Revista Española de Herpetología

Asociación Herpetológica Española
Volumen 20 (2006)
VALENCIA

Rev. Esp. Herp. (2006) 20:47-56

Diet in two syntopic neotropical lizard species of *Liolaemus* (Liolaemidae): interspecific and intersexual differences

MONIQUE HALLOY,[1] CECILIA ROBLES [1, 2] & FABIANA CUEZZO [2]

[1] *Instituto de Herpetología, Fundación Miguel Lillo, Miguel Lillo 251, 4000 San Miguel de Tucumán, Argentina*
(e-mail: mhalloy@webmail.unt.edu.ar)

[2] *CONICET, Facultad de Ciencias Naturales, Universidad Nacional de Tucumán, Miguel Lillo 205, 4000 San Miguel de Tucumán, Argentina*

Abstract: The study of the diet of a species can help us understand its natural history and strategies involved in searching for food. Here we describe the diets of two syntopic lizard species from northwestern Argentina, *Liolaemus quilmes* and *L. ramirezae*. We compare the two species with respect to their general diet and we compare males and females of *L. quilmes* with respect to their favorite prey item, ants. Both species are insectivorous and diurnal, and they are of similar sizes, *L. quilmes* being slightly larger than *L. ramirezae*. We examined fecal samples of field captured lizards and stomach contents of preserved specimens from the Fundación Miguel Lillo (54 *L. quilmes* and 16 *L. ramirezae*). Prey items were identified to order and, in Formicidae (Hymenoptera), to species. The two *Liolaemus* species ate prey that belonged mainly to three insect orders: Coleoptera, Hemiptera (Heteroptera), and Hymenoptera. *Liolaemus quilmes* ate significantly more Hymenoptera than *L. ramirezae*, whereas the latter ate more Coleoptera and Hemiptera (Heteroptera). With respect to Formicidae, female *L. quilmes* ate significantly more ants of three species characterized by soft bodies and lack of functional stings than males. These dietary differences between the two species and between males and females of *L. quilmes* suggest that, with similar prey availability, the lizards use resources differently. Further studies are needed to address these differences. Finally, we compare our results to those obtained in other *Liolaemus* species.

Key words: diet, *Liolaemus quilmes*, *Liolaemus ramirezae*, syntopic species.

Resumen: Dieta en dos especies sintópicas de lagartos neotropicales de *Liolaemus* (Liolaemidae): diferencias interespecíficas e intersexuales. – El estudio de la dieta de una especie puede ayudarnos a comprender su historia natural y las estrategias involucradas en la búsqueda del alimento. En este trabajo, describimos las dietas de dos especies sintópicas de lagartos del noroeste argentino, *Liolaemus quilmes* y *L. ramirezae*. Comparamos las dos especies con respecto a su dieta general y comparamos machos y hembras de *L. quilmes* con respecto a su presa favorita, hormigas. Ambas especies son insectívoras y diurnas, y son de tamaño similar, *L. quilmes* siendo un poco más grande que *L. ramirezae*. Examinamos muestras fecales de lagartos capturados en el campo y contenidos estomacales de especímenes de la colección de la Fundación Miguel Lillo (54 *L. quilmes* y 16 *L. ramirezae*). Las presas fueron identificadas hasta orden y, en Formicidae (Hymenoptera), hasta especie. Las dos especies de *Liolaemus* comieron presas que pertenecían principalmente a tres ordenes de insectos: Coleoptera, Hemiptera (Heteroptera), e Hymenoptera. *Liolaemus quilmes* comió significativamente más Hymenoptera que *L. ramirezae*, mientras que este último comió más Coleoptera y Hemiptera (Heteroptera). Con respecto a Formicidae, las hembras *L. quilmes* comieron significativamente más que los machos tres especies de hormigas que se caracterizan por sus cuerpos blandos y la falta de aguijones

funcionales. Estas diferencias en las dietas de las dos especies y entre machos y hembras de *L. quilmes* sugieren que, con una disponibilidad similar de presa, los lagartos utilizan los recursos de manera diferente. Se necesitan estudios que traten estas diferencias. Finalmente, comparamos nuestros resultados con los obtenidos en otras especies de *Liolaemus*.

Palabras clave: dieta, especies sintópicas, *Liolaemus quilmes*, *Liolaemus ramirezae*.

