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Short Communication

Diet and feeding behavior of the parrot snake *Leptophis nigromarginatus* (Günther, 1866) (Serpentes, Colubridae)

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Abstract: Specimens (50) of *Leptophis nigromarginatus* from northern Brazil, Peru, Ecuador and Colombia were examined for the composition of stomach contents. Most prey items were tree frogs, especially those of the family Hylidae (96%). Most of the anurans identified belong to the *Scinax ruber* species group (14%) and *Scinax* sp. (8%). Both sexes preyed on small-sized items (1.8–4.4% of snake snout-vent length), but females capture larger prey than males. *Leptophis nigromarginatus* seems to manipulate captured prey before ingestion since most of the prey items (68%) were swallowed head-first. There is a positive correlation between female snout-vent length and prey size and between and head length and prey size.
Keywords: *Diet; Feeding behavior; Anura; Parrot snake; Leptophis nigromarginatus.*

Dieta e comportamento alimentar da cobra-papagaio *Leptophis nigromarginatus* (Günther, 1866) (Serpentes, Colubridae)

Resumo: Espécimes (50) de *Leptophis nigromarginatus* do Norte do Brasil, Peru, Equador e Colômbia foram examinados quanto à composição do conteúdo estomacal. A maioria das presas eram pererecas, especialmente as da família Hylidae (96%). A maioria dos anuros identificados pertence ao grupo de espécies *Scinax ruber* (14%) e *Scinax* sp. (8%). Ambos os sexos predaram itens de pequeno porte (1,8-4,4% do comprimento focinho-cloaca da serpente), mas as fêmeas capturam presas maiores que os machos. *Leptophis nigromarginatus* parece manipular as presas capturadas antes da ingestão, uma vez que a maioria das presas (68%) foi engolida pela cabeça. Há uma correlação positiva entre o comprimento do focinho-cloaca da fêmea e o tamanho da presa e entre o comprimento da cabeça e o tamanho da presa.
Palavras-chave: *Dieta; Comportamento alimentar; Anura; Cobra-papagaio; Leptophis nigromarginatus.*

Introduction

The Neotropical genus *Leptophis* Bell, 1825 (parrot snakes) comprises a group of 19 colubrine snakes widely distributed from Mexico through Central- and South America (Uetz et al. 2024). These diurnal serpents inhabit both arboreal and terrestrial environments, and are known to feed predominantly on hylid frogs (e.g., Beebe 1946, Oliver 1948, Albuquerque & Di-Bernardo 2005). However, Oliver (1948), Hero & Magnusson (1987), Teixeira & Porto (1991), Martins & Oliveira (1999), Albuquerque et al. (2007), Muniz et al. (2013) and Leite et al. (2022) also recorded lizards, snakes, young birds and salamanders in their diet.

Among the currently recognized taxa in the genus, *Leptophis nigromarginatus* (Günther, 1866) is a diurnal and arboreal snake (Dixon & Soini 1977, Duellman 1978) that can also be found on shrubs and banana plants (Duellman 2005). It is a medium-sized parrot snake, with snout-vent length usually not larger than 835 mm, known from Guyana, the western- and middle Amazon regions of Brazil, the Amazonian lowlands of Colombia, Ecuador, and Peru, and extreme northern Bolivia (Albuquerque & Fernandes 2022). Although general accounts state that this species feeds on 'bird eggs, geckos, hylid frogs and young birds' (Oliver 1948) some basic aspects of its natural history, including its dietary habits, are still little-known. To date, they are known to consume the following species of frogs: *Scinax ruber* (Laurenti, 1768) and *Osteocephalus alboguttatus* (Boulenger, 1882) (Dixon & Soini 1977, Duellman 1978, 2005). Nothing else is known about diet in this species.

The goal of this paper is to report the feeding habits of *L. nigromarginatus* addressing also the following question: Are there differences in the size of prey items ingested by males and females of *L. nigromarginatus*?

