Diet of *Ctenotus xenopleura* (Reptilia: Scincidae) in the southern Goldfields of Western Australia

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ABSTRACT

The diet of *Ctenotus xenopleura*, a species found in spinifex grasslands in the southern Goldfields of Western Australia, consisted primarily of termites. The high proportion of termites was consistent over different sampling periods, and was higher than observed for most other *Ctenotus* species. It is not clear whether this high proportion of termites is the result of specialised foraging for termites by *C. xenopleura*.

Key words: *Ctenotus,* lizard, diet, termites, temporal variation, foraging

Introduction

The scincid genus *Ctenotus* is the largest reptile genus in Australia. There are over 95 described species and several more that await formal scientific description (Wilson and Knowles 1988; Cogger 2000; Wilson & Swan 2003). The ecology of *Ctenotus* species has been investigated at several sites in the arid zones of Western Australia (Pianka 1969; Twigg *et al.* 1996), Northern Territory (James 1991a, 1991b, 1991c) and South Australia (Read 1998). However, most species of *Ctenotus* are relatively unknown ecologically, partly because many species are recently described and occur only in remote areas.

Ctenotus xenopleura is a small (snout-vent length up to 49 mm) member of the *C. atlas* group (Wilson and Knowles 1988; Storr *et al.* 1999) (Fig. 1) with a restricted distribution in the semi-arid southern Goldfields of Western Australia. The species was described in 1981 (Storr 1981) and is currently known from five sites; Boorabbin, Toomey Hills, Mt. Holland, Goongarrie and a patch of sandplain 18 km NE of Bulgalbin Hill (Storr *et al.* 1999). Most members of the *C. atlas* group are known to feed primarily on termites (Pianka 1969, 1986; James 1991a) but the ecology and diet of *C. xenopleura* are unknown. We examined the diet of *C. xenopleura*, collected at the site NE of Bungalbin Hill, to determine the importance of termites in the diet and how the proportion of termites varies over time.

Figure 1. *Ctenotus xenopleura,* captured in the study area in April 1992.

Methods

Site description: The study area, centred 18 km NE of Bungalbin Hill (30°17'S, 119°50'E) in the southern Goldfields of Western Australia, was located on a sandplain and soils throughout the study area were deep sands derived from granites. The habitat was predominantly *Eucalyptus leptopoda* Mallee (JK 35), with scattered patches of *Banksia elderiana* Tall Shrubland (JK 39) (Fig. 2). Both habitats were similar floristically and structurally, with sparse canopy cover (<4 %) and a predominant ground cover of *Triodia scariosa* (c.20 %). The habitat codes (JK) above are from Dell *et al.* (1988), which provides detailed descriptions of these habitats.

Assessment of diet: The stomach contents of 30 individual *C. xenopleura* were examined. Fourteen individuals were captured in pit-traps in September 1992, killed with a 0.2 ml injection of 300 mg ml^{-1} of Valabarb and preserved by

Figure 2. The sandplain in the study, showing a large *Conospermum stoechadis* bush and various Myrtaceae and *Triodia scariosa* in the background.

freezing. The remaining specimens were collected by staff of the Western Australian Museum, six in September 1979 and ten in April 1980. The volume of each stomach was estimated to the nearest 5 μl using volumetric displacement. Stomach contents were identified to order, except for ants which were identified to family. Additional stomach contents were insect eggs, plant material and sloughed lizard skin. The number of each prey type was counted and the volumetric proportion of each prey type in the stomach was visually estimated to the nearest percent. Where possible, individuals were sexed and aged. Individuals between 27 and 32 mm snout-vent length (n = 4) could not be sexed, so were classified as juveniles. Specimens between 36 and 45 mm snout-vent length (n = 12) were classified as adults.

Statistical analysis: Dietary information was summarised in three ways; (1) volume, (2) number of individual items and (3) frequency of occurrence (see James (1991a) for a discussion of the advantages and disadvantages of each measure). Two of the stomachs from lizards captured in September 1992 did not contain any prey items and were excluded from the analyses. To standardise for differences in prey volume and prey number between individual lizards, all data were converted to proportions for analysis. To analyse the degree of specialisation, prey diversity indices were calculated using the Shannon-Weiner Index (Pianka 1986).

MANOVA was used to examine temporal differences in diet, using year as the factor and all 11 prey item categories as the dependent variables. Prey volume and prey number were analysed separately. Further, univariate ANOVA were also used for each prey item, for prey volume and number separately. Tukey's test was used for post-hoc analyses (Day and Quinn 1989). All analyses were conducted using JMP Version 3.2.1 (SAS 1997).