INTRODUCTION

The study of the diet of a species can give insight into other aspects of its ecology (HIRAI & MATSUI, 2002). It can contribute to the understanding of differences between males and females of a species and among syntopic species (DUNHAM, 1983). Species of the iguanian Neotropical lizard genus *Liolaemus* (Liolaemidae, FROST *et al*., 2001) are generally reported to be insectivorous, eating mainly insects and other small arthropods, although they occasionally include plant parts, such as soft leaves and flowers, in their diets, depending on season and availability (e.g., DONOSO-BARROS, 1966; FUENTES & DI CASTRI, 1975; FUENTES, 1981; CEI, 1986, 1993). More than 160 *Liolaemus* species (SCHULTE *et al*., 2000) are currently known with new species being described every year (e.g., ABDALA, 2005a, b; ABDALA & LOBO, 2006). Yet, in spite of reports indicating the overall diet for this genus, specific information on their feeding habits and preferences is scarce. Only about 10% of *Liolaemus* species have been studied in more detail (see below).

Here we report on the diet of two syntopic *Liolaemus* species, *L. quilmes* and *L. ramirezae*, from northwestern Argentina. We compare the diets of the two species and that of males and females of *L. quilmes* with respect to a preferred prey item, ants. We also compare our results to information reported in the literature on other *Liolaemus* species.

MATERIALS AND METHODS

Liolaemus quilmes belongs to the *darwinii* complex of the *boulengeri* group of *Liolaemus* (ETHERIDGE, 1993, 1995), whereas *L. ramirezae* belongs to the *alticolor* group within the *chiliensis* group of the same genus (LOBO, 2001, in press). They are both diurnal, oviparous species (*L. quilmes*, RAMIREZ PINILLA, 1992; *L. ramirezae*, LOBO & ESPINOZA, 1999). Males of *L. quilmes* are larger (average snout-vent length of 66 mm in males vs. 61 mm in females) and more colourful than females (ETHERIDGE, 1993; HALLOY, 1996). *Liolaemus ramirezae* is somewhat smaller than *L. quilmes*, with no apparent size or color dimorphism, males averaging 51.8 mm and females 51.3 mm in snout-vent length (LOBO & ESPINOZA, 1999). Both species occur in northwestern Argentina, *L. ramirezae* being more restricted in its range. They occupy arid to semi-arid habitats of the Monte (*L. quilmes*, ETHERIDGE, 1993) and Prepuna phytogeographic provinces (*L. quilmes* and *L. alticolor*, HALLOY *et al*., 1998; LOBO & ESPINOZA, 1999; for phytogeographic provinces see CABRERA & WILLINK, 1980). *Liolaemus quilmes* is found at elevations from 1600 m to just below 3000 m (ETHERIDGE, 1993), whereas *L. ramirezae* is found between 2800 and 3200 m (LOBO & ESPINOZA, 1999).

Both species occur syntopically at the study site in Los Cardones, Tucumán (26° 40' 1.5" S, 65° 49' 5.1" W, datum: WGS84; 2725 m above sea level). The site is characterized

by firm substrate, scattered large rocks, and it is sparsely vegetated with shrubs and cacti, such as *Adesmia horridiuscula* (Leguminosae), *Baccharis* sp. (Compositae), *Flourencia* sp. (Compositae), *Junellia* sp. (Verbenaceae), *Justicia* sp. (Acanthaceae), *Senecio* (Compositae), and the tall cacti called "cardón", *Thrichocereus pasacana* (Cactaceae) (HALLOY *et al*., 1998).

We obtained information on diet during different seasons from two sources: fecal samples and stomach contents (Table 1). Fecal samples were obtained from lizards that had been captured as part of another study. The lizards were kept individually in cloth bags. A few hours later or by the next morning at the latest, we checked each bag for scats. These were collected and placed in individually marked vials filled with 90% ethanol. The lizards were then released at their site of capture. Fecal samples were collected between March 2003 and March 2005 (Table 1).

Stomach contents were obtained from lizards collected within 500 m of the study site during years prior to the present study (1983-1993, Table 1). Specimens were from the FML collection (Fundación Miguel Lillo, Tucumán, Argentina). They had been used for a study of reproduction and already had their abdomens opened. We removed stomachs and their contents. After examination, the contents were placed in small vials with 70% ethanol.

Fecal samples and stomach contents were analyzed using a microscope (Nikon, S-MZ10). Insects were identified to order and within Formicidae, to species. The frequency of occurrence (number of individuals containing a prey category) and the number of prey items per prey category were determined. Volume was not considered since we were not addressing the nutritional aspects of their diets but only the general content over the years.

For statistical analyses, since results may vary depending on period of collection (season) and source of data (stomachs or scats, e.g., NUÑEZ *et al*., 1989), we compared the two *Liolaemus* species based on data obtained during the summer, from stomachs only (Table 1). We also compared males and females of *L. quilmes* with respect to ant preferences, based on data obtained during

TABLE 1. Number of lizards used in the study of diet in two *Liolaemus* species, indicating the type of sample (sto: stomach; sca: scats). Spring: 21 September to 20 December; summer: 21 December to 20 March; fall: 21 March to 20 June; winter: 21 June to 20 September.

