Ecology of *Ischnocnema parva* (Anura: Brachycephalidae) at the Atlantic Rainforest of Serra da Concórdia, state of Rio de Janeiro, Brazil

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ABSTRACT. *Ischnocnema* (Brachycephalidae) includes many species that are important members of the leaf litter frog communities in the Atlantic Rainforest of Brazil. *Ischnocnema parva* (Girard, 1853) is endemic to the Atlantic Rainforest biome and is restricted to the forests of southeastern Brazil. Currently, the available information about the ecology of *I. parva* is scarce. We studied the diet, the habitat use, reproduction and density of *I. parva* in an area of Atlantic Rainforest at the Concórdia mountain range, Rio de Janeiro. Individuals of *I. parva* were captured in April 2005 using different sampling methods: time constrained search (transects), plots of 5 x 5 m (25 m²) on the litter, and pitfall traps with drift fences. We found 240 frogs; 35 females and 205 males. Females (mean SVL = 19.1 mm) were significantly larger ($F_{1,238}$ = 143.016, R^2 = 0.375, $p < 0.001$) than males (13.2 mm). The species preyed mainly on arthropods, with ants and isopods being the most important items, both showing high values of importance index (Ix = 50.0 and 26.7, respectively). *Ischnocnema parva* is a terrestrial species whose preferential microhabitat at the Serra da Concórdia was the litter of the forest floor (78.7%). The activity was predominantly crepuscular-nocturnal and the estimated density of *I. parva* was 24.9 ind/100 m². For the eight ovigerous females captured, the mean number of mature oocytes per female was 25 (range: 22-30) and the oocyte mean diameter was 1.11 mm (N = 40 oocytes). Oocyte number increased with female body size (R^2 = 0.504, $F_{1,6}$ = 6.107, $p < 0.05$, N = 8), indicating that as females increase in size they produce larger clutches. Some ecological aspects such as diet and microhabitat use were similar to that observed for an insular population of *I. parva*, whereas reproductive traits differed. Thus, long term studies are necessary to understand the extent to which these differences are explained by environmental factors.

KEY WORDS. Activity; density; diet; habitat use; reproduction.

Ischnocnema Reinhardt & Lütken, 1862 includes several species that are important members of the leaf litter frog communities in the floor of the Atlantic Rainforest biome. Its current distribution includes areas of Atlantic forest in southeastern Brazil and savannas in central-western Brazil and northern Argentina (FROST 2008). These species were previously included in *Eleutherodactylus* Duméril & Bibron, 1841 and were relocated following molecular analyses (HEINICKE *et al.* 2007). Individuals of *Ischnocnema* are usually abundant where they occur (*e.g.* ROCHA *et al.* 2000, 2001) and are relatively easy to locate in the field (LYNCH & DUELLMAN 1997) and therefore can be considered suitable for ecological studies (*e.g.,* ROCHA *et al.* 2000, 2001). These frogs are characterized by the direct development of their terrestrial eggs (HADDAD & PRADO 2005, POMBAL & HADDAD 2007).

Ischnocnema parva (Girard, 1853) (formerly *Eleutherodactylus parvus*) is a small anuran species (females up to 26.0 mm; males up to 23.0 mm snout-vent length; MARRA *et al.* 2004),

endemic to the Atlantic Rainforest in southeast Brazil. The species occurs in the southeast portion of the state of Minas Gerais and in the states of Espírito Santo, Rio de Janeiro and São Paulo (FROST 2008). Despite being distributed along a relatively large area, information on the ecology of *I. parva* is mostly restricted to five studies, two of which (HEYER *et al.* 1990, BERTOLUCI & RODRIGUES 2002) provide information on calling activity of this frog in Boracéia (state of São Paulo), whereas all other three were conducted at the insular environment of Ilha Grande (municipality of Angra dos Reis, state of Rio de Janeiro), which provided information on density, activity and diet (ROCHA *et al.* 2000, 2001, MARRA *et al.* 2004).

