ZOOPLANKTON COMMUNITY STRUCTURE OF TWO MARGINAL LAKES OF THE RIVER CUIABÁ (MATO GROSSO, BRAZIL) WITH ANALYSIS OF ROTIFERA AND CLADOCERA DIVERSITY

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ABSTRACT

In the present study, two small lakes on the margins of the River Cuiabá were analyzed regarding taxonomic composition and population densities of the zooplankton. Diversity was evaluated for two groups, Rotifera and Cladocera; sampling was carried out on two dates: 2 March 1999, in the rainy season, and 25 August 1999, in the dry season. Seventy-nine rotifer taxa, 30 cladoceran taxa, and 6 copepod taxa were found. Comparing the species identified in the present study with those recorded by other authors for several water bodies in Mato Grosso and Mato Grosso do Sul states, it was found that 9 species of Cladocera, 2 of Copepoda, and 14 of Rotifera are new records for the region. The most abundant rotifer species were *Keratella cochlearis*, *Brachionus angularis*, *Polyarthra vulgaris,* and *Keratella americana. Moina minuta* and *Bosminopsis deitersi* were dominant among the cladocerans, and *Notodiaptomus transitans* and *N. devoyorum* among the copepods. Comparing both lakes, the greatest species richness of both Rotifera and Cladocera was observed in Lake Souza Lima, during the rainy season. This is probably linked to the fact that the littoral region of this lake is densely colonized by macrophytes. The lake also has better environmental conditions since it does not receive domestic sewage inputs, as does Lake Parque Atalaia. The diversity of the Rotifera was markedly low in Lake Parque Atalaia, during the dry season, again perhaps linked domestic sewage input found in this water body.

Key words: zooplankton, Pantanal, Rotifera, Cladocera, Copepoda.

RESUMO

A estrutura da comunidade zooplanctônica de duas lagoas marginais do rio Cuiabá (Mato Grosso, Brasil) com análise da diversidade dos Clodocera e Rotifera

Este trabalho se baseia no estudo das comunidades zooplanctônicas de duas lagoas marginais ao rio Cuiabá, próximas às cidades de Cuiabá e Várzea Grande, e teve por objetivo analisar a composição de espécies, a abundância das populações zooplanctônicas e a diversidade dos Rotifera e dos Cladocera. Realizaram-se duas campanhas para amostragens, com coletas efetuadas nos dias 2/3/1999, no período chuvoso, e

25/8/1999, no período seco. Foram identificados no total 115 táxons, distribuídos em 79 táxons de Rotifera, 30 táxons de Cladocera e 6 táxons de Copepoda. Comparando-se as espécies registradas no presente estudo com aquelas já registradas por diferentes autores para os Estados de Mato Grosso e Mato Grosso do Sul, observa-se que 9 espécies de Cladocera, 2 espécies de Copepoda e 14 espécies de Rotifera são novas ocorrências para esses Estados ou região. As espécies mais abundantes foram *Keratella cochlearis*, *K. americana, Brachionus angularis* e *Polyarthra vulgaris* para Rotifera, *Moina minuta* e *Bosminopsis deitersi* entre os Cladocera e *Notodiaptomus transitans* e *N. devoyorum* entre os Copepoda. Comparando-se ambas as lagoas, observa-se que a maior riqueza de espécies foi registrada para a lagoa Souza Lima durante a estação chuvosa, em relação aos Rotifera e aos Cladocera, o que pode estar relacionado ao fato de a região litorânea dessa lagoa ser densamente colonizada por macrófitas e não receber esgoto doméstico, como observado na lagoa Parque Atalaia. A diversidade de Rotifera foi notadamente baixa na lagoa Parque Atalaia durante a estação seca, o que também pode estar relacionado à entrada de esgoto doméstico nesse corpo d'água.

Palavras-chave: zooplâncton, Pantanal, Rotifera, Cladocera, Copepoda.

INTRODUCTION

Brazilian freshwater biodiversity is poorly known, especially with regard to invertebrates. These ecosystems, being situated in the tropics and not presenting atypical or extreme conditions (such as saline, alkaline, or extremely acidic waters), constitute, in their great majority, habitats favorable to the development of species-rich communities (Rocha *et al*., 1995). Among freshwater communities, of particular importance is the zooplankton which consists of different taxonomic groups, with well-diversified morphologies, reproductive strategies, and feeding habits (Pennak, 1957), and participates as a link between the first trophic level, and the other trophic levels. The structure of zooplankton communities depends on a complex of factors. These include morphometric and regional climatic conditions, which govern important physical characteristics of water bodies, and chemical characteristics of the water, which are generally determined by edaphic features and vegetation cover (Sioli, 1975; Margalef, 1983); biogeographical factors, which control species colonization (Dumont, 1999; Rocha *et al*., 1999); and biotic interactions, principally competition for resources and prey (DeMott, 1989; Gliwicz & Pijanowska, 1989).

