Acta Scientiarum

http://www.uem.br/acta
ISSN printed: 1679-9283
ISSN on-line: 1807-863X
Doi: 10.4025/actascibiolsci.v34i4.11161

Passive zooplankton community in different environments of a neotropical floodplain

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ABSTRACT. Zooplankton is able to respond promptly to environmental changes, producing resting forms in order to maintain populations when the conditions become unfavorable. The hatchling of the resting eggs was assessed in environments from the upper Paraná river floodplain, during the limnophase of 2008. We predicted that a higher production of these eggs and individuals' hatchling are observed at isolated lakes, during dried period. Sediment samples were obtained with a corer sampler. The resting eggs were sorted and kept in filtered water from the same environment, in the laboratory. We recorded the occurrence of 378 resting eggs, of which 122 individuals hatched (70 cladocerans and 52 rotifers). The highest number of hatchlings was verified for the isolated lakes (84 individuals), as well the shorter time for hatchling (2 days). The hatchlings occurred mainly in September, when we registered the lowest hydrologic level of Paraná river (2.40 m). *Grimaldina brazzai* presented the longest time for hatchling, 44 days; and *Brachionus dolabratus* and *B. falcatus*, the shortest time, 2 days. This result suggests that the longer residence time of the water, which did not allow a renewal of food resources and limnological conditions of the environment, caused a higher stress in the zooplankton.

Keywords: resting eggs, hatchling time, residence time of the water, Paraná river.

Comunidade zooplanctônica passiva em diferentes ambientes de uma planície de inundação neotropical

RESUMO. O zooplâncton é capaz de responder prontamente às mudanças das condições ambientais produzindo formas de resistência, a fim de manter as populações quando essas condições se tornam desfavoráveis. A eclosão dos ovos resistência foi avaliada em diferentes ambientes da planície de inundação do alto rio Paraná, no período de limnofase em 2008. Foi pressuposto que ocorre uma maior produção desses ovos e de eclosões dos indivíduos nas lagoas fechadas, no período mais seco. As amostras do sedimento foram obtidas com um amostrador do tipo "corer". Os ovos de resistência foram triados e mantidos na própria água do ambiente filtrada, em temperatura ambiente. Foram triados 378 ovos de resistência, dos quais eclodiram 122 indivíduos (70 cladóceros e 52 rotíferos). Uma maior eclosão (91 indivíduos), e em um menor tempo (2 dias), foram observados nas lagoas fechadas. As eclosões ocorreram principalmente em setembro, quando o nível hidrológico do rio Paraná foi menor (2,40 m). *Grimaldina brazzai* apresentou o maior tempo de eclosão, 44 dias; e *Brachionus dolabratus* e *B. falcatus*, o menor tempo, 2 dias. Esse resultado sugere que o elevado tempo de residência da água, que não propiciou uma renovação dos recursos alimentares e das condições limnológicas no ambiente, foi o fator de estresse para o zooplâncton.

Palavras-chave: ovos de resistência, tempo de eclosão, tempo de residência da água, rio Paraná.

Introduction

Environments in the upper Paraná river floodplain show high diversity of zooplankton, stemming from the wide spatial heterogeneity and large fluctuations in water level caused by seasonal variations (LANSAC-TÔHA et al., 2004).

The colonization success of zooplankton populations in these environments is related to the strategies that allow the establishment and development of organisms in aquatic environments, as the production of dormant stages that enable the survival and maintenance of populations facing adverse environmental conditions (CRISPIM; WATANABE, 2000; FRYER, 1996; GILBERT, 1995; MAIA-BARBOSA et al., 2003). These stages are found in the sediment of aquatic environments and may remain viable for a long period of time (FRYER, 1996; MAIA-BARBOSA et al., 2003; RICCI, 2001).

Resting eggs from numerous species, produced at different times, compose an eggs bank that reflects the evolutionary history and environmental features of a given system (RICCI, 2001). Additionally, resting eggs enable the maintenance of genetic variability in the community (HAIRSTON; KEARNS, 1995), and contribute significantly for both temporal dynamics of active populations in the environment (CRISPIM et al., 2003; DE STACIO, 1990; HAIRSTON et al., 2000), and the dispersal of organisms (BILTON et. al., 2001; BRENDONCK; RIDDOCH, 1999; CÁCERES; SOLUK, 2002; JARNAGIN et al., 2000).

