DISTRIBUTION AND DIVERSITY OF ICHTHYOFAUNA IN THE RIO CLARO

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Abstract. Freshwater rivers within Corcovado National Park exhibit low species richness compared to other neotropical freshwater systems. An analysis of fish distribution and abundance in the Rio Claro indicated that low species richness may be attributed to the continuous distribution of all habitat types and food resources throughout the lower 2.5 km of the river. Of the 17 species observed, only 8 were limited to a range of 500 m or less. Sand, pebble and rock substrates were contiguous in most regions of the study area. Aquatic vegetation and deep pools appeared to be the only resources limited to a small range and these were accompanied by a fairly distinctive assemblage of fish. The diversity and abundance of food resources do not appear to be limiting. This suggests that a lack of trophic partitioning may be limiting the number of fish species coexisting within the river.

Key words: ichthyofauna, resource partitioning, Rio Claro

INTRODUCTION

The rivers of Corcovado National Park support a total of twenty fish species which is a surprisingly low total for neotropical freshwater systems (Constantz et al. 1981). Low species richness may result from limited resource diversity, low resource abundance, uniform resource distribution, or poor partitioning of these resources. The Rio Claro, a tidally influenced stream within the park, supports freshwater, marine and peripheral species. A 1983 census revealed a total of 17 species (Winemiller 1983), and a 1995 census found only 9 species (Kaveeshwar 1995). Sampling for these studies was conducted at four and two sites respectively and only roughly characterized the spatial distribution of fish. Our goal was to build upon these studies by resolving the distribution and abundance of Rio Claro ichthyofauna on a finer spatial scale and by identifying possible factors underlying the low species richness of this aquatic system. We chose to test the hypothesis that low species richness is a function of poor niche partitioning of the river with respect to food and habitat resources.

METHODS

Beginning at the river mouth, we sampled fish along 10 transects, 250 m apart, extending across the Rio Claro, Corcovado National Park. All transects were sampled at low tide, between 0830 and 01130 on 3-4 February. In addition, transects 1 through 5 were sampled at high tide on the afternoon of 3 February. While snorkeling, we counted all fish observed within 5 m of the transect. The length and distinguishing characteristics of each taxa were recorded. We estimated an index of biomass by multiplying the average length of each taxa by the number of individuals present in a transect. We characterized vegetation by estimating the percent cover of aquatic weeds, algae, and detritus. Abundance of potential invertebrate food resources such as decapods and gastropods was noted. Detritus and sand/pebble samples were examined under a dissecting scope to determine if insect larvae were present.

In addition, we recorded abiotic characteristics of the river at each transect: substrate composition (percent sand, pebbles, rocks, and clay); sunlight (percent of the transect in the sun); temperature (mid-column water temperature in the middle of the transect); salinity (with a refractometer); underwater visibility (in m); water depth (average of depth measurements taken every 10 m along the transect); and river width. We also recorded any other striking features of the river at a given site such as high water velocity, proximity to rapids or side-stream inputs, and tidal variation in depth.

Multiple stepwise regressions were performed to search for statistical models that related patterns of distribution and abundance to biotic and abiotic characteristics of the river. Fish data collected on all 10 transects (3 and 4 February) were used to analyze fish distribution patterns. Finally, we tested the reproducibility of fish observations by comparing the communities found in the first four transects during two low tide periods (2 and 3 February).

RESULTS

Biotic factors tended to vary with distance from the river mouth. Differences in vegetation were greatest between the two aquatic-weed dominated transects at the river mouth and the remaining eight transects (see Appendix A). Detritus was more abundant upstream where stronger currents may have formed deeper pools, allowing for accumulation. Decapod and gastropod abundance also increased upstream. Insect larvae were not found in any sand or pebble samples but did appear in detritus samples.

Abiotic factors did not appear to differ greatly between transects (see Appendix A). Several substrate types were present at most sites. Sand dominated at the sidestream input of transect 10 and in the calm lagoon of transect 1. Water velocity was greater at the shallower upstream sites. Percent sun, mid-column water temperature, and water volume varied little between transects. Visibility decreased at high tide in transect 1, but salinity remained constant throughout the river at high and low tide. Depth was influenced by tidal input only at transects 1 and 2.

We found 17 fish taxa in 10 transects (Table 1). Total number of individual fish decreased as distance from the river mouth increased (Figure 1). Average fish size increased upstream, but biomass was still greatest near the river mouth (Figure 2). This trend in biomass appeared to be driven by high abundances of relatively small species (A, B, E, and F) in transects 1 and 2 (Table 2).

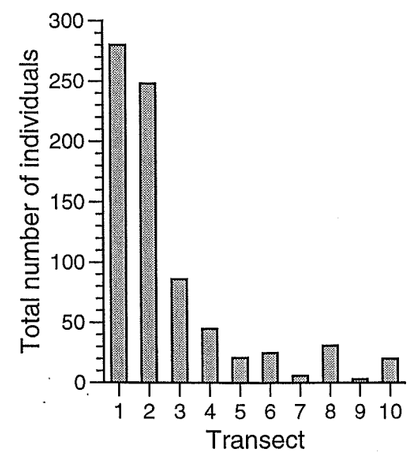

Figure 1. Total number of fish observed along 10 transects, 250 m apart, in the Rio Claro, Corcovado National Park, Costa Rica. Transect 1 is at the river mouth.

