Ecology of the Pygmy Monitor *Varanus brevicauda* in Western Australia

Dennis R. King † & Eric R. Pianka

Abstract

We examined 167 specimens of the smallest of all monitors, *Varanus brevicauda,* lodged in the Western Australian Museum, 82 of which were collected at Yamarna in the Great Victoria Desert. These samples allow comparison of the diet of a local population with a regional sample that covers many different localities. We also report data on anatomy, behavior, and reproduction in Western Australia and compare these with a study from central Australia.

Key words: Squamata, Varanidae, *Varanus brevicauda*; anatomy, behavioral and reproductive ecology, Australia.

Introduction

The smallest of all monitors, *Varanus brevicauda* are cryptic denizens of spinifex flats in red sand deserts of interior Australia (Pianka 2004). Most specimens collected are captured in pit traps, but sample sizes of previous studies have usually been small (Pianka 1970, 1986, 1994). Here we collate and report data from 167 specimens lodged in the Western Australian Museum (hereafter WAM). Nearly half of these (82) were collected near the southern limit of the geographic range at Yamarna between 1989 and 2003 by ERP in the Great Victoria Desert (hereafter GVD). This sample allows us to examine a local population, whereas the complete WAM sample covers about 50 different localities scattered about arid inland Western Australia (Fig. 1).

This secretive terrestrial pygmy monitor is seldom seen, but can be common. Dozens have been pit trapped on flat sandplains covered with large, long unburned, clumps of spinifex, possibly the preferred habitat of *V. brevicauda* in the GVD (Pianka 1994, 1996). At this site, 90% of lizards were found on flat sandplains and only a few lizards were trapped on sandridges. However, at another spinifex dominated sand-dune site in central Australia, *V. brevicauda* were associated with crests of sand dunes, where they were quite abundant, with densities estimated at about 20 adults per hectare (James 1994, 1996). A mark-recapture study in central Australia suggested that they are relatively sedentary (James 1996). The ecology of *V. brevicauda* in central Australia (James 1996) differs from its ecology in the GVD (see discussion).

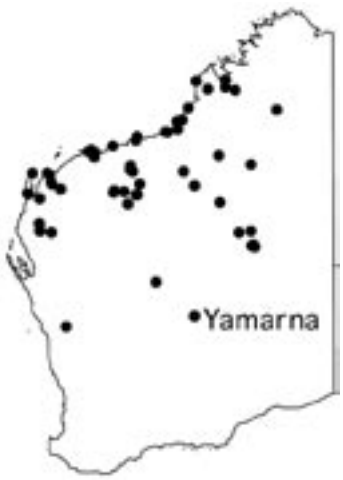

Fig. 1. Map showing localities of *Varanus brevicauda* in Western Australia.

Varanus brevicauda are terrestrial but they probably climb around within spinifex tussocks. Their tails are very muscular and prehensile and they "hang on for dear life" when inside a spinifex grass tussock using their legs as well as their muscular

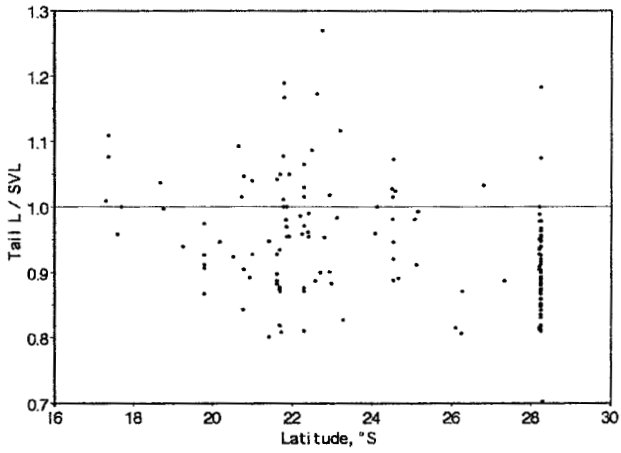

Fig. 2. Ratio of preserved tail length over preserved SVL for all specimens plotted against latitude.