The factors that stimulate the production of resting stages may act distinctly on different species, and also among different populations within a same species. The intensity of production may also vary from one species to another (CACERES; TESSIER, 2004a and b; SCHRODER; GILBERT, 2004).

In this way, the present study aimed to evaluate the production and viability of resting eggs from zooplankton organisms, as well their time to hatchling, in eggs pool at connected and isolated lakes and backwaters from the upper Paraná river floodplain, during the periods of ebb and drought in 2008. We predicted that a greater number of eggs and hatchlings is verified in isolated lakes, during dry months.

Material and methods

We established different environments to this study: two backwaters (Pau Véio and Leopoldo Backwaters), three connected (Patos, Guaraná, and Garças Lakes) and four isolated lakes (Ventura, Fechada, Osmar and Genipapo Lakes), from the systems Paraná, Baia, and Ivinheima (Figure 1). Sediment samples were taken in different sampling points in the littoral and pelagic regions of the environments, according their size. In general, two samples were carried out in the environments during May, June, August, September and November 2008. There was not possible to sample in all environments during each months, mainly in August. Although major of them (7 environments) were sampled at the same time.

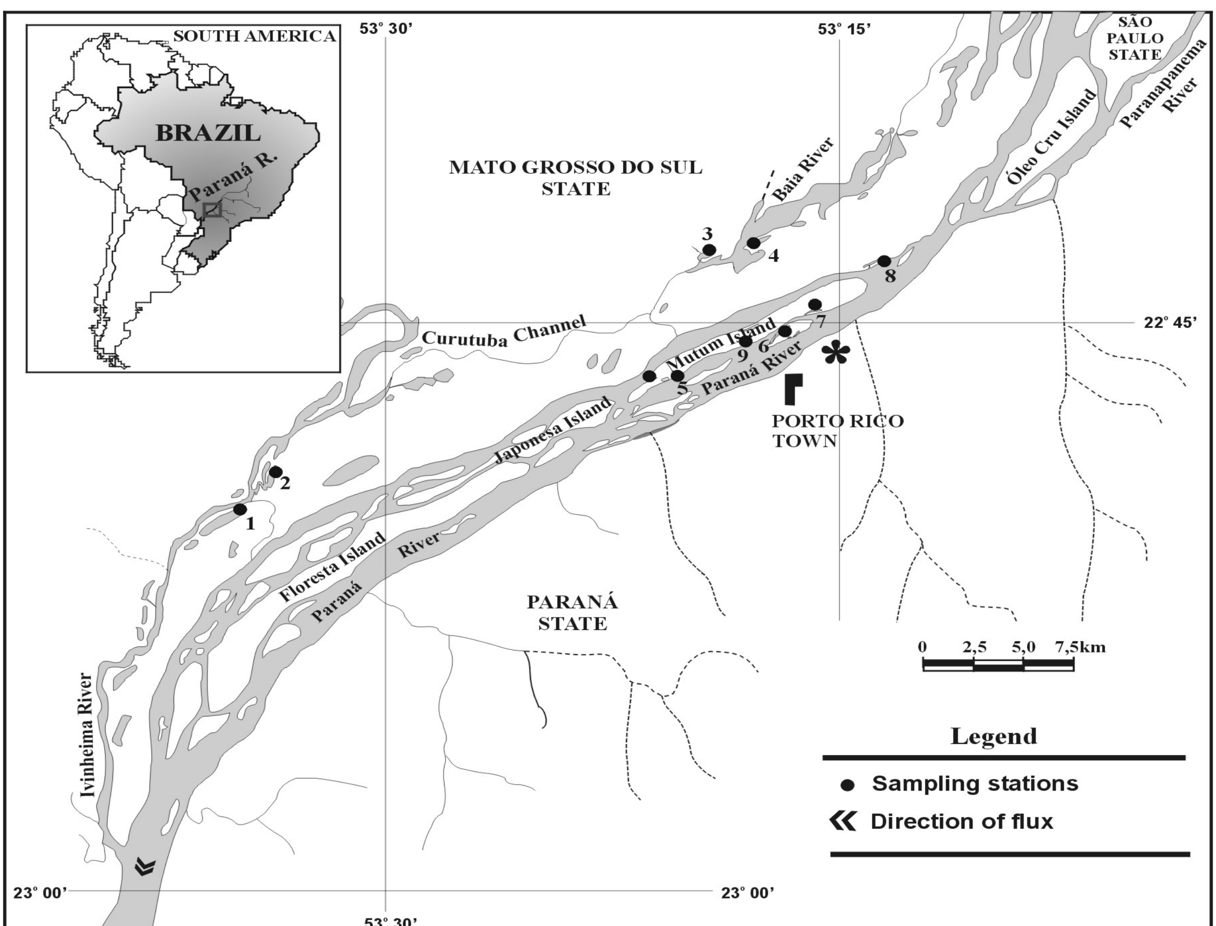

Figure 1. Studied lakes in the upper Paraná river floodplain: Ivinheima system - 1 = Ventura lake, 2 = Patos lake; Baia system - 3 = Guaraná lake, 4 = Fechada lake; and Paraná system - 5 = Osmar lake, 6 = Leopoldo backwater, 7 = Pau Véio backwater, 8 = Garças lake, and 9 = Genipapo lake.

The sediment samples were obtained using a corer sampler (194.5 cm^3), and we considered for analysis only the first five centimeters of the sediment. Samples were kept in dark flasks, and refrigerated (1-10 days) until laboratory analysis (MAIA-BARBOSA et al., 2003).

In order to obtain the resting eggs, the sediment samples were removed from refrigeration and kept under room temperature for 2 hours. Each sample was homogenized and 50 grams of sediment were diluted in a solution of sucrose and distilled water (MAIA-BARBOSA et al., 2003; ONBÉ, 1978). This solution was then centrifuged, at 3,600 rpm, for 5 minutes, and the supernatant was filtered through a 15 μm mesh net.

After this procedure, the material retained in the net was washed with distilled water and put into Petri dishes containing water from the same environment also filtered through 15 μm mesh net. The resting eggs were identified according to the literature and then they were examined daily, during 30 days, under a stereoscopic microscope (MAIA-BARBOSA et al., 2003) to verify the hatchling. After 30 days, unhatched eggs were examined every two days, and after three months (90 days) without hatchling, the hatchling experiments were finished.

