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Effect of the spatial heterogeneity on the predation of *Scinax fuscovarius* and *Physalaemus cuvieri* tadpoles by Odonata larvae

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ABSTRACT. The objective of this work were to analyze the effect of predation by Odonata naiads on two amphibian species with distinct habits – benthic and mid-water – and to verify whether the presence and architecture of macrophytes can mediate this interaction. All tadpoles and Odonata larvae were captured in a temporary pond. Sixteen tanks were used for three different treatments: *Pistia*, *Salvinia* and no macrophytes. Ten tadpoles of each species and two Odonata larvae were placed in each tank. The survival of tadpoles according to treatments was assessed through analysis of repeated measures. We concluded that the survival of *P. cuvieri* and *S. fuscovarius* tadpoles was not affected by the presence and architecture of the macrophytes (*Pistia* and *Salvinia*) or by their behavior.

Key words: tadpole, macrophyte, odonata, predation.

RESUMO. Efeito da heterogeneidade ambiental na predação de girinos de *Scinax fuscovarius* e *Physalaemus cuvieri* por larvas de Odonata. Os objetivos deste trabalho foram analisar o efeito da predação por náiades de Odonata em duas espécies de anfíbios com hábitos distintos, um bentônico e outro meia-água, e verificar se a presença e a arquitetura das macrófitas podem mediar essa interação. Todos os girinos bem como as larvas de Odonata foram capturados em poça temporária. Dezesseis aquários foram utilizados nos três diferentes tratamentos: *Pistia*, *Salvinia* e sem macrófitas. Dez girinos de cada espécie e duas larvas de Odonata foram colocados em cada aquário. Uma análise de medidas repetidas foi realizada para se determinar a sobrevivência dos girinos em função dos tratamentos. Concluímos que a sobrevivência dos girinos de *P. cuvieri* e *S. fuscovarius* não foi afetada pela presença e arquitetura das macrófitas (*Pistia* e *Salvinia*) nem pelo seu comportamento.

Palavras-chave: girino, macrófita, odonata, predação.

Introduction

Predation is one of the main causes of mortality among tadpoles (ALFORD, 1999) and one of the major factors influencing the structure of amphibian larval communities, both in their composition and in their spatial distribution patterns (AZEVEDO-RAMOS et al., 1999). Tadpoles can coexist with predators due to their physiological anti-predatory mechanisms such as unpalatability and rapid growth or due to behavioral responses like search for shelter or activity decrease (FORMANOWICZ JR., 1986; HOFF et al., 1999; STAV et al., 2007).

Associated with anti-predatory mechanisms, habitat complexity has shown great importance in the predator-prey interaction (SREDL; COLLINS, 1992; BABER; BABBITT, 2004; KOPP et al., 2006). The presence of aquatic vegetation leads to an increase in both habitat complexity and tadpole survival (KOPP et al., 2006). Habitats of higher structural complexity can expand the shelter areas for tadpoles and reduce the foraging success of preys (FOLSOM; COLLINS, 1984; BABBITT; TANNER, 1998). Babbitt and Tanner (1997) demonstrated that increased plant cover allowed a larger shelter area for *Hyla squirella* tadpoles, increasing their survival.

Tadpole predation by fish has Çbeen well studied. Hero et al. (1998) recorded that habitat occupation by amphibians in the Amazon Rainforest was directly related to fish distribution. According to those authors, the strong predation pressure by fish on amphibians was determinant to reduce the amphibian population. However, predation by aquatic macroinvertebrates has been poorly studied.

Odonata larvae are one of the main predators in the marginal zone, being recorded on the sediment and especially associated with aquatic plants in both permanent and temporary environments (CORBET, 1999). Odonata are voracious predators of tadpoles and use tactile and visual stimuli to detect their prey (RICHARDS; BULL, 1990).

The predator-prey interaction is extremely complex and can be mediated by several factors from environmental variables to intrinsic features of each species. Thus, the present study hypothesizes that: the presence of macrophytes and the higher habitat complexity will improve the survival of *P. cuvieri* and *S. fuscovarius* tadpoles; a tadpole that presents a behavior similar to that of the predator will present shorter survival. Therefore, the aims of this work were to analyze the effect of predation by Odonata naiads on two amphibian species of distinct habits, benthic (*Physalaemus cuvieri*) and mid-water (*Scinax fuscovarius*), and to verify whether the presence of macrophytes and the habitat structural complexity can mediate such interaction.

