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Spatial Variation of Five Co-Existing Siluriformes in an Atlantic Rain Forest Drainage

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ABSTRACT

Five species of Siluriformes were registered in the Ubatiba system. Pimelodella lateristriga was the dominant one, followed by Hypostomus gr. punctatus, Rineloricaria sp., Callichthys callichthys and Rhamdia sp. Simple correlation analysis between species density and habitat parameters indicated that hydrology explained density patterns of four species. Pimelodella densities were negatively correlated with pools, Callichthys and Hypostomus densities were positively correlated with runs and Rhamdia densities were positively correlated with riffles; Rineloricaria densities did not respond to any hydrological parameter. Substrata were an important factor to all species, but specific preferences were observed. Marginal vegetation was positively correlated only to Pimelodella densities. Sorensen dissimilarity analysis indicated that site groups, based on both species composition and habitat parameters, were very similar and corroborated the correlation analysis suggesting that Siluriformes composition should be explained by many habitat parameters. Analysis of co-variation of species densities at each sampling occasion showed to be statistically similar in at least all (100%) analysed cases indicating that Siluriformes composition was strongly persistent in time.

Key words: Coastal stream, habitat characteristics, distribution, catfishes

INTRODUCTION

Biotic and abiotic are the major agents that affect fish species occurrence and abundance in a given environment (Matthews, 1998). Geology and geomorphology are among the abiotic attributes that determine specific environmental conditions and provide local support for certain species (Giller and Malmqvist, 2001). On the other hand, biotic attributes should be interpreted, among others, as morpho- and physiological adaptations that facilitated the co-existence of populations (Matthews, 1998).

Despite such believes, the recognition of parameters involved in the organisation of populations and communities continues to be a major challenge in animal ecology (Van Winkle et al., 1991; Matthews, 1998), and the disagreement between the defenders of biotic parameters, such as competition (e.g., Hutchinson, 1958; MacArthur, 1972), and abiotic ones, such as environmental settings (e.g., Andrewartha and Birch, 1954; Connor and Simberloff, 1979) is still common.
The purpose of the present work was to describe the distribution and abundance of five Siluriformes

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species (*Callichthys callichthys*, *Hypostomus* gr. *punctatus*, *Pimelodella lateristriga*, *Rhamdia* sp., *Rineloricaria* sp.) along the longitudinal axis of a rain forest drainage in the southeast of Brazil (Ubatiba basin, Maricá – RJ).

MATERIAL AND METHODS

The Ubatiba river (22°60' S and 42°48' W) forms a small fluvial system that drains the east watershed of Serra do Mar. It flows down through about 18 km, and discharges itself into the Maricá lagoon system, located 70 km north of Rio de Janeiro metropolis. Bimonthly samples were taken between July 1994 and November 1995 (Jul/94, Sep/94, Nov/94, Jan/95, Mar/95, May/95, Jul/95, Sep/95 and Nov/95) and included four sites in the Ubatiba river: U1, U2, U3 and U4 and one site in each of its four tributaries: Silvado (Si), Caboclo (Ca), Fundo (Fu) and Itapeteiú (It). Spatial distribution of sampling sites has been presented elsewhere (Mazzoni et al., 2006). Sampling sites were approximately 80 m long and about 4 km apart from each other. Samples were taken by electrofishing (900 W, 2-3 A) through the three-removal method (Zippin, 1958). At the end of the last removal of each sampling month, captured fishes were measured (standard length, *SL*, cm) and returned alive to the water. Fish abundances were estimated through the Zippin Method (Zippin 1958) and transformed into densities ($ind.ha^{-1}$) according to the sampled area of each site. Sampled area was calculated for each sampling month and site, according to bathymetric maps based on transversal transects registered within an interval of 5 m long, from the lower to the upper section of the sampling site. Habitat parameters were also quantified within the same transects considering the following major variables: hydrology, substrata and vegetation.

Simple correlation analysis between the species densities and habitat parameters were applied in order to detect which habitat parameter should explain species distribution. Patterns of dissimilarity between the sites were analysed through Sorensen (Bray-Curtis) cluster analysis (UPGMA) considering both habitat parameters and species composition. Correlation between both habitat and species densities matrixes was tested through a Mantel's asymptotic approximation test. Cluster analysis and the Mantel's test were loaded with the statistic program PCOrd 4. Spearman correlation analyses ($p<0.05$), based on species densities were also used in a temporal scale in order to detect the persistence of Siluriformes composition at each studied site (Zar, 1999).

