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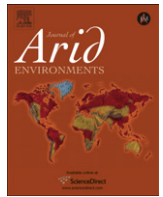
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Short Communication

Diet of the desert lizard *Liolaemus pseudoanomalus* (Iguania: Liolaemini) in northern La Rioja Province, ArgentinaM.L. Kozykariski^{a,*}, L.C. Belver^b, L.J. Avila^a^a CENPAT, CONICET, Boulevard Almirante Guillermo Brown 2915 (U9120ACD), Puerto Madryn, Chubut, Argentina^b Universidad Nacional de la Patagonia Sede Esquel, Sarmiento 840 (9200), Esquel, Argentina

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ABSTRACT

The diet of a species can help us to understand its natural history, ecological requirements, and strategies involved in searching for food. *Liolaemus pseudoanomalus* is a rare desert lizard where previous studies showed no seasonal, ontogenetic or sexual differences observed in microhabitat use; however the sexual dimorphism is evident in the number of precloacal pores and in the snout-vent length. In this work, we investigate if there are differences in the diet composition between sexes and age groups. Herein we describe the diet of *L. pseudoanomalus*, of the Central West Monte desert of Argentina, based on the analysis of 63 stomach contents. We found that ants are the most important food item and some characteristics of foraging behavior suggest similarities with other ant-eating lizards.

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1. Introduction

In arid and semiarid environments of western Argentina, lizards of the genus *Liolaemus* are a significant component of the vertebrate community in both species richness and population density (Cei, 1993). *Liolaemus pseudoanomalus* (Burmeister, 1861) is a small (mean adult snout-vent length [SVL] = 45.8 ± 11.1 mm), diurnal, terrestrial, and oviparous desert lizard restricted to open sandy flat areas of intermontane valleys, across southern Catamarca to San Juan Provinces (Avila et al., 2003, but see Abdala, 2007). This lizard has an ambiguous conservation status, defined as a species for which “insufficient knowledge” exists (Avila et al., 2000). At that time, only Sage (1972) reported a few ecological observations of *L. pseudoanomalus*, without any quantitative or detailed analysis. But in recent years, several studies were carried out, and added important information about its natural history, habitat, behavior, karyology, and geographic distribution (Avila et al., 2003), as well as on its reproduction, thermoregulation, sexual dimorphism, time budgets, and spatial use (Villavicencio et al., 2002, 2003a,b, 2006, 2007a,b). Villavicencio et al. (2006) reported no sexual differences in microhabitat use, but in another study, sexual differences were reported in snout-vent length (Villavicencio et al., 2003b). Thus, our expected results were to find differences between sexes,

and ontogenetic categories according to requirements and behavior. Food is one of the principal components in the ecological niche of a species, and data about diet provide basic information in studies of population and community ecology (Pianka, 1982). The goal of this study was to describe the diet of *L. pseudoanomalus*, and document sexual and ontogenetic variation in the diet.

Lizards were collected as part of an ecological study on lizard communities carried out in the Monte phytogeographic formation (Cabrera, 1976), along Provincial Road No. 7, 6 km east of Anillaco (28°49'S, 66°57'W), Castro Barros Department, La Rioja Province, Argentina. The study area was in an open sand-rocky environment with clumps of bushes. Mean annual temperature is 19.7 °C, and there is a marked rainy season (December–February). Vegetation is typical of the northern area of Monte, an open shrubland of “jarilla” (*Larrea* spp.) with several species of xerophytic plants associated with species of cacti. Lizards were sampled between October 1998 and May 1999, with a total of 63 lizards ranging from 25 to 63 mm snout-vent length (SVL) collected by hand, forks or rubber bands. In most cases, lizards were collected under similar weather conditions (sunny days) within an interval of two or 3 h in the late afternoon after they had the opportunity to ingest food. Lizards were killed in the laboratory by freezing or by cardiac injection of an anesthetic drug (Pentotal® Sodico Abbott) (Simmons, 2002). Carcasses were fixed in 10–20% formalin within 3 h of the capture and stored in 70% ethanol. Snout-vent length (SVL) and jaw length (JL) were taken to the nearest mm on all individuals, and lizards were divided in two groups on the basis of their age category: adults

