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Spatial variations in the zooplankton community from the Corumbá Reservoir, Goiás State, in distinct hydrological periods

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ABSTRACT. This study evaluated the spatial variations in species richness and abundance of zooplankton over a hydrological cycle, and also verified the influence of physical and chemical water variables and chlorophyll-*a* concentrations on the abundance of these organisms. The tested hypothesis was that the zooplankton community presents higher species richness in lotic environments and higher abundance in lentic ones. One hundred forty species were identified, distributed among rotifers (88), testate amoebae (35), cladocerans (13) and copepods (4). Higher values of species richness and abundance were observed during the dry period. During both hydrological periods, the copepods presented high abundance values, due to the contribution of young stages, followed by rotifers, cladocerans and testate amoebae. In general, testate amoebae presented high values of species richness and abundance in lotic sampling stations, whereas the other zooplankton groups (rotifers, cladocerans and copepods) presented higher abundances in lentic environments and higher species richness in lotic ones. The Pearson correlation analysis evidenced the importance of physical and chemical water variables and food resource availability influencing the variation of organisms' abundance.

Key words: zooplankton, tropical reservoir, spatial variation, dry and rainy periods.

RESUMO. Variações espaciais da comunidade zooplanctônica no reservatório de Corumbá (Estado de Goiás), em distintos períodos hidrológicos. O objetivo deste estudo foi avaliar as variações espaciais da riqueza e abundância do zooplâncton ao longo de um ciclo hidrológico, bem como verificar a influência das variáveis físicas e químicas da água e concentrações de clorofila-*a* sobre a abundância desses organismos. Pressupõe-se que a comunidade zooplanctônica apresente maior riqueza de espécies em ambientes lóticos e maior abundância em ambientes lênticos. Foram identificadas 140 espécies, sendo 88 de rotíferos, 35 de amebas testáceas, 13 de cladóceros e quatro de copépodes. Os maiores valores de riqueza e abundância foram verificados no período de estiagem. Em ambos os períodos hidrológicos, os copépodes apresentaram maiores valores de abundância, pela contribuição de formas jovens, seguidos pelos rotíferos, cladóceros e amebas testáceas. Em geral, as amebas testáceas apresentaram maior riqueza e abundância nas estações lóticas do reservatório. Os demais grupos zooplanctônicos (rotíferos, cladóceros e copépodes) foram mais abundantes nos ambientes lênticos e apresentaram maior número de espécies em ambientes lóticos. A correlação de Pearson evidenciou a importância das variáveis físicas e químicas da água e da disponibilidade de alimento sobre a variação da abundância dos organismos.

Palavras-chave: zooplâncton, reservatório tropical, variação espacial, estiagem, chuvoso.

Introduction

Currently, reservoirs are inseparable components from Brazilian landscape, present in all major river basins. Result of the choice made by the country to generate electricity, these engineering works have proliferated in a growing way and play an important role in national energy matrix (AGOSTINHO et al., 2007).

The zooplankton community is one of the aquatic communities favored by reservoir formation, mainly due to the reduction in current flow. According to Marzolf (1990), more lentic environments, as reservoirs, are suitable for the development of large planktonic populations, in view of their growth rate is commonly high in these environments. The favorable development of these organisms in reservoir was pointed out by Rocha et al. (1999), which still argued that this community may establish diversified assemblages in relatively short time periods after the damming.

In most aquatic environments, zooplankton community plays substantial role in energy transfer, nutrients regeneration and transfer, moreover, the structure of this community is result of biotical processes, as colonization and species selection (ARMENGOL, 1980), and abiotical processes, as changes in the physical and chemical water variables. In this way, the present study evaluated the spatial variations in the structure of zooplankton community from the Corumbá Reservoir, Goiás State, over a hydrological cycle, besides investigated the influence of physical and chemical water variables on their abundance distribution. In general, we predict that the zooplankton community presents higher species richness in lotic environments and higher abundance in lentic ones.

Material and Methods

Study area

Corumbá River is one of the tributaries from Paranaíba River, located in Goiás State (15°79'S and 48°31'W) (Figure 1).

