Diet and feeding behaviour of the Neotropical parrot snake (*Leptophis ahaetulla*) in northern Brazil

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Abstract
Specimens (289) of *Leptophis ahaetulla* from northern Brazil and western Maranhão were examined for the composition of stomach contents. Most prey items were tree frogs, especially those of the family Hylidae (90%). Most of the anurans identified belong to the *Scinax ruber* species group (27%) and *Scinax* sp. (25%). Prey size was significantly related to snake length but not to head length. There was no significant difference related to sex in either case. Both sexes preyed on small to medium-sized items (3–10% of snake snout–vent length). *Leptophis ahaetulla* seems to manipulate captured prey before ingestion since most of the prey items (83.6%) were swallowed head-first. *Leptophis ahaetulla* is primarily diurnal and semi-arboreal, inhabits disturbed and undisturbed forest, and forages primarily on the ground and in fallen vegetation, where its prey items are likely to be found at rest.

Keywords: Diet, feeding behaviour, *Leptophis ahaetulla*, northern Brazil, parrot snake

Introduction

*Leptophis ahaetulla* (Linnaeus, 1758) is one of the most widespread species in the genus with 12 subspecies (Oliver 1948; Peters and Orejas-Miranda 1970) occurring throughout Central and South America (Oliver 1948). It is also the most variable species in the genus, exhibiting extremes in coloration and dentition (Oliver 1948; Peters and Orejas-Miranda 1970; Mertens 1973). They are semi-arboreal, diurnal snakes, commonly seen in shrubbery and trees. In Brazil, *L. ahaetulla* is reported to occur over a wide range of habitats including the Amazon rainforest (Cunha and Nascimento 1978; Martins and Oliveira 1999), the Pantanal (Strüssmann and Sazima 1993), Savanna (Cunha and Nascimento 1980; Colli et al. 2002), and Caatinga (Vanzolini et al. 1980). All snakes studied were previously identified as the nominal subspecies (*sensu* Oliver 1948; Peters and Orejas-Miranda 1970; Cunha and Nascimento 1978, 1993), which feeds predominantly on hylid frogs (Beebe 1946; Oliver 1948). However, Oliver (1948), Hero and Magnusson (1987), Teixeira and

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Porto (1991), and Martins and Oliveira (1999) have also recorded Anolis sp., Thecadactylus rapicauda, Mastigodryas boddaerti, and young birds (Tachyphonus cristatus) in its diet. The goal of this paper is to report the feeding habits of L. ahaetulla from northern Brazil and western Maranhão, addressing also the following questions: (1) what are the macro-habitat niches utilized by L. ahaetulla? (2) Are there differences in the size of prey items ingested by males and females of L. ahaetulla?

Material and methods

We analysed a total of 289 adult specimens of L. ahaetulla for the composition of stomach contents, of which 53 had identifiable prey items (Appendix I). The snakes are deposited in the Instituto Butantan (IBSP), São Paulo; Museu de História Natural Capão da Imbuia (MHNCI), Curitiba; Museu Nacional do Rio de Janeiro (MNRJ), Rio de Janeiro; Museu Paraense Emílio Goeldi (MPEG), Belém; and Museu de Zoologia da Universidade de São Paulo (MZUSP), São Paulo. Most of the stomach contents analysed were obtained from snakes collected in eastern Amazonia, mainly in Pará State, and western Maranhão, which have similar flora and rainfall distribution (Ab'Saber 1977; Cunha and Nascimento 1982).

We made a small incision in the stomach of each snake and removed all intact or partially digested prey items for further examination. Direction of ingestion (i.e. head-first or tail-first) was recorded. Prey items that were transversely orientated in the gut were not included in the analyses. The sex of all snakes was determined by dissecting the base of the tail, and by inspection of gonads. Prey size was measured to the nearest 0.1 mm using a digital caliper.

Analyses of covariance (ANCOVA) were used to test for the correlation between prey length versus snake length and between prey length versus snake head length (covariates), using sex as factor. Assumptions of normality and homoscedasticity were evaluated using Kolmogorov–Smirnov’s test and the Levene’s test, respectively (Zar 1999).

Results

Fifty-three of the 289 stomachs of L. ahaetulla examined contained prey items. Anurans were the most frequent prey category (90% of the total prey items), including 10 species representing five genera (Dendropsophus, Hypsiboas, Osteocephalus, Scinax, and Sphaenorhynchus) of Hylidae. The most frequent prey items were frogs of the Scinax ruber species group (27%; Table I), which were ingested throughout the year, except September and December.

