) to be one and the same species. Little wonder then that workers generally did not follow Worrell. Klemmer (1963) retained *Denisonia* (*sensu* Boulenger) in his list of the world's elapid snakes, and so did almost all workers until 1975.

Boulenger's concept of *Denisonia* was admittedly unsatisfactory, but its worst feature was rectified by McDowell (1970) when he proposed the genus *Salomonelaps* for the Solomon Island species, *Hoplocephalus par* Boulenger. Among the remainder, i.e. the Australian and Tasmanian *Denisonia,* clusters of closely related species are recognizable, e.g. the recently studied *Denisonia gouldii* species-group (Storr 1981). Another cluster consists of the species grouped by Worrell under *Drysdalia* and *Austrelaps.* However, these species appear to be less closely related to *Denisonia* (*sensu* Worrell) than to certain other snakes, including *Notechis scutatus,* that have never been placed in *Denisonia* (*sensu lato*).

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In formulating the present concept of *Notechis* I have made use of characters not previously employed by students of Australian snakes, viz. the shape of the frontal, postocular and dorsal scales, and the colour of the iris, ventrals and concealed skin between the dorsals. On the other hand I have been less impressed than my predecessors on the value of certain other characters. For example, Boulenger separated *Elapognathus* from its former congeners on the basis of a single character, namely the lack of maxillary teeth behind the fangs. Now the size, shape and number of teeth in snakes is intimately concerned with the capture and ingestion of prey. Consequently dental characters must be interpreted with caution when used in phylogenetic studies.

This revision is based largely on material in the Western Australian Museum (registered numbers cited without prefix). In order to check the validity of *Hoplocephalus temporalis* Gunther, I extended my study of *Notechis curtus* to south-eastern Australia, which required the loan of specimens from the South Australian Museum (registered numbers prefixed with SAM), the National Museum of Victoria (NMV) and the Australian Museum (AM). For descriptions of two south-east Australian members of *Notechis*, viz. *N. coronoides* (Gunther) and *N. rhodogaster* (Jan), see Coventry and Rawlinson (1980).

Systematics

Genus *Notechis* Boulenger, 1896

Echiopsis Fitzinger, 1843, Systema reptilium, p. 28. Type-species (by original designation): *Naja curta* Schlegel. *Nomen oblitum.*

Notechis Boulenger, 1896, Cat. snakes Brit. Mus. (Nat. Hist.) 3: 351. Type-species (by monotypy): *Naja (Hamadryas) scutata* Peters.

Brachyaspis Boulenger, 1896, *ibid.*, p. 353. Type-species (by monotypy): *Naja curta* Schlegel. Not *Brachyaspis* Salter 1866 (Trilobita).

Elapognathus Boulenger, 1896, *ibid.*, p. 356. Type-species (by monotypy): *Hoplocephalus minor* Gunther.

Drysdalia Worrell, 1961, West. Aust. Nat. 8: 25. Type-species (by original designation): *Hoplocephalus coronoides* Gunther.

Austrelaps Worrell, 1963, Aust. Reptile Park Rec. No. 1: 2. Type-species (by original designation): *Hoplocephalus superbus* Gunther.

Diagnosis

Small to moderately large elapid snakes with anal and subcaudals normally undivided; midbody scales in 15-21 rows; frontal concave-sided (except in many *curtus* and most *scutatus*); iris partly orange-yellow (except in *scutatus*); dorsal scales narrow and imbricate along middle of back, becoming juxtaposed and as wide as long towards ventrals; scales matt to slightly glossy in texture; concealed skin between scales black; lower surfaces yellow, orange or red, the base of ventrals edged with black or grey.

Description (based on western species)

Head variable in shape, e.g. deep in *scutatus*, *curtus* and *minor*, moderately deep in *coronatus*, shallow in *mastersii*; snout short in *minor*, moderately long in other species; and head slightly to well marked off from neck. Frontal much longer than wide, usually with anterior corner angular and posterior rounded. Preocular normally in short contact with nasal and widely separated from frontal. Postoculars normally 2, the lower usually longer and narrower than the upper. Temporals normally 2 + 2 (except in *curtus*). Upper labials normally 6. Lower labials normally 7. Dorsal scales smooth or striate, rows increasing on neck (except in many *scutatus*) and reducing before vent.

Distribution

Southern Australia, including Tasmania.

Remarks

Of the available names for this genus, the two oldest (*Notechis* and *Elapognathus*) were published on the same date. I hereby select *Notechis* for this genus, thereby conserving the combination *Notechis scutatus* for its most dangerous member. The affinities of the recently described *'Brachyaspis' atriceps* Storr are uncertain, and it is excluded from this paper.

Key to Western Species

1 Midbody scale rows 17-21 2
Midbody scale rows 15 3

2 Upper surfaces mostly blackish, with or without narrow paler cross-bands; lower surfaces anteriorly bright yellow; scales smooth; iris wholly dark .... *scutatus*
Upper surfaces olive to reddish-brown (never blackish); lower surfaces pale yellow to whitish (never bright yellow); scales striate; iris partly yellow .... *curtus*

3 Conspicuous head markings, including white streak on upper lips bordered above by black streak; subcaudals 53 or fewer; ventrals 129 or more 4
No conspicuous markings on head (only a pale oblique bar on side of neck); subcaudals 53 or more; ventrals 129 or fewer .... *minor*

4 Usually a black bar across nape; tip of snout rounded in profile; dorsal scales smooth .... *coronatus*
A pale brown bar across nape; tip of snout obliquely truncate (i.e. hog-nosed); dorsal scales striate .... *mastersii*

Notechis scutatus occidentalis Glauert, 1948

Figure 1

Notechis scutatus occidentalis Glauert, 1948, West. Aust. Nat. 1: 139. Bassendean, W.A.

Diagnosis

A large stout *Notechis* with 17 or 19 midbody scale rows, predominantly blackish above and yellow below (at least anteriorly). Further distinguishable from *N. curtus* by its smooth (rather than striate) scales, more numerous ventrals and subcaudals, fewer and wider temporals, and entirely dark eye.

Description

Snout-vent length (mm): 173-1020 (N 116, mean 599.7). Length of tail (% SVL): 15.5-21.7 (N 109, mean 18.4).

Rostral slightly narrower or slightly wider than high. Internasal from a little less than half to about two-thirds as long as prefrontal. Frontal 1.2-1.7 times as long as wide (N 20, mean 1.44), 1.3-2.1 times as wide as supraocular (N 20, mean 1.59); sides usually straight, but converging anteriorly. Nasal long and low; entire

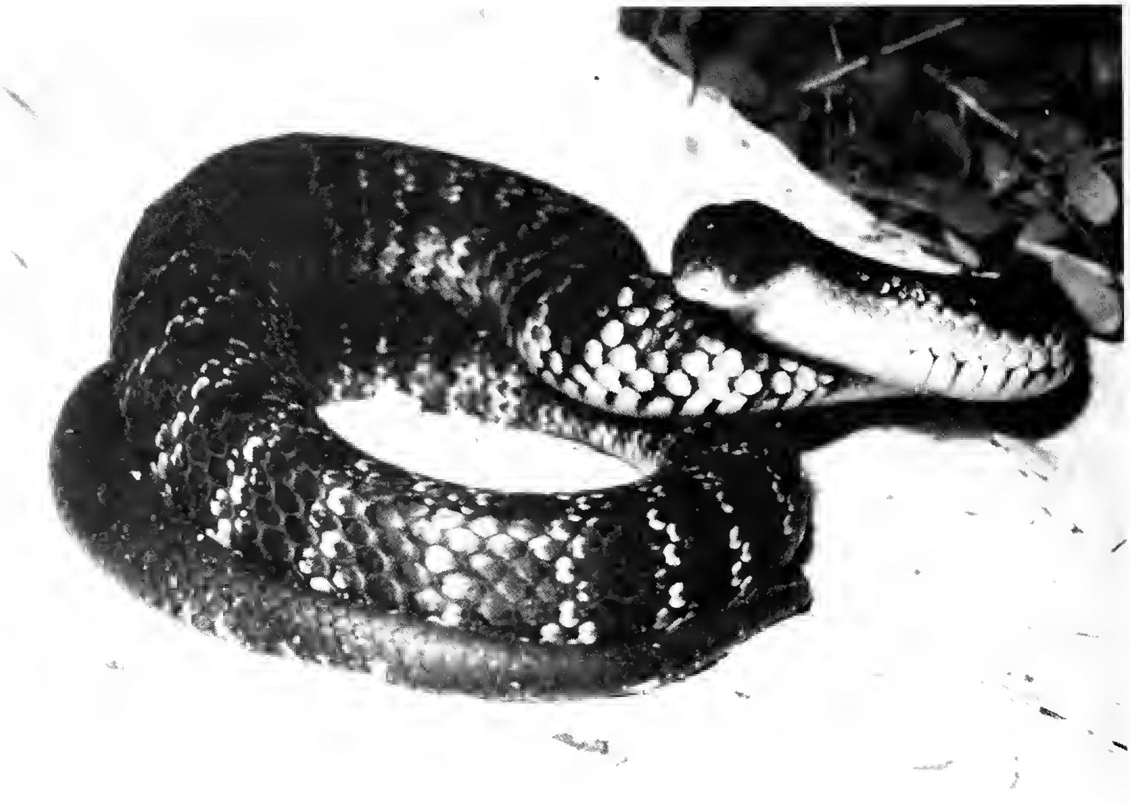

Figure 1   A *Notechis scutatus* from Lake Bambun, W.A., photographed by R.E. Johnstone.

or divided by a shallow groove. Preocular much higher than wide. Diameter of eye a little greater than distance from mouth in juveniles, much smaller than distance from mouth in large adults; pupil circular; iris dark brown. Temporals 2 + 2 (N 22), upper primary much wider than high, lower primary much the largest temporal and occasionally (N 5) reaching lip. Upper labials 5 (N 1), 6 (19), 7 (1). Lower labials 7 (N 19), 8 (2). Scale rows at midbody 17 (N 47) or 19 (28); usually increasing by 2 on neck or not changing, rarely reducing; usually reducing by 2 before vent. Ventrals 140-165 (N 33, mean 152.9). Anal entire (N 31) or divided (2). Subcaudals 36-51 (N 33, mean 45.3), single except occasionally for first. Ventrals plus subcaudals 176-213 (N 32, mean 198.9).

Upper surfaces mostly black, blackish-brown or dark brown; head occasionally dark olive-grey; back often narrowly and indistinctly banded with dark brown, yellowish-brown or brownish-orange (bands usually discontinuous and often confined to anterior half of body; never more than a scale wide and often less). Upper lips pale brownish-grey. Lower 3 rows of dorsals on side of neck yellow, sharply demarcated from upper laterals. Lower 2 or 3 rows of dorsals on side of body partly yellow or orange and partly blackish-brown (dark pigment on distal part of scale). Lower surface anteriorly yellow (occasionally orange-yellow), gradually replaced posteriorly by grey or blackish-grey; ventrals anteriorly edged with black or dark grey. In south, lateral edges of anterior ventrals thickly margined with black, resulting in a zigzagging lateroventral stripe.

Distribution

Subhumid and humid zones of southern Western Australia (mainly about streams and swamps on coastal plains), north to Gingin and east to Israelite Bay. Other subspecies in south-eastern Australia and Tasmania.

Geographic Variation

Southern snakes have more scale rows than northern snakes, e.g. mostly 19 at midbody and 15 before vent, v. mostly 17 and 13. They are also generally darker, including the extent of dark grey on the venter and the development of the black laterodorsal stripe.

Remarks

Mitchell (1951) rightly doubted the criteria on which Glauert based this subspecies. However, Mitchell's own data revealed that ventral counts (154-185, N 36, mean 169.4) were considerably higher in Tasmania and south-eastern Australia than in south-western Australia.

Material

South-West Division (W.A.)

Gingin (8458, 26200-1) and 7 km N (39981); Lake Chandala (59705); Lake Pinjar (20557); Twin Swamps Reserve (59525); Wanneroo (28404, 31208, 31465); Gnangara Lake (1854, 28161, 58936); North Beach (761); Mussel Pool (51563); Beechboro (10599, 21954); Mt

Yokine (34714); Mundaring (19499); Bassendean (659, 5204); Bayswater (5056, 5373, 9761); Maylands (2364, 5090); Mt Lawley (635); Herdsman Lake (654, 3876, 6961, 49286); Wembley (3825); East Perth (4808); Perth (495, 880, 73776); 10 km E Kalamunda (21891); Mosman Park (16908); Cannington (5769); Riverton (14470, 25361, 25860, 34571); Gosnells (5215); Bibra Lake (13922); Jandakot (9255); Carnac I. (4975, 12818, 12827, 14377); Kelmscott (763, 5166, 10456, 13541); Garden I. (12302, 17107); Byford (47849); Mundijong (13811); White Lake (64729); Serpentine (12026, 12791); North Dandalup (5550); Mandurah (3319, 14376, 19122, 20558); Dwellingup (39974); Coolup (22515); Waroona (9096, 25906); Collie (5110, 5113); Noggerup (4973); Capel (5813); Busselton (2377, 5861, 25970); Katanning (21892); Jerramungup (14142); Tambellup (37496); Borden (10217); Pabelup Lake (34347); lower Fitzgerald River (36784); West Mt Barren (59048); Cranbrook (787); Chillinup (26552); Bremer Bay (31954); between the upper reaches of the Tone and Perup Rivers (42547); Manjimup (12422) and 10 km WNW (39731); Carey Brook (28095); Augusta (12831); Pemberton (22981-2); Cape Riche (8744); near Mt Barker (4999); Porongorup Range (46174); Meerup (47874); Chorkerup (6938); Upper Kalgan (23330); Cheyne Beach (36039); Waychinicup River (15099); Walpole (51442); Denmark (5776, 8244, 13764, 73775); Albany (73773); Bornholm (6480).

Eucla Division (W.A.)

16 km W Israelite Bay (31090); Esperance (11362, 12338, 14188, 73774) and 25 km W (37724); Cape LeGrand (42524-6).

Notechis curtus (Schlegel, 1837)

Figure 2

Naja curta Schlegel, 1837, Essai sur la physionomie des serpens 2: 486. King George Sound, Western Australia.

Hoplocephalus temporalis Gunther, 1862, Ann. Mag. nat. Hist. (3) 9: 130. South Australia.

Diagnosis

A moderately small to medium-sized *Notechis* with 17-21 (mostly 19) midbody scale rows. Distinguishable from *N. scutatus* by its partly yellow eye, much paler coloration, striate (rather than smooth) dorsals, fewer ventrals and subcaudals, and more numerous temporals.

Description

Snout-vent length (mm): 110-605 (N 170, mean 276.9). Length of tail (% SVL): 12.6-23.6 (N 161, mean 17.9).

