Seasonal variation in the input of allochthonous matter in an Atlantic Rain Forest stream, Ilha Grande-RJ.

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ABSTRACT: Seasonal variation in the input of allochthonous matter in an Atlantic rain forest stream, Ilha Grande-RJ. Aspects of the seasonal variation of allochthonous matter input are discussed. Allochthonous matter was quantified in five sampling occasions between May 2002 and February 2003 in a covered site of Andorinha stream. At each sampling occasion four boxes (40 cm x 20 cm - 0,8 m² each) were randomly exposed, during 48 hours, through a 100 m long stretch of the study site. Allochthonous matter was composed of arthropods (mainly insects and mites), leaves, flowers and vegetal parts. Considering the five sampling occasions altogether, vegetal input was 16x higher than animal input (t test; t= 3.50, P< 0.01). Seasonal analysis indicated that the input of allochthonous matter is higher during the wet season, both for vegetal (t test; t= -2.54, P< 0.01) and for animal (t test; t= -3.13, P< 0.01) matter. Arthropods biomass, as well as diversity was higher during rainy season. Acaridae, Odonata, Homoptera, Lepidoptera, Lepidoptera larvae and Diptera larvae were not found during the dry season, but Diptera adults and Hymenoptera predominated during both rainy and dry seasons. The obtained data indicated that input rates, as well as animal and vegetal matter diversity, vary seasonally.
Key words: Atlantic forest, Streams, Allochthonous matter input.

RESUMO: Variação sazonal do aporte de matéria alóctone no córrego Andorinha, Ilha Grande – RJ. Aspectos da variação sazonal do aporte de matéria alóctone são discutidos. O aporte de matéria alóctone foi estimado durante cinco experimentos desenvolvidos entre maio de 2002 e fevereiro de 2003 em um trecho do córrego Andorinha, coberto por mata ciliar. A cada experimento quatro bandejas (40 cm x 20 cm - 0,8 m² cada) eram aleatoriamente expostas, por um período de 48 horas, ao longo de um trecho com 100 m de extensão. A matéria alóctone era composta de artrópodes (principalmente insetos e ácaros), folhas, flores e restos vegetais. Considerando a totalidade dos experimentos, o aporte de matéria vegetal foi 16x superior ao de matéria animal (teste t; t= 3.50, P< 0.01). As análises sobre a sazonalidade indicaram que o aporte de material alóctone é maior na estação chuvosa, tanto para a matéria vegetal (teste t; t= -2.54, P< 0.01) como para a matéria animal (teste t; t= -3.13, P< 0.01). A biomassa e a diversidade de artrópodes foram maiores na estação chuvosa; ácaros, odonatos, homópteros, lepidópteros, larvas de lepidóptero e larvas de dípteros não foram registrados na estação seca, mas dípteros adultos e himenópteros predominaram tanto na estação chuvosa como na seca. Os resultados obtidos indicaram que as taxas de aporte de material alóctone e a diversidade de animais e vegetais variam sazonalmente.
Palavras-chave: Mata Atlântica, Riachos, Aporte de matéria alóctone.

Introduction

A consistent pattern of loading, transport, utilization, and storage of organic matter (Vannote et al., 1980) is the main characteristic that determines a continuous

gradient of physical parameters of streams. Organic matter is one of the main energetic resources of such ecosystems (Cummins, 1974) and should be originated from autochthonous and/or allochthonous matter (Minshall, 1996).

The amount and quality of organic matter and light availability for photosynthesis are lotic characteristics strongly determined by riparian vegetation (Afonso et al., 2000). In streams with dense riparian vegetation the scarce incidence of sunlight determines an important reduction of the primary production (Vannote et al., 1980; Henry et al., 1994; Benfield, 1996; Afonso et al., 2000) and emphasizes the importance of allochthonous matter as carbon input (Minshall, 1996).