In the Atlantic Rainforest of Serra da Concórdia, western state of Rio de Janeiro, *I. parva* was one of the most abundant species of the leaf litter frog community. Herein, we studied the ecology of *I. parva* at Serra da Concórdia, investigating its diet, activity, habitat use, density and reproduction. Based on the in-

formation obtained, we compared the traits of this population from the Serra da Concórdia (mainland) with those available in the literature, and evaluated to what extent they are similar to the insular population of Ilha Grande. Specifically, we aimed to answer the following questions: I) what is the diet composition of *I. parva* and what are the types of prey preferably consumed? II) To what extent does mouth size affects the size of prey consumed? III) What are the daily activity patterns of *I. parva*? IV) What are the main microhabitats used by these frogs? V) What is the density of *I. parva* at Serra da Concórdia? VI) What are the clutch size and reproductive effort of gravid females?

MATERIAL AND METHODS

This study was conducted at the Santo Antônio da Aliança farm, an area partly included in the Santuário de Vida Silvestre da Serra da Concórdia (22°22'S, 43°47'W), in the municipalities of Barra do Piraí and Valença, state of Rio de Janeiro. The farm has an area of 295 ha, with altitudes ranging from 600 to 925 m above sea level. The area is covered by Atlantic forest at different levels of regeneration, and the best preserved areas are located, in general, at the less accessible portions of the forest. The vegetation of the area consists predominantly of Semideciduous Seasonal Forest (ATTIAS *et al.* 2009). Mean annual temperature is 20.4°C and varies from 10.8°C (winter) to 28.7°C (summer), and mean annual rainfall in the region is about 1469 mm (ATTIAS *et al.* 2009).

Fieldwork was carried out along 20 days on April 2005, using three methods of capture: active search (CRUMP & SCOTT 1994), 25 m² plots (or quadrats; JAEGER & INGER 1994) established on the forest floor, and pitfall traps with drift fences (CORN 1994). Active search was performed by time-constrained transects (30 minutes). During each transect, the observer walked slowly through the forest carefully looking for frogs on the floor, under and on logs, twigs, roots and stones, as well as on the vegetation. In addition, some water bodies such as shallow rivulets and streams were also surveyed. Transects were conducted during the day (09:00 to 16:00 h), dusk (17:30 to 18:30 h) and at night (19:00 to 22:00 h), for a total of 120 transects (= 60 hours of search), 40 per period (= 20 hours of search/period).

For the plot method we established 18 quadrats of 5 x 5 m on the forest floor during the afternoon, for a total of 450 m² of sampled forest floor. We marked the corners of each plot with wooden stakes and the area inside was enclosed with a 50 cm high soft plastic fence, whose base was buried or attached to the ground. At night, each plot was carefully searched (for about half an hour, on average) by a crew of five persons wearing head lamps, moving on hands and knees, side-by-side. Within each plot, leaves, branches and stones were overturned with the aid of hand rakes and rock crevices and spaces among tree roots were also checked. All individuals of *I. parva* found were captured. Based on the number of individuals of *I. parva* sampled in these plots we estimated the density in the leaf litter of Serra da Concórdia in terms of number of frogs per 100 m².

Additional specimens of *I. parva* were captured using pitfall traps with drift fences. Three pitfall trap systems were used during the 20 days of fieldwork. Each system consisted of ten 30-liter buckets buried on the ground and set *ca*. 5 m apart, with soft plastic drift fences about 50 cm high extended between them. Six buckets were set in line and the remaining four were placed at opposite ends of the fence, perpendicularly to the main axis. Pitfalls were checked once per day (always in the morning).

After capture, the frogs were immediately identified, killed in a 10% alcohol solution, fixed in 10% formalin solution and then preserved in a 70% alcohol solution. In the laboratory, the SVL and jaw width (JW) of individuals were measured with a digital caliper (to the nearest 0.1 mm). The mass (in grams) of individuals was recorded using an electronic balance (to the nearest 0.001 g). The sex of frogs was identified and recorded after dissection. We tested for sexual differences in body size (SVL) using one-way analysis of variance (ANOVA) (ZAR 1999).