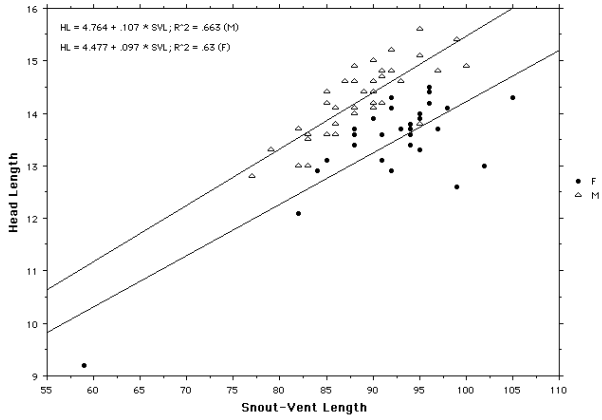

Fig. 3. Head length plotted against SVL. Females shown with solid circles, males shown with triangles.

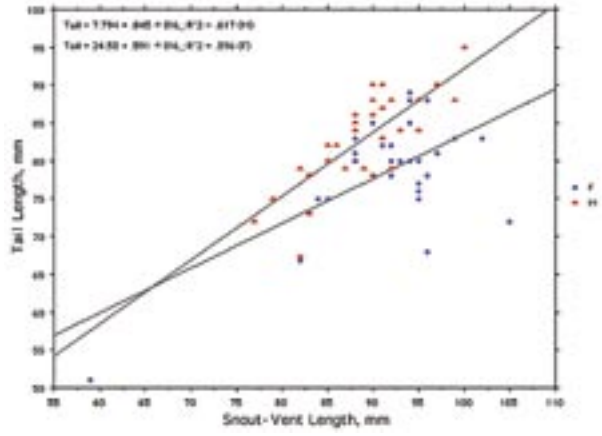

Fig. 4. Tail length plotted against SVL. Females shown with solid circles, males shown with triangles.

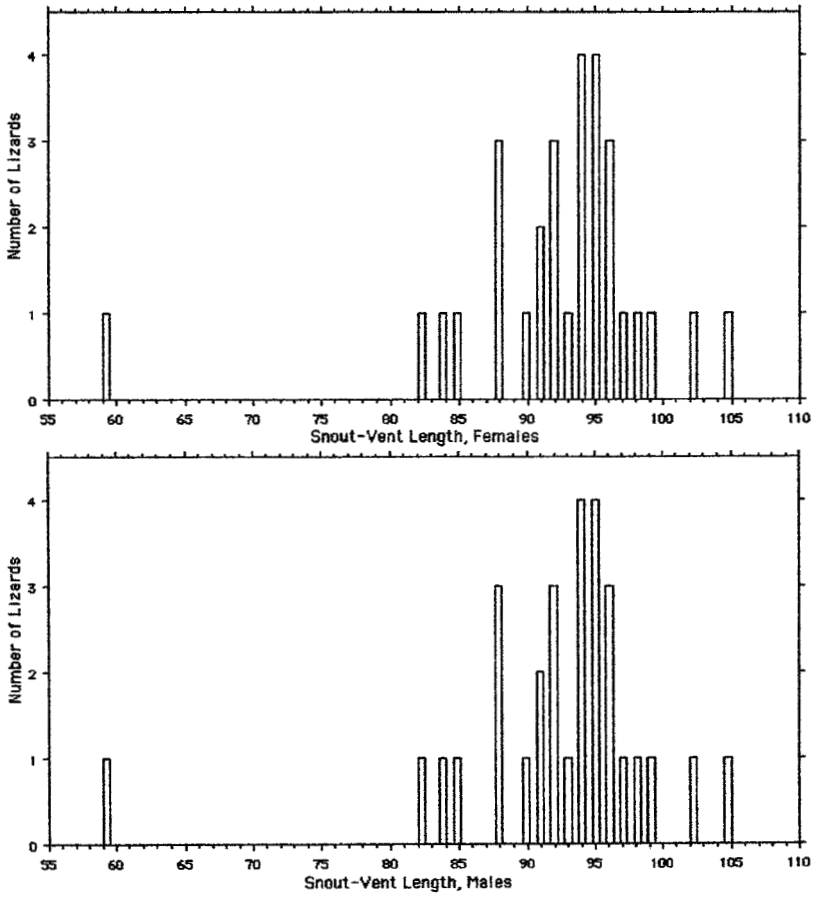

Fig. 5. Histograms of SVLs of males (above) and females (below).

prehensile tail (Pianka 2004). They appear to rely on spinifex for protection. One was found in the stomach of a *Varanus gouldi flavirufus* (Pianka 1994).

The typical monitor lizard threat posture and behavior has been conserved in the evolution of these tiny monitors, which hiss and lunge with their throat inflated as if they are a serious threat (Pianka 2004).

