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FOOD HABITS AND ECOLOGY OF *PSEUDIS BOLBODACTYLA* (ANURA: PSEUDIDAE) FROM A FLOOD PLAIN IN SOUTH-EASTERN BRAZIL

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This study presents some ecological data on the aquatic frog *Pseudis bolbodactyla* (Pseudidae) of south-eastern Brazil, with emphasis on diet. Frogs ranged in size (SVL) from 33.2 to 58.0 mm and in mass from 6.2 to 28.5 g, with females larger and heavier than males. Fourteen food categories were found in the stomachs of *P. bolbodactyla*, most of them arthropods. The main prey found in the stomachs were Diptera, adult Coleoptera, Homoptera, and Araneae. Sex and size of frogs do not seem to significantly affect diet composition.

Key words: diet, frog, morphology, size

The family Pseudidae is represented by two genera (*Pseudis* and *Lysapsus*) of highly aquatic frog species that are distributed throughout most of cisandean South America (Pough *et al.*, 2001). The larger genus, *Pseudis*, currently comprises six species, four of which are known only from Brazil (Kwet, 2000; Frost, 2002), and is remarkable for its giant tadpoles, which are often much larger than the adult animals (e.g. Emerson, 1988; Caramaschi & Cruz, 1998). Little has been published about the ecology of pseudid frogs, with most information referring to the widely distributed species *P. paradoxa* (Cei, 1980; Dixon *et al.*, 1995; Bosch *et al.*, 1996; Duré & Kehr, 2001; Arias *et al.*, 2002). *Pseudis bolbodactyla*, the subject of this study, occurs in the Brazilian states of Minas Gerais, Espírito Santo, Goiás and Bahia (Caramaschi & Cruz, 1998). The main goal of this study was to analyze the diet of *P. bolbodactyla* from a site in Espírito Santo state, south-eastern Brazil. Other aspects of the ecology of the species, such as habitat use, sex ratio and sexual dimorphism are also briefly assessed.

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Field work was conducted in a permanent pond (estimated area c. 750 m^2; maximum depth c. 3 m) located at 19° 07'S, 39° 46'W within a farmland area in the lowlands of Pontal do Ipiranga, municipality of Linhares, Espírito Santo state, south-eastern Brazil. According to our surveys, *P. bolbodactyla* is scarce or absent in other ponds in the area. Vegetation in the pond is dominated by the cattail, *Typha* aff. *dominguensis* (Typhaceae), and comprises other plants such as *Fuirena* sp. (Cyperaceae), *Nymphaea* sp. and *Cabomba* sp. (Nymphaeaceae), *Utricularia* aff. *neglecta* (Lentibularianaceae), *Eichornia* sp. (Pontederiaceae), *Polygonium* sp. (Polygoniaceae), and *Salvinia natans* (Salviniaceae). Annual temperatures and total annual rainfall in the region of Linhares average 23.6° C and c. 1400 mm, respectively (Peixoto & Gentry, 1990).

The frogs were collected by hand from 19.00 hr through 23.00 hr, in February (n=18), April (n=17), June (n=12), August (n=9), September (n=1), and October (n=4). Due to the heavy rains, the roads were flooded during late spring and summer (November-January), which impeded us from taking samples during that period. Soon after collections, frogs were euthanased with ether and snout-vent length (SVL) measured with a caliper (0.1 mm precision) and weighed on an electronic balance to the nearest 0.1 g. Individuals still bearing a tail were considered to be juveniles. All frogs were dissected for verification of their sex and extraction of their stomachs. Stomach contents were analyzed using a stereomicroscope. Each prey item was identified to the taxonomic level of order, measured across its longer axis with a caliper (to the nearest 0.1 mm) and weighed to the nearest 0.1 mg on an electronic balance.