Studies on species composition and morphometric, physical, and chemical characterization of water bodies are necessary to obtain basic knowledge on the biodiversity in a given region. While various studies have been carried out in Brazil in recent decades on the taxonomy and population density of zooplankton communities in various water bodies (Rocha *et al*., 1995), one can observe that for the states of Mato Grosso and Mato Grosso do Sul, such information is relatively sparse so that the list of existing works is short. In lotic environments, inventories have been carried out for the rivers Abobral, Miranda, and Itaqueri (Oliveira-Neto, 1990; Segers *et al*., 1993; Bezerra *et al*., 1999), and Paraguay (Reid & Moreno, 1990; Oliveira-Neto, 1990; Segers *et al*., 1993). In lentic environments, studies have focused on lakes connected with rivers, the meandrous lakes of the River Suiá Missú (Green, 1972a, b), Lake Albuquerque (Espíndola *et al*., 1996), the "Baía" (lake) Acurizal (Turner & da Silva, 1992), and the "Baía" Sinhá Mariana (Morini-Lopes, 1999); isolated lakes which only enter into connection with rivers during great floods, such as "Baía" Jacadigo (Reid & Moreno, 1990) and Lake Buritizal (Pinto-Silva, 1991); lakes without connection which are not influenced by the floods, such as Lake Recreio (Pinto-Silva, 1991; Lima, 1996); and small lakes, both freshwater and saline (Mourão, 1989; Turner & da Silva, 1992; Kretzschmar *et al*., 1993; Medina-Junior, 2000). Finally, a specific study on the fauna of floating vegetation was carried out by Rocha & Por (1998).

Zooplankton species composition can differ markedly between lakes, even when situated close together, particularly when physically isolated, or when the trophic degree is very different, or when in different stages of ecological succession. A particularly instructive example of this was provided by Tundisi & Matsumura-Tundisi (1994) for the lakes of the Rio Doce valley. More frequently, however, the systems are influenced by processes occurring in the hydrographic basin, leading to a certain level of uniformity in composition for systems of the same basin.

Along the River Cuiabá are various artificial and natural lakes used for recreation, watering of stock, fish production, and effluent dilution. However, studies or inventories of the invertebrates of these water bodies do not exist. The object of the present work was to study the zooplankton communities in two lakes close to the River Cuiabá, analyzing the taxonomic composition and abundance of the populations in two distinct periods, the dry and rainy seasons, with the aim of contributing to the knowledge of freshwater biodiversity in the State of Mato Grosso.

DESCRIPTION OF STUDY AREA

The hydrographic basin of the River Cuiabá occupies a drainage area of 102,750 km² and has a climate of the Aw type according to the classification of Köppen, corresponding to a tropical semi-humid climate, with a mean annual temperature of 26ºC and mean annual precipitation varying between 800 and 1600 mm.year^{-1}. In this area, two distinct seasons exist defined by rainfall: the rainy season, extending between October and March, and the dry season, from April to September (Fig. 1). This hydrographic basin is an integral part of the mato-grossan Pantanal, and is characterized by a dense hydrographic net, with numerous natural and artificial lakes. Lakes Souza Lima and Parque Atalaia are located near the banks of the River Cuiabá (Fig. 2), at distances of 500 m and 300 m from the river, respectively. Lake Parque Atalaia is located on the urban perimeter of the city of Cuiabá (15°40'05.7"S and 56°03'59.3"W), and is connected with the river through the Atalaia stream. The lake is 300 m long, 100 m wide, and has a mean depth of 1.70 m. Natural woodland grows on its margins, and it receives part of the domestic sewage of the Parque Atalaia vicinity, through the stream. Lake Souza Lima is located in the municipality of Várzea Grande (15°43'27.3"S and 56°06'52.4"W). An artificial lake originating from soil excavation for clay extraction, it is 70 m long, 40 m wide, and has a mean depth of 1.50 m. The littoral zone is densely colonized by macrophytes, with *Eichhornia azurea* dominating. This lake does not receive input from any stream, being supplied only by phreatic groundwater and precipitation. The lakes are never directly inundated by the River Cuiabá, even during major floods, as they are situated on much higher terrain.

MATERIAL AND METHODS

Zooplankton samples were collected on 2 March (in the rainy season) and 25 August 1999 (in the dry season). One collection was made with horizontal net-tows in the littoral zone, and another in the limnetic part of the lake, with vertical tows, using a plankton net of 68 µm mesh. Carbonated water was added to the samples before fixation in 4% formaldehyde (Schaden, 1985) in order to diminish the degree of contraction of the Rotifera. Organisms were identified to the greatest possible taxonomic level (genus or species), using an optical microscope and a specialized bibliography (Koste, 1978; Matsumura-Tundisi, 1983, 1986; Reid, 1985; Segers, 1995; Nogrady *et al*., 1995; Smirnov, 1996; Elmoor-Loureiro, 1997).

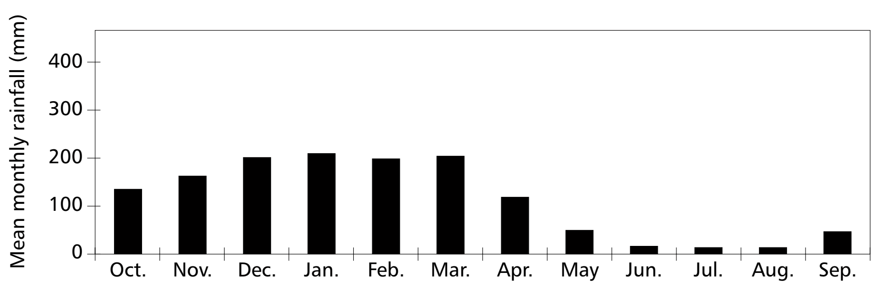

Fig. 1 — Mean monthly rainfall for the Cuiabá Meteorological Station. (*Source*: PCBAP, 1997.)