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(SVL > 45.00 mm) and juveniles (SVL < 45 mm). Stomachs were removed and stored separately in vials with 70% ethanol. Stomach contents were analyzed under a Leica Zoom 2000 stereomicroscope. Non-food items (small gravel, sand) were separated and recorded. Only items found in the stomachs were considered because these were the least digested and easiest to identify. Prey items were identified to the lowest useful taxonomic level, usually order or family, based on entire items or estimates of residues. Length and width of each prey item was measured and its volume estimated as Dunham (1983): $Volume = 4/3 \Pi (0.5 \text{ length}) (0.5 \text{ width})^2$. The equitability index was calculated as Pielou (1969): $J = H/H_{max}$. For each sex and age, the trophic diversity was calculated with Shannon's Index ($H = -\sum p_i \log_2 p_i$). In order to appreciate the variation of H with respect to the number of analyzed stomachs and to infer if sample size is adequate, the accumulated diversity of 1, 2, 3, ... n stomachs was calculated from the sample dates (Maury, 1981).

Diet was summarized in three ways: 1) the proportion of the total number of prey items in the stomach; 2) the proportion of the total volume of prey items in the stomach; and 3) the proportion of lizards eating a prey taxon. The relationship between the JL and the length and width of the prey consumed by lizards was estimated using the Spearman rank correlation. Sexual and ontogenetic differences in the distribution of the items in the diet (in terms of volume and number of items) were tested using analysis of covariance (ANCOVA, with SVL as covariable). The relationship between SVL, sex and percentage of volume of ants, beetles and other prey items consumed by lizards were tested using Pearson correlation.

Out of 63 lizards collected, 28 were adults (16 males, 12 females), and 35 were juveniles (17 males, 18 females). The equitability index (*J*) was 0.14. The estimated trophic diversity for juveniles was higher than adults, but the equitability index was similar between ages. When we calculated the trophic (*H*) and equitability (*J*) indices considering sex, both indices were higher in males than females, indicating that males eat all prey items in a more proportional way than females (Table 1). A sample of 23 stomachs was considered sufficient to stabilize the diversity curve and show the diet composition of *L. pseudoanomalous* (Fig. 1). No empty stomach was found in the sample. Non-food items represent less than 1% of the stomach content (in volume). Adult males are not significantly larger than adult females in SVL (ANOVA, $F = 1.61$; $p = 0.2153$; $SVL_{\delta} = 57.18 \pm 4.09$, $SVL_{\varphi} = 55.19 \pm 4.13$ mm) but differences were observed in JL between adults males and females (ANOVA, $F = 12.11$; $p = 0.002$; $JL_{\delta} = 13.41 \pm 0.90$, $JL_{\varphi} = 11.90 \pm 1.38$ mm). Differences in average values of SVL between juvenile males and females were observed (ANOVA, $F = 6.44$; $p = 0.02$; $SVL_{\delta} = 34.36 \pm 5.25$, $SVL_{\varphi} = 38.53 \pm 4.46$ mm), but this differences were not observed in average values of JL (ANOVA, $F = 1.97$; $p = 0.17$; $SVL_{\delta} = 8.68 \pm 1.26$, $SVL_{\varphi} = 9.23 \pm 1.01$ mm). A summary of the diet of *L. pseudoanomalous* is presented in Table 2. Formicidae was the dominant prey item by volume, number, and frequency of occurrence. Coleoptera (50%), Aranaeae (31%) and Homoptera (22%) were important when considered as frequency by occurrence (Table 1). There was no significant correlation between jaw length (JL) and length ($R = 0.10$,

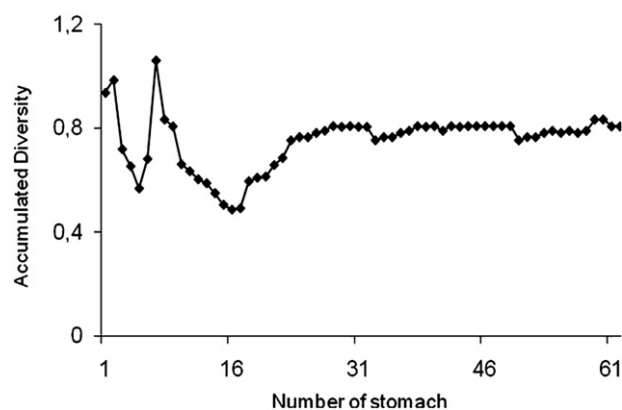


Fig. 1. Accumulated trophic diversity of *Liolaemus pseudoanomalous*, a good estimation of the trophic diversity by individuals was obtained from 23 stomachs.