A Chi-square analysis was used to test if the sex-ratio deviated from a 1:1 ratio. Differences between sexes in mean SVL and mass were tested using one-way analyses of variance (ANOVA), after testing for homogeneity of variances. The slope of the SVL/body mass relationship was compared between sexes using an analysis of covariance (ANCOVA), with SVL as the covariate. For each prey category found in the diet, we calculated the Index of Relative Importance (Ix), which was based on number of items, collective mass and frequency of occurrence (see Howard *et al.*, 1999). Diet composition was compared (based on the Ix, which was also calculated separately for each sex) between males and females using the Kolmogorov-Smirnov two-group test (Siegel, 1956). A simple regression analysis was used to test the relationship between maximum prey size and frog SVL; maximum prey size was based on the length of the largest prey item in each stomach (only items whose original length could be accurately measured were considered). Basic statistics given throughout the text represent arithmetic means ±SD.

We examined 59 individuals of *P. bolbodactyla* (34 males, 14 females, and 11 juveniles whose sex could not be ascertained). Male/female ratio was 2.43:1, being significantly different from the expected 1:1 ratio (χ^2=6.4, P<0.05). Except for one individual, found at

the pond's edge, all frogs were collected in the water. Specimens ranged in size from 33.2 to 58.0 mm SVL (mean=40.6±5.0 mm), and in mass from 6.2 to 28.5 g (mean=11.4±4.1 g). Males ranged in size from 33.9 to 45.9 mm SVL (mean=40.1±3.1 mm), and in mass from 7.4 to 14.0 g (mean=10.6±1.9 g). Females ranged in size from 37.1 to 58.0 mm SVL (mean=45.6±6.2 mm), and in mass from 9.2 to 28.5 g (mean=15.6±6.0 g). Although females were significantly larger (ANOVA: $F_{1,46}$=17.41, P<0.001) and heavier (ANOVA: $F_{1,46}$=19.16, P<0.0001) than males, the slope of the SVL/body mass relationship did not differ significantly (ANCOVA: $F_{2,45}$=1.02, P=0.317).

Of the 59 specimens examined, 56 (94.9%) had food in their stomachs. Fourteen food categories were found in the stomachs of *P. bolbodactyla*; except for Gastropoda and shed skin, all other food items were arthropods (Table 1). Overall, the most important prey categories were Diptera, adult Coleoptera, Homoptera and Araneae, in that order (Table 1). For males, the predominant items in the diet (based on values of *Ix*) were adult beetles (0.246), dipterans (0.240) and homopterans (0.215), whereas for females the most important food items were dipterans (0.365), followed by adult beetles (0.149) and homopterans (0.126). Diet composition did not differ significantly between sexes (Kolmogorv-Smirnov: D_{max}=0.165, df=2, P=0.97).

Individual prey varied in length from 2.0 to 14.1 mm (mean=4.8±1.9 mm, n = 161). There was no significant relationship between maximum prey size and snout-vent length for *P. bolbodactyla* (r^2=0.001, P=0.85, n=42).

The proportion of *P. bolbodactyla* with food in their stomachs was high (56/59). Duré & Kehr (2001) found much lower proportions of stomachs with prey for *Pseudis paradoxa* (21/50) and *Lysapsus limellus* (46/75) sharing a pond in Corrientes, Argentina.

The most frequent and abundant items in the diet of *P. bolbodactyla* were dipterans (particularly mosquitoes), though coleopterans and homopterans were also frequently consumed and contributed a greater proportion of the total prey mass ingested. Dipterans (types not specified) dominated the diet of the small pseudid *Lysapsus limellus* in Corrientes, Argentina, but were not as important in the diet of the sympatric *Pseudis paradoxa*, which had a more varied diet (Duré & Kehr, 2001). In our study, the diet of *P. bolbodactyla* was also varied, with no clear dominance of a single prey type. This suggests that larger pseudids may tend to have less specialized food habits than smaller ones, since their larger size allows them to exploit a wider range of prey sizes.