Daily values of fluviometric levels of Paraná river were measured at Meteorological Station from the Agência Nacional de Energia Elétrica (ANEEL), located at the right bank of Paraná river, in Porto São José District.

Results

Hydrological periods

Results from the hydrometric levels of Paraná river, responsible for the flood of floodplain environments, evidenced the occurrence of an ebb period in May (3.02 m) and June (2.86 m), and a dry period in August (2.76 m), September (2.40 m) and November (2.74 m), since the level of 3.5 m is considered as reference for the floodplain overflow (SOUZA FILHO, 2009).

Composition of resting eggs from zooplankton organisms

The resting egg bank presented 20 taxa in the different environments, 12 cladocerans and 8 of rotifers, with prominence of the family Sididae (4 taxa) among the first group, and the family Brachionidae (6 taxa), for the second group (Table 1).

Table 1. Faunistic survey of zooplankton species present in the passive zooplankton community and the time to hatchling in the different environments of the upper Paraná river floodplain (PA = Patos lake, GA = Garças lake, FE = Fechada lake, VE = Ventura lake, OS = Osmar lake), in the period from May through November 2008. There were no hatchlings (x) in the backwater and Guaraná lake (connected lake).

	Connected Lakes		Isolated Lakes			Time to hatchling (days)
	PA	GA	FE	VE	OS	
		Rotifers				
Total of resting eggs of rotifers	1	3	23	12	13	
	4			48		
Asplanchnidae						
Asplanchna sieboldi Leydig, 1854			x			5
Brachionidae						
Brachionus calyciflorus Pallas, 1766			x	x		3 - 6
B. caudatus Barrois and Daday, 1894			x			5
B. quadridentatus Hermann, 1783					x	4
B. dolabratus Harring, 1915		x	x	x		3 - 6
B. falcatus Zacharias, 1898		x	x	x	x	2 - 6
Synchaetidae						
Synchaeta pectinata Ehrenberg 1832					x	4
Polyarthra vulgaris Carlin, 1943					x	4
		Cladocerans				
Total of ephippial	6	28	1	7	28	
	34			36		
Bosminidae						
Bosminopsis deitersi Richard, 1895	x					4
Chydoridae						
Alona poppei Richard, 1897		x				22
Ephemeroporus tridentatus (Bergamin, 1932)				x		5 - 37
Chydorus sp.	x					4
Macrothricidae						
Grimaldina brazzai Richard, 1892		x				44
Daphniidae						
Daphnia gessneri Herbst, 1967					x	3 - 27
Ceriodaphnia sp.			x			6
Moinidae						
Moina minuta Hansen, 1899					x	3
Sididae						
Diaphanosoma fluviatile Hansen, 1899		x				6
D. spinulosum Herbst, 1975		x				3 - 6
Diaphanosoma sp.					x	21
Sarsilatona sp.					x	27

