UNIVERSIDADE FEDERAL DA BAHIA

Instituto de Biologia

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EFEITO DA MISTURA DE DUAS ESPÉCIES DE PLANTAS NA DECOMPOSIÇÃO FOLIAR EM UM ECOSSISTEMA LÓTICO

Dissertação de Mestrado apresentada ao Instituto de Biologia do Campus de Ondina, Salvador, da Universidade Federal da Bahia, como parte dos requisitos para obtenção do título de Mestre em Ecologia e Biomonitoramento.

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Salvador – BA

2011

“Sucesso é uma questão de não desistir, e fracasso é uma questão de desistir cedo demais”

Walter Burke

Banca Examinadora

Drº.José Francisco Gonçalves Júnior

Drª Adriana Oliveira Medeiros

Drº Eduardo Mendes da Silva

(Orientador)

Agradecimentos

Primeiramente, agradeço à minha família (Mário, Eliane e Leonardo), por todo esforço e dedicação à minha educação e formação anterior, assim como por todo apoio e compreensão durante esses dois anos.

Agradeço à UFBA, ao Programa de pós-graduação Eco-Bio, e todo seu corpo docente, pela formação teórica e ensinamentos durante o decorrer das disciplinas do curso, fornecendo grande base para o desenvolvimento do projeto e desenvolvimento científico pessoal, assim como à secretária do curso Jussara, por sua dedicação e eficiência.

À Capes pela bolsa concedida, por intermédio de cotas para o ppg Eco-Bio e Fapesb pelo financiamento do projeto.

Agradeço também, aos professores: Dr.º Eduardo Mendes da Silva, pela oportunidade de ingresso neste programa, e pelo apoio, disposição e orientação durante o desenvolvimento do projeto; Drª Adriana Oliveira Medeiros, pelas dicas, ao convite a participação de projeto conjunto em Mucugê, e à participação na banca avaliadora; Drº José Francisco Gonçalves Júnior, pelo aceite de participação na banca avaliadora e às dicas, disposição e contribuições

À toda equipe do Marenba, pela disposição e colaboração sempre que necessária, especialmente à servidora técnica em química do laboratório de preparação de amostras 'Jojó', e ao Leonardo, pela grande ajuda com a realização das análises químicas da água.

Ao coordenador do Parque Municipal Sempre Viva, Euvaldo Ribeiro, e toda sua equipe, pelo apoio, oportunidade e colaboração sempre que necessário para a execução do projeto.

Aos colegas de curso do Eco-bio, pelas conversas e troca de idéias ao longo e após as disciplinas do curso, e especialmente à Henrique e Tatiana, pelas muitas conversas e toda convivência e colaboração nos trabalhos de campo.

Aos estagiários Rodrigo e Eduardo, por toda ajuda e paciência (muita!) na triagem das amostras, a estes e também a Tâmires, pela ajuda, força, amizade, convivência e disposição sempre que necessária nas atividades de laboratório e de campo.

Meu muitíssimo obrigado a todos!

Sumário

Introdução geral

A relação entre diversidade, complexidade e estabilidade com função do ecossistema tem sido uma importante questão na história da ecologia (Bengtsson, 1998). Tilman (1999) destaca que inicialmente o interesse desta relação residia nos efeitos da diversidade e complexidade trófica sobre a estabilidade dos ecossistemas e comunidades, contudo, este interesse enfraqueceu-se e apenas no início da década de 1990 começou a reaparecer, com interesses principalmente na relação da biodiversidade com os processos e serviços ecossistêmicos.

Desde então, nesses últimos vinte anos, este programa de pesquisa tem crescido e recebendo destaque na literatura de ecologia (ver revisões de Giller et al., 2004; Reiss et al., 2009; Sandini e Solomini, 2009). Em uma abordagem de ciênciometria realizada por Caliman et al. (2010), os autores verificaram que os artigos publicados sobre o tema foi a uma baixa freqüência em relação a literatura ecológica no início da década de 90, aumentando bastante a partir de 1997, e conquistando uma significante freqüência ao longo dos quatro últimos anos analisados, de 2003 a 2007.

Alguns estudos analisando esta questão têm utilizado a decomposição foliar como processo funcional de estudo (Briones e Ineson, 1996; Salamanca et al., 1998), principalmente na última década (Lecerf et al., 2007; ; Ball et al., 2008; Chapman e Newman, 2010; Barantal et al., 2011). Porém em menor quantidade nos ecossistemas aquáticos (Swan e Palmer, 2004; Kominoski et al., 2007; Moretti et al., 2007a; Abelho, 2009; Kominoski et al., 2009; Hoorens et al., 2010). Em ecossistemas lóticos, a vegetação circundante (ripária) constitui uma zona de transição entre o rio e os terrenos adjacentes mais acima (Mishall e Rugensk 2006). Esta vegetação ripária está intimamente relacionada à cadeia alimentar do rio, através do fornecimento de detritos foliares originária do folhiço como principal suprimento de energia (Benfield, 2006; Abelho, 2009).