Rostral a little narrower or a little wider than high. Internasal a half to a little more than three-quarters as long as prefrontal. Prefrontals normally 2, occasionally divided longitudinally into 3, 4 or 5 scales. Frontal 1.6-2.6 times as long as wide (N 86, mean 1.89) except when occasionally divided transversely, and 0.9-1.6 times as wide as supraocular (N 85, mean 1.20); sides straight, concave or convex. Nasal long and low; entire, semi-divided by shallow groove upwards from nostral or completely but shallowly divided. Preocular higher than wide. Diameter of eye much greater than distance from mouth in juveniles, slightly less than distance from mouth in large adults; pupil vertically elliptic; iris dark brown

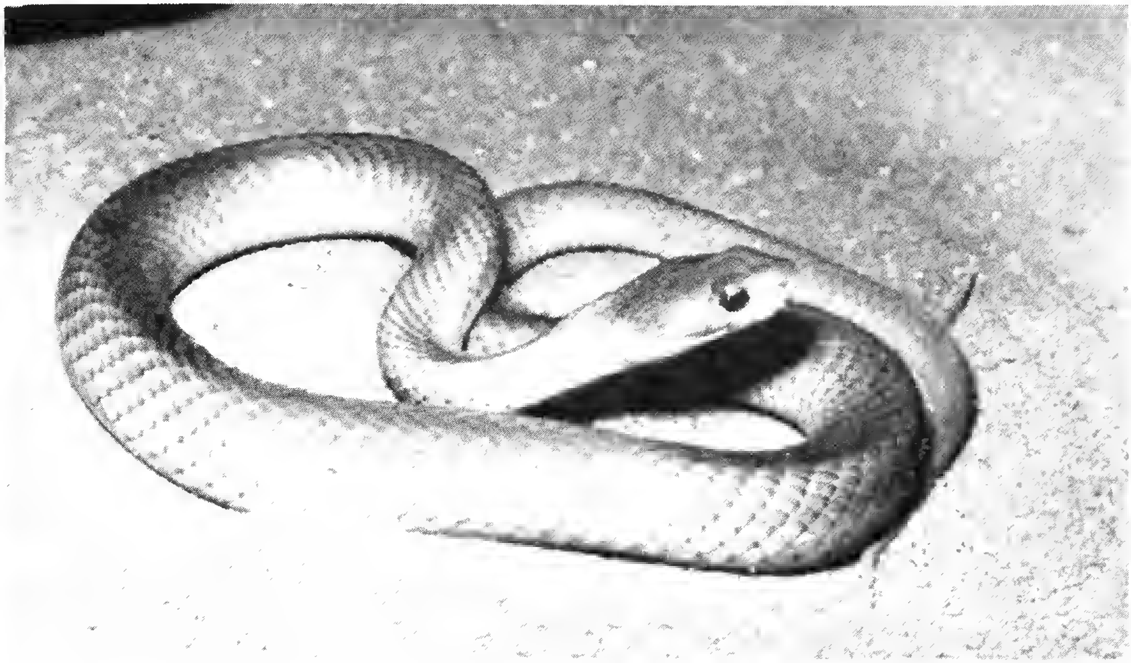

Figure 2 A *Notechis curtus* from Green Head, W.A., photographed by R.E. Johnstone.

except for yellow upper third or quarter and occasionally narrow yellow ring around pupil and yellow flecks in lower two-thirds of eye. Temporals 2 + 2 (N 28), 2 + 3 (30), 3 + 2 (12), 3 + 3(78), 3 + 4 (1), 4 + 2 (2), 4 + 3 (9), 4 + 4 (1) or 5 + 4 (1), lowest primary largest but not reaching lip. Upper labials 6 (N 90) or 7 (6). Lower labials 6 (N 2) or 7 (100). Scale rows at midbody 17 (N 8), 18 (1), 19 (152), 20 (2) or 21 (1); on neck 19 (N 7), 20 (9), 21 (30), 22 (28), 23 (22), 24 (3) or 25 (2); and before vent 13 (N 28), 14 (11) or 15 (69). Ventrals 121-144 (N 87, mean 129.9). Anal entire (N 89). Subcaudals 27-43 (N 88, mean 34.7), undivided except occasionally for first and rarely for a few pairs towards tip. Ventrals plus subcaudals 152-178 (N 86, mean 164.3).

Upper surface olive-brown, locally becoming darker and greyer on head, except for short, oblique, pale brown streak dorsolaterally on rear of head (somewhat reminiscent of that in *N. minor* but not so well-defined). Rostral, lips, chin and side of throat often dark grey, flecked or dappled with creamy-white. Rest of lower surfaces pale yellow, creamy-white or greyish-white, the ventrals with or without a narrow to moderately wide dark grey base. In an uncommon colour variant upper surface brick-red, lower surface pink.

Distribution

Mid-west coast of Western Australia from the Greenough River south to the Swan River and inland to Yuna, Carnamah, Moora and Caversham; far south of Western Australia north to Mandurah, Highbury and the Narembeen district and east to the Great Australian Bight; semi-arid zone of South Australia (Eyre Peninsula, Murray Mallee and Upper South-East); south-western New South Wales (Balranald); and semi-arid interior of far western Victoria from the Raak Plain south to the Little Desert.

Geographic Variation

The range of *N. curtus* is broken up into four more or less isolated areas (Figure 3). The populations in each area have developed some peculiarities of their own:

A *Mid-west coast of Western Australia*
Here the tail is longer than elsewhere (15.7-23.6% of SVL, N 50, mean 19.5; v. 12.6-23.3%, N 111, mean 17.2) and the subcaudals are consequently more numerous (32-43, N 21, mean 37.4, v. 27-41, N 67, mean 33.9). Temporals are fewer here than elsewhere, e.g. only 24% of specimens have more than five, v. 69% in area B, 71% in C and 78% in D. In this population alone the head is substantially different in colour to the back, i.e. dark grey rather than olive-brown, and the pale oblique bar on each side of back of head is usually well developed.

B *Southern Western Australia (south of lat. 32° S)*
Snakes from here are larger than elsewhere (SVL 128-605 mm, N 77, mean 305.3; v. 110-460 mm, N 93, mean 253.7). They are also darker, especially those from the south coast, which is by far the wettest part of the species' range.

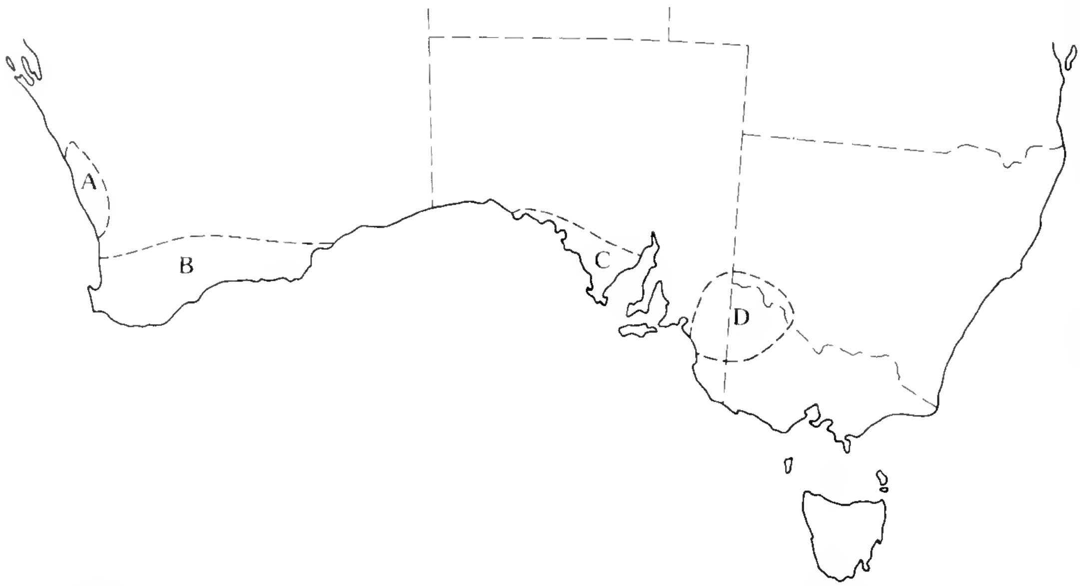

Figure 3 Map of southern Australia, showing range of *Notechis curtus* and areas A, B, C and D.

C *Eyre Peninsula (western South Australia)*
These snakes are in most respects close to the average for the species. They are pale as in area A, but the head is usually the same colour as the back, and the pale streak at rear of head is poorly developed. Their only peculiarity is the somewhat long and narrow frontal (1.8-2.6 times as long as wide, N 15, mean 2.08; v. 1.6-2.4, N 71, mean 1.85 elsewhere).

D *Interior of south-eastern Australia*
Ventral counts are higher here than elsewhere (127-144, N 21, mean 135.9; v. 121-137, N 66, mean 128.0). Longitudinal division of the prefrontals is much more frequent in this population than the others. Complete division of the nasal is also more frequent here than further west (60%, v. 40% on Eyre Peninsula and 14% in Western Australia). Coloration is much the same as on Eyre Peninsula.

Material

South-West Division (W.A.)

20 km SSE Yuna (24859); c. 32 km N Eneabba (53685) and 5 km S (59010); 4 km N Leeman (72972); Carnamah (69490); Green Head (15112, 52145); 4 km NW Mt Peron (49138); 5 km W Padbury (49101-2, 49112-3) and 6 km S (48515); Jurien Bay (12873, 59723, 59725) and 15 km E (46572-3, 47985); Badgingarra (21900, 40011, 60009); Thirsty Point (15091); 24 km E Cervantes (49295); sandplain west of Coomberdale (16907); Moora district (26078); 7 km E Bindoon Hill (28093); Guilderton (31564); Two Rocks (29395); Muchea (452); Bullsbrook (32365, 46251); Wanneroo (13141); Sorrento (32022); Trigg (13046); between Trigg and Scarborough (22892); Scarborough (19231); Morley (8148); Caversham (3853); Guildford (2442); City Beach (13690, 22307, 25971, 26851-2, 28401, 42546); Wembley (28402); Bayswater (1281-2, 6361); Maylands (6475); Mt Lawley (4480), Perth (60485); Gibb Rock, 66 km E Narembeen (47795); Mandurah (15092-6, 25826); Holt Rock (34336); Highbury (37741); North Tarin Rock Reserve (40050, 44446-7); Lake Grace (938); Dumbleyung (20567); Bunbury (48800); Chinocup (47342); Lake Magenta Reserve (39871, 39938); Cape Naturaliste (54468); Dunsborough (34704); Busselton (3760, 9583, 9596, 9603, 34113, 46169, 60437); Hopetoun (7065, 7296, 9181, 12171, 55937, 62731); Jerramungup (46599); Margaret River and vicinity (29691, 34002, 45713, 48173, 71746); Witchcliffe (7968); Tambellup (21281-2); Augusta (45551); Cranbrook (5873, 10975); Bluff Knoll (51765); Doubtful Island Bay (19795-7); Bremer Bay (56838); Cape Riche (9692) and 12 km N (18563); Cheyne Beach (57800); Two Peoples Bay (6822); King River (5614); Walpole (59720); Denmark (2156, 29282, 37469-70); Youngs (5908); Bornholm (5811, 5879, 7925); Little Grove (22963); Albany (9156, 10002, 13802, 14018); Nanarup (22599).

Eucla Division (W.A.)

Toolinna Rock-hole (32°46′S, 124°57′E) (45351); Esperance (8365, 11364, 11430, 13675); Cape LeGrand National Park (41958, 67731-2).

South Australia

Fowlers Bay (NMV R12858); Ceduna (SAM R4290); Streaky Bay (SAM R18134); 25 km NW Poochera (SAM R3850); near Kimba (SAM R4997); 50 km SW Whyalla (SAM R17927); Carappee Hill (SAM R14318*a-b*); 40 km N Cowell (SAM R9306); Hincks Conservation Park (SAM R10190); Port Neill (SAM R12750, 13071); Port Lincoln (AM 6634-5, 6637); 'West Coast' (SAM R5020*a-c*); Danggali Conservation Park (SAM R16062); Waikerie (SAM R53); 13 km S Alawoona (SAM R13050); Kynoch Station, Keith (SAM R9501); Salt Creek, Coorong (SAM R2285).

Victoria

'Mallee' (NMV D4754); 21 km SW Rocket Lake (SAM R9009; NMV D54271); near Chinaman Well (NMV D53492, 53505, 53975, 54421, 54516, 54746, 54798-9, 55069); Kaniva (NMV D33512); Kiata (NMV D10044); Little Desert, 16 km S Kiata (NMV D9836-7, 15343); 2 km S Dimboola (NMV D53538); 'Victoria' (NMV D4560).

Notechis minor (Gunther, 1863)

Figure 4

Hoplocephalus minor Gunther, 1863, Ann. Mag. nat. Hist. (3) 12: 362. S.W. Australia.

Diagnosis

A small, long-tailed, short-snouted, large-eyed *Notechis* with 15 midbody scale rows and upper surface uniformly dark except for pale oblique bar on side of neck. Further distinguishable from *N. coronatus* by its striated dorsal scales and from *N. mastersii* by its more numerous subcaudals (more than 50).

Description

Snout-vent length (mm): 121-391 (N 15, mean 240.8). Tail (% SVL): 26.9-36.4 (N 13, mean 31.1).

Rostral slightly wider or slightly narrower than high. Internasals from a little more than half to a little more than three-quarters as long as prefrontals. Frontal

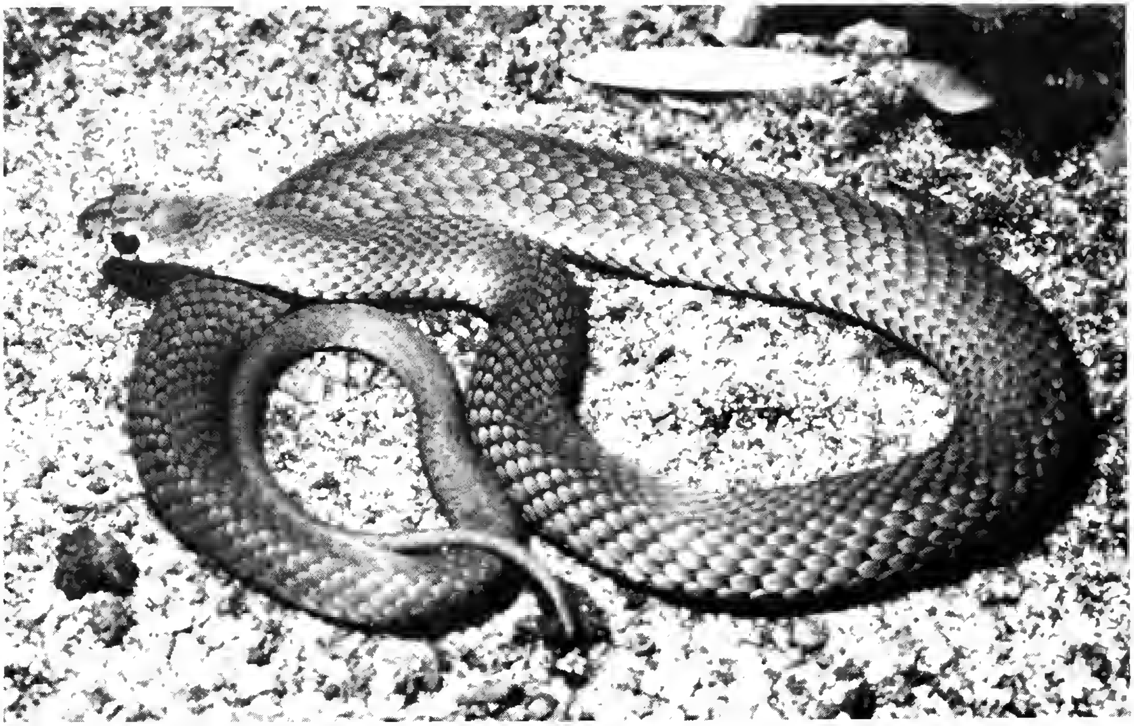

Figure 4 A *Notechis minor* from Albany, W.A., photographed by G. Harold.