Material and Methods

We analyzed 50 adult specimens of *L. nigromarginatus* for stomach contents (Appendix I). The snakes are housed in eight herpetological collections and institutional abbreviations follow Sabaj (2023). We obtained most of the analyzed stomach contents from snakes collected in northern Brazil, Peru, Ecuador and Colombia. Most of the gut contents were already exposed in the specimens examined. Otherwise, in some cases we made a small incision in the stomach of snake and removed all intact or partially digested prey items for further examination. For the intact prey items, we measured the length (in mm) using Mitutoyo digital callipers (±0.01 mm). We also recorded the direction of ingestion of prey (inferred from orientation in the gut i.e., head-first or tail-first) and the snout-vent length (SVL) of intact prey.

We recorded the following data for each snake: head length (HL), snout-vent length (SVL), tail length (TL) and condition of the tail tip (mutilated or not).

We determined the sex of all snakes by dissecting the base of the tail, and by inspection of gonads. We used linear regression to test for the correlation between prey length versus predator SVL and between prey length versus predator HL, using sex as factor.

We evaluated the assumptions of normality and homoscedasticity using Kolmogorov–Smirnov's test and the Levene's test, respectively (Ayres et al. 2007). Prey items (n = 19) whose length could not be calculated due to lack of measurement data (i.e., fragmented prey) were excluded from the regression analyses. According to Albuquerque & Fernandes (2022), there is no significant difference between the TL and the SVL of females and males in *L. nigromarginatus*.

Results

Table 1 summarizes prey taxa exploited by *Leptophis nigromarginatus* in the samples. Anurans were the only prey items found, including nine species representing seven genera (*Boana*, *Callimedusa*, *Dendropsophus*, *Hemiphractus*, *Pristimantis*, *Scinax*, and *Sphaenorhynchus*) of the families Hemiphractidae, Hylidae and Strabomantidae.

The most frequent prey items were frogs of the species *Scinax ruber* (14%) and some predation events occurred in the Andean regions (Figure 1).Thirty-six of the 50 specimens (72%) contained a single prey item. Eight (16%) had two prey items in their stomachs. One (2%) had three and two (4%) had four prey items. Three (6%) of the 50 specimens (TCWC 44090, TCWC 44660 and TCWC 44661) contained frog eggs.

Forty-three prey items (68%) were consumed head-first and nineteen (30%) were consumed tail-first. The direction of ingestion could not be determined for one prey (2%).

Thirteen specimens (46.4%, n = 28) had mutilated tails. Prey lengths ranged from 1.8 to 3.8% of the snake SVL in males (n = 4) and from 1.8 to 4.4% in females (n = 9).

Prey size was not significantly related to SVL ($F = 0.9979$, $P = 0.6593$) not to HL ($F = 0.9962$, $P = 0.6588$) in males (Figure 2). On the other hand, the linear regression show that ingested prey size increased significantly with both SVL ($F = 11.9937$, $P = 0.0021$) and HL ($F = 5.5206$, $P = 0.0246$) of females (Figure 3).

Table 1. Summary of prey taxa in the diet of *Leptophis nigromarginatus* from northern Brazil, Peru, Ecuador and Colombia.

Prey taxa	New record	Snakes with prey items		Prey items	
		n	%	n	%
Amphibians					
Strabomantidae					
Pristimantis Jiménez de la Espada, 1870	X	1	2.00	1	1.52
Hemiphractidae					
Hemiphractus Wagler, 1828	X	1	2.00	1	1.52
Hylidae					
Boana cinerascens (Spix, 1824)	X	1	2.00	1	1.52
Boana geographica (Spix, 1824)	X	2	4.00	4	6.06
Callimedusa tomopterna (Cope, 1868)	X	1	2.00	1	1.52
Dendropsophus parviceps (Boulenger, 1882)	X	1	2.00	3	4.55
Dendropsophus triangulum (Günther, 1869)	X	1	2.00	1	1.52
Scinax Wagler, 1830		4	8.00	5	7.58
Scinax cruentomma (Duellman, 1972)	X	1	2.00	1	1.52
Scinax ruber (Laurenti, 1768)		7	14.00	12	18.18
Sphaenorhynchus lacteus (Daudin, 1800)	X	2	4.00	2	3.03
Unidentifiable Hylidae		24	48.00	30	45.45
Unidentifiable anurans		1	2.00	1	1.52
Unknown no. of anuran eggs	X	3	6.00	3	4.55
Total		50	100	66	100

