Density and biomass of planktonic rotifers in different habitats in upper Paraná River (PR, Brazil).

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ABSTRACT: Density and biomass of planktonic rotifers in different habitats in upper Paraná River (PR, Brazil). The present study intends to analyze the influence of the water level variation and other abiotic and biotic factors on the densities and biomass of dominating rotifers in different environments of the upper Paraná River. Samples were collected in lakes (connected or not with the main channel), inter-bar lakes, and in the Paraná River during the flood (February) and dry periods (August) of the year 2000. Rotifer samples were collected at the surface of the pelagic region of each environment. The highest number of individuals and biomass occurred in the flood season at the isolated lakes. The PCA and correlation analyses showed that chlorophyll-a, DOC, total phosphorus and water transparency influenced the density and biomass variation of dominating rotifers. The obtained results can be explained by the unusual hydrologic cycle in the period. The prevalence of low hydrological levels would promote a partial disconnection of the studied environments. This fact could have lead to a major stability, favouring a development of the dominating plankton groups during the flood period, increasing the interactions between communities. At optimal rotifer development, chlorophyll-a (phytoplankton biomass) played a major role as a food resource. Lower densities and biomass values of the dominating rotifers during the dry season were probably caused by a combination of a decrease of available food sources and temperature, and an increase of predation pressure.
Key-words: rotifers, density, biomass, predation, chlorophyll-a.

RESUMO: Densidade e biomassa de rotíferos planctônicos em diferentes habitats do alto rio Paraná (PR, Brasil). O presente estudo se propõe a analisar a influência da variação do nível hidrométrico, e de outros fatores abióticos e bióticos sobre a densidade e biomassa das espécies de rotíferos mais abundantes presentes em diferentes ambientes do alto rio Paraná. Foram realizadas coletas em lagoas (com e sem comunicação), ressacos (lagoas de anexação) e no rio durante os períodos de cheia (fevereiro/2000) e de seca (agosto/2000). As amostragens dos rotíferos foram realizadas à sub-superfície da região pelágica de cada ambiente. A densidade e a biomassa dos rotíferos foram maiores no período de cheia nas lagoas sem comunicação. A ACP e as analises de correlação evidenciaram que a variação da densidade total e biomassa dos principais táxons de rotíferos foram influenciadas significativamente pela clorofila-a, COD, fósforo total e transparência. Os resultados encontrados neste estudo responderiam, em grande parte, ao atípico ciclo hidrológico durante o período descrito. O predomínio de níveis hidrológicos baixos teria promovido uma desconexão parcial dos ambientes em estudo, conduzindo a uma maior estabilidade nesses meios. Esta estabilidade promoveria o desenvolvimento dos principais grupos planctônicos durante a cheia, potencializando as interações entre essa e outras comunidades, favorecendo assim o estabelecimento dos rotíferos. No ótimo desse grupo, a clorofila–a (biomassa fitoplanctônica) teve um papel fundamental como item alimentar. Já na seca, os menores valores da densidade e da biomassa das principais espécies de rotíferos teriam tido como principais causas as baixas temperaturas, a queda da oferta de alimento e uma maior pressão de predação.
Palavras-chave: rotíferos, densidade, biomassa, predação, clorofila-a.

Introduction

Rotifers importance lies in three fundamental aspects: their short life cycle - or high turnover (Lansac-Tôha et al., 1997; Esteves, 1998); their intermediate position in aquatic food webs (Sanders & Wickham, 1993), and their domination in the zooplankton community during some periods of the year in many lakes and rivers (Sanders & Wickham, 1993; Esteves, 1998; Hansson et al., 1998).

It is important to collect information about availability of organic material in each trophic level, in order to understand the dynamics of the environment. Concerning rotifers, studies to understand the biomass dynamics have not been enough, especially in floodplain environments. Melão (1997), in an oligotrophic reservoir (Dourada Lake, SP, Brazil), observed that rotifers, although numerically dominant in the plankton community, were the least representative in biomass. A similar situation was verified by Matsumura-Tundisi et al. (1989) in Lobo Reservoir (São Paulo, Brazil): although there was a numerical prevalence of rotifers during the whole year, they represented only 5% of total zooplankton biomass. Okano (1994) observed rotifers biomass prevalence (61,13%) over total zooplankton in the reservoir of Monjolinho (Southeast of Brazil).

Studies in upper Paraná River floodplain have been trying to show differences in richness and abundance of the rotifer community regarding the spatial heterogeneity of that ecosystem, as well as to verify the influence of limnological variables on the structure and dynamics of those organisms (Lansac-Tôha et al., 1997; Serafim, 1997; Bonecker et al., 2002). The only research which focus the role of rotifers in the zooplankton production in upper Paraná River floodplain was developed by Rossa (2001). In a general way, those studies previously mentioned revealed that the highest densities and biomass values of rotifers always occurred in lentic environments during low water periods.

