DIET OF THE INVASIVE FROG *LITHOBATES CATESBEIANUS* (SHAW, 1802) (ANURA: RANIDAE) IN VIÇOSA, MINAS GERAIS STATE, BRAZIL

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ABSTRACT. Based on the stomach content analysis of 113 individuals, the diet of the invasive amphibian *Lithobates catesbeianus* (American Bullfrog) was examined in four sites located within the municipality of Viçosa (20°45'S and 42°51'W), state of Minas Gerais, Brazil, from August 2005 to March 2007. The effects of frog size and sexual maturity on stomach contents were determined. Prey items were grouped according to their primary habitat, being classified as aquatic, terrestrial and amphibious. In general, the most frequent prey categories were post-metamorphic Anura, Diplopoda, Hemiptera, Hymenoptera Formicidae and Araneae. The diet of adults of both sexes was similar, but differed from the diet of young frogs. Terrestrial prey were most abundant both in number and occurrence. For adult Bullfrogs, amphibious prey were most significant in volume. There was a significant correlation between prey and predator sizes, as well as a greater consumption of native anurans by larger Bullfrogs. The results confirmed that Bullfrogs have a generalist feeding habit that can have important negative effects on native amphibian communities in environments occupied by this invasive species.

KEYWORDS. Feeding habits; biological invasion; American Bullfrog; *Lithobates catesbeianus*.

INTRODUCTION

Native to North America, *Lithobates catesbeianus* (Shaw, 1802), commonly known as the Bullfrog, was introduced in several countries for commercial harvest (Moyle, 1973; Bury and Whelan, 1984; Giovanelli et al., 2008). The Bullfrog is the largest anuran species in North America. It is mostly aquatic and is a generalist predator, reflecting prey availability, including cannibalism (Bury and Whelan, 1984). The feeding habits of *L. catesbeianus* have been studied several times and many of these studies described the occurrence of uncommon prey types for an anuran, such as moles, mice, bats, birds, snakes, lizards, turtles, small alligators, salamanders and fish (Korschgen and Moyle, 1955; Cohen and Howard, 1958; Korschgen and Basket, 1963; Brooks Jr., 1964; Corse and Metter, 1980; Bury and Whelan, 1984; Silva et al., 2007; Camargo Filho et al., 2008).

The Bullfrog was chosen for commercial exploitation because of its high fecundity, which results in greater performance in captivity than other frog species (Vizotto, 1984; Fontanello, 1994). In Brazil, the first individuals of *L. catesbeianus* arrived in 1935 (Fontanello, 1994), and since then tadpoles and mature frogs were freely given to producers in order to stimulate the cultivation of this species. This species easily colonized different ecosystems in Brazil, which lead to the recommendation of its production in many Brazilian states (Fontanello, 1994).

It is well known that intentional introductions and farming escapes due to harvest deficiencies lead to population establishment in aquatic sites near frog farms (Hammerson, 1982; Bury and Whelan, 1984). The occurrence of invasive populations of the Bullfrog have been reported in the south, southeast and central regions of Brazil (Guix, 1990; Batista, 2002; Martins et al., 2002; Boelter and Cechin, 2007; Giovanelli et al., 2008; Kaefer et al., 2007; Reis et al., 2007; Silva et al., 2007). Given the generalist predatory habits of the Bullfrog, its introduction into natural environments is a cause for concern and prompts further investigation. Its ability to prey on other anurans, as well as competitive effects among tadpoles (Kupferberg, 1997; Lawler et al., 1999; Kiesecker et al., 2001) and possible pathogen transmission (Hanselmann et al., 2004; Garner et al., 2006; Barrasso et al., 2009), makes the Bullfrog a possible agent of amphibian population decline at its introduction sites (Hayes and Jennings, 1986; Kats and Ferrer, 2003; Pearl et al., 2004).

In the municipality of Viçosa, state of Minas Gerais, the first Bullfrogs arrived in the early 1980’s after the construction of the “Ranário Experimental” (RE; experimental frog farming) at the Universidade Federal de Viçosa (UFV) campus (Lima, 1994). Since then, the RE has become a source of tadpoles and immature frogs that have established invasive populations in aquatic sites located in surrounding areas, due to escapes from the RE. The aim of the present study...
was to describe the diet of *L. catesbeianus* in aquatic environments on the UFV campus in an attempt to analyze the effects of frog size, sex and sexual maturity on the prey types consumed.

