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A new species of taipan (Elapidae: *Oxyuranus*) from central Australia

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Abstract

Snakes in the Australo-Papuan elapid genus *Oxyuranus* are considered to be the most venomous species in the world. A recent expedition to the central ranges of Western Australia discovered a third species, which is described here from the only known specimen. Molecular genetic analyses using mitochondrial nucleotide sequences places the new species as the sister lineage of the two described *Oxyuranus* species, with all three species united by a long branch that also separates them from the nearest of the brown snakes species (*Pseudonaja*) to which the taipans are close relatives. Morphologically, the new species shares with the other *Oxyuranus* an undivided anal scale, high midbody scale row (21) and ventral scale (250) counts, but differs in having a single primary temporal scale and fewer lower labials (six). Maximum body size and venom potency are unknown. The discovery of a third species of taipan in the remote central ranges of Australia underlines the paucity of collecting from this region.

Key words: Elapidae, mitochondrial DNA, species boundary, snake, taipan

Introduction

Australian elapid systematics has advanced in recent years largely through phylogenetic analysis of new molecular and detailed morphological data (e.g., Smith 1982, Keogh 1998, 1999; Keogh *et al*. 1998,2000; Slowinski & Keogh 2000; Skinner *et al.* 2005; Wüster *et al.* 2005). Recently, subtly distinct, cryptic species have been described from widespread highly variable taxa (e.g., Keogh & Smith 1996; Aplin & Donnellan 1999). However, it has been very rare to discover new species of large-bodied Australian snakes readily distinguished by traditional morphological features (but see Smith 1981 for a python example).

The two described species of *Oxyuranus* are among the most venomous snakes in the world, with *O. microlepidotus* (McCoy 1879) ranked the most and *O. scutellatus* (Peters 1867) the third most venomous (after *Pseudonaja textilis*) (Broad *et al.* 1979). These rankings were based on laboratory tests of venom toxicities on mice and do not reflect actual human fatalities from snake bites. In essence, the high venom potency of taipans is believed to be an adaptation to cope with potentially harmful mammal prey, upon which they feed almost exclusively (Shine & Covacevich 1983). The potential danger of *O. scutellatus* and to a lesser degree *O. microlepidotus*, has been well publicised (Worrell 1958; Stackhouse 1970; Jones 1977). Despite the high profile of taipans, and that the two species were described over 125 years ago, documentation of their ecology,

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behaviour, reproductive biology, relationships and distribution has been slow (Covacevich *et al.* 1981; Covacevich 1987; Shine & Covacevich 1983; Skinner *et al.* 2005). More recently, observations of captive taipans (Barnett 1978, 1986) have complemented data on reproduction and feeding from available museum specimens (Shine and Covacevich 1983).

The inland taipan, *O. microlepidotus*, occurs in two populations, one in the channel country of arid south-western Queensland and northeastern South Australia, and a second on the cracking clay plains north and east of Coober Pedy in central South Australia (Fig. 1). In contrast, the coastal taipan, *O. scutellatus*, occurs in a wider variety of habitats including sugarcane fields and woodlands along the eastern and northern coast of Australia in separate populations in the northwest Kimberley region of Western Australia, Northern Territory and from Cape York to northern New South Wales (Fig. 1). The species also occurs in a range of savannah habitats in southern New Guinea (O'Shea 1996).

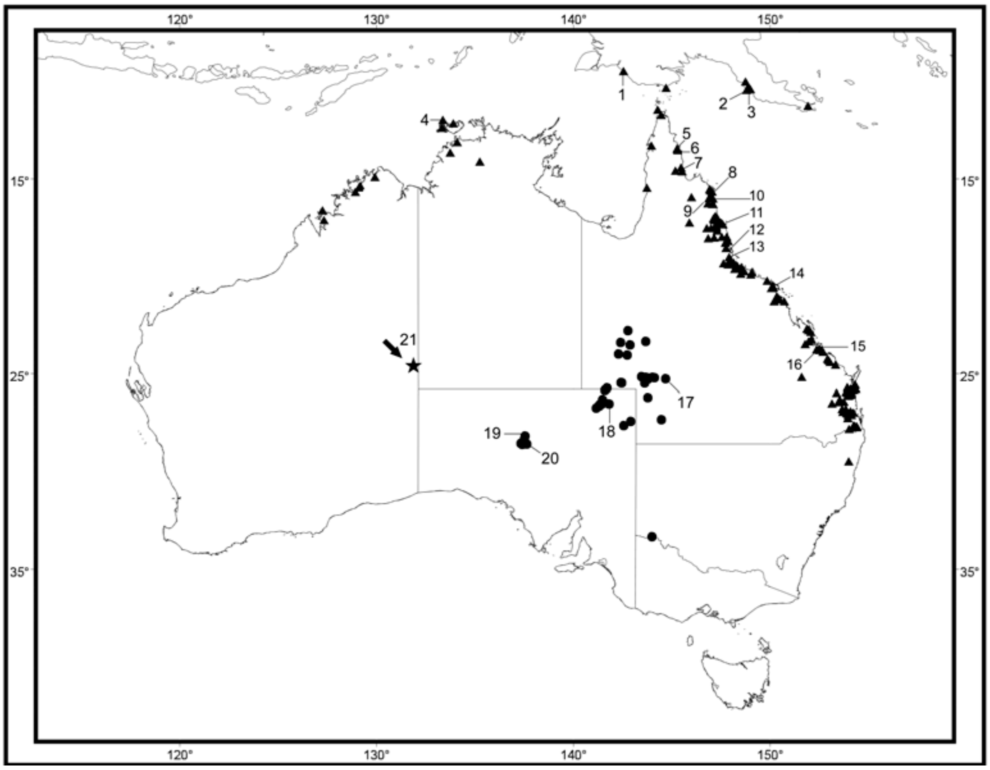


FIGURE 1. Distribution of *Oxyuranus scutellatus, O. microlepidotus* and *O. temporalis* sp. nov. in Australia and New Guinea from McCoy (1879) and records in the collections of the Australian, Northern Territory, Queensland, South Australian and Western Australian Museums, and the Australian National Wildlife Collection (CSIRO). Numbered collection locations are detailed in Table 1 and indicate sites sampled for the molecular genetic analyses. *Oxyuranus microlepidotus* ●, *O. scutellatus* ▲, and *O. temporalis* ★.