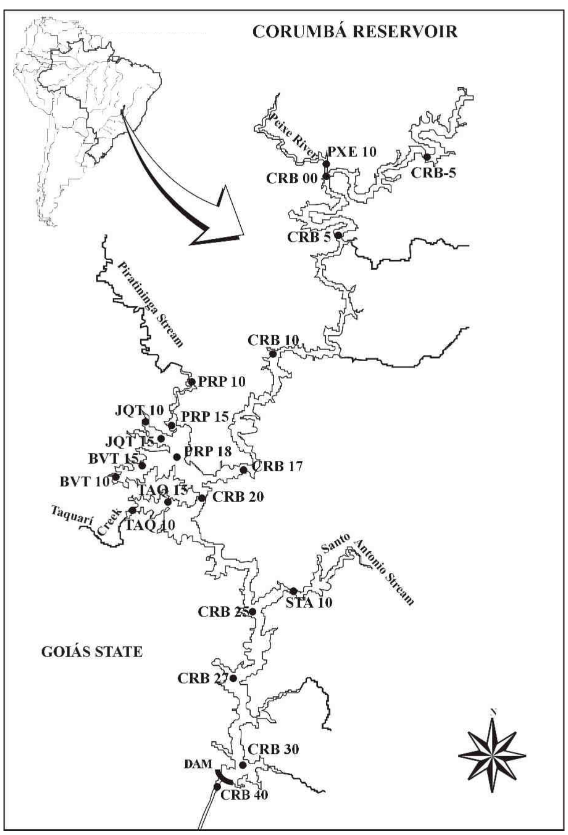

Figure 1. Study area with the location of sampling stations.

Its watershed has 27,800 km^2 of area, and its main tributaries are the Peixe and Pirapetinga rivers. The reservoir, dammed in 1996, presents 65 km^2 of flooded area, 1,500 x 10^6 m^3 of total volume, mean depth of 23 m and mean residence time of 30 days (BONECKER et al., 2001).

Sampling and laboratory analysis

To accomplish this study, 21 sampling stations were established: two in Corumbá River (CRB–5, CRB 40), eight in the main channel (fluvial: CRB00, CRB05; transition: CRB10, CRB17, CRB20; lacustrine: CRB25, CRB27, CRB30), two in tributaries (PXE10, PRP10) and nine in lateral arms (TAQ10, BVT10, STA10, JQT10, PRP15, PRP18, JQT15, TAQ15, BVT15) (Figure 1).

Samplings were carried out at subsurface from pelagic region, in March (rainy) and September (dry) of 1998, using motorized pump (1,000 L per sample) and plankton net (68 μm). The samples were preserved in solution of formaldehyde 4%, buffered with calcium carbonate.

The species composition analysis was performed using glass slides, optical microscope and specialized literature.

Zooplankton abundance was estimated from the integral counting of the samples, in Sedgewick-Rafter counting cells. The samples with large abundances, subsamples were made using Hensen-Stempell (2.5 mL) pipette, and, at least, 200 individuals from each group was counted. The abundance was expressed in individuals per cubic meter (ind. m^{-3}).

Concomitantly to zooplankton samplings, some physical and chemical variables of the water were measured, as water temperature (°C), dissolved oxygen (mg L^{-1}) (YSI Model 55-12FT), electric conductivity (μS cm^{-1}) (Digimed conductivimeter), pH (Digimed), turbidity (NTU) (portable digital turbidimeter) and total alkalinity (mEq L^{-1}) (CARMOUZE, 1994). The concentrations of chlorophyll-*a* were quantified through 90% acetone-extraction and spectrophotometer reading at 663 nm, applying the correction for other dissolved compounds and turbidity (GOLTERMAN et al., 1978). The total dissolved nitrogen (TDN) (μg L^{-1}) and total dissolved phosphorus (TPN) (μg L^{-1}) were determined from cooled samples, using the methods described by Koroleff (1976) and Mackereth et al. (1978), respectively.

Data analysis

In order to characterize the study area and reduce the dimensionality of data obtained with the physical and chemical water variables, an Principal Component Analysis was employed, using a matrix of log data (log x + 1), except the pH. To select the significant axes, we used the Broken-Stick criteria, proposed by Jackson (1993). This analysis was made using PC-ORD version 4.01 (McCUNE; MEFFORD, 1999).

To evaluate the significance ($p < 0.05$) of spatial and temporal variations in species richness and abundance of zooplankton, we applied a Kruskal-Wallis Anova. The influence of physical and chemical variables and chlorophyll-*a* concentration on the zooplankton abundance was evaluated through a Pearson Correlation Analysis. These analyses was made using Statistica version 7.1 (STATSOFT INC., 2005).