Varanus brevicauda is broadly sympatric with *V. eremius*, both of which belong in the clade *Odatria.*

Methods

Preserved snout-vent length (SVL) and tail lengths of specimens were measured in mm. Lizards were then dissected and reproductive condition and stomach contents examined. Length and widths of testes were measured for males, and numbers and sizes of ovarian and oviductal eggs were counted and measured for females. Fresh SVL, tail

length, and weight were measured before preservation for Yamarna specimens. Ten body measurements were taken on preserved Yamarna specimens with mm rulers and/or digital calipers: preserved SVL, preserved tail length, head length, head width, head depth, jaw length, foreleg length, hind leg length, forefoot length, and hind foot length. For Yamarna specimens, lengths of fat bodies were also measured.

Results

SVL ranges from 42 to 126 mm across WA (mean = 88.9 ± 1.33), and tail length varies from 38 to 118 mm (mean = 83.3 ± 1.38). In the GVD of Western Australia, fresh SVL ranges from 59 to 105 (mean = 90.0 ± 0.81), with fresh tail lengths ranging from 51 to 95 mm (mean = 80.85 ± 0.82). Tail length ranges from 80-128% of SVL (mean = 94.1 ± 0.7) (Fig. 2). In the southern part of the geographic range in the GVD, tail length is usually slightly less than or approximately equal to SVL, but in the northern and western parts of the geographic range, tails of some lizards are somewhat longer (Fig. 2). In the GVD, females reach sexual maturity at about 94 mm SVL and males do so at about 82 mm SVL (Pianka 1994). Males are slightly smaller than females (SVL means, females = 93.9 ± 1.72, males =88.9 ± 1.58, but tend to weigh a little more (females = 8.93 ± 0.393, males = 9.15 ± 0.275). Males have larger heads (females = 13.45 ± 0.18, males = 14.24 ± 0.11) and relatively longer tails than females (Tail/SVL ratios, females = 0.86 ± 0.012, males = 0.933 ± 0.006) (Figs. 3, 4, and 5).

Larger males have larger testes than smaller males (Fig. 6), but a plot of testes size against day of the year does not show much of a seasonal cycle (Fig. 7), although testes of some males do seem to be enlarged during September-November.

Fat bodies in females are larger (23.97 ± 2.323) than they are in males (12.86 ± 2.876). Fifteen females had enlarged yolked ovarian eggs during late October, November, and early December. Shelled oviductal eggs were found in six other females in late November and early December when eggs are presumably laid. Incubation time in captivity is 107-109 days (Thompson 1996). In the present sample, thirteen females had clutches of two, and 8 females had clutches of three (average CS = 2.42). Relative clutch mass

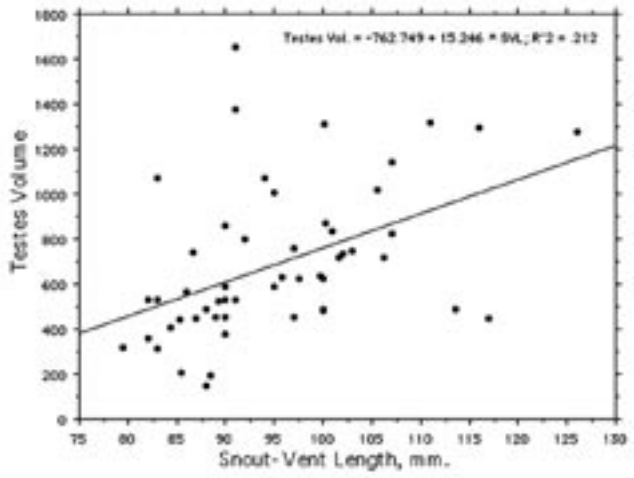

Fig. 6. Testes volume plotted against male SVL.

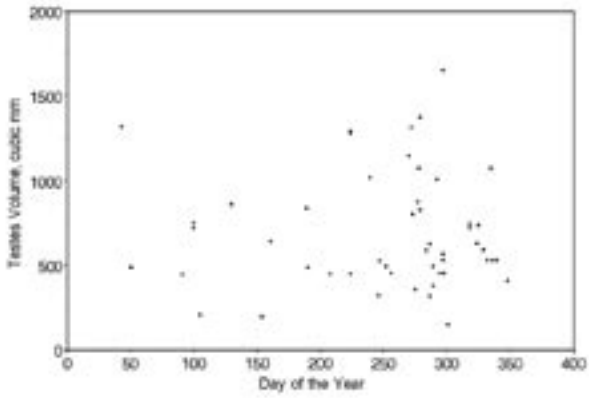

Fig. 7. Testes volume plotted against day of the year.