The upper Paraná River is composed by floodplain lakes and inter-bar lakes, among other environments. The floodplain lakes are divided into connected and isolated lakes when concerning their links to the main river, while the inter-bar lakes (lentic environment formed by the union between bars and bed islands obstructing the intermediate channel, according to Drago, 1973) present permanent communication with the channel (Thomaz et al., 1997).

Considering the data observed in upper Paraná River floodplain, this study intends to corroborate the validity of the following hypothesis: rotifer densities and biomass are higher at the isolated lakes during the dry season.

Studied sites

This study was undertaken in the area delimited by coordinates 22°40' - 22°50'S and 53°10' - 53°30'W, next to Porto Rico City, Paraná State, 1560 km far from the origin of the Paraná River (Fig. 1).

The system presents an outstanding temporal change in physical, chemical and biotic factors when associated to alterations in the water levels as a consequence of flood and dry seasons (Neiff, 1990). According to Agostinho & Zalewski (1996), despite the numerous dams located above the studied area, the variability of water levels would maintain the season patterns, with a 5 m average range. Even so, as it was observed in the last years, that situation has been reverting once it was observed a smaller variation of those levels, between high and low water seasons.

The collection sites were two isolated lakes (Genipapo and Osmar), two connected lakes (Garças and Pombas) and two inter-bar lakes (Bilé and Manezinho), as well as the upper Paraná River itself (one sampling station) (Fig. 1).

Material and methods

The samples were collected at the water surface, in the pelagic area of each environment, in high (February/2000) and low (August/2000) water level periods. For

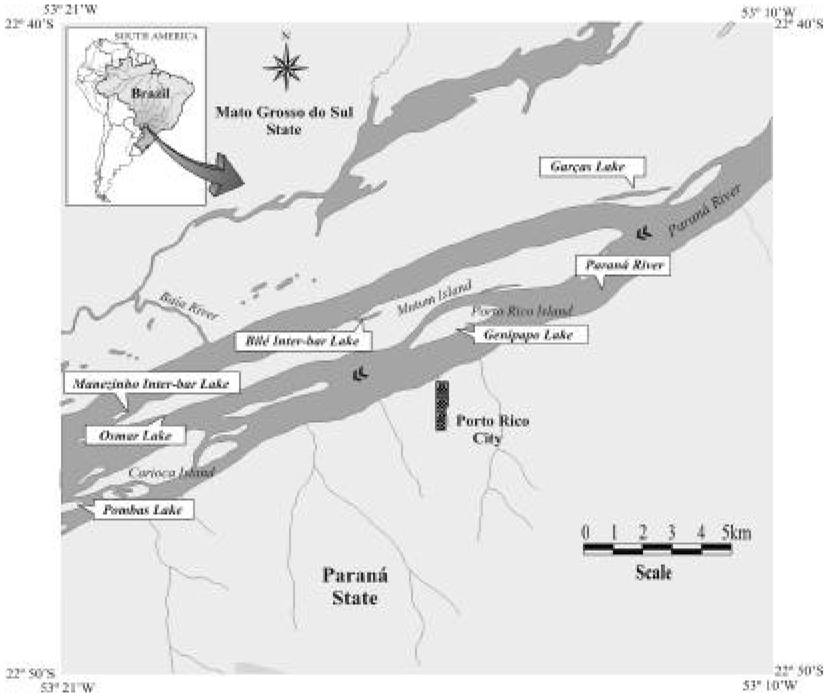

Figure 1: Sampling sites.

rotifers sampling, a motorized pump and a 70 mm mesh net were used filtering 600 l of water by sample. The collected material was fixed on a 4% formaldehyde solution.

The limnological variables analyzed were temperature (°C); dissolved oxygen (mg l^{-1}); dissolved organic carbon (DOC) (mg l^{-1}); total suspended material (TSM) (mg l^{-1}); water transparency (m); depth (m); water level (cm); pH; electrical conductivity (mS cm^{-1}); total alkalinity (mEq l^{-1}); turbidity (NTU); total nitrogen (mg l^{-1}); total phosphorus (mg l^{-1}) and chlorophyll – a (mg l^{-1}). The methods used in the fieldwork and in the laboratory are described elsewhere (Thomaz et al., 1992a; 1992b). Hydrometric levels of the Paraná River were measured around the city of Porto São José (Paraná State).