Recent efforts to map biodiversity on a continental scale in Australia have led to the identification of several areas in eastern Western Australia that are under-surveyed for biological diversity (How & Cowan 2006). A recent targeted survey to the central ranges of Western Australia to address the lack of biological survey in eastern Western Australia resulted in the discovery of a third species of taipan. Only one immature animal was captured and at the time was presumed to be a western brown snake (*Pseudonaja nuchalis*). Closer examination of the specimen in the laboratory indicated that it possessed several key characters found either in *Oxyuranus* or *Pseudonaja* (i.e., similar colouration, undivided anal scale, single primary temporal scale). Molecular genetic analysis indicates the specimen is a distinctive member of *Oxyuranus*, resolving the ambiguity of the odd combination of morphological characters. We herein describe the new species based on the only known specimen and redefine *Oxyuranus* to accommodate the new taxon.

Methods

Molecular genetic analyses

Mitochondrial *ND4* sequence for the holotype (WAM R166250) was obtained by PCR and direct sequencing following the molecular genetic methods of Skinner *et al*. (2005). This sequence was aligned by eye with other *ND4* sequences which comprised a) a subset of sequences of *Pseudonaja*, published by Skinner *et al*. (2005), and selected to represent the diversity within the major clades found by Skinner *et al*. (2005) within each species; b) 7 published *Oxyuranus* sequences (Skinner *et al*. 2005, Wüster *et al*. 2005) and a further 15 *Oxyuranus* sequenced in the present study; c) sequences from three outgroups — *Pseudechis australis* (Skinner *et al*. 2005) and *Neelaps calonotus* and *Vermicella intermedia* donated by J.S. Keogh; and d) and a further four *P. nuchalis* (SAMA R62113–4, WAM R166246–7; GenBank accession EF210837–40) which were collected on the same survey and in the same region as WAM R166250. Details of specimens sequenced in the present study and obtained from published sources are presented in Table 1.

TABLE 1. Specimens of *Oxyuranus* and outgroups examined for molecular genetic analysis. Numbers in locality column for *Oxyuranus* refer to sample locations on Fig. 1.

Species	Locality	Voucher	GenBank
O. scutellatus	1 - Merauke, West Papua Indonesia	WW274	AY340788
	2 - Port Moresby, PNG	AMS R119562	DQ098438
	3 - Central Prov, PNG	WW1256	AY340788
	4 - Bathurst Island	NTM R17009	DQ098436
	5 - Iron Range	ABTC77163	EF210831
	6 - Lockhart River Road	ABTC77161	EF210828
	7 - McIlwraith Ranges	ANWCR05246	EF210833
	8 - Cooktown	ABTC82464	EF210825
	9 - Julatten	ANWCR06772	EF210834
	10 - Cairns	WW1199, 1132	AY340788
	10 - Cairns	ABTC76944	EF210829
	11 - Bingil Bay	ABTC77160	EF210826
	12 - Jourama Falls	ABTC81245	EF210836
	13 - Crystal Creek	ABTC82991	EF210832
	14 - Mt Ossa	ABTC32087	DQ098437
	15 - Gladstone	ABTC92267	EF210835
	16 - Mt Larcom	SAMAR55909	EF210830
	Queensland	SAMAR24408	EF210827
O. microlepidotus	17 - Windorah	ABTC82463	EF210824
	18 - Goyders Lagoon	SAMAR20583, 26876	DQ098434, EF210823
	19 - 20k NE Coober Pedy	SAMA R49883	DQ098435
	20 - 30k E Coober Pedy	ABTC64860	EF210822
O. temporalis	21 - Walter James Range	WAM R166250	EF210821
Vermicella intermedia	Darwin	SAMAR25672	EF210842
Neelaps calonotus	Muchea Muchea Air Weapons Range	WAMR152960	EF210841

TABLE 2. Specimens of *Oxyuranus* and outgroups examined morphologically. Localities without a State designation are in WA.