Three males contained lizard tails and remains of Gonatodes humeralis (Gekkonidae). One male contained remains of Hemidactylus mabouia and two females contained remains of H. mabouia (Gekkonidae) and Bolitoglossa paraensis (Amphibia, Plethodontidae). The lizards and salamander were not measured in our analysis.

Forty-seven of the 53 specimens (88.7%) contained a single prey item. Six had two prey items in their stomachs. Forty-six prey items (83.6%) were consumed head-first and nine were consumed tail-first. The direction of ingestion could not be determined for four prey items.

Prey lengths ranged from 3 to 10% of the snake snout–vent length in males, and from 3 to 8% in females. Prey size was significantly related to snake length (P=0.009; r²=0.21;
Discussion

Our results agree with published reports on the diet of *L. ahaetulla* (Oliver 1948; Lopez et al. 2003). Most prey items were treefrogs of the genus *Scinax*, which are among the most frequently encountered hylid frogs in the Amazon Basin (Duellman and Wiens 1993). They are nocturnal and inhabit primarily cleared areas in the rainforest (Lutz 1973; Duellman and Wiens 1993) on the ground and in bushes, and trees (Duelmann 1990), and include a perianthropic species (Hoogmoed and Ávila-Pires 1991; Ávila-Pires and Hoogmoed 1997). The species of *Scinax* have also been recorded as the major prey for other semi-arboreal snakes such as *Chironius exoletus* (Dixon et al. 1993) and *Thamnodynastes strigatus* (Bernarde et al. 2000).

The presence of the salamander *Bolitoglossa paraensis* was unexpected. This species is nocturnal (Crump 1977) and was probably taken at rest during the day. The anurans of the genus *Hypsiboa* and *Dendropsophus* are also nocturnal (Ávila-Pires and Hoogmoed 1997) and were probably also taken from their daytime resting sites.

The presence of two tails of *Thecadactylus rapicauda* may corroborate the efficiency of autotomy as one of the defences utilized by lizards for escaping predation attempts (Vitt and Vangilder 1983; see also Hero and Magnusson 1987). *Thecadactylus rapicauda* and *Hemidactylus mabouia* are primarily nocturnal (Ávila-Pires 1995) although the former may

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Table I. Prey items in the diet of *Leptophis ahaetulla* from northern Brazil and western Maranhão.

| Prey taxa       | New record | Snakes with prey items | Prey items |
|-----------------|------------|------------------------|------------|
|                 |            | n          | %    | n          | %    |
| Amphibians      |            |            |      |            |      |
| Plethodontidae  |            |            |      |            |      |
| *Bolitoglossa paraensis* (Unterstein, 1930) | X | 1 | 0.02 | 1 | 0.02 |
| Hylidae         |            |            |      |            |      |
| *Dendropsophus marmoratus* (Laurenti, 1768) | X | 1 | 0.02 | 1 | 0.02 |
| *Dendropsophus melanargyreus* (Cope, 1887) | X | 2 | 0.04 | 2 | 0.03 |
| *Dendropsophus minutus* (Peters, 1872) | X | 1 | 0.02 | 1 | 0.02 |
| *Dendropsophus walfordi* (Bokermann, 1962) | X | 2 | 0.04 | 2 | 0.03 |
| *Hypsiboa cinerascens* (Spix, 1824) | X | 1 | 0.02 | 1 | 0.02 |
| *Hypsiboa multifasciatus* (Günther, 1859 “1858”) | 4 | 0.08 | 4 | 0.07 |
| *Osteocephalus taurinus* (Steindachner, 1862) | 1 | 0.02 | 1 | 0.02 |
| *Sphaenorhynchus* sp. | 2 | 0.04 | 3 | 0.05 |
| *Scinax* sp. | 13 | 0.25 | 15 | 0.25 |
| *Scinax boesemani* (Goin, 1966) | X | 1 | 0.02 | 1 | 0.02 |
| *Scinax gr. rostratus* | X | 1 | 0.02 | 1 | 0.02 |
| *Scinax gr. ruber* | 15 | 0.26 | 16 | 0.27 |
| Unidentifiable Hylidae | 4 | 0.08 | 6 | 0.8 |
| Lizards         |            |            |      |            |      |
| Gekkonidae      |            |            |      |            |      |
| *Gonatodes humeralis* (Guichenot, 1855) | X | 1 | 0.02 | 1 | 0.02 |
| *Hemidactylus mabouia* (Moreau de Jonnès, 1818) | X | 1 | 0.02 | 2 | 0.03 |
| *Thecadactylus rapicauda* (Houttuyn, 1782) | 2 | 0.04 | 2 | 0.03 |
| Total           |            |            |      |            |      |

\( n = 33 \) (Figure 1) but not to head length \((P=0.079; r^2=0.109; n=34)\). There were no sex-related differences in either case \((P=0.405 \text{ and } P=0.687, \text{ respectively})\).
be active during the day (Hoogmoed and Ávila-Pires 1989). On the other hand, *Gonatodes humeralis*, the other gekkonid lizard consumed by *Leptophis ahaetulla*, is a diurnal species (Ávila-Pires 1995; Ávila-Pires and Hoogmoed 1997). Nocturnal lizards were probably taken in their daytime resting sites (see also Hero and Magnusson 1987). The presence of salamanders and lizards in low frequencies corroborates the results of other studies (Oliver 1948; Lopez et al. 2003).

