RELATION BETWEEN *A. COLLINSII* NECTARY DENSITY AND DISTURBANCE-INDUCED ACTIVITY OF *P. SPINICOLA*

ABIGAIL ADAMS, PAUL WRIGHT, KATHERINE R. AMATO, CATRINA LINDGREN, MARCIE WING

Project design: Erik E. Stange. Faculty editor: David R. Peart

Abstract: Acacia collinsii produces nectaries on leaf petioles for the mutualistic *Pseudomyrmex spinicola* ants that defend them. We examined the relationship between the density of nectaries and ant activity, hypothesizing that ant activity would increase with nectary density. We measured ant activity and nectary density on small (<1 m tall), medium (1-2 m tall), and large (2-3 m tall) ant acacia trees. Ant activity increased with nectary density on small and medium trees, suggesting that higher tree investment resulted in greater ant defense. However, we found that large trees with the same nectary density had less ant activity than small and medium trees, suggesting a lower return on investment as trees grow larger than 2 m tall.

Key Words: Acacia collinsii, Pseudomyrmex spinicola*, mutualism, plant defense, nectary*

INTRODUCTION

In the obligate mutualism between the ant, *Pseudomyrmex spinicola*, and the tree, *Acacia collinsii*, the ant receives food and shelter from the tree in return for defense against herbivores and competing plants (Janzen, 1983). One reward for ants is a sugar solution at nectaries on leaf petioles. We reasoned that ants would defend most vigorously those plants that provide the greatest reward. Thus, we predicted that as the investment in the reward (nectary density) increased, the investment return (ant activity) would also increase. We used ant activity as a proxy for the level of defense provided by the ants.

METHODS

On 9 January 2006, we sampled 26 *A. collinsii* trees in a heavily cattle-grazed area, northeast of the OTS station in the tropical dry forest of Palo Verde National Park, Costa Rica. This area has been used for ant-acacia research in several studies by the Dartmouth Tropical Studies FSP (e.g. Iwamoto et al., 2003). On trees containing the mutualist ant species *P. spinicola,* we haphazardly chose 4 branches on each of 10 small (0 - 1 m tall) and 10 large trees (2 - 3 m tall), and 3 branches on each of 6 medium trees (1 - 2 m tall). We visually estimated tree height and chose branches representative of the entire tree. We counted the number of nectaries on the leaf petioles along various branch lengths (4 - 103 cm), measuring on each branch from the first node with green leaves to the last node with green leaves.

We quantified nectary density as the number of nectaries/cm along branches. We measured ant activity by tapping for 5 seconds at an arbitrary point near the middle of the sampled length on each branch. We counted the number of ant crossings at that point over 1 minute immediately after tapping each branch. We defined investment return as ant activity/nectary/cm. We analyzed the

relationship between ant activity and nectary density using linear regression in JMP 5.0.1. We then used an ANOVA to determine if return on investment varied among tree sizes.

RESULTS

Ant activity increased with nectary density (r^2= 0.21, df=1, P=0.02; Fig. 1). Return on investment depended on tree size ($F_{2, 24}$= 7.35, P=0.0032; Fig. 2). Medium trees (1-2 m) had the highest return on investment (52.56 ± 7.00 ant ativity/nectary/cm; mean ± SE), followed by small trees (< 1 m; 43.46 ± 2.90), and then large trees (2-3 m; 24.30 ± 5.88).

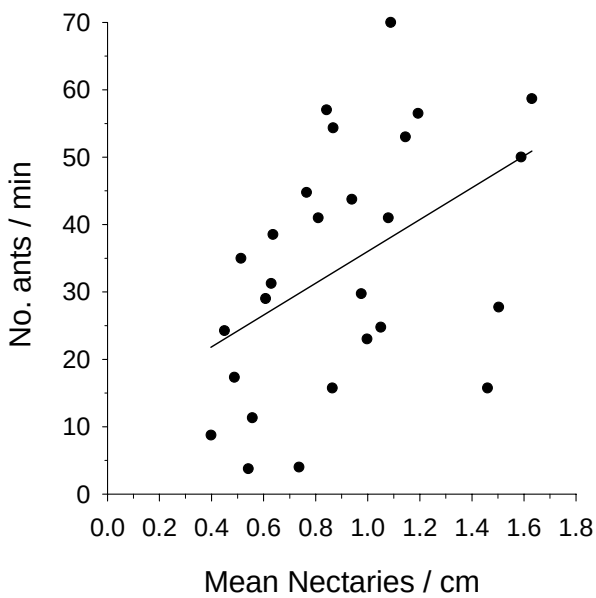

Figure 1. The relationship between *Pseudomyrmex spinicola* ant activity (measured as number of ant crossings on a point after branch disturbance) and nectary density on *Acacia collinsii* in Palo Verde National Park, Costa Rica (r2=0.21, df=1, P=0.02).

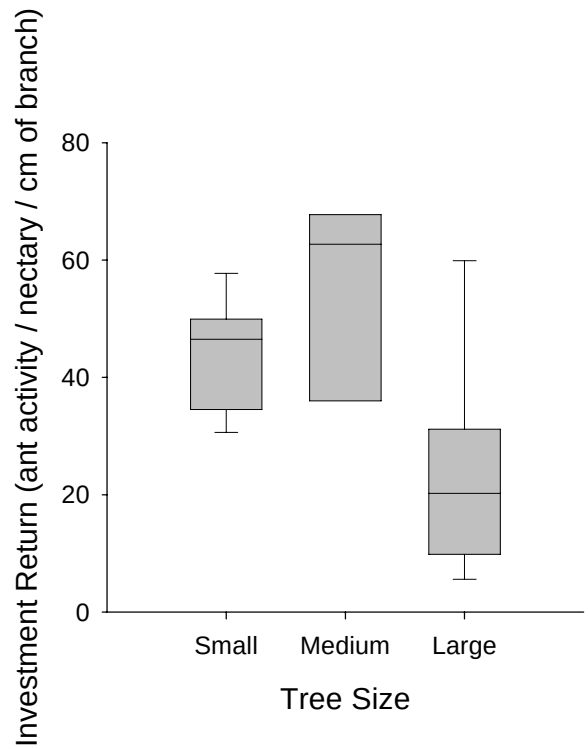

Figure 2. Differences in investment return in ant defense among size classes of *Acacia collinsii* at Palo Verde, Costa Rica. Small trees were < 1 m tall, medium trees 1-2 m tall, and large trees 2-3 m tall. Investment return was defined as the activity of mutualist *Pseudomyrmex spinicola* ants per nectary per meter of branch supporting green growth. See Figure 1 for definiton of ant activity. Error bars represent 95% confidence intervals. (Error bars on medium trees coincide with horizontal bars.)

DISCUSSION

Our results supported our hypothesis that greater plant investment would lead to more effective defense by ants. However, in the largest trees, investment return was less than expected. Because the amount of nectar per nectary does not depend on tree size (Matsuura et al. 2005), lower ant activity in large trees cannot be explained by lower nectar availability. We do not have a good alternative hypothesis. However, large

trees may be subject to different constraints (due to different ratios of photosynthetic/non-photosynthetic tissue).

LITERATURE CITED

Janzen, D.H. 1983. *Pseudomyrmex spinicola* (Hormiga del Conizuelo, acacia-ant). Pp. 762-764 in D. H. Janzen, ed. Costa Rican Natural History. University of Chicago Press: Chicago.

Matsuura, T.R. et al. 2005. Nectar production and plant size in *Acacia collinsii*. Pp. 6-7 in Dartmouth Studies in Tropical Ecology 2005. Dartmouth College: Hanover, NH.