The abundance analysis was determined by using an optical microscope, following Bottrell et al. (1976) methodology that states 3 sub-samples for each sample, in which, at least 80 individuals were counted. The results were expressed in individuals by cubic meter (ind m^{-3}).

Species identification was based on basic bibliography (Koste, 1972, 1978; Koste & Robertson, 1983). The rotifer species chosen to estimate the biomass were those whose densities represented more than 65% of the total sample density.

The biomass of the most abundant species (dry weight) was estimated from wet weight (WW) and biovolume. Biovolume was estimated from geometric formulas, as suggested by Ruttner-Kolisko (1977); 30 individuals of each specie were measured. Those values were transformed into WW: 10^6 mm^3 is equal to 1 mg of WW (Bottrell et al., 1976). Dry weight (DW) was estimated as 10% of WW (Pace & Orcutt, 1981).

The Principal Components Analysis (PCA) was used to reduce the dimensionality of the abiotic data, previously log transformed (log10 (y+1)), excepting the pH (Pla, 1986).

The environment type influence (isolated or connected lake, inter-bar lake and river) and period (low or high water) on the density and biomass of dominant rotifers were evaluated using a factorial ANOVA. Considering the presuppositions of the applied ANOVA, the data were previously log transformed (log10 (y+1)).

In order to identify what variable (a/biotic) could influence the density and biomass variance of dominant rotifers, a Pearson's correlation analysis was used (Sokal & Rohlf, 1981). For this, we have taken the significant axes of PCA, according to the random method of the broken-stick model, as well as the abiotic variables with higher coefficient of structure of the first PCA axis, and chlorophyll-a concentrations. Taking into account the presuppositions of Pearson's correlation, the data were previously log transformed (log10 (y+1)). When such expectations were not accomplished, a non-parametric correlation was applied (Spearman).

Two statistical softwares were used: PC-ORD, version 2.0 (McCune & Mefford, 1995) and STATISTICA, version 5.5 (Statsoft Inc., 1997).

Results

Environment characterization

The difference between dry and flood periods could not be clearly observed at Paraná River in 2000. In spite of the summery season being characterized as a period of high waters, the means of the hydrological levels of Paraná River in February was of 3.06 m, situation that leaded to the total or partial disconnection of lentic environments in study (Tab. I) (Thomaz et al., 2001, 2002).

Table I: Values of abiotic variables registered in the different habitats studied during flood (February 2000) and dry season (August 2000) (Paraná River-PARR; Garças Lake-GARL; Pombas Lake-POML; Genipapo Lake-GENL; Osmar Lake-OSML; Manezinho inter-bar Lake-MAIL; Bilé inter-bar Lake-BIIL).

VARIABLES	FEBRUARY/2000							AUGUST/2000						
	Parr	Garl	Poml	Genl	Osml	Mail	Biil	Parr	Garl	Poml	Genl	Osml	Mail	Biil
Total Alkalinity (mEq l^{-1})	441	837	514	1,051	1,187	501	545	411	411	483	405	206	419	413
Chlorophyll-a ($\mu g\ l^{-1}$)	2.5	16.1	5.3	56	17.8	5.5	9.8	1.9	5.1	4.6	15.5	5.5	3.9	2.2
DOC ($\mu g\ l^{-1}$)	2.3	3.1	2.4	11.2	5.8	2.2	2.4	1.7	2.3	2.2	5.7	3.7	2.1	1.7
Electric. Conduct. ($\mu S\ cm^{-1}$)	53	49	60	71	75	58	51	61	61	70	52	36	60	55
Total Phosphorus ($\mu g\ l^{-1}$)	17	37	18	126	94	21	23	5	28	10	45	31	9	13
TSM (mg l^{-1})	2.6	10.1	3.4	28	13.8	3.2	9	1.1	7.8	3.1	8.3	27.2	2.6	3.5
Total Nitrogen ($\mu g\ l^{-1}$)	303	366	269	901	485	281	299	266	350	363	376	266	249	258
Dissolved oxygen (mg l^{-1})	9.7	7.8	7.8	5	2.7	7.7	7.4	10.1	8.4	5.9	5.5	5.6	7.8	7.9
pH	7.1	6.7	7.2	6.4	6.3	6.7	6.6	7.1	7	6.6	6.6	6.3	6.9	6.8
Water level (cm)	306	306	306	306	306	306	306	284	284	284	284	284	284	284
Depth (m)	4.5	2	2.3	1.1	1.5	2.4	1.5	5	1.4	1.1	0.9	1	2	1.1
Water temperature (°C)	27.2	28.8	30.9	27.6	29.3	29.4	28.4	19.7	21.1	19.9	21.7	21	20.4	20
Water transparency (m)	1.5	0.8	1.2	0.4	0.7	1.3	0.7	3.3	0.9	1.1	0.9	0.4	2	1.1
Water turbidity (NTU)	11.1	14	8.8	26.3	13.7	8.5	13.8	2.3	8.2	4.1	7.5	46.5	2.6	9.4