Material and methods

All tadpoles of *Scinax fuscovarius* (Anura, Hylidae) and *Physalaemus cuvieri* (Anura, Leiuperidae), as well as the larvae of *Micrathyria* sp. (Libellulidae), were captured by using a 3 mm² mesh fishing net in a temporary pond located at the Fish Farm Station of the School of Veterinary Medicine and Animal Science, Unesp - Botucatu Campus, São Paulo State, Brazil (22º50'S; 48º25'W).

The experiment was carried out at the Department of Zoology, Institute of Biosciences, Unesp – Botucatu Campus. Analyses included 16 tanks with dimensions 50 x 30 x 30 cm (length x width x depth), containing 15 liters of water each. The water used in the experiment was collected at the same site tadpoles and Odonata naiads were sampled. We tested three treatments: with *Pistia* Linnaeus 1753, with *Salvinia* Aublet and without plant cover, including four replicates each. *Pistia* and *Salvinia* were sampled in one single fish farming tank containing both macrophyte species. In addition to the treatments, there were four control replicates with tanks receiving water and tadpoles but no macrophytes or predators. Macrophytes were washed before the experiment for complete removal of all macroinvertebrates linked to the aquatic plants. After washing, we delimited with a string 50% of the tank transversal surface area, and *Pistia* were added until the delimited area was completely filled. In another tank, the same procedure was done for *Salvinia*. Both *Pistia* and *Salvinia* are floating macrophytes and only their roots kept inside the tanks. We standardized root length for *Pistia* and *Salvinia* at 20 and 5 cm, respectively. *Pistia* roots touched the bottom of the tank, whereas *Salvinia* leaves modified into root kept around 10 cm away from the bottom of the tank.

The laboratory temperature was kept between 26 and 30°C (similar to field temperature). We began the experiment at 9:00 a.m. on February 8, 2007, and finished it at 9:00 a.m. on February 10, 2007. Ten tadpoles of each species were placed in each tank at 24 hours before the beginning of the experiment for acclimation. Odonata nymphs were kept unfed for 24 hours; after this period, two of them were placed in each tank.

The number of tadpoles in each experimental treatment was recorded after 48 hours from the beginning of the experiment. Control was not excluded from analyses since all tadpoles survived. Thus, all deaths during the experiment were related to predation.

We performed a repeated measures analysis (F) using the software Statistical Analysis System - SAS (LATOUR; LITTEL, 1996), at 0.05% significance level, to verify whether there was difference in tadpole survival among treatments and between species or interaction between those two variables.

Results

The survival of *Scinax fuscovarius* tadpoles was longer than that of *Physalaemus cuvieri* tadpoles, except in the treatment with *Salvinia*, in which *P. cuvieri* survival was longer. We could also notice that there were no differences in *S. fuscovarius* survival in the treatments with *Salvinia*, with *Pistia* and without plant cover, and that *P. cuvieri* showed the shortest survival in the treatment without plant cover (Figure 1). However, the repeated measures analysis (F) did not evidence significant survival differences among treatments and between species (treatment: $F_{2,9} = 1.23$; $p = 0.33$; species: $F_{1,9} = 4.73$; $p = 0.06$; interaction treatment-species: $F_{2,9} = 4.02$; $p = 0.05$ indicating there was no difference between the survival of *S. fuscovarius* tadpoles and that of *P. cuvieri* tadpoles in the treatments with macrophytes and without plant cover, as well as between the survival of tadpoles from both species and the treatments with *Salvinia* and with *Pistia*.

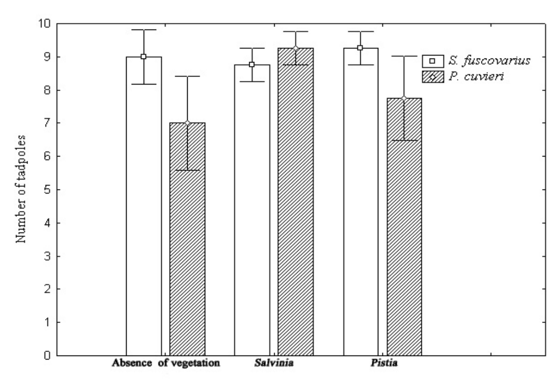

Figure 1. Number of tadpoles that survived predation by Odonata nymphs in the treatments with *Pistia*, *Salvinia* and absence of vegetation.

