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Cyanobacteria bloom: selective filter for zooplankton?

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(With 4 figures)

Abstract

The Ibirité reservoir is an urban and eutrophic environment, with regular occurrences of cyanobacteria blooms. The reservoir is warm monomict and remains stratified most of the year, circulating in the dry season (winter). During the hydrological cycle of October/07 to October/08 there were four scenarios with different environmental conditions, which influenced the structure of the zooplankton community, as confirmed in a previous study. Changes in the zooplankton community structure between the scenarios were studied, aiming at analyzing the stability and persistence of this community. The Spearman's coefficient of correlation was used to measure the stability; the persistence was evaluated through a cluster analysis and changes in community composition were estimated by the "temporal" β diversity index. Considering the distribution patterns of abundance, the community was stable only in the transition between scenarios 1 and 2 ($n = 30$, $r = 0.71$, $p = 0.00001$), when there were no cyanobacteria blooms. The persistence of zooplankton between the scenarios was low, showing a distinct species composition for each scenario. The highest variations in species composition, observed by the values of temporal β diversity index, were the transitions between scenarios 3-0 (1.45) and 0-1 (1.05), and the lowest variations occurred in the transition between scenarios 1-2 (0.57). The results suggest that the cyanobacteria blooms at Ibirité reservoir are be acting as "selective filters", and are, thus, disturbances with sufficient ability to change the structure of the zooplankton community.

Keywords: Urban Reservoir, zooplankton, bloom of cyanobacteria, stability, persistence.

Floração de cianobactéria: filtro seletivo para zooplâncton?

Resumo

O reservatório de Ibirité é um ambiente urbano, eutrófico com periódicas ocorrências de florações de cianobactérias. O padrão de mistura deste reservatório é monomítico quente, permanecendo estratificado a maior parte do ano, circulando na estação seca (inverno). Durante o ciclo hidrológico de outubro/07 a outubro/08, ocorreram quatro cenários com condições ambientais distintas, que influenciaram na estruturação da comunidade zooplanctônica, conforme observado em estudo prévio. As mudanças na estrutura da comunidade zooplanctônica entre os cenários foram estudadas objetivando analisar a estabilidade e persistência desta comunidade. O coeficiente de correlação de Spearman foi utilizado para medir a estabilidade; a persistência foi considerada por meio de uma análise de agrupamento; e as mudanças na composição da comunidade foram estimadas através do índice de diversidade β temporal. A comunidade foi estável, considerando os padrões de distribuição da abundância, somente na transição entre os cenários 1 e 2 ($n=30$; $r= 0,71$; $p=0,00001$), nos quais não foram observadas florações de cianobactérias. A persistência do zooplâncton entre os cenários foi baixa, apresentando composições de espécies distintas. As maiores variações na composição das espécies, estimadas através dos valores de diversidade β temporal, foram nas transições entre os cenários 3-0 (1,45) e 0-1 (1,05), e o menor valor na transição entre os cenários 1-2 (0,57). Os resultados do presente trabalho sugerem que as florações de cianobactérias no reservatório de Ibirité estariam funcionando como "filtros seletivos", ou seja, distúrbios com capacidade suficiente para alterar a estrutura da comunidade zooplanctônica.

Palavras-chave: Reservatório urbano, zooplâncton, floração de cianobactéria, estabilidade, persistência.

1. Introduction

Every community can be characterized by its structure, density, productivity and temporal stability (Worm and Duffy, 2003; Begon et al., 2007). The association between structure and stability of biological communities has been the study object for ecologists for, at least, half a century. This interest is, mainly, due to a concern about the consequences of the decrease of diversity to the stability and productivity of biological communities (Begon et al., 2007).

Modern ecologists use mathematical models in populations or communities, based on the theory of stability, with the idea of analyzing the processes which structure the systems.

However, it is necessary to verify if the study objects (populations or communities) are stable or not in a given temporal scale before the application of the mathematical models (Connell and Sousa, 1983).

Stability is a result of two mechanisms: resilience and resistance. The first refers to the speed at which the community, or any other system, returns to equilibrium after a disturbance with enough intensity to move it from its original state. The resistance of a community refers to its capacity to avoid the displacement generated by the disturbance. In this way, in order to be considered stable, a system (ex: community), should contain one or more points of equilibrium, to which it returns or remains at after the disturbance (Connell and Sousa, 1983; Ives et al., 2000; Begon et al., 2007).

