

# Trophic ecology and morphology of *Anolis bartschi* (Squamata: Dactyloidae) in Viñales National Park, Cuba

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## Abstract

**Trophic ecology and morphology of *Anolis bartschi* (Squamata: Dactyloidae) in Parque Nacional Viñales, Cuba.** Little is known about the trophic ecology of most anoles of Cuba. Morphology is directly related to ecological functions in lizards, such as feeding strategies, interspecific competition or energetic demands linked to reproduction. *Anolis bartschi* is a regionally endemic species, restricted to karstic hills of western Cuba. Here, we offer new insights into the trophic ecology of this species, and its relation to head morphology. We captured 131 adults; males were larger than females in size and head width. Most of them had prey in their stomachs. Males consumed more prey than females, but the latter consumed larger prey. Prey overlap within sexes was detected in the dry season, but trophic segregation occurred in the rainy season. Hymenoptera was the most frequently consumed prey in both sexes. In addition, females ate Blattodea and Coleoptera, and males consumed more Diptera. We suggest that this lizard prefers sedentary rather than mobile prey. According to our dataset and field observations, *A. bartschi* is a bimodal forager lizard, but research on temporal (daily and annual) variation in diet is recommended for a proper forage classification of this lizard.

**Keywords:** conservation, diet, food niche, lizards, niche overlap, protected area, West Indies.

## Resumen

**Ecología trófica y morfología de *Anolis bartschi* (Squamata: Dactyloidae) en el Parque Nacional Viñales, Cuba.** Se conoce poco sobre la dieta de los anolinos cubanos. La morfología en lagartos está directamente relacionada con funciones ecológicas, como estrategias de forrajeo, competencias interespecíficas, o demanda energética ligada a la reproducción. *Anolis bartschi* es un endémico regional, restringido a las alturas cársicas del occidente de Cuba. Aquí ofrecemos datos nuevos sobre la ecología trófica de esta especie y su relación con la morfología de su cabeza. Se capturaron 131

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individuos adultos, donde los machos poseen mayor tamaño del cuerpo y de la cabeza que las hembras. La mayoría de los individuos tenía presas en el estómago. Los machos consumirán más presas que las hembras, pero de menor tamaño que estas. Se detectó solapamiento trófico en época de seca, pero hubo segregamiento trófico en lluvia. Hymenoptera fue la presa más consumida por ambos sexos. Además, las hembras consumieron más Blattodea y Coleoptera, mientras los machos más Diptera. Esta especie prefiere presas sedentarias en lugar de móviles. Sugerimos que esta especie prefiere presas sedentarias a presas móviles. De acuerdo a nuestros datos y las observaciones de campo, *A. bartschi* es un forrajeador bimodal, aunque se recomiendan futuras investigaciones sobre la variación temporal (diaria y anual) en la dieta de esta especie para una apropiada clasificación sobre su actividad forrajeadora.

**Palabras claves:** Caribe, conservación, dieta, lagarto, solapamiento trófico.

### Resumo

**Ecología trófica e morfología de *Anolis bartschi* (Squamata: Dactyloidae) no Parque Nacional Viñales, Cuba.** Pouco se sabe sobre a ecologia trófica da maioria dos anoles de Cuba. Nos lagartos, a morfologia está diretamente relacionada com funções ecológicas, tais como estratégias de forrageio, competição interespecífica ou demandas energéticas ligadas à reprodução. *Anolis bartschi* é uma espécie endêmica regional, restrita a colinas cársticas do oeste de Cuba. Apresentamos aqui novos dados sobre a ecologia trófica dessa espécie e sua relação com a morfologia da cabeça. Capturamos 131 adultos; os machos eram maiores do que as fêmeas em tamanho na largura da cabeça. A maioria dos indivíduos apresentou presas nos estômagos. Os machos consumiram mais presas do que as fêmeas, mas estas últimas consumiram presas maiores. Na estação seca, detectamos uma sobreposição de presas entre os sexos, mas na estação chuvosa ocorreu segregação trófica. Hymenoptera foi a categoria de presas mais frequentemente consumida em ambos os sexos. Além disso, as fêmeas consumiram Blattodea e Coleoptera, e os machos, mais Diptera. Sugerimos que esse lagarto prefere presas sedentárias em vez de presas móveis. De acordo com nosso conjunto de dados e observações de campo, *A. bartschi* é um lagarto forrageador bimodal, mas recomenda-se a investigação sobre a variação temporal (diária e anual) da dieta para uma classificação adequada de sua estratégia de forrageio.