According to our field observations, mosquitoes were very abundant at the study area, being found in great concentrations on and among the vegetation, including

TABLE 1. Food items found in the stomachs of 56 specimens of *Pseudis bolbodactyla* from Pontal do Ipiranga, south-eastern Brazil. Frequency of occurrence (*F*), number of individual items (*N*) and total ingested mass (*M*) are given in absolute values and proportions (%) for each prey category. Indexes of relative importance (*Ix*) are also given.

Prey	*F*	%*F*	*N*	%*N*	*M*	%*M*	*Ix*
Insecta							
Coleoptera (adults)	21	37.5	32	15.8	584.4	26.4	0.220
Coleoptera (larvae)	3	5.4	3	1.5	62.4	2.8	0.026
Diptera	28	50.0	90	44.3	296.1	13.4	0.298
Hemiptera	1	1.8	7	3.4	32.1	1.4	0.020
Homoptera	17	30.4	51	25.1	199.7	9.0	0.178
Hymenoptera	2	3.6	2	1.0	4.6	0.2	0.018
Lepidoptera (larvae)	4	7.1	5	2.5	96.0	4.3	0.038
Odonata	1	1.8	1	0.5	7.1	0.3	0.006
Orthoptera	1	1.8	1	0.5	23.2	1.0	0.009
Unidentified insect	1	1.8	1	0.5	46.1	2.1	0.01
Arachnida							
Araneae	5	8.9	6	3.0	709.1	32.1	0.136
Crustacea							
Isopoda	1	1.8	1	0.5	0.7	<0.1	0.006
Mollusca							
Gastropoda	3	5.4	3	1.5	71.0	3.2	0.027
Other							
Shed skin	3	5.4	-	-	77.1	3.5	0.023
Total	-	-	203	-	2209.6	-	

Typha leaves. Homopterans were also frequently seen on the leaves of *Polygonium* sp. (Polygoniaceae). *Pseudis bolbodactyla* is likely to prey mainly on insects detected above the water surface, on the leaves of plants found inside and at the margins of the pond, which the frogs may be able to do without leaving the water. This feeding behaviour was observed by Duré & Kehr (2001) for two other pseudids, *P. paradoxa* and *L. limellus*.

Shifts in diet composition according to an increase in body size have been commonly reported in anurans (e.g. Lima & Moreira, 1993; Flowers & Graves, 1995; Evans & Lampo, 1996; Giaretta *et al*., 1998; Lima, 1998; Hirai & Matsui, 1999). However, in this study we found no relationship between prey size and frog size for *P. bolbodactyla*. This could be due to the ingestion of great quantities of relatively small items (such as mosquitoes) by many individuals, regardless of size.

The results of our study suggest that the area of Pontal do Ipiranga, found within a region subjected to periodic flooding (the Suruaca valley), represents an appropriate environment for the maintenance of a large population of *P. bolbodactyla*. The frogs seem to find abundant food resources and suitable habitat conditions. Nevertheless, *P. bolbodactyla* seems to have some specific habitat requirements, and are not found uniformly throughout the various permanent ponds. Although several ponds of various sizes were found in the study area, individuals of *P. bolbodactyla* were found in substantial numbers in only one, which was characterized by having denser vegetation at its margins and by the presence of *Typha* aff. *dominguensis* (not observed in the other ponds). Thus, there seems to be a close relationship between *P. bolbodactyla* and the plant *T.* aff. *dominguensis* at our study site, which may be due to the utility of the plant both as shelter and as oviposition sites (*Pseudis paradoxa* of the Argentinian Chaco is known to lay eggs among the aquatic vegetation; Dixon *et al.*, 1995). We believe that the increase in drainage currently occurring throughout the Suruaca valley, for agricultural and developmental (i.e. opening of roads) purposes, may negatively affect the local population of *P. bolbodactyla*.