The items found in the stomachs were identified and characterized to the taxonomic level of order or family (in the case of Formicidae). In the case of Coleoptera and Lepidoptera, the items were classified according to the stage of development (larvae or adult). Prey remains that could not be identified were grouped into a category "unidentified arthropod remains" (UAR). For each stomach the items were counted and measured in their length (L) and width (W) with a digital caliper (precision of 0.1 mm). Diet composition was analyzed in terms of number, volume and frequency of occurrence of each type of prey. The volume of each item (in mm³) was estimated by the formula of the spheroid: $V = 4/3\pi \ (L/2) \ (W/2)^2$, using the values of length and width (DUNHAM 1983). The frequency of occurrence of each item in the diet was estimated based on the number of frogs containing a given item in its stomach in relation to the total number of individuals sampled. For each category of prey, we calculated an index of importance (Ix), which represents the sum of the percentages of the number, volume and frequency of each item divided by three [Ix = (%N +%V +%F)/3] (POWELL *et al.* 1990). To assess whether the number and size of items consumed were related to body and mouth sizes, the number and mean volume (both log-transformed) of prey per stomach were related, respectively, with frog SVL and JW, using Simple Linear Regression Analysis (ZAR 1999).

To evaluate the patterns of microhabitat use, only those individuals sampled during active searches were considered. For each individual, the type of substrate on which the animal was found when first seen was recorded.

To assess at what time of day *I. parva* individuals were predominantly active, frog activity was estimated on the number of frogs found during the transects performed with active search. This method was used due to the same sampling effort in different periods of the day.

Additionally, we analyzed the reproductive parameters of mean size of eggs, the mean number of eggs in the ovaries and reproductive effort. For these analyses, only females with ma-

ture oocytes were considered. For each reproductive female, the number of oocytes was counted, their total mass was recorded with an electronic balance (to the nearest 0.001 g) and the diameter of five of them was measured using a digital caliper (to the nearest 0.1 mm). To evaluate if the size of ovigerous females affected the number of eggs produced or the mass of the clutch, the SVL of females was related to the number and mass of eggs (both log-transformed) through Simple Linear Regression Analysis. Reproductive effort was estimated by dividing the total mass of eggs by the body mass of the female, including eggs.

The results for the descriptive statistics are presented throughout the text as mean ±1 standard deviation. All data were tested for homoscedasticity of variances and for the normality of distribution before performing statistical analyses.

RESULTS

We analyzed a total of 240 individuals, of which 20 (8.3%) had empty stomachs. We identified 20 types of food items in a total of 659 items (Tab. I). In terms of number of items, the most common prey were Hymenoptera Formicidae (58.1%) and Isopoda (12.4%). Volumetrically, the highest proportion of total prey consumed was that of Isopoda (35.9%) followed by Hymenoptera Formicidae (24.3%). Hymenoptera Formicidae and Isopoda were also the most frequent items in the analyzed stomachs (present in 67.7 and 31.8% of stomachs respectively). Hymenoptera Formicidae (50%) and Isopoda (26.7%) had the highest values of relative importance index of prey in the diet. We found plant remains in the stomachs of 21 individuals (8.7%),

Table I. Number (N), volume (V, mm³), frequency of occurrence (F) (percentage in parenthesis) and Importance Index (Ix) of each food item in the diet of *I. parva* (N = 220) in Santuário Ecológico da Serra da Concórdia, Barra do Piraí/Valença. (UAR) Unidentified arthropod remains.