**Palavras-chave:** área protegida, conservação, dieta, Índias Ocidentais, lagartos, nicho trófico, sobreposição de nicho.

### Introduction

In ecology, the knowledge of diet and trophic interactions are essential for understanding aspects of the natural history, population dynamics, assessment of energy flow, and food webs in the communities (Anderson 1991, Solé and Rödder 2010). Dietary information can aid in elucidating predator-prey interactions, especially in endangered species (Solé and Rödder 2010), and this knowledge may lead to the development of management and conservation programs (Anderson 1991). Morphological traits may be directly related to

ecological functions in lizards, such as feeding strategies (e.g. sit-and-wait or active foragers), interspecific competition (Astudillo *et al.* 2015), or energetic demands (Andrews and Asato 1977), because differences in lizard size may lead to differences in resource intake (Pianka 1986, Herrel *et al.* 2004). In trophic ecology, morphology of the head is essential to understand the diet preferences of lizards (Schoener and Gorman 1968, Gvozdik and Boukal 1998, Beuttner and Koch 2019) because lizards with broader and higher heads are capable of producing stronger bite forces (McBrayer and Corbin 2007, Miles *et al.* 2007, Losos 2009,

Campos 2016) and are thus capable of feeding on harder prey (Herrel *et al.* 2001a, b, Verwaijen *et al.* 2002, Herrel 2007, Huyghe *et al.* 2009, Losos 2009).

In Cuba, 64 species of lizards belong to the family Dactyloidae, all within the genus *Anolis* (Torres *et al.* 2017). The diet of most anoline lizards in western Cuba is poorly known. Martínez (1998) analyzed the diet of anoline lizard communities in western Cuba, and Pérez and Rodríguez (2009) and Rodríguez (2010) offered new data on the diet of two related species, *A. quadriocellifer* and *A. homolechis*, respectively. Most published records of the diet of *Anolis* are fortuitous observations (Valido 2006, Cajigas *et al.* 2018, Armas and Iturriaga 2019, Iturriaga and Armas 2019). Such studies suggested that these lizards mostly consume hymenopterans (especially ants) (Martínez 1998, Pérez and Rodríguez 2009, Rodríguez 2010), coleopterans (Pérez and Rodríguez 2009), and heteropterans (Rodríguez 2010), independent of ecomorph or body size.

*Anolis bartschi* (Cochran, 1928) is a regional endemic species, restricted to cliffs of karstic hills (*mogotes*) of Pinar del Río Province. It is known from 49 localities in Sierra de los Órganos (León *et al.* 2019) located at the western part of Cordillera de Guaniguánico, in Cuba. This species is associated with rock walls and reproduces at the entrances of caves (Novo and Estrada 1986, Henderson and Powell 2009). Due to its particular morphology (e.g. extremely long hindlimbs) and ecology (e.g. rock-cave dweller) (Losos 2009), *A. bartschi* is not included in any of the traditionally recognized ecomorph categories (Poe 2005, Losos 2009). In addition, this species has not been assigned to any IUCN threat category (Torres López *et al.* 2017). In terms of trophic ecology, Rodríguez and Martínez (1992) studied a single population at San Vicente, Viñales National Park, and offered the first data on the diet of this species. They found that it feeds mostly on ants, snails, beetles, dipterans, roaches, arthropod larvae, and plant material (Rodríguez and Martínez 1992). No

further research on the trophic ecology of this species has been conducted for more than 27 years following this diet analysis. In this paper, we offer new data on the trophic ecology of *Anolis bartschi* from two populations in Viñales National Park, Cuba. Because differences in head morphology could determine prey preferences in lizards (Losos 2009), we analyzed the head morphology of *A. bartschi* to determine whether this species exhibits different feeding behavior in the two localities and between the sexes.

## Materials and Methods

### Fieldwork

We visited two karstic hills (*mogotes*) in Viñales National Park: Mogote El Capón (22°38'208" N, 83°41'448" W; WGS 84, ~139 m a.s.l.), and San Vicente (22°40'123" N, 83°42'115" W; WGS 84, ~131 m a.s.l.). Each area was visited once in March and April (dry season), and in June and August (wet season) of 2019. We performed 100 m-transect surveys to capture lizards in each area. In order to avoid bias due to niche characteristics, both transects were selected to be homogeneous in soil characteristics, altitude, and vegetation type. The forests of these *mogotes* are mesophyllic semi-deciduous distributed in strips at the base of the *mogotes* (Luis 2000). The typical vegetation is composed of *Oxandra lanceolata* (Sw.) Baill. (Annonaceae), *Pachira emarginata* A. Rich. (Malvaceae), *Spathelia brittonii* P. Wilson (Rutaceae), and large trees, such as *Ficus* spp. (Moraceae) (Luis 2000).

