The fish community of an upland stream in the Central Amazon (Presidente Figueiredo - Amazonas - Brazil).

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ABSTRACT: The fish community of an upland stream in Central Amazon (Presidente Figueiredo-Amazonas-Brazil). **The fish community of an upland stream in Central Amazon (Presidente Figueiredo-Amazonas-Brazil) was studied by experimental fisheries using gillnets and fish trap in two sampling sites of the Lajes stream, a low order river located approximately 100 km from Manaus. A total of 10 fish species of Characiformes, Siluriformes, Perciformes and Gymnotiformes were collected. The diversity index and species abundance models showed significant differences between the assemblages of each experimental unity, indicating the existence of a longitudinal gradient explained by the presence of natural barriers, with rapids and waterfalls.**
Key-words: **fish community, rapids, waterfalls, Amazon, stream.**

RESUMO: A comunidade de peixes de um igarapé de terra firme na Amazônia Central (Presidente Figueiredo-Amazonas-Brasil). **A comunidade de peixes de um igarapé de terra firme na Amazônia Central (Presidente Figueiredo-Amazonas-Brasil) foi estudada através de pescarias experimentais, realizadas com redes de espera e armadilhas iscadas em dois pontos do Igarapé das Lajes, um rio de baixa ordem situado a cerca de 100 Km de Manaus. Foram capturados 10 espécies das Ordens Characiformes, Siluriformes, Perciformes e Gymnotiformes. O índice de diversidade e os modelos de abundância de espécies aplicados mostraram diferenças significativas entre as assembléias de cada unidade experimental, sugerindo a existência de um gradiente longitudinal, que pode estar relacionado com as barreiras físicas naturais, corredeiras e cachoeiras, existentes ao longo do igarapé.**
Palavras-Chave: **Comunidade de peixe, corredeira, cachoeira, Amazônia, riacho.**

Introduction

The influence of abiotic factors over natural communities composition and dynamics have been discussed by several authors (Menge & Sutherland, 1987; Dunson & Travis, 1991). It is generally accepted that very specific environmental conditions favour the development of highly specialized and vulnerable communities (Dunson & Travis, 1991), once small variations in environmental conditions can have catastrophic effects on the community structure. In these environments, abiotic factors are the main attributes driving natural communities formation.

Silva (1993) states that tropical freshwater fish communities present particular patterns in relation to natural resources use. Riverine fishes, for example, are very motile and several species perform trophic or reproductive migrations. In other water systems, like streams and "igarapés", fish communities are more stable, that is, most species exhibit autochthonous life strategies, passing almost their whole life in the same system (Lowe-McConnel, 1975). Microhabitats or biotypes are very important to biodiversity maintenance (Copp, 1992) and are considered the unities of an habitat where individuals of one species are able to establish themselves and complete their life cycles (Goodall, 1986).

In the last ten years, the river rapids and waterfalls of Presidente Figueiredo municipality have been aim of a strong tourist activity that resulted in a potentially high

degradation of visited places, leading to environmental disturbance that achieved critical levels, sometimes irreversible. The impacts are strongest in the public river rapids that do not have any access restriction. Some owners have taken some measures to restrict access through implementation of private conservation unities in their areas, in order to warrant legal aid for protection.

Few studies on the ecology and composition of the aquatic fauna of Amazon small streams were done until now (Franken et al., 1979; Walker, 1987; 1995). Still more rare are those about rapid rivers environments (Freitas, 1998; Angelini & Freitas, 2002) and the associated flora composition of the riparian zone. Studies about the communities that live at these systems, aiming to evaluate the interactions between biotic and abiotic components, were not done yet. This work intended to identify the fish community structure of a small stream, in the Urubuí river basin, and hypothesize about the relevant environmental factors for the communities formation, in order to subsidize proposals for natural resources management.