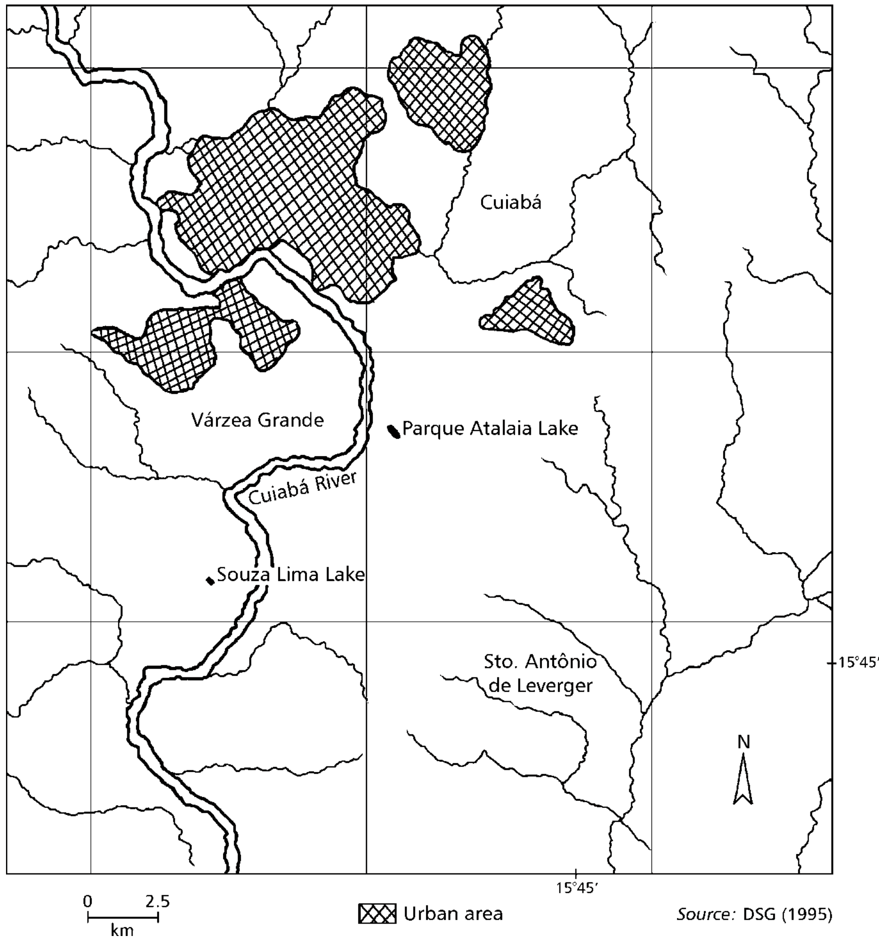

Fig. 2 — Location of Lake Parque Atalaia and Lake Souza Lima on the banks of the River Cuiabá.

The sample taken in the littoral zone by the horizontal net-tow was analyzed only qualitatively, while the samples from the limnetic area were analyzed both qualitatively and quantitatively, with Rotifera, Cladocera, and Copepoda abundance being determined.

The volume of filtered water was calculated by multiplying the area of the mouth of the net by the depth of the lake (i.e., the length through which the net was towed). Counting of the Rotifera and Copepoda nauplii was carried out using a Sedgewick-Rafter cell. The Cladocera and Copepoda were counted in acrylic counting chambers, using 5 ml sub-samples. Which were counted until identifing all species, even rare ones which were found. For the Copepoda, three species of Calanoida and three species of Cyclopoida occurred simultaneously, so that the naupliar and initial copepodite stages were counted together.

The data was used only to express the relative abundance of the principal zooplankton groups. For identifying most species and genera of Rotifera, organisms were examined after drop-wise addition of 10% hypochlorite, which permitted examination of the trophi on dissolution of the soft body parts (Schaden, 1985).

Zooplankton community diversity was analyzed only for Rotifera and Cladocera. Species diversity (*H'*), with log to base two, was calculated using the Shannon-Wiener Index which has moderate sensitivity to the sample number (Magurran, 1988). Values for Rotifera and Cladocera were calculated for each lake, considering each sampling date separately, in order to establish variations as a function of the climatic season. Uniformity (*E*) was calculated using the formula: $E = H'/Hmax$, in which *H'* is the Index of Diversity of Shannon-Wiener and *Hmax* is the maximum theoretical diversity. The taxonomic composition considering total richness of the zooplankton communities was compared between lakes, and between the dry and wet seasons for each lake, using the Sorensen Index of Similarity (Magurran, 1988).

Simultaneously with the zooplankton collections, measurements were made of local depth, water transparency (Secchi disc), temperature, dissolved oxygen concentration, and percentage saturation (at a 0.3 m depth), in the central part of the lakes. Readings of pH, conductivity, and turbidity were carried out using Micronal-B 374, Portátil DIST 3 ATC – Tester für Leitfähigkeit, and Mod. AP1000 II Polilab meters, respectively. Dissolved oxygen concentration and percentage saturation were measured using a WTW meter. Geographic coordinates were noted using a GPS model 45 XL Garmin. To identify new records an inventory was made of the species registered by other researchers in the states of Mato Grosso do Sul and Mato Grosso.

RESULTS

Physical and chemical variables

In Table 1 are presented for the two lakes the values recorded for the physical and chemical variables in the samplings carried out in March and August 1999. Water transparency in Lake Parque Atalaia in both months, and Lake Souza Lima in August, was low, while, for the latter lake in March (the rainy season), the transparency was greater (0.80 m). The pH values were approximately neutral. Dissolved oxygen concentrations were lower in Lake Parque Atalaia than in Lake Souza Lima, with values being lower in August for both lakes. The lowest values of dissolved oxygen saturation were recorded for Lake Parque Atalaia. Water conductivity varied widely, with the lowest values being recorded in March for both lakes. Water temperature reflected the climatic season by its greater values (approximately 3°C), recorded in March as compared to August, for both lakes.