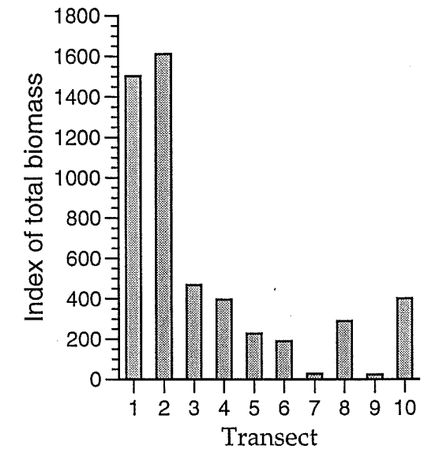

Figure 2. Index of fish biomass (total number of fish x average length) at 10 transects, 250 m apart, in the Rio Claro, Corcovado National Park, Costa Rica. Transect 1 is at the river mouth.

Stepwise multiple regression analyses failed to reveal any relationships between environmental variables and fish distributions, however, several trends are apparent. There was considerable overlap in distribution between species (Table 2). The grouping of taxa A - F in primarily transects 1 and 2 may be correlated to the tidal influence (Appendix A). The lack of fish in transects 7 and 9 may relate to the presence of shallow, fast-moving water (Appendix A). Increased abundance of invertebrate communities in transects 3 through 10 may account for the apperance of taxa N - Q.

The reproducibility of our visual census results was supported by the comparison of the first four transects at two low tide periods. All but one species (A) found in each transect on 2 February were also found in the same location on 3 February. Seven new species (E, F, I, J, K, L, M) were found on 3 February, most of which were small, cryptic, goby-like fish. Therefore, the apparent increase in fish observed on 3 February was probably due to sharpened observatory techniques.

Table 1. Description of the 17 taxa of fish found along 2.25 km of the Rio Claro, Corcovado National Park.

Species	Description [a]	Length (cm)	Notes
A	*Eucinostromus currani*	2-9	
B	Edge of caudal fin black	9-20	Schools over sand
C	*Sphoeroides annulates*	20	Beak-like mouth; shy
D	*Astyanax fasciatus*	7	Schooling and solitary
E	False black eye patch	5	Schooling
F	Silver; like B but no black on tail	10	Algae feeder
G	Clingfish; brown with black stripes; tint of yellow/ pink near tail	0.5	Bottom feeder
H	Silver; black vertical barring with white stripe down side; 2 dorsal fins	12	
I	Gobi-like; large pink and black stripes	5	Bottom feeder
J	Gobi-like; brown and beige vertical striping; red dorsal fin	3	Bottom feeder
K	*Aweous transandeanus*	5	Bottom feeder
L	Gobi-like; like J but without red dorsal fin	4	Bottom feeder
M	Greenish body with red-orange dorsal and caudal fins	7-20	Small schools in pools
N	Tuna shape; yellow tail with black stripe along length	20	Often found with M
O	Psudophallus starski	4	Pipefish
P	Pomadasys bayanus	7-20	
Q	Brachyrhaolis rhabdophora	7-20	

[a] Species names given when possible based on Peces de las Aguas Continentales de Costa Rica (Bussing 1987)

Discussion

The lack of species richness in the Rio Claro may be attributable to the surprising homogeneity of food lower 2.5 km of the river. We initially assumed that the ocean would produce strong habitat gradients extending from the river mouth to upstream pools. The influence of the ocean on the river, however, was restricted to the first 500 m and was probably most apparent in the numerous marine fish that entered the river at high tide. In a 20 minute period, beginning 80 minutes before high tide, 356 fish passed through the channel at mouth of the river. Most of these were large (> 20 cm), fast-moving fish in schools of 20 to 50 individuals. The effect of these potentially piscivorous fish, however, appeared localized within the first 500 m of the river where water levels fluctuated. Only two species (A and B) migrated further upstream at high tide. Tides did affect the depth, turbidity, and water flow, but again these changes were concentrated at the mouth. Saline conditions, once present at the mouth of the Rio Claro (Winemiller 1983), no longer penetrate the river at high tide. This may be due to the change in conformation of the mouth from a wide flowage to a narrow channel emptying a large lagoon. The change, in turn, may represent the elimination of a niche that could otherwise have supported one or more additional species within the Rio Claro fish community.

The distribution of species along the Rio Claro may best be explained by the distribution of food and substrates. Though diverse, individual substrates and associated food resources did not occur patchily on a large scale, but instead, were distributed almost continuously throughout the river. As a result, the range of individual fish species was wide and overlapping (Table 2). The substrates of most sites were comprised of sand, pebbles and rocks and thus, the numerous species inhabiting these substrates were found throughout the river (K-Q). Only two habitats appeared distinct from the rest of the river, and only these supported semi-unique populations. Aquatic vegetation was limited in its distribution and grew only within 250 m of the river mouth. This vegetation, along with the tidal influence, may explain the approximate restriction of species A-I to the first 500 m. Large aquatic weeds likely provide a source of food and protection to the numerous small fish making up the majority of biomass at the mouth. These fish, in turn, may represent a food source for the large, presumably piscivorous, fish coexisting there. Given the striking absence of vegetation from the majority of the river, this resource may be limiting the abundance of ichthyofauna within the Rio Claro.