TABLA 1. Número de lagartos usados en el estudio de dieta de dos especies de *Liolaemus*, indicando el origen de la muestra (sto: estómago; sca: heces). Primavera: 21 de septiembre a 20 de diciembre; verano: 21 de diciembre a 20 de marzo; otoño: 21 de marzo a 20 de junio; invierno: 21 de junio a 20 de septiembre.

	L. quilmes				*L. ramirezae*			
	♂♂		♀♀		♂♂		♀♀	
	sto	sca	sto	sca	sto	sca	sto	sca
spring	2	1	4	1	0	0	0	0
summer	10	6	4	5	6	2	5	0
fal	5	0	0	0	2	0	1	0
winter	14	0	2	0	0	0	0	0
Totals	31	7	10	6	8	2	6	0

the spring and summer, when more species of ants are active, from stomachs and scats, since we had samples of both for both sexes (Table 1). Comparisons were made using Chi-square goodness-of-fit tests (SIEGEL & CASTELLAN, 1988; df = 1 in all cases).

RESULTS

Stomach and fecal contents of both lizard species contained prey that belonged mainly to three insect orders: Coleoptera, Hemiptera (Heteroptera), and Hymenoptera (mainly Formicidae). Besides prey belonging to these taxa, a few Aphididae (Hemiptera: Sternorrhyncha) were found in *L. ramirezae* (1 male). Parts of bees (Hymenoptera: Apoidea) were found in *L. quilmes* (7 males and 5 females). Remains not belonging to the above insect orders were: in *L. quilmes*, parts of a grasshopper's femur (Orthoptera, 1 male), a scorpion's claws (Scorpionida, 1 male), and plant parts (1 male); in *L. ramirezae*, parts of a Lepidoptera (1 female), the head of a Diptera (2 males), and parts of a spider (Araneida, 1 male). The following analyses are based on the more numerous prey items belonging to Coleoptera, Hemiptera (Heteroptera), and Hymenoptera, taking into account season and source of data, as specified in each table (see below).

All but one individual of *L. quilmes* contained Hymenoptera, followed by Coleoptera (less than a third of the lizards) and Hemiptera (only one individual or 7%, Table 2). *Liolaemus ramirezae* followed the same pattern, although the proportion of individuals found containing the various categories varied. The two species did not differ statistically with respect to frequency of occurrence. When considering the number of prey items, *L. quilmes* ate significantly more Hymenoptera than *L. ramirezae* (Chi-square goodness-of-fit test: $\chi^2 = 10.82$, $p < 0.01$) whereas the latter ate significantly more Coleoptera and Hemiptera than the former ($\chi^2 = 13.75$; $\chi^2 = 16.51$, $p < 0.001$, respectively).

When comparing male and female *L. quilmes* with respect to ants (Table 3), significantly more females than males contained *Dorymyrmex wolffhuegeli*, *Camponotus* sp. 2, and *Paratrechina silvestrii* (Chi-square goodness-of-fit test: $\chi^2 = 16.66$, $p < 0.001$; $\chi^2 = 15.09$, $p < 0.001$; $\chi^2 = 8.32$, $p < 0.01$, respectively). There were no significant differences between males and

TABLE 2. Number of stomachs (Fr, percent given in parentheses) of *Liolaemus quilmes* and *L. ramirezae* collected during the summer (Table 1) containing food items belonging to three orders of insects, and number of food items per food category (N, percent given in parentheses). Asterisks indicate a significant difference between the two species for a particular food category, Chi-square goodness-of fit tests, ** $p < 0.01$, *** $p < 0.001$. nl = number of lizards, np = number of prey items.

TABLA 2. Número de estómagos (Fr, porcentaje entre paréntesis) de *Liolaemus quilmes* y *L. ramirezae* colectados durante el verano (Tabla 1) que contenían alimento perteneciente a tres ordenes de insectos, y número de items de alimento por categoría de alimento (N, porcentaje entre paréntesis). Los asteriscos indican una diferencia significativa entre dos especies para una categoría particular de alimento, tests de Chi-cuadrado, ** $p < 0.01$, *** $p < 0.001$. nl = número de lagartos, np = número de presas.

