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Ecological aspects of the pumpkin toadlet, *Brachycephalus garbeanus* Miranda-Ribeiro, 1920 (Anura: Neobatrachia: Brachycephalidae), in a highland forest of southeastern Brazil

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Brachycephalus garbeanus is an aposematic toadlet, endemic to the Atlantic Forest in the mountains of the state of Rio de Janeiro, southeastern Brazil. Information regarding the ecology of species in this genus is scarce, with no information on most species, including *B. garbeanus*. We provide ecological information about *B. garbeanus*, in particular regarding microhabitat use, sexual dimorphism in body size, and feeding habits. Our study was conducted in a montane area of the Parque Estadual dos Três Picos, the largest State park in Rio de Janeiro. Most of the *B. garbeanus* in the study area were found on the forest floor leaf litter. Females were larger on average than males. *Brachycephalus garbeanus* consumed a wide array of prey, comprising exclusively invertebrates and predominantly arthropods. There were seasonal differences in the diet composition, but mites and ants were important in both wet and dry seasons.

Keywords: diet; habitat use; myrmecophagy; seasonal differences; sexual dimorphism

Introduction

The life histories of amphibians are highly diverse, mainly with respect to reproductive and feeding aspects, and also microhabitat usage (Duellman and Trueb 1994; Haddad and Prado 2005). The preference for certain microhabitats in anurans may be influenced by territorialism, food availability, or favourable environmental conditions for breeding and oviposition (Crump 1986; Prado et al. 2005). Amphibian diet composition is influenced by the size, mobility, palatability, availability and abundance of prey in the environment and may vary ontogenetically and seasonally (Toft 1980a, 1981; Duellman and Lizana 1994; Siqueira et al. 2006; Dietl et al. 2009). Seasonality may affect diet because the relative abundance of prey types changes seasonally (Toft 1980b; Lima and Magnusson 1998; Hodgkison and Hero 2003).

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In Brazil, direct-developing frogs of the genus *Brachycephalus* (Brachycephalidae) are characterized mainly by their diminutive body size (snout–vent length < 20 mm), and reduced number of toes and of phalanges of some digits (Izecksohn 1971; Pombal et al. 1998; Alves et al. 2006). Most species in the genus are aposematically coloured, predominantly in bright yellow or orange hues (Clemente-Carvalho et al. 2011). Currently, the genus *Brachycephalus* encompasses 18 species, all endemic to the Atlantic Rainforest of southern and southeastern Brazil (Pombal and Izecksohn 2011). Recently, the taxonomic status of three "varieties" (*atelopoide*, *garbeana* and *bufonoides*) of the pumpkin toadlet *Brachycephalus ephippium* proposed by Miranda-Ribeiro (1920) was re-evaluated and all were considered as full species (Pombal 2010). *Brachycephalus garbeanus* Miranda-Ribeiro, 1920, unlike the other two forms, has well developed dorsal plates, as seen in *B. ephippium*, but differs from the latter as its dorsal plates are keeled. Moreover, *B. garbeanus* differs from *B. ephippium* in having more developed bone projections of the head plate. *Brachycephalus garbeanus* is currently known only from Nova Friburgo municipality, in Rio de Janeiro state (Pombal 2010).

Information regarding the ecology of species of the genus *Brachycephalus* is restricted to reproductive behaviour of *B. ephippium* (Pombal et al. 1994; Pombal 1999), to vocalization activity of *Brachycephalus hermogenesi* (Verdade et al. 2008), to food habits of *Brachycephalus brunneus* (Fontoura et al. 2011), and to estimated density, diet and some reproductive aspects of *Brachycephalus didactylus* (Almeida-Santos et al. 2011). The present study provides information about some ecological aspects of *B. garbeanus*, specifically sexual dimorphism in body size, habitat use and feeding habits in an Atlantic Rainforest area of southeastern Brazil.

Materials and methods

Fieldwork was conducted in a montane area locally known as Baixo Caledônia (22°21′34″ S; 42°34′04″ W), in the municipality of Nova Friburgo, Rio de Janeiro state, southeastern Brazil. This area is within the Parque Estadual dos Três Picos, a conservation unit that encompasses much of the Serra dos Órgãos mountain range. Vegetation at Baixo Caledônia ranges from High Montane Forest in the lower areas to Montane Fields ("campos de altitude") in the higher region (IBGE 1992). Mean annual temperature is *c.*18°C in the general area, and annual rainfall is about 1700–2300 mm, with < 50 mm mean rainfall in September and > 150 mm in March (INEA 2009).