### Data Analysis

To obtain diet information we used the stomach flushing method following Legler and Sullivan (1979). Snout-vent length (SVL) and head width (HW; measured at the junctions of the mandible) were measured on each individual with a caliper to the nearest 0.02 mm. The

specimens were sexed *in situ* and released at the site of capture. Stomach content samples were placed in 20 cm<sup>3</sup> containers with 75% ethanol immediately after extraction and identified in the laboratory under a dissecting microscope to the lowest possible taxonomic level (Espinosa and Ortea 2009, Mancina and Cruz 2017).

We determined the prey volume (mm<sup>3</sup>) following the ellipsoid formula  $V = 4/3\pi (L/2)(W/2)^2$  (Magnusson *et al.* 2003). In addition, we report the total number of consumed items ( $N$ ) and calculated the percent ( $N_{\%}$ ); the frequency of occurrence ( $F$ , number of stomachs in which a given prey category was found); and the percent ( $F_{\%}$ ) and the volume ( $V$ ) and its percent ( $V_{\%}$ ) for each prey category. The Index of Relative Importance is calculated for every prey category by  $IRI = (N_{\%} + V_{\%} + F_{\%})/3$  (Biavati *et al.* 2004). We use the Levins index ( $B$ ) (Krebs 1989) to calculate the trophic niche breadth:  $B = 1/(\sum Pi^2)$ , where  $Pi$  = fraction of items in the prey category  $i$ ; range from 1 to  $N$ . Values of  $B$  vary from 1 (no diversity, exclusive use of a single prey category, specialist) to  $N$  (highest diversity, prey items in the majority of categories, generalist). In addition, we calculated niche overlap using Pianka's overlap index ( $POI$  hereafter) (Pianka 1973), which varies from 0 (no overlap) to 1 (complete overlap). We compared male-female food niche breadth and niche overlap between dry and wet season.

To define the foraging strategy of *Anolis bartschi*, the consumed prey was categorized as either "sedentary" or "mobile" following Beuttner and Koch (2019). We classified as sedentary the prey that moves slowly and/or only covers short distances during movements (e.g. slugs, ants, diplopods, Lepidoptera larvae), and mobile as prey that moves fast enough to escape from capture and/or can cover great distances (over 3 m from predator) (e.g. bees, dipterans, crickets, chilopods, roaches).

To demonstrate if the data were homogenous, we applied the Kolmogorov-Smirnov normality test and the Levene variance homogeneity test.

Because the data are normally distributed, T-tests and one factor ANOVAs were used to determine if significant differences exist for (1) the total prey consumed by males and females in each area; (2) the total amount of prey items consumed in each study area; and (3) the SVL and head width of the lizards in the two study areas. We also use the Pearson correlation coefficient for niche overlap between males and females. A simple linear regression is made to test the tendencies and correlations between SVL/HW, and HW/prey length.