Os estudos iniciais de decomposição foliar se focavam em folhas de espécies individuais e a comparação entre elas, visando estabelecer os fatores principais que influenciam neste processo (Webster e Benfield, 1986; Abelho, 2001; Gartner e Cardon, 2004). A composição química do detrito foliar em decomposição é um importante fator para determinar a taxa de decomposição em muitos sistemas

(Hoorens et al., 2010; Bonanomi et al., 2010). E, juntamente com os fatores físicos e químicos, podem interferir nos mecanismos da biota que atua na decomposição (Webster e Benfield, 1986; Suberkropp e Chauvet, 1995; Jonsson e Wardle, 2008).

Posteriormente, dado a existência de grande quantidade de espécies nas formações vegetais, e ao fato de o processo de decomposição de seus detritos ocorrerem em conjunto, misturadas uns com os outros, a indagação passou a ser se elas podem se influenciar, (Gartner e Cardon, 2004; Abelho, 2009). Nesta perspectiva, muitos estudos verificaram o efeito da riqueza de espécies em uma mistura na decomposição da mistura como um todo (Swan e Palmer, 2004; Sanpera-Calbet et al., 2009; Bonanomi et al., 2010), e outros verificaram a partir da comparação da decomposição observada da mistura, e o esperado em relação á decomposição individual de cada componente da mistura (Gartner e Cardon, 2004; Ball et al., 2008; Abelho, 2009). Nestes, é verificado ausência de efeito quando o esperado e o observado da variável de resposta não diferem significativamente, e um efeito quando diferem, significando que ocorreu algum tipo de interferência de um ou mais componentes da mistura sobre outros (Lecerf et al., 2007).

Contudo, os resultados com experimentos de misturas têm sido diversos, mostrando efeitos positivos (aumento da decomposição), negativos (redução da decomposição) ou sem efeitos (Swan e Palmer, 2004; Moretti et al., 2007a; Abelho, 2009; Hoorens et al., 2010). Também são diversos quanto ao efeito da mistura na comunidade colonizadora e vice-versa, podendo ocorrer estimulo da colonização ou ausência de efeito (Leroy e Marks, 2006; Kominoski et al., 2007; Kominoski et al., 2009; Chapman e Newman, 2010). Além disso, poucos estudos têm verificado os mecanismos pelos quais os efeitos ocorrem, ou seja, quais componentes foliares da mistura estão sofrendo o efeito (Salamanca et al. 1998; Moretti et al. 2007a, Sanpera-Calbet et al., 2009; Hoorens et al., 2010).

Portanto, os mecanismos pelo quais como a composição de espécies de uma mistura afeta as taxas de decomposição em misturas ainda é uma questão em aberto, (Hoorens et al., 2010) e necessitando de esforços e estudos para uma melhor compreensão do processo.

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The missing effect of mixing two plant species on the foliar decomposition process in a lotic tropical ecosystem

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The missing effect of mixing two plant species on the foliar decomposition process in a lotic tropical ecosystem

Studies had showed the existence of interaction in the leaf mixture decomposition and consequent change of the total rate of decomposition, but less effort has been done in attempt the mechanism underlining these interactions. The study aimed to test the foliar mixture effect of two plant species on the decomposition rate and invertebrate colonization. The hypothesis tested was that each single leaf plant species decompose differently when in mixture, and the invertebrate colonization would differ between the single treatments and the mixture one. The study was carried out on a second order stretch of the Piabinha Creek, in the Parque Municipal Sempre Viva conservation unity, Mucugê, located in Chapada Diamantina region. A total of four litterbags types were prepared: *Bonnetia stricta* isolated (B), *Humiria balsamifera* isolated (H), *Bonnetia stricta* and *Humiria balsamifera* mixed and with post sampling separation (HBs) (weighing of each one in the mixture treatment), and another mixture of both without post sampling separation (HBj) (all mixture leaves weighing). An ANCOVA was used to test the difference between the isolated *Bonnetia stricta* and *Humiria balsamifera* with the mixed part, and two ANOSIM was used to test the effect of mixture in invertebrate colonization (one for functional group and another for taxonomic group). We found a significant effect of the mixture on *Humiria balsamifera* ($p<0,01$), however no effect *Bonnetia stricta* was detected. Futhermore, in the ANOSIM results, the mixture did not show any effect on the invertebrate colonization, but the time of incubation was the most important factor for the colonization. Therefore, the evidences suggest that the invertebrates had less contribution for the decomposition process and the existence of mixture effect joins to the crescent evidences that the leaf species interaction in decomposition are important in the aquatic ecosystem, changing the expected predictions based on isolated leaf species decomposition.