Persistence analysis is another way used to verify the temporal changes in the community structure. This analysis has a qualitative approach, which indicates if a population or species has become extinct at a certain time. In case of extinction, in order to have the persistence of a determined species acknowledged, this species has to resettle the area in a time inferior to the one needed for a turnover of all individuals at the specified environment. (Connell and Sousa, 1983).

The concepts of stability and persistence refer to the responses of the community or population to discrete or punctual disturbances (pulses) that disturb the abundancy, but do not cause long term changes in the environment (Connell and Souza, 1983).

The reservoirs constitute a complex web of interactions between biological communities and the physical and chemical environment. Such associations are in a permanent process of response to the functions and forces of climatology, effects produced by operational management of the dam (Tundisi, 1999) and algal blooms (Pinto-Coelho, 1998).

The cyanobacterial blooms are disturbances of biological nature, with the ability to modify the abiotic and biotic matrix of the system (Rolland et al., 2005), however, the zooplactonic adjustments to these events are still understudied in tropical environments (Pinto-Coelho, 1998).

The Ibirité reservoir is urban, warm monomictic (Garcia et al., 2009), euthrophic, with frequent occurrences of cyanobacterial blooms (Pinto-Coelho et al, 1998; Almeida and Giani, 2000; Moreno and Callisto, 2006; Garcia et al., 2009). During the period of October 2007 to October 2008, four scenarios of distinct environmental conditions were verified at Ibirité reservoir, which were determined mainly by environmental factors such as: rainfall, water column relative stability, fluctuation on the water level of the reservoir, temperature, transparency and cyanobacterial bloom occurrence, and influenced the structure of the zooplankctonic community (Mello et al., 2011).

Scenario 0 is represented by the months of October 2007 and 2008, characterized by rainfall and peak cyanobacterial bloom occurrences. In this scenario, the reservoir was thermally stratified and the water column stable, showing an intense cyanobacterial bloom, confirmed by the high levels of chlorophyll-*a* and the low transparency of the water (Secchi) and high densities of cyanobacteria (Pinto-Coelho et al., 2010; Barbosa et al., 2011). The highest variations on the water levels (altimetric quote) were registered during this period, indicating a need to control the bloom through the operational management of the reservoir`s dam.

In scenario 1 (December 2007, February and April 2008) the highest rainfall volumes were registered, and, as a consequence, the dilution of the algal bloom. The peak of this dilution occurred on February 2008, where the lowest concentration of Chl-*a* was obtained.

In scenario 2 (June 2008), the reservoir was in the mixture process, with low relative stability in the water column. During this period, there were no algal blooms, with the lowest registered rainfall volume and temperatures. Scenario 3 (August 2008), comprehended the transition between the dry season (scenario 2) and the rainfall season (scenarios 0 and 1). The reservoir was partially stratified, representing the beginning of the algal bloom (Mello et al., 2011).

The aim of this study was to verify the changes in the structure of the zooplancktonic community between the four scenarios, through analysis of stability, persistence and β diversity index (Whittaker, 1960), answering the following questions: (i) In which scenarios (periods) the disturbances would have enough intensity to cause instability in the zooplanktonic community? (ii) Would the zooplanktonic community persist during the studied hydrological cycle? (iii) In which transition(s) between the scenarios the zooplanktonic community would present its highest changes in composition?

Thus, it was hypothesized that the variations on the environmental factors through the hydrologic cycle lead to the absence of stability and the persistence of the zooplanktonic community in the transitions between the scenarions with cyanobacterial blooms.

2. Material and Methods

2.1. Study area

Ibirité Reservoir (20°01'28.1"S; 44°07'07.7"W) is located at the Paraopeba river basin, a large tributary of the São Francisco river (Minas Gerais State). Its basin is formed by Pintados, Retiro and Onça sub-basins (Fundação João Pinheiro, 2001). It is surrounded by *Eucalyptus* plantations, small farms, industrial and urban areas with neighborhoods and slums (Moreno and Callisto, 2006) (Figure 1).