Surveys were carried out in 17–19 March (wet season) and 1–2 September (dry season) 2009 at 1600 m of altitude, always at night (between 18:00 h and 01:00 h). A team of five researchers searched for frogs in the forest, using time-constrained visual encounter surveys (Crump and Scott 1994), totalling 40 hours of searching effort (20 hours in each season). For each individual *B. garbeanus*, the type of substrate on which it was found was recorded. In each season, the first 40 individuals found during surveys were collected for stomach content analysis.

After collection, frogs were killed with a topical anaesthetic gel containing 5% lidocaine, fixed in 10% formalin, and transferred to 70% ethanol within 24 h. In the laboratory, we measured the snout–vent length (SVL) and jaw width (JW) of the preserved frogs with callipers (to the nearest 0.1 mm) and their body mass (BM) on an electronic balance (to the nearest 0.01 g). After that, the frogs were dissected and their stomach contents were analysed qualitatively and quantitatively. We identified animal prey to the taxonomic level of Order, except in the case of ants (identified to Family), gastropod molluscs, millipedes and centipedes (identified to Class). Unidentified arthropod remains were grouped in the “Arthropod Remains” category. For each food item the length and width were measured using callipers (0.1 mm precision) and prey volume (mm^3) was estimated using the formula for an ovoid spheroid: $V = 4/3 \times \Pi \times (\text{length}/2) \times (\text{width}/2)^2$ (Dunham 1983). The frequency of each prey category in the diet was expressed as the number of stomachs that contained that category. For each category of prey we also calculated an importance index (Ix) which represents the sum of the proportional values of number, volume and frequency divided by three (Howard et al. 1999). Based on the numeric and volumetric proportions of each prey category in the diet we calculated the food niche breadth, by sex and by season, using the inverse of Simpson’s diversity index (Magurran 1988).

For statistical analysis, variables were log-transformed whenever the criteria for normality and homoscedasticity were not met. To assess whether sex ratios differed from 1 : 1 at each season, chi-square tests (Zar 1999) were performed. We tested for differences in SVL, JW and BM between sexes using one-way analysis of variance (ANOVA). To test for differences between sexes in JW and in BM factoring out the effect of SVL we used analysis of covariance (ANCOVA; with SVL as covariate). We tested for differences between seasons in SVL and BM of females and males, using, respectively, ANOVA and ANCOVA (with SVL as covariate). To compare the diet composition of the frogs between seasons, both in terms of proportional number and volume of prey, we used a Spearman Rank Correlation (Zar 1999). We tested for differences between seasons in terms of proportional number and volume of food items ingested by the frogs using ANOVA. The relationship between the number of items consumed and the corresponding frog body size (SVL) and between the volume of the largest prey item per stomach and frog jaw width was tested, for each season, with simple regression analysis. All statistical analyses were performed in SYSTAT 11 software. Basic statistics shown throughout the text refer to the arithmetic mean ± one standard deviation.

Results

We recorded a total of 138 individuals of *B. garbeanus* at Baixo Caledônia (70 in the wet season and 68 in the dry season). Most frogs (77% in wet season and 77.9% in dry season) were found on the forest floor leaf litter (Table 1).

We collected 80 frogs, 40 per season. In the wet season, 24 individuals (60%) were male, 11 (27.5%) were female, and we were unable to determine the sex of five (12.5%). In the dry season, 19 individuals (47.5%) were male, 15 (37.5%) were female, and we were unable to determine the sex of six (15%). Sex ratio differed significantly from 1 : 1 in the wet season (chi-square test: $\chi^2 = 4.82$; $p < 0.05$), but not in the dry season ($\chi^2 = 0.47$; $P = 0.49$).

In terms of body size, when analysing the data from both seasons together, females of *B. garbeanus* had a significantly greater SVL (mean 16.5 ± 1.8 mm) than males (mean 14.6 ± 2.0 mm) ($F_{1,67} = 16.49$; $p < 0.001$) (Table 2). Jaw width did not differ significantly ($F_{1,67} = 0.68$; $p = 0.413$) between females and males, but when we excluded the effect of SVL from the analysis, JW of males was significantly larger than that of females ($F_{1,1,66} = 5.05$; $p < 0.05$). Females were significantly heavier ($F_{1,67} = 16.67$; $p < 0.001$) than males, but when we excluded the effect of SVL from the analysis, the difference was not significant ($F_{1,1,66} = 0.36$; $p = 0.550$). Females sampled in the wet

Table 1. Frequency of utilization of microhabitat categories in the forest by individuals of *Brachycephalus garbeanus* (Anura: Brachycephalidae) during two seasons in an Atlantic Rainforest area of southeastern Brazil.

