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A STUDY IN ISLAND BIOGEOGRAPHY: AQUATIC BRACT COMMUNITIES OF HELICONIA AND CALATHEA

Greg Goldfarb, Christy Goodale, and Geoff Kunz

Abstract (C.G.)

Heliconia sp. and Calathea sp. floral bracts contain isolated aquatic micro-communities. We tested the predictions of the MacArthur and Wilson species-area model relating a region's size to the number of species it contains. Our results support the overall prediction of this model, in that the number of species contained within the bracts increased with the bracts' volumes. We then predicted that the larger bracts, containing a larger number of species, would have a higher probability of containing a species which could consume the bract's flower. This prediction was not supported in that bracts of all sizes were found to contain Quichuana angustriventris, a larval dipteran known to prey on floral parts. No other predatory species were positively identified. Thus we were not able to conclude that greater species diversity placed larger bracts at any greater risk of flower predation than smaller flowers.

Introduction (G.G., G.K.)

Our study looked at the bract communities of Heliconia sp. and Calathea sp., two similar species of broad-leafed second growth plants. These fluid-filled bracts provide ideal habitats for many species of insect larvae and other aquatic animals. Because each bract supports its own physically isolated aquatic community, we examined the variations in species and abundance of the animals from an island biogeographical perspective. The MacArthur-Wilson island biogeography model predicts that larger isolated habitats will host greater numbers of species (MacArthur and Wilson, 1967). Our first hypothesis was that bracts holding a larger volume of fluid would support a more diverse aquatic community.

A main line of reasoning behind the island biogeography theory says that larger islands contain a greater number of distinct niches than small islands. We reasoned that a bract containing a wider range of niches is more likely to support a species that may eat the flower and reproductive structures. It has been shown that the bract fluid is instrumental in protecting the flower parts against insect herbivory (Wootton and Sun, 1989). We theorized that the protective advantage of a very large bract may be compromised if its larger size makes it more prone to be inhabited by a flower-consuming animal. Our second hypothesis was that larger bracts have a higher probability of containing a flower consuming species than smaller bracts. This tradeoff would limit the maximum effective size of a bract.

Methods (G.K., G.G.)

We collected nine Heliconia and seven Calathea bracts from second growth forest around the Sirena Station in Corcovado National Park, Costa Rica on 23 January 1991, and censused their aquatic animal populations. Since the amount of time a bract has been open may influence its diversity and abundance of aquatic organisms, we tried to select similarly aged bracts. On an inflorescence bracts open sequentially from the bottom up. Accordingly, in order to control for age differences, we collected samples from inflorescences with approximately the same number of open bracts and always used the lowest bract on an inflorescence.

In gathering our samples we first extracted the bract fluid using a graduated syringe and recorded the volume. We stored bract fluid in individual 35ml plastic containers. We then removed the bract and its contents from the plant. Back at the lab we dissected the flowers under a hard lens, extracted all larvae and aquatic animals found, and put them in their respective fluid containers. We censused each vial for aquatic organisms separately under a hard lens. We grouped the organisms into twelve taxonomic categories and recorded the number of individuals in each class for each bract collected.

Results (C.G.)

Quichuana angustriventris was the most abundant larval species, found in all sizes of the Heliconia and Calathea bracts. Also common were any of three species of mosquito larvae and nematodes. At least three types of beetle larvae, one type of beetle adult, two types of Chironomid, scales and mites were also found. No other organisms were identified (Table 1).

The number of species contained within a bract increased with the bract's volume (Figure 1 $r^2 = 0.6247$, $p < 0.01$). The number of individuals within each bract also increased with bract volume (Figure 2, $r^2 = 0.7501$, $p < 0.01$).

Discussion (C.G., G.G., G.K.)

Our results support our hypothesis that species diversity increases with bract size. This finding is consistent with the MacArthur-Wilson island biogeography model. We were unable to examine the more specific predictions of this model due to a small sample

size and time and resource limitations.