1.3-1.8 times as long as wide (N 14, mean 1.60), and 1.2-2.1 times as wide as supraocular (N 14, mean 1.58). Preocular much higher than wide. Eye much longer than distance from mouth; iris blackish except for narrow orange ring around pupil, widest at top. Temporals: primaries 2 (N 12) or 3 (2); secondaries 2 (N 14). Upper labials 6 (N 14). Lower labials 7 (N 14).

Midbody scale rows 15 (N 15), increasing on neck to 17-21, and reducing before vent to 13 (N 14) or 14 (1). Ventrals 116-129 (N 13, mean 123.6). Anal entire (N 14). Subcaudals 53-61 (N 13, mean 56.2), single except occasionally for divided first. Ventrals plus subcaudals 175-183 (N 12, mean 179.2).

Upper surface dark steel-grey usually becoming dull reddish-brown towards tip of tail. Face pale grey. Lower half of rostral and of upper labials usually white, occasionally only a little paler than face. Oblique bar on side of neck orange. Lower surfaces mostly orange-red, anterior and central ventrals with a yellow centre, ventrals and subcaudals usually edged black.

Distribution

Humid coastal plains of deep south-west of Western Australia, north to Busselton and east to Two Peoples Bay.

Material

South-West Division (W.A.)

5 km W Busselton (34112); Karridale (44539); lower Warren River (34°33'S, 115°55'E) (59023); Northcliff (13999); 30 km S Rocky Gully (34°56'S, 116°32'E) (73582); south-east corner of Broke Inlet (34°56'S, 116°32'E) (68158); 5 km W Walpole (49909); Denmark (8431); Bornholm (6485-6); south-west corner of Princess Royal Harbour (15098); Albany (11886, 13423); mainland opposite Gull Rock, King George Sound (61502); Two Peoples Bay (30952).

Notechis coronatus (Schlegel, 1837)

Figure 5

Elaps coronatus Schlegel, 1837, Essai sur la physionomie des serpens 2: 454. Australia. [Lectotype locality: King George Sound, W.A., *fide* Coventry and Rawlinson 1980: 67.]

Trimesurus olivaceus Gray, 1841, *in* G. Grey's Journals of two expeditions of discovery in north-west and western Australia . . . 2: 443. Australia.

Diagnosis

A medium-sized *Notechis* with 15 midbody scale rows, a black crown (consisting of a black loreo-temporal streak and black nuchal bar), a white streak through labials and non-striate scales. Further distinguishable from *N. mastersii* by snout rounded (not obliquely truncate) in profile, and from *N. minor* by more numerous ventrals (130 or more) and fewer subcaudals (53 or fewer).

Description

Snout-vent length (mm): 135-543 (N 152, mean 298.6). Length of tail (% SVL): 19.0-26.4 (N 144, mean 22.3).

Rostral slightly wider than high. Internasals half to three-quarters as long as prefrontals. Frontal 1.6-2.4 times as long as wide (N 101, mean 1.95), and 0.9-1.7 times as wide as supraocular (N 101, mean 1.27). Preocular about as high as wide. Eye longer than (juveniles) or as long as (adults) distance from mouth; upper third of iris golden-yellow, remainder dark. Temporals: primaries 1 (N 1), 2 (81), 3 (4) or 4 (1); secondaries 2 (N 80) or 3 (7). Upper labials 6 (N 90) or 7 (4). Lower labials 7 (N 94).

Midbody scale rows 15 (N 150), increasing on neck to 16-20, and reducing before vent to 14 (N 1), 13 (95) or 12 (3). Ventrals 130-153 (N 68, mean 139.0). Anal entire (N 68). Subcaudals 39-53 (N 66, mean 45.8), single except occasionally for divided first and very rarely a few pairs towards tip. Ventrals plus subcaudals 172-201 (N 66, mean 184.8).

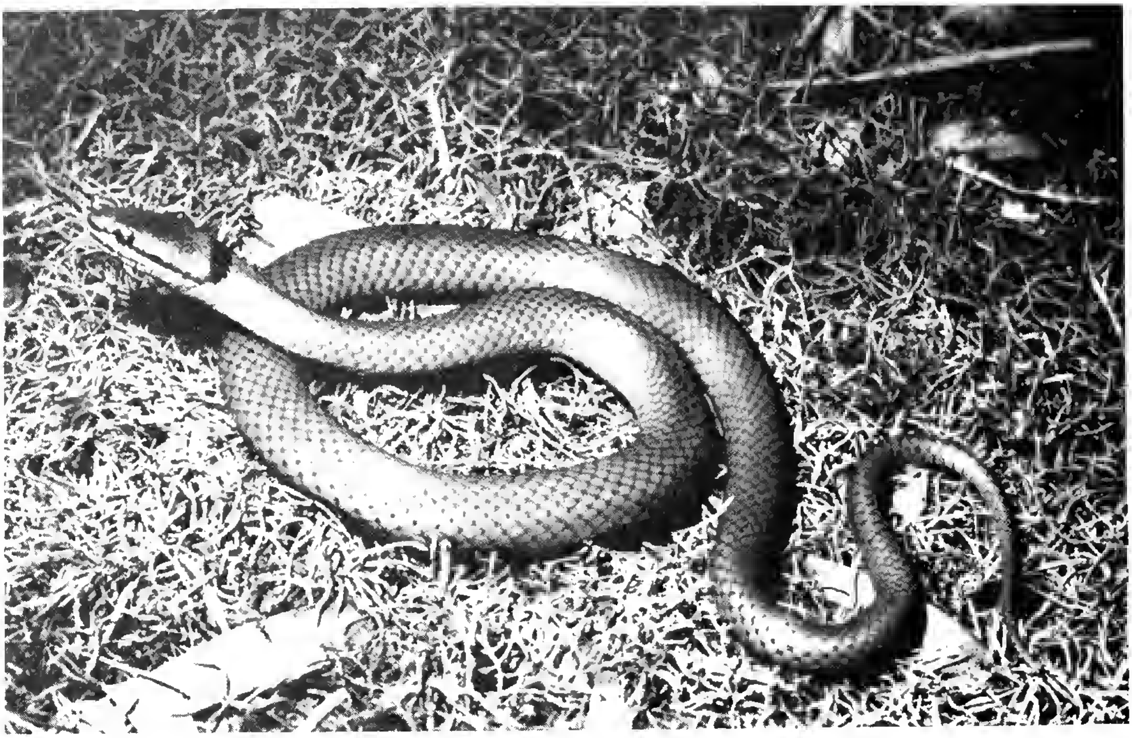

Figure 5 A *Notechis coronatus* from Israelite Bay, W.A., photographed by G. Harold.

Top of head grey, olive-grey, olive brown, blackish-grey or black, edged with black, i.e. by (1) a loreo-temporal streak, narrowest on tip of snout and widest immediately in front of and behind eye, usually continuous with (2) a transverse nuchal bar, widest at midline. Rest of upper surface olive-grey, olive-brown or blackish-grey. Black loreo-temporal streak edged below by a white streak, narrowest at tip of snout and sometimes continuous with a narrow pale brown bar immediately behind black nuchal bar. Lower half of rostral and of anterior upper labials pale yellow, suffused with grey and stippled with black. Lower surfaces yellow, orange or orange-red, partly suffused with grey and peppered with greyish-black; dark pigment on ventrals concentrated along anterior strip of scale, the strip widening on posterior ventrals and in darkest specimens spreading over most of scale.

Distribution

Southern Western Australia (mainly on coastal plains) north to Muchea, east nearly to Point Culver (Great Australian Bight) and inland to Wagin and Pingrup (southern Wheat Belt); also Archipelago of the Recherche.

Geographic Variation

The most distinctive population is that of the Archipelago of the Recherche. Snakes from these islands are notable for their dark coloration, poor development of black nuchal bar (often absent, fragmentary or indistinct), high ventral and subcaudal counts, relatively shorter and wider frontal, and greater size (SVL in four of 18 specimens exceeds 423 mm, compared to only one of 134 mainland specimens).

At first sight the Recherche population might seem to merit subspecific recognition. However, most of its peculiarities can be matched in odd specimens from other regions, and in some respects snakes from the adjacent mainland are intermediate. For example, ventrals plus subcaudals in the Recherche range from 188 to 201 (N 17, mean 193.7), on the mainland of the Eucla Division from 178 to 193 (N 14, mean 184.4) and in the South-West Division from 172 to 186 (N 35, mean 180.7).

Material

South-West Division (W.A.)

Muchea (459); Wanneroo (6346); Bassendean (4734); North Perth (4835); South Belmont (4976, 14485); South Como (6551); Rossmoyne (60877); Riverton (39781); Jandakot (1206, 47649); Banjup (61504); Armadale (13817); Rockingham (6910, 36175); Safety Bay (15072); Serpentine (53737); Mandurah (4349); Waroona (7813); Wagerup (6904, 8986, 9364); Yarloop (6925); Wagin (8370); Bunbury (31196); Pingrup (22489); Busselton (6057, 6196, 9597); Jerramungup (18547); Hopetoun (11100, 59569, 62875); Nannup (56752-3, 56770-1); Witchcliffe (7766, 21965, 36716); Tambellup (2104); lower Fitzgerald River (67807); Mid Mt Barren (36899); 5 km N Fitzgerald Inlet (55936); Boondardup River in 34°13′S, 119°31′E (37217); Scott River (41717); Augusta (5190, 24906); Cape Leeuwin (58797) and 5 km N (25879); Cranbrook (6566, 11333, 53734-6); Doubtful Island Bay (19798-9); Bluff Knoll (51775-6); Bremer Bay (45651); Wellstead (69492); Cape Riche (8384); Upper Kalgan (21368-70); Meerup (47885); Chorkerup (4489, 6069); Many Peaks (14167); Cheyne Beach (15073-4, 31169); King River (4233, 5615, 53733); south-east corner of Broke Inlet (68156-7); Walpole and vicinity (33426, 51472-3, 62237); Nornalup and vicinity (22420, 41773); Kent

River (46544-5); Denmark and vicinity (4993-4, 10098, 17119, 24960-2, 30680); Bornholm (6483-4); West Cape Howe (9160); Albany (7763-4, 8922, 10960, 22488); Two Peoples Bay (37837-8, 44995, 61389, 69498).

Eucla Division (W.A.)

20 km W Point Culver (44973); Israelite Bay (9397, 14205, 67473); Dalyup River (15075); Esperance (8938, 11365, 12338, 13674, 17863, 43864, 58868) and 23 km E (15076, 43884) and 33 km E (21995); Cape LeGrand National Park (29643, 41955-7, 41959, 67730, 67733, 67736, 67746, 67749-51, 67755-60); North Twin Peak I. (53092-4, 54342); Goose I. (9182); Middle I. (41915, 47725); Wilson I. (53142); Mondrain I. (10106-7, 53116, 53119, 54461, 68220, 68226, 68228-9, 68372); Daw I. (76362).

Notechis mastersii (Krefft, 1866)

Figure 6

Hoplocephalus mastersii Krefft, 1866, Proc. zool. Soc. Lond. 1866: 370. 'Flinders Range', S.A.

Diagnosis

A very small *Notechis* with 15 midbody scale rows; top of head wholly or posteriorly black, bordered behind by pale brown nuchal bar and below by black loreo-temporal streak; upper lips white; lower surfaces mostly reddish. Further distinguishable from *N. coronatus* by hog-nosed snout and striate scales; and from *N. minor* by more numerous ventrals (129 or more) and fewer subcaudals (fewer than 45).

Description

Snout-vent length (mm): 121-271 (N 19, mean 230.1). Length of tail (% SVL): 16.8-23.6 (N 19, mean 20.0).

Rostral as wide as high or slightly wider. Internasals a little less or a little more than half as long as prefrontals. Frontal 2.4-3.2 times as long as wide (N 20, mean 2.72), and 0.65-1.0 times as wide as supraocular (N 20, mean 0.83). Preocular usually a little wider than high. Eye a little larger than distance from mouth; upper third of iris and narrow ring around pupil orange-yellow, rest of iris dark. Temporals 2 + 2 (N 19). Upper labials 6 (N 19). Lower labials 7 (N 19).

Midbody scale rows 15 (N 20), increasing on neck to 16-19, and reducing before vent to 13 (N 20). Ventrals 129-145 (N 18, mean 136.7). Anal entire (N 18). Subcaudals 32-44 (N 18, mean 38.3), single except rarely for divided first and for a few pairs towards tip. Ventrals plus subcaudals 169-182 (N 18, mean 175.0).

Top of head dark grey or olive-grey, freckled with black, most densely posteriorly and often becoming wholly black on frontal, supraoculars, parietals and first 2-3 vertebrals; behind last-named an orange-brown or brownish-yellow transverse bar about two scales wide, not sharply defined and often broken in middle. Irregular black streak from nasal back through top of upper labials to side of neck, bordered below by a white streak. Remaining dorsal surfaces blackish-brown in juveniles, and olive-grey finely freckled with blackish-brown in adults. Rostral, bottom of anterior upper labials, lower labials and gulars pale grey heavily stippled or finely freckled with black. Under neck greenish-yellow. Anterior edge of ventrals and subcaudals suffused or blotched with dark grey; lateral quarter of scales coloured like dorsals; remainder of each scale (central posterior) red in juveniles and orange in adults.