TABLE 1

Values registered for the physical and chemical variables in lakes Souza Lima and Parque Atalaia, in March and August 1999.

Variable	Lake Souza Lima		Lake Parque Atalaia	
Date	2/3/99	25/8/99	2/3/99	25/8/99
Collection time (h)	15:20	14:30	10:05	9:30
Maximum depth (m)	2.10	2.00	1.50	1.40
Transparency (m)	0.80	0.20	0.30	0.35
Water temperature (°C)	30.7	27.7	28.8	25.1
pH	7.01	7.39	7.01	7.14
Conductivity ($\mu S.cm^{-1}$)	5.0	71.9	10.0	240.0
Dissolved oxygen ($mg. L^{-1}$)	8.1	6.6	5.6	4.2
Dissolved oxygen saturation (%)	88.0	79.0	63.0	58.0
Turbidity (NTU)	15.0	130.0	52.0	37.0

Taxonomic composition and abundance of the zooplankton

Considering both lakes, and both sampling dates, a total of 115 taxa of zooplankton was recorded, consisting of 79 taxa of Rotifera, 30 taxa of Cladocera, and 6 taxa of Copepoda (Table 2).

In Lake Souza Lima, the zooplankton was composed of 71 taxa of Rotifera, 29 taxa of Cladocera, and 6 taxa of Copepoda, while in Lake Parque Atalaia 60 taxa of Rotifera, 9 taxa of Cladocera, and 6 taxa of Copepoda were found. Comparing the species registered in the present study with those reported by other authors in the states of Mato Grosso and Mato Grosso do Sul, 9 species of Cladocera, 2 species of Copepoda, and 14 species of Rotifera are recorded for the first time for these states (Table 2).

Greatest taxon richness was recorded in March 1999 in Lake Souza Lima, with 62 taxa of Rotifera, 26 taxa of Cladocera, and 4 taxa of Copepoda. The lowest number of taxa was recorded in August 1999 in Lake Parque Atalaia, when 30 taxa of Rotifera, 5 taxa of Cladocera, and 4 taxa of Copepoda were found (Table 2). The Rotifera were most abundant in both systems (Fig. 3) in both samplings. Considering the number of taxa found in both samplings and in both lakes, it can be observed that taxon richness decreased in the following sequence: Rotifera, Cladocera, and Copepoda. However, when considering individual abundance, the sequence changed to Rotifera, Copepoda, and Cladocera, due to the great abundance of copepod nauplii (Fig. 4).

Of the Cladocera, the most abundant species in March 1999 were *Moina minuta* in Lake Parque Atalaia, and *Bosminopsis deitersi* in Lake Souza Lima. In August 1999, *Diaphanosoma fluviatile* dominated in Lake Parque Atalaia, and *Moina minuta* in Lake Souza Lima. On both sampling dates among the Copepoda, nauplii of Cyclopoida and Calanoida were most abundant in both lakes. Of the Rotifera, *Brachionus angularis* in Lake Parque Atalaia, and *Keratella americana* in Lake Souza Lima, were most abundant in August 1999. *Keratella cochlearis* in Lake Souza Lima, and *Polyarthra vulgaris* in Lake Parque Atalaia, were most abundant in March 1999 (Fig. 5).

For the Copepoda, considering only adult individuals, the following species of Cyclopoida were found: *Mesocyclops brasilianus*, *Thermocyclops minutus,* and *T. decipiens*. For the species *T. minutus* and *T. decipiens*, the mean lengths of the females were 0.62 and 0.84 mm, respectively (six measurements each, specimens taken from both lakes).

The following species of Calanoida were found: *Notodiaptomus amazonicus, N. transitans,* and *N. devoyorum*. The mean lengths of the males of these species were 1.23, 1.02, and 1.24 mm, respectively, while the mean lengths of the females were 1.39 and 1.19 mm, respectively, for *N. amazonicus* and *devoyorum* (three measurements each, specimens taken from both lakes).

Diversity, uniformity, and similarity of the zooplankton communities

Table 3 presents the calculated values of the index of similarity. For the total zooplankton community, there was 60% similarity in taxonomic composition between the two seasons in Lake Souza Lima, while in Lake Parque Atalaia this value was 65%. For the Rotifera, similarity was 63%; for the Cladocera, 55%; and for the Copepoda, 80%, in Lake Souza Lima. In Lake Parque Atalaia, these values were 65%, 50%, and 80%, respectively. Comparing the lakes, there was a similarity of 68% for Rotifera; 42% for Cladocera; and 100% for Copepoda.

Values of the index of uniformity of the populations varied between 0.17 and 0.65 for the Rotifera, and 0.48 and 0.71, for the Cladocera (Table 3). The results show that greater variation in uniformity occurred for the populations of Rotifera than for those of Cladocera, comparing the samplings taken for the two climatic periods.

Comparing the diversity of the Rotifera in each lake, it was observed that in Lake Souza Lima this value was higher in August in the dry season, in contrast to Lake Parque Atalaia where the higher value was recorded in March (Table 3). As for the Cladocera, the values were similar for both periods and both lakes. Overall, diversity of the Rotifera was greater than that of the Cladocera on three of the 4 samplings carried out on the two different dates.

TABLE 2

Taxonomic composition of the zooplankton community (Rotifera, Cladocera, and Copepoda), of lakes Souza Lima and Parque Atalaia, in March (the wet season) and August (the dry season), of 1999, and the occurrence of the taxa recorded by other authors in the states of Mato Grosso do Sul and Mato Grosso.

