AQUATIC COMMUNITIES IN BROMELIADS: A STUDY OF ISLAND BIOGEOGRAPHY

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Abstract. We studied the species richness, diversity, and abundance of organisms living in bromeliad tank communities as a function of bromeliad size. Based on the equilibrium theory of island biogeography, we predicted that these parameters should increase as the size of the bromeliad increases. Our results did not agree with our predictions, perhaps because of a low sample size or incomplete inventory of each sample due to time constraints. Also, larger bromeliads seemed to contain larger, predatory organisms which may have reduced the number of organisms in those samples. (JJB)

INTRODUCTION (JJB)

Some aquatic communities within the rainforest represent island microhabitats. A good example of this is evident in epiphytic members of the family Bromeliaceae. These plants have long branched leaves which funnel water and detritus into a cistern, creating a favorable habitat for minute aquatic organisms (Forsyth and Miyata 1984). The presence of these organisms leads to colonization by larger, predatory organisms, resulting in complex trophic relationships. Since larger bromeliads have greater reservoirs of water and presumably nutrients, they might be expected to contain a different community structure than smaller bromeliads. This is a prediction of the equilibrium theory of island biogeography, developed by MacArthur and Wilson, which states that larger islands should have greater species richness and a higher number of organisms than smaller islands (Deshmukh 1986). Accordingly, we hypothesized that the number of individual organisms and species richness would increase as the size of the host bromeliad increased. We also predicted that diversity would follow the same pattern.

METHODS (ABS)

Data for the present study were collected on Campbell's Farm, which is adjacent to the Monteverde Cloud Forest Preserve, Costa Rica. All bromeliads sampled belonged to the same species and grew epiphytically within 3m of the ground. They were located no more than 20m apart from one another and were chosen to represent a variety of sizes.

The following information was obtained for each sampled individual: height, measured from the base of the rosette to the top of the highest leaf; rosette width, measured as the distance between the edges of two leaves growing on opposite sides of the plant; and the total number of green leaves.

We then attempted to collect all the liquid contained in each plant's cistern as well as between the bases of its over-lapping leaves. These samples were then taken to our lab for analysis.

For 30 minutes, portions of each liquid sample were analyzed under a microscope. For each of these sub-

samples, we recorded the total number of species, and the number of individuals representing each species. Taxonomic identifications were not always possible however, so morphological attributes were noted so that recurring species could be identified as such. Non-aquatic organisms, if present in the solution, were not counted (see Discussion).

RESULTS (ABS)

For our analyses, it was necessary to estimate an individual bromeliad's size. We performed several allometric tests which demonstrate that the number of green leaves on a plant was correlated with its height (r=0.90) and width (r=0.96). This suggests that all of these measurements are equally representative of size. In the field, number of leaves was most accurately quantified, thus we use it as our estimate of an individual's size.

Those organisms found in our samples were assigned to a "morpho-species" based on their physical attributes (Table 1). Correlations between

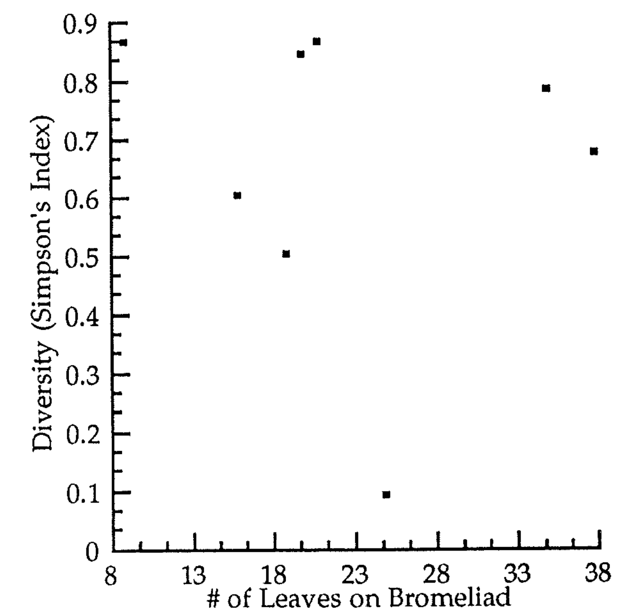

Figure 1. The diversity of aquatic bromeliad communities as a function of bromeliad size.

the number of leaves on a plant and the species diversity (Simpson's index) of the aquatic faunal community within it were not significant (r=-0.23, n=8, p>0.25; Figure 1). A corre-lation between number of leaves and species richness yielded similar results (r=-0.31, n=8, p>.25).

A correlation between number of leaves and the total number of organisms located in the 30min time period was also insignif-icant (r=-0.52, N=8, p>0.1). However, a scatter plot of these variables suggests a neg-ative relationship (Figure 2).

Table 1. Morphospecies found in bromeliads of varying size.