The first three axes of a PCA of abiotic variables accounted for 89.55% of the total variance (Tab. II). PC1 (% of total variance = 53.03%) was mainly affected by water transparency, total phosphorous, TSM and DOC (coefficient of structure = 0.35, -0.36, -0.35 and -0.34, respectively). PC2 (% of total variance = 21.99%) was affected mainly by water level, temperature, electrical conductivity and total alkalinity variables (0.38, 0.35, 0.46 and 0.46, respectively) while PC3 (% of total variance = 14.53%) was mainly affected by water level, temperature and electrical conductivity (-0.45, -0.46 and 0.43, respectively).

The environment and abiotic variables scores, obtained from the first two PCA axes, showed a separation of most of the studied sites in each hydrological period (Fig. 2).

Spatial and temporal density variance

88 rotifer species were identified. The most representative genera were Trichocerca (15 species), Lecane (9 species), Brachionus (9 species), Notommata (5 species) and Keratella (4 species).

In absolute terms, the largest number of individuals was registered in the isolated lakes during the period of high waters, mainly Genipapo Lake, with a maximum of 5,499,000 ind m^{-3}.

Table II: Percentage of explanation and eigenvalues of the first ten principal components (in bold the significant axes obtained from to the broken-stick model).

Components	Eigenvalues	% of explication	% of accumulated explication	Eigenvalues from the broken-stick model
1	**6.89**	**53.0**	**53.0**	**3.179**
2	**2.86**	**22.0**	**75.0**	**2.179**
3	**1.89**	**14.5**	**89.5**	**1.679**
4	0.53	4.1	93.6	1.347
5	0.34	2.6	96.2	1.097
6	0.18	1.4	97.7	0.897
7	0.14	1.1	98.7	0.730
8	0.07	0.5	99.3	0.587
9	0.05	0.4	99.6	0.462
10	0.04	0.3	99.9	0.351

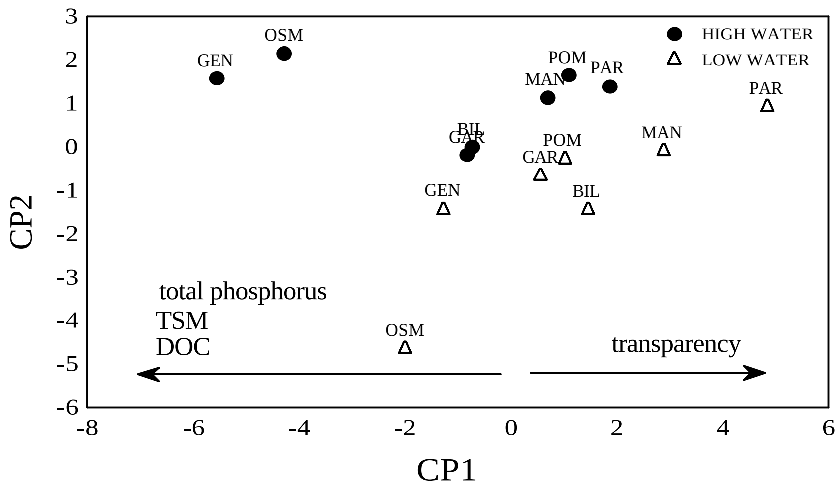

Figure 2: Dispersion of sampling sites and abiotic variables along two first PCA axes scores (75.02% explanation) (Paraná River-PAR; Garças Lake-GAR; Pombas Lake-POM; Genipapo lake-GEN; Osmar lake-OSM; Manezinho inter-bar Lake-MAN; Bilé inter-bar Lake-BIL).

During the low water period, the highest densities occurred at the connected lakes. In both circumstances, the smallest densities were always observed in the river (Fig. 3).

Brachionus mirus (1,988,167 ind m^{-3}), Filinia longiseta (1,692,000 ind m^{-3}) and Keratella americana (10,667 ind m^{-3}) showed high values of density in the high water season in isolated lakes (Genipapo and Osmar). In the dry season, K. tropica (17,833 ind m^{-3}), K. lenzi (3,694 ind m^{-3}) and K. cochlearis (2,361 ind m^{-3}) showed important densities.

Filinia opoliensis (248,500 ind m^{-3}), Lecane proiecta (179,667 ind m^{-3}) and Plationus macracanthus (1,333 ind m^{-3}) presented higher densities in the high water season in connected lakes (Garças and Pombas), and Keratella cochlearis (47,667 ind m^{-3}), Brachionus calyciflorus (45,667 ind m^{-3}) and Gastropus hyptopus (5,167 ind m^{-3}), in dry season.