The regional climate is tropical sub-humid (Cwb in Köppen's classification), with a wet summer (from October to March) and a dry winter (from April to September). The reservoir, which is classified as warm monomitic,

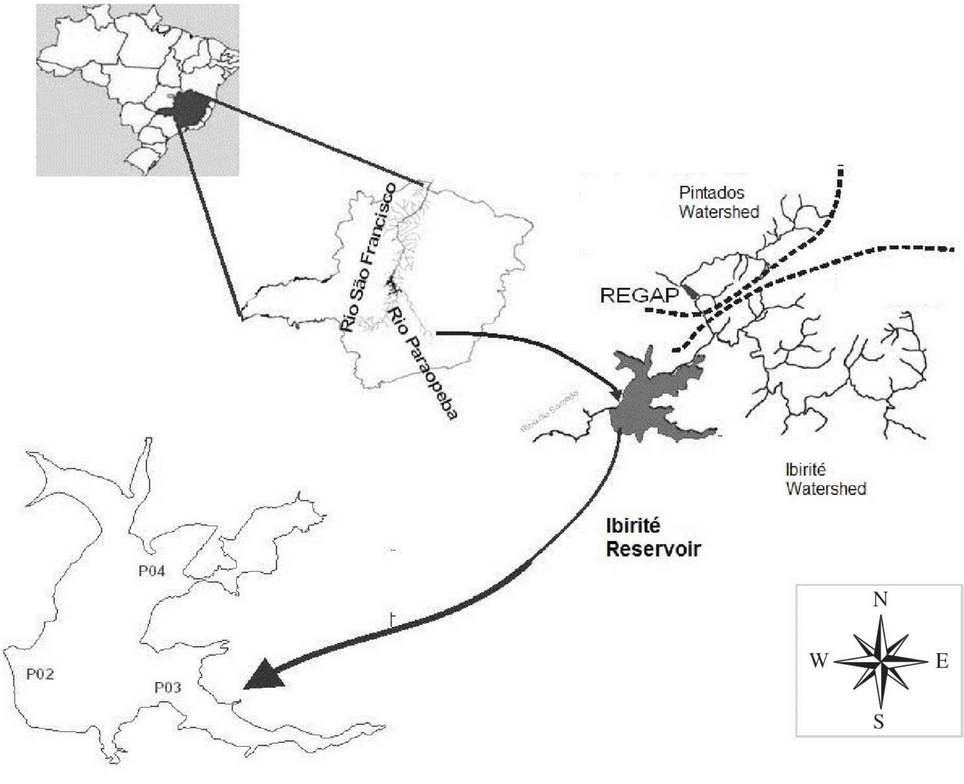

Figure 1. Localization of Ibirité reservoir, Ibirité and Pintados watershed limits. Highlighted in the larger image are the sampling sites at the reservoir.

and circulates during the winter months (June-August) (Garcia et al., 2009), has an area of 2.05km^2, a total volume of 11.6 x10^6 m^3, and average and maximum depth of 5.6 and 17.67m, respectively (Pinto-Coelho et al., 2010).

2.2. Sampling characterization and periodicity

Three sampling points were defined: P02 (20°01'24.8"S; 44°07'06.1"W) near the dam, P03 (20°03'02.7"S; 44°06'32.2"W) near the Employees of Petrobras' Country Club (CEPE) and P04 (20°01'34.6"S; 44°06'24.5"W) near the mouth (lotic zone) of Ibirité river, the reservoir's main tributary. Sampling was performed every two months from October 2007 to October 2008.

2.3. Sampling and laboratory analysis of zooplankton

Zooplankton samples were collected at depths determined by Secchi disk, by filtering 100 liters of water in a plankton net (68µm). For the quantitative analysis, subsamples were taken and counted in a Sedgwick-Rafter chamber. The results were expressed in organisms per liter (org L^{-1}). Microzooplankton (<200µm) and mesozooplankton (>200µm) fractions were analyzed separately.

2.4. Data analysis

To measure the stability of the zooplanktonic community between the scenarios pre-established by Mello et al., (2011) (Figure 2), the Spearman's correlation coefficient was applied using the software Statistica 7.0 (STATSOFT, 2002). For this analysis, the average of the densities of the species that occurred in all three sampling points was used.

The community is considered stable in situations where the species ranking is maintained through time (Connell and Sousa, 1983). According to the applied analysis, a positive and significant correlation ($p<0.05$) indicates that the dominant (or rare) species of a scenario are the same in the next period, leading to the deduction that there is stability in the distribution pattern of the abundance between the species. As for the stability scenarios, only species that were common to both scenarios were considered, whether or not they were the most abundant in both periods. (Connell and Sousa, 1983; Vieira et al., 2005; Bonecker et al., 2009).