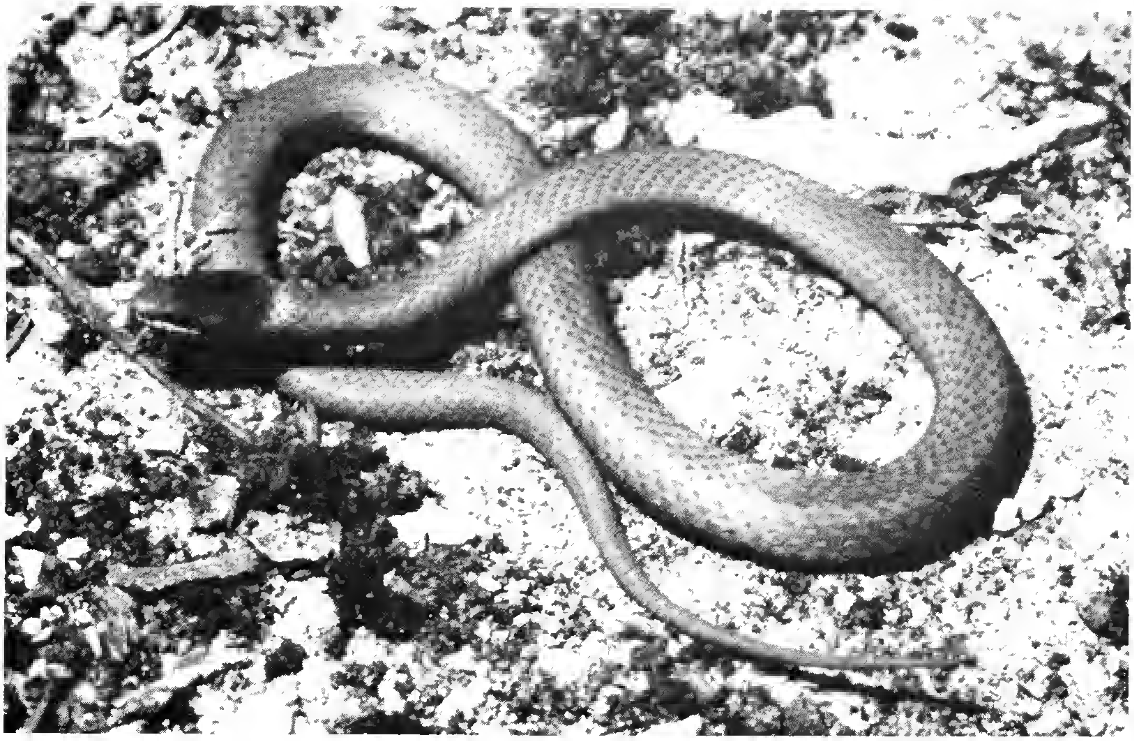

Figure 6 A *Notechis mastersii* from Eucla, W.A., photographed by G. Harold.

Distribution

Coastal areas of south-eastern Western Australia, west nearly to Esperance and inland to Mt Newmont. Also southern South Australia (Eyre and Yorke Peninsulas and south-eastern interior) and Victoria (western interior).

Geographic Variation

The specimens from Esperance (much the wettest part of the species' range in Western Australia) are considerably darker than adults from elsewhere.

Material

Eucla Division (W.A.)

4 km E Eucla (70019-20) and 4 km S (18482, 24644); 40 km SSE Mundrabilla HS (36717); 45 km W Madura (28900) and 43 km S (34417); 8-15 km SSE Cocklebiddy (24668, 27370,

53425-6, 60811, 66775); Eyre (56867, 67260, 67311); 18 km ESE Mt Newmont (32°56′S, 123°12′E) (59916); 32 km ENE Esperance (40009-10).

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Description of a New *Dinematichthys* (Ophidiiformes: Bythitidae) from Rottnest Island, Western Australia

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Abstract

A new species of ophidioid fish, *Dinematichthys dasyrhynchus*, is described from Rottnest Island, located off the coast of south-western Australia. It differs from the only other known member of the genus *D. iluocoeteoides* by its more numerous dorsal fin rays (96-103 v. 83) and pectoral fin rays (25-28 v. 22-23), greater number of lateral line scales (140 v. 100), smaller eye (6.9 v. 5 in head), and in having an unsheathed maxillary.

Introduction

Among the host of unnamed species of viviparous, free-tailed ophidiiform fishes found in warm water reef areas around the world is a highly distinctive form that appears to inhabit only the reefs of Rottnest Island, Western Australia (32° 00′S, 115° 30′E). We name this species because it is appropriate to commence describing reef bythitids so that eventually they can be correctly classified.

Nine nominal genera of bythitid fishes with ossified pseudoclaspers have been grouped together in the tribe Dinematichthyini by Cohen and Nielsen (1978), who have noted that the limits of several of the included genera are poorly drawn, not least of all because they represent numerous undescribed species. One of the genera, *Dinematichthys*, represents a particularly difficult problem because apparently there are no known specimens of the type species, *D. iluocoeteoides*. Although the name has been used widely in the literature, it seems likely that other species and in some instances other genera were represented. A detailed explanation of the allocation of the name *Dinematichthys* has been presented by Cohen and Nielsen (1978).

We have compared our material of the Rottnest Island species with Bleeker's (1855) description of *D. iluocoeteoides*, and we tentatively assign our specimens to *Dinematichthys* because they share with *D. iluocoeteoides* an anterior nostril

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placed high on the snout and because of an extensive scale covering on the head. Differences between the two are numerous and when more species are described and specimens of the true *D. iluocoeteoides* are re-collected and become available for study, it may be necessary to establish the Rottnest Island species in a separate genus.

Methods and Abbreviations

Methods are as described in Cohen and Neilsen (1978). The following abbreviations are used in the text: SL, standard length; AM, Australian Museum, Sydney; USNM, National Museum of Natural History, Washington, D.C.; WAM, Western Australian Museum, Perth.

Systematics

Dinematichthys dasyrhynchus sp. nov.

Figures 1-3; Tables 1-3

Dinematichthys iluocoeteoides Mees 1960: 18.
Dinematichthys sp. Hutchins 1979: 93.

Holotype

WAM P.26614-010, 88 mm SL, male, collected with rotenone from limestone reef at 3 m in Rocky Bay, Rottnest Island, Western Australia, J.B. Hutchins and N. Sinclair, 6 June 1980.

Paratypes

Twenty-three specimens from Rottnest Island, 49-121 mm SL (unless otherwise designated, all specimens at WAM): P.25725-017, 2 specimens, 102 mm SL, Green Island, by rotenone at 10 m, J.B. Hutchins and C.W. Bryce, 27 January 1977; P.25781-013, 99 mm SL, Mary Cove, by rotenone at 11 m, J.B. Hutchins, 5 May 1977; P.26616-009, 5 specimens, 57-116 mm SL, Point Clune, by rotenone at 8 m, J.B. Hutchins and N. Sinclair, 7 June 1980; P.26619-015, 2 specimens, 111-121 mm SL, Parker Point, by rotenone at 4 m, J.B. Hutchins and N. Sinclair, 13 June 1980; P.26620-010, 2 specimens, 84-119 mm SL, Geordie Bay, by rotenone at 5 m, J.B. Hutchins and N. Sinclair, 14 June 1980; P.27146-001, 2 specimens, 57-119 mm SL, collection data as for holotype; AM I.20245-016, 3 specimens, 65-95 mm SL, Horseshoe Reef, by rotenone at 12-15 m, B.C. Russell and J.B. Hutchins, 12 April 1978; USNM 222629, 2 specimens, 49-102 mm SL, Fish Hook Bay, by rotenone at 8 m, J.B. Hutchins, 8 March 1977; USNM 224475, 3 specimens, 71-79 mm SL, collection data as for P.26616-009; P.4683, 94 mm SL, Salmon Bay, University of Western Australia, 23 November, 1956.

Diagnosis

This species is placed in the genus *Dinematichthys* on the basis of the anterior nostril located high on the snout, the extensive scale covering on the head, and the expanded posterior end of the maxillary. It differs from the only other known member of the genus *D. iluocoeteoides* by its more numerous dorsal fin rays (96-103 v. 83) and pectoral fin rays (25-28 v. 22-23), greater number of lateral line scales (140 v. 100), smaller eye (6.9 v. 5 in head), and in having an unsheathed maxillary (see Table 1).

Table 1 Differences between the two species of *Dinematichthys*. (Data for *D. iluocoeteoides* from original description.)

Character	*D. iluocoeteoides*	*D. dasyrhynchus*
Head length/eye diameter	A little over 5	6.9-9.4
Lateral scale rows	About 100	About 140
Dorsal fin rays	83	96-103
Pectoral fin rays	22-23	25-28
Posterior end of maxillary	Sheathed	Unsheathed

Description

Measurements and counts of holotype and selected paratypes are presented in Table 2.

Body compressed and relatively elongate, deepest at or near origin of dorsal fin, depth at vent 4.8-6.1 in SL. Dorsal profile of head descends from nape at an angle of about 25°-30° to the rounded and slightly protruding snout, which bears rows of bilobed filaments (Figure 2A) as does anterior end of lower jaw. Opercle carries a sharp-pointed spine (sometimes hidden). Lower jaw slightly included, upper expanded and unsheathed posteriorly. Eye covered by a clear, round spectacle, which goes 1.6-1.9 in interorbital. Posterior nostril, located about its own diameter anterior to eye, has a raised rim of skin. Anterior nostril, located well above upper lip and a diameter ahead of posterior nostril, has a raised rim with a longer flap at rear margin.

Lateral canal has 2 pores; supratemporal 1 or 2; supraorbital 4, 1 in fold of skin above upper lip, 1 medial to anterior nostril, 1 above space between rear nostril and anterior margin of eye, and 1 postero-dorsal to eye; infraorbital 6, 7 or 8, including 1 below anterior nostril and 1 or 2 that are postorbital in position; preoperculo-mandibular with 9 or 10, including 3 or 4 in a double series (sometimes incomplete) along mandible (Figure 2B). Lateral line marked by a narrow, pale line that originates near angle of opercle and extends posteriorly along body about one head length, at which point it is interrupted and resumes in the midline.

Premaxillary, dentary, and palatine each with a broad band of granular teeth and a single row of larger more widely-spaced, needle-like teeth. Head of vomer carries a triangular patch of granular teeth and an inner row of needle-like teeth. No developed gill rakers; however, first arch bears a row of flat plates covered with tiny granular teeth. Tongue a slender, elongate, prowlike structure.

All but ventral fin rays are branched. Anterior rays of dorsal are distally free for about one-half their length. Caudal fin rather rounded. Pectoral fin less than one-half head length, and also rounded. Ventral fins, each with a single ray

Table 2 Measurements (mm) and fin ray counts of selected type specimens of *Dinematichthys dasyrhynchus*.

	Holotype WAM P.26614-010	USNM 222629	AM I.20245-016	Paratypes USNM 224475	USNM 224475	AM I.20245-016
Standard length	88	102	95	79	71	65
Head length	23	27	24	21	19	17
Snout length	5.5	6.1	5.7	5.5	4.2	3.8
Eye diameter	2.5	3.0	2.9	2.4	2.4	2.2
Interorbital width	4.9	5.5	4.8	4.3	4.0	3.9
Upper jaw length	12	13	13	11	9.2	8.8
Greatest maxillary width	4.3	4.8	4.2	3.8	3.8	3.0
Predorsal length	25	28	25	23	20	18
Preanal length	50	55	48	40	39	—
Body depth at vent	18	19	17	13	13	11
Pectoral length	11	12	10	10	8.3	—
Ventral length	20	19	20	16	17	15
Dorsal fin count	96	98	102	103	101	97
Anal fin count	62	66	69	68	68	68
Pectoral fin count	25	25	27	28	27	26
Caudal fin count	18	17	17	18	17	17
Gill raker count	5+18	5+18	5+16	5+16	5+11*	—
Vertebral number	14+33	14+34	14+33	14+34	14+33	13+33
Lateral line count	C. 140	C. 140	C. 140	C. 150	C. 140	—
Sex	Male	Female	Female	Female	Male	Male

* Count affected by apparent teratological conditon.

Table 3 Frequency distributions for fin ray counts and vertebral counts of *Dinematichthys dasyrhynchus.*

Dorsal fin rays								Anal fin rays								Pectoral fin rays			
96	97	98	99	100	101	102	103	62	63	64	65	66	67	68	69	25	26	27	28
2	1	3	4	2	5	3	2	1	0	1	1	7	3	5	4	1	7	6	5

Vertebrae		
13 + 33	14 + 33	14 + 34
1	10	10

inserted immediately adjacent to each other, insert more than an eye diameter behind symphysis of cleithra; the rays fall short of vent.

Body completely covered with small cycloid scales arranged in regular rows. Head scales lacking only on muzzle and interorbital region.

Male intromittent organ (Figure 3) has two pairs of pseudoclaspers; anterior ones are obliquely to posteriorly directed pegs; posterior ones are short and rounded, and fit into a thickened, pad-like area at anterior of anal fin base. Genital flap does not completely cover claspers, and has a rounded posterior margin. Penis is variable in length. (*D. dasyrhynchus* resembles another ophidioid, the aphyonid *Barathronus,* in which penis length has been shown by Nielsen, 1969 to be related to degree of sexual maturity as well as absolute size of the fish.)

Ribs present on first six centra, subsequent abdominal vertebra have ribs at ends of parapophyses. Neural spine of centrum one shorter than those following; spines of middle abdominal centra depressed. Vertebrae 14 (one with 13) + 33-34.

Colour of holotype in alcohol: an overall pale brown, the scale centres on sides of body somewhat darker; cirri on snout and lower jaw dark brown. Colour when fresh (based on colour transparencies of recently collected specimens): an overall brownish-yellow; , throat and breast somewhat paler; cirri on snout and lower jaw brown.

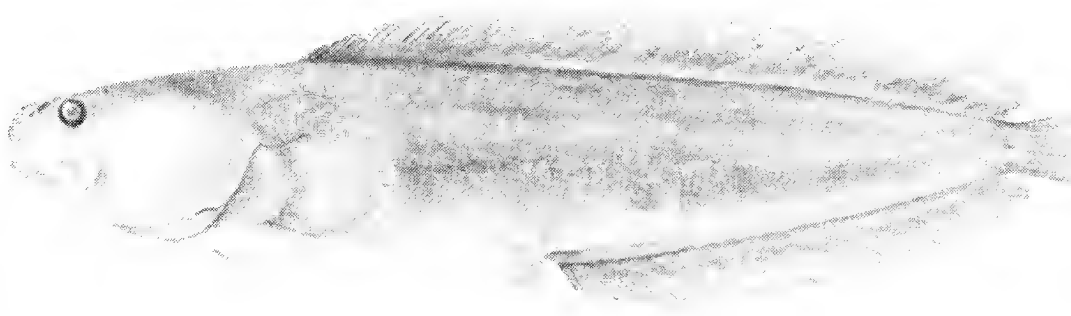

Figure 1 *Dinematichthys dasyrhynchus* sp. nov., holotype, WAM P.26614-010, male, 88 mm SL.

