

Microbial biomass in a haplic gleysol in the Mato Grosso State Pantanal

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Abstract

The Pantanal is a biome that lives under water conditions and resists to two very distinct periods: flooded and drained. The objective of this study was to evaluate the behavior and quantify the microbial biomass during the flood period, in soils under riparian forest and cerrado vegetation in Mato Grosso State pantanal, at two depths. At depths of 0.00-0.05 m, the highest levels of C-BM and RB were found in cerrado soils; for the metabolic quotient no differences were observed in the two vegetations; the total organic carbon content was higher in riparian forest soils and the microbial quotient was higher in cerrado soils. Bacteria and fungi were found to be more abundant in the cerrado soil at the two evaluated depths and the actinomycetes in the forest. It is concluded that in the flood period there are the presence of active microorganisms which produce a differentiated biomass due to the phytophysiology of the location.

Keywords: Biomass carbon, basal respiration, bacteria, fungi and actinomycetes

Introduction

Flooded areas, which are extensive and heterogeneous, such as those of the Pantanal region, play an important role in biological diversity, due to the diversity of natural habitats that open up opportunities for feeding and reproductive niches, as well as essential functions in the ecosystem such as the carbon stock, fish production and recharge of aquifers (Alho, 2008).

The low slope in the Pantanal region makes it difficult to drain the water and, in combination with the meso relief, is possible to observe different and characteristic environments, associated with the mosaic vegetation, such as the "mountain ranges", with denser tree vegetation, or riparian

vegetation, which is very dynamic, due to the sinuous and unstable fluvial beds (Pott & Pott, 2005).

The seasonal changes between flood and drought phases and also the permanent cover vegetation results in the addition of large amounts of nutrients and their rapid cycling, allowing productivity for a region considered to be poor and directly affecting the local microbial community (Alho, 2008).

The microbial population in the soils represents the most abundant and diversified life form in the planet and plays important roles in the decomposition of vegetal residues, mineralization, biological fixation of nitrogen, formation of

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mycorrhizal associations and in bioremediation, besides others (Bunemann et al., 2006).

The aim of this study was to evaluate the behavior and quantify the microbial biomass of the soils under riparian forest (RF) and cerrado in the Poconé, MT, Pantanal region.

Material and Methods

The study was conducted with soils collected in the Private Reserve of Natural Heritage (RPPN) / National System of Conservation Units (SNUC), from the Pantanal Social Service of Commerce (SESC), located in the Poconé municipality, in the northeast region of Pantanal, Mato Grosso State, Brazil, at 16°33'19" south latitude and 56°17'11" west longitude coordinates, with 120 m of altitude. The Reserve occupies an area of approximately 1,076 km².

The soil is classified as haplic gleysol (Embrapa, 1999). The climate of the region is Aw, with average annual temperature between 22°C and 32°C and annual mean rainfall between 1100 and 1200 mm (Hasenack et al., 2003).

The collection was realized in May 2010, corresponding to the ebb period, which is from April to June, in which the region has the water level reduced until reaching total drought, a period known as the dry period of the

Pantanal region. In the month of collection the precipitation was 200 mm and the temperature varied between 23°C to 28°C.

The soil was collected in two phytophysiognomies: riparian forest and cerrado, at depths of 0.00-0.05 m and 0.05-0.20 m. In each phytophysiognomy, a transect was performed, where 20 sub-samples (10 for each depth) were collected at points located 30 cm from each other, making a total of 40 samples.

In the riparian forest, the soil presented a clayey texture (630 g clay kg dry soil⁻¹) and vegetation composed of thinner trees closer to each other and near the river bed; The cerrado had shrubby vegetation, with the presence of grasses and soil with loamy sand texture (134 g of clay kg dry soil⁻¹).

The samples were conditioned in plastic bags, protected from light and kept in thermal boxes until the arrival in the laboratory. Samples were dried in the air to adjust the humidity to 50 to 60% of the field capacity, sifted through a sieve of 2 mm mesh, packed in plastic bags and kept in a cold room at 4°C. The chemical characterization of soils was performed in a private laboratory, following a methodology recommended by Embrapa (1997) and shown in Table 1.