	L. quilmes Fr, nl = 14	*L. ramirezae* Fr, nl = 11	*L. quilmes* N, np = 126	*L. ramirezae* N, np = 32
Coleoptera	4 (28.57)	4 (36.36)	8 (6.35)	9 (28.12)***
Hemiptera (Heteroptera)	1 (7.14)	2 (18.18)	1 (0.79)	6 (18.75)***
Hymenoptera	13 (92.86)	8 (72.73)	117 (92.86)**	17 (53.12)

TABLE 3. Number of scats and stomachs (percent given in parentheses) of male and female *Liolaemus quilmes* collected during the spring and summer seasons (Table 1) containing food items corresponding to different ant species (Hymenoptera: Formicidae, WARD, 2003), and number of food items (percent given in parentheses) per food category. Asterisks indicate a significant difference between males and females for that food category, Chi-square goodness-of fit tests used except when expected frequencies were lower than five, ** $p < 0.01$, *** $p < 0.001$. nl = number of lizards, np = number of prey items.

TABLA 3. Número (porcentaje entre paréntesis) de heces y estómagos de machos y hembras de *Liolaemus quilmes* colectados durante la primavera y el verano (Tabla 1) que contenían presas pertenecientes a distintas especies de hormigas (Hymenoptera: Formicidae, WARD, 2003), y número de ítems de alimento (porcentaje entre paréntesis) por categoría de alimento. Asteriscos indican una diferencia significativa entre machos y hembras para esa categoría de alimento, tests de Chicuadrado usados excepto cuando frecuencias esperadas eran menores que cinco, ** $p < 0.01$, *** $p < 0.001$. nl = número de lagartos, np = número de presas.

	L. quilmes ♂♂ Fr, nl = 19	*L. quilmes* ♀♀ Fr, nl = 14	*L. quilmes* ♂♂ N, np = 146	*L. quilmes* ♀♀ N, np = 224
Dorymyrmex wolffhuegeli	4 (21.05)	8 (57.14)***	8 (5.48)	20 (8.93)
Dorymyrmex ensifer	0 (0)	1 (7.14)	0 (0)	4 (1.79)
Dorymyrmex sp.	1 (5.26)	0 (0)	1 (0.68)	0 (0)
Forelius chalybaeus	7 (36.84)	7 (50.00)	19 (13.01)	48 (21.43)
Brachymyrmex sp.	5 (26.32)	6 (42.86)	11 (7.53)	21 (9.38)
Camponotus sp. 2	7 (36.84)	11 (78.57)***	26 (17.81)	51 (22.77)
Paratrechina silvestrii	2 (10.53)	4 (28.57)**	4 (2.74)	9 (4.02)
Paratrechina sp.	1 (5.26)	0 (0)	1 (0.68)	0 (0)
Acromyrmex striatus	6 (31.58)	6 (42.86)	16 (10.96)	21 (9.38)
Pheidole sp. 1	4 (21.05)	4 (28.57)	11 (7.53)	8 (3.57)
Pheidole bergi	0 (0)	1 (7.14)	0 (0)	4 (1.79)
Solenopsis sp. 1	8 (42.11)	5 (35.71)	40 (27.40)	28 (12.50)
Solenopsis sp. 2	1 (5.26)	2 (14.29)	1 (0.68)	10 (4.46)
Solenopsis sp. 4	1 (5.26)	0 (0)	7 (4.79)	0 (0)
Not identified	1 (5.26)	0 (0)	1 (0.68)	0 (0)

females with respect to number of prey items ($p \leq 0.01$). The three ant species that female *L. quilmes* preferred over males are soft-bodied and do not have functional stings.

With respect to diet preferences in other *Liolaemus* species (Table 4), the three insect orders found in *L. quilmes* and *L. ramirezae*, Coleoptera, Hemiptera and Hymenoptera, also occur in many other *Liolaemus* species. Considering frequency of prey items, Hymenoptera was a first choice for two thirds of *Liolaemus* species (8 of 12 species, or 66.7%, including the two species in this study), whereas Coleoptera was first choice in only 25% of *Liolaemus* species and Hemiptera did not come up as first choice in any of the species. Considering number of prey items, 73.7% (14 of 19 species, including the two species in this study) preferred Hymenoptera as their first choice, followed by 15.8% choosing Hemiptera, and 5.3% choosing Coleoptera as their first choices.

DISCUSIÓN

Liolaemus quilmes ate more Hymenoptera than *L. ramirezae*, whereas the latter ate more Coleoptera and Hemiptera (Table 2). This suggests that the two species differ in their use of available prey indicating possible niche segregation (DUNHAM, 1983). FUENTES & IPINZA (1979) came to the same conclusion when they observed three syntopic *Liolaemus*

TABLE 4A, B. Prey preferences (first three categories in order of importance) in *Liolaemus* species by frequency (Table 4A) and number of prey items (Table 4B), based on information from the literature. Sample size is given in parentheses after species name.