Items	N (%)	V (%)	F (%)	Ix
Gastropoda	3 (0.5)	1.1 (0.06)	3 (1.4)	0.7
Arachnida				
Scorpiones	7 (1.1)	4.3 (0.2)	7 (3.2)	1.5
Araneae	27 (4.1)	51.1 (2.8)	23 (10.5)	5.8
Opiliones	8 (1.2)	79.7 (4.4)	8 (3.7)	3.1
Acari	30 (4.6)	10.1 (0.6)	24 (10.9)	5.4
Chilopoda	12 (1.8)	64.9 (3.6)	10 (4.5)	3.2
Malacostraca				
Isopoda	82 (12.4)	646.7 (35.9)	70 (31.8)	26.7
Decapoda	1 (0.2)	0.5 (0.02)	1 (0.5)	0.2
Hexapoda				
Collembola	20 (3.0)	3.9 (0.2)	17 (7.7)	3.6
Orthoptera	16 (2.4)	107.7 (6.0)	16 (7.3)	5.2
Isoptera	2 (0.3)	35.1 (1.9)	2 (0.9)	1.0
Blattodea	8 (1.2)	41.7 (2.3)	8 (3.6)	2.4
Hemiptera	3 (0.5)	2.9 (0.2)	3 (1.4)	0.7
Homoptera	3 (0.5)	27.1 (1.5)	2 (0.9)	0.9
Coleoptera				
Adults	15 (2.3)	32.5 (1.8)	14 (6.4)	3.5
Larvae	9 (1.4)	14.6 (0.8)	9 (4.1)	2.1
Hymenoptera				
Formicidae	383 (58.1)	438.2 (24.3)	149 (67.7)	50.0
Others	8 (1.2)	12.0 (0.7)	6 (2.7)	1.5
Lepidoptera				
Larvae	4 (0.6)	83.9 (4.7)	4 (1.8)	2.4
Diptera	18 (2.7)	14.2 (0.8)	17 (7.7)	3.7
UAR	–	28.4 (1.6)	–	–
Plant Remains	–	101.5 (5.6)	21 (8.7)	–
Total	659	1802.1	–	–

representing 5.6% of the total volume of the contents (Tab. I). In all cases plant remains corresponded to fragments of dead leaves. The number of items ingested per frog (mean = 3.2 ± 2.5, range: 1-24, N = 215) was not significantly related (Regression Analysis, $R^2 = 0.009$, $F_{1,213} = 1.998$, p = 0.159) to frog SVL (mean 14.1 ± 3.4 mm, range: 6.7-25.5, N = 240), whereas the mean volume of items ingested (mean = 3.4 ± 6.8 mm³; range: 0.01-77.0, N = 220) was significantly ($R^2 = 0.249$, $F_{1,218} = 72.336$, p < 0.001) related to jaw width (mean 5.1 ± 1.1, range: 2.5-7.9 mm, N = 220) (Fig. 1).
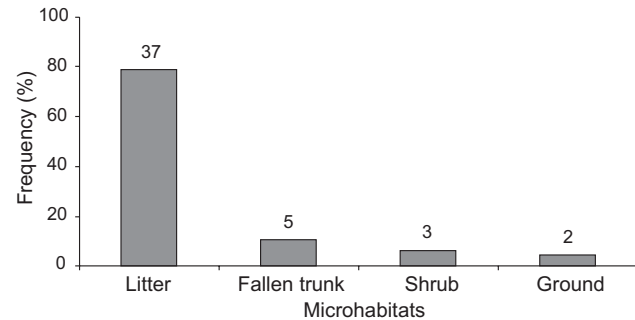

Figure 2. Frequency of use of different microhabitat categories by *I. parva* in Santuário Ecológico da Serra da Concórdia. Values above the bars indicate the number of individuals.

Figure 1. Relationship between jaw width (mm) and mean volume (mm³) of food items (in log) ingested by *I. parva* in Santuário Ecológico da Serra da Concórdia.