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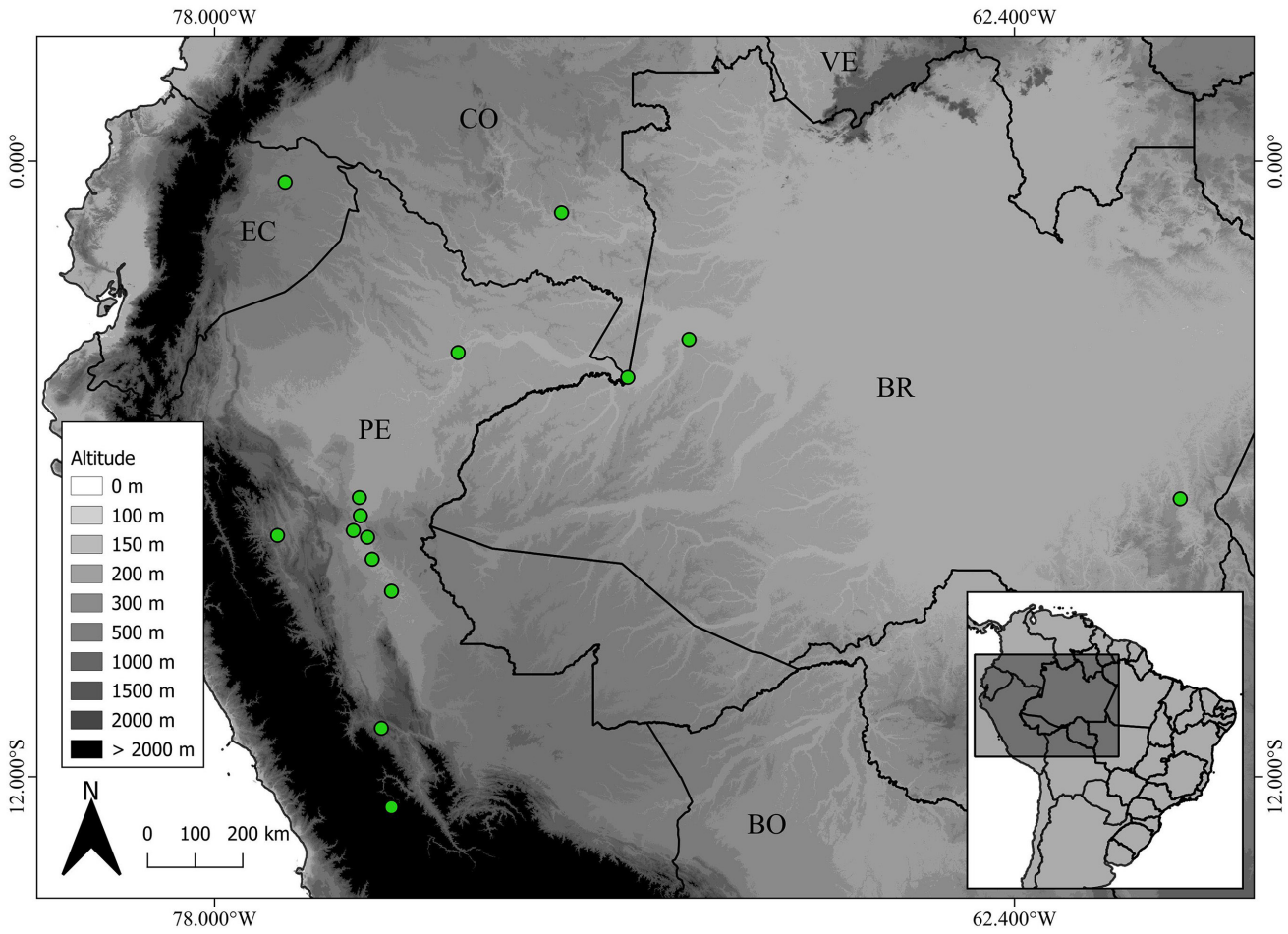