Results and discussion

Limnological Variation

The Principal Component Analysis (PCA) explained 66.92% of total data variability. The axis 1 represented 44.05% of this variation and was negatively influenced by pH (-0.46), electric conductivity (-0.46) and total alkalinity (-0.43); and positively, by turbidity (0.38) and total dissolved nitrogen (0.32). On the other hand, the axis 2 explained 22.87% of data variability, and it was directly related to total dissolved phosphorus (0.48) and total dissolved nitrogen (0.35), and negatively with water temperature (-0.61) and dissolved oxygen (-0.31) (Figure 2a).

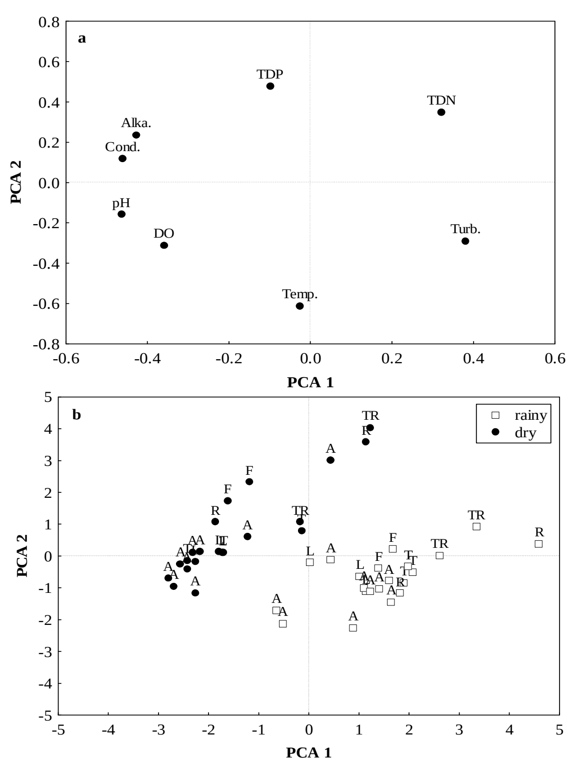

Figure 2. Dispersion of scores from Principal Component Analysis (PCA) of the physical and chemical water variables (a) and the different sampling stations and periods (b) in Corumbá Reservoir, Goiás State. (Turb. = turbidity; Alka. = alkalinity; Cond. = conductivity; Temp. = water temperature; DO = dissolved oxygen; TDN = total dissolved nitrogen; TDP = total dissolved phosphorus) (F= fluvial; T= transition; L= lacustrine; R=river; TR= tributary; A= lateral arm).

The scores of different sampling stations and hydrological periods, obtained from the first two PCA axes, evidenced higher distinction in a temporal scale than in spatial one (Figure 2b). The rainy period was related with lower values of pH, electric conductivity, total alkalinity, considering the axis 1; and higher values of water temperature and dissolved oxygen and lower values of total dissolved phosphorus, according to the axis 2. The dry period presented limnological characteristics distinct from previously described (Figure 2b).

Zooplankton species richness

In this study, we recorded 140 species, and the rotifers compounded the most species-rich group (88 species), followed by testate amoebae (35), cladocerans (13) and copepods (four). The families Brachionidae (17), Trichocercidae (15) and Lecanidae (14) presented the highest number of species among the rotifers, the families Difflugiidae, Arcellidae and Centropyxidae (12, ten and four species, respectively), amongst the testate amoebae. Considering the cladocerans, the family with most importance for species composition was Chydoridae (four species). The copepods were represented by the families Cyclopidae (three species) and Diaptomidae (one species) (Table 1).

Table 1. Faunistic survey of zooplankton community registered in Corumbá Reservoir, Goiás State, Brazil.

