FOOD HABITS AND ONTOGENETIC DIET SHIFTS OF THE LITTER DWELLING FROG *PROCERATOPHRYS BOIEI* (WIED)

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ABSTRACT. Here is described the diet of *Proceratophrys boiei* (Wied, 1825), a leaf litter frog of the Atlantic Forest, and test for relationships between frog size and prey size and type. The diet was determined by stomach content analysis. In 38 frogs, was found 76 prey items belonging to 23 taxa. Insects predominate in the diet and the most frequent categories were coleopterans (39.4 % of total volume) and orthopterans (25.0 %). There was a positive correlation between frog size and volume of prey taken. The most important ontogenetic shift in prey type was an increase in the consume of coleopterans and insect larvae with increasing frog size.
KEY WORDS. Amphibia, Anura, Leptodactylidae, *Proceratophrys boiei*, food habits, litter frog, Atlantic Forest, Brazil

When in land, frogs are thought to be opportunistic predators with their diets just reflecting the availability of food of appropriated size. The main factors influencing the diets and feeding habits of amphibians are seasonal abundance of food, size/shape constraints and ecological tolerances (DUELLMAN & TRUEB 1986). *Proceratophrys boiei* (Wied, 1825) is a litter dwelling frog of the Atlantic Forest and little is known about its food habits. Its relatively large mouth (46-52% of the total length) suggests that it preys on large items (COCHRAN 1955). Because of the pronounced difference in size between recently metamorphosed young (18 mm) and adults (50-75 mm) ontogenetic changes are expected in prey size and type, as documented for some other frog species (LABANICK 1976; CHRISTIAN 1982; LIMA & MOREIRA 1993; DE BRUYN *et al.* 1996; EVANS & LAMPO 1996). Herein, is described the diet of *P. boiei* and examine whether prey size and type vary with frog size.

MATERIAL AND METHODS

The analyzed individuals of *Proceratophrys boiei* came from the Parque Florestal do Itapetinga (23°15'S; 46°45'W, 900-1,300m alt., 1,600mm rain/year), municipality of Atibaia, Mantiqueira Range in the state of São Paulo, Brazil. The region is mountainous and covered by semideciduous forest. In this site, *P. boiei* is

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found on litter most of the year, except in the dryer months (June-August). In the wetter months, they can be found in densities of 1 individual/1,600m^2. The analyzed frogs were collected only in the wetter months, from December 1991 to May 1997. The stomach contents of *P. boiei* were obtained by dissection of preserved individuals and by stomach eversion of living frogs. To minimize the effects of digestion, the frogs were preserved, or stomachs everted, just after collection. In the studied species, the eversion of the stomach throughout the mouth is easy and allows us to collect all its contents without killing the frog. The living analyzed frogs showed no evidence of injury after manipulation and were released in the field. The food items were identified and grouped into categories (mainly insect orders). Individual prey items were measured with calipers (0.05 mm), and their volumes were estimated with the ellipsoid formula:

$$\text{Volume} = 4/3\pi \text{ (length/2) (width/2) (thickness/2)}$$

The percentages of prey volume, number, and frequency of occurrence were calculated for each category. Some very digested prey were identified but it was not possible to determine their volume. It was tested the relationship between frog size and the log-transformed volumes of the largest and smallest prey items. It was used Principal Components Analysis (PCA) (MANLY 1986) to summarize individual variation in the proportions (% of volume) of Araneae, Coleoptera, Insect larvae, Orthoptera, and Others (insect orders contributing with less than 4% of total prey volume). It was used Sperman Rank Correlation (ZAR 1984) to test the relationship between the frogs' size and the first principal component (PC1) to search for ontogenetic shifts in prey type (*cf.* LIMA & MOREIRA 1993). Multivariate analysis were done with the Fitopac computer program (SHEPHERD unpublished). A voucher frog specimen is in the Museu de História Natural da Universidade Estadual de Campinas (ZUEC 9560), Campinas, São Paulo, Brazil.