Material and Methods

Study site

The municipality of Presidente Figueiredo is located 100 Km north far from Manaus, capital and most important city of Amazonas state, in the northwestern region. It is located between the Km 99 (Urubu River) and Km 250 (Alalaú River) on the road BR-174, that leads to Caracaraí, Boa Vista and Venezuela. It has a total area of 24,781 Km^2, including the administrative district of the Hydroelectric Plant of Balbina, the Pitinga village and around 22 rural communities. The population in Presidente Figueiredo is around 22,000 people and demographic density is of 0.9 persons/km^2 (Nava et al., 1998). The city was created at the end of seventies as a small village, with the construction of the Hydroelectric Plant of Balbina.

Actually, Presidente Figueiredo represents the most accessible municipality in Amazon state. Because its geographical situation and natural resources (waterfalls, water rapids, caves, tropical forest and Reservoir of the Hydroelectric Plant of Balbina lake), it presents a good scenario for several tourist activities such as: ecological tourism, sport fishery, adventure tourism, cave exploration among others (Nava et al., 1998).

The study area is first order tributary of Urubuí River, placed on it's left margin in the medium part of the river. Soils in this region are poor, acid and encompass sandy over rocky layers that feature whole estuary of Lajes stream. These region presents a typical "Baixio" forest that is always found on streams margin, sometimes flooded by strong rains. Vegetation occurs over low deep flooded sandy soils, with canopy standing between 15 to 30 meters, few emergent trees, several superficial roots, and trees with adventitious and/or support roots.

Two sampling sites were selected, through the Lajes stream and represent stretches of the river source and outfall. Between these sites there are several water rapids and waterfalls that are physical barriers between the sampling stations. The both sites exhibit poorly habitat complexity, once the stream is canalized and the bottom is predominantly rocky. The first sampling site is located 50 meters far from a small waterfall and the bottom is predominantly rocky, the stream is shallow and its width is approximately 10 meters. The second sampling site is located after a extensive rapid and in these stretch the width is bigger than in the site one, the bottom is shaped by sand and rocky.

Data collection

Samples were performed each two months, during a period of six months, between January and June/2002, and consisted of standardized experimental fisheries with gillnets and pitfalls with baits. The experimental procedure result in a total sampling effort of 1280 m.h for each experimental unity in each fishery.

Fishes caught were separated in lots by experimental unity and net. Fishes were fixed in formaldehyde 10% and maintained in alcohol 70% for posterior identification at the laboratory using identification keys, reference collections or specialists. All specimens caught were weighted (g) and measured (cm). We measured dissolved oxygen (mg/l) and temperature (°C), each two hours.

Analysis of data

The Shannon-Wiener (1949) measurement of information content was used as a diversity index. The inverse of Berger-Parker index, a dominance measure, was used to indicate diversity (Berger & Parker,1970). For the evenness, the predicted diversity and species richness ratio (Magurran, 1988) and the Jackknife technique to estimate species richness (Zar, 1999) were selected.

Models of abundance distribution are statistical descriptions used to investigate the structure of communities (Krebs, 1989). The adjustment of the following models was tested by the Geometric Series, Logarithmic Series and Lognormal Distribution. The fitting to the models was evaluated by an adherence test of c^2 (Zar, 1999).

Results

During samplings, temperature varied between 24.4 and 26.3 °C and dissolved O_2 varied between 8.14 and 8.8 mg/l. A total of 113 fishes were caught, distributed in 10 species, from 10 genera of seven different families and four different orders (Tab.I). The Characiformes was the predominant group of the Lajes Stream, with four species belonging to two different families.

Diversity index was very low, being lower in site one than in site two. A major dominance in site one than in site two was possibly due to a great abundance of *Moenkhausia* gr. *lepidura*. The estimated evenness showed that individuals were distributed in a more homogeneous way in site two than in site one (Tab. II). The species richness estimated by Jackknife technique was very close to observed value (Tab. II).

Sampled community in site one fitted only to the Logarithmic Series, while fish community of site two adjusted to both Geometric and Logarithmic Series. Lognormal Distribution did not fitted to community data of any of the sampled site (Tab. III).

Table I: Abundance of species in two sampling sites of Lajes Stream (UPS – upstream; DOT – downstream).

