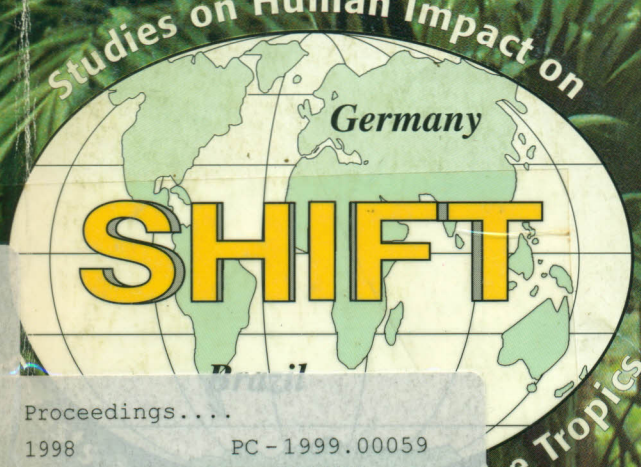
Proceedings of the Third SHIFT-Workshop Manaus March 15-19, 1998



A German-Brazilian Research Program

Microbial respiration and biomass in tropical forest soil and litter

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ABSTRACT

Microorganisms play a major role in the decomposition of organic matter and in the cycling of nutrients. Microbial biomass and metabolic activity are ecologically relevant parameters for the description of the structure and function of ecosystems. We measured the microbial substrate-induced respiration (SIR) and the basal respiration (BR) of the top soil and of the litter layer of a primary forest, a secondary forest and of a plantation. Measurements were made in a continuous flow-through system connected to an infra-red gas analyzer (IRGA). Microbial biomass was calculated on the basis of the SIR values. From the data of the first three sampling dates we conclude that microbial biomass of the three field sites does not differ significantly. There is a high natural spatial variability within each field site.

RESUMO

Microorganismos têm um papel principal na decomposição de matéria orgánica e no ciclo de nutrientes. Biomassa microbiana e atividade metabôlica são parámetros ecológicos pertinentes para a descrição da estrutura e função de ecossistemas. Nos medimos a respiração microbiana induzida por substrato (SIR) e a respiração basal (BR) do solo de topo e da camada de serrapilheira de uma floresta primária, uma floresta secundária e de uma plantação. As medidas foram feitas em um sistema de fluxo continuo conectado a um analisador de g_s infra-vermelho (IRGA). Biomassa microbiana foi calculada em base dos valores de SIR. Dos dados das primeiras trés datas concluimos que a biomassa microbiana dos trés locais de campo não difere significativamente. Há uma variabilidade espacial natural alta dentro de cada local de campo.

ZUSAMMENFASSUNG

Mikroorganismen spielen eine bedeutende Rolle in der Zersetzung organischer Substanz und in Nährstoffkreisläufen. Mikrobielle Biomasse und Stoffwechselaktivität sind ökologisch relevante Parameter für die Beschreibung von Struktur und Funktion von Ökosystemen. Wir maßen die mikrobielle substratinduzierte Atmung (SIR) und die Basalatmung (BR) im Oberboden und in der Streuschicht eines Primärwaldes, eines Sekundärwaldes und einer Plantage. Die Messungen wurden in einem "continuous-flow" - System durchgeführt, das mit einem Infrarot-Gas-Analysator verbunden war (IRGA). Die mikrobielle Biomasse wurde auf der Basis der SIR-Werte kalkuliert. Aus den Ergebnissen der ersten drei Probentermine schließen wir, daß sich die mikrobielle Biomasse der drei Untersuchungsflächen nicht signifikant unterscheidet. Es gibt eine hohe natürliche räumliche Variabilität innerhalb jeder Untersuchungsfläche.

INTRODUCTION

Microorganisms are the most abundant organisms in soil and litter layers. The microbial biomass is an important structural element of the soil compartment. In the Northern hemisphere more than 80 % of the non-plant biomass of soil is provided by microorganisms. Moreover microorganisms play an important role in the decomposition of organic matter and in the cycling of nutrients, thus fulfil essential ecosystem functions.

There are only few data available on the microbial biomass and activity in tropical forest soil and litter (Yang and Insam 1991, Feigl et al. 1995, Wood 1995).

The aim of the study was to compare the microbial biomasses and the metabolic activities of soil and plant litter of different tropical forest types: a primary forest (FLO), a secondary forest (SEC) and an abandoned plantation of rubber trees (Seringueira) which was used as a polyculture forestry research area since 1992 (POA/POC).