Keywords: foliar decomposition; leaf mixture; benthic invertebrates; *Bonnetia stricta; Humiria balsamifera*

Introduction

Leaf decomposition is a fundamental ecological process that provides the main nutrients sources for the biota in most lotic ecosystems associated to the riparian vegetation (Abelho 2009). In these systems there are two primary energy sources: the photosynthesis internally realized and the organic matter from the surrounding vegetation, specially the litter that enters on the aquatic trophic cascade through decomposition (Benfield 2006).

The decomposition process in aquatic environment fallows some mechanisms: fast initial loss, despite the chemical compounds leaching and the associated effects of the invertebrates and microorganisms on the colonization process (Webster and Benfield 1986; Gessner et al. 1999). The microorganisms act on the leaf degrading and transforming the recalcitrant compounds and increasing their nutritional value for the invertebrates (Suberkropp and Chauvet 1995; Graça 2001).

The leaf chemical composition is a factor that affect the dynamics and activity of microorganism and invertebrate and therefore the decomposition rate. A slower decomposition is expected when the leaf has a great proportion of recalcitrant and structural compounds (Sinsabaugh et al. 1993; Gessner and Chauvet 1994), and an accelerated decomposition when most nutrients or labile compounds dominate its composition (Sinsabaugh et al. 1993; Suberkropp and Chauvet, 1995; Mathuriau and Chauvet 2002).

Then, the leaves decomposition is an integrative ecological process because it interconnects many elements of the lotic ecosystem, that is, plant leaf species, microbial activity, invertebrate and physical and chemical characteristics) (Benfield 2006).

Many initially studies regarding the factors and mechanisms in the decomposition process have been obtained through comparisons between different leaf species decomposition (Webster and Benfield 1986; Abelho 2001). However, in natural ecosystems the leaves were not separated in species, so its decomposition in mixture can be another important factor that interfere in the process (Gartner and Cardon 2004; Taylor et al. 2007). In this way, the decompositions rates provided for a system based on the isolated decomposition of leaves species can be underestimated or overestimated if these interferences occurs.

In this sense, some authors have attempted to determine these effects observing the interactions between the leaf species resulting in antagonistic or synergistic effects (Briones and Ineson 1996; Swan and Palmer 2004; Kominoski et al. 2007; Abelho 2009; Hoorens et al. 2010). These effects that have been documented are assigned to two principal explanations: due to a single species that plays a heavy control on the others components of the mixture (Swan and Palmer 2004); or due to the emergent effect of the mixture heterogeneity (Epps et al. 2007).

In these initial studies regarding the mixing effects (reviewed by Gartner and Cardon 2004) a diversity effect is indicated when exist difference between the decomposition rate observed from the mixture and the expected value calculated from each isolated leaf pack decomposition (Lecerf et al. 2007). However, this does not allows to identify and quantify the effect of one leaf species in the decomposition of another, consisting an open question (Hoorens et al. 2010). This identification is important because it is possible that an component is accelerated in relation to the others which can not be inferred just from the mixture total mass loss (Salamanca et al. 1998). One way to determine the responsible for these influences is to analyze the mixture components individually and compare it with isolated component's loss, something that has been little accomplished and even less in aquatic ecosystems (Salamanca et al. 1998; Moretti et al. 2007b, Sanpera-Calbet et al. 2009; Hoorens et al. 2010).

So, this work had the objective to examine the mutual influence between leaf species decomposition, seeking to answer the questions: (1) Does exist decomposition interaction effect between two leaf species mixed?; (2) Does exist effect on the colonizing fauna between isolated leaf species and the mixture?

Methods

Area description

The study was carried out on a second order stretch of the Piabinha creek, in the Parque Municipal Sempre Viva, Mucugê, located in Chapada Diamantina region (Bahia, Brazil) (Figure 1). The park is a conservation unity and therefore, a possibility for a reference site for the region. The region is totally included in a drought polygon presenting an average temperature of 19.5ºC, with annual average precipitation of 800 – 1100 mm and the wet season from November to January (Harley and Simons, 1986), and has been described in detail by Harley and Giulietti (2004).