Figure 1. Geographic distribution of Anuran predation by *Leptophis nigromarginatus*. Map depicts locations (green circles) where *L. nigromarginatus* predated anurans.

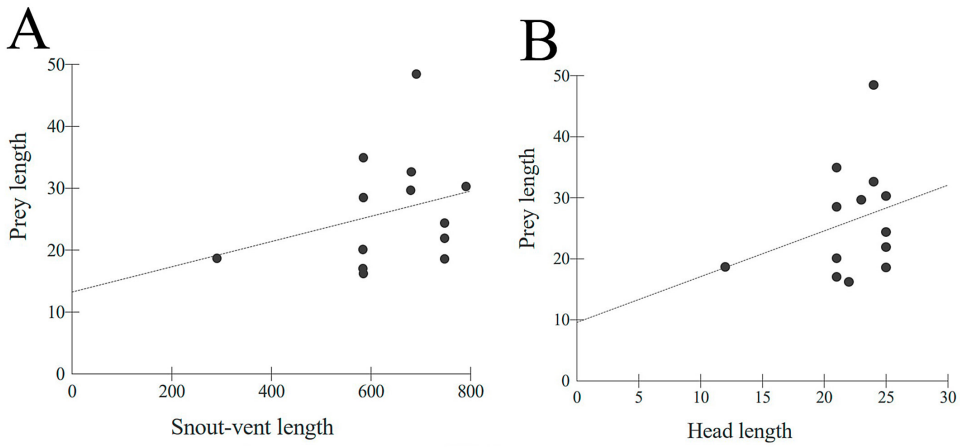

Figure 2. Correlation between *Leptophis nigromarginatus* (A) snout-vent length and prey length and between (B) head length and prey length in males. Values in mm.

Discussion

Our data revealed that *Leptophis nigromarginatus* specializes on anuran prey (100 % of all prey items), supporting the general consensus of anecdotal reports found in the literature (Oliver 1948, Dixon & Soini 1977, Duellman 1978, 2005) and providing additional information on feeding biology. Most prey items were treefrogs of the genus *Scinax*, followed by *Scinax* sp., *Boana geographica* and *Sphaenorhynchus lacteus*. *Boana cinerascens*, *Callimedusa tomopterna*, *Dendropsophus parviceps*, *D. triangulum*,

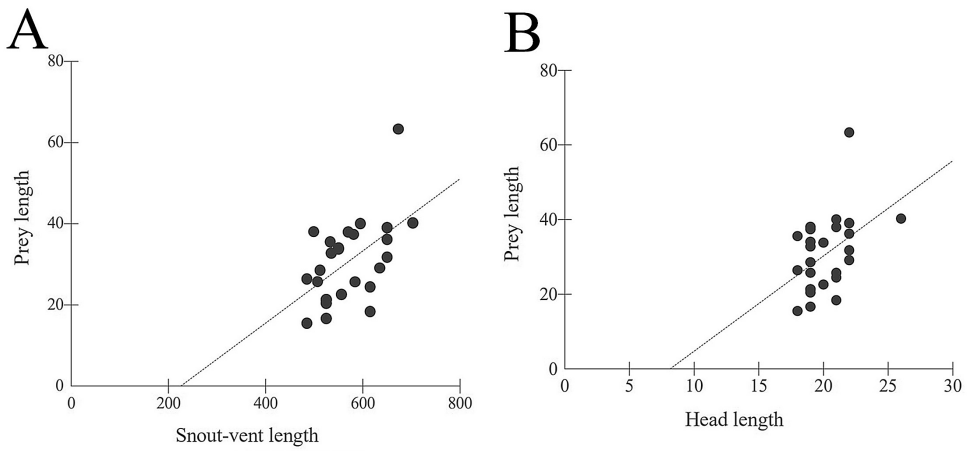

Figure 3. Correlation between *Leptophis nigromarginatus* (A) snout-vent length and prey length and between (B) head length and prey length in females. Values in mm.