*Leptophis ahaetulla* seems to manipulate captured prey before ingestion because 87% of prey items were consumed head-first. Such prey manipulation is probably facilitated by toxins which are lethal to small prey (Mertens 1971; Boos 2001).

The correlation between the body size of a snake and the size of its prey (Figure 1) corroborates findings by Shine (1991), but see Sazima and Martins (1990).

Based on information about habitat use by prey (Hoogmoed 1979; Duellman 1990; Zimmerman and Rodrigues 1990; Hoogmoed and Ávila-Pires 1991; Duellman and Wiens 1993; Ávila-Pires and Hoogmoed 1997; Van Sluys and Rocha 1998; Bernarde et al. 1999), we infer that *Leptophis ahaetulla* from northern Brazil and western Maranhão is one of the most wide-ranging habitat species of colubrine snakes, occurring in forested areas, along forest edges, open areas, lake borders, savanna and pasture areas, being also abundant in disturbed forest areas. *Leptophis ahaetulla* is primarily diurnal and semi-arboreal, forages primarily on the ground and in fallen vegetation, as an active forager. Our results also corroborate the hypothesis (Henderson and Nickerson 1976, 1977) that *L. mexicanus* and other arboreal snakes such as *Imantodes* and *Leptodeira* partition food resources, through the occupation of different temporal and dietary niches. Where snakes of the genus *Imantodes* and *Leptodeira* from forests of the Manaus region prey primarily upon lizards and several species of leptodactylid frogs, respectively (Vitt 1996; Martins and Oliveira 1999), *L. ahaetulla* eat primarily hylid frogs.

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**Figure 1.** Correlation between prey and snake length (snout–vent length): $P=0.009; r^2=0.21; n=33$. m, males; f, females.
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**Appendix 1. Material examined**

Amazonas State: MPEG 17378 and MPEG 17413 (margem direita do Rio Uatumã, área de inundaçãoda UHE de Balbina, Presidente Figueiredo), MPEG 18 (Iauaretê, Rio Vaupés).

Pará State: IBSP 18529 (Cachimbo), IBSP 40019 (Itupiranga), IBSP 23577 (Conceição do Araguaiá), IBSP 14839 and IBSP 14842 (Tomé-Açu), MPEG 3313 (Santo Antônio do Tauá), MPEG 5899 (Curuçá), MPEG 19332 (Muaná, ilha de Marajó), MPEG 3209, MPEG 3808, and MPEG 5407 (Cacoal, Augusto Corrêa), MPEG 5060, MPEG 7926, and MPEG 8344 (Bom Jesus, Bragança), MPEG 16835 (Ananindeua), MPEG 15453 (Barcarena), MPEG 6033 (Santa Bárbara, Benevides), MPEG 4014, MPEG 1554, MPEG 5721, and MPEG 1473 (Boa Vista, Castanhal), MPEG 5161, MPEG 13928 (Rio Gurupi, Col. Nova, BR-316), MPEG 12181 (Santa Luzia, Capitão Poço), MPEG 14447 (Curupati, Viseu).

Maranhão State: MPEG 15258, MPEG 16180, MPEG 16181 (Puraqueú, BR-222), MPEG 13480, MPEG 13482, MPEG 13520, MPEG 14632, MPEG 14635, MPEG 15035, and MPEG 16155 (Arari, Ganco do Arari, BR-222, between Miranda and Arari), MPEG 13589 and MPEG 13591 (Paruá, BR-316), MPEG 11163, MPEG 11128, MPEG 11130, MPEG 13740, MPEG 14789, MPEG 14793, and MPEG 12281 (Nova Vida, 25 km from Rio Gurupí, BR-316).

1242  N. R. de Albuquerque et al.
Rondônia State: MHNCI 9592 (Espigão do Oeste), MPEG 16869 (Km 11 da linha 12-B, Ji-Paraná), MZUSP 8505 and MZUSP 8506 (Nova Colina), MZUSP 8516 (Nova Brasília).

Roraima State: MPEG 477 (Col. Cel Mota, Região do Traiano).