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# Functional structure of benthic community in a tropical stream in northeast Brazil: seasonal variation

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**Abstract.** The aim of this study was to describe the functional structure of the benthic community and how these patterns vary among the rainy and dry season. The study site is the Salvia stream, a second order tributary of Mundaú River, Rio Largo –AL. This stream drains a fragment of Atlantic forest and does not have any direct anthropic activity. The macroinvertebrates were collected using a D net of 0,25mm mesh, during the rainy season (August) of 2010 and the dry season (March) of 2011. The macroinvertebrates were identified and classified as one of the following functional feeding groups: Shredders, Gathering Collectors, Filtering Collectors, Scrapers or Predators. The results showed a clear distinction among the two seasons, the rainy season, dominated by Shredders, and the dry season, dominated by the Gathering Collectors, suggesting a difference between the quality of the food available for the benthic community on the seasons. On the other hand, since both of the dominant functional groups are dependent on allocthonous organic matter, its shows that the stream is highly heterotrophic on both seasons. The study shows that the functional organization of the benthic macroinvertebrates in Salvia stream has clear seasonal patterns and also reinforces the importance of the season to biomonitorng studies for this region.

**Keywords:** Aquatic macroinvertebrates, functional feeding groups, seasonality, shredders, gathering-collectors.

**Resumo. Estrutura funcional da comunidade bentônica em um córrego tropical no Nordeste do Brasil: variação sazonal.** O objetivo deste estudo foi descrever a estrutura funcional da comunidade bentônica e como esses padrões variam entre a estação chuvosa e seca. A área de estudo foi o córrego Salvia, uma segunda ordem afluente do rio Mundaú, Rio Largo-AL. Este córrego drena um fragmento de Mata Atlântica e não tem qualquer atividade antrópica direta. Os macroinvertebrados foram coletados por meio de uma rede D de 0,25 mm de malha, durante o período chuvoso (agosto) de 2010 e na estação seca (março) de 2011. Os macroinvertebrados foram identificados e classificados em um dos seguintes grupos funcionais de alimentação: trituradores, coletores, coletores de filtragem, raspadores ou predadores. Os resultados mostraram uma clara distinção entre as duas estações, a estação chuvosa, dominado por trituradores, e a estação seca, dominada pelos coletores, sugerindo uma diferença entre a qualidade dos alimentos disponíveis para a comunidade bentônica nas estações. Por outro lado, uma vez que ambos os grupos funcionais dominantes são dependentes de matéria orgânica, mostrando que o córrego é altamente heterotrófico em ambas as estações. O estudo mostra que a organização funcional dos macroinvertebrados bentônicos no córrego Salvia tem padrões sazonais claros e também reforça a importância da temporada para estudos de biomonitoramento desta região.

**Palavras-chave:** Macroinvertebrados aquáticos, grupos funcionais de alimentação, sazonalidade, trituradores, coletores.

## Introduction

Tropical rivers support a rich but incompletely known biota and an important effort should be made to develop realistic models of the structure and functioning of natural tropical streams (Tomanova *et al*., 2006). To characterize those ecosystems conditions, a functional approach may be more appropriate, since it is more rapid, require lesser taxonomic effort and also provide data more applicable to other systems than the taxonomic methodologies (Cummins *et al*., 2005; Santoul *et al*., 2005).

The ability to view a faunal assemblage as a collection of functional groups provides valuable insight into which food resources are prevalent, and allows one to observe how different groups of organisms respond to environmental variables (Allan & Castillo, 2007). The functional feeding group (FFG) method, which has been developed, refined and applied over the last 40 years, is based on morphological and behavioral adaptations to acquire the food resources (Cummins, 1973; Cummins, 1974; Merritt & Cummins, 1996; Cummins *et al*., 2005). This grouping reflects both convergent and parallel evolution leading to functionally similar organisms and reflects the four most important food resources found in streams: periphyton, coarse particulate organic matter, fine particulate organic matter, and animal prey (Principe *et al*., 2010).

Functional feeding classification of aquatic organisms enhances of trophic dynamics in aquatic systems, as macroinvertebrates derive their nutrition from a spatially and temporally variable system since streams and rivers are characterized by seasonal, local, and stream order differences in inputs, production, and storage of food resources (Cummins & Klug, 1979). The use of functional groups in monitoring and assessment is considered to have potential, especially for consistency in regional applications in which species composition would change but functional composition might not (Poff, 1997; Rabeni *et al*., 2005; Compim & Céréghino, 2007). It constitutes an important tool in biomonitoring programs and provides basic knowledge for the identification of policies and proposal for conservation and maintenance use of natural resources of a given area (Oliveira & Nessimian, 2010).

Studies based on macroinvertebrate feeding habits and plasticity may allow more precise results in relation to the spatial-temporal variations in the functional organization of benthic communities, which is of great ecological importance since, in combination with other monitoring procedures, the functional approach is clearly superior to the commonly used biomonitoring procedures (Chavet *et al*., 1998). Many aspects of trophic organization and food web structure and functioning can reveal fundamental properties of stream ecosystem, leading to the understanding of relationships and predicting dynamics (Ueda & Motta, 2007). This approach may allow more accurate assessment of water quality and ecological integrity which indeed could makes possible the application of more appropriate conservation and restoration strategies in the regional lotic ecosystems (Principe *et al*., 2010).