Table 1. Chemical characteristics of soils under riparian forest and cerrado in the Pantanal of the Mato Grosso State.

Areas	Depth m	pH water	P --mg dm ⁻³	K	Ca	Mg	Al	H + Al	MO g dm ⁻³
Forest	0,00-0,05	5,4	38	135	4,3	2,0	0,3	11,2	67,0
	0,05-0,20	4,5	4,3	103	1,1	1,3	3,1	8,8	48,4
Cerrado	0,00-0,05	4,8	4,6	44	0,6	0,3	0,6	4,9	22,7
	0,05-0,20	4,6	3,0	32	0,1	0,1	0,8	2,9	10,7

The microbial biomass carbon (C-BM), along with basal respiration (RB) were quantified by the fumigation-incubation method (Alef, 1995), in which were determined the C-BM and CO₂ from 50 g of soil. The C-BM was obtained from the calculation: biomass-C = (fumigated CO₂-C - CO₂-C not fumigated) / kc; where kc corresponds to a coefficient which varies according to the incubation temperature. The Kc of 0.45 was used, which corresponds to an incubation temperature of 25°C.

The metabolic quotient (qCO₂) was

obtained by the ratio between RB and C-BM (Anderson & Domsch, 1993); the microbial quotient (qMic) was obtained by the C-BM/TOC ratio (Sparling, 1992). Total organic carbon was determined by the equipment TOC Multi N/C 3100 HT 1300-Analytik Jena AG.

For the enumeration of viable total microorganisms, the serial dilution technique described in Wollum (1982) using the following culture media was used: nutrient agar for total bacteria, potato dextrose water (PDW) medium for total fungi and soil extract for actinomycetes.

The plates were incubated at 28°C, the bacteria reading was performed after 24 hours, for fungi in 72 hours and for actinomycetes in 7 days.

The data were submitted to the non-parametric Kruskal-Wallis multiple comparisons test, since the experiment consists of areas with distant treatments, with no randomization. The statistical package Assisat, version 7.6, beta 2012 was used for calculations (Silva & Azevedo, 2002).

Results and Discussion

It was verified the presence of total microorganisms in activity in Pantanal soils, which was proved by the statistical differences observed in the two evaluated areas. The behavior of the microbial biomass of the soils was different in the two areas evaluated for most of the quantified microbiological parameters. The levels of C-BM, RB and qMic were higher in soils under the cerrado vegetation, at both depths. For the metabolic quotient (qCO₂) no significant statistical differences were observed (Table 2).

Table 2. Microbial biomass carbon (C-BM), basal respiration (BR), metabolic quotient (qCO₂), total organic carbon (TOC) and microbial quotient (qMic) in soils under riparian forest and cerrado in the Pantanal of the Mato Grosso do State, Brazil.

Areas	C-BM --C-CO ₂ µg of CO ₂ g ⁻¹ --	RB	qCO ₂ µg C-CO ₂ µg de C-BM day ⁻¹	TOC g.kg ⁻¹	QMic %
-----0,00-0,05 m-----					
Forest	29.75 b	14.31 b	0.51 a	8.43 a	3.52 b
Cerrado	150.35 a	49.69 a	0.38 a	1.74 b	86.4 a
CV (%)	22	26	26	32	32
0,05-0,20 m					
Forest	19.74 B	4.17 a	0.24 a	2.68 a	7.36 b
Cerrado	138.86 A	8.04 a	0.07 a	0.07 b	1983.71 a
CV(%)	20	22	25	22	36

Means followed by the same letter in column and for each variable are not different, according to Tukey's test at 5% (p>0.05).

The released CO₂ is generated entirely by C-BM mineralization in response to the rapid increase in soil water potential and that the flooded and drained periods releases the physically protected organic matter, increasing the amount of C extractable from organic matter by up to 200 % (Fierer & Schimel, 2003).

The soil of the forest presented higher total organic carbon (TOC) when compared to the cerrado, which confirms the organic matter content, which was 67 g dm⁻³ in the forest and 22.7 g dm⁻³ for cerrado. The decomposition of organic matter in soils under anoxic conditions, such as those of Pantanal, is low and carbon tends to accumulate in the soil (Alho et al., 2008).