Active individuals of *I. parva* found during active search transects (N = 47) used four categories of microhabitats, of which the leaf litter on the forest floor (78.7%) was the most frequently used (Fig. 2). In terms of activity, 33 individuals (70.2%) were active during the crepuscular period, 12 (25.5%) during the night and two (4.2%) during the day. The estimated density for *I. parva* on the leaf litter of Santuário Ecológico da Serra da Concórdia was 24.9 ind/100 m².

The mean body size (SVL) of females (19.1 ± 3.1 mm, range = 9.8-25.5 mm, N = 35) was significantly larger (ANOVA, $F_{1,238} = 143.020$, $R^2 = 0.370$, p < 0.001) than that of males (13.2 ± 2.6 mm, range = 6.7-21.6 mm, N = 205) (Fig. 3).

Eight females were ovigerous and had a mean SVL of 19.2 ± 0.8 mm (range: 17.8-20.0 mm). The average number of eggs per female was 24.9 ± 2.6 (range: 22-30), with 10.1 ± 1.5 (range: 8-12) oocytes in the right ovary and 14.7 ± 1.5 (range: 13-18) in the left ovary. The average diameter of oocytes was 1.11 ± 0.38 mm (range: 0.4-1.6 mm, N = 40) and the mean mass of eggs per female was 0.024 ± 0.013 g (range: 0.010-0.053 g, N = 8). The
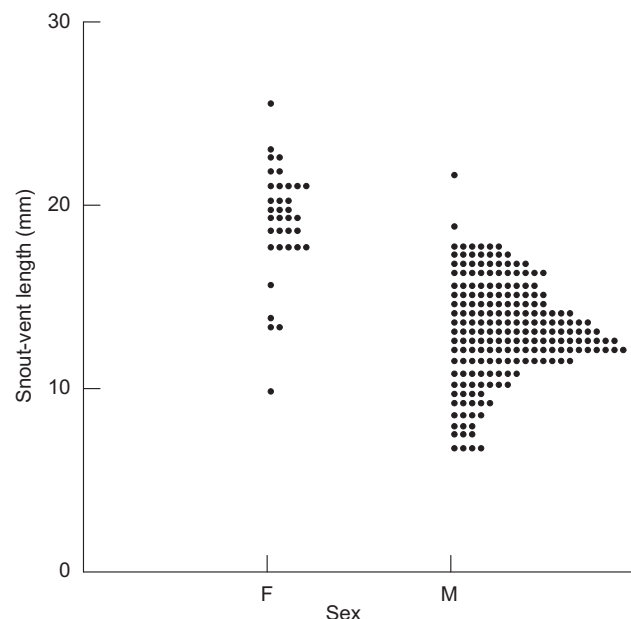

Figure 3. Body size distribution (snout-vent length, in mm) of males (M) and females (F) of *I. parva* (N = 220) in Santuário Ecológico da Serra da Concórdia.

number of oocytes in ovaries was positive and significantly related to females' SVL ($R^2 = 0.504$, $F_{1,6} = 6.107$, p < 0.05, N = 8) (Fig. 4), but there was a marginally significant relationship between the total mass of oocytes and female SVL ($R^2 = 0.48$, $F_{1,6} = 5.608$, p = 0.056, N = 8) (Fig. 5). The reproductive effort of ovigerous females averaged 3.1 ± 1.2% (range: 1.9-5.6%, N = 8).