Synchaeta stylata (11,500 ind m^{-3}), Polyarthra dolichoptera (8,667 ind m^{-3}) and Plationus macracanthus (1,388 ind m^{-3}) showed high density values during the high water season in inter-bar lakes (Bilé and Manezinho). In the dry season, Gastropus hyptopus (3,800 ind m^{-3}) and Polyarthra vulgaris (2,786 ind m^{-3}) showed important values.

Lecane proiecta (236 ind m^{-3}) and Filinia opoliensis (187 ind m^{-3}) presented high density values in the high water season in Paraná River, and Polyarthra dolichoptera (3,770 ind m^{-3}) and Synchaeta oblonga (708 ind m^{-3}), in the dry season.

A significant relationship was not observed through the results of factorial ANOVA between densities and the environment type, besides the hydrological period ($F = 1.675$, $p > 0.05$, $n = 14$ and $F = 0.494$, $p > 0.05$, $n = 14$ respectively).

The densities of the studied sites presented high correlation with the first PCA axis ($r = -0.701$, $p < 0.05$, $n = 14$) (Fig. 4). The correlations observed for axes two and three were not significant ($r = 0.147$, $p > 0.05$, $n = 14$ and $r = 0.135$, $p > 0.05$, $n = 14$, respectively). When DOC, TSM, total phosphorus and water transparency were considered, the correlation analyses were significant ($R = 0.648$, $p < 0.05$, $n = 14$; $r = 0.684$, $p < 0.05$, $n = 14$; $r = 0.743$, $p < 0.05$, $n = 14$; $R = -0.778$, $p < 0.05$, $n = 14$ respectively). In the same way, the correlation observed for chlorophyll-a concentrations was highly significant ($r = 0.821$, $p < 0.05$, $n = 14$) (Fig. 5).

Spatial and temporal biomass variance

As well as density results, higher biomass values were registered at isolated lakes during high water season, and at connected lakes, in dry season. In the high water period, Genipapo Lake stood out again, with a maximum of 66,972 mg DW m^{-3}. In both phases, the lowest biomass values were registered in the river (Fig. 3).

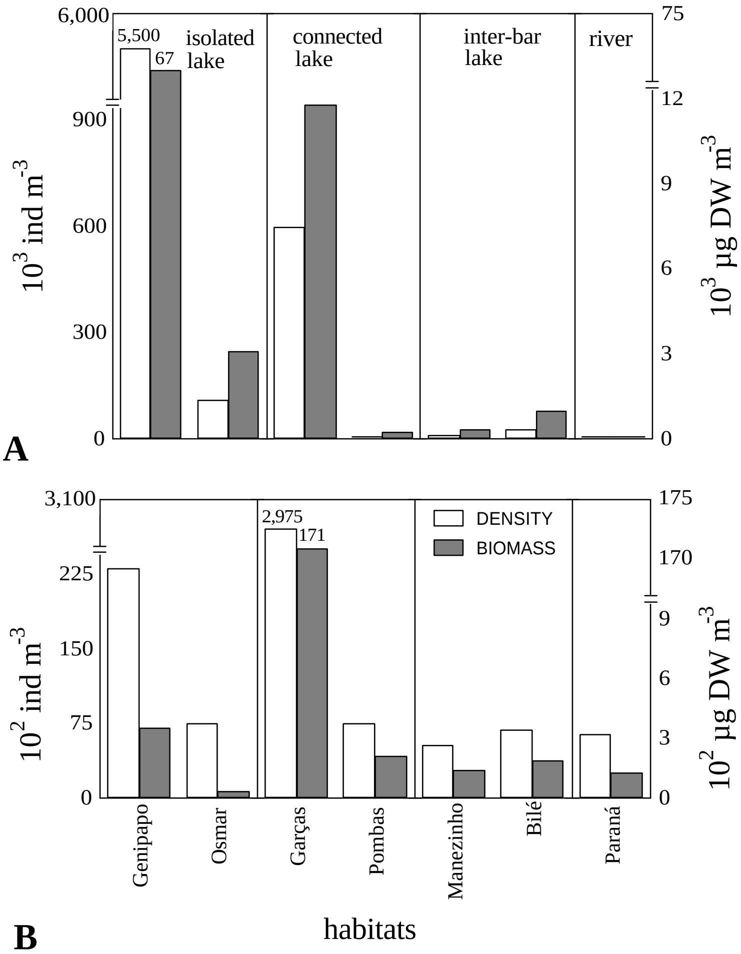

Figure 3: Rotifer densities (ind m^{-3}) and biomass (mg DW m^{-3}) registered in the different sites studied during flood (A) and dry (B) season.