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REFERENCES

Arias, M. M., Peltzer, P. M. & Lajmanovich, R. C. (2002). Diet of the giant tadpole *Pseudis paradoxa platensis* (Anura, Pseudidae) from Argentina. *Phyllomedusa* **1,** 97-100.

Bosch J., De La Riva, I. & Márquez, R. (1996). The calling behaviour of *Lysapsus limellus* and *Pseudis paradoxa* (Amphibia: Anura: Pseudidae). *Folia Zoologica* **45,** 49-55.

Cei, J. M. (1980): Amphibians of Argentina. *Monitore Zoologico Italiano, n.s., Monografie* **2,** 1-609.

Caramaschi, U. & Cruz, C. A. B. (1998). Notas taxonômicas sobre *Pseudis fusca* Garman e *P. bolbodactyla* A. Lutz com a descrição de uma nova espécie correlata (Anura, Pseudidae). *Revista Brasileira de Zoologia* **15,** 929-944.

Dixon, J. R., Mercolli, C. & Yanosky, A. A. (1995). Some aspects of the ecology of *Pseudis paradoxa* from northeastern Argentina. *Herpetological Review* **26,** 183-185.

Duré, M. I. & Kehr, A. I. (2001). Differential exploitation of trophic resources by two pseudid frogs from Corrientes, Argentina. *Journal of Herpetology* **35,** 340-343.

Emerson, S. B. (1988). The giant tadpole of *Pseudis paradoxa*. *Biological Journal of the Linnean Society* **34,** 93-104.

Evans, M. & Lampo, M. (1996). Diet of *Bufo marinus* in Venezuela. *Journal of Herpetology* **30,** 73-76.

Flowers, M. A. & Graves, B. M. (1995). Prey selectivity and size-specific diet changes in *Bufo cognatus* and *B. woodhousii* during early postmetamorphic ontogeny. *Journal of Herpetology* **29,** 608-612.

Frost, D. R. (2002). *Amphibian species of the world: an online reference*. V. 2.21. Available at http://research.amnh.org/herpetology/amphibia.index.html.

Giaretta, A., Araújo, M. S., Medeiros, H. F. & Facure, K. G. (1998). Food habits and ontogenetic diet shifts of the litter dwelling frog *Proceratophrys boiei* (Wied). *Revista Brasileira de Zoologia* **15,** 385-388.

Hirai, T. & Matsui, M. (1999). Feeding habits of the pond frog, *Rana nigromaculata*, inhabiting rice fields in Kyoto, Japan. *Copeia* **1999,** 940-947.

Howard, A. K., Forester, J. D., Ruder, J. M., Parmerlee J. S. & Powell, R. (1999). Natural history of a terrestrial Hispaniolan anole, *Anolis barbouri*. *Journal of Herpetology* **33,** 702-706.

Kwet, A. (2000). The genus *Pseudis* (Anura; Pseudidae) in Rio Grande do Sul, southern Brazil, with description of a new species. *Amphibia-Reptilia* **21,** 39-55.

Lima, A. P. (1998). The effects of size on the diets of six sympatric species of postmetamorphic litter anurans in central Amazonia. *Journal of Herpetology* **32,** 392-399.

Lima, S. L. & Moreira, G. (1993): Effects of prey size and foraging mode on the ontogenetic change in feeding niche of *Colostethus stepheni* (Anura: Dendrobatidae). *Oecologia (Berlin)* **95,** 93-102.

Peixoto, A. L. & Gentry, A. H. (1990). Diversidade e composição florística da mata de tabuleiro na Reserva Florestal de Linhares (Espírito Santo, Brasil). *Revista Brasileira de Botânica* **13,** 19-25.

Pough, F. H., Andrews, R. M. Cadle, J. E., Crump, M. L., Savitzky, A. H. & Wells, K. D. (2001). *Herpetology. 2nd ed*. New Jersey: Prentice-Hall..

Siegel, S. (1956). *Nonparametric statistics for the behavioral sciences*. New York: McGraw-Hill.

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