**Material and Methods**

**Study sites**

Bullfrog specimens were collected at four sites located on the campus of the Universidade Federal de Viçosa, in the municipality of Viçosa (20°45’S and 42°07’W), Minas Gerais state, southeastern Brazil. The municipality of Viçosa lies within the Atlantic Rainforest domain; the region was originally covered by semi-deciduous forest. Currently, secondary forest fragments surrounded by agriculture, pastures, and eucalyptus plantations make up the landscape (Ribon et al., 2003; Coelho et al., 2005).

The first sampling site, known as the “Represa do Belvedere”, consists of a group of small connected dams surrounded by a secondary forest fragment and a grassplot. The dams have abundant aquatic vegetation composed of *Salvinia* sp. and *Nymphaeaceae*. The second site, known as “Estação Experimental de Fruticultura” is an area designated for the experimental cultivation of fruit trees, with four small dams originally built to serve as water reservoirs for irrigation. The shoreline herbaceous vegetation is managed regularly. There are a few aquatic plants, including *Nymphaeaceae*. The third sampling site consists of two artificial reservoirs located in an area of experimental grain production. The shoreline is dominated by *Poaceae* and sparse tree coverage, and there is no evident aquatic vegetation. The last site is an experimental fish station located near the Ranário Experimental site. It consists of 95 dams of different sizes, surrounded by regularly cut herbaceous vegetation. Some of the dams have aquatic vegetation, with the presence of *Eichhornia crassipes* and *Nymphaeaceae*.

**Data collection**

Frogs were captured at night (18:30-22:00 h) from August 2005 to March 2007. Field activities in sites 1 and 2 were carried out twice per month, and sites 3 and 4 were sampled sporadically, starting in August 2006. Frogs were captured by hand with the help of nets and an air rifle. The specimens collected were killed in situ and stored on ice to retard digestion (Boelter and Cechin, 2007). The samples were then deposited in the herpetological collection at “Museu de Zoologia João Moojen” (MZUFV). In the laboratory, frogs were weighed to the nearest 1 g, and the snout-vent length (SVL) and jaw width (JW) were measured to the nearest 0.05 mm using calipers. The individuals were grouped in seven size classes based on the SVL, adapting the classification of Lima et al. (1998): class 1 (< 50 mm); class 2 (50.05-70 mm); class 3 (70.05-90 mm); class 4 (90.05-110 mm); class 5 (110.05-130 mm); class 6 (130.05-150 mm) and class 7 (> 150.05 mm).

Frogs were dissected to remove the stomachs which were preserved in 70% ethanol. The individuals were sexed by gonad analysis and development of the secondary sexual traits (diameter of tympanic membrane, throat coloration and swollen thumbs; Bury and Whelan, 1984). Females (young and mature) were separated based on gonad development (Costa et al., 1998). Males weighing more than 45 g were classified as adults (Lima et al., 1998). Three groups were considered in diet analyses: adult males, adult females and juveniles.

The stomach content was analyzed with the help of a stereomicroscope. Food items were determined to the lowest possible taxonomic level. The plant remains found were considered to be accidently ingested. Prey items were grouped according to their primary habitat, being classified as aquatic, terrestrial and amphibious. The length and maximum width of each intact prey item was measured with calipers (the nearest 0.05 mm) (Wu et al., 2005). Individual prey volume (mm$^3$) was calculated using the formula for an ellipsoid (Magnusson et al., 2003):

$$\text{Prey volume} = \frac{4}{3} \pi \left(\frac{\text{lenght}}{2}\right) \left(\frac{\text{width}}{2}\right)^2$$

The total volume (cm$^3$) of prey categories was estimated by water displacement (Magnusson et al., 2003). This method was used because of the presence of fragmented prey items that could be identified but not measured, and could be grouped to estimate the total volume of each prey sample.

**Data analysis**

Frogs with empty stomachs or with only plant remains were not considered in the analysis. The frequency of prey occurrence per Bullfrog (FO = 100 x number of stomachs containing the prey category t divided by the total number of stomachs), relative
abundance of prey in Bullfrog stomachs (NF = 100 x total number of individuals of the prey category divided by the total number of all individuals consumed), and relative volumetric abundance of prey in Bullfrog stomachs (VF = 100 x total volume of individuals of the prey category divided by the total volume of all prey categories in all stomachs) were calculated for each prey category.

