Physical factors influencing the distribution of aquatic invertebrates in two cloud forest streams

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Abstract. We quantified invertebrate communities in streams on the Caribbean (east) and Pacific (west) sides of Cerro Chomongo, Monteverde, Costa Rica. We hypothesized that the higher precipitation on the east would lead to different invertebrate assemblages and that higher productivity would be reflected in greater species richness and evenness than on the west side. But the west side had higher order level richness and evenness of invertebrates, possibly because the rocky substrate provided a greater diversity of microhabitats than on the east.

Key Words: River Continuum Concept, stream ecology, diversity

Introduction

The southeast trade winds drop most of their moisture on the east side of Cerro Chomongo, in the Monteverde Biological Station property. If moisture limits growth in the understory, allochthonous nutrient intput would be lower to stream communities on the west than on the east side.

The River Continuum Concept (RCC) predicts that physical conditions and carbon sources change as streams widen downstream, and that aquatic invertebrate assemblages change in response (Vannote et al. 1980). Cover *et al* (1997) tested the RCC at Monteverde and concluded that the predictions of the RCC apply there.

We hypothesized that because the higher rainfall may generate higher productivity on the east side, assemblages of aquatic invertebrates would differ between east and west. Second, according to the productivity hypothesis for the maintenance of high species diversity (Begon et al. 199x), we predicted higher species richness, diversity, and evenness on the east side. Finally, we predicted that there would be physical differences beween the streams on the east and west sides, because the higher rainfall on the east side would result in higher flow rates and greater inputs of leaf substrate to the streambed.

Methods

We sampled a tributary of Río Negro (2 km east of Estacion Biologica Monteverde) on the east slope and a tributary of Quebrada Maquina (1 km southeast of the station) on the west. Macroinvertebrates were sampled from two sections in each stream, one second order and one third order. A randomly placed 20 m segment was marked in each section, and 5 points along it were randomly selected for sampling with kicknets (0.3 m^2 sample for each kicknet). Individuals were counted and sorted to order within the class Insecta. Diversity and evenness were calculated using the Shannon Diversity Index (Begon et al. 1990).

We measured pH, temperature, and flow rate at 3 of the above 5 random sampling points. Volume flow rate was calculated by timing the travel of a plastic bottle along a 1 m section of the stream and measuring the cross sectional area of the stream. At each of the 3 points, substrate was classified as percent cover of rock, organic matter, algae, or sand in a 0.2 m wide band perpendicular to the direction of flow. Canopy cover at each point was estimated visually in 5% increments.

Results

Percent canopy cover, temperature, percent algal cover and pH (pH=5) were similar across all sites. The mean flow rate in the east second order stream was the lowest (8900 cm^3 /s ± 1800 (S.E.)). The average flow rate of the other three sites was 40000 cm^3 /s ± 8800. Rock was the dominant substrate on the west side, but there was a higher proportion of leaves and sand on the east (Fig. 1).

The numbers of insect orders at the 4 sites were similar, though numerical abundance within orders differed (Table 1). The 2nd order east site was dominated by amphipods, while Dipterans dominated the other 3 sites. There were more invertebrates in second order than in third order sites. Diversity and evenness were higher in the west than in the east sites (Table 2).

Discussion

The similar temperature and algal cover among sites was probably due to the relatively uniform canopy cover, admitting similar levels of solar radiation. Substrate differences between the east and west were as expected. Greater cover of leaf substrate in the east sites may reflect a greater abundance of understory vegetation there.

The dominance of amphipods at the second order east site could be associated with its relatively sandy substrate and low flow rate. Within invertebrate orders, abundance was associated with substrate and physical conditions (Table 1).

Contrary to our prediction, diversity and evenness were higher in the west than in the east sites (Table 2). The spatially complex rocky substrate on the west side may provide a greater diversity of microhabitats than on the east. This effect may outweigh any influence of productivity on taxonomic diversity.

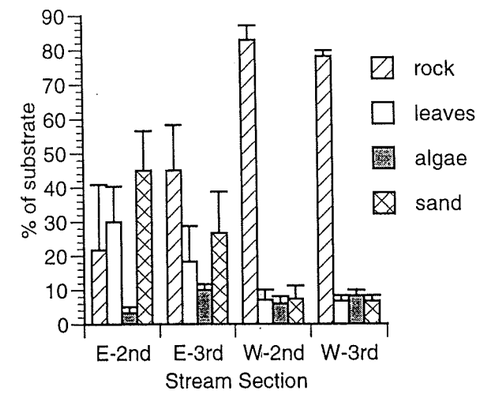

Fig. 1. Comparison of substrate composition among 2nd and 3rd order sites in two streams near Estación Biologica Monteverde, Costa Rica (mean + SE).

Table 1. Relative abundance (% of individuals in each insect order) and mean number of individuals per kicknet sample, for aquatic invertebrate orders at four sites near Estación Biologica Monteverde, Costa Rica.

Aspect	Stream Order	Diptera	Ephemeroptera	Trichoptera	Coleoptera	Amphipoda	Hemiptera	Plecoptera
Relative Abundance (%)								
East	2	12	6	1	0	67	10	1
East	3	56	9	2	4	6	8	4
West	2	36	26	10	1	13	0	5
West	4	42	17	4	6	19	9	0
Mean Number per Sample								
East	2	6	3	1	1	32	3	1
East	3	17	3	1	1	2	0	4
West	2	15	11	4	1	5	1	5
West	3	5	2	1	0	2	5	0

Table 2. Diversity (Shannon Weiner Index, H)and evenness (J) of insect orders at 4 stream sites near Estación Biologica Monteverde, Costa Rica.

Aspect	Stream Order	#Individuals	#Insect Orders	H	J
Caribbean	2	239	8	1.11	0.53
Caribbean	3	153	10	1.48	0.64
Pacific	2	206	7	1.57	0.81
Pacific	3	64	7	1.58	0.81

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