TABLA 4A, B. Preferencias de presa (primeras tres categorias en orden de importancia) en especies de *Liolaemus* por frecuencia (Tabla 4A) y número de presas (Tabla 4B), basado en información de la literatura. El tamaño muestral está indicado en paréntesis después del nombre de la especie.

TABLE 4A

	Prey 1	Prey 2	Prey 3	Source
L. boulengeri (125)	Formicidae	Winged insects	Coleoptera & plants	ACOSTA *et al*. (1996)
L. darwinii (Mendoza, 36)	Formicidae	Coleoptera	Hemiptera	AVILA & ACOSTA (1993)
L. fuscus (7)	Formicidae & Araneae	Coleoptera	Hymenoptera & Psocoptera	HURTUBIA (1973)
L. koslowskyi (60)	Formicidae	Coleoptera	Hemiptera	AUN & MARTORI (1998)
L. kuhlmani (129)	Coleoptera	Hymenoptera	Homoptera	ORTIZ & RIVEROS (1976)
L. lemniscatus Central (18)	Araneae	Coleoptera & Hymenoptera	Coleoptera larvae	HURTUBIA (1973)
L. lemniscatus North (15)	Coleoptera	Araneae	Formicidae	HURTUBIA (1973)
L. lutzae (30)	Formicidae	Plants	Coleoptera & larvae	ROCHA (1989)
L. pictus (66)	Diptera	Homoptera	Araneae	ORTIZ (1974)
L. quilmes (Salta, 24)	Formicidae	Coleoptera	Diptera	DE VIANA *et al*. (1994)
L. quilmes (Tucumán, 54)	Hymenoptera	Coleoptera	Hemiptera	this study
L. ramirezae (16)	Hymenoptera	Coleoptera	Hemiptera	this study
L. tenuis (20)	Coleoptera	Diptera	Solifugae	HURTUBIA (1973)
L. wiegmannii (474)	Formicidae	Araneae	Larvae	AUN *et al*. (1999)

TABLE 4B

	Prey 1	Prey 2	Prey 3	Source
L. bibronii (20)	Formicidae	Homoptera	Hemiptera	VIDELA (1983)
L. boulengeri (125)	Winged insects (Diptera & Hemiptera)	Formicidae	Coleoptera	ACOSTA *et al*. (1996)
L. curis (?)	Hymenoptera	Diptera	Hemiptera	NUÑEZ (1996)
L. cuyanus (Mendoza, 22)	Hymenoptera no Formicidae	Homoptera	Hemiptera	VIDELA (1983)
L. darwinii (Mendoza, 36)	Formicidae	Coleoptera	Hemiptera	AVILA & ACOSTA (1993)
L. darwinii (Mendoza, 29)	Formicidae	Homoptera	Hymenoptera no Formicidae	VIDELA (1983)
L. elongatus (40)	Formicidae	Hemiptera	Homoptera & Hymenoptera no Formicidae	VIDELA (1983)
L. fuscus (7)	Formicidae	Araneae	Coleoptera	HURTUBIA (1973)
L. hernani (?)	Hymenoptera	Coleoptera	Lepidoptera	NUÑEZ (1996)
L. koslowskyi (60)	Formicidae	Coleoptera	Diptera	AUN & MARTORI (1998)

.../...

TABLE 4B (cont.)

	Prey 1	Prey 2	Prey 3	Source
L. kuhlmani (129)	Homoptera	Coleoptera	Hymenoptera	ORTIZ & RIVEROS (1976)
L. lemniscatus Central (18)	Formicidae	Coleoptera	Hemiptera	HURTUBIA (1973)
L. lemniscatus North (15)	Formicidae	Coleoptera	Araneae	HURTUBIA (1973)
L. lutzae (30)	Plants	Formicidae	Coleoptera	ROCHA (1989)
L. monticola (50)	*Camponotus* sp. Formicinae	Other arthropods, (not specified)		FUENTES & IPINZA (1979)
L. pictus (66)	Formicidae	Diptera	Homoptera	ORTIZ (1974)
L. quilmes (Salta, 24)	Formicidae	Diptera	Coleoptera	DE VIANA *et al*. (1994)
L. quilmes (Tucumán, 54)	Hymenoptera	Coleoptera	Hemiptera	this study
L. ramirezae (16)	Hymenoptera	Coleoptera	Hemiptera	this study
L. ruibali (44)	Hemiptera	Coleoptera	Formicidae	VIDELA (1983)
L. tenuis (20)	Coleoptera	Diptera	Homoptera	HURTUBIA (1973)
L. wiegmannii (474)	Formicidae	Araneae	Coreidae (Hemiptera)	AUN *et al*. (1999)