Testate amoebae	
Arcellidae	Diffllugiidae
Arcella conica (Playfair, 1917)	*Difflugia acuminata* (Ehremberg, 1838)
A. costata Ehrenberg, 1847	*D. curvicaulis* Pénard, 1899
A. dentata Ehrenberg, 1838	*D. corona* Wallich, 1864
A. discoides Ehrenberg, 1843	*D. echinulata* Pénard, 1911
A. gibbosa Pénard, 1890	*D. elegans* Pénard, 1890
A. hemisphaerica Perty, 1852	*D. globularis* (Wallich 1864)
A. megastoma Pénard, 1902	*D. gramen* Pénard, 1902
A. mitrata spectabilis Deflandre, 1928	*D. limnetica* Pénard, 1902
A. vulgaris Ehrenberg, 1830	*D. lobostoma* Leidy, 1879
A. vulgaris undulata Deflandre, 1928	*D. oblonga* Ehrenberg, 1838
Centropyxidae	*D. urceolata* Carter, 1864
Centropyxis aculeata (Ehrenberg, 1838)	*Difflugia* sp.
C. ecornis Ehrenberg, 1830	Hyalospheniidae
C. discoides (Pénard, 1890)	*Heleopera petricola* Leidy, 1879
C. platystoma Deflandre, 1929	Lesquereusiidae
Euglyphiidae	*Lesquereusia mimetica* var. *parva*, G.L. and Th., 1958
Euglypha acanthophora Ehrenberg 1841	*L. modesta* Rhumbler, 1896
Trigonopyxidae	*L. spiralis* Ehrenberg, 1840
Cyclopyxis kahli Deflandre, 1929	Plagiopyxidae
C. impressa (Daday, 1905)	*Hoogenraadia cryptostoma* G.L. and Th., 1958
Cyclopyxis sp.	
Rotifers	
Asplanchnidae	Collothecidae
Asplanchna sieboldi (Leydig, 1854)	*Collotheca* sp.

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Brachionidae	Conochilidae
Anuraeopsis cf. *navicula* Rousselet 1910	*Conochilus coenobasis* (Skorokov, 1914)
Brachionus angularis Gosse, 1851	*C. dossuarius* (Hudson, 1875)
B. bidentatus Anderson, 1889	*C. natans* (Seligo, 1990)
B. budapestinensis Daday 1885	*C. unicornis* Rousselet, 1892
B. calyciflorus Pallas, 1866	Dicranophoridae
B. dolabratus Harring, 1915	*Encentrum* sp.
B. falcatus Zacharias, 1898	Epiphanidae
B. mirus Daday, 1905	*Epiphanes macrourus* (Barrois and Daday, 1894)
B. quadridentatus Hermann, 1783	Euchlanidae
Keratella americana Carlin, 1943	*Euchlanis dilatata* Ehrenberg, 1832
K. lenzi Hauer, 1953	*E. incisa* Carlin, 1939
K.cochlearis Gosse, 1851	*Dipleuchlanis propatula* (Gosse, 1886)
K. tropica Apstein, 1907	Floscularidae
Plationus patulus macracanthus (Daday, 1905)	*Floscularia* sp.
P. patulus patulus (Müller, 1953)	*Ptygura* sp.
Platyias quadricornis brevispinus Daday, 1905	Hexarthridae
P. quadricornis quadricornis (Ehrenberg, 1832)	*Hexarthra intermedia* Wieszniewski, 1929
Gastropodidae	*H. mira* (Hudson, 1871)
Ascomorpha ecaudis (Perty, 1850)	Lepadellidae
A. ovalis Bergendal, 1892	*Lepadella ovalis* (O. F. Müller, 1786)
A. saltans (Bartsch, 1870)	Mytilinidae
Lecanidae	*Mytilina ventralis* (Ehrenberg, 1832)
Lecane bulla (Gosse, 1886)	Notomatidae
L. closterocerca (Schmarda, 1859)	*Cephalodella mucronata* Myers, 1924
L. cornuta (O.F. Müller, 1786)	*Monommata* sp.
L. curvicornis (Murray, 1913)	*Notommata* sp.
L. hamata Stokes, 1896	Proalidae
L. leontina (Turner, 1892)	*Proales* sp.
L. ludwigii (Eckstein, 1883)	Synchaetidae
L. luna (O. F. Müller, 1776)	*Synchaeta pectinata* Ehrenberg, 1832
L. lunaris Ehrenberg, 1832	*Polyarthra dolichoptera* Idelson, 1924
L. monostyla (Daday, 1897)	*P. vulgaris* Carlin, 1943
L. papuana Murrayi, 1913	Testudinellidae
L. signifera (Jennings, 1896)	*Testudinella mucronata* (Gosse, 1886)
L. stenroosi (Meissner, 1908)	*T. patina* (Hermann, 1783)
L. stichaea Harring 1913	*T. tridentata* Smirnov 1931
Trichocercidae	*T. truncata* (Gosse, 1886)
Elosa sp.	*Pompholyx complanata* Gosse, 1851
Trichocerca bicristata (Gosse, 1887)	*P. sulcata* (Hudson, 1885)
T. cylindrica chattoni (Beauchamp, 1907)	*P. triloba* Pejler, 1957
T. capucina Wierzejski and Zacharias, 1893	Trichotriidae
T. cylindrica (Im Hof, 1891)	*Trichotria tetractis* (Ehrenberg, 1830)
T. elongata (Gosse, 1886)	Trochosphaeridae
T. flagellata Hauer, 1937	*Filinia longiseta* (Ehrenberg, 1834) Koste 1973
T. heterodactyla (Tschugunoff, 1921)	*F. opoliensis* (Zacharias, 1898)
T. inermis (Linder, 1904)	*F. pejleri* Hutchinson, 1964
T. insignis (Herrich, 1885)	*F. saltator* (Gosse, 1886)
T. pusilla (Lauterborn, 1898)	*Horaella thomassoni* Koste, 1973
T. rousseleti (Voigt, 1902)	*Trochosphaera aequatorialis* Semper 1872
T. scipio (Gosse, 1851)	Philodinidae
T. similis (Wierzejski, 1893)	*Dissotrocha aculeata* (Ehrenberg, 1832)
T. stylata (Gosse, 1851)	
Cladocerans	
Bosminidae	Chydoridae
Bosmina hagmanni Stingelin, 1904	*Alona eximia* Kiser, 1948
B. tubicen Brehm, 1953	*Alona* sp.
Bosminopsis deitersi Richard, 1834	*Chydorus eurynotus* Sars, 1901
Ilyocryptidae	*Disparalona dadayi* (Birge, 1910)
Ilyocryptus spinifer (Herrich, 1884)	Daphniidae
Macrothricidae	*Ceriodaphnia cornuta* (Sars, 1886)
Macrothrix spinosa King, 1853	*Daphnia gessneri* Herbst, 1967
Sididae	Moinidae
Diaphanosoma spinulosum Herbst, 1967	*Moina minuta* Hansen, 1899
Copepods	
Cyclopidae	Diaptomidae
Thermocyclops decipiens Kiefer, 1929	*Notodiaptomus iheringi* Kiefer, 1936
T. minutus Lowndes, 1934	
Mesocyclops longisetus Thiébaud 1914	