Results

Diet

All food items recorded were arthropods, except for some plant material and lizard skin. The plant material was leaf and was presumably ingested incidentally with arthropod prey. The lizard skin most likely represents ingestion of its own sloughed skin rather than predation. The arthropod groups recorded as prey were Araneae, Coleoptera, Formicidae, Hemiptera, Hymenoptera (excluding Formicidae), Isoptera, Lepidoptera and Orthoptera (Table 1).

C. xenopleura had a fairly narrow food niche. Overall, its prey diversity was 1.03 when calculated from prey volume and 0.72 when calculated from prey number. Prey diversity was higher in September 1979 than in either April 1980 or September 1992 for both prey volume and prey number (Table 1). Termites dominated the food items both in terms of frequency of occurrence, volume, and number of prey items. No other prey item comprised more than 7% of prey volume, 12% of prey number, or was found in more than 40% of stomachs (Table 1).

Temporal, sex and age differences

There were no significant temporal differences in the diet of *C. xenopleura* for either prey volume ($F_{2,25}$= 2.31, P = 0.121) or prey number ($F_{2,25}$= 0.29, P = 0.748) (Table 1). Termites dominated prey items in all three time periods. Neither termite volume ($F_{2,25}$= 1.44, P = 0.256) or termite number ($F_{2,25}$= 1.27, P = 0.299) differed between years, although proportionately less termites were eaten in September 1979 than in April 1980 or September 1992 (Table 1). The volume of spiders differed significantly between years ($F_{2,25}$ = 3.62, P = 0.042) and was significantly greater in 1979 then in 1992 (P = 0.044). None of the other prey items differed in abundance between the three time periods for either prey volume or prey number.

There was no significant difference between males (n = 6) and females (n = 5) in either prey volume ($F_{1,9}$ = 0.82, P = 0.389) or prey number ($F_{1,9}$ = 0.55, P = 0.479) and none of the individual prey items differed between the sexes. There was also no significant difference between adults and juveniles in either prey volume ($F_{1,14}$ = 0.52, P = 0.481) or prey number ($F_{1,14}$ = 0.32, P = 0.582) and none of the individual prey items differed between the age groups.

Table 1. Proportion of different prey items in the diet of *Ctenotus xenopleura* by volume (Vol.), number of individuals (#) and frequency of occurrence (Freq.). Values are given for the three years and overall.

	Year											
Prey item	1979			1980			1992			Overall		
	Vol.	#	Freq.	Vol.	#	Freq.	Vol.	#	Freq.	Vol.	#	Freq.
Isoptera	.601	.476	.833	.844	.912	.900	.698	.941	1.00	.741	.815	.929
Formicidae	.162	.435	.750	.011	.014	.300	.039	.029	.333	.058	.119	.393
Araneae	.082	.034	.500	.020	.020	.200	.004	.006	.083	.031	.020	.214
Coleoptera	.054	.020	.500	.114	.020	.600	.015	.012	.167	.066	.018	.393
Lepidoptera	.017	.007	.167	.004	.003	.100	.201	.006	.083	.066	.005	.107
Hymenoptera	0	0	0	0	.003	.100	.042	.006	.083	.013	.003	.071
Hemiptera	.007	.007	.167	.001	.003	.100	0	0	0	.002	.003	.071
Orthoptera	.039	.007	.167	0	0	0	0	0	0	.010	.002	.036
Insect Eggs	0	0	0	.005	.020	.100	0	0	0	.002	.010	.036
Plant Material	.013	.007	.167	.001	.003	.100	0	0	0	.004	.003	.071
Lizard Skin	.023	.007	.167	0	0	0	0	0	0	.006	.002	.036
Prey Diversity	1.34	1.08		0.72	0.45		0.92	0.31		1.03	0.72	

Discussion

C. xenopleura may be a termite specialist, with termites dominating its diet in terms of both volume and number (Table 1). Moreover, the predominance of termites was consistent across all years, sexes and ages. Its dietary niche breadth was narrower, and the proportion of termites in its diet higher, than has been recorded for any other species in the *Ctenotus atlas* group, with the exception of the similar-sized *C. ariadnae* (Pianka 1969, 1986; James 1991a; Table 2). The predominance of termites in the diet of *C. xenopleura* is comparable to the larger *C. pantherinus*, a member of the *C. pantherinus* group (Wilson and Knowles 1988), which is considered a termite specialist (James 1991a,c; Pianka 1986).