It is expected that seasonal variation of rain and winds regime determine different patterns of allochthonous matter input in streams (Angermeier & Karr, 1983). Following this rationale, the main purpose of the present work was to quantify the input of allochthonous matter in a Mata Atlântica stream (Córrego Andorinha) both in dry and rainy seasons.

Material and methods

Ilha Grande (23º 04', 23º 14'S e 44º 05', 44º 23'W) is composed of an Atlantic Rainforest with different levels of regeneration following century-old anthropogenic disturbances (Alho et al., 2002).

Small streams, flowing down through the oceanic and continental slopes, compose the fluvial systems of the island. Córrego Andorinha is a third order stream that drains the oceanic slope of Ilha Grande and runs, through a primary and secondary Atlantic Rainforest, for about 10 Km from its headwaters to its mouth at Enseada dos Dois Rios (Fig. 1). Study site has almost (90%) covered by canopy primary atlantic rain forest and composed by rapids (0.12 m/s) and lateral pools with sand (60%), gravel (10%), boulder (5%) and litter (25%).

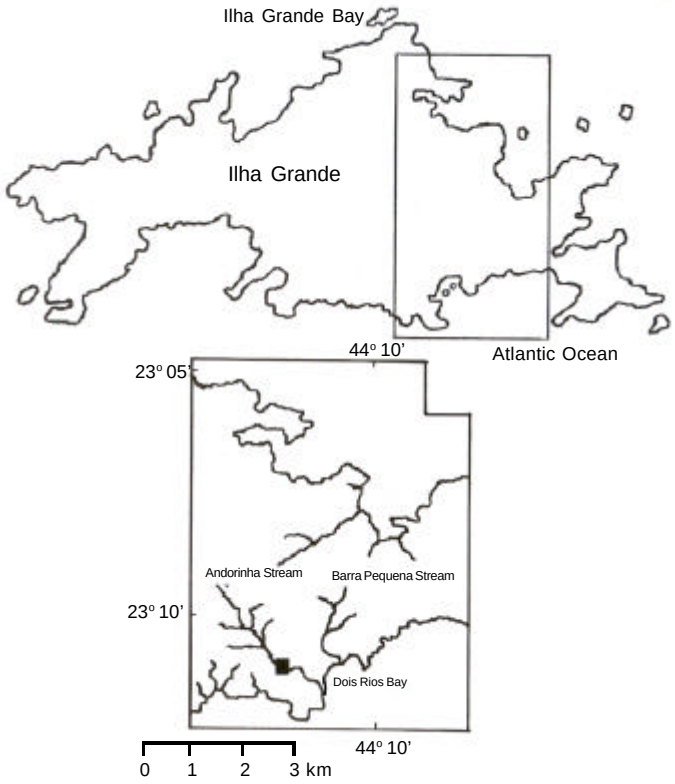

Figure 1: The study site: the córrego Andorinha fluvial system in the Ilha Grande (Rio de Janeiro- Brazil).

Seasonal variation of allochthonous matter input were studied according to the methodology described in Angermeier & Karr (1983) and adapted by Henry et al. (1994) and Uieda & Kikuchi (1995). Allochthonous matter input was quantified in five sampling occasions (May/2002, July/2002, October/2002, December/2002 and February/2003). At each sampling occasion four boxes (40 cm x 20 cm - 0,8 m^2 each), filled with water and some detergent, were randomly exposed through a 100 m long stretch of the study site during 48 hours. Thereafter, boxes content was filtered in a 0.25 mm mesh net and preserved in a 70% alcohol solution. Quantification of the allochthonous matter was done through weighing animal and vegetal matter. Each animal specimen was identified under stereomicroscopic, to the lowest feasible taxonomical level (Borror & DeLong, 1988; Buzzi & Miyazaki, 1999).

Animal and vegetal biomass ($g.m^{-2}.day^{-1}$) were estimated for each season: dry (May / 2002 and June / 2003) and wet (October / 2002, December 2002 and February 2003) in order to access the effect of rain regime on the allochthonous input of animal and vegetal biomass.

