FEEDING HABITS AND MICROHABITAT UTILIZATION BY TWO SYNTOPIC BRAZILIAN AMAZONIAN FROGS (*Hyla minuta* AND *Pseudopaludicula* sp. (gr. *falcipes*)

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(With 1 figure)

ABSTRACT

We studied the feeding habits and microhabitat use of the Amazonian frogs *Hyla minuta* and *Pseudopaludicula* sp. at Serra Norte, Carajás, Brazil. Although living syntopically, the two species differed markedly in both prey types and sizes. Standardized feeding niche breadth of *H. minuta* (B_{st} = 0.572) was larger than that of *Pseudopaludicula* sp. (B_{st} = 0.149) and their feeding niche overlap was considerably low (10.5%). The two frog species also differed in microhabitat use. When active, *Pseudopaludicula* sp. were found partially submerged at the lake border whereas *H. minuta* were found predominantly on *Nymphaea* sp. leaves. Although we have not evaluated taxonomic effects on diet composition, differences in diet may be partially explained by differences in microhabitat use and frogs' size.

Key words: diet, frogs, resource partitioning, syntopy.

RESUMO

Hábitos alimentares e uso do microhabitat por duas espécies sintópicas de anuros amazônicos (*Hyla minuta* e *Pseudopaludicula* sp. (gr. *Falcipes*)

Nós estudamos os hábitos alimentares e o uso do microhábitat pelos anuros amazônicos *Hyla minuta* e *Pseudopaludicula* sp. em Serra Norte, Carajás, Brasil. Apesar de serem sintópicas, as duas espécies diferiram acentuadamente nos tipos e tamanhos de presas consumidas. A largura padronizada do nicho alimentar de *H. minuta* (B_{st} = 0,.572) foi maior do que a de *Pseudopaludicula* sp. (B_{st} = 0,149) e a sobreposição do nicho alimentar foi relativamente baixa (10,5%). As duas espécies de anuros também diferiram acentuadamente em relação ao uso do microhábitat. Quando em atividade, os indivíduos de *Pseudopaludicula* sp. eram encontrados parcialmente submersos próximo à margem do lago, enquanto os indivíduos de *H. minuta* eram encontrados predominantmente sobre folhas de *Nymphaea* sp. Apesar de não termos avaliado efeitos da taxonomia sobre a composição da dieta, as diferenças encontradas na dieta podem ser parcialmente explicadas por diferenças no uso do microhábitat e tamanho dos anuros.

Palavras-chave: dieta, anuros, partição de recursos, sintopia.

As pointed out by Duellman & Trueb (1986), there is little information concerning the feeding habits of amphibians and the few data that are available are mostly anedoctal. Sympatric species may be subject to a similar spectrum of potential prey, but not necessarily feed on the same items, due to differences in taxonomy, patterns of microhabitat use, or body size.

At Serra Norte, Carajás, Brazilian Amazon (5o 54'S; 49o 53'W), two species of frogs, the Hylidae *Hyla minuta* Peters and a Leptodactylidae, *Pseudopaludicula* sp. (gr. *falcipes*) are syntopic, living along the banks of the lake "Campo N1".

Although supposedly exposed to a similar spectrum of prey, they have some differences which may result in differences in the type and range of prey that they ingest. Furthermore, they belong to two distinct families, and our preliminary field observations suggested that they apparently differ in body size and probably also in microhabitat use.

In this work, we studied feeding habits and microhabitat use of these two frog species, specifically adressing the following questions: 1) What are the food items and microhabitat niche breadths explored by *H. minuta* and *Pseudopaludicula* sp.?; 2) Are there differences in the mean size of prey ingested by the two frogs?; 3) Are there similarities in diet composition and microhabitat use by these two species?

The study was carried out in a lake (Lake N1) located at Serra Norte, State of Pará, Brazil. The lake has a maximum depth of approximate/g 1.5 m and has vegetation only at its banks. The vegetation consists mainly of Nymphaeaceae, Leguminosae, Eriocaulaceae, and Xyridaceae.

We collected active frogs (N = 15 *H. minuta* and N = 16 *Pseudopaludicula* sp.) by hand, between 21:30 and 22:30 h, during July 1987. Voucher specimens are deposited at the Museu de História Natural from the Universidade Estadual de Campinas (ZUEC).

For each individual we recorded the microhabitat where they were when first sighted. Frogs were immediately killed with ether, measured to the nearest 0.1 mm with a vernier caliper, and weighed to the nearest 0.1 g with a Pesola spring scale.