## Results

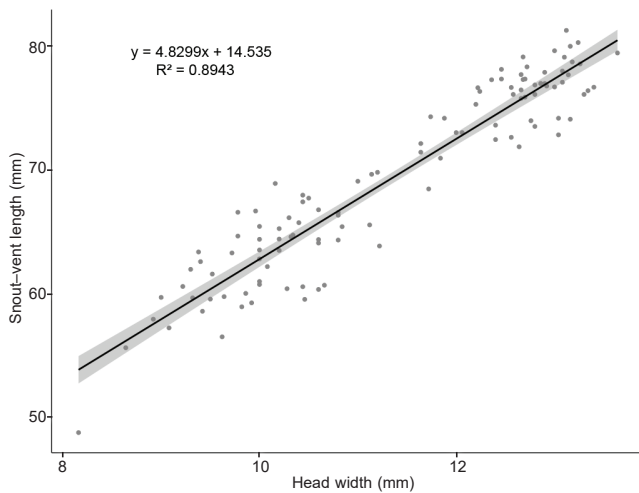
### *Morphological Analysis*

There were 131 adults of *Anolis bartschi* captured, 66 males and 65 females. Females are smaller (range; mean  $\pm$  SD) (57.3–69.68 mm;  $63.2 \pm 4.92$ ,  $N = 46$ ) in SVL than males (69.92–81.28 mm;  $73.37 \pm 5.01$ ,  $N = 56$ ) ( $p = 0.000$ ;  $F = 0.590$ ;  $N = 102$ ). No differences in size were found when comparing males and females together from both localities ( $p = 0.730$ ;  $N = 102$ ). Comparison of the SVL of males between areas showed no significant difference ( $p = 0.718$ ;  $F = 2.092$ ; El Capón:  $73.42 \pm 5.08$  mm,  $N = 32$ ; San Vicente:  $78.41 \pm 2.01$  mm,  $N = 24$ ). Differences in SVL were found among females ( $p = 0.001$ ;  $F = 2.558$ ; El Capón:  $67.94 \pm 1.65$  mm,  $N = 27$ ; San Vicente:  $61.88 \pm 2.97$  mm,  $N = 19$ ). In all individuals, HW was significantly wider in males than in females ( $p = 0.020$ ;  $F = 5.606$ ;  $N = 87$ ), and a positive correlation was found between SVL and HW (Figure 1).

### *Diet Analysis*

A total of 102 individuals of *Anolis bartschi* had prey in the stomachs (77.9 % of all captured individuals), whereas 22.1% had empty stomachs ( $N = 29$ ). We found 19 prey categories in the stomachs, plus ripe fruits, reptile skin molt (Table 1), plant material (other than ripe fruits),





**Figure 1.** Correlation between snout–vent length and head width in adults of *Anolis bartschi* ( $N = 112$ ) from both study areas.

and dirt/stones. Were found 346 prey items in the stomachs of *A. bartschi*, with a rate of 3.39 prey items/stomach ( $N = 102$ ). All females together had consumed 184 prey items (3.41 prey items/stomach,  $N = 54$ ), and had a large volume of prey ( $V = 6152.58$ , total  $V_{\%} = 58.7$ ). Males had consumed 162 prey items together (3.38 prey items/stomach,  $N = 48$ ), with a smaller volume of prey items than females ( $V = 4328.62$ , total  $V_{\%} = 41.3$ ) (Table 1).

We found that *A. bartschi* consumed more prey items during the dry season (206 total items consumed, with a rate of 4.38 prey/stomach;  $N = 47$ ) than during the wet season (146 total items consumed, with 2.65 items/stomach;  $N = 55$ ) ( $p = 0.025$ ;  $F = 14.585$ ) (Table 2).

With regard to the prey niche breadth, males consumed more prey categories in both seasons (Levin index, dry  $B = 2.74$ , wet  $B = 2.53$ ) than females (dry  $B = 2.53$ , wet  $B = 1.56$ ). No significant differences were observed in niche overlap (Pearson index,  $p < 0.05$ ) between sexes in both seasons. In the dry season males and females shared almost the same food resources ( $POI = 0.942$ ), whereas we observed some segregation in food resource exploitation ( $POI = 0.877$ ) in the wet season.

### Stomach Contents

In *Anolis bartschi*, the most abundant prey consumed was Hymenoptera, detected in 63.73% of samples, followed by Coleoptera (25.49%), Arachnida and Gastropoda (with 20.59% each). Within Hymenoptera, Formicidae was found in 42.5% of the stomach samples. We especially note the presence of large numbers of invasive fire ants [*Wasmannia auropunctata* (Roger, 1863)], with a mean of 1.16 individuals per stomach (Table 1). Except for the large consumption of hymenopterans by both sexes, differences in prey preference were detected: females consumed mostly Coleoptera and Blattodea, whereas males consumed more Diptera and Gastropoda (Table 1). All Lepidoptera found in the stomachs were still in the larval stage. We were able to identify the genus or species of some taxa consumed: bee (*Apis mellifera* Linnaeus, 1758; Hymenoptera, Apidae), amblypygid (*Phrynus* sp.; Phrynidae), cockroaches (*Eurycotis cribose* Rehn and Hebard, 1927 and *Periplaneta americana* Linnaeus, 1758; Blattodea), cave cricket [*Otteius thoracicus* (Saussure, 1874); Orthoptera], earwig [*Euborellia annulipes* Lucas, 1847]; Dermaptera], land snails (*Jeanneretia* sp., *Zachrysia* sp., Gastropoda), and land slug (*Leidyula* sp., Gastropoda). In addition, we observed fruits in the stomach of 14 lizards (13.7% of the sampled lizards), but only *Ficus* sp. could be identified, which was observed in four stomach samples.