The diet overlap among the three Bullfrog groups (adult males, adult females and juveniles) was calculated using the index of Pianka (1973). Diet overlap between predator group j and group k was calculated as

\[ O_{jk} = O_{kj} = \frac{[\Sigma (p_{ij} \times p_{ik})]}{[\Sigma p_{ij}^2 \times p_{ik}^2]^{0.5}} \]

Where \( p_{ij} \) and \( p_{ik} \) are the relative abundance (NF) of the category i used as prey by the groups j and k paired in each treatment, and \( O_{jk} = O_{kj} \) means that the effect of group j on group k is equal to the effect of group k on group j.

An analysis of variance (ANOVA) was used to examine differences between Bullfrog groups in terms of the number of ingested prey items and SVL. Prey length and volume were also compared among adult males, females and juveniles by using ANOVA. If one of these differences was significant, a Tukey’s test was used to make a side-by-side comparison of the corresponding variable among Bullfrog groups.

The average prey length and volume, as well as the length and volume of the largest prey items obtained from each stomach were compared to the SVL with the Pearson Correlation test. Only the specimens that had at least one prey that could be measured were considered in this analysis.

**RESULTS**

Bullfrog body size (SVL) varied from 35.9 to 187.2 mm (113.9 ± 42.6 mm), and was highly correlated to JW (\( r_s = 0.982; p < 0.05 \)). Adult males and females had no significant differences in size, but were significantly larger than juveniles (\( F = 232.4; df = 2; P < 0.05; Q_{[0.05, 110]} = 3.364; \) Table 1).

A total of 129 specimens of *L. catesbeianus* were collected and 11 of them (8.5%) had empty stomachs. Plant remains were found in the stomachs of 81 individuals (62.8%), of which five (3.9%) proved to have nothing but plant remains present. After the exclusion of those individuals with empty stomachs or with stomachs containing only plant remains, information on diet composition was obtained from 113 specimens (46 adult males, 33 adult females and 34 juveniles). Of the 129 collected frogs, 107 (82.9%) had at least one identifiable prey, and the other six specimens (4.6%) had only arthropod fragments or non-identifiable remains in their stomachs.

**Table 1. Snout-vent length (SVL), prey length (all these in mm), and prey volume (mm³) of Lithobates catesbeianus collected in Viçosa, Minas Gerais State, Brazil (N = 113), presented as mean ± one standard deviation. Nᵣ = number of frogs; Nᵰ = number of prey measured.**

<table>
<thead>
<tr>
<th>SVL</th>
<th>Individual prey length</th>
<th>Individual prey volume</th>
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<tbody>
<tr>
<td>Adult males: ( Nᵣ = 46; Nᵰ = 85 )</td>
<td>(136.65 ± 19.79)</td>
<td>(1810.94 ± 3532.26)</td>
</tr>
<tr>
<td>Adult females: ( Nᵣ = 33; Nᵰ = 65 )</td>
<td>(144.27 ± 20.05)</td>
<td>(1696.81 ± 3979.04)</td>
</tr>
<tr>
<td>Juveniles: ( Nᵣ = 34; Nᵰ = 68 )</td>
<td>(59.37 ± 13.71)</td>
<td>(103.55 ± 278.29)</td>
</tr>
<tr>
<td>Size class 1</td>
<td>(35.90-99.80)</td>
<td></td>
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<tr>
<td>Size class 2</td>
<td>(44.70-47.11)</td>
<td>(9.8 ± 7.19)</td>
</tr>
<tr>
<td>Size class 3</td>
<td>(51.50-69.30)</td>
<td>(2.05-30.85)</td>
</tr>
<tr>
<td>Size class 4</td>
<td>(61.36-60.90)</td>
<td>(10.13 ± 7.05)</td>
</tr>
<tr>
<td>Size class 5</td>
<td>(70.70-88.65)</td>
<td>(2.80-72.95)</td>
</tr>
<tr>
<td>Size class 6</td>
<td>(76.98-67.61)</td>
<td>(14.48 ± 12.73)</td>
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<tr>
<td>Size class 7</td>
<td>(99.65-108.60)</td>
<td>(26.05-97.60)</td>
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<tr>
<td>Size class 8</td>
<td>(103.10 ± 4.27)</td>
<td>(61.83 ± 50.59)</td>
</tr>
<tr>
<td>Size class 9</td>
<td>(111.05-129.90)</td>
<td>(8.10-34.35)</td>
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<tr>
<td>Size class 10</td>
<td>(118.85 ± 6.12)</td>
<td>(17.40 ± 9.10)</td>
</tr>
<tr>
<td>Size class 11</td>
<td>(130.25-149.90)</td>
<td>(1.55-96.90)</td>
</tr>
<tr>
<td>Size class 12</td>
<td>(141.22 ± 5.07)</td>
<td>(29.48 ± 21.68)</td>
</tr>
<tr>
<td>Size class 13</td>
<td>(152.20-187.25)</td>
<td>(1.25-95.60)</td>
</tr>
<tr>
<td>Size class 14</td>
<td>(162.34 ± 10.28)</td>
<td>(32.68 ± 28.06)</td>
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</table>
A total of 309 prey items were identified (127 in adult males, 90 in adult females and 92 in juveniles; Table 2). The number of prey items per individual was similar among Bullfrog groups (range, average ± SD; adult males: 1-9; 2.98 ± 2.20; adult females: 1-13; 3.13 ± 2.42; juveniles: 1-10; 2.94 ± 2.06; F = 0.066; df = 2; P > 0.05).

