THE EFFECTS OF TANK WATER VOLUME ON COMMUNITY ABUNDANCE IN *GUZMANIA*

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Abstract: The abundance of macro-invertebrates in bromeliad tanks in *Guzmania monostachyia* has been shown to be positively correlated to the volume of detritus and water in the tank. *G. monostachyia* occur on both sides of the continental divide in the Monteverde Biological Preserve, where they are subject to different precipitation. Because detritus input should be similar between the two slopes, this provided a means of separating the effects of water and detritus on tank fauna. We measured water volume, detritus dry mass and macro-invertebrate abundance and diversity for eight *G. monostachyias* on each slope. Caribbean tanks had higher water volumes, but there was no difference between the slopes in the number of macro-invertebrates. As predicted, detritus mass did not differ between slopes. There was a significant positive correlation between detritus dry mass and macro-invertebrate abundance on the Pacific slope, but, not on the Caribbean slope. The lack of water and very low number of inhabitants was in stark contrast to previous studies. The frequency and duration of droughts in tank bromeliads might be quite important for the structure of tank communities. Recent decreases in regional precipitation might be making such droughts more common.

Key words: Caribbean slope, macro-invertebrates, Monteverde, Pacific slope, phytotelmata

INTRODUCTION

Phytotelmata are a common source of standing water in forest ecosystems, and provide habitat and breeding grounds for multiple macroorganisms (Varga 1928). Tank bromeliads such as *Guzmania monostachyia* (Bromeliaceae) are important phytotelmata in areas with high levels of atmospheric moisture and precipitation. *G. monostachyia* is an epiphytic plant that collects water and detritus in a tank created by its interlocking leaves, and can support a community of insect larvae, zooplankton, and other invertebrates (Forsyth and Miata 1984, Yanoviak 2001). Previous studies have shown that the volume of both detritus and water in the tanks influence the abundance of organisms in the tank communities (Yanoviak 2001, Licona 2003). Tank bromeliads occur on both the Caribbean and Pacific slopes of the continental divide in the Monteverde Biological Preserve, Costa Rica. The two slopes are subject to different moisture regimes. The prevailing easterly winds from the Caribbean Sea drive clouds up the Caribbean slope, where precipitation is generated as moist air rises and cools. The air masses continue across the divide to the Pacific slope with a reduced moisture load. We hypothesized that *G. monostachyia* would have higher water volumes on the Caribbean slope than on the Pacific slope, and that the organismal abundance in the tank communities would be higher as a result of the greater water volume.

METHODS

On 22 January 2004, within the Monteverde Biological Preserve, Monteverde, Costa Rica, we sampled eight bromeliads on the Pacific side of the continental divide and eight on the Caribbean side. Sampling occurred at 1700 - 1720 m elevation, on plants that were 0.5 ± 0.1 m at their greatest diameter from leaf tip to leaf tip. We removed all detrital matter and visible organisms with forceps before collecting water from the tanks using a 600 cc syringe and surgical tubing.

For each bromeliad, we weighed (1) the water, and (2) the water plus all detritus and macroorganisms. Using a dissecting microscope, we removed and identified (to morphotype) all macroscopic organisms in our samples.

We then dried the detritus to determine its dry mass.

RESULTS

In *G. monostachyia* tanks of similar size, water volume was low overall (0 - 1.74 mL/tank) but was modestly higher on the Caribbean slope than on the Pacific slope ($F_{1,14} = 3.60$, $P = 0.079$; Fig. 1). The amount of detritus did not differ between the Caribbean and Pacific slope ($F_{1,14} = 0.016$, $P = 0.90$; Fig. 1). There were surprisingly few invertebrates within the tanks (total of 16 individuals, representing seven recognizable taxa, within 16 tanks; Table 1). The fauna, including chironomids of the diptera family, appeared to be normal inhabitants of bromeliad phytotelmata, and not incidental captures from the terrestrial environment. The number of individual organisms per tank did not differ between slopes ($F_{1,14} = 1.80$, $P = 0.21$; Fig. 2).

There was a positive correlation between organismal abundance and detrital load on the Pacific slope ($P = 0.04$), but not on the Caribbean slope ($P= 0.16$; Fig. 3). There were no other significant correlations, on either slope, among water volume, number of organisms, and detrital mass ($P > 0.50$).

Table 1. Total captures of macroorganisms in eight tanks of *G. monostachyia* on either slope.

	Caribbean slope	Pacific slope
Dipterans	4	1
Nematoda	2	2
Hemiptera	1	1
Eubrachiopoda	1	1
Isopoda	1	0
Coleoptera	1	0
Copepoda	0	1

DISCUSSION

The lack of water in bromeliad tanks was surprising. There was a major discrepancy between the water volumes found in our study (largest volume = 1.74 mL) and those of Licona et al. (2003), who reported volumes of 31 - 189 mL in approximately the same population of tank bromeliads. While a simple lack of precipitation over a week may explain our low volumes, Lawton, et al. (2001) suggests that lowland deforestation may be systematically reducing the amount of rainfall received at Monteverde.