Discussion

Aquatic plants play extremely important roles in the marginal zones of aquatic ecosystems. Macrophytes affect the water chemistry, the prey-predator interaction, the availability of food, and especially the availability of shelters for amphibian larvae against predators such as Odonata naiads (JEPPESEN et al., 1998; NYSTROM et al., 2007). Odonata are one of the major predators in marginal zones, being recorded on sediments and mainly associated with aquatic plants (CORBET, 1999). According to that author, Odonata associate with macrophytes for two reasons: firstly, they search for shelter in macrophytes against their main predators, such as fish; secondly, macrophytes also constitute shelter for other communities such as tadpoles, which are eaten by Odonata larvae. However, in our experiment Odonata naiads had benthic behavior, which might have been due to several reasons, especially: absence of predators like fish, difficulties in climbing up to the aquatic plants or short acclimation time of Odonata larvae. The studied tadpole species, *S. fuscovarius* and *P. cuvieri*, showed distinct behaviors. According to Rossa-Feres et al. (2004), *P. cuvieri* has benthic behavior, whereas *S. fuscovarius* stays in mid-water. Therefore, *P. cuvieri* was expected to have shorter survival than *S. fuscovarius* since the former has benthic habit like its predator in the present experiment. Nevertheless, the statistical analysis did not show significant differences for *P. cuvieri* survival.

Tarr and Babbitt (2002) reported that tadpoles subjected to treatments with macrophytes had longer survival relative to treatments without macrophytes. According to those authors, macrophytes provide higher spatial heterogeneity, which increased the number of shelters, making tadpoles less susceptible to predation. However, in our experiment, there were no significant differences in *P. cuvieri* and *S. fuscovarius* abundances in the treatments with macrophytes (*Pistia* and *Salvinia*) and without macrophytes. Possibly, the presence of macrophytes like *Pistia* and *Salvinia* not only increased the number of shelters for tadpoles, but also allowed their predators, Odonata naiads, to use the macrophytes as shelter, which might have increased the efficiency in capturing tadpoles. Odonata larvae had different behaviors in the presence of their predators such as fish during food capturing. In the presence of fish, Odonata naiads reduce their activity, decreasing thus their exposure to predation (CORBET, 1999). However, according to that author, in the absence of fish, as in the present experiment, Odonata larvae may present two behaviors: passive, in which larvae keep immobile and stretch their labium to feed when detecting prey; or active, walking and actively searching for prey. The latter behavior generally occurs when naiads notice dead prey. In this experiment, the expected behavior was the passive one since tadpoles were actively swimming. Therefore, the presence of macrophytes, especially submerged roots, might have provided Odonata naiads with a tadpole capturing site.

Macrophyte roots form an important habitat for macroinvertebrates such as Odonata and tadpoles (PARSONS; MATTHEWS 1995; HUMPHRIES, 1996; ROSSA-FERES et al., 2004). However, the architecture of *Pistia* is different from that of *Salvinia*, especially regarding roots (JOLY, 1987). *Salvinia* presents a horizontal rhizome formed by a colony of branches, which are composed of internode, node, a pair of floating leaves and modified leaves functioning similarly to a small root (CROXDALE, 1978, 1979, 1981; ROOM, 1983). *Pistia* has floating leaves in the format of a rosette, which can be alone or together with stolons and a numerous and extensive adventitious root (LANGELAND; BURKS, 1998). This difference in architecture, especially concerning *Salvinia* and *Pistia* root length, may affect shelter availability. TORRETTA et al. (2006) noticed that 78.5% of the sampled macroinvertebrates were associated with *Pistia* roots, whereas only 2% were linked to *Salvinia* roots. The greater availability of shelters created due to *Pistia* root length contributed, according to those authors, to the high macroinvertebrate abundance. In this experiment, we used distinct root lengths, *Salvinia* root being shorter than *Pistia* root. However, we did not observe differences in the survival of *P. cuvieri* and *S. fuscovarius* tadpoles in the treatments with *Pistia* and *Salvinia*. Sredl and Collins (1992) had already recorded that differences in root length did not affect *Hyla eximia* survival.

We concluded that the survival of *P. cuvieri* and *S. fuscovarius* tadpoles did not alter with the presence and architecture of *Pistia* and *Salvinia* or with the distinct behaviors of tadpoles.

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