### Foraging Strategy

In general, *A. bartschi* preferred sedentary over moving prey (Table 2). In this study 87 items ( $N_{\%} = 26.0\%$ ) were assigned to moving prey, with a volume of  $V = 1587.26 \text{ mm}^3$  ( $V_{\%} = 15.2\%$ ), which were found in 71 stomachs ( $F_{\%} = 35.6\%$ ). In contrast, 247 items were sedentary prey ( $N_{\%} = 43.4\%$ ), with a volume of  $V = 8887.79 \text{ mm}^3$  ( $V_{\%} = 84.9\%$ ), which were found in 129 stomachs ( $F_{\%} = 65.0\%$ ). We also observed that the *IRI* of sedentary prey (149.21) is 2.9 times higher than the *IRI* of mobile prey (51.31). We found higher values in

**Table 1.** Prey consumed by *Anolis bartschi*. For each category the number (*N*), the percent by number ( $N_{\%}$ ), the frequency (*F*), the percent by frequency ( $F_{\%}$ ), the volume (*V*; mm<sup>3</sup>), and the percent ( $V_{\%}$ ) is given. The Index of Relative Importance (*IRI*) of each prey category is given for males, and females separately. The volume and *IRI* of ripe fruits and skin molt could not be calculated because no entire item was obtained.

Groups	Males ( <i>N</i> = 48)				Females ( <i>N</i> = 54)			
	<i>F</i> (%)	<i>N</i> (%)	<i>V</i> (%)	<i>IRI</i>	<i>F</i> (%)	<i>N</i> (%)	<i>V</i> (%)	<i>IRI</i>
Diplopoda	2 (2.25)	2 (1.18)	79.98 (1.85)	1.76	4 (3.64)	4 (2.44)	197.0 (3.2)	3.09
Chilopoda	2 (2.25)	2 (1.18)	115.23 (2.66)	2.03	0	0	0	0
Scutigermorpha	1 (1.12)	1 (0.59)	138.71 (3.2)	1.64	0	0	0	0
Orthoptera	2 (2.25)	2 (1.18)	305.32 (7.05)	3.49	3 (2.73)	3 (1.83)	472.59 (7.68)	4.08
Blattodea	5 (5.62)	5 (2.96)	198.0 (4.57)	4.38	9 (8.18)	9 (5.49)	381.17 (6.2)	6.62
Coleoptera	9 (10.11)	9 (5.33)	6.9 (0.16)	5.2	17 (15.45)	18 (10.98)	14.87 (0.24)	8.89
Hexapoda (unidentified)	1 (1.12)	1 (0.59)	1.54 (0.04)	0.58	0	0	0	0
Hymenoptera (non Formicidae)	13 (14.61)	16 (9.47)	3006.47 (69.46)	31.18	13 (11.81)	19 (11.59)	4431.2 (72.02)	31.81
Formicidae	22 (24.72)	87 (51.48)	15.16 (0.35)	25.52	17 (15.45)	58 (35.37)	14.3 (0.23)	17.02
Hemiptera	0	0	0	0	5 (4.55)	6 (3.66)	97.46 (1.58)	3.26
Dermaptera	0	0	0	0	1 (0.91)	1 (0.61)	35.51 (0.58)	0.7
Lepidoptera (larvae)	4 (4.49)	4 (2.37)	271.9 (6.28)	4.38	5 (4.55)	5 (3.05)	312.8 (5.08)	4.23
Diptera	10 (11.24)	22 (13.02)	16.95 (0.39)	8.22	8 (7.27)	11 (6.71)	15.03 (0.24)	4.74
Aranae	4 (4.49)	4 (2.37)	67.0 (1.55)	2.8	8 (7.27)	8 (4.88)	72.65 (1.18)	4.44
Amblypygi	3 (3.37)	3 (1.78)	22.41 (0.52)	1.89	3 (2.73)	3 (1.83)	19.98 (0.32)	1.63
Opiliones	1 (1.12)	1 (0.59)	3.01 (0.07)	0.59	2 (1.82)	2 (1.22)	5.73 (0.09)	1.04
Isopoda	0	0	0	0	4 (3.64)	6 (3.66)	3.62 (0.06)	2.45
Gastropoda	10 (11.24)	10 (5.92)	80.1 (1.85)	6.34	11 (10.0)	11 (6.71)	78.67 (1.28)	6.0
Ripe fruits	5 (5.62)	5 (5.92)	–	–	9 (8.18)	9 (5.49)	–	–
Skin molt	3 (3.37)	3 (1.78)	–	–	2 (1.82)	2 (1.22)	–	–

