RESOURCE ALLOCATION IN ACACIA COLLINSII: PLANT GROWTH AND ANT COLONY MAINTENANCE

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ABSTRACT (AEL)

We investigated the relationship between growth rates of Acacia collinsii and investment in their mutualistic relationship with ants (Pseudomyrmex). We hypothesized that faster growing trees woud invest more resources in ants because they have more tissue to defend from herbivores. To test this proposition we measured tree growth rate, ant activity and number of Beltian bodies on acacias in Palo Verde National Wildlife Refuge. Counter to our prediction, trees with high growth tended to have lower and less variable ant activity than did trees with low growth. Only three of 19 trees had any Beltian bodies; those trees that did tended to recruit more ants to the site of a disturbance. We speculate that tree growth rate may sometimes exceed the reproductive capacity of the ant colony, with the result that a limited number of ants are spread across more plant tissue.

Key Words: Ant-acacia, mutualism, resource allocation

INTRODUCTION (JJR & MPA)

Acacia collinsii and ants of the genus Pseudomyrmex have coevolved a mutualistic symbiosis. The trees provide food for the ants in the form of extra-floral nectar and proteinaceous Beltian bodies, and shelter in the form of hollow thorns. The ants sting potential herbivores, and one species even removes seedlings and other matter from the area surrounding its host tree.

Spatial heterogeneity in light and nutrients leads to high variation in tree growth rate. We hypothesized that fast-growing trees would have relatively larger and more vigorous ant colonies because they have more resources to invest in ants and because they have more leaf tissue to defend. We tested this hypothesis by measuring the current year's growth in acacia trees, and estimating the relative size and activity by resident ant colonies.

METHODS (HMF)

The experiment was performed 0.5km east of the OTS field station at Palo Verde National Wildlife Refuge, Guanacaste Province, Costa Rica. Nineteen acacias were chosen haphazardly in both sunny and shady locations.

We calculated indices of growth rate, ant activity and quantified investment into Beltian Bodies. Growth rate was measured on each plant as the summation of current year's shoot extension and number of new leaves. Old growth was the height of the individual below the annual scar. The Growth Rate Index was new growth divided by old growth. Ant activity is assumed to be an indicator of the trees' investment in the maintanance of that colony. Number of domiciles and number of ants observed immediately after a disturbance were recorded to determine ants per domicile in undisturbed branches. After two minutes of disturbance, another count was taken in order to determine ant density in response to the disturbance. The number of leaves containing the proteinacious Beltian bodies was noted as well.

RESULTS (PLK & MPA)

Acacia shoot extension was highly correlated with the number of new leaves (Figure 1), indicating that these variables were interchangeable measures of tree growth. On average, trees produced one new compound leaf for every 1.85cm of growth in the leader shoot.

Ant density (ants per domicile in undisturbed branches) tended to be lowest in fast growing trees (r = -0.34; Figure 2). Slow growing trees were highly variable in ant density, ranging from 0 to 6 ants per domicile; the fastest growing trees always had low ant density (< 1.8 ants/domicile in six fastest growing trees). The variance in ant density was significantly lower in fast growing trees than in slow growing trees ($F_{12} = 17.24$, df = 5, $p < 0.001$).

Ant density in response to disturbance also tended to be lower in fast-growing trees than slow-growing trees, but the pattern was less pronounced (r = -0.14; Figure 3). Again, the variance in ant density was significantly lower in fast growing trees than in slow growing trees ($F_{12} = 4.819$, df = 5, $p = 0.02$).

Only three of 19 trees had any Beltian bodies at the time of our study. Those trees that did have Beltian bodies were of intermediate growth rate (range of 16-48 new leaves) and tended to have high levels of ant activity: mean ± SE = 3.77 ± 0.34 vs. 2.31 ± 0.48 ants/domicile after 24 minutes of disturbance (t = 1.29, df = 17, p = 0.20).

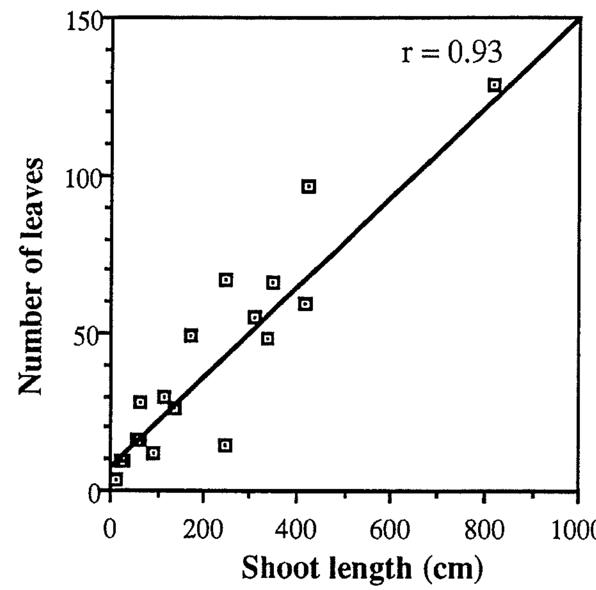

Figure 1. Relationship between shoot extension and number of new leaves in Acacia collinsii.