Season date	L. Souza Lima		L. Parque Atalaia		Other authors												
	Wet 2/3/99	Dry 25/8/99	Wet 2/3/99	Dry 25/8/99	1	2	3	4	5	6	7	8	9	10	11	12	13
CLADOCERA																	
Bosminopsis deitersi	X		X								X		X		X		
Bosmina hagmanni	X	X	X		X			X			X		X		X	X	
B. tubicen	X	X						X					X				
Alona monacantha	X	X						X					X				
A. intermedia	X	X	X										X				
A. affinis	X				X								X		X		
A. karua	X	X			X								X		X		
Alonella dadayi	X							X					X				
Ephemeroporus tridentatus	X				X										X		
E. hybridus	X												X				
**Chydorus parvireticulatus*	X																
C. pubescens	X				X										X		
C. eurynotus	X			X	X								X		X		
C. nitidulus	X				X												
Euryalona orientalis	X				X								X				
Ceriodaphnia cornuta	X	X			X	X		X			X		X		X	X	
**Daphnia ambigua*		X															
**Simocephalus acutirostris*	X	X		X													
S. serrulatus		X									X						
Ilyocryptus sordidus	X																X
I. spinifer	X	X			X	X							X		X	X	
**Macrothrix paulensis*	X	X															
**M. superaculeata*	X																
Moina minuta	X	X	X	X	X	X					X		X				
Diaphanosoma birgei	X				X			X			X		X				
**D. fluviatile*		X	X	X													
**D. spinulosum*	X	X	X	X													
D. brevireme			X		X								X				
**Pseudosida ramosa*	X																
**Latonopsis australis*	X																
COPEPODA																	
Thermocyclops decipiens	X	X	X	X							X			X			
T. minutus	X	X	X		X	X					X			X			
Mesocyclops brasilianus		X	X								X						
Notodiaptomus devoyorum	X	X	X	X									X				
**N. amazonicus*	X	X	X	X													
**N. transitans*		X	X	X													

TABLE 2 (*Continued.*)

Season date	L. Souza Lima		L. Parque Atalaia		Other authors												
	Wet 2/3/99	**Dry 25/8/99**	**Wet 2/3/99**	**Dry 25/8/99**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
ROTIFERA																	
Asplanchna sieboldi	X		X	X	X		X		X			X					
Brachionus caudatus	X		X	X				X	X	X	X	X	X				
B. bidentata	X	X	X				X		X			X	X				
B. calyciflorus	X		X	X				X									
B. falcatus falcatus	X	X	X	X	X			X	X		X	X	X				
B. dolabratus	X							X	X		X	X	X				
B. quadridentatus quadridentatus	X	X	X		X			X	X	X	X	X	X				
**B. forfícula*	X	X	X														
B. angularis			X	X	X												
**B. havanaensis*	X	X	X	X													
B. mirus	X								X		X	X	X				
**B. leydigi*				X													
K. tropica	X	X	X		X							X	X				
K. americana	X	X		X						X	X	X	X				
K. cochlearis	X	X	X	X				X	X	X	X	X					
**K. quadrata*	X		X														
K. lenzi	X	X	X		X				X		X	X	X				
Plationus patulus patulus	X	X	X		X				X	X	X	X	X				
P. patulus macracanthus	X				X				X								
Platyias quadricornis	X	X	X	X	X				X		X	X	X			X	
Collotheca sp.	X																
Lepadella patella	X	X	X	X	X		X		X							X	
**Conochilus dossuarius* cf.	X	X	X	X													
C. coenobasis	X	X							X		X	X					
C. unicornis	X		X								X	X				X	
**Dicranophorus caudatus*	X		X														
D. epicharis	X		X	X								X					
Epiphanes macrourus		X	X	X								X					
Euchlanis dilatata	X	X	X	X					X		X	X					
Dipleuchlanis propatula propatula	X		X	X	X						X	X				X	
Filinia longiseta	X	X	X	X	X				X		X	X	X				
F. opoliensis	X	X	X		X				X		X	X	X				
F. novaezealandiae cf.	X	X	X	X				X	X		X		X				
Ptygura sp.	X		X														
Manfredium eudactylota	X										X	X				X	
Ascomorpha sp.	X																
Hexarthra intermedia brasiliensis	X	X	X	X					X		X	X	X				
Hexarthra mira mira		X							X	X							
Lecane sp.			X														
L. bulla	X	X	X	X	X			X	X	X	X		X			X	
L. hastata	X								X								

TABLE 2 (*Continued.*)