species of Chile, *L. monticola*, *L. nigroviridis*, and *L. fuscus*. In spite of being active at the same hours of the day (but see HUEY & PIANKA, 1983, who found that time of activity had no dramatic effect on diet) and in spite of occupying the same microhabitat and being exposed to the same prey, they consumed different prey. FUENTES & IPINZA (1979) found that, in *L. monticola*, 72-100% of food items were ants from the genus *Camponotus*, Formicinae, whereas in *L. nigroviridis*, only about 25% were ants, none being Formicinae, and in *L. fuscus*, only 3 to 5% were ants, also none being Formicinae. The authors suggested that *L. monticola* could be specializing on congeneric ants because these would have relatively similar chemical and behavioral defenses against predators and it would be less costly adapting to their toxins. NUÑEZ (1996), in a study of two sympatric *Liolaemus* species, noted that many of the ants found in *L. curis* belonged to the genus *Camponotus*, whereas those found in *L. hernani* belonged to the genus *Solenopsis*. VAN SLUYS *et al*. (2004) found that the two *Tropidurus* species they studied at one location were very similar in their microhabitat use and activity patterns but they differed in their food habits. Selection might favor these differences in diet preferences. This would tend to reduce competition for food and facilitate coexistence (DUNHAM, 1983, and references therein). However, although competition could be a factor in this scenario, it might not necessarily explain the particular patterns reported here (HUEY, 1979). Other factors, such as phylogenetic constraints, could also be involved.

Differences in diet preferences between males and females have been reported in other *Liolaemus* species, although not at a species level within Formicidae, e.g., in *L. quilmes* from Salta (DE VIANA *et al*., 1994), in *L. scapularis* (GARCÍA *et al*., 1989), and in *L. wiegmannii* (AUN *et al*., 1999). Other authors found no differences between males and females, e.g., in *L. boulengeri* (ACOSTA *et al*., 1996), and in *L. koslowskyi* (AUN & MARTORI, 1998). We found differences in male-female

preferences with respect to ant species (Table 3). Female *L. quilmes* seemed to prefer ants that were soft-bodied and did not have functional stings. It may be that *L. quilmes* is affected by predator defenses of their prey, especially females. Or it may be that the three ant species preferred by females contain nutritional elements important to their reproductive effort. Studies are needed to investigate further species and sex differences related to prey type.

Although there is little information on the diet of many *Liolaemus* species, two-thirds of those reported in the literature ate insects belonging to Hymenoptera as their first choice (Table 4). Other lizard species included this prey item as second or third choice. Only two species, *L. pictus* (ORTIZ, 1974) and *L. tenuis* (HURTUBIA, 1973), did not include Hymenoptera in their main diet. It is difficult to make comparisons among these studies since number of lizards and methods varied, but it is clear that Hymenoptera, particularly Formicidae, is a main ingredient in the diet of many *Liolaemus* lizards.

Acknowledgments

We are grateful to anonymous reviewers for their comments and suggestions. We thank Recursos Naturales y Suelos of the Tucumán province (permits # 394-98 and 95-2000) for permission to work in the field. We thank E. Lavilla for permission to use specimens from the collection of the Instituto de Herpetología, Fundación Miguel Lillo (FML) and S. Kretschmar for her help in the FML collection. CONICET-PIP 4966/97 and 02668 (Consejo Nacional de Investigaciones Científicas y Técnicas, Buenos Aires) and CIUNT 26/G218 (Universidad Nacional de Tucumán, Argentina) provided financial support to MH and CR and CONICET-PIP 6502 and PICT 12605 to FC.

REFERENCES

ABDALA, C.S. (2005a): Dos nuevas especies del género *Liolaemus* (Iguania: Liolaemidae) y redescripción de *Liolaemus boulengeri* (Koslowsky, 1898). *Cuadernos de Herpetología,* 19: 3-33.

ABDALA, C.S. (2005b): Una nueva especie del género *Liolaemus* perteneciente al complejo *darwinii* (Iguania: Liolaemidae) de la provincia de Catamarca, Argentina. *Revista Española de Herpetología*, 19: 5-17.

ABDALA, C.S. & LOBO, F. (2006): Nueva especie del grupo de *Liolaemus darwinii* (Iguania: Liolaemidae) del noroeste de Argentina. *Cuadernos de Herpetología,* 19: 3-18.

ACOSTA, J.C., AVILA, L.J. & BLANCO, G. (1996): Ecología de *Liolaemus boulengeri* (Sauria: Tropiduridae) en el noroeste de la estepa Patagónica (Ing. Jacobacci, Río Negro, Argentina). *Cuadernos de Herpetología*, 9: 100-107.