The two plant species selected for the experiment were: *Bonnetia stricta* (Nees) Nees & Mart (Bonnetiacea) and *Humiria balsamifera* (Aubl) J. St. Hil. (Humiriacea). Both are abundant and with high leaf productivity along stream riparian zone and widely distributed in the Chapada Diamantina (Harley and Giulietti 2004).

Experimental design

Leaves of both plant species were collected intact and without microbial activity signal from the ground along the stream site edge. In the laboratory, they were air dried until the weighing day and litterbags preparations (Benfield 2006; Bärlocher 2007).

Leaves were weighed with values from 3.4 ± 0.5g for each litterbag (30cm x 20 cm; with mesh of 0.2 cm x 1.0 cm). One treatment was prepared for each plant species, and two treatments were prepared for the mixture with 50% proportion of each plants.

In one of these, the leaves were weighed separately in each sampling date (similarly to Salamanca et al. 1998; Swan and Palmer 2004; Moretti et al. 2007a, 2007b; Hoorens et al. 2010). In all, were prepared four litterbags treatments: one containing only *B. stricta* (B), a second one containing only *H. balsamifera* (H), other containing both plants, without posterior plant leaf separation (HBj) and another (also containing both plants: HBs) and with posterior separation for weighing (being Bh for leaves of *B. stricta* and Hb for *H. balsamifera*) (Figure 2).

Each litterbag type had four replicates for sampling date, in a total of six times (7, 14, 26, 44, 63 and 140 days) and one more replicate set aiming calculate the conversion factor to correct the humidity in the air dried samples (Bärlocher 2007).

Immediately after each sampling procedure the litterbags were conditioned in low temperatures in a isothermal box, containing crushed ice and transported to the laboratory, where the samples were washed, separated by foliar species and sieved (200µm mesh size). The trapped material was fixed in 70% alcohol for the posterior screening in stereomicroscopy and proceeding for colonizing invertebrates identification and counting. The taxonomic identification was performed with specialized keys (Ward and Whipple 1959; Froelich 2007) and the functional classification with basis on studies in tropical regions (Cummins et al. 2005; Tomanova et al. 2006; Watzen and Wagner 2006). Groups assigned to more than one functional group had their values equally distributed between them (like in Ligeiro et al. 2010). The leaves samples were taken to the oven where stay for 72h in 65ºC, until reaching constant weight, and subsequently weighted to estimate the remaining mass (in %).

To analyze the decomposition rate was used the negative exponential model be the formula (1), where *Mt* is the remaining mass in the time *t* (in days), Mo is the initial mass and *k* is the decomposition coefficient (Bärlocher 2007).

$$Mt = M_o \times e^{-kt} \qquad (1)$$

To test the difference between the treatments a covariate analysis (ANCOVA) was employed taking into account the natural logarithm (Ln) of the remaining foliar mass (%) as categorical variable and time (days) as covariate. In this analyze, the Levene test for the homogeneity of variances and pairwise comparisons was used to assess differences between each treatment (i.e. B, H, Bh, Hb e HBj) (Pallant 2005), using the software SPSS, version 17.0. The invertebrates were indentified in taxonomically and functional groups. Two analysis of similarity (ANOSIM) was carried out using the software Primer 6, one comparing functional groups and another comparing taxonomic groups. The abundance data were log(x+1) transformed (McCune and Grace 2002) and the Bray-Curtis distance used for the similarity matrix. The significance level was partitioned by the Bonferroni method considering for each analysis as $\alpha = 0.015$.

Results

In the water abiotic characteristics was little general variation. The N values was low, although have presented variation throughout the experiment, reaching the highest values in 140 days. The P values presented also an increase trend. The oxygen measurements was mainly above 100% and had a reduction trough the time, but with an increase in the end. It content near 100% relative saturation is expected in unpolluted mountain streams, because of the constant exchange of gases, enhanced by the turbulence, between the atmosphere and water (Lampert and Sommer 2007). The low water pH observed is a naturally characteristic of the region, common in some locations associated with the high organic matter decomposition.

Decomposition interaction

The decomposition coefficient (k) average for each treatment in each time are listed in table 02. The highest value was k=-0.12 for Bh in 140 days and the lowest was -0.00018 for H in seven days.

The variance homogeneity assumption was indicated by the Levene test ($p=0.576$), being the ANCOVA result presented a significant difference ($p<0.001$; $F=38.25$) and most of the pairwise comparisons had significant results.

In the mixture comparisons were observed difference for *H. balsamifera* (H and Hb; $p< 0.01$), and no significance for *B. stricta* (B and Bh; $p>0.01$) (Figure 3), indicating an effect of the mixture on the *H. balsamifera* decomposition.