The persistence of zooplanktonic organisms between the scenarios was verified by means of the cluster analysis; Jaccard was the similarity index used and the connection method was the UPGMA (Unweighted Pair Method with Arithmetic Mean). The persistence was confirmed when the sampling units (point/month and year) between different periods were more similar than sampling units at the same period (Vieira et al., 2005).

The changes in the community composition between the scenarios were examined by the beta diversity index of Whittaker (1960), using the software PAST, version 1.94b (Hammer et al., 2001). The temporal beta diversity (i.e. used as an index of temporal species turnover, since it varies from 0, when two samples present no difference

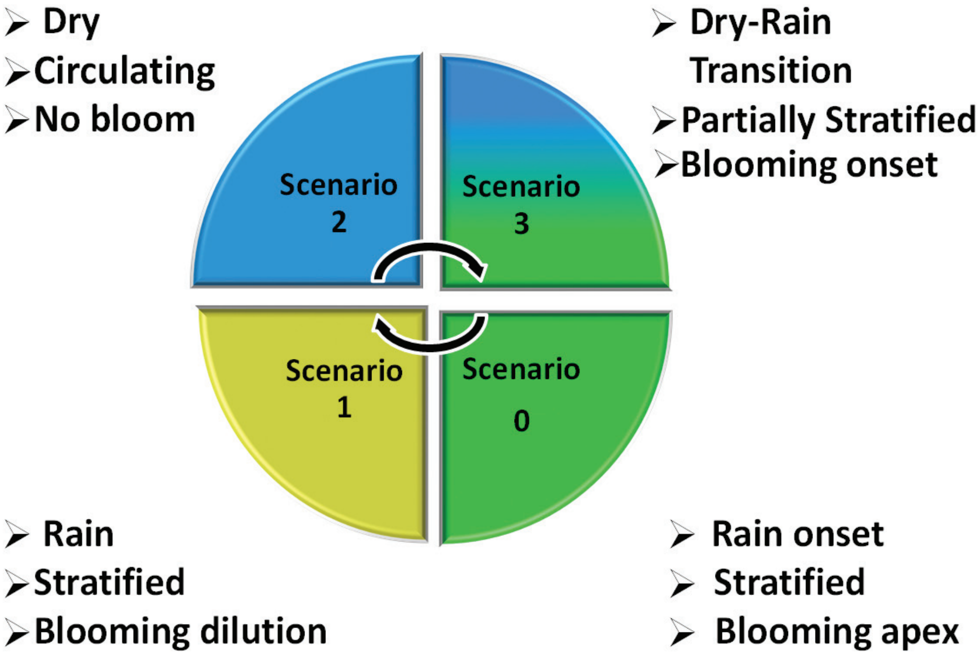

Figure 2. Scheme of the four scenarios during the studied hydrological cycle (Oct/07 to Oct/08) at Ibirité reservoir by Mello et al. (2011).

in composition species, to 2, when this difference is maximum) is a simple and efficient method to characterize and compare different species compositions in habitats where time seems to be an important factor in explaining variations in community composition (i.e. habitats with high frequency of disturbance) (Romanuk and Kolasa, 2001; Jiang and Patel, 2008).

3. Results

The zooplanktonic community (Copepoda, Cladocera and Rotifera) of Ibirité reservoir was represented by 75 species distributed in 21 families. Considering richness, Rotifera was the most representative group, containing 55 taxa, followed by Cladocera (11 taxa), and Copepoda (9 taxa).

In scenario 0, the mean density of the zooplanktonic community was 3411.8 org.L^{-1}, considering a total of 36 taxa, with 22 species of rotifers, 7 species of cladocerans and 7 species of copepods. In scenario 1, the total average density was 1158.6 org.L^{-1}, distributed in 48 taxa, of which 37 were rotifers, 5 cladocerans and 6 copepods. The average density of the zooplankton in scenario 2 was 4832.1 org.L^{-1}, distributed in 47 taxa, comprising 35 rotifers, 7 cladocerans and 5 copepods. In scenario 3 an average of 4439.1 org.L^{-1}, was sampled, registering a richness of 35 taxa, including 26 rotifers, 4 cladocerans and 5 copepods.

Scenario 3 presented the highest diversity value (H'=2.0) and equitability (E=0.62), while in scenario 1 (H'=1.34 and E=0.45) these parameters showed the smallest values (Table 1).