Registration no.	Locality	Latitude	Longitude
Oxyuranus temporalis			
WAM R166250	Walter James Range	24°40'06"S	128°45'52"E
Oxyuranus microlepidotus			
QM J41471/8	Morney Plain, 100km W Windorah, Qld	25°22'00”S	141°28'00”E
QM J49901	unknown locality		
QM J50268	captive bred		
SAMA R04284	4.8km S Planet HS, Qld	25°55'00" S	141°07'00" E
SAMA R04289	Mt Leonard Stn, Qld	25°41'00" S	140°45'00" E
SAMA R04303	Mt Leonard HS, Qld	25°41'00" S	140°45'00" E
SAMA R04719–21	Planet HS, Qld	25°52'00" S	141°07'00" E
SAMA R14618	Innamincka area, SA	27°45'00" S	140°44'00" E
SAMA R14649	near Birdsville Track, SA	26°02'00" S	139°19'00" E
SAMA R19201	20km N Moomba, SA	27°59'00" S	140°21'00" E
SAMA R20583	Goyders Lagoon, SA	26°46'00" S	139°08'00" E
SAMA R24128	35km N Clifton Hills HS, SA	26°49'00" S	139°01'00" E
SAMA R26876	Goyders Lagoon, SA	26°46'00" S	139°08'00" E
SAMA R26942	Goyders Lagoon, SA	26°33'00" S	139°10'00" E
SAMA R35074	Goyders Lagoon, SA	26°33'00" S	139°10'00" E
SAMA R40464	61km NNE Coober Pedy, SA	28°33'00" S	134°55'00" E
SAMA R40733	near Clifton Hills Stn, SA	27°01'00" S	138°50'00" E
SAMA R40985	Tomcat Hill, Coober Pedy, SA	29°01'00" S	134°45'00" E
SAMA R42484	7km N Coober Pedy, SA	28°57'00" S	134°47'00" E
SAMA R44080	36km N Coober Pedy, SA	28°42'00" S	134°52'00" E
SAMA R47573	Goyders Lagoon, SA	26°46'00" S	139°08'00" E
SAMA R49764	8km NNW Coober Pedy, SA	28°58'00" S	134°41'00" E
SAMA R49883	20km NE Coober Pedy, SA	28°51'00" S	134°53'00" E
Oxyuranus scutellatus			
SAMA R00358	Coen River, Qld	13°52'00" S	142°51'00" E
SAMA R04365	Mackay, Qld	21°09'00" S	149°11'00" E
SAMA R06754	Cairns, Qld	16°55'00" S	145°46'00" E
SAMA R09964–7	near Cairns, Qld	16°42'00" S	145°38'00" E
SAMA R24518	Funnel Creek S Mackay, Qld	21°48'00" S	148°55'00" E
SAMA R55909	Mt Larcom area, Qld	23°48'00" S	150°58'00" E
WAM R46865	Prince Regent River	15°07'00"S	125°33'00"E
WAM R60666	6km WNW Amax Camp	14°49'00"S	125°47'00"E
WAM R64845	Mitchell Plateau	14°52'00"S	125°49'00"E
WAM R71206	40km S Cooktown, Qld	15°48'00"S	145°14'00"E

...... *continued*

TABLE 2 (continued)

Registration no.	Locality	Latitude	Longitude
WAM R77024–5	Mitchell Plateau	14°49'15"S	125°50'30"E
WAM R103731	Koolan Island	16°09'00"S	123°45'00"E
WAM R106029	Koolan Island	16°09'00"S	123°45'00"E
WAM R146363–4	Kalumburu	14°18'00"S	126°38'00"E
Pseudonaja nuchalis			
WAM R24679	Warburton	26°08'00"S	126°35'00"E
WAM R31325	50km W Windy Corner	23°30'00"S	124°43'00"E
WAM R53588	10km S Jackie Junction	25°46'00"S	126°41'00"E
WAM R55966	52km S Wiluna	25°46'00"S	125°56'00"E
WAM R83670	40km S Balgo	20°31'00"S	127°55'00"E
WAM R95036	Lake Winifred	22°41'00"S	123°32'00"E
WAM R110560	7–8km WNW Point Salvation	28°12'00"S	123°35'00"E
WAM R144978	Doon Doon HS	16°18'45"S	128°14'30"E
WAM R166246	18.3km ENE Blackstone	25°55'51"S	128°26'58"E
WAM R166247	3.3km S Gill Pinnacle	24°55'22"S	128°46'36"E
Pseudechis australis			
WAM R22178	Warburton	2608'00"S	126°35'00"E
WAM R22731–2	Kumarina	24°42'00"S	119°36'00"E
WAM R31020	Tom Price	22°42'00"S	117°47'00"E
WAM R48755	30km N Neale Junction	28°03'00"S	126°00'00"E
WAM R60909	10km W One Arm Point	16°27'00"S	122°59'00"E
WAM R78977	Eneabba	29°49'00"S	115°16'00"E
WAM R81414	Kununurra	15°46'00"S	128°44'00"E
WAM R139398	Ripon Hills	21°14'00"S	120°42'00"E
WAM R166244	Walter James Range	24°39'15"S	128°45'18"E

Phylogenetic analysis by Bayesian inference of the aligned sequences was performed with MrBayes version 3.1.2 (Huelsenbeck & Ronquist 2001; Ronquist & Huelsenbeck 2003). Four data partitions were applied: the three codon positions in *ND4* and the tRNA genes. The GTR+I+G model of nucleotide substitution was found the most suitable model for each partition under the Akaike Information Criterion with Modeltest version (Posada & Crandall 1998). Convergence of the MCMC was assessed from two exploratory runs of 1 x 10^6 generations with convergence assessed in AWTY (Wilgenbush *et al*. 2004) by: plotting log likelihoods of trees sampled every 500 generations against generation, plotting posterior probabilities (PP) of each split against generation after burnin trees were eliminated and by comparing posterior probabilities of each split between the two tree files after burnin trees were eliminated. MCMC chains had converged within 200,000 generations with a few splits with PP <0.95 showing about 10% variation in PP values post-burnin. Final MCMC analyses were performed in two runs of 5 x 10^6 generations with trees sampled every 500 generations.

Morphological analyses

Table 2 lists details of voucher specimens examined for morphological comparisons. Standard body measurements and scale counts were made following Cogger (2000) and Storr *et al.* (2000). To determine the number and configuration of maxillary and palatine teeth we dissected the right side of the mouth by teasing the tissue away from the underlying teeth. X-ray radiographs were also used as a dry skeletal preparation was not possible with only one specimen. As we have no photographs or notes on the colour in life, all description of the colouration is taken from the preserved specimen.

Abbreviations used are: Qld — Queensland; QM — Queensland Museum, Brisbane; SA — South Australia; SAMA — South Australian Museum, Adelaide; SVL — snout-vent length; WA — Western Australia; WAM — Western Australian Museum, Perth.