We found macro-invertebrate abundances in the tank communities to be very low. Licona et al. (2003) found abundances of 10 - 299 individuals *per tank sampled*, while our total catch for 16 plants was 16 individuals. A portion of the fauna found by Licona et al. (2003) were probably facultative inhabitants of phyto-

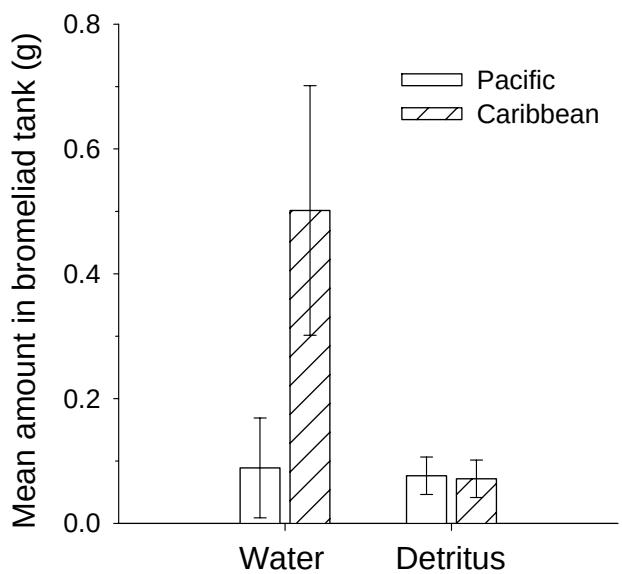

Figure 1. Mass of water and dry detritus (± SE) in the central tanks of G. monostachyia bromeliads on the Carribean slope versus the Pacific slope.

telmata. We found so few organisms in total that it is impossible to judge whether we found a lower or higher proportional representation of obligate inhabitants of phytotelmata. However, with the low water volumes found in our study, it is possible that facultative inhabitants were largely absent, and even obligate macro-invertebrates exhibited low abundances in drier conditions.

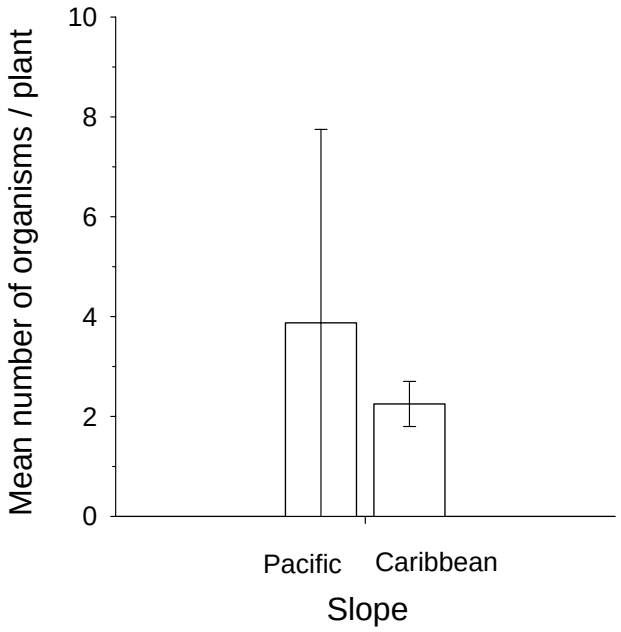

Figure 2. Mean number of organisms (± SE) per *G. monostachyia* tank on Carribean and Pacific slopes.

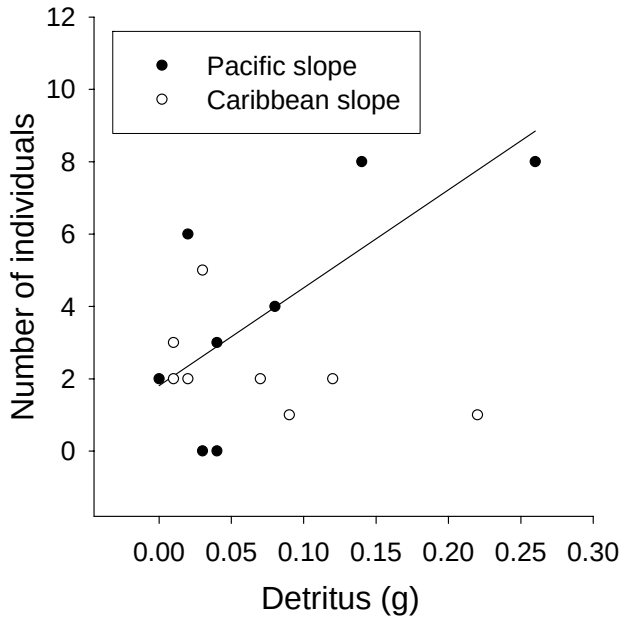

Figure 3. Number of individuals vs. detritus mass within tank bromeliads. Regression for Pacific slope: y = 0.019x + 0.002, r^2 = 0.52. There was no correlation on the Caribbean slope (no line shown).

The severe lack of water and very low organismal abundance of inhabitants prevented us from obtaining a satisfying comparison of Pacific vs. Caribbean fauna. However, the interested unexpected result was that tank bromeliad communities in this environment could be so impoverished. Even at the continental divide, it seems that neither precipitation nor condensation were enough to provide tank water volumes necessary for what we assumed to be the normal tank fauna (Laconia et al. 2003). While this may be a function of a brief lack in precipitation, our data could be a biological harbinger of Lawton et al.'s (2001) suggestion that regional precipitation is declining due to deforestation. Future studies could investigate the bromeliad community to determine if the stark contrasts between our study and 2003's study (Licona et al.) are a simple year to year variation or the sign of a broader and potentially significant change in biological communities.

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