RESOURCE PREFERENCE AND FORAGING EFFICIENCY IN LEAF-CUTTER (*ATTA COLUMBICA*) ANTS

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Abstract: Leaf-cutter ants (*Atta spp.)* move enormous amounts of woody and herbaceous biomass in neotropical forests. We examined *Atta columbica* plant preference across 5 colonies by presenting four different leaf and flower types on primary and secondary foraging trails. We examined (1) whether plant resource preference varied across colonies, (2) whether trail type affected foraging preference and efficiency, and (3) whether the least desirable plant resources were removed (dumped) from the foraging trail. Our results suggest that *Atta columbica* has about the same rank preference of plant resources across all colonies. Of the four species samples, tougher plant species were preferred over less tough species. All plant resources were picked up faster on primary trails than secondary trails and dumping rate was highest for the least tough, least preferred resource. Although clearing a well-defined primary trail requires additional energy expenditure by the ants, the benefit to the colony appears to be a faster, more efficient return of resources to the nest.

Key Words: leaf-cutter ants, foraging preference, foraging trails, Atta columbica

INTRODUCTION

Leaf-cutter ants (*Atta spp.*) are important herbivores in neotropical forests. Mannan et al. (1996) estimated that *A. columbica* in Corcovado, Costa Rica, can consume roughly 4.78 tons of leaves/ha/yr which presumably has broad impacts on forest structure and composition. Vegetation is cut and carried back to the nest to support fungal gardens which feed the colony. Although leaf-cutter ants are generally regarded as highly selective foragers (Stevens 1983, Grace et al. 1997), there is limited knowledge on plant preference within and across colonies. We investigated the tendency of *A. columbica* to pick up non-target plant resources (ie not being used by the colony at that time) on primary and secondary foraging trails. Primary trails are wider, well-cleared, and have higher ant activity than secondary trails, which may directly affect the costs and benefits of picking up non-target resources on each trail type.

We examined how resource preference varied across colonies and how costs and benefits are weighed in picking up non-target resources on different trail types. We tested whether preference differed between colonies, predicting that toughness of plants may influence preference.

A. columbica colonies invest much energy clearing and maintaining primary trails, which may benefit the colony by increasing the efficiency of workers. We hypothesized that non-target resources would be picked up faster on primary than secondary trails.

There may be a benefit to removing undesired plant resources from foraging trails to prevent the resource from accidentally being brought back to the colony. Thus, we hypothesized that the rate of dumping (when a plant fragment is

moved off a trail) would be highest for the least preferred plant species.

METHODS

We examined 5 leaf-cutter ant colonies (*Atta spp.*) on 2-3 February 2006 in secondary forest near the Estación Sirena, Corcovado National Park, Costa Rica. For each colony, we chose a primary trail (high ant activity, well-cleared, wide) and a secondary trail (low ant activity, less cleared, narrow) and recorded ant activity on each trail (ants per minute crossing an arbitrary line within 2 m of the nest). To test plant resource preference, we chose four different plant species—an unknown woody leaf species, a flower, a petal, and a heliconia leaf species—which all had evidence of leaf-cutter ant foraging. We calculated preference as the average time it took to pick up each plant resource, standardized by the trail's ant activity. For each test, we cut each plant species into five 1 x 0.5 cm square fragments and placed each resource at randomly selected points along the trail within 2 meters of the nest. We then recorded the time it took for the ants to pick up each fragment within a 10 minute trial, and whether the fragment was taken towards the colony or removed from the trail (dumped). We measured toughness, a putative criteria for plant preference, with a penetrometer.

To compare the difference in ant activity (number of ants per minute) on primary versus secondary trails, we performed an ANOVA. Next, to examine how time to pick up per ant-minute was affected by colony, trail type, plant type, and the interactions between colony and plant type and colony and trail type, we performed a three-way ANOVA. Finally, to compare how the rate of dumps per ant-minute was affected by colony, trail type, and plant type, we performed a two way ANOVA. We used JMP 5.0.1 for all analyses.