Results

The aligned sequence dataset comprised 772 sites. A majority rule consensus tree derived from the final two Bayesian runs is shown in Fig. 2. WAM R166250 forms a strongly supported clade with the two described species of *Oxyuranus* (hereafter the *Oxyuranus* clade) and in particular is the strongly supported sister lineage to the two described *Oxyuranus*. Genetic distances among the three lineages range between 11.9% and 14.2% uncorrected sequence divergence. In contrast, inter-specific genetic distances among *Pseudonaja* range between 7% and 16% uncorrected sequence divergence. In contrast to the high levels of genetic divergence between the three lineages of the *Oxyuranus* clade, diversity within the two described species is low. In particular within *O. scutellatus* it is very low with eight haplotypes that differ by a maximum of 1.5% uncorrected sequence divergence present in the 19 specimens sequenced from eastern and northern Australia and New Guinea. Three haplotypes were found among the five *O. microlepidotus* collected from each of the two apparently separate populations of this taxon, i.e. Lake Eyre basin in South Australia and the Cooper basin in south-west Queensland and north-eastern SA. Uncorrected sequence divergence between these populations ranged from 2.8 to 3.1%. The four *Pseudonaja nuchalis* sequenced from the same region as WAM R166250 cluster within one of the '*P. nuchalis*' clades (Fig 2; see also Skinner *et al*. 2005).

Examination of the main characters for large terrestrial elapids in the keys of Cogger (2000) and Storr *et al.* (2000) indicated WAM R166250 had a combination of characters from *Oxyuranus* and *Pseudonaja*. The two genera each have characters thought to be derived with respect to Australian elapids in general. *Pseudonaja* species have lost the lower secondary temporal, evidently via fusion with the last upper labial scale, retain the plesiomorphic divided anal scale and have typical Australian elapid counts of 17 mid-body scale rows (most species; 17–19 in *affinis*, 19–21 in *guttata*). The maxilla is relatively long with numerous (often 8–10) small maxillary teeth following a relatively short fang. Known species of *Oxyuranus* retain a distinct lower primary temporal wedged between the second-last and last upper labial, have a derived single anal scale and have small body scales (in 23 rows, rarely in 21 or 25). The maxilla is shorter with few (1–3) small maxillary teeth following a relatively long fang. WAM R166250 has a single primary temporal, single anal scale and high midbody scale count of 21 (high for a *Pseudonaja*, low for an *Oxyuranus*). It has a single post-fang maxillary tooth, and in other respects (elongate head, high ventral count) is more like *Oxyuranus* than *Pseudonaja*.

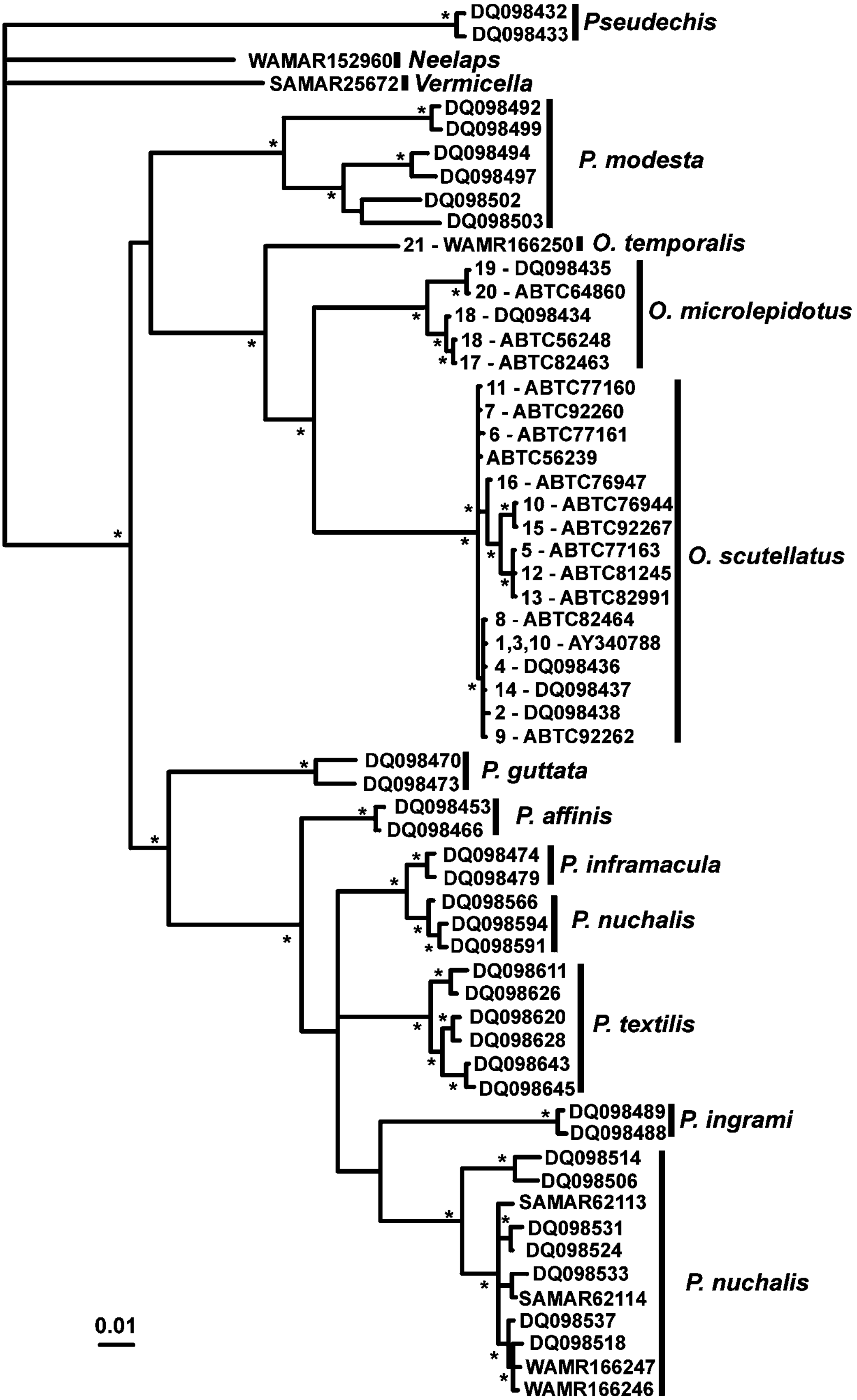


FIGURE 2. A majority rule consensus tree derived from the final two Bayesian runs showing phylogenetic relationships among mitochondrial *ND4* haplotypes from *Oxyuranus* and *Pseudonaja*. Asterisks at nodes indicate posterior probabilities ≥0.95. Terminal taxa are designated by GenBank Accession numbers or voucher registration numbers. Numbers at the start of each *Oxyuranus* specimen refer to collection locations in Table 1 and Fig. 1.

