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Predation of *Piaractus mesopotamicus* and *Oreochromis niloticus* larvae by *Pantala flavescens* with different length classes

Carlos Henrique Figueiredo Lacerda[1*], Carmino Hayashi[2], Eliana Maria Galdioli[3] and Carlos Eduardo Bento Fernandes[3]

*[1]Laboratório de Ecologia e Gerenciamento de Ecossistemas Costeiros e Estuarinos, Departamento de Oceanografia, Universidade Federal de Pernambuco, Cidade Universitária, 50740-550, Recife, Pernambuco, Brazil. [2]Instituto de Pesca, Secretaria de Agricultura e Abastecimento do Estado de São Paulo, São Paulo, São Paulo, Brazil. [3]Departamento de Biologia, Universidade de Maringá, Maringá, Paraná, Brazil. *Author for correspondence. E-mail: lacerdachf@hotmail.com*

ABSTRACT. The experiment had as objective to study the survival of *Piaractus mesopotamicus* and *Oreochromis niloticus* larvae subject to predation by *Pantala flavescens* larvae with different length classes. We used 120 larvae of *P. mesopotamicus*, 120 of *O. niloticus*, and also 24 larvae of *Pantala flavescens*, distributed in 24 aquariums with useful volume for 2 L, being placed one Odonate for aquarium. The treatments differed as regard to the prey species and the predator size, being kept a control treatment. An aquarium (2 L) containing one larvae of Odonate and 10 larvae of fish were considered an experimental unit. After the beginning, each three hours (18:00, 21:00, 0:00, 3:00, 6:00, 9:00, 12:00, 15:00 and 18:00h), the remnant larvae of fish (alive) in each experimental unit was quantified, and we replaced the consumed larvae, so that we always had 10 larvae of fish at each aquarium after each counting. For both fish species, there was a slight increase in consumption by the Odonate with intermediate size, but the values did not differ statistically ($p > 0.05$). Larvae of Odonate in the treatments with greater length presented a lower consumption ($p < 0.05$) than in other treatments.

Keywords: experiment, Odonate, fish larvae, predator and prey.

RESUMO. Predação de *P. mesopotamicus* e *O. niloticus* por larvas de *Pantala flavescens* de diferentes classes de coprimento. O experimento teve como objetivo avaliar a sobrevivência de larvas de *P. mesopotamicus* e *O. niloticus* submetidas à predação por larvas de *Pantala flavescens* de diferentes classes de comprimento. Foram utilizadas 120 larvas de cada espécie de peixe e 24 larvas de Odonata, distribuídas em 24 aquários (2 L), sendo colocada uma Odonata por aquário. Os tratamentos diferiram quanto à espécie de presa e o tamanho do predador, sendo mantido um tratamento-controle. Um aquário (2 L) com uma Odonata e dez larvas de peixe foi considerada uma unidade experimental. As Odonatas foram colocadas nos aquários 1h antes das larvas de peixe. Foram efetuadas contagens a cada 3h (18, 21, 0, 3, 6, 9, 12, 15 e 18h) das larvas de peixe remanescentes (vivas) em cada unidade experimental, sendo repostas as larvas consumidas, de modo a ter dez larvas de peixe em cada aquário logo após cada contagem. Para ambas as espécies de peixe, foi observado leve aumento no consumo das larvas pelas Odonatas de tamanho intermediário, porém os valores não diferiram estatisticamente ($p > 0,05$). As larvas de Odonata nos tratamentos em que apresentavam maior comprimento tiveram consumo menor ($p < 0,05$) que nos demais.

Palavras-chave: experimento, Odonatas, larvas de peixe, predador e presa.

Introduction

The coastal region of continental water bodies provides essential habitats for the initial development of most species of freshwater fish. Also in this region, a great diversity of macroinvertebrates is usually found (CALLISTO et al., 2002).

Normally inhabiting these environments, larvae of insects such as Odonate, have been considered important predators of fish larvae (McCORMICK; POLIS, 1982; LOUARN; CLOAREC, 1997), with a high diversity in tropical systems (CORBET, 1980).

The *O. niloticus* is an African species introduced in Brazil after 1950 by officers attached to government agencies, aiming to develop aquaculture. Today it is commonly found in many water bodies in the country. Considered the "rustic" species with great adaptability (PÉREZ et al., 2004), *O. niloticus* is now considered one of the most successful exotic species in Brazilian freshwaters. The *P. mesopotamicus* is in the list of migratory Brazilian species that has shown a decrease in their natural populations in many environments (AGOSTINHO et al., 2007).