Souza et. al (2008) studying the cerrado soil also did not observed variations in the qCO₂ between the different grazing intensities evaluated. According to these authors, very high values of qCO₂ are found in stressful environmental conditions, in which BMS spends more C for its maintenance and as BMS becomes more efficient, less C is lost as CO₂ by respiration and a significant fraction is incorporated into the microbial tissue; Therefore, soils with low qCO₂ would be closer to the equilibrium stage.

The metabolic quotient (qCO₂), the basal respiration rate of the microbial biomass and the attributes related to the organic carbon cycle were evaluated in the study of Cardoso et al. (2009), which verified that although there was a tendency for greater release of C-CO₂ in environments under greater anthropic intervention, as in cultivated pastures implanted instead of native forests, significant increases were observed.

Habitats change as water moves nutrients and sediments, depositing inorganic and organic materials, which enrich micro-habitats, favoring the proliferation of micro-organisms, as well as invertebrates and fish.

The microbiological attributes are higher in soils of the South-Mato Grosso Pantanal that passed through the conversion of the native forest into cultivated pasture and of native pastures to continuous grazing system (Cardoso et al., 2009). It was verified that despite the cerrado soil presented lower content of organic matter and TOC, the microorganisms were able to mineralize C-BM, releasing more CO₂, showing greater efficiency in the organic matter C extraction.

The number of colony forming units (CFU) of bacteria and total fungi was higher in cerrado soils and in the depth of 0.00-0.05 m. For the other evaluated microorganisms and depth, no significant statistical differences were observed (Table 3).

Table 3. Number of colony forming units for total bacteria in nutrient agar medium (Agar), total fungi in PDA medium and actinomycetes in soil extract medium (Soil ext), in soil samples collected under forest and cerrado in the Mato Grosso State Pantanal.

Areas	N° UFCx 10 ³ g ⁻¹ dry soil			N° UFCx 10 ³ g ⁻¹ dry soil		
	Agar	PDA	Soil ext	Agar	PDA	Soil ext
	0.00-0.05 m			0,05-0,20 m		
Forest	125.33 B	13.67 b	26.0 a	13,67 a	5,33 a	14,33 a
Cerrado	258.33 A	26.67 a	12.0 a	26,67 a	2,33 a	9,66 a
CV (%)	5.13	9.35	7.09	2.57	4.07	20.52

Means followed by the same letter in column and for each variable are not different, according to Tukey's test at 5% ($p > 0.05$).

that are responsible for the activity, but was not observed in this study, which indicates that the microorganisms present in the forest were not in large number, but were able to degrade the plant materials available to them during the soil collection period (Perez et al., 2004).

The number of actinomycetes found in the higher amounts in forest soils may have been due to the fact that they present a great diversity of habitats and also because they produce spores that can increase their survival in unfavorable environments.

In soils, actinomycetes are numerically less dominant than other bacterial populations, but are more numerous when compared to fungal populations (Wollum, 1982).

The activity of soil microorganisms is considered a positive attribute for soil quality, with basal respiration being a sensitive indicator of the residues decomposition, the soil organic carbon and ecosystem disturbances. It is important to carefully interpret the results, since the high values of basal respiration do not always indicate desirable conditions, where a high respiration rate can mean, in the short term, release of nutrients to the plants and, in the long term, loss of carbon from the soil to the atmosphere (Tótolá & Chaer, 2002).

These results are different from Melloni et al. (2001) and Stieven et al. (2009), who verified an increase in soil microbial population in a forest ecosystem with lower water content and report that this result is due to the greater

In the forest were found lower amounts of microorganisms, but the highest organic matter and total organic carbon content in the two depths. The deposition and decomposition of organic residues in forest soils is linked to the growth and development of the microorganisms

cycling of organic matter or to the presence of organic residues with higher C/N ratio in these environments.

Conclusion

In soils of the Mato Grosso State Pantanal, in the period of ebb, there are the presence of aerobic microorganisms and that are able to survive in the region's flood period.

The vegetation under the soils of the Pantanal biome modifies the amount and activity of the soil microorganisms.

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