Results

Allochthonous matter was composed of arthropods (mainly insects and mites), leaves, flowers and vegetal parts (Tab. I). Considering the five sampling occasions together, vegetal input was 16x higher than animal input (t test; $t = 3.50$, $P < 0.01$); mean value of vegetal biomass was 0.301 $g.m^{-2}.day^{-1}$ whereas mean animal input was 0.019 $g.m^{-2}.day^{-1}$ (Fig. 2). Seasonal analysis indicated that the input of allochthonous

Table I: Densities ($ind.m^{-2}.day^{-1}$) of each allochthonous animal during dry (DS) and wet (WS) seasons at córrego Andorinha.

	DS	WS
Class Arachnida		
Order Araneae	0.47	2.46
Order Acarinae	0	35.14
Class Insecta		
Order Diptera	5.24	37.89
Order Hymenoptera	2.35	5.46
Order Odonata	0	2.07
Order Hemiptera	0.63	1.33
Order Coleoptera	0.47	0.54
Order Homoptera	0	0.23
Order Orthoptera	0	0.05
Order Lepidoptera	0	0.07

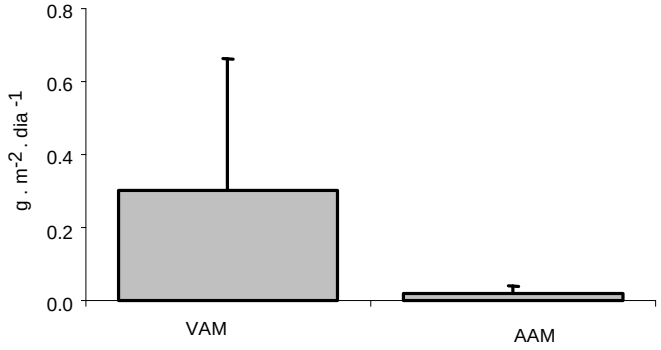

Figure 2: Mean values of animal (AAM) and vegetal allochthonous matter (VAM) biomass ($g.m^{-2}.day^{-1}$) registered in a 100 m long stretch of Andorinha stream, between May/2002 and February / 2003.

matter is higher during the wet season both for vegetal (t test; t= -2.54, P< 0.01) and animal (t test; t= -3.13, P< 0.01) matter (Fig. 3). Arthropods biomass as well as diversity was higher during rainy season. Acaridae, Odonata, Homoptera, Lepidoptera, Lepidoptera larvae and Diptera larvae were not found during the dry season, but Diptera adults and Hymenoptera predominated during both rainy and dry seasons.

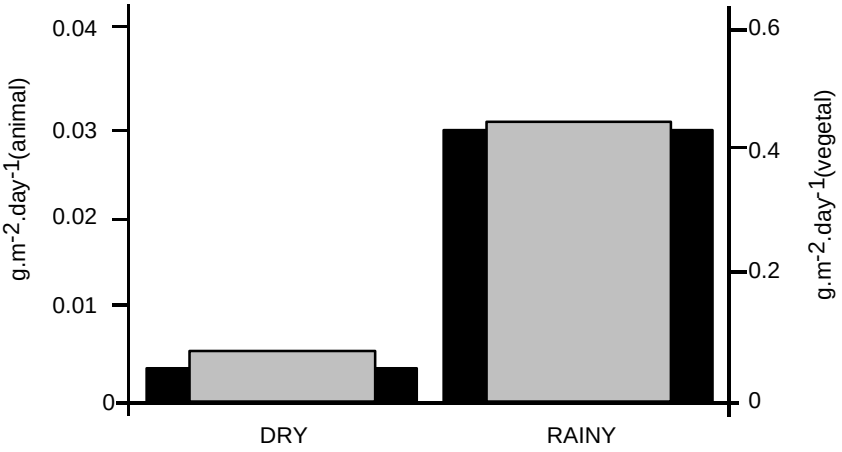

Figure 3: Seasonal variation of mean values of animal and vegetal allochthonous biomass ($g.m^{-2}.day^{-1}$) registered during rainy and dry seasons. Black boxes represent animal biomass and gray boxes vegetal biomass.