Table 1. Descriptive metrics of the zooplanktonic community in the four scenarios (C0, C1, C2 and C3) during the studied hydrological cycle at Ibirité reservoir. (S) Species richness, (H') Shannon's diversity index and (E) equitability.

Scenario	S	H'	E
C0	35	1.56	0.44
C1	46	1.34	0.45
C2	47	1.87	0.55
C3	36	2.00	0.62

From the total number of species (44) that occurred in scenario 0 (October 2007 only) and scenario 1, 19 appeared in both periods. In scenario 0, *Brachionus calyciflorus* (Rotifera) was the dominant species, whereas in scenario 1 *Diaphanosoma spinulosum* (Cladocera) was numerically predominant. The zooplanktonic community showed no stability between these two scenarios, as verified by the non-significative Spearman correlation index (n=19; r=0.27; p=0.26).

In scenarios 1 and 2, a total of 57 species was registered, with 30 species common to both scenarios. In scenario 2, *Keratella tropica* was the dominant species. Between these two scenarios, the stability of the zooplanktonic community was verified (n=30; r=0.71; p=0.00001), indicating that the species maintained their positions in both scenarios. In other words, the dominant and rare species were practically the same at both moments.

A total of 54 species was registered in scenarios 2 and 3, with 21 species in common. As in scenario 2, *K. tropica* was the dominant species in scenario 3. However, no stability between these two periods was found (n=21, r=0.39; p=0.07).

A total of 40 species was registered in scenarios 3 and 0 (October 2008), with 12 common to both analysed periods. In scenario 0, on October 2008, as well as on October 2007, *B. calyciflorus* was numerically dominant. Stability between these two scenarios was not found (n=12; r=0.50; p=0.09) (Table 2 and Figure 3).

The cluster analysis (cofenetic coefficient = 0.79) demonstrated that the zooplanktonic community presented higher similarity according to time (scenario/sampled period) and not to space (sampled point), which indicates that there was no persistence of the zooplanktonic species between the four scenarios during the studied hydrological cycle (Figure 4).

The β diversity values indicate a clear variation in the species composition between the scenarios. The highest β diversity value (1.45) was found during the transition between scenarios 3 and 0, followed by the transition between scenarios 0 and 1 (1.05). The lowest value (0.57) was found during the transition between scenarios 1 and 2 (Table 3).

Table 2. Sampled taxa and its occurrence in the four scenarios (C0, C1, C2 and C3), during the studied hydrological cycle (October/07 to October/08) at Ibirité reservoir.

Taxon	C0	C1	C2	C3
COPEPODA				
Cyclopidae				
Eucyclops elegans (Herrick, 1884)			X	
Mesocyclops meridianus (Kiefer, 1926)	X	X	X	X
Metacyclops mendocinus (Wierzejski, 1892)	X	X	X	X
Paracyclops chiltoni (Thomson, 1883)	X			
Thermocyclops decipiens (Kiefer, 1929)	X	X	X	X
Thermocyclops inversus (Kiefer, 1936)	X	X		
Tropocyclops prasinus (Fischer, 1860)	X	X		
Diaptomidade				
Notodiaptomus cearensis (Wright, 1936)	X	X	X	X
Harpacticoida				
Potamocaris sp.				X
CLADOCERA				
Bosminidae				
Bosmina freyi De Melo and Hebert 1994				X
Bosmina hagmanni (Stingelin, 1904)			X	
Daphniidae				
Ceriodaphnia cornuta (Sars, 1886)	X	X	X	X
Ceriodaphnia silvestrii (Daday 1902)	X			
Daphnia gessneri Herbst, 1967	X	X		
Daphnia laevis (Birge, 1879)	X	X	X	X
Simocephalus semiserratus Sars, 1901			X	
Sididae				
Diaphanosoma fluviatile Hansen 1899			X	
Diaphanosoma spinulosum Herbst, 1975	X	X	X	X
Macrothricidae				
Macrothrix elegans Sars (1901)	X			
Moinidae				
Moina minuta Hansen, 1899	X	X	X	
ROTIFERA				
DIGONONTA				
Philodinidae				
Bdelloidea	X	X	X	X
MONOGONONTA				
Asplanchnidae				
Asplanchna sp.		X	X	
Brachionidae				
Anuraeopsis fissa (Gosse, 1851)	X	X	X	X

Table 2. Continued...