$p = 0.22$) or width ($R = 0.13$, $p = 0.10$) of consumed prey. Diet of juveniles and adults and between sexes, did not differ significantly by number and volume (ANCOVA, effect Prey Number: sex, $F = 3.60$, $p = 0.06$; age, $F = 0.96$, $p = 0.33$; Sex * age, $F = 2.92$, $p = 0.09$; effect Prey Volume (mm^3): sex, $F = 2.38$, $p = 0.13$; age, $F = 0.19$, $p = 0.67$, Sex * Age, $F = 1.39$, $p = 0.24$). No significant relationship was found between SVL and percentage of ingested ants ($R_{\varphi} = 0.14$, $p_{\varphi} = 0.48$; $R_{\delta} = 0.04$, $p_{\delta} = 0.84$), beetles ($R_{\varphi} = -0.19$, $p_{\varphi} = 0.32$; $R_{\delta} = 0.07$, $p_{\delta} = 0.70$) or "others" ($R_{\varphi} = -0.07$, $p_{\varphi} = 0.71$; $R_{\delta} = -0.10$, $p_{\delta} = 0.58$) was found.

Our data indicate that *L. pseudoanomalous* eat mainly ants, which constitute 90% of food items and up to 74% of the total volume in the diet. They also feed on a variety of other arthropods such as spiders, grasshoppers, leafhoppers, beetles and beetle larvae, this is also indicated in the low equitability index. A high abundance of ants in the habitat could be an explanation of our results, but we do not evaluate food availability. In *Phrynosoma*, another lizard genera from the northern hemisphere, any single individual could feed on several ant nests within the same day, and this was the most widely selected prey item, no ontogenetic and sexual differences were observed in the diet (Munger, 1984); suggesting that ants consumption may imply high energetic convenience for the lizards. This pattern of high Formicidae consumption in *L. pseudoanomalous* could have a similar energetic advantage in this environment, however in this study we observed that females eat fewer prey items than males and there are items that are more represented than others. These results could indicate that males and females use this resource in different ways, as was observed in *Liolaemus quilmes* (Halloy et al., 2006). Other *Liolaemus* species also eat Formicidae at high frequencies in the Argentinean lowland deserts, e.g. 90% in *Liolaemus inacayali* in an ecotonal area between Patagonian Steppe and Austral Monte (Acosta et al., 1996); 100% in *Liolaemus*

Table 2

Diet of *Liolaemus pseudoanomalous*, with prey items presented as frequency of occurrence, percentage by number and percentage by volume (mm^3), for eight major taxa of food items.

	Frequency		Number		Volume	
	N	%	N	%	Vol	%
Aranaeae	20	31.75	26	0.90	996.42	6.25
Acari	5	7.94	13	0.45	9.83	0.06
Coleoptera	32	50.79	102	3.54	1816.03	11.40
Formicidae	63	100.00	2671	92.77	11,863.3	74.47
Hemiptera	1	1.58	1	0.03	58.830	0.37
Homoptera	14	22.22	52	1.81	267.46	1.68
Hymenoptera	5	7.93	7	0.24	232.81	1.46
Orthoptera	3	4.76	7	0.24	684.95	4.30

Table 1

The diversity index (*H*) and equitability index (*J*) for age (adults and juveniles) and sex (males and females) for *Liolaemus pseudoanomalous*.

Index	Age		Sex	
	Juveniles	Adults	Males	Females
H	0.42	0.33	0.55	0.13
J	0.16	0.14	0.24	0.06

darwinii, in northern Austral Monte desert of Mendoza (Avila and Acosta, 1993); 79% in *Liolaemus koslowskyi* in a Monte desert environment less than 50 km from our study site (Aun and Martori, 1998), and 93% in *L. quilmis* (Halloy et al., 2006). However another species from the Monte Desert (*Liolaemus scapularis*) rarely consumes Formicids (García et al., 1989). None of these studies was carried out with a study of food availability or behavior. Ants are common and abundant arthropods of the Monte biodiversity, and usually they are active in early morning and late afternoon to avoid the hottest midday hours in coincidence with the *liolaemids* regular activity in this desert. Ant consumption could be related only to a coincidence with *L. pseudoanomalus* daily activity and not to prey selection behavior. Nevertheless, our study supports Sage's (1972) hypothesis that *L. pseudoanomalus* appears to be an ecological equivalent of the ant specialists *Moloch horridus* in the Australia deserts and, similarly, to *Phrynosoma platyrhinos* in North American deserts. However, a more detailed study of the ecology of this species must be carried out to test this hypothesis.

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