	Bromeliad Size (#leaves)							
Morpho-species	9	16	19	20	21	25	35	38
Large Nematode	X	X	X	X	X			
Cyclopoid Copepod	X							
Calanoid Copepod				X				
Harpactacoid Copepod		X		X	X			
Copepod Type 4	X			X	X	X		
"Football"	X				X	X		X
Mite		X		X		X		
Beetle With Two Spots		X		X			X	
Beetle With One Spot	X							
Small Nematode		X		X				X
Dipteran Larva			X					X
Coleopteran				X				
Rotifer					X			
"Clam"						X		X
Small "Lobster"							X	
Brine Shrimp							X	

DISCUSSION (JLD)

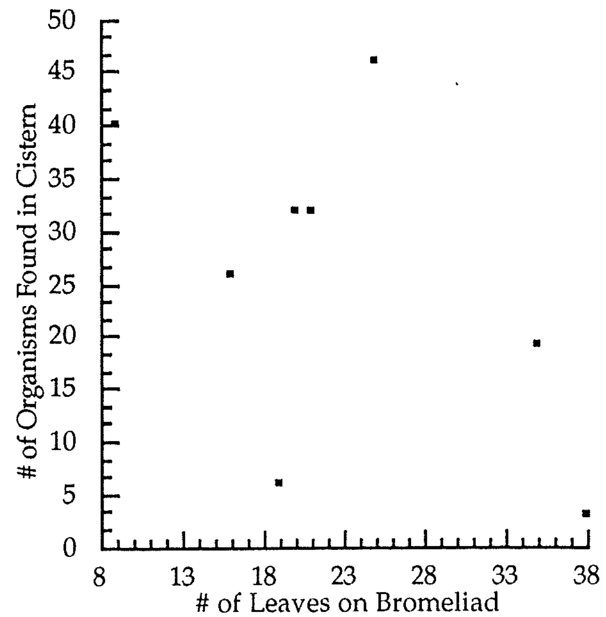

Figure 2. The number of organisms found in the cistern of a bromeliad as a function of its size.

Although our data do not support our hypotheses, they may not invalidate basic island biogeography theory. In our study, we may not have accounted for the entire is-land, or there may have been stronger ecological forces (e.g., predation) affec-ting the bromeliad community that counter the predictions of island biogeography. We did not attempt to separate out random influx of new organisms, predation or other similar factors.

Our objective was to examine the organisms found only in the water trapped by the bromeliads, not the entire biota living within the plants. In addition, we were unable to count each organism due to time constraints or to identify positively each species due to our lack of taxonomic expertise and available manuals. We had hoped to identify the trophic level to which each organism belonged and elucidate the community structure, but were unable to do so.

It was difficult to accurately and consistently sample the water in the bromeliads. We think that removing the bromeliad and analyzing the entire community would be the most consistent sampling method. Perhaps if we had counted all the organisms living in the bromeliads we would have obtained results as expected. This would have indicated that the aquatic portion of a bromeliad is only a part of the total community. It may be that non-aquatic organisms were feeding upon the aquatic organisms present.

Our strongest correlation was negative, between bromeliad size and the number of organisms (Figure 1). We noticed that the small bromeliads with large numbers of organisms were predominantly uninhabited by zooplankton (e.g., copepods) that we observed feeding on detritus. Casual observation suggests that larger organisms, which may have been feeding on the zooplankton, seemed to be lacking in smaller bromeliads, while they were the few organisms found in larger bromeliads. This "culling hypothesis" was developed after observing many of our samples. Comparing organism size or biomass would be good questions for future investigation. We suspect it may be commonplace for the larger organisms to feed upon the smaller, strongly reducing their numbers. If our culling hypothesis is correct, biomass and average organism size should be positively correlated with bromeliad size.

This may not be as contrary to conventional ecological thinking as it first appears. If low trophic levels are turning over rapidly, a static picture of the biomass might be an inverse

pyramid. This would be further facilitated by a plentiful and continuous supply of detritus. Another plausible scenario would be one of boom-and-bust. If the predators are insect larvae, they could cull most of the microorganisms and then undergo metamorphosis, no longer depending on the depleted aquatic community.

Our research barely scratches the surface of the interesting aspects of bromeliad communities. Examining why the equilibrium hypothesis of island biogeography doesn't seem to apply to aquatic bromeliad communities is one approach. Other questions we suggest are what the trophic interactions are in different bromeliads. They may vary with size or light exposure (bromeliads in gaps may have a more phytoplankton based community than ones in non-gaps). Artificial tanks would be an intriguing way to approach these questions. Age is almost certainly positively correlated with size, but tanks would allow the manipulation of one variable while holding the other constant.

LITERATURE CITED

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Forsyth, A. and Miyata, K. 1984. *Tropical Nature*. Charles Scribners Sons: New York.