Microhabitat	Frequency of use (%)	
	Wet season	Dry season
Leaf litter	54 (77.0)	53 (77.9)
Bromeliad	6 (8.0)	
Root	4 (6.0)	
Inside fallen bamboo leaf	2 (3.0)	3 (4.4)
Rock	2 (3.0)	
Tree trunk	2 (3.0)	1 (1.5)
Cavity in soil		11 (16.2)
Total	70 (100.0)	68 (100.0)

Table 2. Means, standard deviation and range of snout–vent length, jaw width and body mass for females and males of *Brachycephalus garbeanus* (Anura: Brachycephalidae) from an Atlantic Rainforest area of southeastern Brazil.

	n	Snout–vent length (mm)	Jaw width (mm)	Body mass (g)
Females				
Wet season	11	17.4 ± 0.8 (16.0–18.6)	6.7 ± 0.4 (6.2–7.7)	0.56 ± 0.08 (0.43–0.69)
Dry season	15	15.9 ± 2.1 (9.7–17.9)	4.4 ± 0.6 (2.6–5.2)	0.42 ± 0.13 (0.09–0.59)
Total	26	16.5 ± 1.8 (9.7–18.6)	5.4 ± 1.3 (2.6–7.7)	0.48 ± 0.13 (0.09–0.69)
Males				
Wet season	24	14.9 ± 1.8 (9.4–18.1)	6.0 ± 0.6 (4.1–6.7)	0.39 ± 0.12 (0.08–0.63)
Dry season	19	14.2 ± 2.1 (10.3–17.5)	4.1 ± 0.7 (2.6–5.0)	0.31 ± 0.12 (0.11–0.54)
Total	43	14.6 ± 2.0 (9.4–18.1)	5.1 ± 1.1 (2.6–6.7)	0.35 ± 0.13 (0.08–0.63)

season were longer ($F_{1,24} = 4.80$; $p < 0.05$) and heavier ($F_{1,24} = 9.30$; $p < 0.01$) than those from the dry season, but males did not differ in SVL ($F_{1,41} = 1.66$; $p = 0.20$) and body mass ($F_{1,41} = 3.99$; $p = 0.052$) between seasons. When we excluded the effect of SVL from the analysis, both females ($F_{1,1,23} = 7.78$; $p < 0.05$) and males ($F_{1,1,40} = 7.51$; $p < 0.01$) had higher BM in the wet season (Table 2).

All frogs sampled in the wet season had food in their stomachs, but six individuals (15%) from the dry season sample had empty stomachs. We found 17 categories of food items in the diet of *B. garbeanus* (Table 3). In both seasons, mites (Acari) constituted the most important prey category in terms of number of items (wet season 57.3%; dry season 62.8%) and frequency of occurrence (wet season 97.5%; dry season 52.5%). Volumetrically, the most important items in the diet differed among seasons, with Isopoda (32.6%), Araneae (13.8%) and Formicidae (13.0%) representing most of the volume of consumed prey in the wet season, whereas Coleoptera (33.2%), Acari (18.4%) and Collembola (12.5%) were the most important items in terms of volume in the dry season. Acari had the highest values of Index of Importance in both seasons (wet season = 0.549; dry season = 0.618) (Table 3). The diet composition of

Table 3. Diet of *Brachycephalus garbeanus* (Anura: Brachycephalidae) in two seasons in an Atlantic Rainforest area of southeastern Brazil.