The results pointed out the highest contribution of rotifer species on the other zooplankton groups, which is generally found in other Brazilian reservoirs, as emphasized by Rocha et al. (1995). Rotifers are opportunistic organisms, with high consumption rate and assimilation of wide range of food resources, allowing them to colonize even unstable environments (ALLAN, 1976). Due to these traits, these organisms dominate, regarding the species richness, the zooplankton community in these environments (MATSUMURA-TUNDISI et al., 1990; NOGUEIRA; MATSUMURA-TUNDISI, 1996; NOGUEIRA, 2001; BRANCO et al., 2002; LANSAC-TÔHA et al., 1999; 2005).

Temporally, the highest mean number of zooplankton species was observed during the dry period. Rotifers and testate amoebae presented higher mean values of species richness in dry period. On the other hand, the microcrustaceans (cladocerans and copepods) presented higher mean values of this attribute during the rainy period (Figure 3). In accordance to Velho et al. (2005), studying reservoirs from the Paraná State, cladocerans also were more specious during the rainy season.

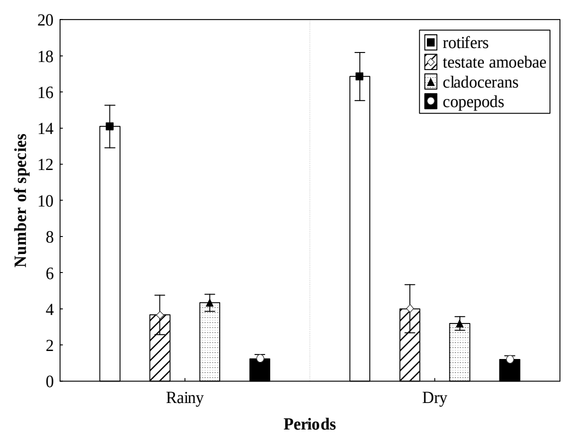

Figure 3. Number of species of rotifers, testate amoebae, cladocerans and copepods recorded during different hydrological periods in Corumbá Reservoir, Goiás State (symbol and box = mean, bar = standard error).