Taxon	C0	C1	C2	C3
Anuraeopsis navicula Rousselet, 1910	X	X	X	X
Brachionus angularis Gosse, 1851	X	X	X	X
Brachionus calyciflorus Pallas, 1766			X	X
Brachionus caudatus Barrois and Daday 1894		X	X	
Brachionus cf. plicatilis O. F. Müller, 1786			X	
Brachionus dolabratus Harring, 1914	X	X		
Brachionus falcatus Zacharias, 1898	X	X	X	X
Brachionus havanaensis Rousselet, 1911	X			
Brachionus mirus Daday, 1905	X	X		
Brachionus quadridentatus Hermann, 1783			X	
Brachionus urceolaris Müller, 1773			X	X
Colurella sp.		X		
Kellicottia bostoniensis (Rousselet, 1908)				X
Keratella americana Carlin, 1943		X	X	
Keratella cochleares (Gosse, 1851)	X	X	X	X
Keratella tropica Apstein, 1907	X	X	X	X
Plationus patulus O. F. Müller,1786		X	X	
Platyias quadricornis Daday, 1905	X	X	X	
Collothecidae				
Collotheca sp.	X	X	X	X
Conochilidae				
Conochilus dossuaris Hudson, 1885	X	X	X	X
Conochilus unicornis Rousselet, 1892		X	X	X
Euchlanidae				
Euchlanis dilatata Hauer, 1930				X
Euchlanis incisa Carlin, 1939	X			
Trochosphaeridae				
Filinia longiseta Ehrenberg, 1834	X	X	X	
Filinia opoliensis Zacharias, 1891	X	X		X
Filinia terminalis Plate, 1886	X			
Hexarthridae				
Hexarthra intermedia Wiszniewski, 1929		X	X	
Lecanidae				
Lecane bulla Gosse, 1886	X	X	X	X
Lecane closterocerca (Schmarda, 1859)			X	
Lecane cornuta (O. F. Muller, 1786)		X		
Lecane curvicornis Murray, 1913		X	X	
Lecane hamata (Stokes, 1896)		X	X	X
Lecane luna (Müller, 1776)		X		
Lecane papuana (Murray, 1913)		X	X	X
Lecane rhenana Hauer 1929			X	
Lecane sp1.		X		
Lepadellidae				
Lepadella patella (O.F. Müller, 1786)			X	
Lepadella ovalis (Müller, 1786)			X	X
Lepadella rhomboides (Gosse, 1886)				X
Mytilinidae				
Mytilina acantophora Hauer, 1938				X
Mytilina bisulcata Lucks, 1912		X		
Mytilina ventralis Ehrenberg, 1832		X		
Notommatidae				

Table 2. Continued...

Taxon	C0	C1	C2	C3
Cephalodella gibba (EHRB., 1838)		X		
Cephalodella sterea (GOSSE, 1887)		X		
Synchaetidae				
Ploesoma triacanthus Jennings, 1894	X			X
Polyarthra spp.	X	X	X	X
Ptygura sp.		X	X	X
Trichocercidae				
Trichocerca flagellata Hauer, 1937			X	
Trichocerca pusilla Lauterborn, 1898	X	X	X	
Trichocerca similis Wierzejski, 1893			X	
Trichocerca stylata (Gosse, 1851)		X		X
Species richness	**36**	**48**	**47**	**35**