We can suggest two hypotheses that might explain this blurring of the distinction between the two lineages: 1) WAM R166250 is a new species of *Oxyuranus* that shares some morphological character states with *Pseudonaja*; 2) WAM R166250 is an intergeneric hybrid between species of *Pseudonaja* and *Oxyuranus*. If the specimen is a hybrid, the female parent was an *Oxyuranus,* as the sequence is unambiguously placed as a sister to the known species of *Oxyuranus*. However, the same data show that this sequence is as divergent from the known species of *Oxyuranus* as they are from each other. Similarly, the area from which the specimen comes is remote from the known geographic range and habitat preferences of either known species of *Oxyuranus*. Therefore, if the specimen is a hybrid, the distinctive DNA sequence and habitat data are such that it in all likelihood the female parent was a previously unknown species of *Oxyuranus,* a conclusion not very different from hypothesis 1. Two candidate species for the male parent of such a hybridisation occur sympatrically with WAM R166250, *P. modesta* and *P. nuchalis*. On the basis of adult body sizes *P. nuchalis* (max SVL 140 cm) would be the more likely participant in an inter-generic mating with *Oxyuranus* than *P. modesta* (maximum SVL 52 cm). Throughout their ranges, the two known species of *Oxyuranus* are sympatric with one or more species of *Pseudonaja*, but a wild hybrid has never been recorded. In spite of the fact that both *Pseudonaja* and *Oxyuranus* species have been widely kept as captives over many decades, no instance of a hybridisation between the two has been documented.

Of the two explanations, we find hypothesis 2 requires a more complex and unlikely set of circumstances than hypothesis 1. We conclude that hypothesis 1, i.e. WAM R1616250 represents a hitherto unknown species of *Oxyuranus,* is the best explanation for our data. Under this view, the principal morphological anomaly is the temporal scale arrangement, which matches the apparently derived state seen in *Pseudonaja*. The cause of this homoplasy might be parallel evolution, with independent acquisition by *Pseudonaja* and the ancestor of WAM R166250, or reversal, with loss of the lower temporal in the common ancestor of *Oxyuranus* and *Pseudonaja* followed by re-expression of the lower primary temporal in *O. microlepidotus* and *O. scutellatus*. As noted above the precise branching order among these snakes is still poorly supported, so the choice between these explanations must await better resolution of the phylogeny of these snakes.

In the description below we provide a detailed morphological assessment of WAM R166250, which, based on the molecular genetic analysis and novel combination of morphological characters, we describe as a new species of *Oxyuranus*.

Taxonomy

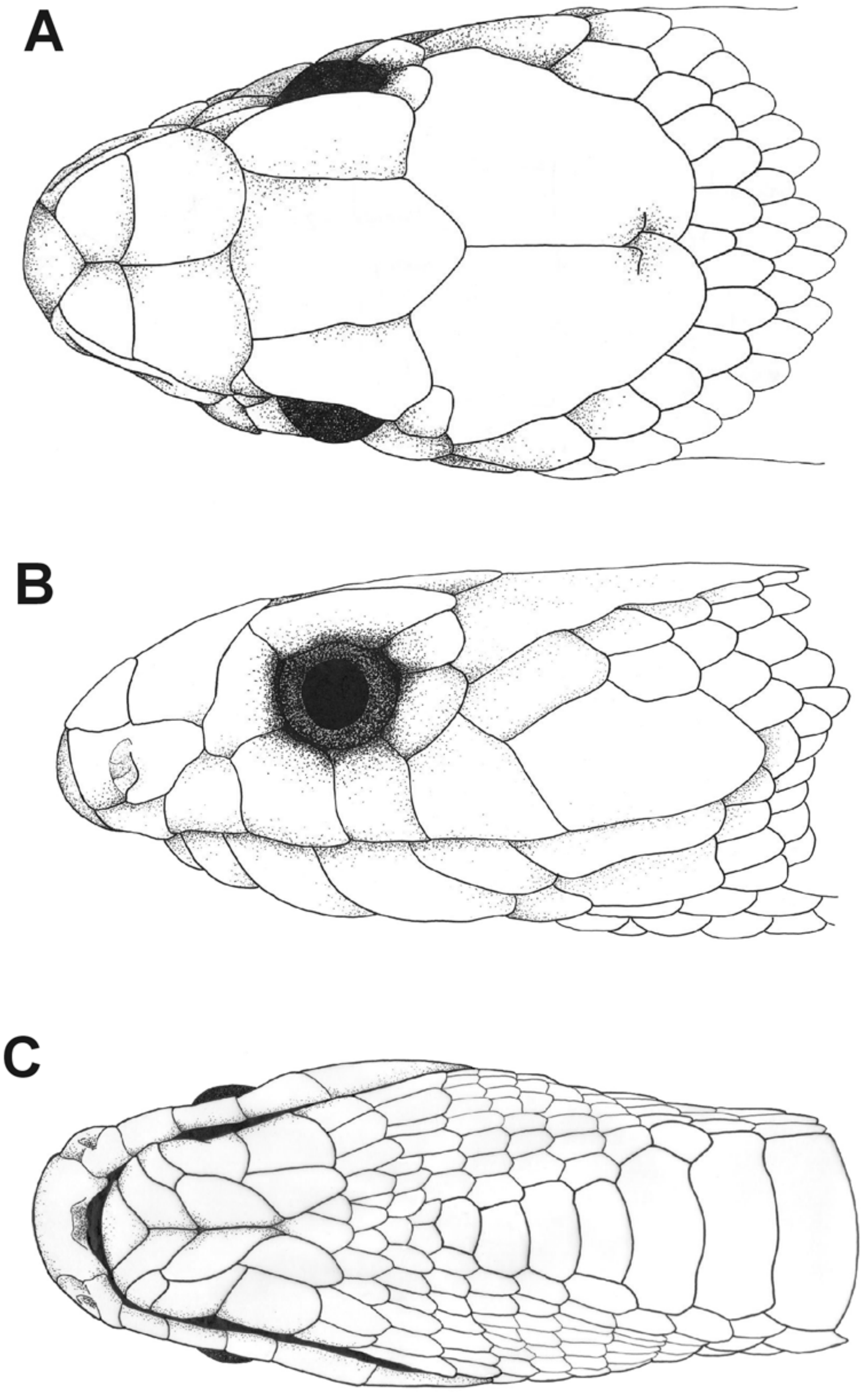
Within the Australo-Papuan Elapidae, the specimen is diagnosable as a member of *Oxyuranus* (Covacevich *et al.* 1981; Cogger 2000; Storr *et al*. 2000) based on the following characters: undivided anal scale, paired subcaudals, high midbody scale rows (21), absence of suboculars, few maxillary teeth (1) and tail tip not ending in a soft spine. To this diagnosis we now add the presence of either one or two primary temporal scales.

