Diversity of the Zooplankton (Alpha and Beta) in the Lentic Environment in the Miranda River Basin (MS, Brazil)

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Abstract

The zooplankton is one the main components of the freshwater environments, and play fundamental services in aquatic system. The diversity of the zooplankton is central to maintain these services and increase resilience of the system. The aim of this present work was to obtain the values of alpha-diversity, ecological diversity and beta-diversity for zooplankton (Rotifera, Cladocera and Copepoda) in lentic environments with different origins, uses, preservation stages in the Miranda River Basin (MRB), Mato Grosso do Sul State (Brazil). The zooplankton was sampled with a graduated trap and filtering water using a net with 20 µm of pore size. After counting, the organism it was applied the Whittaker beta diversity coefficient and Shannon-wiener diversity index. The total richness for each zooplankton group was 62 for Rotifera, 32 for Copepod and 26 for Cladocera. The MRB has two hotspot with different origin and use, one a urban

reservoir and another a water outcropping. Cladocera presents a more restricted distribution with highest diversity in the plateau and more homogenous population than Rotifera and Copepoda presented a similar pattern.

Keywords: zooplankton distribution, aquatic ecology, freshwater dispersion, Paraguay River Basin.

Introduction

The zooplankton is one the main components of the freshwater environments, and play fundamental services in aquatic system. These services include the nutrient cycling in water (VANNI, 2002) and the energy transfer by food chain web (TUNDISI, MATSUMURA-TUNDISI, 2003; DICKMAN et al. 2008). The diversity of the zooplankton is central to maintain these services and increase resilience of the system (DOWING, LEIBOLD, 2010; AWITI, 2011).

Among the many ways to measure the biological diversity, the richness (alpha-diversity) and ecological diversity (Shannon-Weiner index) are the most used (MATSUMURA-TUNDISI, 1997). Another diversity related to spatial area is the Beta-diversity that is the product of Gamma diversity (total species of some area) by alpha-diversity (the local number of species) (WITHAKER, 1972). Where, if the environment is composed by many sites with low beta-diversity means there is high similarity among them.

The environment changes promote by climate and by human activities impact the freshwater system (PERKINS et al., 2015; WALSH et al. 2016) and the diversity decreasing resulting in loss of biodiversity and diminishing the ecosystem services. In many freshwater systems surrounded by

human activities, the biodiversity decrease changing the ecological diversity too in general became the environment less heterogenic. According McKnight et al. (2007) the environmental homogenization promoting by human activities implies in reduction of beta-diversity.

The aim of this present work was to obtain the values of alpha-diversity, ecological diversity and beta-diversity for zooplankton (Rotifera, Cladocera and Copepoda)

in lentic environments with different origins, uses, preservation stages in the Miranda River Basin (MRB), Mato Grosso do Sul State (Brazil).

Material and Methods

The figure 1 show the Miranda River Basin location and the sample point distributions. It were sampled 24 lentic water bodies, including natural and artificial ones. In each lake were sampled water for chemical and physical analysis. The zooplankton was sampled with a graduated trap and filtering water using a net with 20 μm of pore size. The filtered sample was preserved using formaldehyde with 4% in a polyethylene flask. The identification and quantification of zooplankton were done using optical microscope and

stereoscope microscope and specialized bibliography. It were apply the Whittaker beta diversity coefficient (γ/α), where γ is the gamma diversity (all species in the river basin) and α is the alpha diversity (all local species) and Shannon-wiener diversity index ($-\sum p_i \ln p_i$) where p_i is the relative density of each species at local. The median ($\bar{x}$) was calculated for each group.

Results

The total richness for each zooplankton group was 62 for Rotifera, 32 for Copepod

and 26 for Cladocera. The Rotifera has recorded in 23 sites, the Copepoda in 22 sites and the Cladocera in 15 sites.

The table 1 shows the values for richness, Shannon-Weiner Index and β -diversity for zooplankton groups in each sample point.

The results shows that Rotifera presented 12 sites above the median values for diversity index and 11 for Beta-diversity. Copepoda had the same values 12 sites for diversity index and 11 for Beta-diversity, but with one site less and Cladocera presented 8 and 7 respectively.

Figure 1 – Location of the Miranda River Basin in the Mato Grosso do Sul State and the samples points distribution.

Table 1 – The values for richness, Shannon-Weiner index (H) and Beta-diversity (β) for Rotifera, Copepoda and Cladocera in the MRB sites and median ($\tilde{x}$).