Filinia longiseta (34,326 mg DW m^{-3}), *Brachionus mirus* (32,646 mg DW m^{-3}) and *Plationus macracanthus* (1,834 mg DW m^{-3}) showed high biomass values in the high water season in the isolated lakes (Genipapo and Osmar), and *Keratella tropica* (350 mg DW m^{-3}) in the dry one.

Lecane proiecta (7,359 mg DW m^{-3}) and *Filinia opoliensis* (4,396 mg DW m^{-3}) presented high biomass value in the high water season in connected lakes (Garças and Pombas). In dry season, *Brachionus calyciflorus* (16,948 mg DW m^{-3}) and *Gastropus hyptopus* (214 mg DW m^{-3}) were important.

Synchaeta stylata (511 mg DW m^{-3}), *Polyarthra dolichoptera* (442 mg DW m^{-3}) and *Plationus macracanthus* (188 mg DW m^{-3}) showed high biomass values during the high water season in inter-bar lakes (Bilé and Manezinho), and *Polyarthra vulgaris* (142 mg DW m^{-3}) and *Gastropus hyptopus* (137 mg DW m^{-3}) in dry season.

Lecane proiecta (9 mg DW m^{-3}) and *Trichocerca chattoni* (5 mg DW m^{-3}) showed high biomass values in the high water season in Paraná River, and *Polyarthra dolichoptera* (114 mg DW m^{-3}) in dry one.

A significant relationship was not observed through the results of factorial ANOVA upon biomass and the environment type, besides the hydrological period ($F = 1.522$, $p > 0.05$, $n = 14$ and $F = 0.912$, $p > 0.05$, $n = 14$ respectively).

The biomass of the studied sites presented high correlation with the first PCA axis ($r = -0.587$, $p < 0.05$, $n = 14$) (Fig. 4). The correlation observed for axes two and three were

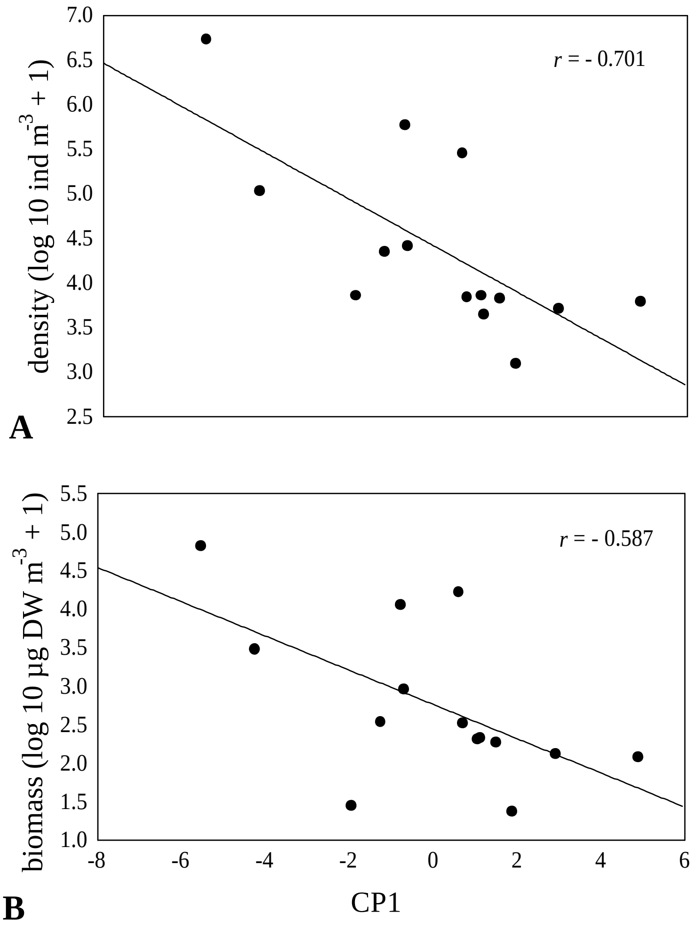

Figure 4: Relations between the first PCA axis and (A) rotifer densities (ind m^{-3}) ($r = -0.701$; $p < 0.05$; $n = 14$), and (B) rotifer biomass (mg DW m^{-3}) ($r = -0.587$; $p < 0.05$; $n = 14$) obtained in Pearson's correlation analysis.

not significant ($r = 0.311$, $p > 0.05$, $n = 14$; $r = 0.149$, $p > 0.05$, $n = 14$ respectively). When DOC, total phosphorus and water transparency were considered, the correlation analyses were significant ($R = 0.587$; $p < 0.05$; $n = 14$; $r = 0.656$; $p < 0.05$; $n = 14$; $R = -0.570$; $p < 0.05$; $n = 14$ respectively). The correlation observed for TSM was not significant ($r = 0.516$; $p > 0.05$; $n = 14$). On the other hand, when chlorophyll-a concentrations were considered, the correlation obtained was highly significant ($r = 0.744$; $p < 0.05$; $n = 14$) (Fig. 5).