Items	Wet season ($n = 40$)				Dry season ($n = 34$)			
	N (%)	*V* (%)	*F* (%)	*Ix*	*N* (%)	*V* (%)	*F* (%)	*Ix*
Gastropoda	6 (1.5)	11.8 (3.7)	4 (10.0)	0.051				
Arachnida								
Pseudoscorpiones					3 (3.2)	0.4 (1.6)	3 (7.5)	0.088
Araneae	7 (1.7)	44.2 (13.8)	7 (17.5)	0.110	2 (2.1)	0.8 (3.5)	2 (5.0)	0.059
Acari	232 (57.3)	31.7 (9.9)	39 (97.5)	0.549	59 (62.8)	4.3 (18.4)	21 (52.5)	0.618
Chilopoda					2 (2.1)	1.5 (6.3)	2 (5.0)	0.059
Diplopoda					2 (2.1)	0.9 (4.0)	2 (5.0)	0.059
Malacostraca								
Isopoda	31 (7.6)	104.4 (32.6)	15 (37.5)	0.259	1 (1.1)	1.1 (4.5)	1 (2.5)	0.029
Hexapoda								
Collembola	17 (4.2)	12.5 (3.9)	10 (25.0)	0.110	3 (3.2)	2.9 (12.5)	3 (7.5)	0.088
Dermaptera	8 (2.0)	16.0 (5.0)	5 (12.5)	0.065				
Hemiptera	5 (1.2)	4.6 (1.4)	3 (7.5)	0.034	2 (2.1)	0.4 (1.5)	1 (2.5)	0.029
Coleoptera	22 (5.4)	23.2 (7.2)	13 (32.5)	0.150	8 (8.5)	7.8 (33.2)	7 (17.5)	0.206
Neuroptera	2 (0.5)	2.3 (0.7)	2 (5.0)	0.021				
Hymenoptera								
Formicidae	49 (12.1)	41.8 (13.0)	23 (57.5)	0.275	10 (10.6)	2.6 (11.3)	8 (20.0)	0.235
Other	3 (0.8)	3.5 (1.1)	2 (5.0)	0.023	1 (1.1)	0.5 (2.3)	1 (2.5)	0.029
Lepidoptera					1 (1.1)	0.2 (0.6)	1 (2.5)	0.029
Diptera								
Adult	4 (1.0)	10.4 (3.2)	3 (7.5)	0.039				
Larvae	19 (4.7)	14.3 (4.5)	7 (17.5)	0.089				
Arthropod remains*						36.6		
Total	405 (100)	320.7 (100)			94 (100)	60.0 (100)		

N (number), *V* (volume, in mm^3), *F* (frequency), and *Ix* (Index of Importance) of each prey category are presented.
*"Arthropod Remains" were not considered for estimates of volumetric percentages.

B. garbeanus was not significantly correlated among the two seasons either in terms of relative number ($R = 0.289$; $p > 0.05$; $n = 17$) or in terms of volume of the items consumed ($R = 0.318$; $p > 0.05$; $n = 17$). The food niche breadth had similar values for both seasons for numeric data (wet season: 2.80; dry season: 2.40) and volumetric data (wet season: 6.03; dry season: 5.47). Regarding comparisons between sexes, niche breadths had slightly higher values for males for numeric data (males: 2.46; females: 2.07), and for females for volumetric data (males: 3.36; females: 4.70).

In the wet season, the number of prey ($F_{1,33} = 3.24$; $p = 0.08$) and the volume of the largest prey item ($F_{1,33} = 1.61$; $p = 0.21$) ingested did not vary between sexes, but when we excluded the effect of SVL from the analysis the results indicated that females consumed proportionally more prey ($F_{1,1,32} = 4.54$; $p < 0.05$) than males and that males consumed relatively larger prey ($F_{1,1,32} = 4.33$; $p < 0.05$) than females in that season. In the dry season, the number of prey ($F_{1,25} = 0.43$; $p = 0.52$) and the volume of the largest item ($F_{1,25} = 0.88$; $p = 0.36$) ingested also did not vary between sexes, even after we excluded the effect of SVL from the analysis (number of prey: $F_{1,1,24} = 1.91$; $p = 0.18$; volume of largest prey item: $F_{1,1,24} = 1.56$; $p = 0.22$).