RESULTS

Primary trails had significantly higher ant activity than secondary trails ($F_{1,4}$ = 7.96, P = 0.03; Fig. 1). This was not surprising, as ant activity was part of the definition of trail type. *A. columbica* chose plant resources with a consistent preference: the woody leaf resource was always picked up first, followed by the petal and the flower, and last the heliconia ($F_{3,159}$ = 53.5, P = <0.0001; Fig. 2). All plant resources were picked up faster on primary trails than secondary trails ($F_{1,159}$ = 444, P = <0.0001; Fig. 3). The order of resource preference and the faster pick up time of resources on primary trails was the same across all colonies, but the pattern varied among colonies (colony x trail type: $F_{4,159}$ = 18.1, P = <0.0001; colony x plant type: $F_{12,159}$ = 6.93, P = <0.0001). There were no other significant effects in the general linear model (all P values > 0.2). The most preferred resource, the woody leaf species, was the most tough plant species whereas the least preferred species, the heliconia, was the least tough species ($F_{1,4}$ = 4.38, P = 0.06; Fig. 2).

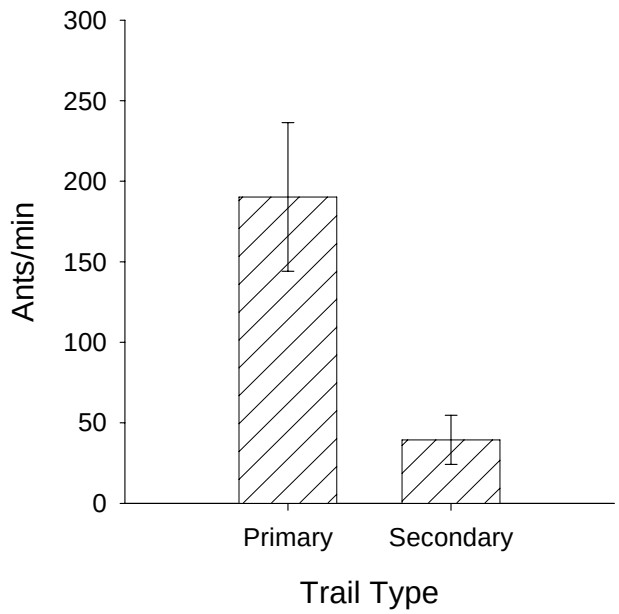

Figure 1. The number of ants/min on primary versus secondary foraging trails across five *A. columbica* colonies near Sirena Biological Station in Corcovado, Costa Rica.($F_{1,4}$ = 7.96, P = 0.03).

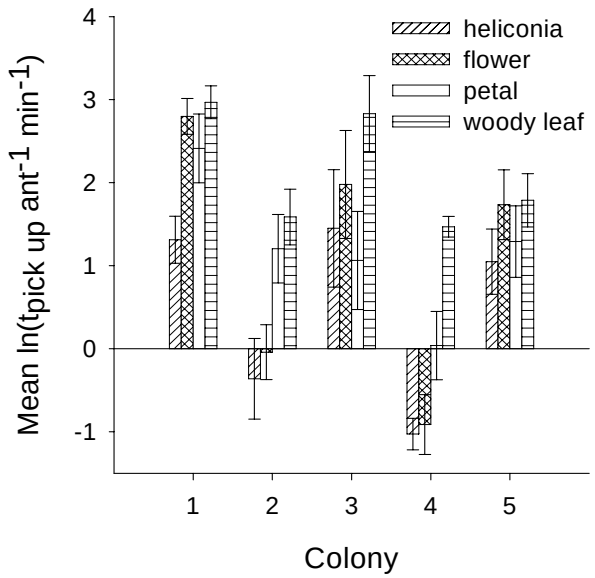

Figure 2. Preference ranking of five *A. columbica* colonies calculated as $\ln(t_{pickup} \cdot ant^{-1} \cdot min^{-1})$ for four species of non-target plant resources ranked in order of toughness (least tough to most tough) ($F_{12,198}$ = 6.81, P = <0.0001). Plant species that are more preferred have lower $\ln(t_{pickup} \cdot ant^{-1} \cdot min^{-1})$. Study was performed near Sirena Biological station in Corcovado, Costa Rica.