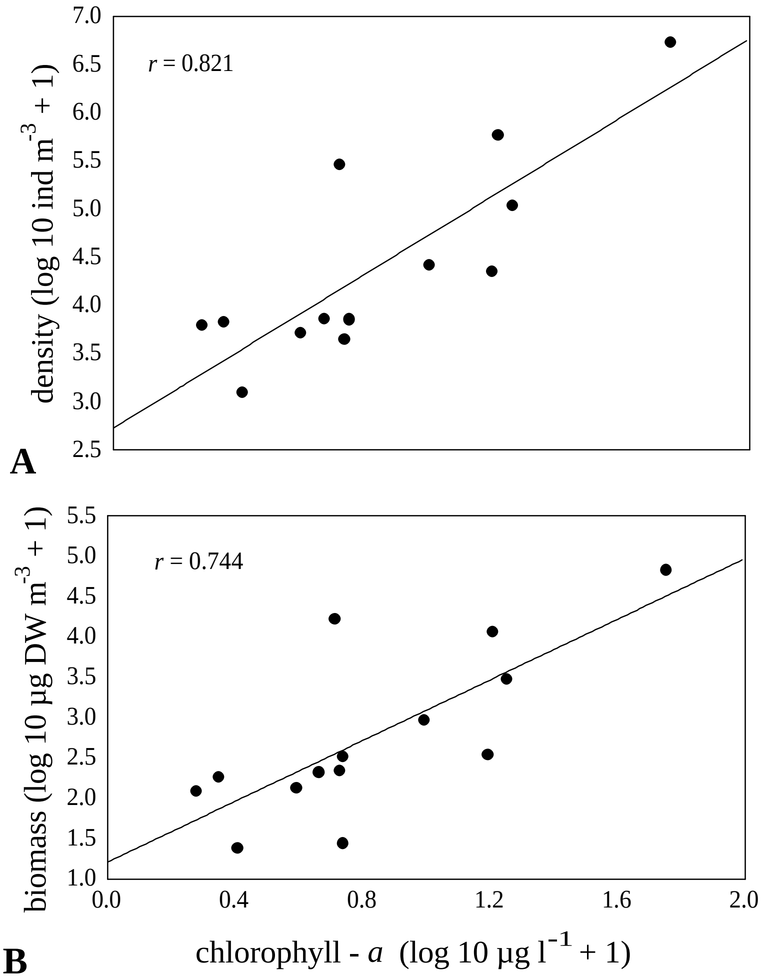

Figure 5: Relations between chlorophyll-a concentrations (mg l^{-1}) and (A) rotifer densities (ind m^{-3}) ($r = 0.821$; $p < 0.05$; $n = 14$), and (B) rotifer biomass (mg DW m^{-3}) ($r = 0.744$; $p < 0.05$; $n = 14$) obtained in Pearson's correlation analysis.

Discussion

The trend toward highest density and biomass values of planktonic rotifers registered in the isolated lakes during high water period would be a direct consequence of the unusual hydrological levels that have occurred during that period. In this way, facing the absence of flood pulses, isolated lakes present stable and favorable abiotic conditions to the development of the planktonic community (Lansac-Tôha et al., 2001; Train et al., 2001), notably the phytoplankton, a fundamental source of food for great part of planktonic rotifers (Pourriot, 1977).

A comparison between some accomplished studies, both in this and in other floodplain ecosystems, opposed considerably the obtained results. For instance, Serafim (1997), Rossa (2001) and Bonecker et al., (2002), observed at the low water period higher rotifer abundance in different lentic environment in the studied floodplain. Higher rotifer densities during the dry season period were reported in Amazon floodplain lakes by Hardy (1980), Hardy et al., (1984), as well as Bozelli (1994), and in a Venezuelan floodplain lake by Medina & Vásquez (1988).

The lowest rotifer densities and biomass values found in connected and inter-bar lakes were probably due to the reduced retention time of water in those environments, promoting outside dragging of organisms by constant water flow (Lansac-Tôha et al., 2001; Rossa, 2001). In the same way, the reduced number of organisms at the lotic environment (river) would be mainly a product of the higher water flow influencing the time of organisms permanence, and obviously, on reproduction in situ (Paggi & José de Paggi, 1974; Lansac-Tôha et al., 1997, 2001).