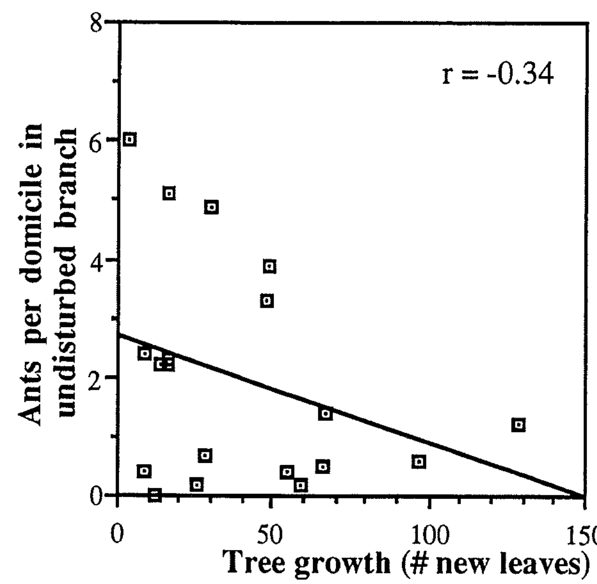

Figure 2. Relationship between ant density and tree growth in Acacia collinsii.

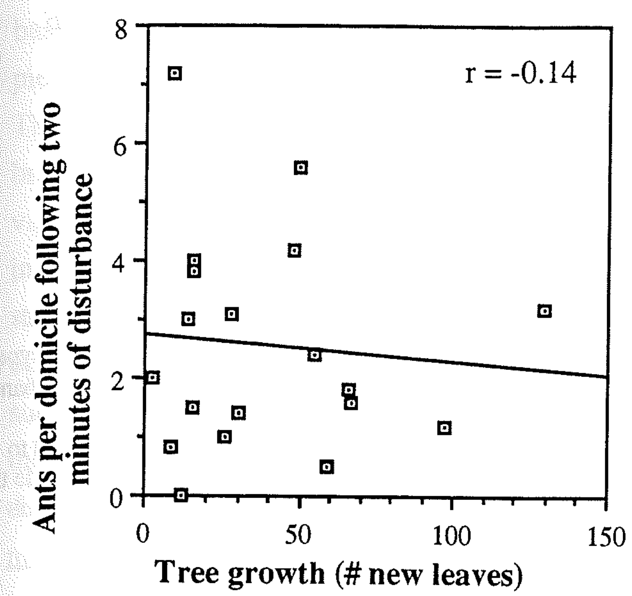

Figure 3. Relationship between ant density and tree growth following two minutes of simulated disturbance.

DISCUSSION (EHA & AEL)

The hypothesis that fast-growing plants invest more in ants as defense because they have more new, nutritious growth to defend was not confirmed by our results. In both resident ants (those already on the branch being disturbed) and ant recruitment after 2 minutes, the results showed that in plants with high growth, ant activity was low, and in plants with low growth, ant activity was variable. This could be because in plants with high growth, ant populations do not necessarily reproduce as fast as the tree grows (in many trees we saw extremely high rates of growth for one growing season). Thus ant populations would be "diluted" until they could "catch up" to the increased biomass in plant material, and we would encounter less ant activity on any given branch. This ties in to our results regarding Beltian bodies and ant activity. We found Beltian bodies only in areas of high ant activity. This may imply that some plants are not investing as much in ants because they are allocating most of their resources to growth.

We further speculate that trees may invest more in proteinaceous Beltian bodies duruing another season, possibly when ants are reproducing. At this point plant growth may be reduced, and ant populations may expand to occupy the new growth which their current nonproductive populations are not substantial enough to defend. Alternatively, Beltian bodies may be in great demand thus, even if production was high, we might not have been able to quantify that production already consumed by ants. We would need to investigate any possible correlation between Beltian body production and ant reproductive cycles, to determine whether or not a relationship actually does exist.