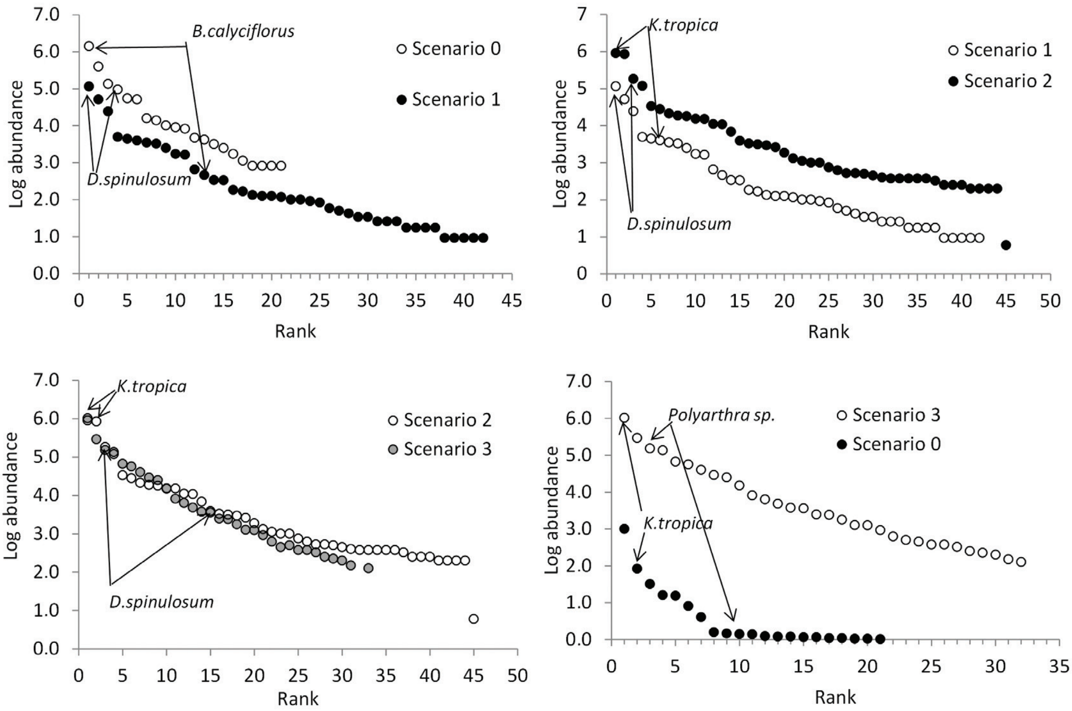

Figure 3. Dominance curves of the species found in the zooplaktonic community samples of Ibirité reservoir sampled in the four scenarios during the studied hydrological cycle.

4. Discussion

Stability of the zooplanktonic community was found only in the transition between scenarios 1 (with high rainfall levels) and 2 (with an evident process of vertical circulation), when cyanobacterial blooms were not found. This suggests that the intensity of the disturbance caused by cyanobacteria growth might be higher than disturbances of other nature, such as rainfall and vertical circulation, having an important influence in the structure of the zooplanktonic community.

The zooplankton of tropical freshwater environments has a short life cycle. According to Allan (1976), the average longevity of zooplanktonic organisms at 25°C is 5 days for rotifers and 40 days for microcrustaceans (cladocerans and copepods). Thus, the temporal scale adopted in this work (two months between the scenarios) was enough to allow a complete substitution of the zooplanktonic community. A study which intends to determine the persistence and stability of a community must adopt a temporal scale that contemplates at least one complete turnover of individuals belonging to the involved populations (Connell and Sousa, 1983).

Pinto-Coelho et al. (1998), when studying the zooplanktonic community at Ibirité reservoir, credited the great temporal oscillations found in that community

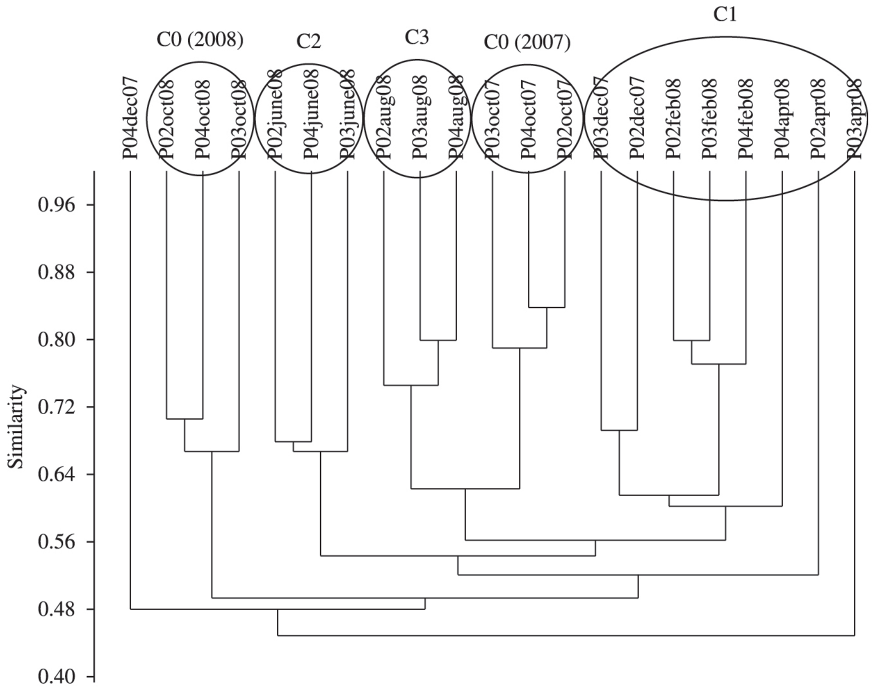

Figure 4. Cluster analysis of the sampling units (point/month and year), during the studied hydrological cycle at Ibirité reservoir.