RESULTS

Site U1 was not considered in the following results as no Siluriform species were registered there. Habitat parameters, registered at each sampling site, are presented in Table 1.

Considering the whole sampled Siluriformes, *Pimelodella lateristriga* was the dominant one (45%) followed by *Hypostomus* gr. *punctatus* (31%), *Rineloricaria* sp. (11%), *Callichthys callichthys* (7%) and *Rhamdia* sp. (7%). Simple correlation analysis between the species density and environmental parameters (Table 2) indicated that the hydrology explained the density patterns of four species; *Pimelodella* densities were negatively correlated with pools, *Callichthys* and *Hypostomus* densities were positively correlated with run and *Rhamdia* densities were positively correlated with riffle. *Rineloricaria* densities did not respond to any hydrological parameters. Substrata were an important factor for all the species, but specific preferences were observed (Table 2).

Cluster analysis for species densities resulted in 3 groups. Group I, formed by U2, U3, Ca, U4 and U5, showed similar densities for all the species; group II, SI and IT, presented the higher and the lower densities of *Pimelodella* and *Callichthys*, respectively and group III, formed by FU, was the one with lower densities of all species, except *Callichthys* (Fig. 1 and Table 3).

Table 1 - Mean values of the percentage of occurrence of the habitat parameters obtained from transects of 5m apart during the seven sampling periods in the eight studied sites where Siluriform species were registered (U2, U3, U4, Si, Ca, Fu, It) in the Ubatiba system. Dist. = distance from the river mouth, Cond. = conductivity, O.M. = organic matter and M.V. = marginal vegetation.

	U2	U3	U4	U5	SI	CA	FU	IT
Deep (cm)	40	49	54	45	35	63	22	46
Dist (km)	13	9	7	1	13	10	5	3
Cond	92	110	160	390	105	120	190	235
Hidrology								
Pool	13	13	10	8	22	22	50	0
Riffles	49	15	86	75	50	8	40	98
Runs	38	72	5	17	27	71	10	2
Substrata								
O.M.	20	11	12	13	14	13	24	2
Silt (0.005–0.074 mm)	10	2	8	8	9	4	45	1
Sand (2.4-4.7 mm)	14	21	5	11	16	32	1	10
Gravel (4.7–19.0 mm)	10	24	12	5	9	20	6	10
Cobble (75.0–256.0mm)	20	27	33	24	30	21	18	42
Boulder (256.0-300.0mm)	16	15	20	39	22	0	6	35
Rock (≥ 300.0 mm)	10	0	10	0	0	10	0	0
Vegetation								
Cannopy	10	20	30	15	85	31	5	90
M. V.	90	80	70	85	15	69	95	10

Table 2 - Correlation parameters, for significant cases, based on the relationships between species densities and environmental variables.

	Slope	Intercept	r^2	p
Pimelodella lateristriga				
Pool	-37.26	2772	0.55	0.03
O.M.	-95.33	3432	0.66	0.01
Silt	-42.04	2585	0.62	0.02
Cannopy	18.90	1453	0.68	0.01
Rhamdia quelen				
Riffle	3.55	154	0.74	0.006
Cobble	8.89	171	0.78	0.003
Hypostomus* gr. *punctatus				
Run	13.03	1081		0.007
Gravel	49.98	874.05	0.59	0.02
Callichthys callichthys				
Sand	18.3	116.91	0.55	0.05
Gravel	24.81	70.78	0.48	0.03
Run	6.72	166.02	0.62	0.02
Riffle	-6.36	702.83	0.74	0.006
***Rineloricaria* sp.**				
Mud	-144.82	2499.23	0.54	0.03
Cobble	119.37	-2684.71	0.57	0.03

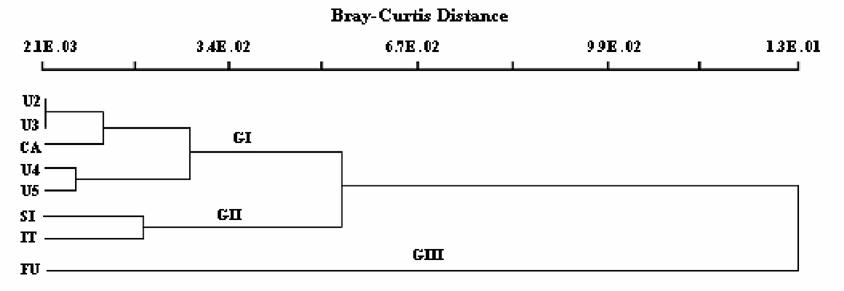

Figure 1 - Sorensen (Bray-Curtis) cluster analysis (UPGMA) based on species composition of each studied site. GI = group I; GII = group II; GIII = group III.