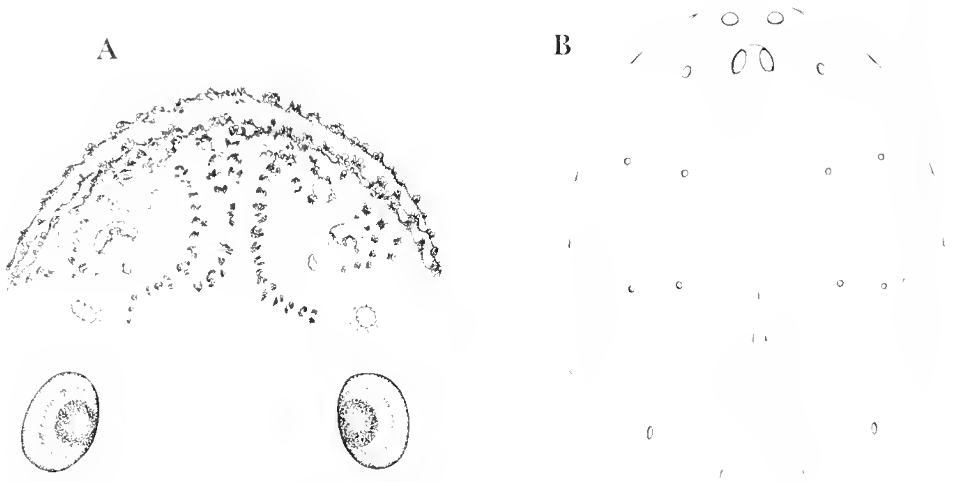

Figure 2 (A) Dorsal view of snout of *Dinematichthys dasyrhynchus*, WAM P.26619-015, 111 mm SL; (B) Ventral view of lower jaw of *Dinematichthys dasyrhynchus*, WAM P.26619-015, 111 SL.
Not to same scale.

Figure 3 Ventral view of the male genital area of *Dinematichthys dasyrhynchus*, USNM 224475, 71 mm SL. Genital flap pushed forward, anterior left pseudoclasper not shown (anterior of specimen to the left).

Distribution

Dinematichthys dasyrhynchus appears to be confined to Rottnest Island. It has been collected only with rotenone from limestone reefs at depths between 3 and 15 m.

Remarks

Males are notably less abundant in our samples with a ratio of one male to three females. We do not know if this ratio exists in nature or whether males are less available to present collecting methods.

This species is named *dasyrhynchus* (Greek: meaning shaggy-snout) with reference to the prominent cirri on its snout.

Acknowledgements

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A New Species of the Echinoid *Rhynobrissus* (Spatangoida: Brissidae) from North-West Australia

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Abstract

A new species of *Rhynobrissus*, *R. tumulus*, is described on the basis of 21 tests found on the northern coast of Barrow Island, Western Australia. The species ranges from Barrow Island north to Broome. Significant ontogenetic changes are described and discussed. A revised key for *Rhynobrissus* is presented.

Introduction

Six species have been attributed to the brissid spatangoid *Rhynobrissus*; viz. *R. pyramidalis* Agassiz, 1872; *R. hemiasteroides* Agassiz, 1879; *R. micrasteroides* Agassiz, 1878; *R. placopetalus* Agassiz and H.L. Clark, 1907; *R. macropetalus* H.L. Clark, 1938; and *R. cuneus* Cooke, 1957. Only three of these six species, *R. pyramidalis*, the type species, *R. hemiasteroides* and *R. cuneus* are valid species of *Rhynobrissus*. *R. micrasteroides* was made the type species of *Neopneustes* by Duncan (1889). *R. placopetalus* was based on three juvenile specimens which are considered by Mortensen (1951: 487) to be young specimens of *R. pyramidalis*. Mortensen (1951) considers *R. macropetalus* to be a 'rather doubtful' species of *Rhynobrissus*, a view with which I concur. H.L. Clark (1938) based the species on a single specimen from Broome, Western Australia which was badly damaged prior to publication. The remaining fragments comprise a specimen much larger than any other species of *Rhynobrissus*. Its broad petals, the anterior pair of which diverge strongly anteriorly, and the posterior having rows of equidimensional pore pairs (see below), suggest a closer relationship to *Metalia* which, like *Rhynobrissus*, possesses peripetalous, subanal and anal fascioles.

Two of the valid species of *Rhynobrissus*, *R. pyramidalis* and *R. hemiasteroides*, have an Indo-Pacific distribution. *R. pyramidalis* has been recorded from China, Gulf of Thailand, Singapore and off Madras (Mortensen 1951). H.L. Clark (1946: 373) records the occurrence of a single specimen from near Darwin. *R. hemiasteroides* occurs around Tahiti and Hawaii (Mortensen 1951) and along the eastern and western coasts of Australia (H.L. Clark 1946). *R. hemiasteroides* has only been recorded from Western Australia near Broome (H.L. Clark 1946:

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374). However, specimens in the collections of the Western Australian Museum have been obtained from Rosemary Island in the Dampier Archipelago, 8 km north-west of Dongara, City Beach, Fremantle and off Pt Peron, suggesting that it occurs along much of the western coast of the continent. On the east coast of Australia, H.L. Clark (op. cit.) records it only from Queensland. It has been found at Shoal Point, Mackay and Bribie Island, Moreton Bay (Endean 1953, 1956). However, I have collected a specimen (WAM 1055-81) from Port Jackson, N.S.W. This is the most southerly record for both the species and the genus. *R. cuneus* was described by Cooke (1957) on the basis of specimens from the Atlantic coast of North Carolina. This greatly extends the range of the genus.

Recently, 21 tests of a species of *Rhynobrissus* were found washed up on the northern coast of Barrow Island, Western Australia. The specimens are clearly distinguishable from any of the three recognized species of *Rhynobrissus* and are herein described as a new species. The only other spatangoid echinoids known to live around Barrow Island are *Breynia desorii* Gray, 1851, *Rhynobrissus hemiasteroides*, (a single specimen of which [WAM 1053-81] was collected with the new species of *Rhynobrissus* described below) and an indeterminate species of *Brissus*. Other irregular echinoids which have been collected from around Barrow Island are *Peronella orbicularis* (Leske, 1778), *Clypeaster reticulatus* (Linnaeus, 1758) and *Echinolampas ovata* (Leske, 1778). The description of a new species of *Rhynobrissus* thus brings to seven the number of species of irregular echinoids recorded from around Barrow Island. Three further specimens of this new species of *Rhynobrissus*, from near the Monte Bello Islands, from Broome and from near Onslow, have subsequently been recognized in the collections of the Western Australian Museum.

Measurements of specimens were carried out using a vernier calliper to an accuracy of 0.1 mm. Relative sizes of features of the test are expressed as percentages of test length (%TL). Specimens examined in this study are housed in the collections of the Western Australian Museum(WAM), Australian Museum (AM) and British Museum (Natural History) (BM).

Systematics

Order Spatangoida Claus, 1876

Family Brissidae Gray, 1855

Genus *Rhynobrissus* Agassiz, 1872

Type Species

Rhynobrissus pyramidalis Agassiz, 1872: 58; by original designation.

Emended Diagnosis

Test small, fragile; frontal notch absent; ambulacrum III flush with test aborally and with very reduced pore pairs. Pore pairs in adaxial rows of posterior petals smaller adapically than abaxial rows. Posterior paired interambulacra not reaching peristome, being blocked by plates of ambulacra I, II, IV and V. Peripetalous, subanal and anal fascioles present; subanal without contained pore pairs; anal almost encircling periproct.

Remarks

Although the original spelling by Agassiz (1872) for the genus was *Rhynobrissus,* in later publications (Agassiz 1879) the name was spelt *Rhinobrissus,* as this is 'the linguistically correct form' (Mortensen 1951: 487). H.L. Clark (1917) reverted to *Rhynobrissus,* but Lambert and Thiéry (1924) and Mortensen (1951) spell it *Rhinobrissus.* This spelling is an unjustified emendation and consequently Agassiz (1872), Clark (1917), Cooke (1957) and Fischer (1966) are followed in using the original spelling, *Rhynobrissus.*

Rhynobrissus is most easily confused with *Metalia.* However, *Rhynobrissus* can be distinguished by the extremely reduced pore pairs in ambulacrum III aborally; smaller pore pairs in inner rows of the posterior petals, relative to outer rows; failure of interambulacra 1 and 4 to extend to the peristome; narrower, rectangular plastron; and absence of pore pairs within the subanal fasciole.

Rhynobrissus tumulus sp. nov.

Figures 1-5

Holotype

WAM 1047-81 (36.5 mm TL), a dried test collected from beach east of Cape Dupuy, northern coast of Barrow Island, Western Australia (20°40'S, 115°26'E) on 27 September, 1981 by K.J. McNamara, W.H. Butler and G.W. Kendrick; Figures 1A, B, 2A, B.

Paratypes

WAM 1048-81 (1), 1049-81 (1), 1050-81 (1), 1051-81 (11); BM 1981.10.27.1 (3); AM J14770 (1), J14771 (1), J14772 (1). All dried tests and collected from the same locality as the holotype.

Diagnosis

Aboral surface of test gently convex in longitudinal profile; highest posterior of apical system. Petals long and shallow; anterior pair transverse. Peristome narrow, labrum projecting only slightly anteriorly. Plastron narrow.

Description

Test ovoid, attaining a maximum known length of 60.0 mm; widest anterior of centre, width 82-88% TL; highest posterior of apical system at about mid-test length in interambulacrum 5, which is developed as a broad keel (Figure 2A) within area bounded by peripetalous fasciole; height 59-69% TL. Ventral half of posterior of test slightly inclined, periproct being visible from above (Figure 1A); dorsal half inclined forward. Apical system ethmolytic with four genital pores;

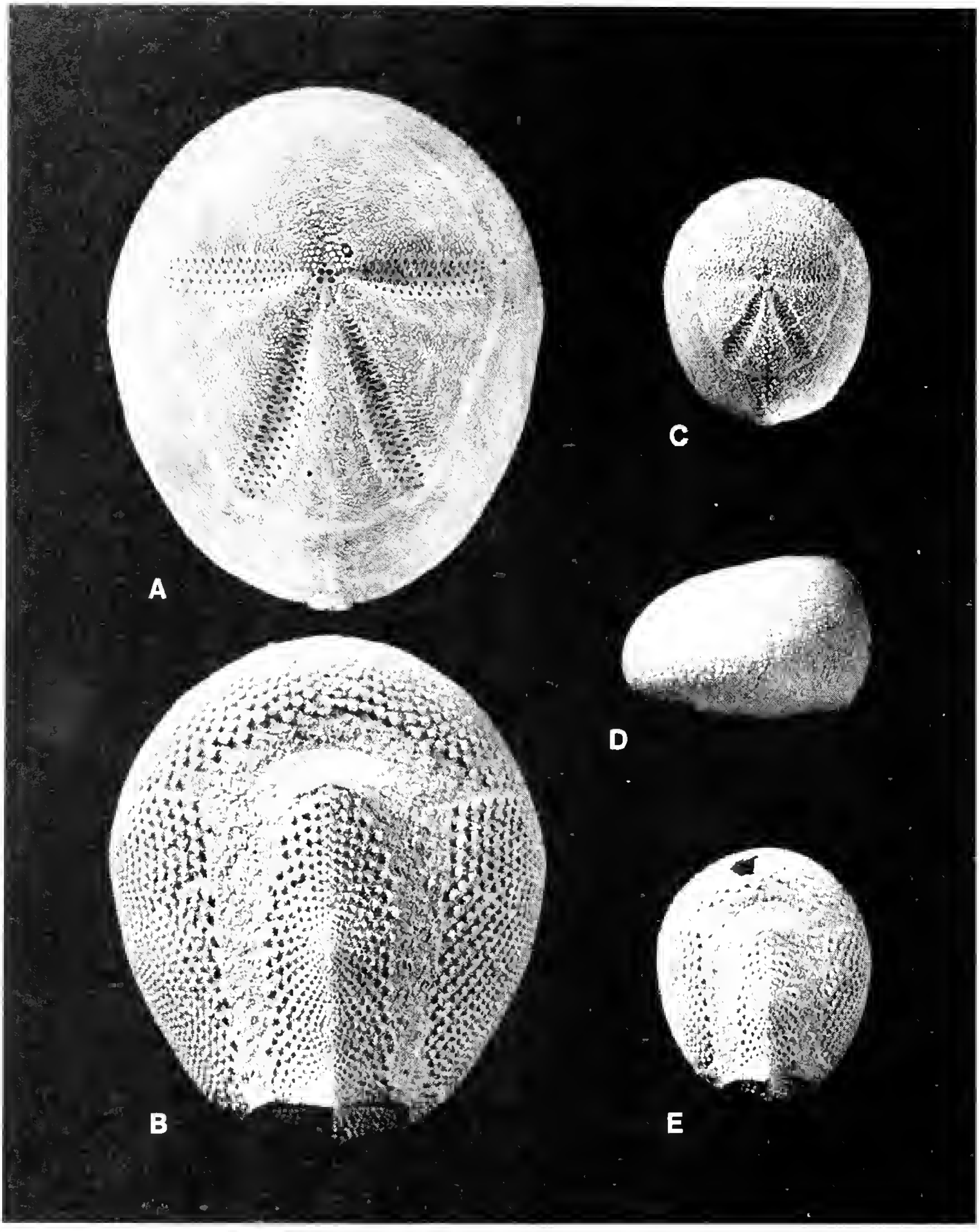

Figure 1 *Rhynobrissus tumulus* sp. nov.; aboral (A) and adoral (B) views of holotype WAM 1047-81; aboral (C), side (D) and adoral (E) views of paratype WAM 1048-81; all x 2.

anteriorly eccentric 35-44% TL from anterior ambitus. Anterior petals transverse; shallow; length of each petal 28-34% TL. Large specimens possess up to 19 pore pairs in each row; smallest specimen, 17.7 mm TL, possesses 16; pores oblong; pores of each row equidimensional; not conjugate; rows situated close to each other. Posterior petals diverge at 35°; longer than anterior petals, being 31-41% TL. Large specimens possess up to 27 pore pairs in each row; smallest specimen has 17. Pore pairs of each row equidimensional posteriorly, but pores of inner rows become relatively much smaller adapically, reducing to one third width of pore pairs of outer row close to apex (Figure 1A). Ambulacrum III flush with test aborally; no anterior notch. Extremely small, exsagittally orientated pore pairs present adapically. Peripetalous fasciole reaches close to anterior ambitus in largest specimens. Indented slightly in interambulacra 2, 3 or 5; reaches up to 0.7 mm in width. Area within peripetalous fasciole occupying up to 82% TL longitudinally and 69% TL transversely.