Taking into consideration the spatial distribution of species richness from the zooplankton groups during the rainy period, the highest mean values for rotifers and cladocerans was verified in the transition zone of Corumbá Reservoir, whereas the lowest ones, in the tributaries. The testate amoebae presented the greatest mean values in the river and tributaries; and the lowest ones in the transition zone. The copepods presented higher species richness in the lacustrine zone, and lower, in fluvial one (Figure 4a). The other groups presented higher mean values of species richness in the sampling stations with more lentic conditions.

Although testate amoebae, in aquatic environments, are mainly associated to the bottom and to the marginal vegetation, they must be considered as common in the plankton (DABÉS, 1995; VELHO et al., 2004; LANSAC-TÔHA et al., 1999; 2005; 2007), due to the sediment resuspension for the water column, besides their displacement caused by the water flow.

During the dry period, the spatial distribution of zooplankton groups was similar to the pattern observed in the rainy period (Figure 4b).

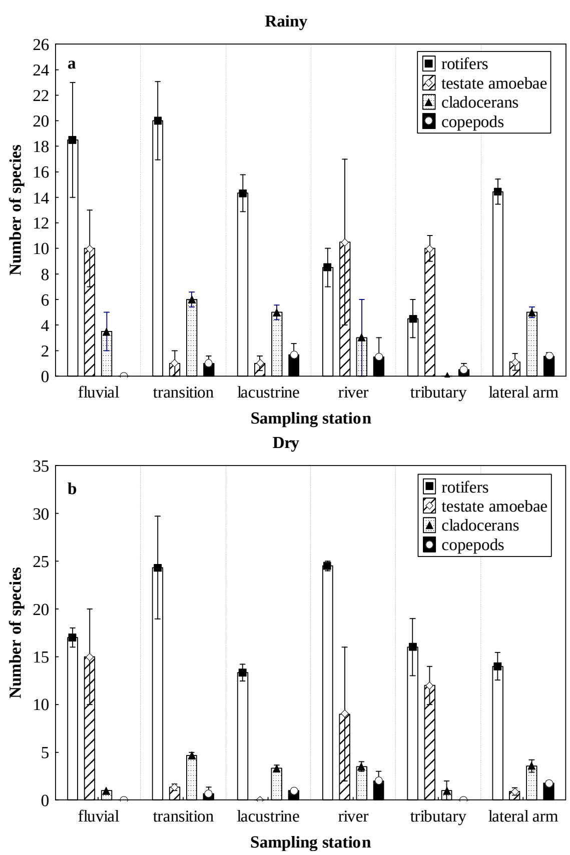

Figure 4. Number of species registered during the rainy (a) and dry (b) periods, in the different sampling stations in the Corumbá Reservoirs, Goiás State (symbol and box = mean, bar = standard error).

The results from Anova evidenced that the species richness varied significantly ($p < 0.05$) over the space. Nevertheless, the temporal variation of this community attribute was significant only for cladocerans (Table 2).

Table 2. Anova Kruskal-Wallis results of species richness and abundance of rotifers, testate amoebae, cladocerans and copepods over a hydrological period and in the sampling stations. Underlined values indicate significant differences ($p < 0.05$).

	Temporal variation				Spatial variation			
	Species richness							
	DF	n	H	p	DF	n	H	p
Rotifers	1	42	2.104	0.147	5	42	10.737	0.057
Testate amoebae	1	42	0.680	0.979	5	42	25.498	<u>0.000</u>
Cladocerans	1	42	4.747	<u>0.029</u>	5	42	14.917	<u>0.011</u>
Copepods	1	42	0.029	0.864	5	42	14.936	<u>0.011</u>
	Abundance							
	DF	n	H	p	DF	n	H	p
Rotifers	1	42	4.626	<u>0.032</u>	5	42	17.596	<u>0.004</u>
Testate amoebae	1	42	0.115	0.735	5	42	22.080	<u>0.001</u>
Cladocerans	1	42	1.040	0.308	5	42	22.675	<u>0.000</u>
Copepods	1	42	1.811	0.178	5	42	25.485	<u>0.000</u>