(clutch volume) of 4 females with oviductal eggs averaged 20% of female weight. Neonates hatch in January and February at about 42-45 mm SVL and weigh about 1-2 grams. In captivity, they grow very fast, with one almost doubling its weight in just a month (Thompson 1996).

Major prey are grasshoppers, spiders, and beetles. Other items eaten include centipedes, scorpions, isopods, cockroaches, caterpillars, other insect larvae, and pupae (Tables 1, 2, and 3). Eleven of 122 stomachs with food contained lizards or parts of lizards. Lizard species eaten include *Ctenotus calurus, Ctenotus duricola,* and *Ctenotus piankai.* Several stomachs contained only *Ctenotus* tails. Two individuals had eaten tails of *Diplodactylus conspicillatus*, a nocturnal gecko. Since these geckos spend the daytime hours in abandoned trapdoor spider burrows, we surmise that *Varanus brevicauda* individuals must go down into these burrows during the day and bite off gecko tails. Recently, ERP found a *Diplodactylus conspicillatus* tail in the stomach of a *Varanus eremius* (Pianka 2006). Two other pygmy monitors, *Varanus caudolineatus* and *V. gilleni*, are also known to harvest tails of geckos (*Gehyra*) in their diurnal retreats (Pianka 1969).

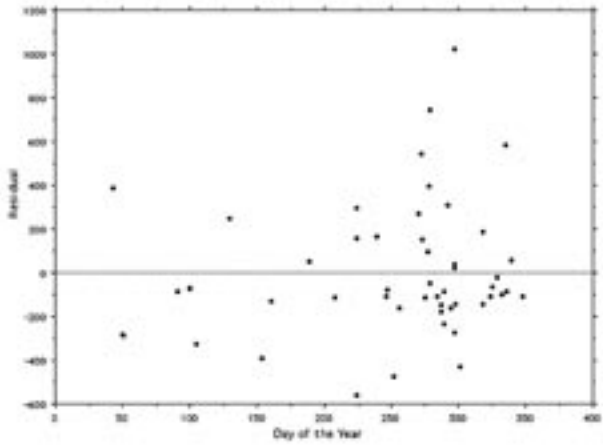

Fig. 8. plots the residuals of the regression shown in Fig. 6 versus day of the year, showing that testes tend to be larger during the Austral spring.

Tab. 1. Summary of stomach contents of 68 (42 new) *Varanus brevicauda* with food in their stomachs (26 other stomachs were empty). Frequencies based on 68 stomachs.

Prey species	Number	Volume	Proportion (ml)	Proportion of Total Number	Frequency of Total(Percent Volume	Stomachs)
Centipedes	3	2.60		0.031	0.068	4.4
Spiders	17	7.75	0.177	0.204	22.1	
Grasshoppers	12	6.55	0.125	0.172	17.7	
Cockroaches	5	1.55	0.052	0.041	7.4	
Hymenoptera	1	0.15	0.010	0.004	1.5	
Beetles	14	2.85	0.146	0.075	20.6	
Caterpillars	2	0.80	0.021	0.021	1.5	
Other Larvae	6	0.40	0.062	0.011	2.9	
Pupae	2	0.25	0.021	0.007	1.5	
Unidentified Insects	26	6.05	0.271	0.159	38.2	
Lizards	5	6.40	0.052	0.168	7.4	
Reptile Eggs	3	2.70	0.031	0.071	2.9	
Totals	96	38.05	100.0	100.0	100.0	

Tab. 2. Summary of stomach contents of 54 WAM *Varanus brevicauda* with food in their stomachs (51 other stomachs were empty). Frequencies based on 54 stomachs.

Prey species	Number	Volume	Proportion (ml)	Proportion of Total Number	Frequency of Total(Percent Volume	Stomachs)
Spiders	1	0.20		0.015	0.011	1.7
Scorpions	3	0.90		0.044	0.047	3.4
Ants	1	0.05		0.015	0.003	1.7
Grasshoppers	14	5.55		0.206	0.293	15.3
Cockroaches	3	1.00		0.044	0.053	5.1
Beetles	2	0.60		0.029	0.032	3.4
Isopods	2	0.10		0.029	0.005	1.7
Caterpillars	2	0.30		0.029	0.016	1.7
Insect eggs	4	0.20		0.059	0.011	6.8
Other Larvae	3	0.25		0.044	0.013	5.1
Unidentified Invertebrates	23	2.20		0.338	0.116	39.0
Lizards	6	5.30		0.088	0.280	10.2
Reptile Eggs	4	2.30		0.059	0.121	5.1
Totals	96	38.05	100.0	100.0	100.0	

Tab. 1. Summary of stomach contents of 122 (96 new) *Varanus brevicauda* with food in their stomachs (77 other stomachs were empty). Frequencies based on 122 stomachs.