In the temperate zone, the pattern of FFG distribution has been related to the environmental gradient by Vannote *et al*. (1980), but ecological information about tropical species is very scarce, fundamental research on this subject is necessary (Tomanova *et al*. 2006). In Brazil the number of studies on has increased on the last decade, mainly on the south and southeast regions (eg. Callisto *et al*., 2001; Cummins *et al*., 2005; Oliveira & Nessimian, 2010; Righi-Cavallaro *et al*., 2010).

The seasonality plays an important factor at the lotic ecosystems of Brazilian northeast region, as rainfall, flow and current speed are the main factor that act directly on the benthic macroinvertebrate fauna (Silveira, 2004), and there is a marked difference among the dry and rainy seasons. Under the hypothesis that the seasonality cause significant difference on the benthic community on Salvia stream, the aim of this study was to describe the functional structure of a benthic community on Salvia stream both on rainy and dry seasons.

## Methodology

### *Study Area*

This study was carried out in the Salvia stream, a small water course that belongs to the Mundaú river watershed, located in Rio Largo Municipality, Alagoas. This environment is a second order stream, with a homogeneous substrate composed of sand, without rocks or algae patches.

The draining area of the Salvia stream is Mata da Sálvia, a 100 ha remnant of Atlantic forest. Its topography includes a very irregular relief, with altitude ranging between 120 m in elevation and 40 m in the valleys, and with typical native vegetation forming a canopy that filters the sunlight considerably, but also contains patches of exotic species, especially Asian bamboos (*Bambusa* sp.). Mata da Sálvia is surrounded by sugarcane plantations, a common characteristic for small Atlantic forest fragments in Alagoas (Assis, 2000). It is located in the bioclimatic zone, close to 75 biologically dry days, within the climate domain As', according to the Köppen-Geiger climate classification, with dry summers, from September to March, and rainy winters, from April to August (Assis, 2000).

The stream is kept free from mostly anthropogenic impacts, as its waters are used for irrigation and human consumption. The only exception is a small water treatment plant, located near the mouth of the river, after the forest fragment delimitation.

## Data Collect

Ten sampling sites were determined along the river (Table 1), with two replicates each site. To represent the two seasons of the region the samples were collected on August/2010, for the rainy season, and on March/2011, for the dry season.

**Table 1.** Location of the sampling sites on the Salvia stream.

| Site | Coordinates | |
|---|---|---|
| **1** | S09°31'02,9" | W35°49'54,6" |
| **2** | S09°31'02,9" | W35°49'56" |
| **3** | S09°31'01,3" | W35°49'55,5" |
| **4** | S09°31'22,4" | W35°49'34,6" |
| **5** | S09°31'11,1" | W35°50'05,3" |
| **6** | S09°31'27,2" | W35°50'15,8" |
| **7** | S09°31'29,2" | W35°50'21,3" |
| **8** | S09°31'33,4" | W35°50'33,9" |
| **9** | S09°31'38,6" | W35°50'41,2" |
| **10** | S10°32'16,7" | W37°14'01,7" |

The macroinvertebrates were collected using a D net (0,250mm mesh), with two sampling units at each site. All samples were preserved in 70% ethanol and the biological material was sorted using a stereomicroscope. The organisms were identified to Family level, except for Oligochaeta and Hydracarina, using specialized literature (Mccafferty 1983; Mugnai *et al*. 2010).

The Functional Feeding Groups (FFG) were determined using the key presented in Cummins *et al*. (2005), which classified the macroinvertebrates as one of the following functional feeding groups: Shredders (SR) invertebrates that chews conditioned litter or live vascular plant tissue (coarse particulate organic matter); Gathering Collectors (GC), that acquire fine particulate organic matter from interstices in the bottom sediments; Filtering Collectors (FC), that capture fine particulate organic matter from the water column using silken nets and filtering fans; Scrapers (SC), who feed on algae attached on stable surfaces; Predators (PR), who feed on living prey. Each taxon is assigned to a single FFG, except for Chironomidae. For this family the key requires that 10% of the specimens to be counted as Predators and the rest as Gathering Collectors. In order to assess whether functional feeding group abundances were different among periods, a T Student test was performed using the software PAST 2.5 (Hammer *et al*., 2001).

## Results

A total of 743 were collected, belonging to seventeen taxa (Table 2). Chironomidae (Diptera) and Palaemonidae were the dominant taxa, consisting, respectively, of 41,05% and 36,47% of the total.