The most frequent prey categories of adult males were post-metamorphic Anura and Diplopoda (Table 2). Post-metamorphic Anura were found to be most common in adult females, along with Araneae, Hemiptera, and Diplopoda. For juveniles, Hymenoptera Formicidae, Orthoptera, Hemiptera, Odonata, and Araneae were the most frequent prey categories.
A total of 49 anurans were consumed by Bullfrogs, being 40 post-metamorphic and nine tadpoles, one of them a *L. catesbeianus* tadpole. The post-metamorphic anurans identified were the native hylids *Dendropsophus minutus* (N = 2), *D. elegans* (N = 3), *Scinax crospedospilus* (N = 1), *S. eurydice* (N = 9), *Hypsiboas faber* (N = 2), and the bufonid *Rhinella pombali* (N = 1), besides 22 undetermined individuals. The post-metamorphic anurans (N = 15) ranged from 12.7 to 56.1 mm in length (average ± SD: 37.3 ± 11.8 mm) and 216.8 to 17,193.8 mm³ in volume (6848.4 ± 5793.1 mm³).

Terrestrial prey items were the most frequent in number, especially in the stomachs of juveniles (82.6%; Table 2). Regarding total volume, terrestrial prey were most frequent only for juveniles (69.37%), while amphibious prey were most frequent in adult Bullfrogs (males: 46.5%; females: 44.3% of the diet). Diet overlap was higher between adult males and females (0.944; 83.3%) than between adults and juveniles (adult females 0.671, 61.6%; adult males 0.554, 55.9%). Adults of both sexes showed no significant differences in relation to prey size, but consumed larger prey than juveniles [prey length: F = 21.01; df = 2; P < 0.05; Q (0.05, 215) = 3.310; prey volume: F = 6.715; df = 2; P < 0.05; Q (0.05, 215) = 3.310]. The length and volume of the largest prey items, as well as the average prey length and volume, were positively correlated to the SVL of frogs (Table 3). Because of the small number of individuals collected (N = 4), size class 4 was not considered in the analyses. Insects were the most abundant prey group in the diet of all size classes, although a progressive reduction was observed in consumption of insects from class 3 to class 7 (Figure 1). On the other hand, the presence of Diplopoda and Amphibia tended to increase ontogenetically, and Amphibia was not consumed by class 1.

**Discussion**

Amphibians are generally considered opportunistic predators. Their diets often reflect the availability of prey in their habitats, and they ingest any prey of appropriate size (Korschgen and Baskett, 1963; Duellman and Trueb, 1994; Stebbins and Cohen, 1995). Compared to other frogs, *L. catesbeianus* seems to be an extremely opportunistic predator (Korschgen and Moyle, 1955; Cohen and Howard, 1958; Korschgen and Baskett, 1963; Brooks Jr., 1964; Corse and Metter, 1980; Bury and Whelan, 1984; Silva et al., 2007; Camargo Filho et al., 2008) and the results herein on the diet of invasive populations corroborate this suggestion.