***Oxyuranus temporalis* new species.**
(Figs 3 & 4)
Central Ranges Taipan

Holotype. WAM R166250 (SAMA field number BS-009075). A subadult female collected to the east of the Walter James Range, Western Australia (24°40’06”S, 128°45’52”E), on 22 September 2006 by M. Hutchinson. Liver stored frozen at SAMA.

Diagnosis. A species of *Oxyuranus* distinguished from *O. microlepidotus* and *O. scutellatus* by one (rather than two) primary temporal scales and six (rather than seven) lower labials.

Description of holotype. Measurements and counts: SVL—845 mm; tail length—125 mm (14.8% of SVL); head length (from rostral to back of parietal scale—19.0 mm; head width (at posterior edge of jaw)—12.1 mm; Midbody scales in 21 rows at midbody (ventral 120), reducing from 31 behind the parietals, to 24 one head-length behind the head, to 17 one head-length in front of the vent; 250 ventrals; 60 subcaudals, all paired.



FIGURES 3 A–C: A, lateral; B, dorsal; and C, ventral head diagrams of the holotype of *Oxyuranus temporalis* sp. nov. (WAM R166250).

Head distinct from neck. Tail elongate, tapering gradually from the cloaca. Scales smooth with a subtle convexity; no hint of keeling. Anal scale entire. Two pairs of pregenial and postgenial scales; anterior edge of pregenial in narrow contact with second lower labial; anterior edge of postgenial in narrow contact with third lower labial. Intergulars six and narrowing anteriorly towards chin; four gular scales between anterior most intergular and postgenial scales.

Head rectangular (sides parallel) tapering to a broadly rounded snout. Moderately sharp canthus rostralis and angular brow ridge that protrudes slightly beyond eye. Eyes large. Rostral scale large and arched dorsally; lingua fossa large and circular. Nasals entire, perforated by large nostril that opens posteriorly. Margin of nostril just reaches ventral border of nasal. Internasals squarish and approximately half the length of the prefrontals. Prefrontals large and as wide as long. Sides of frontal slightly concave, width of anterior edge slightly smaller than length, posterior edges converging at 45° angles. Supraoculars 2.5 times longer than wide, gradually narrowing anteriorly (1.5 times longer than prefrontals). Preocular twice as high as wide, separated from frontal but ventral anterior edge extends to contact nasal. Two postoculars, lower about twice as high as upper. A single primary temporal scale with two secondary temporals. Parietals large, longer than wide; short medial transverse suture located near posterior edge of scales. Upper labials 6; lower labials 6 (7 if small scale below sixth upper labial is counted; see Fig. 3). Labials have a slightly serrated appearance along jaw. Last upper labial large and rectangular except for encroachment of lower secondary temporal into dorsal posterior corner. Right front fang 3.0 mm long (left fang broken inside sheath). A single tooth follows the fang on the maxilla. Palatine with a toothless portion anteriorly, followed by approximately 8 teeth (estimated from partial dissection). 10 dentary teeth.

Colouration in preservative. Body is light pale brown with diffuse darker olive grey variegations (Fig. 4). Head creamy brown and distinctly paler than body. No dark collar separating the pale head from the browner body colour. The skin from many scales has sloughed off revealing a pale whitish underlying ground colour with darker olive grey scales maintaining contrast to ground colour. Ventral surface pale yellowish white; no yellow tinge on subcaudals. Slight indication of spotting on ventral surface towards head. Eye black with black iris, pupil round. Lining of mouth pale.

