MORPHOLOGICAL VARIATION OF EPIPHYTIC BROMELIADS WITH HEIGHT ABOVE GROUND

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Abstract: Epiphytic tank bromeliads in secondary forest are morphologically plastic in response to abiotic factors in the tree canopy (Badar 1999). We hypothesized that a bromeliad assemblage in a high elevation primary cloud forest at Monteverde, Costa Rica would show the same morphological trends. Specifically, we predicted that canopy bromeliads would have a narrower shape, smaller size, and a greater capacity (per unit size) to store water than understory bromeliads, to deal with light, wind, and nutrient stress. As predicted, bromeliad volume (calculated from bromeliad height and diameter) significantly decreased with height above ground. Two non-significant trends were consistent with our predictions: bromeliads tended to be narrower (greater height:width ratio) and to have larger tanks in proportion to plant size, with height above ground.

Keywords: vertical stratification, nutrient gradient, moisture stress

INTRODUCTION

Light, water, and nutrient availability influence vascular epiphyte morphology (Bader 1999). In the more exposed and xeric canopy habitat, bromeliads with tanks tend to have a narrow tubular shape; this minimizes water loss by evaporation, damage by direct radiation (Benzing 1990), and the chance of being dislodged by wind. Individuals growing in the shady and humid conditions of the understory tend to have a greater diameter, which allows them to gather more light (Bader 1999).

Based on this evidence, we hypothesized that abiotic factors in the high elevation cloud forest of Monteverde would affect Bromeliaceae morphology. We predicted that bromeliads higher on the tree would be narrower and smaller, reducing their exposure to wind and sun, while those towards the base would be broader and thus absorb more light. We predicted that canopy bromeliads would also have greater tank capacities due to greater potential for water stress higher on the tree.

METHODS

We sampled on January 24, 2008 in a primary tropical cloud forest along The Great Divide, ca. 1 km E of the Estación Biologíca Monteverde, Costa Rica. We studied type III Bromeliaceae (epiphytic species with tanks that absorb water and nutrients through foliar scales at the leaf base; Pittendrigh 1948), from the Bromelioideae and Tillandiodeae subfamilies. We opportunistically sampled 6 recent tree falls along the ridge of the Great Divide.

We measured the trunk length of each tree and divided it into four equal sections. We randomly chose one bromeliad from each section for further testing. On one of the 24 study sections, no bromeliads were present. We recorded the distance of the bromeliad from the base of the tree (height above ground), bromeliad height (from the base of the bromeliad roots to the tallest leaf) and width (leaf span at the bromeliad's widest point). We measured tank volume by filling it with water and emptying it into a graduated cylinder.

We estimated bromeliad volume by calculating the volume of a cone using measures of height and width. We quantified a shape index for each bromeliad using a height:width ratio. To quantify proportional tank volume we calculated tank volume:bromeliad volume.

RESULTS

Bromeliad volume decreased with height above ground; (r^2 = 0.22, df = 21, P = 0.03; Fig. 1). We found a non-significant positive trend for height:width ratio to increase with increasing height above ground (r^2 = 0.11, df = 21 P = 0.13). There was a weak suggestive trend for relative tank size to increase with height above the ground (r^2 = 0.10, df = 21, P = 0.13).

Bromeliad height did not change with height above the ground (r^2 = 0.05, df = 21, P = 0.32), though bromeliad width decreased as height above the ground increased (r^2 = 0.22, df = 21, P = 0.02). There was no relationship between tank volume and height above the ground (r^2 = 0.03, df = 21, P = 0.46).

With six separate statistical tests, there was a 26.5% chance of finding one significant relationship by chance alone.

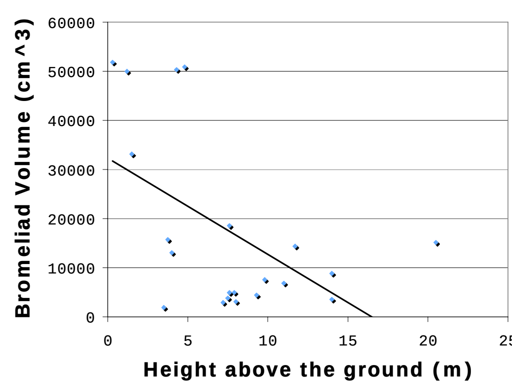

Fig. 1 Bromeliad volume vs. height above ground for fallen trees along the Mirador trail on the Great Divide at Monteverde, Costa Rica.

DISCUSSION

We suggest that bromeliad morphology was driven by light and mechanical stress, although we were unable to measure those abiotic factors. Canopy bromeliads tended to be smaller than understory bromeliads (Fig. 1), suggesting that larger bromeliads are limited to lower sections on the tree or that smaller plant size is selected for in the canopy habitat.

Although statistically insignificant, greater tank volume relative to bromeliad volume in individuals high above ground suggests that moisture stress, perhaps due to greater evaporation and reduced rainfall during the dry season, may be important in the canopy.

Although the pattern of greater height:width ratios in canopy bromeliads was not significant, we believe that wind and light stress influenced the directionality of the data. The streamlined shape found in the canopy could reduce the chance of being blown down and exposure to direct radiation. Bromeliads closer to the ground tended to have a lower height:width ratios which may maximize light absorption in dim light.

Overall, we believe our data indicate that bromeliad volume and width in this high elevation primary cloud forest are influenced by gradients in light, wind stress, and moisture. The results also suggest that canopy bromeliads have a greater capacity to store water and tend to have a narrower, taller shape than understory bromeliads. To make stronger inferences about these patterns, it would be necessary to quantify abiotic gradients and obtain larger samples.

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