Insects were the most diverse and abundant prey group in the diet of *L. catesbeianus*, as observed by Korschgen and Moyle (1955), Korschgen and Baskett (1963) and Corse and Metter (1980), probably because of their high availability, although this was not evaluated in this study. Amphibia and Diploptoda also represented a considerable portion of total prey volume (53.9% and 19.9%, respectively). Our results were similar to those obtained in a similar study by Boelter and Cechin (2007) in areas where the species was introduced in the state of Rio Grande do Sul, southern Brazil.

Plant ingestion by Bullfrogs was considered accidental by several authors (Korschgen and Moyle, 1955; Korschgen and Baskett, 1963; Corse and Metter, 1980; Wu et al., 2005). In area 1, 30.2% of the frogs with plant in their stomachs (N = 43) showed remains of *Salvinia* sp., a common aquatic pteridophyte in local dams. Potential prey of *L. catesbeianus*, such as spiders, moths, and treefrogs were observed on this floating vegetation in several occasions during fieldwork, and were also found in Bullfrog stomachs together with *Salvinia* sp. remains. Thus, *Salvinia* sp.

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**Table 3. Correlation (Pearson) among SVL of Lithobates catesbeianus (N = 87) and prey length and volume, from Viçosa, Minas Gerais State, Brazil.**

<table>
<thead>
<tr>
<th>Variables</th>
<th>r</th>
<th>T</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean prey length</td>
<td>0.4805</td>
<td>5.0519</td>
<td>0.0001</td>
</tr>
<tr>
<td>Largest prey length</td>
<td>0.4916</td>
<td>5.2049</td>
<td>0.0001</td>
</tr>
<tr>
<td>Mean prey volume</td>
<td>0.3348</td>
<td>3.2752</td>
<td>0.0005</td>
</tr>
<tr>
<td>Largest prey volume</td>
<td>0.3331</td>
<td>3.2566</td>
<td>0.0006</td>
</tr>
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</table>

**Figure 1. Diet composition of the size classes of Lithobates catesbeianus collected in Viçosa, Minas Gerais State, Brazil (N = 109) according to the numeric frequency (NF). The group “Others” refers to Annelida, Gastropoda and Crustacea.
may have been ingested accidentally when the Bullfrogs were ingesting arthropods and anurans. Korschgen and Baskett (1963) suggest that the presence of plant remains in Bullfrog stomachs is a result of its proximity to the prey at the moment of capture or due to its movement on the water’s surface.

Ontogenetic shifts in frog diet are often related to size differences among predators (Duellman and Trueb, 1994). Larger individuals can continue feeding on the same types of prey used by the smaller frogs, while also including larger prey in their diets (Stebbins and Cohen, 1995) which can explain the differences in diet composition observed between adults and juveniles of L. catesbeianus. This trend became evident also by the positive correlation between prey size (length and volume) and frog SVL, as observed for Leptodactylus ocellatus by França et al. (2004) and Maneyro et al. (2004). Consumption of Diptera, Odonata, Orthoptera, and Hymenoptera was more frequent in juveniles, and the consumption of Hymenoptera Formicidae stands out as the greatest difference between adult and juvenile frogs. The opposite was true for the consumption of post-metamorphic anurans and diplopods, which were more frequent in the adult diet, a factor most likely due to the fact that most of these prey items are too large for juvenile frogs. This may also contribute to the low diet overlap between adults and juveniles. Our comparison of the diet among size classes (Figure 1) may reflect differences between adults and juveniles, since classes 1 and 2 were composed only of juveniles, class 3 was composed mostly of juveniles, and classes 5-7 were composed only of adults. Similar results were obtained by Govindarajulu et al. (2006) for Bullfrogs introduced in Canada.

A high similarity and overlap between the diet of male and female Bullfrogs were also reported by Brooks Jr. (1964), Werner et al. (1995), and Boelter and Cechin (2007). Spatial distribution of Bullfrogs in sampling sites may explain this similarity. Most adult males and females were collected at the same place, on the edge of water bodies, which is related to the reproductive behavior of this species (see Bury and Whelan, 1984). Similarity in body size and jaw width may also contribute to the higher diet overlap between adult males and females than between adults and juveniles.