Table 3 - Mean values of species densities (ind.ha^{-1}) at each of the 8 studied sites (PL -*Pimelodella lateristriga,* Rh-*Rhamdia* sp.; HP-*Hypostomus* gr. *punctatus;* CC- *Callichthys callichthys* and Ri-*Rineloricaria* sp.).

	PL	Rh	Hy	CC	Ri
U2	1998	290	1659	390	0
U3	1900	250	2000	500	0
U4	1800	381	1500	190	0
U5	2200	500	1500	70	522
SI	2773	268	1300	299	0
CA	2324	230	2014	854	0
FU	721	231	817	420	0
IT	3315	580	1000	225	3628

Three groups of sites, based on habitat parameters, were formed. Group I, U2, U3, CA and U4, showed the predominance of pools and marginal vegetation; group II, SI, IT and U5, presented the predominance of runs and canopy and group III, formed by FU, was the smaller and intermittent tributary (Fig. 2). Site groups based on both species composition and habitat parameters were very similar and corroborated the correlation analysis, indicating that local Siluriformes composition was highly determined by habitat parameters. Mantel's test showed significant correlation between the species densities and habitat parameters matrixes ($t = 2.58$; $p = 0.009$).

Temporal co-variation of species composition, based on 28 analysed pairs of studied months, showed to be statistically similar in all (100%) cases (Fig. 3) indicating high persistence of inter-site community structure.

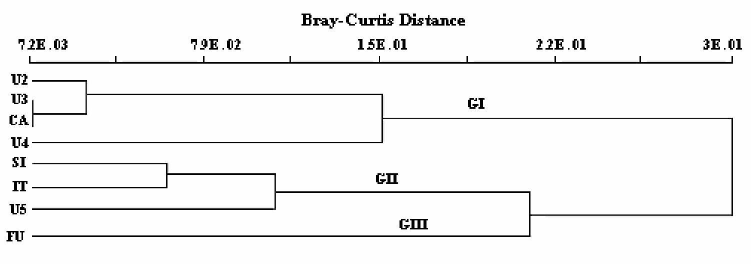

Figure 2 - Sorensen (Bray-Curtis) cluster analysis (UPGMA) based on environmental parameters of each studied site. GI = group I; GII = group II; GIII = group III.

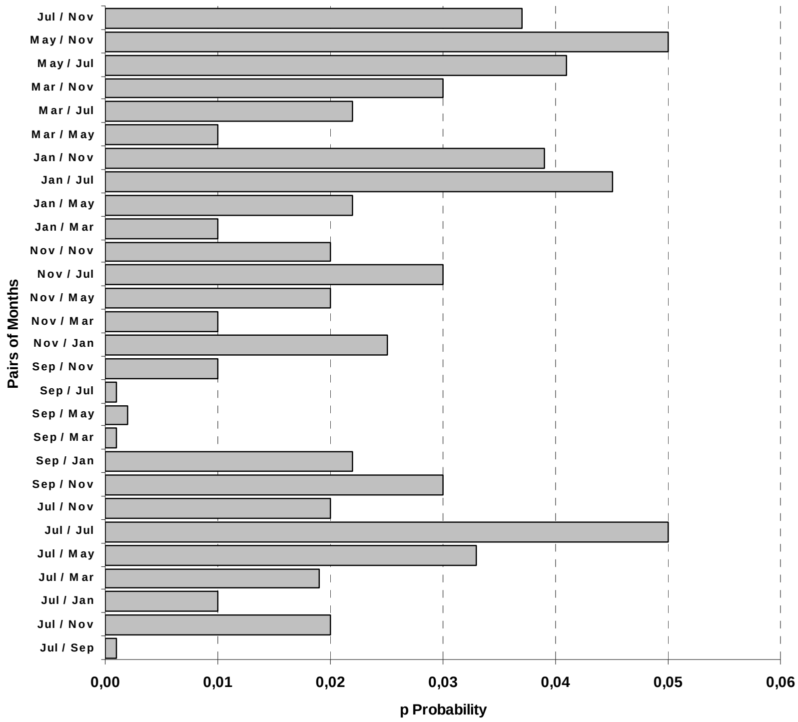

Figure 3 - Probability values (P) of Spearman correlations of species composition, based on 28 pairs of months.