Our findings did not support our second hypothesis that larger bracts are more likely to host flower consuming species. We were unable to determine whether or not most of the organisms we found were flower consumers. However, we discovered that fourteen of the sixteen bracts contained larvae of Quichuana angustriventris (Rat-tailed Maggot Diptera), a known flower consumer of both Heliconia and Calathea (Seifert, 1983). Our results suggest that bracts of all sizes have an equal likelihood of hosting flower-consuming Q. angustriventris. Therefore, it does not appear that flower fitness is compromised by the more diverse aquatic communities of larger bracts.

Other factors which could limit bract size could be: (1) the energy costs associated with producing and supporting unnecessarily large bracts, and (2) the enhanced visual cue oversized bracts provide for terrestrial flower consumers.

Table 1 Species and Abundance Distributions of Bracts.

HELICONIAS

Bract #	Vol.(ml)	Total #Ind.	#Species	Rat	Mosq. A	Mosq. B	Beetle A	Beetle B
1	32.0	37	6	18	2			
2	14.5	19	5	5	1			
3	22.0	23	6	6	4			1
4	18.5	23	5	12	6			2
5	18.0	15	5	8	4		1	
6	32.0	26	7	13	3	2		4
7	35.0	28	5	21	3			
8	27.5	46	6	33	5			
9	17.0	24	8	12	2	1	4	
Totals	216.5	241	11	128	30	3	5	7

Bract #	Beetle C	Adult Beetle	Chiro. A.	Chiro B.	Nemat.	Scales	Mites	Other
1		2			2	12	3	
2					2	6	5	
3					4		8	
4		1			2			
5		1						1
6					2		1	1
7		1			2		1	
8		1			4	2	1	
9		1			1		3	
Totals	0	7	0	0	19	20	22	2

CALATHEAS

Bract #	Vol.(ml)	Total#Ind.	#Species	Rat	Mosq. A	Mosq. B	Beetle A	Beetle B
1	1.8	7	2					
2	2.9	7	5	2	1	1		
3	3.9	2	2		1		1	
4	3.2	10	4	3	1			
5	2.1	14	3	12				
6	2.4	4	3	2				
7	1.5	4	2	2	2			
Totals	17.8	48	9	21	5	1	1	0

Bract#	Beetle C	Adult Beetle	Chiro A.	Chiro B.	Nemat	Scales	Mites	Other
1			6	1				
2	2				1			
3								
4			6		1			
5		1			1			
6	1							1
7								
Totals	3	1	12	1	3	0	0	1

Key: Rat=Rat-tail maggot (Quichuana angustriventris)
Mosq.=Mosquito larva
Beetle(A,B,C)=Beetle larva
Chiro-CHironomid larva
Nemat=Nematode

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Figure 1 Relation between larval species number and bract volume, in Heliconia and Calathea bracts from Corcovado, Costa Rica.

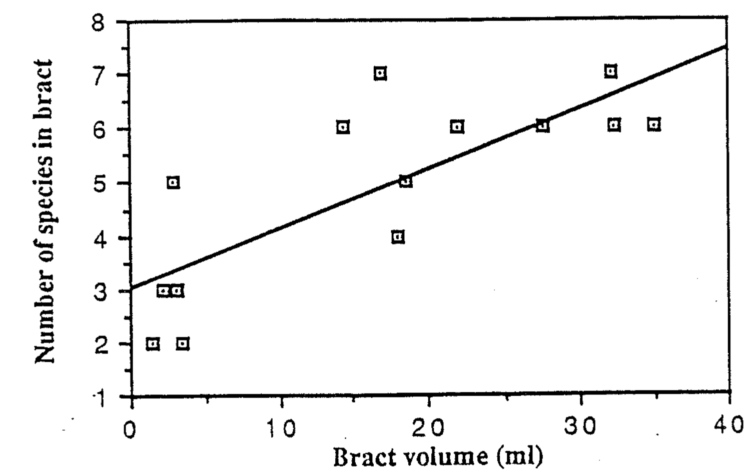

Figure 2 Relation between number of individuals in a bract and bract volume, in Heliconia and Calathea bracts from Corcovado, Costa Rica.