Structure of resting eggs from zooplankton organisms

We registered 378 resting eggs in the sediment samples, of which 122 hatched (32.27%), among them, 70 were cladocerans (57.37%) and 52 rotifers (42.63%). Most of these eggs were recorded in the sediment of isolated lakes (169 eggs, 44.70%), mainly at Osmar lake (63 eggs, 37.27%). In connected lakes, we verified 154 eggs (40.4%), whereas in the backwaters we found 55 eggs (14.55%) (Figure 2).

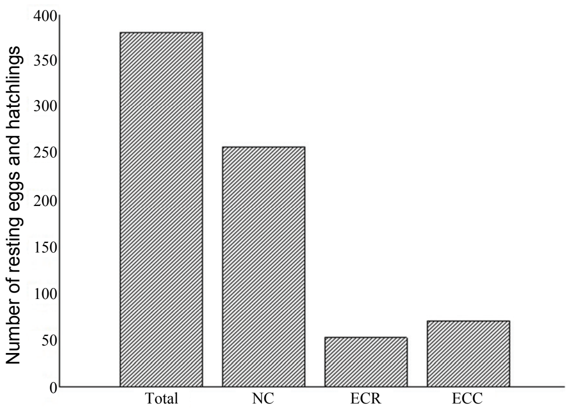

Figure 2. Number of resting eggs of zooplankton organisms and hatchlings, from May to November 2008 (TOTAL = total of resting eggs of zooplankton organisms, NC = number of eggs that not hatched, ECR = number of hatchlings of rotifers, and ECC = number of hatchlings of cladocerans).

Higher number of individuals had hatched from the eggs gathered at isolated lakes (84 individuals, 68.85%), 48 of rotifers (57.15%) and 36 cladocerans (42.85%). Among this type of environment, a greater number of hatchlings were observed for Osmar lake (41 individuals, 48.80%). In the samples of connected lakes, 38 individuals (31.15%), 4 rotifers (10.52%) and 34 cladocerans (89.48%) (Table 1).

The time to hatchling of individuals from different species varied among the environments (Table 1). Individuals from the species *Grimaldina brazzai* presented the longest time, 44 days (one individual), from the eggs bank of Garças lake, in September. On the other hand, individuals of *Brachionus dolabratus* and *B. falcatus* presented the shortest time for hatchling, both with 2 days, from the eggs poll of the same lake, in May (Table 1).

Dynamic of zooplanktonic resting eggs

In the ebb period, we found a lower number of resting eggs (76 eggs) and hatchlings (3 hatchlings). On the other hand, a higher number of resting eggs was verified in the dry period (208 eggs) and, therefore a greater number of hatchlings (101 hatchlings), mainly of cladocerans (49 individuals) (Figure 3).

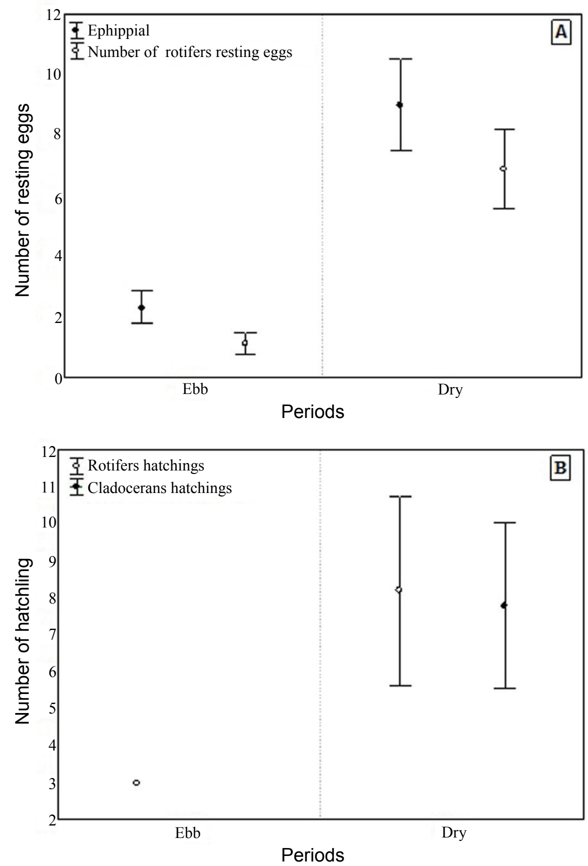

Figure 3. Temporal variation in the number of resting eggs of zooplankton organisms found (A) and in the number of hatchlings from these eggs (B), in the period from May to November 2008. (symbol = mean of the sampling months and bar = standard error).