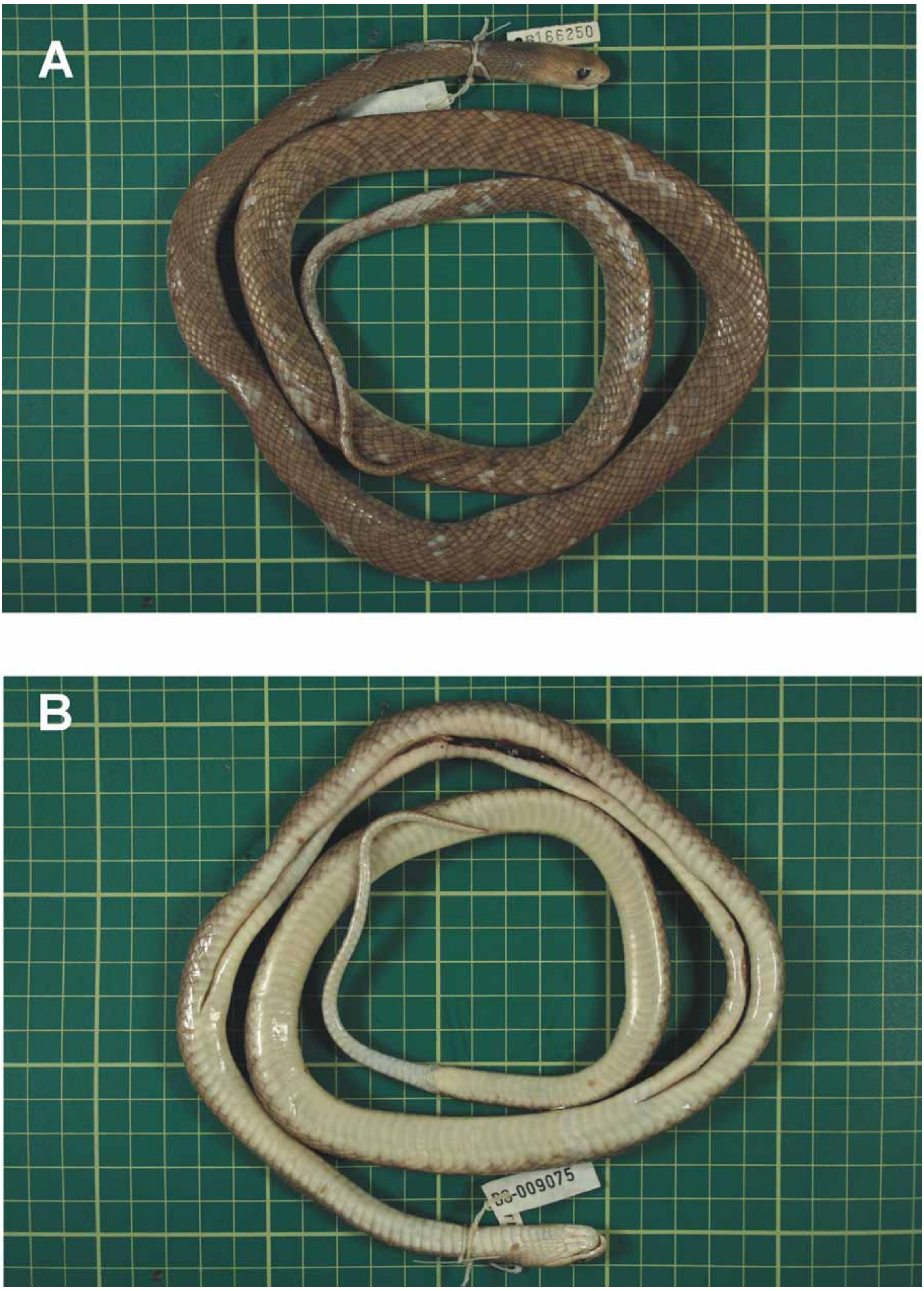
Reproduction and diet. It is likely that the female was approaching maturity as there are four undeveloped follicles in the left ovary (largest = 2.87 mm) and three in the right ovary (largest = 3.18 mm). Size at maturation in the other species of *Oxyuranus* is close to the size of the holotype (Shine & Covacevich 1983). Numerous fat bodies are present. Dissection of the gut revealed several clumps of hair from recent small mammal prey items.

Habitat and behaviour. The specimen was captured on a hot sunny day crossing a dirt road on a deep sandy flat with very open low mallee (*Eucalyptus* spp.) and *Grevillea* over storey and diverse shrubby understorey dominated by *Triodia*. The snake was sighted from a motor vehicle, at approximately 1600 h. When the vehicle passed the snake and stopped, the snake remained immobile rather than fleeing, and when approached it adopted an “S” threat pose typical of *Pseudonaja* and *Oxyuranus* (M. Hutchinson, pers. obs.)

Distribution. The holotype was collected on the eastern margin of the Walter James Range of Western Australia near the borders of Northern Territory and South Australia (Fig. 1). Further specimens need to be encountered before the extent of the distribution of *O. temporalis* is determined.

Comparison with other species. Comparisons with other species are limited owing to only a single specimen of *O. temporalis*. Below we comment on the most obvious characters not likely to greatly vary within species.