The mixture decomposition (BHj) did not show any significant difference with B ($p=0.186$), neither with Hb ($p=0.03$), at presented a significant difference with the Bh and H ($p<0.01$). That is, despite the alone *B. stricta* decomposition results (B) did not show any difference with the mixture, the *B. stricta* isolated from mixture (Bh) presented difference with the mixture (Figure 3).

Invertebrate colonization

Throughout the entire decomposition process 6052 invertebrate individuals were counted. From this total, 19% (1131) colonized B; 19% (1126) did H; 32% (1928) did the mixture HBj and 31% (1867) did the mixture HBs (Table 3).

The invertebrate distribution along the time was as follow: 4% in 7 days; 14.2% in 14 days; 8.8% in 26 days; 10.3% in 44 days; 15.2% in 63 days and 47.5% in 140 days, indicating an increase throughout the time (Table 3).

A total of 15 taxa colonized all treatments. Hydropsychidae occurred only in H and Hydrophilidae was absent only in B. Also, many groups occurred in few periods. Only Chironomidae, Certapogonidae, Baetidae and Elmidae were recorded in all sampling dates. Cladocera and Acari were almost absent in the first dates and increased throughout the time. Oppositely, the Hydroptilidae had more abundance values in the beginning and absence at the end.

When considering the functional feeding groups it was observed a dominance of collector-gatherers (Ga; 59.3%) followed by grazers-scrapers (Sc; 22.4%), predators (Pr; 18%) and collector-filterers (Fil; 0.3%) and with absence of shredders.

The ANOSIM presented significantly result for the exposition time for taxonomic group (R: 0.233; statistic significance level: 0.1%) and functional group (R: 0.167; statistic significance level: 0.1%). However, the result was not significantly for treatments (R: -0.074 and statistic significance level: 97.5% for taxonomic groups; R: 0.022 and statistic significance level: 71.5% for functional group).

Discussion

Mixture effect in decomposition

In the review carried out by Gartner and Cardon (2004), the authors found that 75% of decomposition studies in leaf species mixtures had effects being that's of decomposition increase the most common and these studies primarily made in terrestrial ecosystems. The result presented in this study also indicated an interaction effect between the mixture of different leaf species in accordance to others mixture studies in lotic ecosystem (Swan and Palmer 2004; Taylor et al. 2007; Abelho 2009). However, the approach used here allowed to observe the effect in the leaf species that presented slower decomposition rate when isolated (*H. balsamifera*) which was accelerated when in the mixture.

For the another leaf species (*B. stricta*), despite not being presented effect in the mixture (B x Bh comparison) the comparisons of k values and remaining foliar mass between B and Bh indicated a tendency to differentiate with an increase of Bh decomposition. In this direction, Hoorens et al. (2010) encountered an increased decomposition of one of the fastest decomposing plant (*Griselinia litoralis*) in different mixtures, and Leroy and Marks (2006) encountered a decomposition increase of the mixture composed only by labile species. Besides, Barantal et al. (2011) observed that the presence of effect was more frequent in samples with more exposition time and Swan and Palmer (2004) observed difference in occurrence and intensity of effect in relation to season. So, the tendency indicated in this study could indicate an effect also on *B. stricta* with a major accompanying of the decomposition process. Another result that indicate this tendency is that the mixture (HBj) was significantly different from Bh (*B. stricta* in mixture) but not from it individual (B), if the presence of *H. balsamifera* had no effect on *B. stricta* would be expected no difference between the HBj and B.

Invertebrate colonization

The ANOSIM result showed that the community and functional group structure were similar in both isolated leaf plants treatment (H and B) and also was with the mixture (HBj and HBs) despite the existence of observed effect in the mixture decomposition. This result contradicts others that encountered difference in the structure of the colonizing community (Leroy and Marks 2006; Abelho 2009; Kominoski et al. 2009) even in absence of decomposition mixing effect (Moretti et al. 2007a).

On the contribution of functional groups, the result showed an similar pattern to other studies, with great predominance of collector-gatherers (Gonçalves et al. 2004; Moretti et al. 2007a; Ligeiro et al. 2010). The shredders have been reported with low abundance in many tropical studies even in shaded environment (Dobson et al. 2002; Mathuriau and Chauvet 2002; Gonçalves et al. 2004; Gonçalves et al. 2006; Moretti et al. 2007a; Abelho 2009; Li and Dudgeon 2009; Ligeiro et al. 2010). Although, they are the main invertebrate responsible for direct responses in the decomposition, feeding directly on the leaves (Crowl et al. 2001; Dobson et al. 2002; Yule et al. 2009) and fragmenting it therefore resulting in an increase of surface area available for the microorganisms (Graça 2001). However, in the present study they were absent in all treatments indicating a lesser contribution of the invertebrates on the decomposition.