Zooplankton abundance

The most abundant species were *Polyarthra vulgaris*, *Pompholyx complanata*, *Conochilus unicornis* (rotifers), *Centropyxis aculeata*, *Arcella vulgaris*, *Difflugia gramen* (testate amoebae), *Ceriodaphnia cornuta*, *Diaphanosoma spinulosum*, *Moina minuta* (cladocerans), *Thermocyclops decipiens*, *T. minutus* and *Notodiaptomus iheringi* (copepods). These species have been usually found in other Brazilian reservoirs (LANSAC-TÔHA et al., 1999; NOGUEIRA, 2001; SAMPAIO et al., 2002; AOYAGUI et al., 2003; PANARELLI et al., 2003; LANSAC-TÔHA et al., 2005; MATSUMURA-TUNDISI; TUNDISI, 2005; SENDACZ et al., 2006; NOGUEIRA et al., 2008; SARTORI et al., 2009; SIMÕES; SONODA, 2009).

The highest abundance values from zooplanktonic groups, as well as the species richness, were recorded during the dry period. Aoyagui et al. (2003), in this same reservoir, also observed higher abundances of rotifers in the dry period. These authors associated this result to the higher values of phytoplankton biomass verified in this period. The copepods were the numerically dominant group during both periods, followed by rotifers, cladocerans and testate amoebae (Figure 5).

The great numerical importance of copepods, over a hydrological cycle, in relation to the other zooplanktonic groups, is due to the contribution of young stages (nauplii and copepodids), as shown in Figure 5. The dominance of young stages of copepods in relation to the adults is frequently found in Brazilian reservoirs (LOPES et al., 1997; LANSAC-TÔHA et al., 1999; 2005; SIMÕES; SONODA, 2009). The production of great number of larval stages may be considered as a reproductive strategy of this group to compensate the high mortality before they reach the adult stage (ESPÍNDOLA et al., 2000; LANSAC-TÔHA et al., 2005).