Oral surface of test gently convex; plastron forming sharp keel posteriorly (Figures 1B, 2A). Peristome lunate, width 22-28% TL; only slightly sunken. Wide area around peristome has a dense cover of miliary tubercles. Phyllode poorly developed: 8 small unipores in ambulacra II and IV; 5 in ambulacrum III; and 6 in ambulacra I and V. Basicoronal plates of ambulacra I and II, and ambulacra IV and V in contact, excluding interambulacra 1 and 4 (Figure 3). Labrum very short; lengthening slightly laterally; projecting a little anteriorly. Plastron narrow; sub-rectangular; width 22-28% TL. Periplastronal areas half width of plastron; covered by dense concentration of miliary tubercles. Subanal fasciole subcircular, but with slight posteriorly directed indentation ventro-medially; width 30% TL. Anal fasciole reaches to within 1 mm of subanal fasciole; broad adorally, up to 1.5 mm in width; almost encircles periproct, but branches do not join aborally (Figure 2A). Periproct small, oval, length 12% TL.

Adoral tuberculation largest on lateral and anterior interambulacra, tubercles 0.5 mm in diameter. On plastron tubercles become smaller toward axis. On aboral surface uniform tubercle size (0.2 mm), except for small area anterior of apical system where 0.35 mm in diameter. The small group of larger tubercles would probably have borne a tuft of stout, longer spines, as in *R. hemiasteroides*. On adoral surface, spines on plastron paddle-shaped burrowing spines, distal end of which is twice width of shaft; reaching up to about 17% TL in length. Locomotory spines on lateral and anterior interambulacra about 20% TL in length. All spines are white. Pedicellariae not known.

Ontogenetic Variation

Twenty-four specimens of this species are known. They range in test length from 17.7 to 60.0 mm. The smallest has genital pores which are very small and probably opened at only a slightly smaller test size. On the basis that the opening of genital pores indicates correlation with onset of maturity (McNamara and Philip 1980), all known specimens of *R. tumulus* are adults.

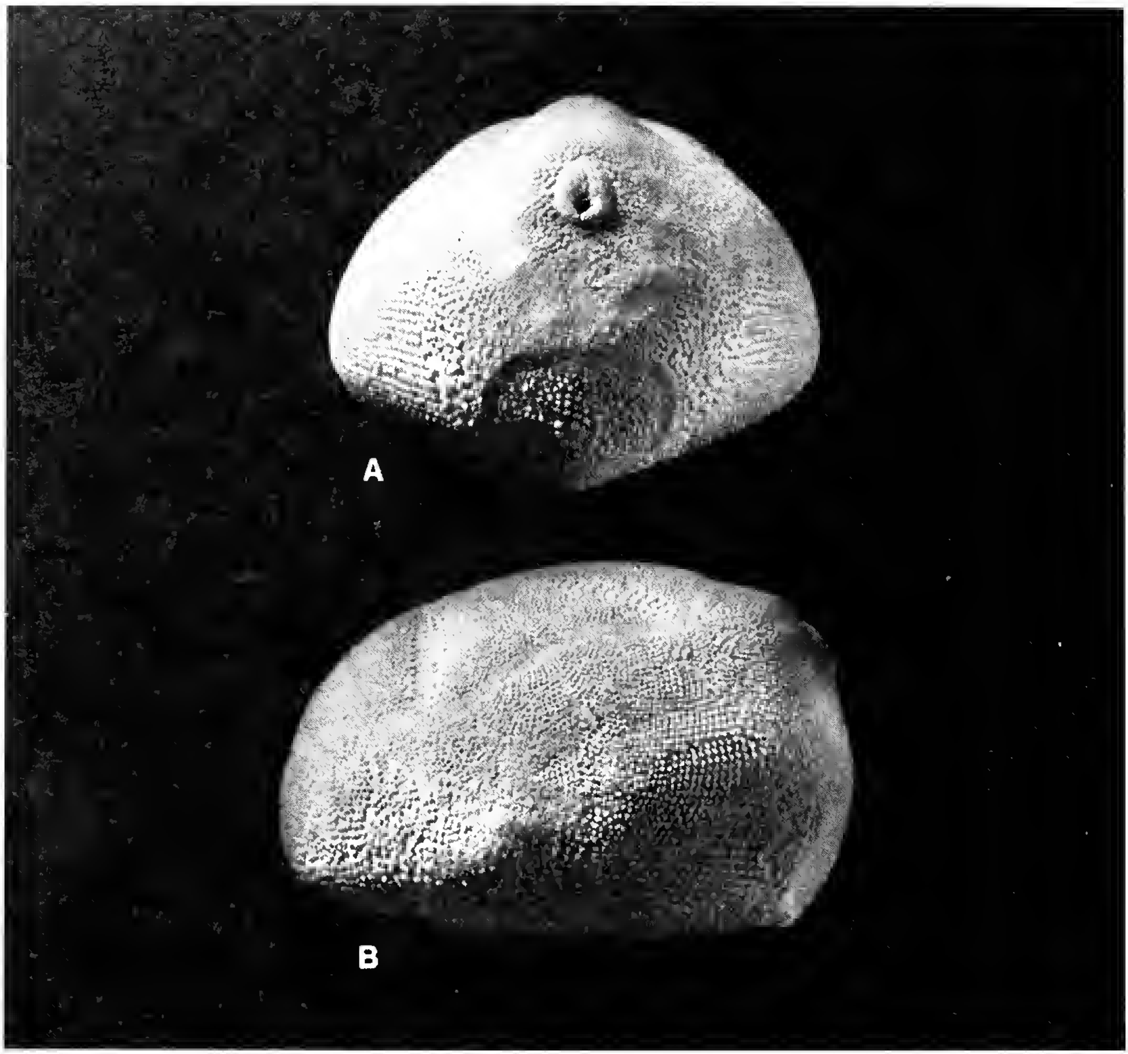

Figure 2 *Rhynobrissus tumulus* sp. nov.; posterior (A) and side (B) views of holotype WAM 1047-81; both x 2.

Significant ontogenetic changes occur to particular structures, however, even during adult growth. In the available specimens these changes occur with almost a fourfold increase in test length. The structures which change are: aboral interambulacrum 5; position of apical system and, consequently, orientation of anterior petals; lengths of petals relative to test; lengths of petals relative to one another; size of peristome; and shape of labrum. Changes to similar structures have been recorded in the ontogeny of the spatangoid *Schizaster myorensis* McNamara and Philip, 1980.

In the smallest specimen (Figure 1C-E) the aboral surface of the test is evenly rounded; with growth, interambulacrum 5 becomes more strongly vaulted and produces a slight keel. The apical system undergoes a slight anterior movement during growth. In the smallest specimens it may be as much as 44% TL from the anterior ambitus; in the largest specimens it reaches to within 35% TL of the anterior ambitus (Figure 4). As a consequence of this anterior movement there is a change in orientation of the anterior petals. In larger specimens the petals are transverse (Figure 1A); in the smallest specimens, where the apical system is more posteriorly situated, the anterior petals diverge forward at an angle of about 165° (Figure 1C).

Both sets of petals increase in length relative to the test during growth, the anterior petals from 28% TL to 34% TL, the posterior from 31% TL to 41% TL (Figure 5). The greater relative increase in length of the posterior petals means that they are proportionately longer than the anterior petals in larger individuals. In the specimen 17.7 mm TL, the petals are of almost equal length (28% TL and 31% TL); in the largest specimens the posterior petals are 25% longer than the anterior petals. Accompanying the relative lengthening of the petals there is a slight increase in number of pore pairs, from 16 to 19 in the anterior petals and

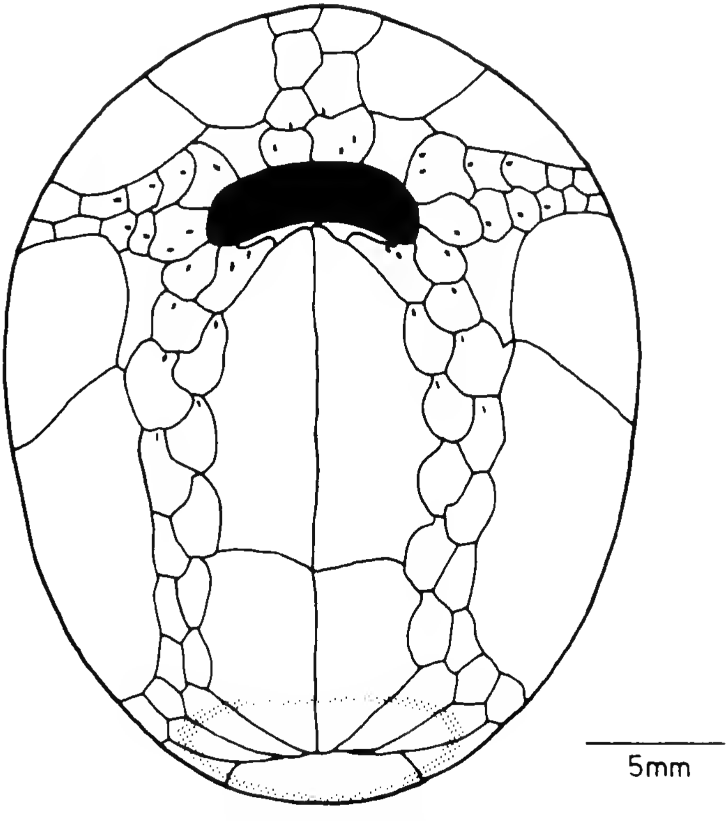

Figure 3 Camera lucida drawing of paratype of *Rhynobrissus tumulus*, WAM 1049-81, showing adoral plating. Note occlusion of interambulacral plates 1 and 4 from peristome.

from 17 to 27 in the posterior pair. Much of the relative size increase of the petals therefore reflects greater growth of the poriferous ambulacral plates relative to the adjoining interambulacral plates.

The peristome undergoes a slight relative decrease in width during growth of the test, from up to 28% TL in small specimens to 22% TL in the largest. An appreciable anteriorly directed growth of the labrum is reflected in a change to the shape of the peristome, from semicircular in small specimens to lunate in large ones. This is reflected in a decrease in the distance from the anterior tip of the labrum to the anterior ambitus, from 33% TL to 22% TL during growth of the test (Figure 4).

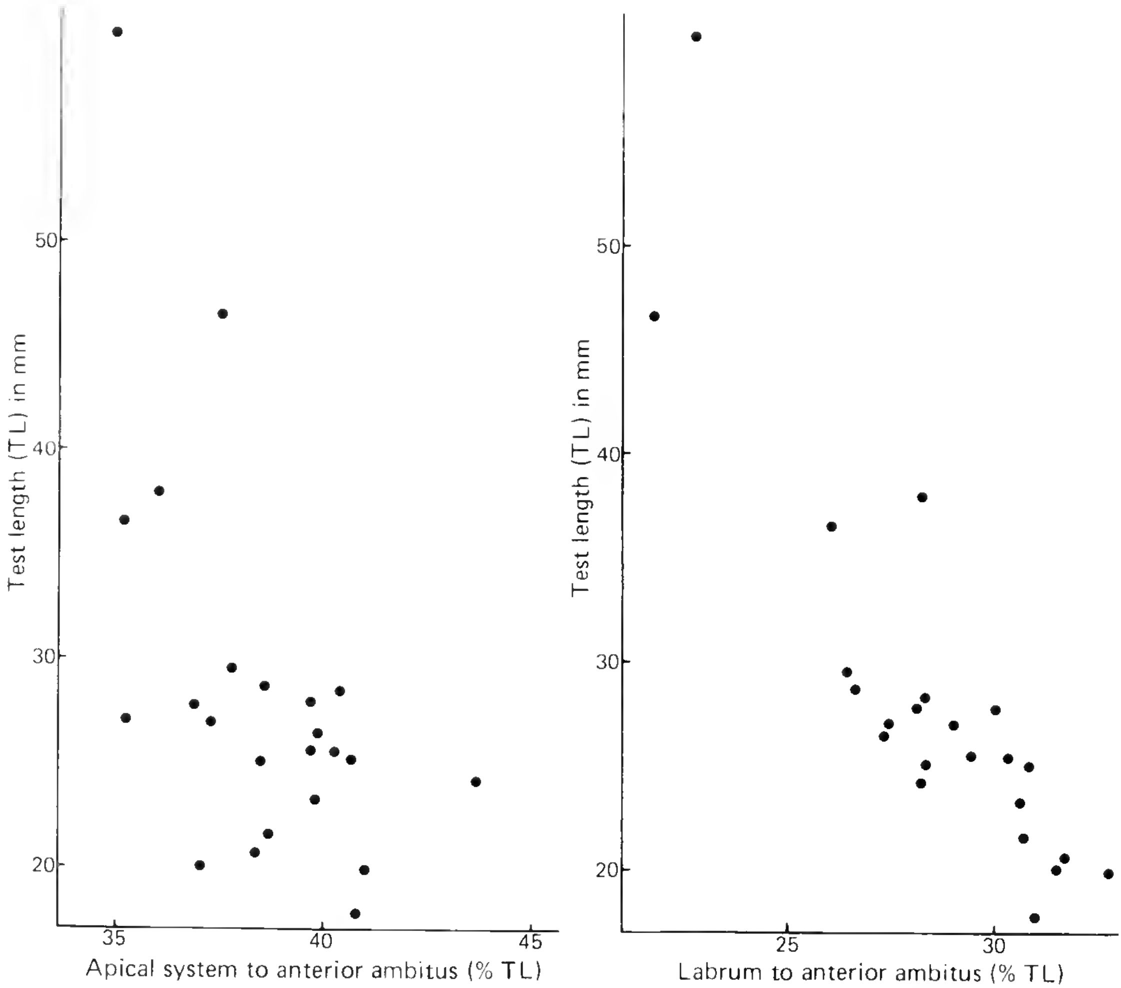

Figure 4 Plots of test length against distance of apical system to anterior ambitus and distance of labrum to anterior ambitus expressed as percentages of test length, for *Rhynobrissus tumulus*.