Season date	L. Souza Lima		L. Parque Atalaia		Other authors												
	Wet 2/3/99	Dry 25/8/99	Wet 2/3/99	Dry 25/8/99	1	2	3	4	5	6	7	8	9	10	11	12	13
ROTIFERA																	
L. cornuta	X	X	X	X	X				X	X	X						
L. curvicornis	X	X	X	X	X				X	X						X	
L. luna			X						X				X			X	
L. elongata			X						X								
**L. donneri*		X															
L. pyriformis		X			X												
L. ludwigii	X		X		X				X				X			X	
L. papuana	X	X	X	X					X	X						X	
L. leontina	X	X	X	X	X			X	X	X			X			X	
L. lunaris	X	X	X		X				X				X			X	
L. signifera	X	X			X				X								
**L. arcula*			X														
**Microcodides longiseta*	X																
**Mytilina bisulcata*				X													
Notommata sp.	X																
N. copeus	X								X								
**N. prodota*		X															
**N. pseudocerberus*		X															
**Cephalodella biungulata*	X	X															
C. gibba	X		X	X					X								
**C. catellina*	X																
**Pleurotrocha robusta*	X																
Scaridium longicaudum	X							X	X			X	X				
Itura sp.	X																
Monommata sp.	X																
Synchaeta sp.				X													
S. pectinata	X	X							X	X							
Polyarthra vulgaris	X	X	X	X			X		X	X	X	X				X	
Testudinella patina	X	X	X	X	X				X		X	X	X			X	
T. mucronata	X				X								X			X	
Trichocerca sp.		X	X														
T. similis	X		X		X				X	X	X	X					
T. bicristata	X	X			X							X	X			X	
T. elongata	X	X		X					X			X	X			X	
Trichotria tetractis	X	X								X		X	X			X	
Macrochaetus sericus		X							X		X	X	X			X	
M. longipes		X							X								
Trochosphaera aequatorialis	X										X						

Legend: Other authors: (1) Medina-Junior, 2000; (2) Mourão, 1989; (3) Kretzschmar *et al.,* 1993; (4) Lima, 1996; (5) Turner & Da Silva, 1992; (6) Green, 1972a; (7) Espíndola *et al*., 1996; (8) Oliveira-Neto, 1990; (9) Morini-Lopes, 1999; (10) Reid & Moreno, 1990; (11) Green, 1972b; (12) Bonecker *et al*., 1998; and (13) Rocha & Por, 1998.

(*) Register of the 1st occurrence of the species in the states of Mato Grosso and Mato Grosso do Sul. With regard to the species tentatively identified as *Filinia novaezealandiae*, we consider that the records by previous authors of *F. terminalis* are in fact most probably of the former species; *F. terminalis* is a cold stenotherm, which can easily be confused with *F. pejleri* or *F. novaezealandiae* (Shiel & Sanoamuang, 1993; Segers *et al*., 1996).

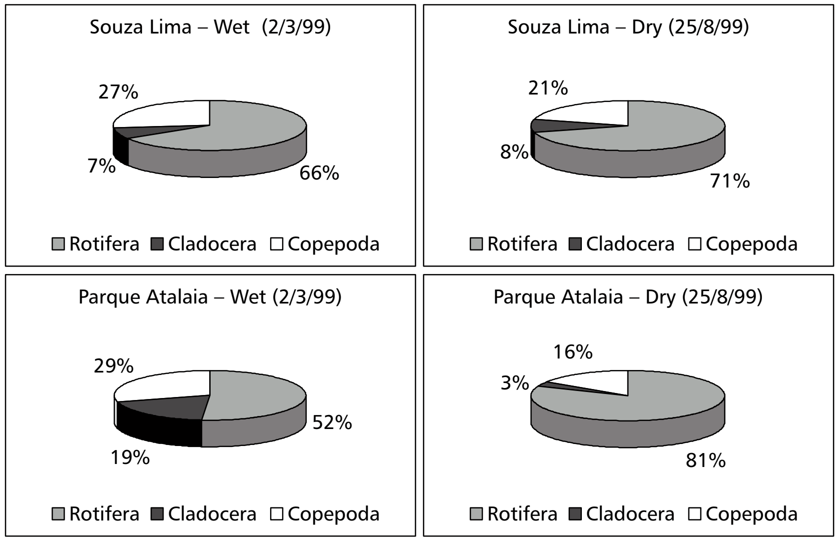

Fig. 3 — Relative abundance of Rotifera, Cladocera, and Copepoda, in the zooplankton community of lakes Souza Lima and Parque Atalaia, in March and August 1999.

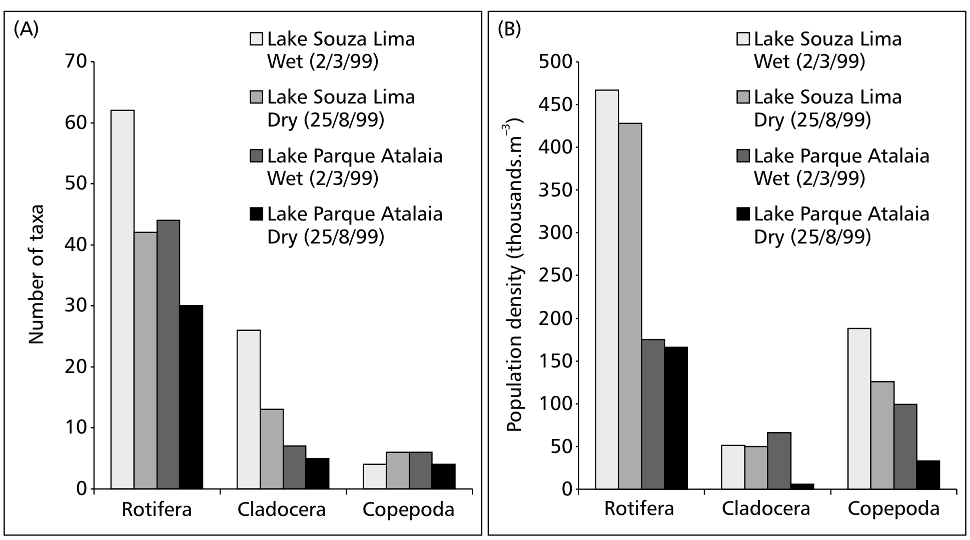

Fig. 4 — Number of taxa (A) and population density (thousands.m^{-3}) (B) of Rotifera, Cladocera, and Copepoda in lakes Souza Lima and Parque Atalaia, in March and August 1999.