Discussion

The lower representativeness of rotifer resting eggs in the sediment of the lakes (156 resting eggs, 41.26%), when compared to cladocerans (222 resting eggs, 58.74%), is related to the greater resistance of this group to adverse environmental conditions. These results could be related to the opportunistic characteristics of rotifers, which allow their colonization in the most unstable environments (ALLAN, 1976), and this trait is often stressed in environments from floodplains (LANSAC-TÔHA et al., 2009; PAGGI; PAGGI, 2007). Moreover the resting eggs production has higher energetic cost than the parthenogenesis. In this way, rotifers, in general, produce just one egg (SANTANGELO, 2009).

The greater number of resting eggs in isolated lakes was related to the absence of connectivity with the river and the longer residence time (hydrodynamic instability) in this type of environment, which do not allow the constant renewal of water masses, and therefore representing a stress for the community in function of the degradation of optimal environmental conditions for the survival of active individuals (PALAZZO et al., 2008b). According to Simões (personal communication), these types of environments are more unstable than connected lakes, since they present a wide environmental variability, and changes in the environmental conditions could be surpass the limit of tolerance of some species. These relationships between zooplankton and environmental conditions in floodplain environments have also been pointed by Palazzo et al. (2008a) and Santangelo (2009).

In contrast, other studies showed that the hydrodynamic of connected lakes, indicated by the constant exchange of water with the river, does not favor the great production of zooplankton dormancy forms (PALAZZO et al., 2008b).

Regarding the time for hatchling, the longer time observed for one cladoceran species and the shorter, for two rotifer species, is certainly related to the life cycle of these organisms, since, according to Esteves (1998) the life cycle of microcrustaceans is quite longer than that of rotifers, which may last only one day. Palazzo et al. (2008b), in experiments performed with resting eggs sampled in one of the studied lakes, also observed that the cladoceran species did not hatch out all at once, however the time for hatchling did not ranged much, when compared with our study. (8 – 12 days). Individuals of *Ephemeropterus tridentatus*, for example, lasted from 5 to 37 days to hatch out, from resting eggs present in the sediment from one same lake. Palazzo et al. (2008b) also showed that species exhibited 8 days to hatch out.

In relation to the lake where we sampled the resting eggs that presented the longer and the shorter time for hatchling (Garças lake), long term studies undertaken in this environment evidenced that the zooplankton was strongly influenced by environmental conditions, especially in function of environmental productivity (SIMÕES et al., 2009).

Analyzing the studied time scale, during the ebb period we found a lower number of resting eggs, and also lower hatchlings, whereas in the dry period we recorded a high number of resting forms and hatchlings. As above discussed, the dry period represent a strong stress for zooplankton organisms, since almost there is no exchange of nutrients, reduced primary production and colonized area, which could increase the competition for food and space.

The resting eggs sampled in September were those that presented a higher rate of hatchling, which is certainly related to the lower values of water temperature, dissolved oxygen, chlorophyll-a and pH, registered during the previous months in the different studied lakes. Thus, these environmental conditions may have induced the production of resting eggs. Studies developed by Palazzo et al. (2008b) showed a greater production of these resting stages in one of the studied lakes after a period with lower values of dissolved oxygen and lower phytoplankton production. The authors considered this latter as a stress factor for cladocerans, and concluded that a higher production of these eggs during this phase would guarantee the maintenance of populations of these microcrustaceans when the food resources were available again. Other studies also considered the food shortage as one of the main factor responsible for the diapause in these organisms (CRISPIM; WATANNABE, 2001; GILBERT, 1995; MAIA-BARBOSA et al., 2003).

Conclusion

The results support the predicted hypothesis, since, among the studied environments, the colonization process from resting eggs occurred more rapidly in the isolated lakes, during dry months.

Among the groups, cladoderans presented a higher production and hatchling of resting eggs, which are more sensitive to adverse environmental conditions, over time, nevertheless, rotifers tend to colonize the environments more quickly, presenting a shorter time for hatchling.

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Received on September 14, 2010.
Accepted on October 13, 2010.