Order	Family	Species	UPS	DOT	å
Characiformes	Characidae	*Moenkhausia lepidura*	54	9	63
Characiformes	Characidae	*Bryconops caudomaculatus*	9	14	23
Characiformes	Characidae	*Brycon melanopterum*	2	0	2
Characiformes	Erythrinidae	*Hoplias malabaricus*	1	1	2
Gymnotiformes	Hypopomidae	*Brachyhipopomus*	0	1	1
Siluriformes	Callichthydae	*Callichthys callichthys*	2	4	6
Siluriformes	Loricariidae	*Rineloricaria lancedata*	1	0	1
Siluriformes	Hypophthalmidae	*Hypophthalmus* sp.	1	1	2
Perciformes	Cichlidae	*Crenicichla gr. saxatilis*	0	3	3
Perciformes	Cichlidae	*Aequidens palidus*	4	5	9
	Total		74	39	113

Table II: Fish community parameters in the two sampling sites of Lajes stream.

Parameters	upstream	downstream
Species Richness (S)	8	9
Number of Individuals (N)	74	39
Shannon's Index (H')	1.014	1.776
Berger-Parker Index of Dominance (d)	0.730	0.359
Inverse of the Berger-Parker Index (1/d)	1.370	2.786
Evenness	0.487	0.808
Jackknife Estimate (S*)	11.031	

Table III: Fit of species abundance models to the data of each sampling site.

SITE	Geometric Series			Logarithmic Series			Lognormal Distribution		
	df	c^2	p	df	c^2	p	df	c^2	p
upstream	7	36.633	< 0.05	5	3.396	> 0.05	3	97.521	< 0.05
downstream	8	2.522	> 0.05	3	2.473	> 0.05	1	50.248	< 0.05

Discussion

Channel morphology, bank and bottom substrates, vegetation and inundation periodicity define specific habitats for the aquatic fauna (Walker, 1995). Schlosser (1995) evaluated the critical landscape attributes that influence fish population dynamics in headwater streams and concluded that three are likely to be particularly critical: functional interactions at terrestrial-aquatic ecotones, large-scale spatial habitat relationships, and the distribution of refuge from harsh environmental conditions. Low orders Amazonian streams are generally narrow and shaded by the forest canopy, which inhibits the scarce primary production allowed for by the low nutrient levels in wider, more quiet and sunny stretches. The food chains start essentially with allochthonous input, forest litter, dead woods and detritus (Walker, 2001).

The predominance of Characiformes in number of species, number of individuals and biomass observed in the Lajes stream follows the neotropical pattern (Lowe-McConnel, 1987). Other Amazonian studies also showed this pattern (Silva, 1993; Merona & Bittencourt, 1993; Saint-Paul et al., 2000), unhappily all studies were developed at the floodplain, an environment markedly different.

Jackknife estimation for species richness presented a number similar to that recorded. This is a tendency predicted by Heltshe & Forrester (1983), once Jackknife estimation for species richness possess a positive vicious. This deviation results in a predicted value generally slowly higher than the observed species richness (S), which as a rule is always lower than the true value (S*) of species richness in the community (Krebs, 1989).

The indices showed higher diversity downstream than upstream (Tab. II). However these results should be carefully interpreted, because in each sample a new species was caught, indicating a sub-estimation of the overall communities of fishes in the Lajes stream. This is a consistent problem in ictiofaunistic Amazonian studies, because the mosaic landscape and the great amount of micro-habitats.

As predicted by theory of species-abundance models, the sampled associations in the two sites of Lajes stream fitted themselves only to Geometric and Logarithmic Series. In agreement with May (1975), these patterns are expected in very unequal communities, with few species that are very abundant and several rare species, recent communities or those that inhabit environments with very specific features. Lognormal distribution did not adjusted itself to any of the data sampled in the experimental stations. According to May (1975), the Lognormal distribution is usually used to describe large and stable communities. However, the absence of fitting can be a result of a low number of samples.

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