Discussion

In the present work we accessed the seasonal variation of allochthonous matter that enter the stream in a canopy site of córrego Andorinha. It was observed that both animal (mainly arthropods) and vegetal compose the allochthonous matter that enters the stream, but vegetal biomass is higher than animal matter. According to Gregory et al. (1991) food chain from densely covered streams is largely influenced by terrestrial ecosystems, so that marginal vegetation determines the relative importance of autochthonous and allochthonous resources (Gregory et al., 1991; Uieda & Kikuchi, 1995). In opposition to rivers (4^{th} order and so one), that have on autochthonous process, mainly photosynthesis, its primary energetic resource (Thorp, 2002; Hein et al., 2003), in streams, where marginal vegetation is almost abundant, 99% of the energy that flows through food chain is constituted of vegetal matter derived from riparian vegetation (Fischer & Likens, 1973).

Allochthonous matter is an important energy resource in many productive systems and may influence community structure and diet composition of stream dwelling fishes (Stanford, 1998; Kawaguchi & Nakano, 2001; Huxel et al., 2002). The amount of allochthonous vegetal acting as nutrient resource for these species is directly correlated to the water velocity. In sites with low water flow leaf retention is higher, whereas, in sites where water flow is high, leaves are retained far from its original place (Afonso & Henry, 2002). Moulton & Magalhães (2003) emphasize the importance of allochthonous matter for aquatic ecosystems and found that leaf decomposition is 50% faster in non-impacted Mata Atlântica streams. Based on such information we should emphasize the importance of allochthonous vegetal matter as energetic resource in córrego Andorinha.

Although allochthonous insects and other invertebrates had lower biomass input at Andorinha stream, it is important to mention that they are important food resource for the carnivourous/insectivourous fish species. Allochthonous Diptera and

Hymenoptera were the most abundant items within the sampled invertebrates and are among the main items that compose the insectivorous fish diet at córrego Andorinha (Rezende & Mazzoni, 2003). The importance of allochthonous insects and larvae as food resource for stream dwelling fishes was also observed for other Mata Atlântica streams by Sabino & Castro (1990), Uieda et al. (1997), Casatti & Castro (1998) and Mazzoni & Rezende (2003) as well as for streams from other biogeography regions (i.e. Garman, 1991).

Allochthonous input in tropical ecosystems varies seasonally being scarce during dry season (Lowe-McConnell, 1987; Angermeier & Karr, 1983). Our results repeat that of Uieda & Kikuchi (1995) that found higher ratios of allochthonous insects input during the rainy season as well as that of Afonso et al. (2000) that recorded higher values of litter input before rainy days and/or during rainy seasons. Angermeier & Karr (1983) observed similar results and hypothesize that these patterns are seasonally determined by rain and winds regime that influence terrestrial invertebrates transport during storms.

The main results of the present study concern the importance of allochthonous input in a canopy site of Andorinha stream as well as the relative importance of such material for the maintenance of its aquatic fauna, mainly fishes. In many other occasions, studies on feeding habits of the fish species from córrego Andorinha revealed an important relationship between food items, utilized by insectivorous species, and its allochthonous origin. It was also suggested that, as the study site is a closed stretch, detritivourous chain is very important. In fact, some results, such as the trophic shift of Phalloceros caudimaculatus from algivorous, in many Mata Atlântica streams (Casati & Castro, 1998), to detritivorous at córrego Andorinha, corroborate this proposition. Following these statements it should be important to compare opened and closed stretches of the same river in order to analyse potential differences in the relative importance of allochthonous input.

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