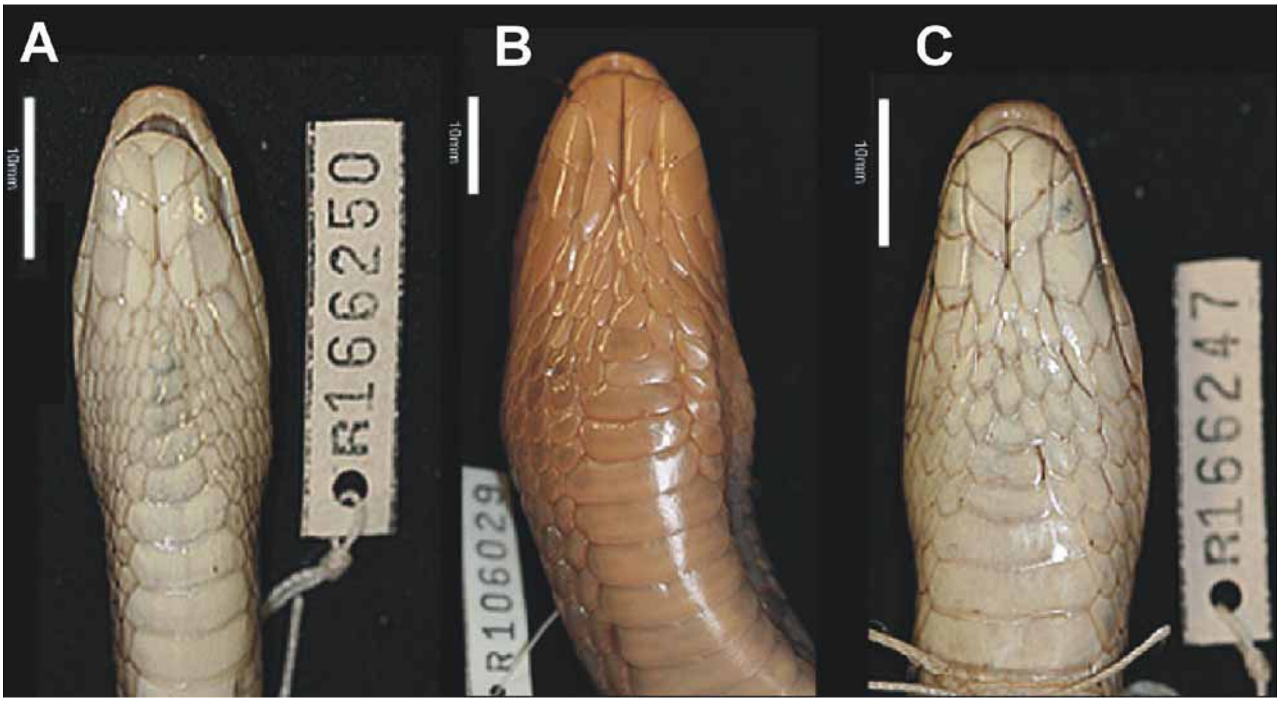
Oxyuranus temporalis is distinguished from the sympatric and related large elapids *Pseudechis australis* and *Pseudonaja nuchalis* by 21 (versus 17) midbody scale rows, undivided anal scale and greater number of ventrals (250 versus < 230). These characters also distinguish *O. temporalis* from *Pseudonaja modesta* that has a much smaller body size and usually some indication of dark rings on body. *Oxyuranus* have more intergulars than *Pseudonaja nuchalis* as well (Fig. 5).



FIGURES 4 A–B: A, Dorsal and B, ventral photographs of the holotype of *Oxyuranus temporalis* sp. nov. (WAM R166250).

Within *Oxyuranus*, *O. temporalis* differs from *O. microlepidotus* and *O. scutellatus* by possessing a single primary temporal scale. In the other two species, as in most Australian elapids, there is a second primary temporal, penetrating deeply between the sixth and seventh upper labials. There are seven lower labials in *O. scutellatus* and *O. microlepidotus* whereas there are six in *O. temporalis*. In most *O. microlepidotus* and *O. scutellatus*, the nasal and preocular are separated or in narrow or point contact. In *O. temporalis*, the contact is more extensive but, given the variation observed in the other two species, this condition needs to be examined in more specimens of *O. temporalis*. *Oxyuranus temporalis* has a single post-fang maxillary tooth, similar to the state seen in *O. scutellatus*, whereas *O. microlepidotus* has 3–5. *Oxyuranus temporalis* can be further distinguished from *O. microlepidotus* by fewer midbody scale rows (21 versus 23–25) and from *O. scutellatus* by the possession of smooth (versus keeled) anterior dorsal scales.

Etymology. From the Latin *temporalis* in reference to the different arrangement of temporal scales compared to the other two species of *Oxyuranus*.



FIGURES 5 A–C: Comparison of gular regions of A, *Oxyuranus temporalis* sp. nov. (WAM R166250), B, *O. scutellatus* (WAM R106029) and C, *Pseudonaja nuchalis* (WAM R166247).

Discussion

Oxyuranus temporalis is a distinctive species of taipan. The molecular data support *O. temporalis* as the sister species of *O. microlepidotus* plus *O. scutellatus*, but the latter two species are also strongly divergent from one another. All three taipans are well supported as a monophyletic group (posterior probability 1.00) with respect to their nearest relatives in *Pseudonaja*. The mix of morphological character states seen in the holotype of *O. temporalis* reduces the number of features that separate *Oxyuranus* from *Pseudonaja*. In scalation (single primary temporal) and colour (spotting, albeit weak, on the belly), this species is more like *Pseudonaja* than the other *Oxyuranus*. While our phylogenetic analysis found a paraphyletic *Pseudonaja*, i.e. the *Oxyuranus* clade is embedded within *Pseudonaja*, it should be noted that our result was not strongly supported (see relevant node in Fig. 2) and that it conflicts with the findings of Skinner *et al*. (2005) who analysed a much larger number of sequences and found the two genera to be reciprocally monophyletic. Also we used a different combination of outgroups to Skinner *et al*. (2005). Taken together these results suggest that the relationships between *Pseudonaja* and *Oxyuranus* as determined from analysis of mitochondrial DNA are sensitive to taxon sampling and should conservatively be regarded at present as not different from the conventional taxonomic arrangement of these taxa, i.e. two lineages.

The large genetic distances among the three species coupled with their disparate distributions (northern and eastern coast [*O. scutellatus*], eastern arid zone [*O. microlepidotus*] and western central ranges [*O. temporalis*]) suggest taipans were once more widespread in Australia. Climate change, competition from other snakes such as *Pseudonaja* and *Pseudechis australis* or changes in the distribution and abundance of mammalian prey may have resulted in their current relictual distributions. Almost nothing is known of the biology, habits and ecology of *O. temporalis*. The other two species of taipans are the largest terrestrial elapids in Australia and among the most venomous species in the world. How *O. temporalis* compares to *O. microlepidotus* and *O. scutellatus* will rely on encounters with more specimens of *O. temporalis* to determine maximum size and to obtain venom samples to test their potency. The rate of discovery of further information on the biology of *O. temporalis* may follow a similar slow course to that of the other taipans owing to the former's remoteness in central Australia (Covacevich 1987).

The discovery of a third species of taipan after more than 125 years since the last species was described is testament to the large expanses of the Australian arid zone that remain poorly surveyed for reptiles. There are likely to be other undescribed species of reptiles in these parts of north-eastern Western Australia and western Northern Territory that have rarely been visited by biologists.

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