DISCUSSION

Individuals of *I. parva* at the Serra da Concórdia feed predominantly on arthropods. Formicidae and Isopoda were the main prey types in the frog's diet. Formicidae and Isopoda were
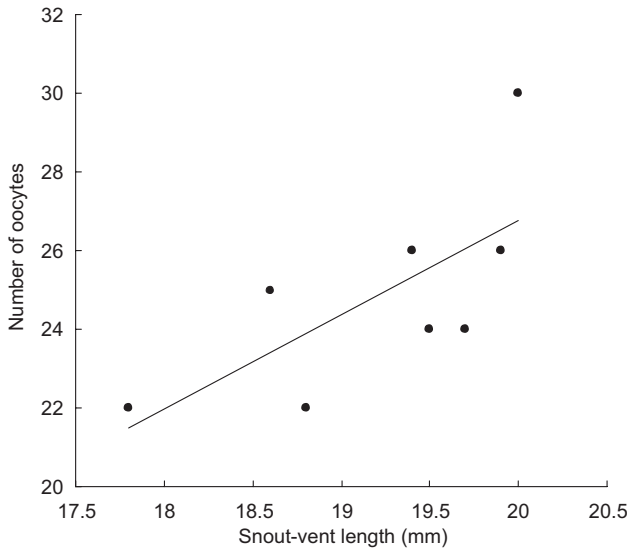
Figure 4. Relationship between snout-vent length (mm) and number of oocytes of ovigerous females (in log) of *I. parva* in Santuário Ecológico da Serra da Concórdia.
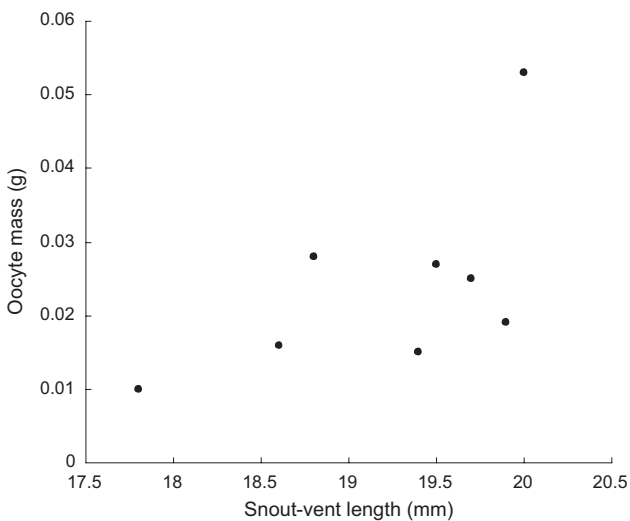

Figure 5. Relationship between snout-vent length (mm) and oocyte mass (g) of ovigerous females (in log) of *I. parva* in Santuário Ecológico da Serra da Concórdia.

also important prey in the diet of the population studied in the forest of Ilha Grande, in the state of Rio de Janeiro (MARRA *et al.* 2004). These results suggest that *I. parva* tend to feed predominantly on these arthropods, even living in different areas (insular and mainland). Formicidae are usually dominant among the arthropods living in the Atlantic forest leaf litter, during both the dry and rainy seasons (LACERDA *et al.* 1998, SANTOS *et al.* 1998).

There was a higher proportion of Araneae in the diet of the population of *I. parva* at Ilha Grande (see MARRA *et al.* 2004) compared to that of Serra da Concórdia, but since we have no data on prey availability for both areas, we do not know to what extent the differential consumption between these two sites reflects differences in availability of this prey type.

In the Atlantic forest, other leaf litter frogs also consume mainly arthropods. At Ilha Grande, the diet of *Leptodactylus marmoratus* (Steindachner, 1867) (Leptodactylidae) consisted mainly of Isopoda, insect larvae and Formicidae (ALMEIDA-GOMES *et al.* 2007). In the same area, *Zachaenus parvulus* (Girard, 1853) (Cycloramphidae) consumed mainly Isopoda and Chilopoda (VAN SLUYS *et al.* 2001). The diet of the population of *Proceratophrys tupinamba* Prado & Pombal, 2008 (Cycloramphidae) at Ilha Grande was predominantly composed by Orthoptera (BOQUIMPANI-FREITAS *et al.* 2002), whereas that of the congener *P. boiei* (Wied-Neuwied, 1824) was mainly composed by Coleoptera at Guapimirim, state of Rio de Janeiro (T. Klaion, pers. comm.), and Orthoptera at Atibaia, state of São Paulo (GIARETTA *et al.* 1998), both located in the Atlantic Rainforest. The composition of the diet of frogs in the Atlantic forest litter varies with the species, probably as a result of differences in energy requirements and in the species body size as well as in food availability in the habitat.