Stomach contents were analyzed and the items counted. Prey types were identified to order and the volume of each prey estimated by multiplying its three dimensions (Schoener, 1967). We compared prey sizes (mean volume in mm3) between the two species using ANCOVA, with SVL as covariate. We calculated the niche breadth for each species using the formula described by Duellman (1978):

$$B_i = \frac{1}{\sum P_{ij}}$$

where P_{ij} is the proportion of individuals of species "i" associated to resource "j". We standardized the values of niche breadth (B_i) dividing it by the number of resources used (Duellman, 1978), to make comparisons possible.

The similarity in food consumption by the two species was calculated following the equation by Duellman (1978):

$$C_{ih} = 1 - \frac{1}{2} \sum | P_{ij} - P_{hj} |$$

where C is the amount of resources consumed simultaneously by species "i" and "h".

Both species were found only at the lake borders. All *Pseudopaludicula* sp., whenever active, were found partially submerged at the lake border, where the depth was up to 1 cm. They usually remained with the legs touching the lake bottom or floating, with only the head out of the water. We did not find any *Pseudopaludicula* outside of the lake. In contrast, active *H. minuta* were found predominantly on *Nymphaea* sp. (Nymphaeaceae) leaves (N = 13). Only two individuals were collected on leaves of *Xyris* sp. The observations suggest that, although living at the same site, the two frogs differ considerably in the type of microhabitats used. Whereas *Pseudopaludicula* sp. uses the habitat only horizontally, *H. minuta* can use it also vertically. Most of these differences in space utilization probably reflect taxonomic differences and can, in turn, be responsible for differences in the use of other resources, such as food, resulting in the observed differences in the diet.

Five *H. minuta* and one *Pseudopaludicula* sp. had empty stomachs. *Hyla minuta* reproduces throughout the year (Rossa-Feres & Jim, 1994) and it is known from the literature that many frog males fast for a while during the reproductive season (Duellman & Trueb, 1986). Males with empty stomachs could be those fasting during that period. Alternatively, it is also known that for some species the reproductive sites may be

different from feeding sites (Berry, 1965). If the occurrence of empty stomachs is associated to reproduction in these species only detailed analysis will clarify.

Seven different prey types were consumed by the two species (Table 1). Hemipterans and Aranaea were the prey type most important numerically to *H. minuta*, but the largest volume of prey was composed by spiders (188.1 mm^3; 82 % of total volume ingested; Table 1). These results suggest that spiders are an important item in the diet of *H. minuta*. Hemipterans and dipterans were the prey items most numerous in the diet of *Pseudopaludicula* sp., but the largest volume (53.8 %) was composed by dipterans (adults and larvae; Table I). Hemipterans were also the most frequent item in the stomachs (Table 1). The results suggest that dipterans and hemipterans are an important prey for this *Pseudopaludicula* species.

Mean volume (± 1 sd) of prey ingested by *H. minuta* (6.33 + 16.6 mm^3 ; range = 0.02 – 76.0; N = 37) was significantly higher (ANCOVA; $F_{1,19}$ = 5.504; P < 0.01) than that of *Pseudopaludicula* sp. (0.93 ± 1.26 mm^3 ; range = 0.02 – 5.81; N = 82). Since the mean body size (± 1 sd) of *H. minuta* (25.9 ± 1.78 mm; range = 20.5 – 28.5; N = 15) was significantly larger (ANOVA; $F_{1,29}$ = 256.5; P < 0.001) than that of *Pseudopaludicula* sp. (14.8 ± 2.0 mm; range = 11.6 – 18.3; N = 16), the differences in prey sizes were due to the larger size of *H. minuta*, which would enable it to ingest larger prey. However, looking at Fig. 1 we can see that, with the exception of the two larger prey ingested by *H. minuta* and the higher number of very small prey volumes ingested by *Pseudopaludicula* sp., the prey spectrum of both frog species is quite similar.

Standardized feeding niche breadth of *H. minuta* (B_{st} = 0.572) is larger than that of *Pseudopaludicula* sp. (B_{st} = 0.149), and suggests that *H. minuta* uses a broader gradient of prey types. There are at least three factors that may act to produce such differences: i) first, since *H. minuta* has larger size, it can forage over a broader spectrum of prey sizes; ii) this may be a consequence of this species using the microhabitat also vertically which may allow access to a broader spectrum of prey, compared to *Pseudopaludicula*, which is restricted to forage on the ground; iii) the taxonomic differences may result in differences in foraging strategies (Toft, 1981) which may have also contributed for the differences. It is possible that the differences in prey

TABLE 1

Number (N), Volume (V, in mm^3) and Frequency (F) of the different prey types in the diet of *Hyla minuta* (N = 15) and *Pseudopaludicula* sp. (N = 16) at Serra Norte, Carajás.