The number of prey items per stomach of *B. garbeanus* was significantly higher ($F_{1,70} = 65.20$; $p < 0.001$) in the wet season (mean 10.1 ± 6.5; range: 2–26; $n = 40$) than in the dry season (mean 3.0 ± 2.1; range: 1–8; $n = 32$). Also, the total volume of food per stomach was significantly higher ($F_{1,72} = 36.12$; $p < 0.001$) in the wet season (mean 8.0 ± 9.8 mm^3; range: 0.3–44.5 mm^3; $n = 40$) than in the dry season (mean 1.8 ± 3.1 mm^3; range: 0.02–14.8 mm^3; $n = 32$). There was no significant relationship between the number of items ingested and the SVL of frogs ($F_{1,38} = 0.98$; $R = 0.16$; $p = 0.33$) and between the volume of the largest prey item and JW of frogs ($F_{1,38} = 1.48$; $R = 0.19$; $p = 0.23$) in the wet season. In the dry season, the SVL of frogs significantly influenced the number of items ingested ($F_{1,30} = 4.71$; $R = 0.37$; $p < 0.05$), but there was no significant relationship between the volume of the largest prey item and frog JW ($F_{1,30} = 1.37$; $R = 0.21$; $p = 0.25$).

Discussion

The brightly coloured species of *Brachycephalus* are generally regarded as being diurnal, as most reports only mention diurnal activity for these frogs (e.g. Pombal et al. 1994, 1998; Alves et al. 2006, 2009). However, Pombal and Izecksohn (2011) reported both diurnal and nocturnal activity for *B. margaritatus*. In the present study, all individuals of *B. garbeanus* were found at night (no diurnal surveys were performed) and most of them appeared to be active. Thus, it seems that at least some of the brightly coloured *Brachycephalus* may not be exclusively diurnal. The fact that the sex ratio of our wet season sample of *B. garbeanus* was significantly male-biased may also suggest that males of this species may be more active (and therefore detectable) than females during some periods of the year, but further data are needed to confirm this.

Similar numbers of *B. garbeanus* were found in both seasons for a similar amount of sampling effort. Nevertheless, the decrease in temperature and humidity during the dry season appears to have a negative effect on the activity of these frogs, considering the proportion of individuals found hidden inside cavities/burrows (20.8%) during that season. *Brachycephalus garbeanus* was the most abundant anuran species in that locality during both seasons (see Siqueira et al. 2011) and individuals were easily spotted, particularly because of their reddish-orange colour, and were usually seen walking slowly on the leaf litter of the forest floor. Studies carried out in other Atlantic Rainforest areas have shown that other species of *Brachycephalus*, such as *B. ephippium* (Pombal 1999) and *B. didactylus* (Almeida-Santos et al. 2011), also occur predominantly on the leaf litter of the forest floor. At Baixo Caledônia, *B. garbeanus* was also sometimes found above ground level, on relatively low perches (generally < 1 m above ground) such as bromeliads, tree trunks, roots and rocks, indicating it also has some climbing ability.

Females of *B. garbeanus* were larger than males on average (female : male ratio 1.13, based on mean SVL), as has also been reported for the congeneric *B. didactylus* (Almeida-Santos et al. 2011) and *B. ephippium* (Pombal et al. 1994). The occurrence of sexual dimorphism with females larger than males seems to be the rule among anuran amphibians (Shine 1979). Females with larger body size may produce a greater volume of oocytes, indicating that the size of females can positively affect their fecundity (e.g. Crump and Kaplan 1979; Prado et al. 2000). Since no females of *B. garbeanus* with mature oocytes were found in our samples, however, we could not assess the effect of female body size on reproductive output in this species. Nevertheless, Almeida-Santos et al. (2011) found a tendency for oocyte diameter (but not number) to increase with female SVL in the congeneric *B. didactylus*.

Brachycephalus garbeanus from Baixo Caledônia consumed a relatively high number of arthropod types, with Acari, Isopoda, Formicidae, Araneae and Coleoptera being the most important items in the diet. In a study on the ecology of the smaller congener *B. didactylus* (SVL up to 10.7 mm) in two Atlantic Rainforest areas in Rio de Janeiro state, the frogs consumed 21 types of prey items, but the diet of the species was composed mainly of Acari and Collembola (Almeida-Santos et al. 2011). Another smaller congener, *B. brunneus* (SVL up to 12 mm), had a diet composed of 15 types of invertebrates at two Atlantic Rainforest areas in Paraná state, though Acari represented over 60% of the consumed prey (Fontoura et al. 2011). Other reports based on more limited data have documented only Acari, Collembola and Araneae as prey for members of this genus (*B. didactylus*, Izecksohn 1971; *B. alipioi*, Pombal and Gasparini 2006). Mites were among the most important items in the diet of *B. garbeanus* and are among the commonest leaf litter arthropods in tropical forests around the world (Simon and Toft 1991), including different areas within the Atlantic Rainforest biome (Santos et al. 1998; Dietl et al. 2009; Fontoura et al. 2011). Nevertheless, mites are usually not important prey in the diets of other terraranan frogs (Simon and Toft 1991; Lima and Magnusson 1998), including brachycephalids of the genus *Ischnocnema* (Marra et al. 2004; Dietl et al. 2009; Martins et al. 2010), which are usually larger (SVL > 20 mm) than those in the genus *Brachycephalus*. Therefore, we believe that the high consumption of Acari by *B. garbeanus* is related to its small body size, which makes it advantageous to feed on such diminutive yet abundant prey (see Simon and Toft 1991). Nevertheless, we do not have data on arthropod availability in the leaf litter at Baixo Caledônia, so we do not know whether the consumption of those food items by individuals of *B. garbeanus* is proportional to their availability in the habitat (Toft 1980a; Miranda et al. 2006) or whether the frogs eat those items selectively (Toft 1980b; Hodgkison and Hero 2003).