Table 3. Values of temporal β diversity (Whittaker, 1960) of the transition between scenarios during the hydrological cycle at Ibirité reservoir.

Transition	β diversity
C 0-1	1.05
C 1-2	0.57
C 2-3	0.80
C 3-0	1.45

to a probable character of ecological instability in this environment. According to Connell and Sousa (1983), the stability analysis is the quantitative approach to the changes in the relative abundance of species through time.

Cyanobacteria bloom events are disturbances of biological nature. Disturbances in ecological systems work as "filters", producing modifications in the energy flux and structure of the communities (Tundisi, 1999). The intense growth of cyanobacteria, usually in euthrophic environments, led to several alterations in the water quality that modified the abiotic and biotic matrix of the system (Pinto-Coelho, 1998; Rolland et al., 2005), affecting the structural pattern and diversity of the zooplanktonic community (Haney, 1987; Bouvy et al., 2001). Cyanobacterial blooms may affect zooplankton through mechanical inhibition, mainly chroococoids colonies, such as *Microcystis*; production of secondary metabolites, in the case of toxic strains, and as a poor nutritional source for growth and reproduction of zooplankton (Porter and Orcutt, 1980; Lampert, 1987, Gulati and DeMott, 1997; Nandini, 2000; Tillmanns et al., 2008). Such alterations in the environment, caused by cyanobacterial blooms, might explain the absence of stability found in the zooplanktonic community in the transitions between scenarios (C0-1; C2-3; C3-0), where bloom events were found (at least in one of the contemplated scenarios).

Persistence is a perspective qualitative, through which it is possible to evaluate the changes in species composition (Connell and Sousa, 1983). During the studied period, a low persistence of the zooplanktonic communities was verified by the cluster analysis which showed difference in the species composition between the scenarios.

In order to classify the community as persistent in relation to its composition, it was expected that, in the cluster analysis, the same sampling point between different scenarios was more similar than other points in the same period (Vieira et al., 2005). In other words, the sampling units (point, month/year) should group themselves according to the sampling place (point) (ex: P02 Oct/07; P02 Dec/07; P02 Feb/08...) and not to the sampling period (scenario) (ex: P02 Oct/07; P03 Oct/07; P04 Oct/07...). Thus, it is possible to affirm that the changes in the environmental conditions, during the studied hydrological cycle, caused changes in the composition of the zooplanktonic community at Ibirité reservoir. As a result, some species were favoured whereas others, which did not adapt to the new conditions, became rare or disappeared from the samples, thus altering the structure of the zooplankton.

The sampling units in scenario 0 (October 2007 and 2008) grouped themselves according to the sampling year. This may be explained by the change in the composition of the phytoplankton during the blooming periods. In October 2007, the algal bloom was predominantly composed by *Microcystis spp*., but in 2008, it was formed by *Sphaerocavum brasiliensis* (Barbosa et al., unpublished data), thus supporting the idea that blooms of different species of cyanobacteria may probably have different influences in the zooplankton composition, depending on the morphology, nutritional value and toxicity of the dominant cyanobacteria species (Ghadouani et al., 2003; Tillmanns et al., 2008).

The major variations in the composition of the zooplanktonic species, verified by the highest values of temporal β diversity, were obtained in the transitions between the scenarios that represent the peak of the cyanobacterial bloom, and the lowest β diversity value in the transition between scenarios where no cyanobacterial bloom was verified. These results suggest, once more, that the intensity of a blooming event is higher than other events, such as strong rains and vertical circulation, creating marked effects on the structure of the zooplanktonic community.

5. Final Consideration

The results of the stability, persistence and β diversity analysis in the present work showed lower stability and higher variation in the composition of the zooplanktonic community in the transitions between scenarios with occurrence of blooms, which strengthens the idea that cyanobacterial blooms work as selective "filters", or in other words, they are disturbances with enough ability to alter the structure of the zooplanktonic community.

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