The high proportion of termites in the diet of *C. xenopleura* suggests that it may specifically forage for termites, in contrast to other studies that have found that most *Ctenotus* species are opportunistic foragers whose diets partly reflect changes in the abundance of prey groups (James 1991a; Read 1998; but see Craig *et al*. 2006). An alternative explanation is that the predominance of termites in the diet of *C. xenopleura* merely reflects a high abundance of termites at the study site. In support of this, studies conducted across Australia have found that the proportion of termites in the diet of *Ctenotus* species is higher in Western Australia than elsewhere in the arid zone (Pianka 1969; James 1991a; Twigg *et al*. 1996; Read 1998). However, this explanation is unsatisfactory because the proportion of termites found in the diet of most other *Ctenotus* species in Western Australia, by Pianka (1969) and Craig *et al*. (2006), was lower than in *C. xenopleura*

Table 2. Proportion of termites in the diet of *Ctenotus xenopleura* by volume (Vol.), number of individuals (#) and frequency of occurrence (Freq.) compared to other members of the *C. atlas* group whose diet is known. The importance of termites in the diet of *C. xenopleura* is higher then for other members of the group, except *C. ariadnae*

Species	Vol.	#	Freq.	Source
C. ariadnae	0.820	0.857	0.400	Pianka 1969
C. xenopleura	0.741	0.815	0.929	this study
C. atlas	0.536	0.808	0.616	Pianka 1969
C. dux	0.372			Pianka 1986
C. piankai	0.083	0.454	0.140	James 1991a
C. quattuordecimlineatus	0.143	0.386	0.183	Pianka 1969
C. quattuordecimlineatus	0.029	0.288	0.390	James 1991a

To conclude, this study shows that *C. xenopleura* feeds primarily on termites and that this preference appears to be consistent between years, sexes and ages. *C. xenopleura* may forage specifically for termites, but this would need to be confirmed by a detailed ecological study of the species.

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References

Craig M.D., Withers P.C. and Bradshaw S.D. 2006. Patterns of diet and microhabitat use by four species of sympatric *Ctenotus* lizards: do they reveal foraging specialisation? *Journal of the Royal Society of Western Australia* **89:** 1-5.

Cogger, H.G. 2000. *Reptiles and Amphibians of Australia*. Reed New Holland, Sydney, NSW

Day, R.W. and Quinn, G.P. 1989. Comparisons of treatments after an analysis of variance in ecology. *Ecological Monographs* **59:** 433-463.

Dell, J., How, R.A., Newbey, K.R. and Hnatiuk, R.J. 1988. The Biological Survey of the Eastern Goldfields of Western Australia-Part 3: Jackson-Kalgoorlie Study Area. *Records of the Western Australian Museum Supplement* **23**.

James, C.D. 1991a. Temporal variations in diets and trophic partitioning by co-existing lizards (*Ctenotus*: Scincidae) in central Australia. *Oecologia* **85:** 553-561.

James, C.D. 1991b. Annual variation in reproductive cycles of scincid lizards (*Ctenotus*) in central Australia. *Copeia* **1991:** 744-760.

James, C.D. 1991c. Population dynamics, demography and life history of sympatric scincid lizards (*Ctenotus*) in central Australia. *Herpetologica* **47:** 194-210.

Pianka, E.R. 1969. Sympatry of desert lizards (*Ctenotus*) in Western Australia. *Ecology* **50:** 1012-1030.

Pianka, E.R. 1986. *Ecology and Natural History of Desert Lizards*. Princeton University Press, Princeton, USA.

Read, J.L. 1998. The ecology of sympatric scincid lizards (*Ctenotus*) in arid Australia. *Australian Journal of Zoology* **46:** 617-629.

SAS 1997. *JMP 3.2.1.* SAS Institute Inc., Cary, USA.

Storr, G.M. 1981. Ten new *Ctenotus* (Lacertilia: Scincidae) from Australia. *Records of the Western Australian Museum* **9:** 125-146.

Storr, G.M., Smith, L.A. and Johnstone, R.E. 1999. *Lizards of Western Australia. 1: Skinks.* Western Australian Museum, Perth, WA.

Twigg, L.E., How, R A., Hatherly, R.L. and Dell, J. 1996. Comparison of the diet of three sympatric species of *Ctenotus* skinks. *Journal of Herpetology* **30:** 567-571.

Wilson, S.K. and Knowles, D.G. 1988. *Australia's Reptiles: A Photographic Reference to the Terrestrial Reptiles of Australia*. Collins Publishers, Sydney, NSW.

Wilson, S.K. and Swan, G. 2003. *A Complete Guide to the Reptiles of Australia*. Reed New Holland, Sydney, NSW.