	Hyla minuta			*Pseudopaludicula* sp.		
PREY TYPES	N (%)	V (%)	F	N (%)	V (%)	F
Araneae	11 (28.0)	188.1 (82.0)	0.53	1 (1.0)	0.54 (1.0)	0.60
Hemiptera						
nymphs	12 (33.0)	5.2 (2.0)	0.13	31 (38.0)	5.24 (6.0)	0.75
adults	0	0	0	2 (2.0)	1.21 (1.0)	0.13
Homoptera	3 (8.0)	11.9 (5.0)	0.13	7 (9.0)	6.48 (8.0)	0.25
Diptera						
adults	3	2.2 (1.0)	0.13	22 (27.0)	29.4 (37.0)	0.50
larvae	0	0	0	11 (13.0)	24.42 (3.0)	0.31
Orthoptera	0	0	0	4 (5.0)	7.63 (9.0)	0.13
Odonata naiads	2 (6.0)	1.4 (1.0)	0.13	0	0	0
Coleoptera	0	0	0	4 (5.0)	6.48 (8.0)	0.25
Arthropod remains	–	11.1 (5.0)	–	–	0	0
Plant material	4 (11.0)	9.3 (4.0)	0.2	–	0	0
Total	37	229.2		82	81.40	

types consumed by the two frog species may be primarily due to differences at the taxonomic level, whereas the observed differences in prey size can be mostly affected by frog body sizes.

Feeding niche overlap was of 10.5 %, which suggests that, although living at the same site, the two species have low similarity in the prey types consumed. These differences may be due to their taxonomic difference and patterns of microhabitat use. Our data show another example of how frog species, even living in syntopy, may differ largely in the use of food resources. If such differences are primarily affected by taxonomy, body size and/or microhabitat differences deserve further study.

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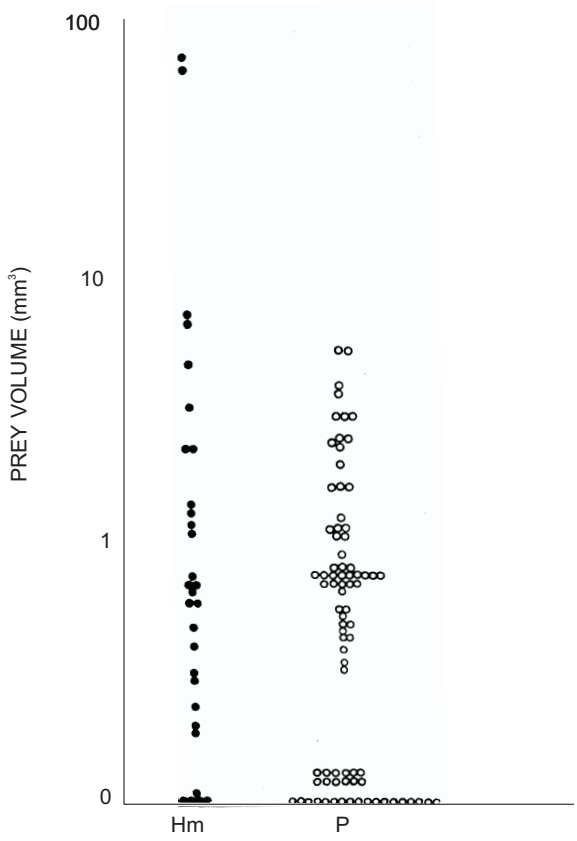

Fig. 1 — Volumes of each prey ingested by *Hyla minuta* (black dots) and *Pseudopaludicula* sp. (open circles) at Serra Norte, Carajás, Pará, Brazilian Amazon.

REFERENCES

BERRY, P. Y., 1965, The diet of some Singapore Anura (Amphibia). *Proc. Zool. Soc. London, 144*(2): 163-174.

DUELLMAN, W. E., 1978, The biology of an Equatorial Herpetofauna of Amazonian Ecuador. *Misc. Publ. Univ. Kansas, 65*: 1-352.

DUELLMAN, W. E. & L. TRUEB, 1986, *Biology of Amphibians*. McGraw-Hill, Inc. 670p.

ROSSA-FERES, D. & J. JIM, 1994, Distribuição sazonal em comunidades de anfíbios anuros na região de Botucatu, São Paulo. *Rev. Bras. Biol., 54*: 323-334.

SCHOENER, T. W., 1967, The ecological significance of sexual dimorphism in size in the lizard *Anolis conspersus*. *Science, 155*: 474-477.

TOFT, C. A., 1981, Feeding ecology of Panamanian litter anurans: Patterns in diet and foragingmode. *J. Herpetol, 15*: 139-144.