The exposition time was the main determinant in the invertebrate colonization like showed in the ANOSIM result with was significantly for time and not for treatments for both taxonomic and functional groups. So, this study was in accordance to others where the exposition was an important factor structuring the invertebrate community (Gonçalves et al. 2004; Abelho 2009; Ligeiro et al. 2010). On the other hand, Ligeiro et al. (2010) observed also some importance of leaf species in more advanced stages of decomposition process, which means that the leaf characteristics could increase in importance for the colonization with longer exposition time.

Therefore, the evidences suggest that the invertebrates had less contribution for the decomposition process, and being the exposure time the principal factor structuring the community (Mathuriau and Chauvet 2002; Gonçalves et al. 2004; Abelho 2009). However, the existence of mixture effect joins to the crescent evidences that the leaf species interaction in decomposition are important in the aquatic ecosystem, changing the expected predictions based on isolated leaf species decomposition.

Table 1. Water chemistry along the experiment

Time (days):	0	7	14	26	44	63	140
N (mg/L)	0.48 – 0.52	0.57 – 0.86	0.33 – 0.56	0.41 – 0.62	0.28 – 0.37	0.73 – 0.99	----
P (mg/L)	0.0014 – 0.015	0.0043 – 0.034	0.0014 – 0.0042	0.0043 – 0.0085	0.0085 – 0.0142	0.0107 – 0.0213	-----
pH	3.86 – 3.99	3.75 – 3.88	3.69 – 3.76	3.83 – 3.9	4.18 – 4.32	4.05 – 4.9	3.99 – 4.02
T (°C)	23.5 – 24.8	23.8 – 24.4	28.1 – 28.5	25.5 – 25.8	23.7 – 24.6	29.3 – 29.2	22.8 – 22.2
DO (%)	103.9 – 120.6	113 – 137.1	98.4 – 117.4	88.3 – 106.2	-----	91 – 100	105.7 – 135.6
Conductivity (µS/cm)	35 – 39	37 – 39	37 – 41	32 – 36	29 – 30	30 – 34	36 – 37

Table 2. Average values of the decomposition coefficient (k) of the treatments

Time (days):	7	14	26	44	63	140
B	-0.00706	-0.00557	-0.00394	-0.0021	-0.00185	-0.0013
HBj	-0.00569	-0.00415	-0.00251	-0.00183	-0.00154	-0.001
Bh	-0.01965	-0.024797	-0.033988	-0.039664	-0.045466	-0.1222
Hb	-0.00346	-0.001935	-0.001362	-0.001018	-0.000804	-0.0005
H	0.00018	-0.000281	-0.000262	-0.000368	-0.0003	-0.0003

Table 3. Abundance and functional group of each taxa, for treatment and time

Taxa	FFG	7 days				14 days				26 days				44 days				63 days				140 days				Total
		B	H	BHj	BHs	B	H	BHj	BHs	B	H	BHj	BHs	B	H	BHj	BHs	B	H	BHj	BHs	B	H	BHj	BHs	
Chironomidae	Ga/Scp/Pre	32	57	65	32	156	161	201	177	44	51	32	128	116	138	109	92	30	75	139	105	142	175	295	302	2854
Ceratopogonidae	Pre	0	0	1	0	1	1	3	2	0	1	1	2	5	2	4	2	3	1	2	1	5	5	4	3	49
Hydroptilidae	Ga	6	12	11	4	25	18	14	25	2	2	3	2	1	0	0	1	0	0	1	1	1	1	6	2	138
Hydropsychidae	Fil	1	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	1	0	0	7
Helicopsychidae	Scp	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	1	0	1	0	5
Polycentropidae	Fil	0	0	0	0	1	1	2	0	0	0	0	0	2	0	0	0	1	0	0	1	0	1	2	1	12
Baetidae	Ga	1	4	4	4	11	12	16	11	7	4	4	2	8	8	4	2	3	8	9	5	1	2	10	8	148
Leptophlebiidae	Ga	0	0	0	1	1	0	1	0	0	0	0	2	0	0	0	0	2	2	4	1	1	4	3	1	23
Zigoptera	Pre	0	0	0	0	0	0	0	0	1	0	2	8	2	0	0	0	0	0	2	1	3	4	1	2	26
Anisoptera	Pre	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Naucoridae	Pre	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	1	0	1	0	0	0	0	0	5
HydrophilidaeLarva	Pre	0	0	2	0	0	0	1	1	0	2	3	2	0	0	0	0	0	0	0	0	0	0	0	0	11
ElmidaeLarva	Ga	0	1	1	1	2	3	2	4	1	0	0	2	1	0	0	0	2	1	1	3	3	0	1	1	30
Cladocera(Chydoridae)	Ga	0	0	0	0	1	0	1	2	12	19	5	143	36	15	25	17	8	65	214	132	318	193	556	447	2209
Acari	Pre	0	0	0	0	0	1	1	0	3	10	3	34	7	7	10	8	7	16	28	43	109	39	117	91	534
Total		40	75	84	43	198	197	242	223	70	89	53	327	180	171	152	122	58	169	401	294	585	425	996	858	6052