Finally, of the 200 total plant resource fragments, 31 of these were dumped. Heliconia, the least preferred species, was dumped substantially more than the other three resources, while the woody leaf resource was never dumped ($F_{3,39}$ = 5.09, P = 0.02; Fig. 4). However, there was no difference in dumping rate among colonies ($F_{4,39}$ = 1.31, P = 0.32) or trail types ($F_{1,39}$ = 1.51, P = 0.24; Fig. 4). There were also no significant interactions involving dumping rate, colony, trail type, and plant type (all P values were > 0.2).

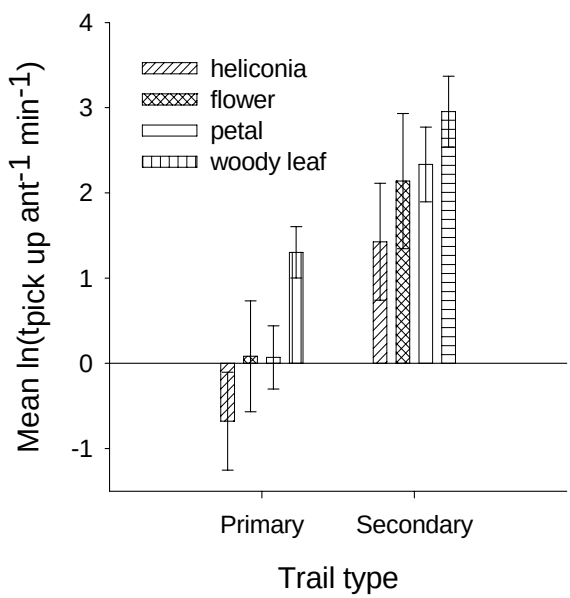

Figure 3. Preference ranking of *A. columbica* calculated as $\ln(t_{pickup} \cdot ant^{-1} \cdot min^{-1})$ for four species of non-target plant resources on primary versus secondary foraging trails. Primary trails have lower $\ln(t_{pickup} \cdot ant^{-1} \cdot min^{-1})$ for all plant resources ($F_{1,198}$ = 436.69, P = <0.0001).

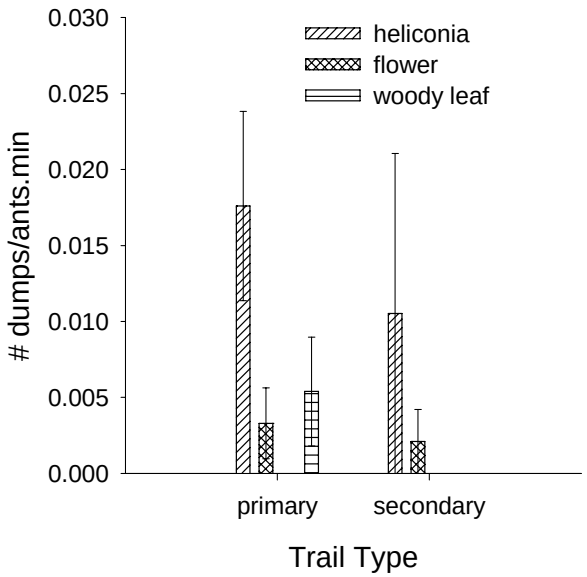

Figure 4. The mean number of dumps/ant/minute between primary and secondary foraging trails for four non-target plant resources. *Atta spp.* Number of dumps for petals across both trail types equals zero.

DISCUSSION

The consistent resource preference ranking across colonies indicates that certain plant resources are more valuable than others to *A. columbica.* The toughest leaves were the most preferred; they may have the highest nutrient availability.

The non-target plant resources were picked up faster by the ants on primary trails than secondary trails. Wider, well cleared primary trails may reduce the effort per ant-minute of bringing non-target resources back to the nest. Higher ant activity on primary trails may result in more pheromones, eliciting a faster behavioral response when the ant encounters a plant resource.

Our finding that rate of dumping of heliconia was higher than any other plant resource indicates that *A. columbica* actively removes the least preferred resources from foraging trails.

LITERATURE CITED

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