**Table 2.** Functional classification and absolute frequency of the macroinvertebrate collected in rainy (August/2010) and dry (March/2011) seasons in Salvia stream, Alagoas state.

| TAXA | Rainy Season | Dry Season | FFG |
|---|---|---|---|
| **Turbellaria** | 02 | 03 | PR |
| **Oligochaeta** | 03 | 02 | GC |
| **Hydracarina** | 02 | 03 | PR |
| **Palaemonidae** | 245 | 26 | SR |
| **Calopterigidae** | 08 | 00 | PR |
| **Caenagrionidae** | 04 | 01 | PR |
| **Corduliidae** | 04 | 10 | PR |
| **Gomphidae** | 18 | 15 | PR |
| **Libellulidae** | 00 | 03 | PR |
| **Corixidae** | 00 | 01 | SC |
| **Hebridae** | 00 | 01 | PR |
| **Mesoveliidae** | 02 | 00 | PR |
| **Baetidae** | 20 | 21 | GC |
| **Leptophlebiidae** | 12 | 08 | GC |
| **Helicopsychidae** | 08 | 01 | SC |
| **Chironomidae** | 35 | 270 | GC/PR |
| **Tipulidae** | 02 | 07 | PR |
| **Elmidae** | 02 | 04 | GC |
| **Total** | **367** | **376** | - |

Considering the Functional Feeding Groups (Table 3), the Shredders were dominant in the rainy season (66,76%) and the Gathering Collectors were dominant in the dry season (73,94%).

**Table 3.** Absolute and relative frequencies of the functional feeding groups collected in rainy (August/2010) and dry (March/2011) seasons in Salvia stream, Alagoas state.

| FFG | Rainy | % | Dry | % |
|---|---|---|---|---|
| **Shredder** | 245 | 66,76% | 26 | 06,91% |
| **Gathering Collector** | 68 | 18,53% | 278 | 73,94% |
| **Scrapper** | 8 | 02,18% | 2 | 0,53% |
| **Predator** | 46 | 12,53% | 70 | 18,62% |
| **Total** | 367 | 100,00% | 376 | 100,00% |

The results of the T test showed a significant difference between the two seasons among the Shredders (t:2,7846; p<0,05) and Gathering Collectors (t:6,2401; p<0,05). The Filtering Collectors (t:2,0494; p:0,0658), Scrappers (t:1,7008; p:0,1061) and Predators (t:1,555; p:0,1373) didn't show significant difference between the two studied seasons.

## Discussion

The results show that most of the macroinvertebrates collected are associated to particulate organic matter. The macrobenthic community in Salvia stream is dominated by Shredders and Gathering Collectors, functional feeding groups dependent on the input of riparian vegetation as primary food source. This is expected to a low order stream that drains a forested area, as allocthonous organic matter, mainly leaves from riparian vegetation, is a major energy source of low order woodland streams with well-developed riparian corridors (Benfield, 1997; Wallace *et al*., 1997; Cummins *et al*., 2005; Tomanova *et al*., 2006; Clarke *et al*., 2008; Uwadiae, 2010).

The high proportion of both Gathering Collectors and Shredders to Scarpers indicate that the Salvia stream is a very heterotrophic environment. The shading caused by the riparian vegetation limits the growth of autotrophic producers, as described by Vannote *et al*. (1980). This explains the rarity of Scarpers collected on this study. Scrapers and Filtering Collectors are also hindered by the unconsolidated substrate. This king of substrate does not allow the attachment of the algae, further limiting the food source available for the Scarpers, and explain the absense of the filtering collectors to attach themselves to consolidate substrata to capture their food on the water column (Cummins *et al*., 2005).

During the rainy season the benthic community is dominated by the Shredders, which indicates a greater input of coarse particulate organic matter originated from the surrounding terrestrial ecosystem, which corroborates with the results from Rezende & Mazzoni (2005). It should be noted that the only taxon characterized as a Shredder was Palaemonidae (Decapoda). Usually the process of shredding is carried by insect taxa, such as Trichoptera larvae and Plecoptera nymphs. Since none of these insect shredder taxa were collected at this study, the decomposition of plant material form coarse to fine detritus in the Salvia stream is operated by macroconsumers, a pattern that is common in tropical environments (Rosemond *et al*., 1998; Dobson *et al*., 2003;

Wantzen & Wagner, 2006; Landeiro *et al*., 2008; Benstead *et al*., 2009; Uwadiae, 2010).

The dominance of the gathering collectors during the Dry season indicates lower input of organic matter from the terrestrial vegetation during this season, which turns the benthic community dependent on the fine particulate organic matter present at the interstices of the sediment. It corroborates with other studies that show that the tropical aquatic insects has strong affinity to fine detritus, demonstrating the importance of this food resource and of the Gathering Collector role in these ecosystems (Palmer *et al*., 1993; Tomanova *et al*., 2006; Carvalho & Ueida, 2009; Principe *et al*., 2010; Suga & Tanaka, 2013).

## Conclusions

The functional organization of the benthic macroinvertebrates in Salvia stream has clear seasonal patterns, varying from a Shredder dominated system during the Rainy season to a Gathering Collector dominated during the Dry season. This show that the available food resources vary qualitatively among the seasons and that they are critical to the functional organization of the benthic community. It also reinforces the importance of the season to biomonitorng studies. However, it requires further studies to fully understand the dynamics of this environment.

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