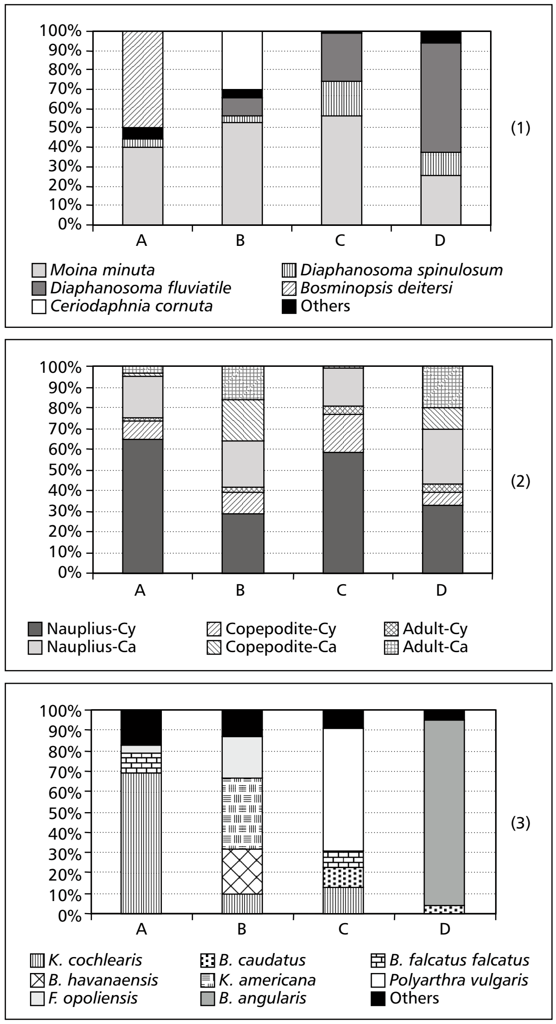

Fig. 5 — Relative abundance of the dominant species of Cladocera (1), Copepoda (2), and Rotifera (3), in Lake Souza Lima (A and B) and Lake Parque Atalaia (C and D), in March (the wet season, A and C) and August (the dry season, B and D) 1999.

TABLE 3

Values for the Sorensen Index of Similarity (IS), the Shannon-Wiener Index (H'), and the uniformity (E) for Rotifera and Cladocera, in the lakes Souza Lima and Parque Atalaia, in March and August 1999.

Location	Lake Souza Lima					Lake Parque Atalaia					Between lakes
Date	2/3/1999		25/8/1999			2/3/1999		25/8/1999			
Groups/Indices	H'	E	H'	E	IS	H'	E	H'	E	IS	IS
Cladocera	1.67	0.48	1.69	0.66	55	1.48	0.64	1.65	0.71	50	42
Rotifera	1.85	0.34	2.55	0.65	63	2.11	0.46	0.72	0.17	65	68
Copepoda					80					80	100
Total					60					65	65

DISCUSSION

The lakes analyzed in the present study are shallow systems, with small water level fluctuations, and with pH around neutral. Oxygen concentration was high in Lake Souza Lima, indicating a well-oxygenated environment, without organic pollution or excessive organic matter decomposition. Lake Parque Atalaia, which receives domestic sewage via a tributary, had somewhat lower values. Perhaps contributing to this difference was that, for the latter lake, measurements were carried out in the morning, as compared to the afternoon for Lake Souza Lima; diurnal patterns of change in dissolved oxygen concentration generally present more elevated values as the day progresses. Increased conductivity values were recorded in the dry season, probably as a result of a combination of greater concentration of organic residues originating from domestic sewage, in Lake Parque Atalaia, and greater evaporation, with a slight water level reduction, in both environments. This is not a general pattern in the lakes of the Pantanal, especially in environments connected to rivers during high water periods. Thus, Morini-Lopes (1999) recorded, during the flood period, for Lake Sinhá Mariana, the greatest peak in conductivity, as did Camargo & Esteves (1995) for an oxbow lake of the Mogi-Guaçu River.

Species richness of the lakes studied here is relatively high considering the small number of samples taken and the small size of the environments. In studies carried out on the Amazonian lakes (Hardy, 1980), the Monjolinho reservoir (Nogueira & Matsumura-Tundisi, 1996), two lakes located in the Pantanal: Albuquerque (Espíndola *et al.*, 1996) and Sinhá Mariana (Morini-Lopes, 1999), and in two marginal lakes of the River Paraná (Nunes *et al.*, 1996), a smaller number of species was recorded, despite the greater number of samples taken and the larger size of the water bodies. High species richness (104 morphospecies, in three samples, taken on one date) was also recorded by Segers *et al.* (1998) in a flood plain lake in Bolivia.

Rotifera was the group with greatest taxonomic richness in the two lakes. Similar results were obtained by Robertson & Hardy (1984), Paggi & José de Paggi (1990), and Sampaio & López (2000). This pattern is common in tropical freshwaters, whether in lakes, ponds, reservoirs, rivers, or streams. The Rotifera families with the greatest number of species were the Brachionidae and Lecanidae, which are considered typical for and most frequent in tropical environments (Dumont, 1983).

The Rotifera were the most abundant organisms recorded in the present study. The numerical dominance of this group in the zooplankton community of the majority of water bodies (although, for example, Sampaio & López (2000) recorded numerical dominance of Copepoda) has been attributed to the fact that these organisms are r-strategists, or opportunists, of small size, with short life cycles and wide tolerance to a variety of environmental factors (Green, 1972b; Robertson & Hardy, 1984). The numerical dominance of the Rotifera in the present study was despite the use of a net of mesh size 68 µm, which could have led to underestimating the quantity of smaller organisms.