MATERIAL AND METHODS

The study area belongs to the agricultural research station EMBRAPA - Amazônia Ocidental (altitude 44 m), which is located close to the city of Manaus, Amazonas, Brazil. In 1997, the mean annual temperature was 27.9 C and the precipitation was 2585 mm. All investigation plots were located within a distance of less than 200 m and share the same soil properties (Table 1), but the vegetation cover differs greatly since especially POA/POC has broad open spaces.

Every three months, 20 soil samples (top soil 0-5 cm and 5-15 cm) were sampled on each plot with a soil corer (6.5 cm diameter). Soil samples were sieved and stored at 10 °C until used.

The amount of microbial biomass in the soil and in the litter was estimated by applying the substrate-induced respiration (SIR) method (Anderson and Domsch 1978).

Metabolic activity was assessed by measuring the basal respiration (BR) of the soil and of the litter. If necessary, soil and litter were adjusted to the optimal moisture (ca. 40 % WHC) and pre-incubated before measuring respiration.

All measurements were done in a continuos flow-through system connected with an Infra-red gas analyser (IRGA) under controlled temperature conditions.

Table 1: Soil properties of the three investigation plots *

Parameter	**FLO**	**SEC**	**POA/POC**
	Primary forest	Secondary forest	Polyculture
Vegetation	diverse	Secondary vegetation	Secondary vegetation
Soil Type	Sandy clay (60 % clay, 25 % sand, 15 % silt)		
pH (H_2O)	4.2 - 4.8	4.7 - 5.0	4.2 - 6.0
Org. content	?	2.4 - 5.3	2.4 - 6.8

* see also Roembke et al., this volume, p. 488

RESULTS AND DISCUSSION

The data of the first four samplings during July 97 and March 98 indicate that there seems to be no statistically significant difference between the three forest soils with respect to the amount of microbial biomass and activity (Table 2). Compared to forest soils from the northern hemisphere the values for microbial biomass (C_{mic}) are low whilst the basal respiration seems to be comparable thus resulting in a relatively high biomass-specific respiration rate.

First measurements of the leaf litter indicate an increased microbial respiration rate as compared to the soil by a factor of roughly 40 (data not shown).

Table 2: Microbial basal respiration [µl CO_2 h^{-1} g^{-1} soil], microbial biomass [µg C_{mic} g^{-1} soil] and specific respiration [µl CO_2 mg^{-1} C_{mic} h^{-1}] of the top soil layer (0 - 5 cm)*

	Basal	Biom.	Spec	Basal	Biom.	Spec	Basal	Biom.	Spec	Basal	Biom.	Spec
July 97	FLO	FLO	FLO	SEC	SEC	SEC	POC	POC	POC	POA	POA	POA
MEAN	1.91	426.13	4.54	2.07	398.29	5.25	1.99	429.46	4.42	1.40	454.82	3.16
SD	0.53	74.77	1.18	0.64	104.59	1.40	1.09	158.60	0.94	0.60	201.33	0.62
Sep. 97	FLO	FLO	FLO	SEC	SEC	SEC	POC	POC	POC	POA	POA	POA
MEAN	1.52	385.63	3.95	1.13	464.88	2.42	1.09	390.07	2.74	1.70	503.71	3.30
SD	0.53	68.47	1.26	0.39	113.79	0.49	0.43	94.49	0.52	0.77	127.69	0.96
Dec.97	FLO	FLO	FLO	SEC	SEC	SEC	POC	POC	POC	POA	POA	POA
MEAN	2.07	396.23	5.15	1.79	418.97	4.15	1.62	421.08	4.00	1.90	510.26	3.69
SD	0.88	121.33	1.45	0.75	95.63	1.03	0.62	107.83	1.28	0.58	113.67	0.97
Mar. 98	FLO	FLO	FLO	SEC	SEC	SEC	POC	POC	POC	POA	POA	POA
MEAN	1.75	378.80	4.58	1.48	411.47	3.60	1.40	393.37	3.47	1.48	370.30	3.98
SD	0.56	52.23	1.21	0.41	46.40	0.99	0.82	72.55	1.67	0.53	62.67	1.20

* Mean values and standard deviation (FLO, SEC, n = 20; POC, POA, n = 10)

ACKNOWLEDGEMENTS

We thank the German Federal Ministry for Education and Research (BMBF) and the Brazilian Research Council (CNPq) for funding the studies reported here.

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