AUN, L. & MARTORI, R. (1998): Reproducción y dieta de *Liolaemus koslowskyi* Etheridge 1993. *Cuadernos de Herpetología*, 12: 1-9.

AUN, L., MARTORI, R. & ROCHA, C. (1999): Variación estacional de la dieta de *Liolaemus wiegmannii* (Squamata: Tropiduridae) en un agroecosistema del sur de Córdoba, Argentina. *Cuadernos de Herpetología*, 13: 69-80.

AVILA, L.J. & ACOSTA, J.C. (1993): Notas sobre el comportamiento de *Liolaemus darwini* (Sauria: Tropiduridae) en el sur de la Provincia de Mendoza. *FACENA, Revista de la Facultad de Ciencias Exactas y Naturales y Agrimensura, Corrientes, Argentina*, 10: 57-61.

CABRERA, A.L. & WILLINK, A. (1980): *Biogeografía de America Latina*, 2nd ed. Secretaría General de la Organización de

los Estados Americanos, Programa Regional de Desarrollo Científico Tecnológico, Washington, D.C.

CEI, J.M. (1986): *Reptiles del Centro, Centro-Oeste y Sur de la Argentina. Herpetofauna de las Zonas Áridas y Semiáridas*. Monografie IV, Museo Regionale di Scienze Naturali, Torino, Italy.

CEI, J.M. (1993): *Reptiles del Noroeste, Nordeste y Este de la Argentina*. Monografie XIV, Museo Regionale di Scienze Naturali, Torino, Italy.

DE VIANA, M.L., JOVANOVICH, C. & VALDÉS, P. (1994): Hábitos alimentarios de *Liolaemus darwinii* (Sauria: Iguanidae) en el Valle de Tin Tin, Argentina. *Revista de Biología Tropical, Costa Rica*, 42: 379-381.

DONOSO-BARROS, R. (1966): *Reptiles de Chile*. Ediciones de la Universidad de Chile, Santiago de Chile.

DUNHAM, A.E. (1983): Realized niche overlap, resource abundance, and intensity of interspecific competition. Pp. 261-280, *in*: Huey, R.B., Pianka, E.R. & Schoener, T.W. (eds.), *Lizard Ecology: Studies of a Model Organism*. Harvard University Press, Cambridge, Massachusetts.

ETHERIDGE, R. (1993): Lizards of the *Liolaemus darwinii* complex (Squamata: Iguania: Tropiduridae) in Northern Argentina. *Bollettino del Museo Regionale di Scienze Naturali, Torino*, 11: 137-199.

ETHERIDGE, R. (1995): Redescription of *Ctenoblepharys adspersa* Tshudi, 1845, and the taxonomy of Liolaeminae (Reptilia: Squamata: Tropiduridae). *American Museum Novitates*, 3142: 1-34.

FROST, D.R., ETHERIDGE, R., JANIES, D. & TITUS, T.A. (2001): Total evidence, sequence alignment, evolution of polychrotid lizards, and a reclassification of the Iguania (Squamata: Iguania). *American Museum of Natural History Novitates*, 3343: 1-38.

FUENTES, E.R. (1981): Depredadores, competidores y alimento como factores en la ecología de *Liolaemus* en Chile Central. *Medio Ambiente*, 5: 22-27.

FUENTES, E.R. & DI CASTRI, F. (1975): Ensayo de herbivoría experimental en especies de *Liolaemus* (Iguanidae) chilenos. *Anales del Museo de Historia Natural de Valparaíso*, 8: 66-75.

FUENTES, E.R. & IPINZA, J. (1979): A note on the diet of *Liolaemus monticola* (Reptilia, Lacertilia, Iguanidae). *Journal of Herpetology*, 13: 123-124.

GARCÍA, S., CHANI, J.M. & DE MANDRI, M.T. (1989): Rasgos particulares en la dieta de *Liolaemus scapularis* Laurent, 1982 (Lacertilia: Iguanidae). *Cuadernos de Herpetología*, 4: 1-3.

HALLOY, M. (1996): Behavioral patterns in *Liolaemus quilmes* (Tropiduridae), a South American lizard. *Bulletin of the Maryland Herpetological Society*, 32: 43-57.

HALLOY, M., ETHERIDGE, R. & BURGHARDT, G.M. (1998): To bury in sand: phylogenetic relationships among lizard species of the *boulengeri* group, *Liolaemus* (Reptilia: Squamata: Tropiduridae), based on behavioral characters. *Herpetological Monographs*, 12: 1-37.

HIRAI, T. & MATSUI, M. (2002): Feeding ecology of *Bufo japonicus formosus* from the montane region of Kyoto, Japan. *Journal of Herpetology*, 34: 719-723.