In populations of Copepoda, the numerical predominance of young forms, especially nauplii, is the most common pattern, as observed by Paggi & José de Paggi (1990), Vasquez & Rey (1992), Lima (1996), Nunes *et al.* (1996), Morini-Lopes (1999), and Sampaio & López (2000) in different freshwater habitats and as also found in the present study. The high densities of the immature forms are generally a result of the continuous reproduction of these organisms, in tropical regions, with superimposition of various cohorts (Edmondson, 1959). A factor which can determine the proportion of young to adult forms is predation intensity and the balance between predation by invertebrates and vertebrates (Dumont *et al.*, 1994). The existence of young forms is of great importance for zooplankton community structure, with regard to population dynamics and also trophic aspects, since in the early phases, the organisms can occupy trophic niches different from those of the adults. A classic example is that of the nauplii and first copepodite instars of the Cyclopoida, which have a filtration feeding habit and are predominantly herbivorous, while the later copepodite stages and the adults have raptorial feeding habits and are predominantly carnivorous. In the present study, adult Copepoda participation was relatively small, without marked differences in abundance between lakes.

As for species composition, congeneric associations were recorded for both the Calanoida and the Cyclopoida. Three species of the genus *Notodiaptomus* (*N. amazonicus, N. devoyorum, N. transitans*) among the Calanoida, and two species of Cyclopoida of the genus *Thermocyclops* (*T.*

minutus and *T. decipiens*) were common in the two lakes studied. Generally, the occurrence of congeneric associations implies the existence of strategies for decreasing competitive interactions. Among these, seasonal succession, vertical and horizontal segregation in space, and differences in body size and filtering apparatus diminish the competition for resources (Sandercock, 1967). Matsumura-Tundisi *et al*. (1983) observed in Amazonian lakes the coexistence of *N. amazonicus* and *N. coniferoides*, and showed that reduced competition between the species was due to body size difference. Also, in the present study, there were differences in the size of the species although, due to the relative adult specimen rarity in the samples, few individuals were measured.

In relation to the Cladocera, the family Chydoridae was the most representative, with the greatest number of species. The richness of the Chydoridae was particularly evident in Lake Souza Lima, with the occurrence of twelve species. This situation is to be expected in the majority of shallow environments with a developed littoral zone colonized by macrophytes, although the majority of studies carried out in Brazil have not sampled or identified the species of this family adequately (Wisniewski *et al*., 2000).

In the present study, the greatest organism abundance was recorded in the two lakes in March, corresponding to the wet season. Although only a single sampling was carried out for each lake in each season, it is possible that this pattern is representative for the seasons. In lakes, without periodic flooding, the dry season brings greater stability and food availability due to organic matter production and decomposition, as exemplified in other Pantanal systems (Pinto-Silva, 1991; Lima, 1996), so that organism abundance can be greatest in that season. In contrast, in environments subject to periodic flooding, generally greatest zooplankton density occurs, once the connection to the river is established, some time after the entrance of the river water (Brandorff & Andrade, 1978; Espíndola *et al*., 1996; Sampaio & López, 2000), as a result of increased food availability, due to nutrient and allochtonous material input.

The values obtained in this study for the Similarity Index of Sorensen show a relatively low 65% degree of overall similarity in the zooplankton species composition between the two lakes.

Considering both lakes, a wide amplitude in diversity was observed for the Rotifera, with values of 0.72 to 2.55 bits/ind. Also, on three occasions Rotifera diversity tended to be higher than that of the Cladocera. In studies carried out in Amazonian lakes, Hardy (1980) obtained values of 0.05 to 0.63 bits/ind. for Cladocera and 0.01 to 1.02 bits/ind. for Rotifera. Also in Amazonian lakes (Magalhães and Jarucuí), values between 0.0275 and 4.63 bits/ind. have been recorded (Schaden, 1978, *apud* Robertson & Hardy, 1984). For marginal lakes of the River Mogi-Guaçu, Güntzel *et al.* (2000) obtained a range of 0.78 to 3.83 bits/ind. for the Rotifera. These data illustrate the great variation found for diversity of this zooplankton group in small to medium sized lakes.

In the present study, both Cladocera and Rotifera diversity tended to be greater in the dry season, with the exception of the Rotifera in Lake Parque Atalaia. Lima (1996) found that zooplankton diversity was lower in the dry season, although there were no significant species composition changes in the zooplankton community between the two seasons. Similarly, Sampaio & López (2000) found greatest zooplankton diversity during the wet season.

In the present study, the uniformity of the populations was low with, in both lakes and on both sampling dates, one to three species dominating which, according to Green (1993), can be an indication of environmental stress. The low diversity and the dominance of a single Rotifera species in Lake Parque Atalaia, in August 1999, could have been related to the organic matter level of the system, due to domestic sewage input through the stream which forms this lake. According to Margalef (1983), organically enriched environments have lower diversity, with a few species dominating. The dominant rotifer species was *Brachionus angularis*, a species associated with such environments (Sladecek, 1983; Barroso *et al*., 1997).

From the results obtained, one can conclude that the zooplankton communities of these marginal lakes of the River Cuiabá are characterized by high richness and diversity, especially Lake Souza Lima, which is subject to a lesser degree of anthropogenic stress. The present data indicate the necessity for conservating these small water-bodies, which seem to contain a significant diversity of aquatic invertebrates, some of which had not been previously recorded for the region.

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