Prey species	Number	Volume		Proportion (ml)	Proportion of Total Number	Frequency of Total(Percent Volume	Stomachs)
Centipedes	3	2.60			0.018	0.046	2.1
Spiders	18	7.95		0.110	0.140	11.0	
Scorpions	3	0.90			0.018	0.016	1.4
Ants	1	0.05			0.006	0.001	0.7
Grasshoppers	26	12.10			0.160	0.213	14.5
Cockroaches	8	2.55		0.049	0.045	5.5	
Hymenoptera	1	0.15		0.010	0.004	1.5	
Beetles	16	3.45		0.098	0.061	11.0	
Isopods	2	0.10			0.012	0.002	0.7
Caterpillars	4	1.10		0.025	0.019	1.4	
Insect eggs	4	0.20			0.025	0.004	2.8
Other Larvae	9	0.65		0.055	0.011	3.5	
Pupae	2	0.25		0.012	0.004	0.7	
Unidentified Insects	49	8.25		0.301	0.145	33.8	
Lizards	11	11.70			0.067	0.206	7.6
Reptile Eggs	7	5.00		0.043	0.088	3.5	
Totals	96	38.05	100.0	100.0	100.0		

Discussion

Although ritualized male combat has not yet been observed in *Varanus brevicauda,* it almost doubtlessly occurs. The sexual size dimorphism in relative head size has probably evolved in response to sexual selection operating between males for superior agonistic behavior. Interestingly, no such sexual dimorphism in head size is detectable in *V. eremius* (Pianka 2006).

In the GVD, *Varanus brevicauda* are usually found on flat desert sandplains and seldom occur on sandridge crests, but in central Australia, they are most abundant on sand dune crests (James 1994, 1996). Males are smaller than females in the GVD, but in central Australia males are larger and heavier than females (James 1996). Reproductive data presented by James (1996) are largely congruent with what we found in WA, except that he reported smaller sizes at sexual maturity. From mark-recapture studies, James (1996) concludes that, in central Australia, *Varanus brevicauda* grow slowly, with males reaching sexual maturity at about 70 mm SVL during their first spring at about age 10 months, whereas females do not reach sexual maturity until they are 85-93 mm SVL at an age of about 22 months.

The anatomy and ecology of *Varanus brevicauda* is briefly compared with that of *Varanus eremius* in another paper in this volume (Pianka 2006). They are sympatric throughout most of their geographic ranges and both species prey on grasshoppers and other lizards. However, anatomically they are highly divergent with *V. brevicauda* having relatively elongate body and a very short tail — in contrast, *V. eremius* has retained

the ancestral varanid Bauplan with a relatively shorter body and a much longer tail. In addition, the sexual dimorphism in head size seen in *V. brevicauda* is not present in *V. eremius*. Also, whereas *V. brevicauda* are sedentary ambush predators, *Varanus eremius* forage widely covering distances of up to a km daily.

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Zusammenfassung

Wir untersuchten 167 Individuen des kleinsten aller Warane (*Varanus brevicauda*), die im Western Australian Museum aufbewahrt werden. 82 dieser Tiere sind in der Victoria-Wüste (Great Victoria Desert) gesammelt worden. Die Kollektion erlaubt einen Vergleich des Nahrungsspektrums einer lokalen Population mit regionalen Proben, die aus verschiedenen Örtlichkeiten stammen. Ferner wird über Anatomie, Verhalten und Reproduktion dieser Art in Westaustralien im Vergleich zu Daten aus einer Studie in Zentralaustralien berichtet.

Schlüsselwörter: Squamata, Varanidae, *Varanus brevicauda*; Anatomie, Verhaltens- und Fortpflanzungsökologie.

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Eric R. Pianka, The University of Texas Austin, Integrative Biology C 0930, One University Station, Austin, Texas 78712 – 0253, USA; e-mail : pianka@mail.utexas.edu