NECTAR PRODUCTION AND PLANT SIZE IN *ACACIA COLLINSII*

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Abstract: Plants have limited resources for growth, reproduction and defense. Resource allocation varies among and within species, and may depend on age and environmental conditions. We hypothesized that allocation to the nectar resource, for maintenance of its mutualist ant defenders, would be less in small *A. collinsii,* because allocation to growth may be more critical in small plants. We found a significant positive relationship between size and defense (measured by nectaries per leaf). Other measures of defense investment (i.e. nectaries per cm branch, nectary volume, and nectar sugar content) were unrelated to size. Overall, our findings provide moderate support for our hypothesis.

Key Words: extra-floral nectaries, plant defenses, Pseudomyrmex spinicola, *resource allocation*

INTRODUCTION

Resource limitation in plants usually results in a tradeoff between allocation to growth and defense. In *Acacia collinsii,* a mutualism with ants of several species provides defense against herbivory. Defense occurs through an intermediary step: the plant invests in extra-floral nectaries, and ants protect their food source by deterring herbivory, as well as removing competing vegetation in the vicinity of their host. The ant mutualists are maintained only if adequate resources are invested (Janzen 1989).

Small plants generally invest more in growth than larger ones. Fast growth may help a small plant compete for limiting resources (e.g. light), or minimize the time for which the plant is highly vulnerable to herbivory.

Abram (1994) documented a positive relationship between individual growth rate and the number of ant defenders for *A. collinsii*. We propose that small trees invest less in nectar rewards than larger conspecifics, because resources available to small trees are preferentially allocated to growth. Thus, we predicted that larger trees would produce more nectaries per cm of branch, more nectaries per leaf, nectaries of greater volume, and nectar of higher sugar content, than small trees.

METHODS

We sampled 12 *A. collinsii* trees with populations of *Psuedomyrmex spinicola* within 2 m of the Metia trail in Palo Verde National Park, Costa Rica. Equal numbers of small (≤ 120 cm tall) and large (≥ 250 cm) trees were selected.

We attached non-absorbent gauze to two petioles per tree on the day prior to sampling. This prevented ant feeding at those petioles which could have biased our results. We wrapped petioles only on

branches with new growth and thorns, as well as active ants. After removing the gauze, we measured the length, width, and height of nectaries on the petiole to the nearest 0.1 mm, to calculate the total volume of nectaries per petiole. We obtained an index of sugar concentration by crushing the nectaries in 40 μL of tap water and measuring the sugar concentration of the solution, using a Sugar/Brix Refractrometer (Model 300010).

We clipped two branches from each sample tree and recorded length, number of leaves, and number of nectaries for each. As before, clipped branches had new growth, new thorns, and active ants.

We performed simple linear regressions using tree height as a continuous variable in JMP 5.0.1. Data met the assumptions of the tests performed.

RESULTS

We found no relationship between tree height and nectary volume ($r^2 = 0.01$, df = 22, P = 0.67), nectaries per cm of branch ($r^2 = 0.00$, df = 22, P = 0.84), or nectar sugar concentration ($r^2 = 0.03$, df = 21, P = 0.39). There was a significant increase in the number of nectaries per leaf with increasing tree height (Fig. 1).

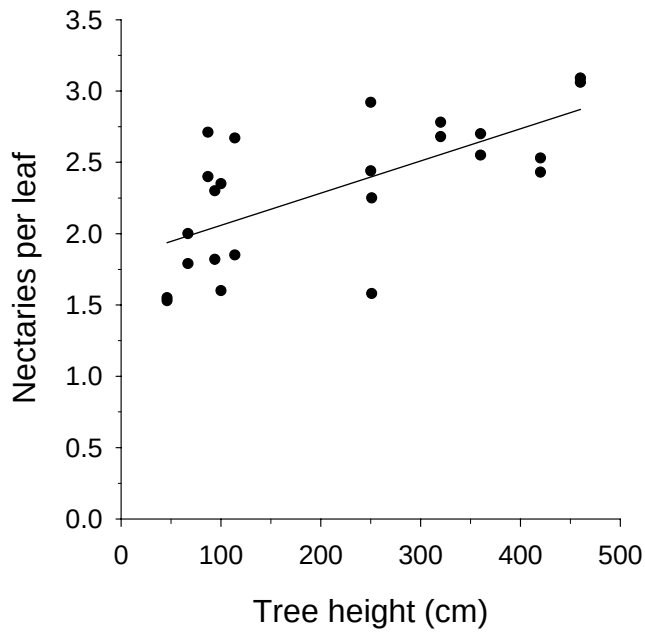

Figure 1. A. collinsii trees sampled along Metia trail in Palo Verde (n = 24; linear regression, $r^2 = 0.44$, df = 22, P < 0.001; lack of fit, F = 1.96, df = 10, P = 0.134).

DISCUSSION

Larger trees produced more nectaries per leaf. Because each nectary is a feeding point for ant mutualists, increasing the number of nectaries increases the reward for defenders, as well as the investment in defense. We found no evidence that the nectaries of larger trees contain more sugar than those of smaller trees (although we suspect that our methods for detecting sugar concentration in the nectary suspension were unreliable).

We suggest that the lower ant abundance on smaller *A. collinsii* (Abram et al. 1994) results from a trade-off between growth and defense. Investigation of plant investment in Beltian bodies, a nitrogen-based ant resource, may reveal similar patterns.

LITERATURE CITED

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WEAK SELECTION ON FLORAL CHARACTERS IN *JUSTICIA COMATA*

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Abstract: Spatial variation in selection pressures on floral traits has not been explored in many plant-pollinator systems. We observed two populations of *Justicia comata* that were visited by different potential pollinators. We predicted that the population visited by predominantly larger butterflies would exhibit different patterns of selection on floral traits than the population visited by smaller flying insects. We measured six floral characteristics and two fitness estimates on 24 plants at each site. A multiple regression showed only one significant trend; petal width was positively associated with one fitness estimate, at one site. We infer that petal width is under selection by pollinators at one site and that patterns of selection on petal width vary between the two sites.

Key Words: directional selection, pollination

INTRODUCTION

*Justicia comata (*Acanthaceae*)* flowers are common at the Palo Verde National Park in Costa Rica. *J. comata* have several floral visitors, including butterflies, hummingbirds, small bees and other insects. Observation of two distinct populations at Palo Verde showed that floral visitors at one site were dominated by larger butterflies and hummingbirds, while smaller flying insects were dominant at the other site. Because these visitors may be attracted by different flower traits, we hypothesized that *J. comata* may be experiencing different patterns of selection at the two sites. Our goal was to compare patterns of phenotypic selection on floral traits through estimates of seed production at the two sites.

Many floral traits affect pollinator attraction. We predicted that six traits would alter pollination success in this system: petal size, which affects the pollinator's ability to locate the flower; corolla width and length, which affect a pollinator's ability to gain access to nectar or pollen rewards; and the distance between the stigma and anthers, which may affect the morphological fit between the flower and visitor. Plant height and number of flowers per plant may both affect pollinator attraction. To estimate plant fitness, we chose the percentage of fruits developed (not aborted), and the mean number of viable seeds in successful fruits.

We predicted that smaller pollinators would select for narrower and shorter corollas, smaller stigma-anther distances,