sedentary prey among males and females compared with mobile prey items (Table 2). Although sedentary prey items were preferred by both sexes, females consumed slightly more mobile prey than males, which ate larger numbers of sedentary prey items than females (Table 2).

### Discussion

Herein we report the largest SVL recorded for this species, with a maximum SVL of 81.28 mm in males, and 69.68 mm in females. Rodríguez and Martínez (1992) categorized *Anolis bartschi* as opportunistic because they take advantage of prey availability despite seasonality. Most *A. bartschi* had prey in the stomach, and a high prey/stomach rate (3.39) was detected. Differences in prey type may reflect intersexual differences in size, microhabitat use, or energetic demands (Losos 2009). Andrews and Asato (1977) found that higher consumption of prey by females could be due to energetic demands; females of *Anolis limifrons* Cope, 1862 had a two-fold energy expenditure producing eggs during reproduction, compared to sperm production in males (Andrews and Asato 1977). In our study, the head width was not directly related to prey size: females consumed slightly fewer and larger prey than males. *Anolis bartschi* consumed more food during the dry season than during the

rainy season, possibly because in the dry season they gather energy from a variety of prey items to prepare themselves for reproduction. In the rainy season, when more prey is available, they eat fewer prey items and prey categories because they can choose their prey and/or spend more time reproducing. We suggest that the consumption of larger prey by females of *A. bartschi* is directly related to energy gain before March and April, during May to September, and after reproduction (October to February) (Novo and Estrada 1986).

Similarities in niche breadth of males and females were observed during the dry season, but in the rainy season males consumed a significantly higher diversity of prey than females ( $B = 2.78$ , and  $B = 1.56$  respectively). In the dry season, both males and females exploited all resources available, and some competition in type of prey may occur, but in the rainy season, when invertebrates are abundant, males seemed to consume a higher diversity of prey categories, and females were more selective. In addition, overlap was detected in type of prey consumed by males and females in the dry season, but less overlap occurred in the rainy season, even though no significant difference was observed. Rodríguez and Martínez (1992) found similar results, suggesting that this difference is due to higher prey availability in the rainy season, and no competition is needed for food resources,

**Table 2.** Moving (MP) and sedentary (SP) prey consumed by *Anolis bartschi* by sex. Shown are the number of items (N) and percentage (%), the frequency of occurrence (F) and percentage (%), the volume (V) and percentage (%), and the IRI. The number of MP and SP categories represents the number of prey categories assigned to MP and SP.

	MP (7)		SP (12)	
	Male	Female	Male	Female
F (%)	31 (34.83)	40 (36.36)	59 (66.29)	70 (63.64)
N (%)	43 (25.44)	44 (26.83)	127 (75.15)	120 (73.17)
V (%)	683.62 (15.79)	903.64 (14.69)	3638.85 (84.06)	5248.94 (85.31)
IRI	25.35	25.96	75.16	74.04

whereas in the dry season less prey availability may lead to competition for food resources. Estrada and Novo (1986, 1987) also observed overlap in space, substrate and temperature, but this species was found to have lower overlap in perch height (Estrada and Novo 1986, LYGP unpubl. data), which may influence spatial segregation during foraging, as suggested by Rodríguez and Martínez (1992).