The amount of plant remains we found in the stomachs of individuals of *I. parva* was low (5.6%) and corresponded to fragments of dead leaves, suggesting that the occurrence of these items in the diet results from accidental ingestion during the capture of prey. The occurrence of plant material in the diet of many Brazilian frog species seems to result from accidental ingestion (*e.g.* VAN SLUYS *et al.* 2001, CANEDO *et al.* 2006, JORDÃO-NOGUEIRA *et al.* 2006, SIQUEIRA *et al.* 2006). In the Atlantic Rainforest, only the hylid *Xenohyla truncata* (Izecksohn, 1959) is known to effectively consume a large amount of small fruits (SILVA & BRITTO-PEREIRA 2006).

TOFT (1980a,b, 1981) analyzed the diet composition of leaf litter frogs of tropical forests of Peru and Panama and classified them in three general guilds according to their feeding habits: the "Ant specialists", the "Non-ant specialists" (which were those specialists in items different from ants) and "generalists". The wide diversity of types of items we recorded in the diet of *I. parva* of Serra da Concórdia (20 prey types) suggests a relatively generalized diet ("generalist" category of TOFT 1980a,b, 1981).

The absence of a significant relationship between the number of prey ingested and body size in Serra da Concórdia may result from the fact that this frog consumes relatively large prey, and most of the time, in small amounts (mean number of items by stomach = 2.8 ± 2.5), resulting in little variation in the number of ingested items.

The data indicated that *I. parva* tend to consume larger prey as body size increases. Possibly, as the frog increases in body size, the consumption of small prey become less energetically rewarding, whereas the consumption of larger prey

favors a positive energy balance in terms of prey consumed. Additionally, this trend is expected for frogs, as they eat entire prey (*e.g.* Toft 1980a,b, Duellman & Trueb 1986, Lima & Moreira 1993, Lima 1998, Caldwell & Vitt 1999).

Our data showed that the leaf litter of the forest floor was the main microhabitat used by *I. parva* in Serra da Concórdia, indicating also a predominantly horizontal habitat use, similar to that observed for this species in other studies (Heyer *et al.* 1990, Haddad & Sazima 1992, Izecksohn & Carvalho-e-Silva 2001, Haddad & Prado 2005, Pombal & Haddad 2007). Other species in the genus *Ischnocnema* [*e.g. I. guentheri* (Steindachner, 1864) and *I. octavioi* (Bokermann, 1965)] and some other brachycephalids [*e.g. Brachycephalus didactylus* (Izecksohn, 1971) and *B. ephippium* (Spix, 1824)] also use the leaf litter of the forest floor as preferred microhabitat (*e.g.,* Pombal *et al.* 1994, Rocha *et al.* 2000, 2001, 2007, Almeida-Gomes *et al.* 2008). At Serra da Concórdia, *I. parva* activity was primarily crepuscular (about 70%), with most of the remaining individuals (around 26%) being active at night. However, at Ilha Grande (Rocha *et al.* 2000), 70% of individuals of *I. parva* found were active at night. This difference can be explained by the fact that, at Ilha Grande, there was actually no sampling on the crepuscular period, as the end of the afternoon sampling (17:30 h) corresponded to the start of the crepuscular period in our study. So, we consider *I. parva* to be active predominantly during crepuscular-nocturnal periods.