HUEY, R.B. (1979): Parapatry and niche complementarity of Peruvian desert geckos (*Phyllodactylus*): the ambiguous role of competition. *Oecologia*, 38: 249-259.

HUEY, R.B. & PIANKA, E.R. (1983): Temporal separation of activity and interspecific dietary overlap. Pp. 281-290, *in*: Huey,

R.B., Pianka, E.R. & Schoener, T.W. (eds.), *Lizard Ecology: Studies of a Model Organism*. Harvard University Press, Cambridge, Massachusetts.

HURTUBIA, J. (1973): Trophic diversity measurement in sympatric predatory species. *Ecology*, 54: 885-890.

LOBO, F. (2001): A phylogenetic analysis ot lizards of the *Liolaemus chiliensis* group (Iguania: Tropiduridae). *Herpetological Journal*, 11: 137-150.

LOBO, F. (in press): Las relaciones filogenéticas en el grupo *chiliensis* de *Liolaemus* (Iguania: Liolaemidae): sumando nuevos caracteres y taxa. *Acta Zoológica Lilloana*.

LOBO, F. & ESPINOZA, R.E. (1999): Two new cryptic species of *Liolaemus* (Iguania: Tropiduridae) from northwestern Argentina: resolution of the purported reproductive bimodality of *Liolaemus alticolor*. *Copeia*, 1999: 122-140.

NUÑEZ, H. (1996): Autoecología comparada de dos especies de lagartijas de Chile central. *Publicaciones ocasionales del Museo Nacional de Historia Natural de Chile*, 50: 5-59.

NUÑEZ, H., MARQUET, P.A., MEDEL, R.G. & JAKSIC, F.M. (1989): Niche relationships between two sympatric *Liolaemus* lizards in a fluctuating environment: the "lean" versus "feast" scenario. *Journal of Herpetology*, 23: 22-28.

ORTIZ, J.C. (1974): Reptiles del Parque Nacional "Vicente Perez Rosales". I. Hábitos alimenticios en *Liolaemus pictus pictus*, Duméril et Bibron (Squamata-Iguanidae). *Anales del Museo de Historia Natural de Valparaíso*, 7: 317-326.

ORTIZ, J.C. & RIVEROS, G.M. (1976): Hábitos alimenticios de *Liolaemus nigromaculatus kuhlmani*, Muller y Hellmich. *Anales del Museo de Historia Natural de Valparaíso*, 9: 131-140.

RAMIREZ PINILLA, M.P. (1992): Ciclos reproductivos y de cuerpos grasos en dos poblaciones de *Liolaemus darwinii* (Reptilia: Sauria: Tropiduridae). *Acta Zoologica Lilloana*, 42: 41-49.

ROCHA, C.F.D. (1989): Diet of a tropical lizard (*Liolaemus lutzae*) of southeastern Brazil. *Journal of Herpetology*, 23: 292-294.

SCHULTE, J.A., MACEY, J.R., ESPINOZA, R.E. & LARSON, A. (2000): Phylogenetic relationships in the iguanid lizard genus *Liolaemus*: multiple origins of viviparous reproduction and evidence for recurring Andean vicariance and dispersal. *Biological Journal of the Linnean Society*, 69: 75-102.

SIEGEL, S. & CASTELLAN, N.J. (1988): *Nonparametric Statistics for the Behavioral Sciences*, 2nd ed. McGraw-Hill, New York.

VAN SLUYS, M., DUARTE ROCHA, C.F., VRCIBRADIC, D., ALESSANDER, C., GALDINO, B. & FIGUEIRA FONTES, A. (2004): Diet, activity, and microhabitat use of two syntopic *Tropidurus* species (Lacertilia: Tropiduridae) in Minas Gerais, Brazil. *Journal of Herpetology*, 38: 606-611.

VIDELA, F. (1983): Hábitos alimentarios en iguanidos del oeste árido de la Argentina. *Deserta*, 7: 192-202.

WARD, P.S. (2003): Subfamilia Pseudomyrmecinae. P. 332, *in*: Fernandez, F. (ed.), *Introducción a las Hormigas de la Región Neotropical*. Instituto de Recursos Biológicos Alexander von Humboldt, Bogotá, Colombia.

ms # 221
Recibido: 13/03/06
Aceptado: 21/06/06

ISSN-0213-6686
Rev. Esp. Herp. 20 (2006)
Valencia

The *Revista Española de Herpetología* is the peer-reviewed scientific journal of the **Asociación Herpetológica Española** (AHE). It is indexed in/abstracted by the following services: BiologyBrowser, BIOSIS, CINDOC, Dialnet, Herpetological Contents, Revicien, and Zoological Record.