### *Stomach Contents*

Ant consumption in anoles is common in Cuban species (Rodríguez and Martínez 1992, 1994, 1996). Ants are clumped species that are easier to catch, and the higher individual numbers compensate for the diminutive size (Rodríguez 2010), even for a medium-large lizard such as *Anolis bartschi*. This species mainly consumed Hymenoptera, especially ants (Rodríguez and Martínez 1992, this study). We found a large number of non-ant Hymenoptera (mostly bees), which occupy most of volume in *A. bartschi* stomachs (Table 1); followed by ants, but, as expected, ants had the greatest  $N_{\%}$  (80.6%) in both sexes. We report for the first time the presence of the introduced fire ant (*Wasmannia auropunctata*) consumed intentionally ( $F_{\%} = 18.8$ ,  $N_{\%} = 42.3$ ) for any Cuban reptile, and consequently for *A. bartschi*. This fire ant is invasive in Cuba, and no evaluation of damage to human and/or native fauna has been studied. Rodríguez-Cabrera *et al.* (2020) reported fire ants in the stomach of the snake *Tropidophis maculatus* (Bibron, 1840), but due to the low number of ants, this consumption seemed to have been accidental. The intentional consumption of this ant was detected in frogs (García-Padrón and Borrego *in press*, LYGP unpubl. data). This observation may be a natural response to invasion and may point to this lizard as another natural control to this invasive species, even though the quantity of fire ants found in stomachs of *A. bartschi* is small.

Besides Hymenoptera, males consumed in general the largest number of dipterans and

mollusks (25% each), and beetles (22.5%), while females consumed mostly beetles (48.6%), arachnids (37.1%), mollusks (31.4%), and roaches (25.7%). It seems that another mechanism of females to avoid trophic overlap (besides temporal segregation) is to consume more categories and larger prey than males. Fruit consumption is known in lizards (Schoener 1968, Herrel *et al.* 2004, Vitt and Caldwell 2013). We observed ripe fruits in the stomach ( $N = 14$ ) of *A. bartschi*, most of them consumed in the rainy season (71.43%); of which we could only identify the genus *Ficus* sp., observed in four stomachs. This observation agrees with Rodríguez and Martínez (1992) who found that a greater amount of fruit was consumed by this species in the rainy season. Females consumed more fruit in the rainy (80%,  $N = 8$ ) than in the dry season (25%,  $N = 1$ ). On the contrary, males eat slightly more fruit in the dry (75%,  $N = 3$ ) than in the rainy season (20%,  $N = 2$ ). We believe that the dirt/stones and (non-fruit) plant material found in the stomachs were consumed accidentally while hunting. Skin molt in the stomach content is common in samples of *A. bartschi* (Rodríguez and Martínez 1992, this study), and Rodríguez and Martínez (1992) disavowed the possibility of saurophagy or cannibalism. We believe that skin molt belongs to the same individual who consumed it.

### *Foraging Mode*


*Anolis bartschi* consumed more sedentary than mobile prey items. During the study, we observed *A. bartschi* consuming preferentially clumped, colonial (e.g. ants) or sedentary prey (e.g. Lepidoptera larvae), rather than mobile prey (e.g. crickets, roaches, dipterans). In general, males consumed more sedentary prey than females, but it seems as if this preference changed seasonally: in the dry season, males consumed more sedentary (73.7%) and less mobile prey (26.3%) than females (64.9% and 35.1% respectively). On the contrary, in the rainy season females consumed more “sedentary”



prey (65.6%) and less “mobile” prey (34.4%) than males (55.6%, and 44.4% respectively). The consumption of sedentary prey can be advantageous for this lizard, as it enables low energy cost during hunting. Active foragers usually consume sedentary prey, have streamlined body shapes, long and narrow heads (Vitt and Caldwell 2013), and can be selective in food choice (Bergallo and Rocha 1994), resulting in low food diversity. Sit-and-wait predators feed on a large variety of prey types, are territorial, and use visual signaling for reproduction (Vitt and Caldwell 2013). According to our dataset and field observation, *A. bartschi* is a bimodal forager: it feeds on sedentary prey, even though this depends on sex and seasonality; consumes a great variety of prey types; has a streamlined body shape with a long and narrow head; is territorial; and uses visual signals for reproduction. Even so, research on diet preferences linked to reproduction and ecology is recommended for a proper forage classification of this lizard.

Urbanization through tourism, agriculture and clear cutting of forests for lumber production around Viñales National Park are the main ecological problems in our study areas. These disturbances could affect not just the forest dynamics, but also the composition of the associated invertebrate fauna and consequently its predator-prey dynamics (Kattan and Álvarez-López 1996). That is why we consider that modification and/or destruction of the habitat may determine the future of this local endemic and ecologically restricted lizard. A fast response to this growing problem must be given by the authorities. Studies on behavior, reproductive ecology, population dynamics, and continuing diet research are needed to clarify aspects of trophic ecology yet unanswered [e.g. trophic dynamics between age classes, potential disturbance on the lizards and their food (the invertebrate community) by habitat fragmentation], and that may contribute to the conservation and management plan for this local endemic species.

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