The study of interspecific interactions such as predation, contributes to a greater understanding of populations dynamics and ecology. Predation is a key mechanism in the structure, stability and maintenance of diversity in aquatic communities, influencing the prey populations and resource partitioning between species (STEIN, 1977).

Bailey and Houde (1989) studied the survival of fish larvae in the natural environment, highlighting the larvae size and the rate of their growth as critical factors in the survival of many fish species.

Few studies assessed the influence of Odonates on the fish larvae survival. Since predation and starvation are considered the main agents of larval mortality, predation can act as a determinant mechanism on the recruitment of many species (GERKING, 1994; PARADIS et al., 1996).

Larvae of fish represent the most critical phase to the success of the species, and are different from the adults in relation to ecological requirements. Thus, knowledge of this phase is essential to understanding the autecology and population dynamics (NAKATANI et al., 2001).

The objective of this study was to evaluate the survival of *Piaractus mesopotamicus* and *Oreochromis niloticus* larvae subjected to predation by *Pantala flavescens* larvae of different size classes, observing the influence of the sizes of predator and prey on the predation rates.

Material and methods

An experiment was conducted at the Aquaculture Laboratory of the Biology Department, in Maringá State University (UEM), during the month of February 2006.

For the experiment was used 120 larvae of pacu (*P. mesopotamicus*) obtained from regional fingerlings producers through artificial fertilization. The same amount of tilapia larvae (*O. niloticus*) was also used. Fifty individuals from each fish species was collected for the measurement of total length and average weight.

We used 24 larvae of Odonate (*P. flavescens*), identified and measured using ocular lens (10x magnification). The Odonate were separated into three length classes and distributed in 24 aquariums with a volume of two liters of water. The aquariums were installed in a completely randomized design with six treatments and four replications in a factorial way, where one factor is the fish species (*Piaractus mesopotamicus* and *Oreochromis niloticus*) and the other, diferent length classes of Odonate larvae (t1; t2; t3) (Table 1).

Table 1. Experimental treatments.

Length (mm) of *P. flavescens* larvae	12.34 - 15.02	20.17 - 23.13	28.42 - 31.33
Piaractus mesopotamicus	Pt1	Pt2	Pt3
Oreochromis niloticus	Tt1	Tt2	Tt3

To obtain the Odonate larvae, we used seven fiberglass pools (six with 120 L volume and one with a 1,000 L) installed outside for adults of Odonate do the postures. The pools were washed, supplied with water and fertilized with chemical fertilizer (NPK-7: 14:8), and were also inoculated with plankton to promote food availability for the developing larvae. Forty days after fertilization, Odonate larvae were collected with help of a net with 1 x 1 mm mesh size and a hand net with a diameter of 25 cm and 1 mm mesh size. The Odonates collected were separated into different size groups and stored in pools (120 L) and trays (4 L) inside the laboratory. This separation was due to the high incidence of cannibalism, observed when the *P. flavescens* larvae of different sizes are stored together.

Beyond the larvae used in the assembly of the experiment, other approximately 100 larvae of each fish species were maintained stored in buckets (ten liters) inside the laboratory, with constant aeration to be used in the replacement of larvae consumed. The larvae of both fish species had about 6-day old. The *P. mesopotamicus* larvae had a weight around 0.001416 g (pre-start of flexion and flexion) while the larvae of *O. niloticus* had an average weight of 0.01639 g (early post-flexion and post-flexion).

The aquariums were installed onto a table, supplied with water from an artesian well and under constant illumination with fluorescent lamps. The experimental unit was considered an aquarium (2 L) containing one Odonate larvae, and ten fish larvae of one species.

Odonate larvae were placed into the aquariums one hour before the fish, moment characterized as the beginning of the experiment. After the start, counts were made every three hours (18:00, 21:00, 0:00, 3:00, 6:00, 9:00, 12:00, 15:00, and 18:00h) of fish larvae remaining (alive) in each experimental unit and replacement the larvae consumed, thus remaining 10 fish larvae in each aquarium after each count. As a control, we used two aquariums containing only ten larvae of *P. mesopotamicus* and other two containing ten larvae of *O. niloticus*, both from the same batch of those placed with the Odonate.

The chemical parameters of water such as pH, electrical conductivity ($\mu S\ cm^{-3}$) and dissolved oxygen ($mg\ L^{-1}$) were measured every six hours with pH meter (Oakton), conductivity (Digital-Leitwert-

Messgerät/VDSF-G) and oximeter (YSI Model 55-12FT), respectively. The water temperature was measured twice daily at 8:00 and 17:00 hours with a mercury thermometer graduated from 0 to 50ºC.