Figure 1. Map presenting the study area in the Piabinha Creek, Mucugê, Bahia, Brazil.

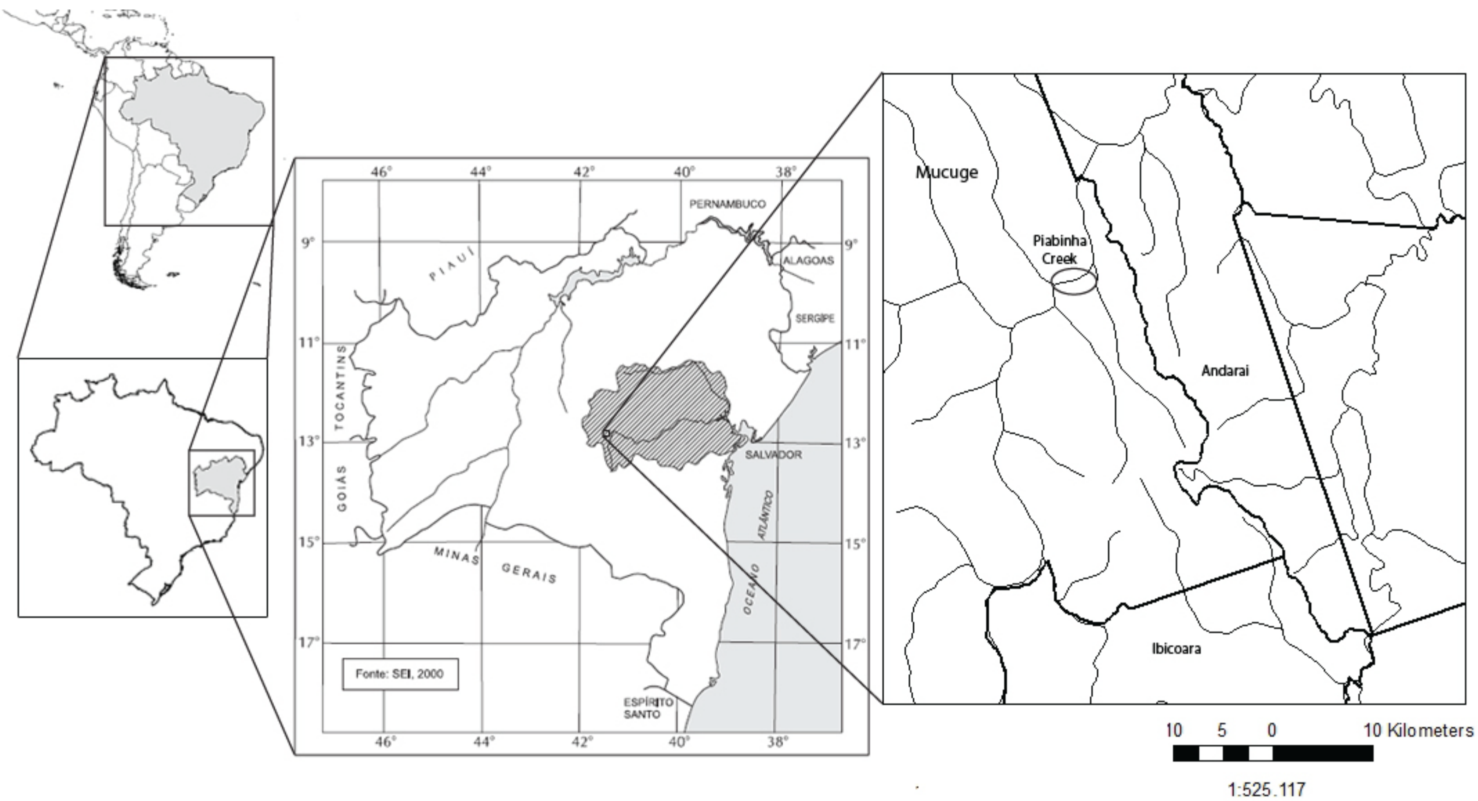


Figure 2. Types of litterbags treatments

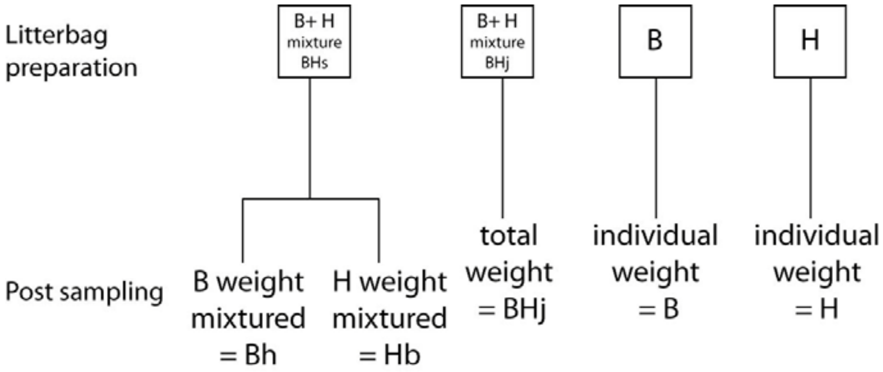
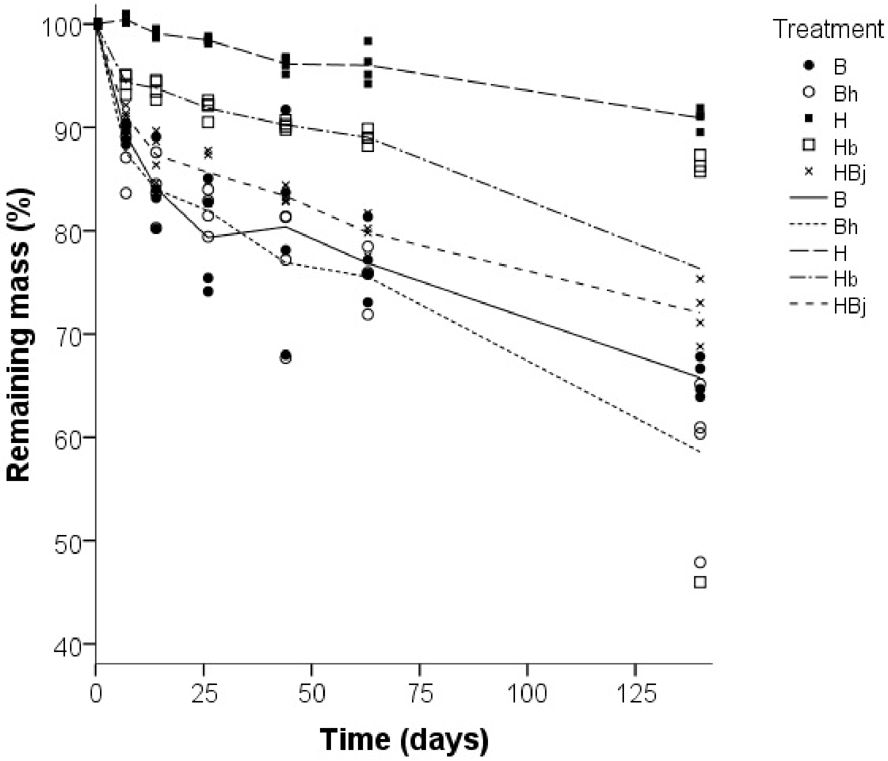


Figure 3. Remaining mass (in %) along the experiment for each treatment



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Conclusões gerais

As evidencias do presente trabalho indicam que os invertebrados possuem menor contribuição no processo de decomposição, devido à ausência de fragmentadores, e apresentam o tempo de exposição como principal fator na estruturação da comunidade, em concordância com outros estudos em regiões tropicais (Mathuriau e Chauvet, 2002; Gonçalves et al., 2004; Abelho, 2009).

Por outro lado, a existência de efeito da mistura, se junta às crescentes evidencias de que as interações de detritos em decomposição são importantes nos ecossistemas aquáticos, mudando as previsões esperadas (por exemplo, ciclagem de matéria e nutrientes no ecossistema) com base na decomposição de folhas individualizadas por espécie. Desta forma, se estas interações forem ubíquas, questionamentos sobre processos de ciclagem da matéria e energia nos ecossistemas deverão ponderar sobre este fator.

Além disso, a decomposição é um processo funcional com potencial para utilização como ferramenta bioindicadora, e, portanto, estas interações também deverão ser consideradas nestas finalidades. De fato, a própria interação poderia ser utilizada como indicadora já que o padrão e intensidade das interações também podem sofrer alterações conforme a alteração do ambiente.

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