RESULTS

Analyzed individuals of *Proceratophrys boiei* ranged from 18.2 to 73.5 mm in SVL. Twenty six (68.4 %) of the 38 dissected individuals and 12 (31.6 %) of the 38 eversed ones had no food in their stomachs. Calling males rarely had stomach contents. In the other 38 frogs were found 76 prey items belonging to 23 taxa. Prey volumes varied from 4 up to 984 mm^3 and the modal number of individual prey in the stomachs was one (range 1-5). It was observed a dominance of orthopterans and coleopterans in the diet (Tab. I). Relatively large beetles and camel crickets (Henicidae), approaching 45% of the frog individual length, were found. Two adults of the froglet *Eleutherodactylus parvus* (adults 15-20 mm SVL) were found as prey. There was a positive correlation between the predator's size and the log-transformed volume of the largest and the smallest prey (Fig. 1). In the PC1 (23.3% of total variance) Coleoptera had a high and positive loading, and Orthoptera had a high and negative one. There was a significant correlation between diet (PC1) and size (SVL) of *P. boiei* ($r_s = 0.35$, $p<0.05$, $N = 33$), indicating an ontogenetic shift in the type of prey taken. The most important change was related to an increase in the consumption of coleopterans and insect larvae with increasing frog size.

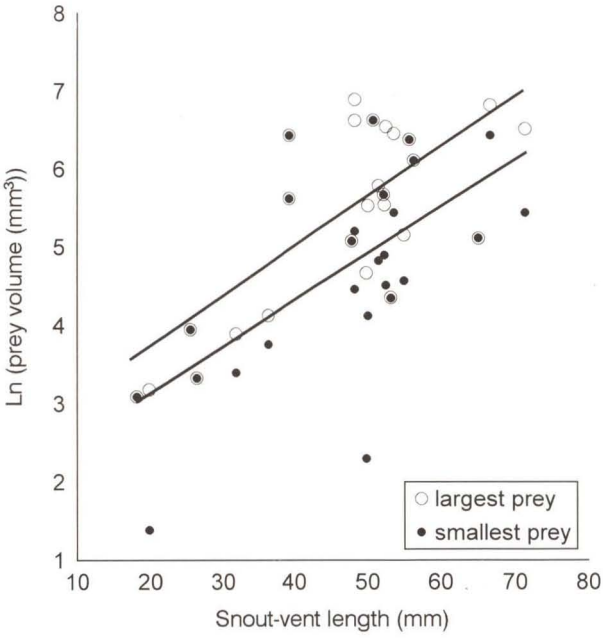

Fig. 1. Relationship between frogs and prey sizes (volume) for *Proceratophrys boiei*. Circles and dots are, respectively, the volumes of the largest and smallest prey found in each stomach. The top line represents the largest prey ($r = 0.748$, $p < 0.001$, $N = 26$ frogs); the bottom the smallest ($r = 0.635$, $p < 0.001$, $N = 26$ frogs).

Table I. Categories of prey and their relative importance in the diet of *Proceratophrys boiei* at Parque Florestal do Itapetinga, São Paulo.

Prey category	Percentage of total volume (N=26)	Percentage of prey number (N=38)	Percentage of occurrence (N=38)
Coleoptera	39.4	30.3	44.7
Orthoptera	25.0	25.0	42.1
Araneae	7.6	6.6	13.2
Hemiptera	5.3	2.6	5.3
Insect larvae	4.5	11.8	18.4
Blattaria	4.1	2.6	5.3
Others *	12.7	21.1	31.6

*. Neuroptera, Vespidae, Formicidae, Anura, Isoptera, Phasmida, Oligochaeta, Gastropoda.

DISCUSSION

Ontogenetic shifts in prey size and type in frogs were reported in previous studies (*e.g.* WOOLBRIGHT & STEWART 1987; LIMA & MOREIRA 1993) and the correlations found indicate that this is also true for *Proceratophrys boiei*. It has been proposed that ontogenetic shifts in prey type may be a consequence of differences in available prey size (PENGILLEY 1971), since the mean size of individuals differs among arthropod orders (SCHOENER & JANSEN 1968), or may reflect an effective

change in prey selection by the frog (LIMA & MOREIRA 1993). Sampling of the availability of prey would be necessary to evaluate the possible causes of the prey type shifts observed in *P. boiei*. Based on the type of prey taken, on their number per stomach and on some *P. boiei* features, such as crypticity and wide mouth, the species is more likely to be a sit and wait forager (see TOFT 1981, 1985).

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