The number and biomass of prey consumed were subjected to statistical analysis using the software Statistica 7.0. The data were submitted to polynomial regression analysis to investigate possible relationships of the Odonate size on the consumption of different fish species. To compare the relationships between the size of Odonate with the consumption in number and biomass of two fish species, we applied an analysis of covariance (ANCOVA), using the SAS program, according to procedure described by Dowdy and Wearden (1985).

Results and discussion

There was no difference ($p > 0.05$) between the values of water parameters in different treatments (Table 2). The measured values of these parameters are within the ideal range for aquaculture (EGNA; BOYD, 1997).

Table 2. Mean values of physicochemical parameters measured in experimental treatments.

Treatments	*Control*	Pt1	Pt2	Pt3	Tt1	Tt2	Tt3
TºC	24.00	24.10	24.00	24.10	24.10	24.00	24.10
pH	7.26	7.27	7.31	7.28	7.35	7.34	7.37
O_2 (mg L^{-1})	4.62	5.30	4.55	4.84	4.70	4.66	4.86
Electrical conductivity (μS cm^{-3})	0.14	0.14	0.14	0.14	0.15	0.15	0.14

We verified a higher consumption in number of *P. mesopotamicus* larvae, and greater biomass consumption of *O. niloticus* larvae ($F2, 17 = 330.91$, $p < 0.00001$) by *P. flavescens* (Figure 1).

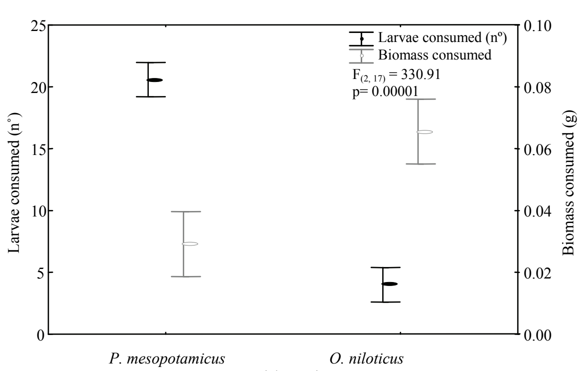

Figure 1. Mean values for the number of fish larvae and biomass consumed by *Pantala flavescens* larvae.

We also observed a significant difference ($p < 0.05$) in the consumption of *P. mesopotamicus* and *O. niloticus* larvae and between size classes (Figure 2). There was a similar pattern of consumption of fish larvae by Odonate (Figure 2). For both fish species, there was a slight increase in consumption by the Odonate larvae between length classes t1 and t2, but the values did not differ statistically ($p > 0.05$).

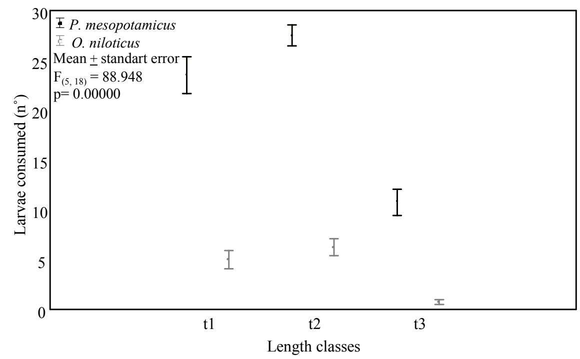

Figure 2. Mean values of fish larvae consumption by *Pantala flavescens* larvae of different length classes.

The Odonate larvae in the treatments with higher length (t3) had a lower consumption ($p < 0.05$) of both fish larvae species. There was no significant difference ($p > 0.05$) in consumption of the *P. mesopotamicus* larvae by Odonate with the shorter length (t1) and intermediate length (t2). Only the larger size of Odonate (t3) presented significantly lower values. The consumption of *O. niloticus* larvae followed a similar curve, being preyed fewer ($p < 0.05$) by Odonate of larger size (t3).

Comparing the survival of two species of fish jointly, the *P. mesopotamicus* larvae were consumed in greater number than the *O. niloticus*. This result is probably because *O. niloticus* larvae has a birth size and weight greater than *P. mesopotamicus* larvae, thus in the treatments containing tilapia larvae (Tt1, Tt2 and Tt3), the Odonate probably consumed fewer preys. Other evidence is the results of consumption (g), which show a higher biomass consumed in the treatments with *O. niloticus* larvae (Figure 3).

