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Leptodactylus latrans tadpoles predating the eggs and tadpoles of sympatric anurans

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ABSTRACT - The Criolla frog, *Leptodactylus latrans*, is one of the most common and widely distributed anuran species in the Neotropics. Tadpoles of this species were previously reported to be omnivorous, feeding on algae and animal remains but observations in the wild suggested that they predate small tadpoles of *Physalaemus* sp. These observations were confirmed by a laboratory test where *L. latrans* tadpoles predated the larvae and eggs of *Physalaemus biligonigerus* and larvae of *Rhinella fernandezae*. There was evidence that the tadpole of *R. fernandezae* was relatively unpalatable.

INTRODUCTION

Most anuran larvae are primarily herbivores or detritivores; however, some species are carnivores (Alford, 1999) and may be cannibalistic (Duellman & Trueb, 1994), a behaviour associated with a high density of tadpoles in water bodies (e.g. *Scaphiopus* spp, *Bombina variegata*, *Epidalea calamita* and *Hyla arborea*) (see Heusser, 1971; Pomeroy, 1981). Some species (e.g. *Anomaloglossus beebei*, *Aparasphenodon arapapa*, *Oophaga pumilio*) (see Pramuk & Hiler, 1999; Bourne et al., 2001; Lourenço-de-Moraes et al., 2013) that breed in the small water bodies retained by plants (*phytotelmata*) show a special case of cannibalism. Low food availability in this situation induces females to lay unfertilised eggs that are then consumed by their tadpoles. The tadpoles of other species breeding in temporary ponds obtain a high-protein diet by being carnivorous. This accelerates metamorphosis and so decreases the risk of death by desiccation (Heusser, 1970; Crump, 1992; Petranka & Thomas, 1995).

For leptodactilid tadpoles, carnivory is unusual but is known in two species; *Leptodactylus labyrinthicus* (Spix, 1824) and *L. pentadactylus* (Laurenti, 1768) (Laurenti, 1768; Silva & Giaretta, 2008; Piraini et al., 2010).

L. latrans (Steffen, 1815) is one of the most widely distributed leptodactylids in South America (Maneyro & Carreira, 2012; Pimenta et al., 2014) and its tadpole is among the largest within the Pampa biome. Previous studies have shown that these tadpoles are omnivorous, feeding on algae and animal remains (Lajmanovich, 1994). However, our casual observations in the field indicated that *L. latrans* tadpoles were preying upon smaller tadpoles of *Physalaemus* sp. The current study describes a laboratory investigation of the potential predatory behaviour of *L. latrans* tadpoles on the eggs and smaller tadpoles of sympatric anuran species.

MATERIALS AND METHODS

To perform the experiment, we used nine *L. latrans* tadpoles, which were split into two size groups. The first group, hereafter named 'smaller' tadpoles, ranged from 40.1 to 46.2 mm total length (stage S 36, Gosner, 1960) and the second group, hereafter named as 'larger' tadpoles, ranged from 69.8 to 71 mm total length (S 40). These were offered fertilised eggs of *Physalaemus biligonigerus* (Cope, 1861) and tadpoles of *P. biligonigerus* in two development stages (mean = 5.79 mm total length, S 22; and mean = 5.90 mm total length, S 25); and tadpoles of *Rhinella fernandezae* (Gallardo, 1957) (mean = 5.67 mm total length, S 25). These were chosen because they are syntopic with *L. latrans* tadpoles in the coastal plain of Rio Grande do Sul, southern Brazil. All individuals were collected in temporary ponds at the university campus of Universidade Federal do Rio Grande (FURG) (33.075694°,52.168390°, 7 m above sea level, Datum WGS 84). A collection permit was authorised by Instituto Chico Mendes de Conservação da Biodiversidade (Licence Number 43658-1).