DISCUSSION

Twenty-two species made up the Ubatiba ichthyofauna (Mazzoni and Lobón-Cerviá, 2000; Mazzoni and Costa, 2007) and five were Siluriformes. Among these, four (*Pimelodella lateristriga*, *Hypostomus* gr. *punctatus*, *Callichthys callichthys* and *Rhamdia* sp.) were widely distributed and *Rineloricaria* sp. was restricted to the lowermost localities U5 and It.

Spatial analysis of Siluriformes composition revealed little similarity among the sites suggesting that local species composition was determined by different factors. According to Winemiller and Leslie (1992), species diversity was positively correlated to the environmental heterogeneity. Cluster analysis for habitat parameters showed medium/low similarity among the sites, suggesting that environmental characteristics varied among them. Following the same analysis, for specific composition, three groups were detected and, such groups were very similar to that determined by the environmental parameters. Following these results it could be concluded that environmental parameters should be considered an important factor for Siluriformes distribution along the studied streams.

As previously shown, habitat characteristics explained a great part of fish distribution along the Ubatiba system. Cyprinodontiformes occurrence was correlated with environmental variables (Aranha and Caramaschi, 1997). Mazzoni and Iglesias-Rios (2002) found that canopy abundance determined the occurrence of *M. microlepis* while *H. malabaricus* densities were positively correlated to marginal vegetation and *P. vivipara* was correlated to the pools and clay substratum. Menezes and Caramaschi (1994; 2000) observed that the occurrence of juveniles of *Hypostomus* gr. *punctatus* was associated with marginal vegetation while adult individuals were found in rocky habitats and holes in the river banks. *A. janeiroensis* changes habitat preference in order to avoid environmental stress during the breeding season (Mazzoni et al., 2004).

In the present study it was observed that each Siluriformes species were correlated to different habitat variables. Hydrological parameters as well as substrata and marginal vegetation characteristics explained density patterns of all the five studied species. According to Power (1984), an ideal specific distribution would arise if animals correctly evaluate habitat quality and were free to settle in the best available habitat at a given time. Moreover, it is suggested that under these circumstances, the fitness of individuals should be improved. Although individual fitness was not measured, high temporal persistence in the Siluriformes composition among the sites was observed. Results suggested that specific settlement was being directed to a better exploitation of habitat characteristics and that each Siluriformes population was adequately adapted to local characteristics.

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RESUMO

Cinco espécies de Siluriformes foram registradas no sistema fluvial do rio Ubatiba, *Pimelodella lateristriga* foi a espécie dominante seguida de *Hypostomus* gr. *punctatus*, *Rineloricaria* sp., *Callichthys callichthys* e *Rhamdia* sp. Análises de correlação simples entre as densidades das espécies e as variáveis de hábitat indicaram que a hidrologia explicou os padrões de densidade de quatro espécies; as densidades de *Pimelodella* foram negativamente correlacionadas com a presença de poças, as densidades de *Callichthys* e *Hypostomus* foram positivamente correlacionadas com os rápidos e as densidades de *Rhamdia* foram positivamente correlacionadas com as corredeiras*;* as densidades de *Rineloricaria* não responderam a nenhum dos parâmetros hydrológicos analisados. O substrato foi um importante fator para todas as espécies, mas preferências específicas foram observadas. A vegetação marginal foi positivamente correlacionada apenas com as densidades de *Pimelodella*. A análise de dissimilaridade de Sorensen indicou que os grupos de localidades que se formaram com base tanto na composição de espécies como nas variáveis de hábitat foram muito semelhantes e corroboraram os resultados das análises de correlação, sugerindo que a composição de Siluriformes do rio Ubatiba pode ser explicada por várias características do hábitat. As análises de co-variância das densidades das espécies em cada momento amostral mostraram-se significativamente similares em todos (100%) os casos analisados, indicando que a composição de Siluriformes é persistente e se mantém em escala temporal.

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