Figure 4. A specimen of *Leptophis nigromarginatus* in the act of consuming an anuran of the species *Osteocephalus taurinus* at San Andrés, Río Momón, Loreto, Peru. Photo by William W. Lamar.

Hemiphractus and *S. cruentomma* are equally represented in the diet. Most of these items demonstrate that hylid frogs constituted the primary prey source for *L. nigromarginatus*. The new dietary records provided for *L. nigromarginatus* include seven hylid, one eleutherodactylid, and one hemiphractylid taxa (Table 1).

The species of *Scinax* are among the most frequently encountered hylid frogs in the Amazon Basin (Duellman & Wiens 1993), and have also been recorded as the major prey for other semi-arboreal snakes such as *Chironius exoletus* (Linnaeus, 1758) (Dixon et al. 1993), *Mesotes strigatus* (Günther, 1858) (Bernarde et al. 2000), *Leptophis ahaetulla* (then the nominotypical subspecies) (Albuquerque et al. 2007) and *L. marginatus* (Lopez et al. 2003).

Although not found in the present study, a specimen of *L. nigromarginatus* was observed and photographed by William W. Lamar (pers. comm., 1 April 2021) in situ in the act of consuming an anuran of the species *Osteocephalus taurinus* Steindachner, 1862 at San Andrés, Río Momón, Loreto, Peru (Figure 4), whereas Duellman (1978, 2005) recorded *O. alboguttatus* (Boulenger, 1882) in their diet.

The high frequency of mutilated tails in *L. nigromarginatus* was also observed in other snakes of the *L. ahaetulla* complex (see Albuquerque & Fernandes 2022). This condition appears to be most frequently found in diurnal and arboreal snake species (Moura et al. 2023). According to some authors, it can be related to predator evasion (Hoogmoed & Ávila-Pires 2011, Lockhart & Amiel 2011).

The utilization of different-sized prey by males and females in species showing sexual size dimorphism may decrease competition for food between sexes (e.g., Shine 1987, Camilleri & Shine 1990, Forsman 1995, but see Shine & Goiran 2021). However, this appears not to be the case, since there were no significant differences between sexes in mean values of SVL and TL (Albuquerque & Fernandes 2022).

Our results suggest that, as in *L. ahaetulla* (see Albuquerque et al. 2007), *L. nigromarginatus* seems to manipulate captured prey before ingestion because 68% of prey items were consumed head-first. Furthermore, consumption of frog eggs not only suggests visits to multiple nests, but also may reflect the occurrence of *L. nigromarginatus* in both ground-level and arboreal habitats.

In conclusion, it seems highly desirable to conduct further studies to better understand whether *L. nigromarginatus* shares food resources in areas of sympatry with *L. ahaetulla*, a species also specialized in eating hylid frogs (Albuquerque et al. 2007) and to verify why females consume larger prey than males.

Supplementary Material

The following online material is available for this article:
Appendix.

Acknowledgments

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Author Contributions

Nelson Rufino de Albuquerque: Substantial contribution in the concept and design of the study; Contribution to data collection; Contribution to data analysis and interpretation; Contribution to manuscript preparation.

Roullien Henrique Martins: Contribution to data analysis and interpretation; Contribution to critical revision, adding intellectual content.

Conflicts of Interest

The authors declares that they have no conflict of interest related to the publication of this manuscript

Ethics

This study did not involve human beings and/or clinical trials that should be approved by one Institutional Committee.

Data Availability

The entire dataset supporting the results of this study was published in the article itself.

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