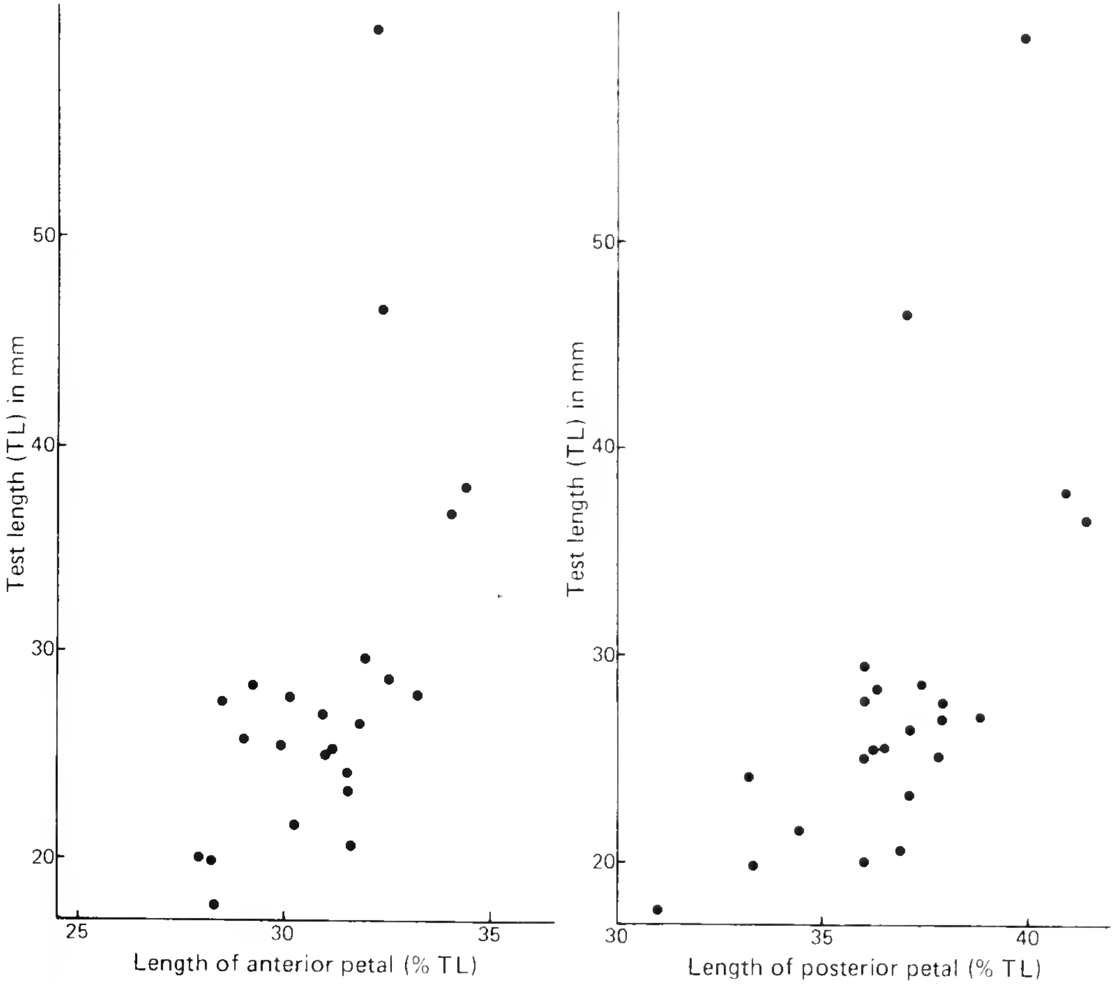

Figure 5 Plots of test length against length of anterior petal and length of posterior petal expressed as percentages of test length, for *Rhynobrissus tumulus.*

Remarks

Rhynobrissus tumulus differs from the other Australian species, *R. hemiasteroides,* with which it has been found, in a number of significant ways. *R. tumulus* lacks the 'hump' anterior of the apical system, so characteristic of *R. hemiasteroides.* It can further be distinguished by the form of the petals, which are longer (anterior 28-34%TL, posterior 31-41% TL, as opposed to 20-24% TL and 24-29% TL, respectively, in *R. hemiasteroides*). The petals are also slightly narrower and shallower in *R. tumulus,* and bear more pore pairs (a maximum of 19 in the anterior petals and 27 in the posterior, in contrast to maxima of only 12 and 16, respectively, in *R. hemiasteroides*). The peripetalous fasciole is situated much closer to the ambitus in *R. tumulus.* Furthermore, the peristome is less sunken and the labrum more transverse.

Rhynobrissus tumulus can be distinguished from the type species, *R. pyramidalis*, by its more oval test and the more anteriorly positioned apical system, which is set generally at 35-40% TL from the anterior in *R. tumulus*, but at 46% TL in the holotype of *R. pyramidalis*. The anterior petals are transverse in *R. tumulus*, but diverge anteriorly in *R. pyramidalis*. Furthermore, the petals are longer in *R. tumulus*, the anterior petals being only 21% TL in *R. pyramidalis*, and the posterior 31% TL. The peristome of *R. tumulus* is smaller and the labrum is more transverse. The plastron of *R. tumulus* is narrower, being 22-28% TL, in contrast to 33% TL in *R. pyramidalis*.

Rhynobrissus tumulus differs from *R. cuneus* in its more tumid test; its more anteriorly eccentric apical system (set at 42.5% TL from the anterior test in *R. cuneus*); its transverse anterior petals; its shorter labrum and the wider subanal fasciole, which is not in contact with the anal fasciole, as it is in *R. cuneus*.

It is significant that many of the characters used to distinguish species of *Rhynobrissus* are those which show appreciable change during ontogeny, suggesting variable developmental rates of particular structures may be important in the evolution of new species.

Although Barrow Island specimens were not collected alive, the presence of gut contents in one specimen (WAM 1050-81) provides some indication of the sediment substrate inhabited by *R. tumulus*. The specimen contained calcareous sand rich in foraminifers. The grain size of the sand varied in diameter between 0.1 and 1.0 mm. *R. tumulus* may thus be considered to be a moderately coarse sand dwelling species. The single specimen collected from north-east of the Monte Bello Islands (WAM 1052-81) is known to have been dredged from a depth of 50-52 m. *R. pyramidalis* has also been recorded from sand (Clark 1946, Mortensen 1951).

The observation that *R. tumulus* possesses paddle-shaped plastron spines, and the inference that it inhabits a sandy substrate, is at variance with deductions made by Smith (1980) that spatangoids which possess plastron spines that show distal flattening inhabit muddy substrates (e.g. in species of *Schizaster*, *Moira* and *Brissopsis*). The correlation between plastron spine shape and sediment type inhabited is probably not so clear-cut. For instance, species of *Brissus* possess plastron spines which are flattened distally, yet the genus inhabits sand (Chesher 1968, Mortensen 1951).

Other Material

WAM 1052-81 trawled from 50-52 m, north-east of Monte Bello Islands, Western Australia at about 20°21'S, 115°37-38'E; WAM 643-74, from sand flats near jetty at Broome, Western Australia; WAM 648-74, from west of Flat Island, near Long Island, off Onslow, Western Australia.

Etymology

From the latin 'tumulus' – a gentle mound, alluding both to the test shape and the Roman name for the six thousand year old burial mounds known as barrows.

Key to the Species of *Rhynobrissus*

1 Apex of test anterior of apical system .... *R. hemiasteroides*
  Apex of test posterior of apical system 2

2 Apical system sub-central, anterior petals diverge 3
  Apical system anteriorly eccentric, anterior petals transverse .... *R. tumulus*

3 Subanal fasciole not in contact with anal fasciole .... *R. pyramidalis*
  Subanal fasciole in contact with anal fasciole .... *R. cuneus*

Acknowledgements

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Hollow Australites from Western Australia

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Abstract

Very few complete hollow australites are known from Western Australia but imperfect ones and fragments are widespread. Cavities sometimes affected the trim in oriented flight. Partial frontal collapse of the secondary form into a cavity is shown by some specimens.

Introduction

Australites which contain bubble cavities more than a millimetre or two in diameter ('hollow forms') and have the cavity unbreached are rare. Baker (1961; 1966a) described in detail two unusually well preserved examples from Victoria and gave shorter accounts of 14 additional specimens to total six from Victoria, nine from South Australia and one from Northern Territory (Baker 1966a; 1966b); he also described specimens with breached cavities and fragments (Baker 1963; 1966b).

The known Western Australian specimens comprise only a single example with an internal bubble cavity readily observable, a specimen in which the likely presence of a cavity can be inferred from the specific gravity, and one in which the former presence of a cavity can be inferred from the external form. There are numerous specimens with breached cavities and many fragments of hollow forms, only typical representatives of which will be described.

Specific Gravity of Hollow Australites

The specific gravities of a localized sample of australites generally vary over a small range because of differences in chemistry or in the content of very small (sub-millimetre) cavities; the relative frequency diagram of specific gravity is usually unimodal (Chapman *et al.* 1964; Chapman 1971; Chalmers *et al.* 1976). Thus, for a sample of 486 australites from the Nullarbor Plain, Chapman *et al.* (*op. cit.* Fig. 7) found specific gravities in the range 2.39-2.47 with a clearly defined mode constituting about 45% of the sample in the 2.44-2.45 interval.

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If an australite contains a bubble cavity more than one or two millimetres diameter but small relative to its own size, the specific gravity may still lie within the usual range for that locality. The possible presence of a cavity will not therefore be suspected and it will not be noticed except in those rare specimens where it is readily observable in transmitted light or by reflection from shallow depth. If a relatively large cavity is present, the specific gravity falls below the usual range for the locality and the cavity may be sought by using, if necessary, strong artificial illumination. Values falling distinctly below the usual range (say, 0.1 unit below) are sufficiently rare as to warrant an immediate check on their correctness or on the presence of a major cavity.

The likely volume of a cavity may be estimated if a specific gravity study is available for the district and provided also that the frequency distribution is unimodal. Let the volume of the cavity be V cm^3. Because the contents are either nearly vacuum or air if the cavity is breached, the specific gravity is effectively zero. The volume of the whole specimen may be obtained from the loss of weight in liquid, or for those with published data, from the mass (M)/ specific gravity (D). The specific gravity of the glass is taken as the mid-value of the modal interval. For specimen no. 1 of Table 1 from the Nullarbor Plain, mass in grams is:

$$6.388 = V(O) + (M/D - V)\ 2.445$$

from which V is *c.* 650 mm^3.

A bubble 'diameter' of 10.7 mm may be calculated from the volume on the assumption that the cavity is spherical. In fact, a cavity may be ovoid, double or complex with thin glass partitions, or there may be two or more distinctly separated cavities. Very rarely, the inner end of a bubble cavity may even be conical, perhaps because a rising, teardrop-shaped bubble has been frozen in position. 'Diameter' should therefore be used with an appreciation that it is only the diameter of an equivalent sphere. If the limits of the usual specific gravity range for the Nullarbor Plain (2.39-2.47) are used in calculations instead of 2.445, it may be shown that the 'diameter' of the cavity is likely to lie within the range 10.4-10.9 mm.

Some General Principles Applicable to Hollow Australites

The aerodynamic stability of australites has been discussed by Chapman *et al.* (1962, p. 14 *et seq.*). The requirement that the centre of gravity should be in front of the aerodynamic centre means that a hollow form (conveniently visualized for present purposes as spherical with a large eccentric cavity) will orient with the larger part of the mass (thickest wall of cavity) presented forward and the larger part of the cavity (thinnest wall) to the rear. Breached cavities are thus most commonly exposed at posterior surfaces except in that minority of cases when aerodynamic and terrestrial losses have so reduced the form as to reverse the initial situation. The anterior wall is sometimes thinned to the extent that there is partial or complete collapse of the hot plastic glass in flight, occasionally to the extent that it is 'blown through'.

Because of their higher ratio of surface area to mass, hollow forms were more rapidly decelerated in the atmosphere and heat loss by radiation was greater than for the equivalent solid forms. They were therefore less severely reduced by ablation stripping and the secondary body constitutes a larger proportion of the primary one, the shape of the posterior (primary) surface being sometimes highly domed or 'bloated' compared with that of solid forms. A good example of the highly domed form is the specimen from Hordern Vale described by Baker (1966a, Fig. 2). The Horsham specimen, for which accurate calculations were possible, lost only 25% of its volume by aerodynamic processes (Baker 1961). In conjunction with the earlier observation regarding flight orientation, a posterior surface may thus be both highly domed and hollow, sometimes a mere shell.

For stability in flight, a spherical or nearly spherical hollow form would tend to orient so that a large cavity was centred on the line of flight but it could be located eccentrically if compensating features were present elsewhere (see notes on specimen no. 1 below).

The ideal orientation of an elongated form was not attainable if it contained an eccentric cavity. Consider the stout-waisted, symmetrical dumb-bell shown in Figure 1A-C (WAM 7118 from Israelite Bay). A symmetrical dumb-bell (one with gibbosities of equal size) would orient with the long axis normal to the flight path but an asymmetrical one would orient with the larger and heavier gibbosity leaning into the airstream, i.e. inclined forward in advance of the smaller and lighter one (Chapman *et al.* 1962). The Israelite Bay specimen shows a large breached cavity on the posterior surface and located off-centre both longitudinally and laterally (Figure 1A). This cavity upset the balance and affected the flight orientation, causing the dumb-bell to trim in flight like an asymmetrical one – see Figure 1B where the orientation is demonstrated by the flow ridges being in planes approximately normal to the line of flight. The pattern of flow ridges on the anterior surface (Figure 1C) is also asymmetrical laterally, showing that the transverse axis was also tilted off the normal to the flight path. The quadrant containing the cavity was rearmost in flight and the diagonally opposite quadrant foremost. Two further examples of the trim being affected by cavities are described below (nos 5 and 8).

For an example which is complementary to the above, i.e. an asymmetrical dumb-bell which behaved like a symmetrical one because of the presence of a compensating cavity in the larger gibbosity, see Baker 1964, Pl. IVA-C, where the asymmetry is shown in Pl. IVA, the flight orientation is indicated by the relationship of the rim to the posterior profile in Pl. IVB, and the large cavity breached by the loss of the stress shell in forming a wedged core is shown in Pl. IVC. The cavity is within the remnant of the larger gibbosity and evidently compensated very closely for what would otherwise have been a more massive gibbosity inclining forward into the airstream.