The data showed that, at Serra da Concórdia, *I. parva* has the highest known density for the species so far (ca. 25 ind./100 m^2). The data available for other Atlantic forest areas showed significantly lower densities (around 2 to 10% of that found for the population from Serra da Concórdia). For example, at Ilha Grande the estimated density of *I. parva* was 2.1 ind./100 m^2 (Rocha *et al.* 2001), whereas in Cachoeiras de Macacu municipality, Rio de Janeiro, the estimated density for the population of *I. parva* was 0.5 ind./100 m^2 (Siqueira *et al.* 2009). These data suggests that, although this species tends to be one of the most abundant species in the communities where it occurs, its density is not constant among different areas, but rather tends to vary conspicuously, depending on the area. This variation in density may result from structural characteristics of the local environment such as depth and structure of the leaf litter layer and its components and the structure of the vegetation, inasmuch as these habitat elements affect the richness and abundance of frogs in the leaf litter (Van Sluys *et al.* 2007). Additionally, some of the differences may, in part, be due to the time of the year when the samplings were performed. Because data on density of *I. parva* are currently available for only a few areas, additional studies that focus on the density of species, in different areas and at different times of the year, are needed in order to better understand the role of seasonality and characteristics of the local environment on the density of *I. parva* along the Atlantic Forest.

Ovigerous females of *I. parva* from Serra da Concórdia produce on average about 25 oocytes per reproductive event. This figure was higher (mean of 11 oocytes) than that found for Ilha Grande (R.V. Marra pers. comm.). However, at Serra da Concórdia, the mean diameter of the eggs produced was about 1.1 mm, whereas at Ilha Grande the eggs were considerably larger (about 1.7 mm diameter) (R.V. Marra, pers. comm.). These points to a trade-off between number and size of oocytes: at Ilha Grande, females produce smaller clutches with larger oocytes, whereas at Serra da Concórdia females produce larger clutches with comparatively smaller oocytes. Because females of the two populations are similar in size (mean SVL: 18.1 ± 0.60 mm in Ilha Grande and 19.2 ± 0.8 mm in Serra da Concórdia), these variations in sizes of clutches and oocytes among areas may result from differences in reproductive strategies of females in different areas of the Atlantic Rainforest. However, for a better understanding of the occurrence of this variation in reproductive strategy, it would be important to obtain information about these aspects from a greater number of areas and in different periods of the year. The number of eggs produced by females of *I. parva*, both from Serra da Concórdia and Ilha Grande, is within the range of what has been reported for other species of frogs with direct development, which may vary from one to about 100 oocytes (Duellman & Trueb 1986, Donnelly 1999, Canedo & Rickli 2006).

Our data showed that fertility increases with female size. We also found that the relationship between female size and mass of eggs produced was close to significance (p = 0.056). It seems that there is a biological trend for a positive correlation between these variables that also reinforces the trend observed between female body size and fertility. At Ilha Grande, there was not a significant relationship between body size of females and number of oocytes for *I. parva* (R.V. Marra, pers. comm.). The different results between our study and that of Ilha Grande may be a consequence of the small sample size in both studies. However, we cannot discard that differences between these populations might exist in this relationship. The increase in fertility as a function of the increase in female body size has also been found for other species of leaf litter frogs (see Duellman & Trueb 1986, Donnely 1999, and reference therein). The mean reproductive effort of ovigerous females of *I. parva* from Serra da Concórdia was considerably higher (3%) compared to that estimated for females from Ilha Grande (0.06%) (R.V. Marra pers. comm.). This is another important variation among species' life history. The measurement of reproductive effort is an important component of many studies on reproductive strategies because it allows estimating parental investment in courtship and reproduction, in the proportional mass (= energy) invested in eggs and in the number of calories expended in gametogenesis and vitellogenesis (Duellman & Trueb 1986).

The population of *I. parva* from Serra da Concórdia is sexually dimorphic in body size, with females growing larger than males, a similar result to that found for the population of Ilha Grande (R.V. Marra pers. comm.). Probably this trend results from intrasexual selection acting on females favoring larger females to produce larger clutches.

The ecological differences between the insular and mainland populations at the Atlantic rainforest of the state of Rio de Janeiro may not be attributed to different selective pressures existing in those areas. It is necessary to consider that the differences in sampling periods between studies, in habitat structure and the small sample size of reproductive females for both areas can account for the observed interpopulational differences in the ecological aspects of *I. parva*.

ACKNOWLEDGEMENTS

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