Six individuals collected in the dry season had empty stomachs (compared with none in the wet season) and the number of items and the total volume of prey consumed were higher in the wet season than in the dry season. Those observations, combined with the lower relative body mass of frogs found during the dry season indicate a decrease of food intake during this period. The larger number of individuals of *B. garbeanus* with empty stomachs in the dry season may be indicative of a more negative energy balance by individuals during this season (Huey et al. 2001; Sabagh et al. 2010). This apparent reduction of food intake could be related to seasonal differences in the availability of potential prey (Toft 1980a; Santos et al. 2004; Miranda et al. 2006) or be a consequence of reduced frog activity during the dry season (as suggested by the greater proportion of individuals found hidden). The greater degree of prey consumption observed during the wet season could also indicate that the frogs were accumulating energy for the reproductive period. However, we have no evidence that this is the case, as we did not find mature oocytes in any of the females analysed from either season and do not know at what time of the year this species reproduces.

The composition of food items in the diet of *B. garbeanus* differed between the two seasons. Isopoda, Araneae and Formicidae were consumed in greater volume in the wet season, whereas the relative consumption of Coleoptera, Acari and Collembola was greater in the dry season. This could be related to possible fluctuations in relative prey availability (see above). Nevertheless, Acari and Formicidae were the dominant items in the diet in both seasons. The diversity of food categories consumed was also similar between the two seasons, both in volumetric and numeric terms. Hence, seasonality in the study area may not have a significant influence on the composition of the diet of *B. garbeanus*, even considering its possible effect on total food intake.

The fact that ants (Formicidae) were among the most important and frequent items in the diet of *B. garbeanus* could be related to the aposematism of this frog. Some studies on the diet of aposematic poison frogs have related the toxicity of those species with myrmecophagy (Toft 1995; Caldwell 1996; Caldwell and Vitt 1999; Biavati et al. 2004). The ingestion of ants can provide a wide variety of alkaloids that can be incorporated into the tissues of frogs, making them poisonous (Daly et al. 1994; Clark et al. 2005). Additionally, mites (which were the dominant items in the diet of *B. garbeanus*) have also been reported as sources of alkaloids for poisonous dendrobatids (Saporito et al. 2007). The existence of toxic compounds (tetrodotoxin and its analogues) in the skin and liver of two aposematic species of *Brachycephalus* (*B. ephippium* and *B. pernix*) was reported by Sebben et al. (1986) and Pires et al. (2002, 2005), and probably occurs in other brightly coloured members of the genus, including *B. garbeanus*. However, whereas the lipophilic alkaloids found in dendrobatid and mantellid poison frogs are known to be acquired from their prey (Clark et al. 2005; Saporito et al. 2009), the origin of tetrodotoxin (and its analogues) present in the tissues of *Brachycephalus* spp. and other toxic amphibians is still a matter of controversy, and there is currently no evidence that it is related to their diets (Daly et al. 1997; Pires et al. 2005; Hanifin 2010). We cannot, therefore, confirm that the aposematism of *B. garbeanus* is related to the ingestion of ants and/or mites.

We conclude that in Baixo Caledônia, *B. garbeanus* is mainly an inhabitant of the leaf litter of the forest floor, and is sexually dimorphic with females growing larger than males. This species feeds exclusively on invertebrates, mainly small arthropods, and the diet varies to some extent between wet and dry seasons, although mites are the most important items in the diet in both seasons.

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