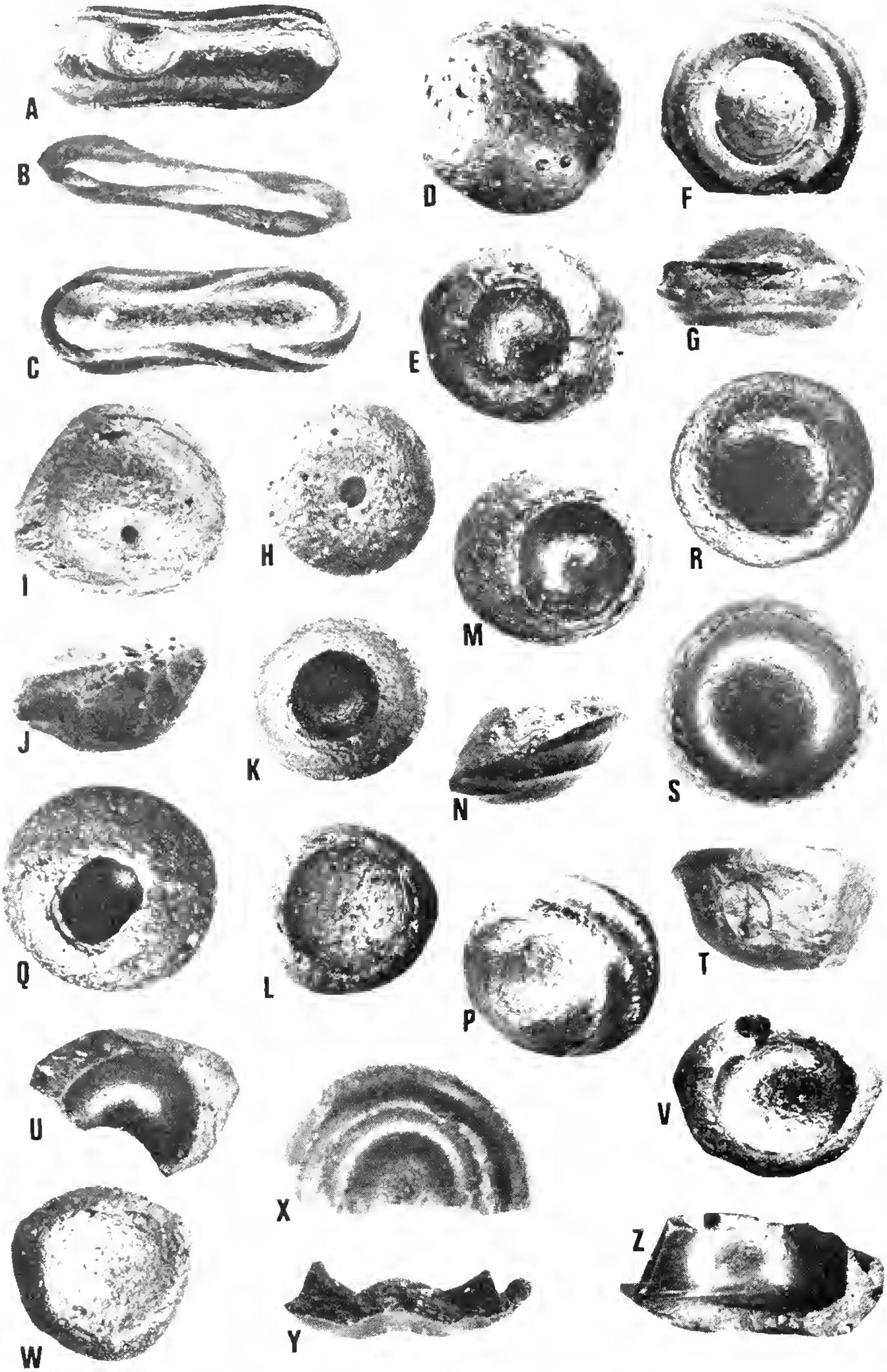

Figure 1 Hollow australites from Western Australia.

Table 1 Data on some hollow australites from Western Australia.

No.	Collection	Site of find	Long. E	Lat. S	Form	Dimensions mm	Mass g	*D
1	SM 10 872	*c.* 95 km NNE of Haig	126°22′	30°11′	Round core	(20.4-18.4) x 16.7	6.338	1.957
2	L.G. Lewis	7 km S of W of Gorge Rock	117°55′	32°28′	Round core	(60.0-57.7) x 51 x 2	200.53	2.375
3	Tillotson family	S edge of Lake Raeside 13 km SSE of Leonora	121°23′	28°59′	Partly flanged button	(18.6-16.8) x 8.9	2.621	2.446
4	Tillotson family	Lake Lefroy adjacent to Kambalda	121°41′	31°11′	Lens	(8.7-8.5) x 3.4	0.281	
5	Tillotson family	Lake Yindarlgooda adjacent to Taurus	121°52′	30°42′	Aberrant	13.6 x 12.5 x 7.5	1.275	
6	R.E. Mitchell	Eastern Goldfields	—	—	Lens	(16.2-15.2) x 6.6	1.368	
7	J.L.C. Jones	Hampton Hill Station	*c.* 121°50′	*c.* 30°50′	Lens	(9.0) x 3.4	0.213	
8	SM 10 609	Menangina Station	122°02′	29°50′	Lens	(12.6-11.6) x 6.6	0.826	
9	SM 10 397	Leonora district	*c.* 121°19′	*c.* 28°53′	Round core	(23.3-21.6) x 17.8	9.038	
10	SM 11 768	SE boundary of Mount Remarkable Station	122°03′	29°26′	Broad oval core	22.0 x 20.4 x 11.2	3.504	
11	WAM 7123	Israelite Bay	123°51′	33°37′	Fragment of round core	(23.0-22.5) x 12.4	5.100	
12	J.L.C. Jones	Hampton Hill Station	*c.* 121°54′	*c.* 30°48′	Fragment of hollow core			
13	SM 11 776	SE boundary of Mount Remarkable Station	122°03′	29°26′	Fragment of hollow core			
14	J.L.C. Jones	Hampton Hill Station	*c.* 121°54′	*c.* 30°48′	Fragment of hollow form			
15	Tillotson family	Boyce Creek, Yerilla Station	121°58′	29°29′	Fragment of hollow button			
16	K. Jenkins	West boundary, Mount Remarkable Station	121°48′	29°21′	Fragment of hollow button			

* Specific gravity

Figure 1: Hollow australites from Western Australia. For specimen numbers used below, refer Table 1. In elevational views, direction of flight is towards bottom of page.
A: Dumb-bell, WAM 7118 from Israelite Bay, view normal to posterior surface of flight, length 31.7 mm. B: Side elevation of A, oblique length 31.7 mm. C: View normal to anterior surface of A, length 31.7 mm. D: No. 1, posterior view over strong back-lighting showing location of cavity by transmitted and internally reflected light. Mean diameter of core 19.4 mm. E: No. 1, elevation (left side of D), width 19 mm. F: No. 3, anterior surface of flight, width 18 mm. G: No. 3, side elevation, width 18 mm. H: No. 4, posterior view, diameter 8.6 mm. I: No. 5, view normal to posterior surface, width 13.6 mm. J: No. 5, end elevation (left end of I), oblique dimension 12.5 mm. K: No. 6, posterior view, mean diameter 15.7 mm. L: No. 7, posterior view, diameter 9 mm. M: No. 8, posterior surface viewed normal to plane of rim, width 12.6 mm. N: No. 8, elevation in final flight orientation, oblique dimension 12.6 mm. P: No. 8, anterior surface viewed normal to plane of rim, width 12.6 mm. Q: No. 9, posterior view, mean diameter 22.5 mm. R: No. 10, posterior view, mean diameter 21.2 mm. S: No. 11, posterior view, mean diameter 22.8 mm. T: No. 11, elevation showing well defined, ovoid 'flake scar' resulting from detachment of stress shell left of centre and remnant of stress shell at right, width 23 mm. U: No. 12, interior view, width 31.2 mm. V: No. 13, interior view, width 20.5 mm. W: No. 14, interior view, width 23 mm. X: No. 15, posterior view showing interior of cavity with central boss, width 17 mm. Y: No. 15, elevational view of lower edge of X, width 17 mm. Z: No. 16, elevational view of broken surface, width 17.6 mm.

Descriptive Notes

The specimen numbers below are those of Table 1 which shows some basic data but omits details unnecessary for an understanding of the cavities. The australites are from the collections of the Western Australian Museum (WAM), W.A. School of Mines (SM) and the persons named in Table 1.

1 The bubble cavity is readily seen in daylight by reflected or transmitted light and is centred well off the main axis of the specimen (Figure 1D). The likely volume and 'diameter' of the cavity have been calculated above as 650 mm^3 and 10.7 millimetres. Compensation for the eccentric location of the cavity was provided partly by another cavity, of which a part (7.5 mm diameter) remains exposed by loss of the aerothermal stress shell (Figure 1E). Other small cavities which were perhaps within the now discarded stress shell could also have contributed to the maintenance of stability.

2 For illustrations and description, see Cleverly (1981, specimen no. 2). The specimen is an extremely large one, ranking ninth in mass amongst known australites. No specific gravity study of a representative sample of all shape types and sizes of australites is available for the district concerned. However, the specific gravities of the highly biased sample of 31 very large specimens vary so little that their mean value could be used as a basis for calculating the likely size of cavity in the exceptional one.

It will be seen in the illustrations (Cleverly *op. cit.* Fig. 2A and B) that the vesicular zones have no evident thickness, being confined to the immediate posterior surface, i.e. the remnant surface of the primary body. It is unlikely therefore that the cavity 15 mm 'diameter' could be accounted for by subsurface glass with vesicular structure.

3 Figure 1F and G. The annular depression on the anterior surface of flight could be a fold resulting from frontal collapse. A large scale profile of the anterior surface was prepared from a traverse with a travelling vernier microscope and a curve was fitted to the flanks of the surface. It is clear from the profile that the collapse of the polar region was through only about one millimetre, that being the amount of movement necessary for restoration of a complete curve. The nearest locality for which a specific gravity study is available is Mount Remarkable Station about 80 km distant to the south-east, from which a sample of 54 specimens gave values in the range 2.40-2.47 with nearly 65% of the sample in the 2.45-2.46 interval (unpublished study by W.H. Cleverly). The specific gravity of the specimen is in the upper part of the range. Even if the glass has the extreme value 2.47, the bubble could have had volume only about 8.6 mm^3 and 'diameter' about 2.5 mm. It seems likely that a cavity only 1-2 mm diameter was located axially because of the symmetry of the collapsed specimen and that it was effectively closed by the frontal collapse.

4 Figure 1H. The bubble cavity, which is breached by a hole 1 mm diameter, has a 'diameter' of 2.3 mm calculated from the mass of liquid required to fill it.

5 The basal remnants of what were evidently drawn-out, canoe-like extensions of secondary glass are located asymmetrically relative to the mid point of the posterior surface (Figure 1I). A small breached cavity on the posterior surface, also located asymmetrically, leads to a sub-surface cavity or cavities. The bulk specific gravity is 2.415, but after vacuum treatment to take in liquid, 2.446. Calculations suggest the volume of the cavity as 7.9 mm^3 and the 'diameter' as about 2.5 mm.

If the specimen is rotated on the length axis (the left-right axis of Figure 1I) until the canoe-like extensions of flange are in the mid line and the breached cavity is rearmost (Figure 1J), the specimen may be visualized in the posterior view as a canoe of complex form arising from the tendency to orient with the cavity rearward and on the line of flight.

6 Figure 1K. This specimen having a cavity exposed at the posterior surface is typical of many for which reconstruction shows the cavity to have been initially beneath the merest film of glass or even breached in the primary form.

7 Figure 1L. The breached cavity in a lens is occasionally large enough to produce a pseudo bowl form. In this example, the cavity is 7 mm diameter at the lip and the lens is 9 mm diameter.

8 A breached bubble cavity 6.5 mm diameter at the lip is exposed eccentrically upon the posterior surface (Figure 1M) and the centre of a system of ring waves upon the anterior surface is displaced eccentrically in the opposite direction to the cavity (Figure 1P). The final flight orientation must have been with the plane of the rim oblique to the line of flight (Figure 1N), the cavity rearmost, the ring waves centred upon the line of flight. Nevertheless, the shape of the specimen could have developed only with the plane of the rim normal to the line of flight and this was evidently the original orientation with some feature – possibly another cavity – compensating for the one now exposed. After the compensating feature had been removed, the flight orientation would change and a new set of ring waves would develop appropriate to it, but evidently time did not permit the re-shaping of the secondary form.

9 The volume of the breached cavity exposed on the posterior surface (Figure 1Q) was estimated from the weight of liquid required to fill it as *c.* 750 mm^3, equivalent to a 'diameter' of 11.3 mm. Direct measurement, necessarily approximate becasue of the breaching, suggests and axial dimension 11.6 mm and the form of the cavity would therefore have approximated to a prolate spheroid *c.* 11.6 x 11.1 x 11.1 mm. This cavity with its largest dimension parallel to the line of flight would have had the same orientation and much the same proportions as that in a very large example from Victoria (Baker 1961). These figures were estimated without the advantages of a cut specimen

and an ideal state of preservation. They do not therefore have the same degree of reliability as those given for the Victorian specimen.

10 Figure 1R. The posterior polar portion of this specimen is much reduced by weathering. The equatorial diameter of the cavity is *c.* 14 mm. An independent estimate of 14.05 mm 'diameter' was calculated from the depth of the cavity and the mass (thence volume) of liquid required to fill it, using the formula for volume of the segment of a sphere.

11 Figure 1S and T. This specimen is the anterior part of a round hollow core with portion of the stress shell still attached, i.e. it is an 'indicator' if that name may be applied for incomplete aerodynamic flaking as it is used for terrestrial flaking. The exposed remnant of the cavity is 18 mm diameter and 6.5 mm deep. The bubble 'diameter' of 22.4 mm was estimated by the same method as for the previous specimen. From it, the depth of the secondary form was calculated as nearly 29 mm plus the thickness of the posterior wall of the cavity. The shape was therefore initially highly domed.

12 Figure 1U. This fragment is typical of numerous broken hollow cores.

13 Figure 1V. This variant of the above with complex cavity is less common.

14 Figure 1W. Dished fragments of this general type are widespread. When badly weathered, the 'hot polish' of the interior of a bubble cavity is completely destroyed and it may no longer be possible to distinguish fragments of hollow forms from pieces of stress shell.

15 Figure 1X and Y. An early stage of frontal collapse has created a dimple centrally on the anterior surface and a complementary boss within the cavity, now visible because of fragmentation. For a less fragmented example (one of two) from Mount Remarkable Station, see Cleverly (1979, Fig. 5 – D1, D2).

16 Figure 1Z. This fragment shows more complete frontal collapse, the anterior wall of the cavity being almost flat and normal to the line of flight. Small, steeply-inclined remnants of the posterior shell suffice to show that the form was highly domed.

Brief accounts of two posterior shells of hollow buttons from Menangina Station have been given elsewhere (Cleverly 1973). Their anterior walls have gone completely, possibly because they were 'blown through' during ablation flight and the remnants subsequently eroded.

Discussion

Though only a single indubitable example of a hollow australite with unbreached cavity was found, specimens with breached cavities and fragments of hollow forms are widespread. There is no reason to think that hollow australites were initially less abundant in Western Australia than elsewhere. The scarcity of well preserved specimens but relative abundance of imperfect ones reflects the fact that nearly 90% of Western Australian australites in collections are from the goldfields region of the interior where rigorous weathering and erosion processes are operative.

Hollow australites occur more abundantly in some districts than in others, e.g. on Mount Remarkable Station where 10 specimens out of 313 showed breached cavities in the range 2-14 mm diameter. This observation prompted an examination of collections of significant size from adjoining areas but the australites from neither Yerilla nor Edjudina are notable for the presence of cavities.

Partial collapse of the secondary form into cavities was shown by five of the specimens examined. I have observed a probable example of a frontally collapsed hollow core from Peake Station, South Australia and it would be surprising if other examples did not occur in eastern Australia, though they do not appear to have been reported.

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