Rotifera				Copepoda				Cladocera			
Sites	Richness	H	β	Sites	Richness	H	β	Sites	Richness	H	β
P1	14	2,4	4,4	P1	3	0,9	10,7	P2	16	1,7	1,6
P2	17	2,4	3,6	P2	13	1,8	2,5	P4	6	1,6	4,3
P3	5	1,3	12,6	P3	4	0,6	8,0	P6	1	0,0	26,0
P4	12	1,5	5,2	P4	4	0,9	8,0	P11	1	0,0	26,0
P5	10	1,6	6,2	P5	3	0,2	10,7	P12	5	1,3	5,2
P5	8	1,7	7,8	P6	4	1,3	8,0	P13	3	0,4	8,7
P6	14	2,5	4,4	P7	1	0,0	32,0	P14	6	0,6	4,3
P8	4	1,3	15,5	P9	4	1,3	8,0	P15	3	0,5	8,7
P9	2	0,5	31,0	P10	1	0,0	32,0	P16	1	0,0	26,0
P11	3	0,6	20,7	P11	2	0,7	16,0	P17	3	1,1	8,7
P12	5	1,3	12,4	P13	4	1,4	8,0	P19	5	1,3	5,2
P13	8	0,7	7,8	P14	2	0,5	16,0	P20	5	0,9	5,2
P14	9	1,4	6,9	P15	11	1,7	2,9	P21	5	0,5	5,2
P15	13	0,8	4,8	P16	5	1,6	6,4	P22	4	0,9	6,5
P16	8	1,4	7,8	P17	3	1,1	10,7	P23	3	0,2	8,7
P17	10	1,6	6,2	P18	9	1,4	3,6				
P18	12	2,0	5,2	P19	3	1,1	10,7				
P19	15	2,6	4,1	P20	3	0,4	10,7				
P20	6	0,4	10,3	P21	6	0,9	5,3				
P21	2	0,7	31,0	P22	2	0,7	16,0				
P22	4	1,3	15,5	P23	8	1,0	4,0				
P23	10	2,0	6,2	P24	2	0,6	16,0				
P24	14	1,8	4,4								
$\tilde{x}$	9,0	1,4	6,9	$\tilde{x}$	3,5	0,9	9,3	$\tilde{x}$	4,0	0,6	6,5

The figure 2 A-C shows the location in the MRB of the samples points with high and lowest diversity for the zooplankton

group. There were few coincident points for both higher and lower diversity.

Figure 2 – Distribution of diversity index and beta-diversity for Rotifera A1 and A2; for Copepoda B1 and B2; for Cladocera C1 and C2.

Discussion

The distribution of zooplankton has two components by local such as water chemistry and regional factors such as climate variation (SHURIN et al. 2000). In the RMB the main regional factor is the altimetry degree with high in the east about 250 to 1200 m and low in the west, Pantanal floodplain about 80 to 150m (ALMEIDA et al. 2015).

Rotifera and Copepoda were the most frequent groups and the Cladocera the less one. The high absence of Cladocera show the narrow ecological when compared with the Rotifera and Copepoda as observed in other studies of distribution (PANARELLI et al. 2013; PINEL-ALLOUL, MIMOUNI, 2013). Cladoceran was not restricted to a region but has presented minor frequency in floodplain area, which is driven by high water fluctuation (ROSSA et al. 2001; PANARELLI et al. 2013; KARPOWICZ, 2016).

Diversity index highest values for Rotifera, Cladocera and Copepoda show some overlap, and point to the hotspot that support high diversity for all groups. Points 2 and 19 are the hotspot. The point 2 is an urban reservoir and 19 is a water outcropping in a cattle farm. These agree with the environmental heterogeneity promotes the diversity in zooplankton communities (COTTENIE, DE MEESTER, 2004; BARNETT, BEISNER, 2007). Both Rotifera and Copepoda has a hotspot too in the Pantanal area, points 23 and 24, and Cladocera not, with agreement of the hypothesis that this group are most susceptible to

water level variation (ROSSA et al. 2001; PANARELLI et al. 2013; KARPOWICZ, 2016).

Beta-Diversity used be high when the diversity index is low, but some incongruence can be found. The Cladoceran presented a high congruence between both diversities and Rotifera and Cladocera less congruence. Cladocera population is more homogenous (shares more species) in the water bodies, and Rotifera and Copepoda more heterogeneous. The Cladocera presents more restricted environments and probably is more sensitive to environmental changes (SHURIN et al. 2010), once that population is more homogenous. Most of lakes show a poor combination for diversity had high beta-diversity and low alpha-diversity (with low diversity index) that is expected (KOLEFF et al. 2003). The small lakes with low diversity index and high beta-diversity values are important repository cause has high density that facility the dispersion (DE BIE et al. 2008).

These results combining beta-diversity and diversity index drives for two main statements, which works as a tool for environmental managers. The first, Cladocera community shows more sensitive to regional changes, such as plateau and floodplain areas that is in agreement with other distribution studies (SHURIN et al. 2000; NEVALAINEN et al. 2010, SWEETMAN, RÜHLAND 2010). The second, Rotifera and Copepoda communities is determinate by local process, such as pollution and eutrophication, these communities historically is used for local

water quality indicator (SLÁDEČEK, 1983, MATSUMURA-TUNDISI, 1999, SILVA, 2011, PERBICHE-NEVES et al., 2013).

Concluding, the MRB has two hotspot with different origin and use, one a urban reservoir and another a water outcropping. Cladocera presents a more restricted distribution with highest diversity in the

plateau and more homogenous population than Rotifera and Copepoda presented a similar pattern.

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