Eggs and tadpoles were collected in the wild and no tadpole was submitted to starvation conditions. Photoperiod in the laboratory simulated natural conditions, that is 12h/12h. Each tadpole of *L. latrans* was placed in a transparent container filled with 0.55 L of rain water (21-23°C) and then simultaneously offered 15 eggs of *P. biligonigerus*; 15 tadpoles of *P. biligonigerus* (S 22), 8 tadpoles of *P. biligonigerus* (S 25) and 15 tadpoles of *R. fernandezae* (S 25). Feeding behaviour of *L. latrans* tadpoles was observed during the first 30 minutes but the total number of tadpoles and eggs consumed was counted only after 12h. The number of tadpoles and eggs were counted, including those that were rejected, that is, those *P. biligonigerus* and *R. fernandezae* tadpoles that were partially consumed (see Fig. 1).

The influence of *L. latrans* tadpole size (smaller vs larger than 50 mm) on the number of prey items consumed was analysed using the Mann-Whitney *U*-test. To detect significant differences between the numbers of consumed items consumed by larger tadpoles, we used the Friedman nonparametric ANOVA for dependent samples. Values were considered statistically significant at $p \leq 0.05$. Results

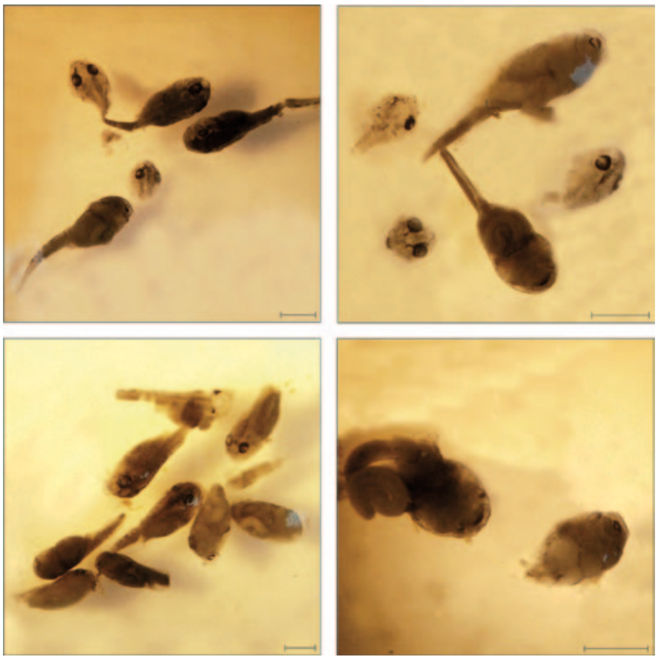

Figure 1. Examples of *R. fernandezae* tadpoles found dead, partially eaten or rejected by tadpoles of *L. latrans* during the experiment. Scale bars represents 1 mm.

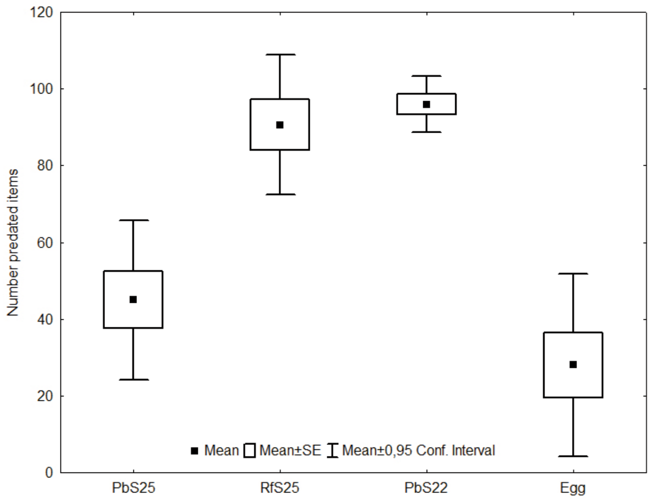

Figure 2. Mean, standard error and confidence intervals for the number of prey items consumed by larger *L. latrans* tadpoles in the experiment. Pb = *P. biligonigerus*; Rf = *R. fernandezae*; S = Gosner developmental stage.

were expressed in mean percentage (± standard deviation). Statistical analyses were performed using Statistica 7.0 software.