A peculiarity in this study was the high consumption of diplopods. These animals have chemical defenses, such as phenolic and quinone compounds, produced by repugnant glands (Ruppert and Barnes, 1996). Although Stebbins and Cohen (1995) report palatability as a factor that affects prey selection by amphibians, our results and those of other authors (Korschgen and Baskett, 1963; Brooks Jr., 1964), suggest that L. catesbeianus can tolerate these repugnant compounds.

The occurrence of a bufonid (Rhinella pombali) among the stomach contents, as well as the observation of a Bullfrog preying upon a toad of the same species (Reis et al., 2007), also indicates tolerance to bufonid chemical defenses. Korschgen and Moyle (1955) also found a bufonid in a stomach of L. catesbeianus, and questioned if the occurrence of only one individual would not indicate a low acceptance of this amphibian group as prey. Bury and Whelan (1984), in their review on L. catesbeianus ecology, cite instances of predation on bufonids and the immobilization effect on Bullfrogs by the secretion of bufonid poison glands. Bufonids were also reported as prey for other frog species, including Rana pretiosa (Pearl and Hayes, 2002), Leptodactylus ocellatus (Gallardo, 1958; França et al., 2004), L. labyrinthicus (Cardoso and Sazima, 1977) and Ceratophrys ornata (Braun et al., 1980).

Terrestrial prey items were numerically dominant and most frequent in the stomachs, although other studies have indicated a high importance of aquatic prey items in the diet of L. catesbeianus (Werner et al., 1995; Hirai, 2004; Wu et al., 2005). The low frequency of prey with amphibious habits in the stomachs of juveniles is a consequence of the low consumption of post-metamorphic anurans, probably because of size constraints (see results). On the other hand, the consumption of anurans also explains the greater volumetric contribution of amphibious prey in adult Bullfrogs. The results of Hirai (2004), in Kyoto, Japan, could have been influenced by the high abundance of the crayfish (Procambarus clarkii) detected in the habitat studied, which resulted in a high frequency of this crustacean in the diet of L. catesbeianus.

Our study confirms that the American Bullfrog has a generalist feeding habit, which together with its capacity to occupy modified environments (Barrauso et al., 2009), appears to favor the establishment of invasive populations in Brazil. The use of native anurans as a food source was high among adult Bullfrogs, which suggests the possible occurrence of a negative effect on native anuran populations in sites occupied by this invasive species. Observations in the western United States suggest a direct correlation between Bullfrog dispersal and decrease of native ranids, and predation is cited as a possible cause of this decline (Moyle, 1973; Hammerson, 1982; Hayes
and Jennings, 1986; Kats and Ferrer, 2003; Pearl et al., 2004). Nevertheless, stating that predation is the cause of population decline based only on stomach content analysis, without data on the size of prey populations, may not be safe (Hayes and Jennings, 1986). In fact, the high presence of native anurans in the diet of the Bullfrog, as reported here, can also indicate some level of co-existence, since the invasion in Viçosa has lasted about 30 years. Unfortunately, data on the size of native anuran populations are lacking for the sites studied, as well as on their fluctuation since the Bullfrog introduction, which does not allow us to draw further conclusions.

On the other hand, competition for food resources among adults of invasive Bullfrogs and ecologically similar species is also suggested as a possible negative interaction (Hayes and Jennings, 1986; Werner et al. 1995; Barrasso et al., 2009). Some species of South American leptodactylids, such as Leptodactylus ocellatus, which is common in lentic water bodies and has a generalist diet, could be affected by this competition, as proposed by Barrasso et al. (2009). Local extinction of leptodactylids was reported by Batista (2002) in a locality of the Brazilian State of Goiás, following Bullfrog introduction. In Viçosa, Lima and Verani (1988) estimated a population around 200 individuals of L. ocellatus at the second site sampled in the present study, based on data collected between January 1978 and January 1979, before the introduction of Bullfrogs. During the fieldwork of the present study few individuals of this species were observed in that site, and their encounter was not frequent, suggesting a possible population decrease since those times. The possibility of negative interactions with Bullfrogs cannot be discarded, although other factors can be involved in this apparent decline. Guix (1990) reported that L. ocellatus was frequent in a locality of São Paulo State, in spite of the presence of invasive Bullfrogs. Thus, the possible relationship between the spread of the Bullfrog and native amphibian population declines in Brazil is a question that remains unclear.

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**LITERATURE CITED**


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