According to Melão (1997), the interaction between planktonic community and abiotic environment, as well as other living beings that compose lacustrine ecosystems would determine the population density and the spatial and temporal structure for that community. Consequently, it is highly probable that the highest density and biomass values of the dominant rotifer observed in this study could be also associated, as showed by the PCA and correlation analyses, to high values of chlorophyll – a, DOC, total phosphorus, and water transparency, presented both in isolated and connected lakes in both hydrological periods.

Another factor that would allow a better understanding of the success of rotifer during high hydrometric periods is related to the fact that feeding would be favored by the reduced size (‹20 mm) (Rodrigues, 1998; Train et al., 2001) of the phytoplankton species in that period.

Nevertheless, many of the herbivore rotifers, as well as other genera classified as microphagous by Pourriot (1977), would have a close relationship with detritus and bacteria associated to them (Ooms-Wilms, 1997). This would also contribute to explain higher population densities of rotifers found in the summer, when there is an increase of suspension matter, involving nutrient and detritus in different stages of decomposition which should also lead to an increase of the microbial populations (Lansac-Tôha et al., 1997; Melão, 1997; Thomaz et al., 1997).

Another factor explaining the success reached by rotifers in isolated lakes in high water phase is that those organisms are exposed to a lower predation pressure by other planktonic invertebrates. Studies in upper Paraná River floodplain suggest the existence of tenuous spatial and temporal isolations among rotifer and crustacean zooplankton that would avoid a better interaction between both zooplanktonic groups. For instance, Lansac-Tôha et al. (1997) observed the largest crustacean densities in high water period, except for cladocerans in the lentic environments, and Serafim (1997) found that both cladocerans and copepods reached the largest density in the end of the low water phase in an isolated lake.

It is also possible that the largest absolute values, both of density and biomass observed during the high water period, at both isolated and connected lakes, could be explained based on the same predation context. According to Twombly & Lewis (1987), it is frequent the entrance of fish larvae in floodplain lakes in high water phase, contributing to a general decline of zooplankton. Consequently, the low water levels of the summer could have acted as effective barriers to the entrance of larvae and young stage of fish in those isolated floodplain environments, favoring, in that way, the development of both rotifers and other zooplankton organisms. The presence of diaptomids and daphnids in the same time (Lansac-Tôha et al., 2001) tends to reinforce that supposition, since those organisms would be indicating, indirectly, that predation pressure by young fish stage on zooplankton was not significant (Dumont, 1986 apud Frutos, 1996).

The lower rotifer densities and biomass values verified in dry period may be related not only to the low temperatures registered at the end of the winter, but also to the conjunction of two biotic factors: lower food offer (phytoplankton and bacterioplankton) and higher predation pressure by crustacean zooplankton, fish and other possible predators.

It could seem contradictory the mention of food shortage for planktonic rotifers in a period that higher phytoplankton density and biomass values are usually registered (dry season). Unlike the high water period, species tending to prevail in low water phase correspond, usually, to forms of great dimensions (›40 mm) (Rodrigues, 1998), difficult to ingest by most rotifers.

Besides the lower phytoplankton biomass availability, the transparency levels tend to increase in low water period or, in other words, the turbidity values tend to decrease. Consequently, the decrease in the turbidity values would also include, indirectly, a decrease in detritus and bacteria offer in that hydrologic phase.

As mentioned before, highest densities of cladocerans and copepods are found in dry period, especially in lentic environments (Lansac-Tôha et al., 1997; Serafim, 1997).

Another important predator can appear in that period improved by a concentration effect, as Chaoborus larvae, effective consumers of zooplankton (Twombly & Lewis, 1987; Frutos, 1996).

In synthesis, rotifer density and biomass values would be regulated, always in the context of the low water levels, for the unequal action of top-down and bottom-up forces in each period. Therefore, in high water season, rotifers were favored by a high food availability (nanophytoplankton and microbial populations associated to detritus), and on the other hand, by a low predatory pressure, both of crustacean zooplankton and larvae and young stage of fish, particularly in the isolated and connected lakes. Unlike the high water season, in the period of low waters, besides the low temperatures, the sum of phytoplankton of great dimensions and the smallest turbidity values, as well as of the appearance of important crustacean zooplankton densities, and other predators, would have influenced negatively the rotifers community in different environments, reflected by lower densities and biomass values.

Finally, based on these discussed results, the work hypothesis is rejected. The highest density and biomass values were registered both at the isolated lakes and at the connected ones during flood period, not in dry season.

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