RESULTS

Smaller tadpoles consumed fewer prey than larger individuals ($U = 28.5$, $p < 0.001$, see Table 1). Therefore, to compare feeding preferences we used only the larger group (>50 mm) and detected a significant difference in consumption between different items (Friedman test, $\chi^2 = 12.62$, df = 3, n = 5, p = 0.006). That is, larger tadpoles of *L. latrans* consumed all items offered to some degree but with higher mean values for *P. biligonigerus* (S 22) (96%±5.96) and *R. fernandezae* (S 25) (90.7%±14.6) and lower mean values for *P. biligonigerus* (S 25) (45%±16.8) and eggs of *P. biligonigerus* (28%±19.1) (Fig. 2). Out of 135 *R. fernandezae* tadpoles 19 feeding attempts were made but rejected, while only one *P. biligonigerus* tadpole was rejected, out of 207 (Fig. 1 and Table 1).

Table 1. The size of *L. latrans* tadpoles (cm) and the number of tadpoles and eggs of other species consumed by each. Values in parentheses are partially consumed prey (considered rejected).

Size (cm) of *L. latrans* (S 36-40)	***P. biligonigerus***			***R.fernandezae***
	Eggs	Tadpole (S 22)	Tadpole (S 25)	Tadpole (S 25)
No. prey items presented/replicated	15	15	8	15
Larger tadpoles				
7.17	1	15	5	15(9)
7.10	6	15	2	13(4)
7.10	8	14	3	15(2)
7.06	2	13	3	10(2)
6.98	4	15	5	15(2)
Smaller tadpoles				
4.62	1	2	0	0
4.48	4	4 (1)	2	0
4.10	4	0	3	1
4.01	8	1	0	0

DISCUSSION

These results support our initial hypothesis that *L. latrans* tadpoles will attack and consume larvae and also the eggs of other anurans. The lower predation capacity of smaller *L. latrans* tadpoles (<50 mm total length) may be attributed to limitations of smaller size. In many kinds of carnivorous and cannibalistic tadpoles, such behaviour is facultative and usually occurs under crowded conditions or when the food supply is limited (Crump, 1992; Duellman & Trueb, 1994). Although we observed predatory behaviour in *L. latrans* tadpoles it is apparent that their mouthparts have no specific morphological adaptations for carnivory, unlike other carnivorous species of the *L. pentadactylus* group (Heyer et al., 1975). The findings in relation to *R. fernandezae* tadpoles, suggest they may be unpalatable. *Rhinella* tadpoles, and related species are known to produce alcianophilic mucous that has an unpleasant taste, a possible anti-predator adaptation (Gunzburger & Travis, 2005). Similarly, it has been reported that *L. pentadactylus* tadpoles avoided *Rhinella marina* tadpoles after initially seizing and killing them (Heyer et al., 1975).

It is important to emphasise that this is the first evidence of carnivory for a species from the *L. latrans* group. Similar behaviour was previously recorded for *L. labyrinthicus* and *L. pentadactylus*, both belong to the *L. pentadactylus* group, which are known for preying upon both con- and heterospecific tadpoles (Heyer et al., 1975; Cardoso & Sazima, 1977; Wells, 1979; Silva & Giaretta, 2008; De Sousa et al., 2014). The ability to forage actively for animal protein may be an essential component of a tadpole's development

(Heyer et al., 1975) leading to enhanced growth (Heusser, 1970; Crump, 1992; Petranka & Thomas, 1995). Also, carnivory could increase tadpole survivorship, particularly in temporary ponds with limited food resources (Blair, 1976; Pomeroy, 1981; Crump, 1983). Our results along with field observations indicate that these tadpoles have the capacity to prey upon smaller tadpoles and anuran eggs, a behaviour that may influence survivorship rates of tadpoles of other anurans and small organisms that are syntopic.

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