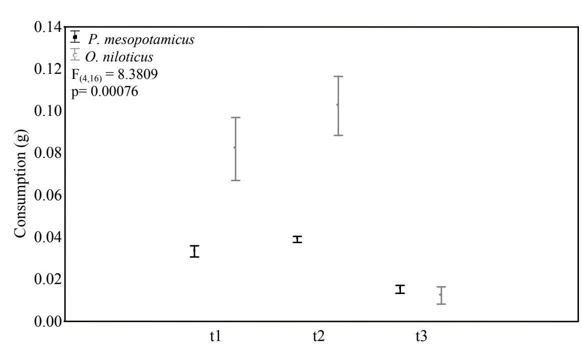

Figure 3. Consumption in grams of fish larvae by *Pantala flavescens* larvae of different length classes.

Travis et al. (1985) studied the predation of Odonate (*Tramea lacerata*) on tadpoles (*Rana areolata*) observed a reduction in predation rate with increasing prey size. The same authors reported a slight increase in consumption of preys with increasing Odonate size.

The birth size of different fish species is a very important feature and at the same time, controversy in the study of ichthyoplankton, especially when it comes to predator-prey interactions. The data found in this study are consistent according to some authors (ANDERSON, 1988, COWAN JÚNIOR; HOUDE, 1992; HOUDE, 2002; MCGURK, 1986; MILLER et al., 1988; PEPIN, 1989; RICE et al., 1993; PETERSON, WROBLEWSKI, 1984) who, studying the ichthyoplankton, consider that larger individuals are less susceptible to predation. However, other studies (FUIMAN, 1989; COWAN JÚNIOR; HOUDE, 1992; LITVAK; LEGGETT, 1992; PEPIN et al., 1992) argue that this process is more complex, and that in some circumstances, larger larvae with fastest growing become more vulnerable to predators, due to the increase in the rate of encounter between predator and prey.

The relationship between vulnerability to predation and body size, can still be represented by some authors (FUIMAN, 1989; PEPIN et al., 1992) as something shaped "dome" with a maximum of vulnerability in an intermediate size.

The reduction in prey consumption by Odonate larvae observed in this experiment was also reported by Soares et al. (2001). Similar results were found by Krishnaraj and Pritchard (1995), which reported that the size of the Odonate larvae is one of the factors that determine the consumption of food by them.

The lowest consumption of prey by the larger-sized Odonate is related to the degree of larvae development, thus, individuals with intermediate size have a higher rate of predation, the larger ones, already in a later stage next to emerge, reduce food consumption due to changes in metabolism (ASKEW, 1988). The same author describes the final phase of Odonate larvae development, marked by great changes in appearance, behavior and feeding, regulated by a delicate balance of hormones produced in the brain and ventral glands in the chest.

The *Pantala flavescens* species shows rapid growth and large size, being perceived as causing considerable economic losses in aquaculture (DE MARCO JÚNIOR et al., 1999). In this study, to work with this species in the laboratory, a large and voracious cannibalism was observed, while allowing its management of storage only to individuals of similar size and at very low density (author note). Ward (1992) says that cannibalism, commonly observed in storage in laboratory, is a rare phenomenon in natural environments. In the laboratory, the high stress, density, high water transparency and lack of natural refuges probably contribute to the cannibalism observed.

Data from this experiment showed a variation in the consumption of fish larvae by Odonate larvae of different sizes, and indicated a large drop in consumption of fish larvae by the larger-sized Odonate that were close to the final stage of the aquatic development.

It is worth adding that the tilapia (*O. niloticus*) is an African species, introduced in different aquatic environments in Brazil. According to Agostinho et al. (2007), tilapia, especially the genus *Oreochromis*, is considered a high competitive specie, with omnivorous habit, high reproductive potential and high hardness in the face of environmental conditions. The pacu (*P. mesopotamicus*), migratory Brazilian species, in some environments as in the case of Paranapanema river, is rarely found today in their aquatic environment (BRITTO et al., 2003), suggesting that this specie is among the victims of the species introduction process, currently considered as the second leading cause of promoting biodiversity loss (COURTENAY JR.; WILLIAMS, 1992; FULLER et al., 1999; MACK et al., 2000).

In this experiment, the *O. niloticus* larvae were consumed in lower number than *P. mesopotamicus* larvae, probably due to the larger size at birth, suggesting that this characteristic, along with other factors may improve the success of this species in the environment.

Conclusion

The size of *Pantala flavescens* larvae affects the consumption on fish larvae, and individuals with greater length, near its final stages of development inside aquatic environment, presented a significant reduction in consumption. In laboratory, *Piaractus mesopotamicus* larvae were more predated than *Oreochromis niloticus* larvae by *Pantala flavescens*.

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