Deep holes also supported unique populations. Water depth may limit the size of fish occurring in the river and therefore, large fish tended to occur only in the deep sandy pools located near rapids in the upper portion of the river. Large adults of two species (M, N) occurred only in these pools, though juveniles of species M occurred further downstream. Partitioning of this habitat seemed to be by size class and not species.

Food resources were inextricably linked to substrate and thus, the distributions of food and the implications for fish tended to be similar. Though difficulties in identifying fish hampered the placement of fish into trophic guilds, observations of fish mor-

Table 2. Distribution of fish species found at 10 transects, 250 m apart, along the Rio Claro (abundance at low / high tide). Transects 6-10 were observed at low tide only.

	Transect									
Species	1	2	3	4	5	6	7	8	9	10
A	160/100	100/ 105	-/100	8/-	4/-	-	-	-	-	-
B	110/32	-/41	-	-	-	-	-	-	-	-
C	1/-	4/1	-/1	-	-	-	-	-	-	-
D	-/30	-	-	-	-	-	-	-	-	-
E	-	60/-	20/-	-	-	-	-	-	-	-
F	-	60/-	-	-	-	-	-	-	-	-
G	-	-	1/-	-	-	-	-	-	-	-
H	-	-	-	5/3	-	-	-	-	-	-
I	-	2/-	-	-	-	-	-	-	-	-
J	-	-	3/-	-	-	-	-	-	-	-
K	-	20/15	10/15	-	2/0	1	1	-	-	-
L	-	-	50/50	20/3	-	-	-	15	-	15
M	9/-	2/-	-	6/12	3/4	-	-	7	-	15
N	-	-	-	6/-	-	-	-	2	-	-
O	-	-	2/-	-/1	-	-	-	2	-	-
P	-	-	-/3	-	9/6	21	-	-	-	5
Q	-	-	-	-/3	3/1	3	5	3	3	-

phology and behavior suggested that feeding strategies of fish were diverse. Diets probably include fish, algae, detritus, insect larvae, decapods, and gastropods. Previous analysis of stomach contents (Winemiller 1983), however, indicated that partitioning of these resources is poor. Of the 16 species studied, half fed on shrimp almost exclusively. As a result, food resources like the large columns of gastropods observed in the river, may be underexploited.

Major sources of primary productivity for most riparian communities are allochthonous and thus, fish communities tend to be limited by the input of food from the surrounding forest (Winemiller 1983). Nonvegetative food resources, however, do not appear to be limiting in the Rio Claro. The continuous distribution of individual substrate types and the lack of trophic specialization appear to be the factors most influencing the fish community. Identification of all species of fish within the river would aid in assessing the degree of partitioning by trophic guilds. In addition, the resolution of this study may not have been sufficiently fine to characterize the patchy distribution of substrate and food resources within individual transects. To better understand the driving forces behind the distribution and abundance of ichthyofauna in the Rio Claro, microhabitats should be defined first and then analyzed for the fish community they support.

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Appendix A. Site description of transects in the Rio Claro, Corcovado National Park, Costa Rica.

					Vegetation (%)			Substrate (%)				
Transect	Distance Upriver (m)	Avg. Depth (m)	Width (m)	Aquatic Weed	Algae	Detritus	Sand	Pebble	Rock	Clay	Description
1	0	80	51	33	33	0	100	0	0	0	Lagoon, tidal depth variation of 18.5 cm, deeper channel along side, no decapods
2	250	42	40	10	60	5	50	50	0	0	Consistently shallow, tidal depth variation 15.2 cm, few creeping gastropods (columns of approx. 2 mm black gastropods), few decapods
3	500	34	25	0	95	5	50	50	0	0	Channel along wall, few small creeping gastropods, many decapods
4	750	68	25	0	0	30	25	65	0	10	Located 15 m downstream of small stream input, deep detritis-filled pool, no decapods or creeping gastropods
5	1000	78	15	0	0	5	0	30	70	0	Upstream of rapids, many decapods, many creeping gastropods
6	1250	42	20	0	0	5	5	15	80	0	Shallow, upstream of rapids, fast water, many decapods, many creeping gastropods
7	1500	22	35	0	0	4	40	55	5	0	Shallow, fast water, many decapods, many creeping gastropods, many 1.5 cm rock barnacles
8	1750	31	22	0	0	5	60	37	3	0	Many decapods, many creeping gastropods
9	2000	19	24	0	3	5	10	40	50	0	Shallow, ripply, fast water, many decapods, many creeping gastropods
10	2250	250	12	0	0	60	100	0	0	0	Deep hole at stream input, much sediment and detritis, fast water, few creeping gastropods along edge