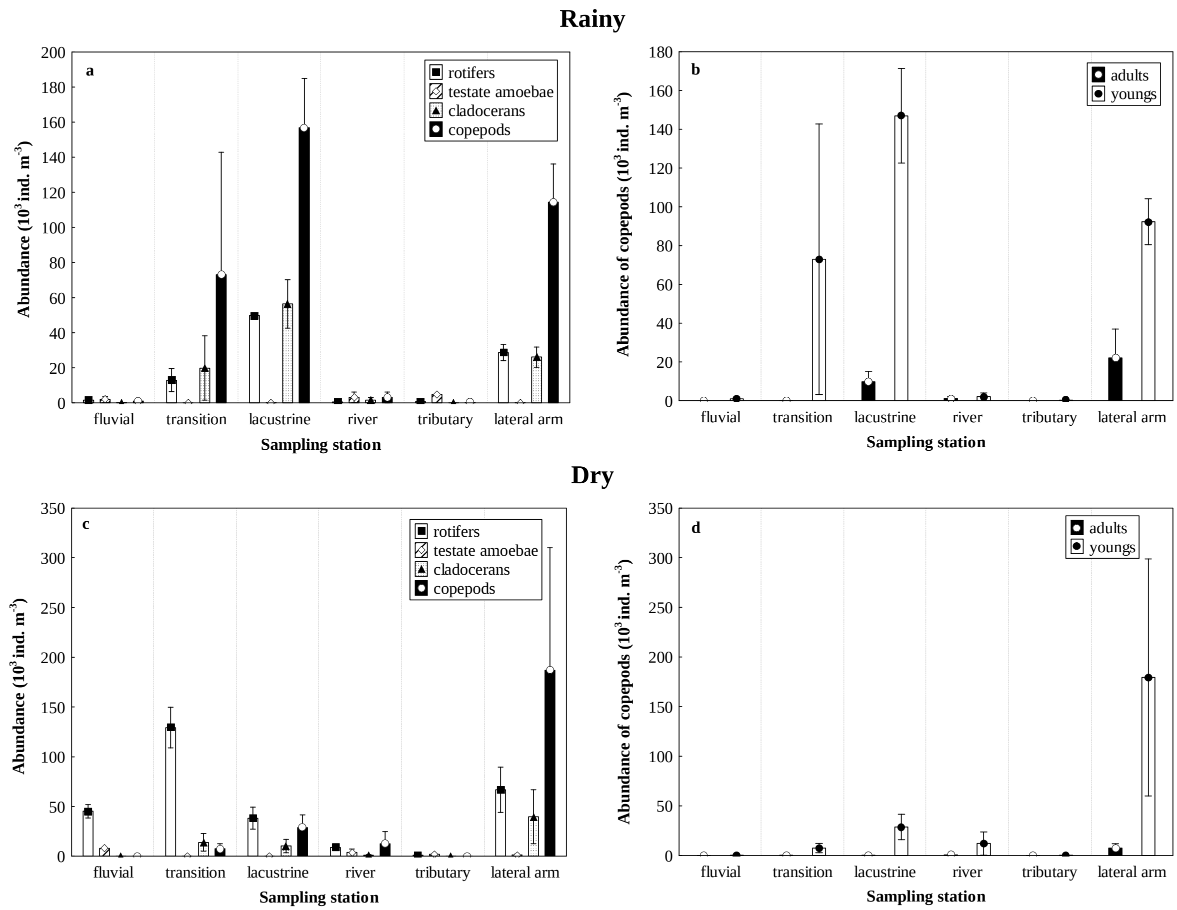

Figure 5. Abundance of different zooplankton groups (a and c) and copepods (b and d) during the rainy and dry periods, in the different sampling stations in the Corumbá Reservoir, Goiás State.

Rotifers, cladocerans and copepods were numerically important in lentic environments (lacustrine zone and lateral arms) and in the transition zone, during both hydrological periods. Other studies also recorded high densities of zooplankton in lentic regions from reservoirs (GARRIDO; BOZELLI, 2000; VELHO et al., 2005). In these areas, the reproductive rate of zooplankton organisms compensates the loss of individuals by death and downstream displacement (MARZOLF, 1990).

Testate amoebae, however, were more abundant in lotic environments (river and tributaries), during both hydrological periods. The presence of these organisms in the water column of lotic environments with high current flow is related to the high contribution of ticoplanktonic species (coming from the littoral region and sediment) for the limnetic compartment (VELHO et al., 2005).

Anova results indicated significant differences ($p < 0.05$) for the temporal variation of rotifers abundance. Regarding the abundance spatial distribution, significant differences were detected for all studied groups (Table 2).

The results of abundance from zooplankton groups, obtained along a hydrological period, allow inferring on the longitudinal distribution of organisms abundance in reservoirs. During the rainy period, higher values of water flow in the Corumbá River influence the sampling stations with lotic characteristics (river, tributaries and fluvial zone), limiting the development of zooplankton populations in these sampling stations. Otherwise, during the dry period, with low water flow, the highest number of individuals was registered from the transition zone. The low abundance of organisms, except for rotifers, in the superior stretch of the reservoir may be associated to the high turbulence observed in this region. Some authors also verified these variations in the zooplankton abundance in reservoirs, related with the differences of lotic and lentic lengths (WEGLENSKA; EISMONT-KARABIN, 1994). These authors argued that the main determining factor on these variations was the environmental water flow.

Pearson Correlation

According to the Pearson Correlation results, the abundance of rotifers presented a negative and significant relationship to the PCA first axis ($r = -0.62$; $p = 0.000001$), and a positive correlation to the chlorophyll-*a* concentration ($r = 0.51$; $p = 0.001$). Moreover, the testate amoebae abundance was positive and significantly related to the PCA 2 ($r = 0.44$; $p = 0.004$). The abundance of copepods was negative and significantly correlated to the same axis ($r = -0.42$; $p = 0.006$).

Aoyagui et al. (2003) verified that the rotifers abundance was related to the variation of chlorophyll-*a* concentrations in the Corumbá Reservoir, which is also observed in the present study. The authors stated that phytoplankton is an important food resource for the populational development of rotifers.

On the other hand, higher values of pH negatively influenced the rotifers abundance. Experimental studies carried out by Frost et al. (1998) highlighted an increase in rotifers biomass when the pH was lower.

Conclusion

The spatial variation of zooplankton community, over a hydrological cycle, evidenced higher values of species richness in lotic environments, where the occurrence of non-planktonic species is favored by the high current flow. Furthermore, the highest abundances were recorded in lentic environments that promote the development of zooplankton populations due to the low current flow. Therefore, the predicted hypothesis was ratified, except for testate amoebae, which presented a spatial distribution of its abundance distinct than predicted. We must emphasize the importance of limnological variables and the food resource availability on the spatial variations of zooplankton abundance in the Corumbá Reservoir, Goiás State.

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