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

João Ânderson Fulan¹* and Silvio César Almeida²

¹Universidade Federal do Amazonas, Instituto de Educação, Agricultura e Ambiente, Rua 29 de Agosto, 786, 69800-000, Humaitá, Amazonas, Brazil. ²Universidade Estadual Paulista, "Júlio de Mesquita Filho", Botucatu, São Paulo, Brazil. *Author for correspondence. E-mail: joaofulan@ig.com.br

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 náuades 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-ROMOS 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 (SREENOM; 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 been 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, Leiopteridae), 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 (22°50’S; 48°25’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 School of Veterinary Medicine and Animal Science, 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 Fish Farm Station of the School of Veterinary Medicine and Animal Science, Unesp – Botucatu Campus, São Paulo State, Brazil (22°50’S; 48°25’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 Fish Farm Station of the School of Veterinary Medicine and Animal Science, Unesp – Botucatu Campus, São Paulo State, Brazil (22°50’S; 48°25’W).

Table 1 shows the mean number of tadpoles and Odonata naiads that survived predation by Odonata naiads in the treatments with *Pistia* and *Salvinia* and without plant cover, as well as between the survival of tadpoles from both species and the treatments with *Salvinia* and *Pistia*.

**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 = 1.23; p = 0.33; species: F = 4.73; p = 0.06; interaction treatment-species: F = 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 *Pistia*.
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 (JEPESENE 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 concerning 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.

Acknowledgements

We thank Prof. Dr. Luzia Aparecida Trinca for statistical support. We are also grateful to CNPQ (SCA, process 14733/2006) and Capes for financial support.

References