TRAIL PRODUCTIVITY AND ALLOCATION OF DEFENSE IN *ATTA COLUMBICA*

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Abstract. Atta columbica transport leaf tissue along trails connecting food resources to the colony's nest. We hypothesized that the number of soldier ants defending these trails would increase with the productivity of the trail. More productive leaf cutter ant trails were defended by more soldier ants than less productive trails, but had fewer soldiers per leaf-carrying ant than on less productive trails. We hypothesize that there is a a limit to the number of soldiers needed on a trail, regardless of the number of workers. Beyond this limit, the cost of producing additional soldier ants to patrol a trail may outweigh the benefits to the colony of having additional soldiers present to respond to potential threats.

Key Words: eusocial insects, leaf cutting ants, trail productivity, defense allocation

INTRODUCTION

The social system of *Atta columbica* (leaf cutter ants) includes three castes, workers, soldiers, and minors. Worker ants are responsible for cutting and transporting pieces of leaves back to the nest, while soldier ants defend and remove obstacles from trails. The rate of cut leaves being carried to the nest differs among trails. Because highly productive trails provide a greater amount of resources, we hypothesized that these trails are more valuable and that the colony will allocate more defense to them. We predicted that the trails with greater productivity would be monitored by more soldier ants, and that the colony will employ a greater ratio of soldier ants to leaf-carrying ants on the trails of highest productivity.

METHODS

On 2 February 1998, we located 19 leaf cutter ant trails near the Guanacaste and Naranjos trails in Corcovado National Park, Costa Rica. We chose a reference point along the ant trail and counted the number of worker ants carrying leaf sections and the number of soldier ants that crossed in one minute. We repeated this procedure three times on each trail to yield one average for the trail. We defined trail productivity as the number of leaves transported past the reference point in one minute and defense as the number of soldiers present in this same time period. We used regression analysis to test for a relation between productivity and number of soldier ants.

RESULTS

The absolute number of soldiers on a trail increased with the number of leaves being transported (Fig. 1; $r^2 = 0.22$, $P = 0.044$). However the rate of increase of soldiers was much lower than the rate at which productivity increased (slope = 0.09 ± 0.04). Consequently, there was a greater ratio of soldier ants to leaf-carrying ants on less productive trails than on trails of higher productivity. For example, at lowest productivity (3 leaves per minute) trails were monitored by 2.1 soldiers per leaf-carrying ant, whereas at highest productivity (98 leaves per minute), there was one soldier for every 6.9 leaf-carrying ants.

DISCUSSION

More productive leaf cutter ant trails were defended by more soldier ants than less productive trails. However, more productive trails were less well defended in the sense of fewer soldiers per worker. We hypothesize that there is a limit to the number of soldiers needed on a trail. Many obstructions and threats may only require a fixed number of soldiers regardless of how many workers are present. Furthermore, an excess of soldier ants might congest trail traffic and reduce the number of soldiers available for more direct threats to the nest. Presumably, there is a cost to a colony of producing and maintaining soldier ant ranks. These ideas could be tested by manipulating the number of soldier ants on the trails. Further

studies could also investigate whether variation among trails in the ratio of soldiers to workers is correlated with the frequency and type of disturbance occurring.

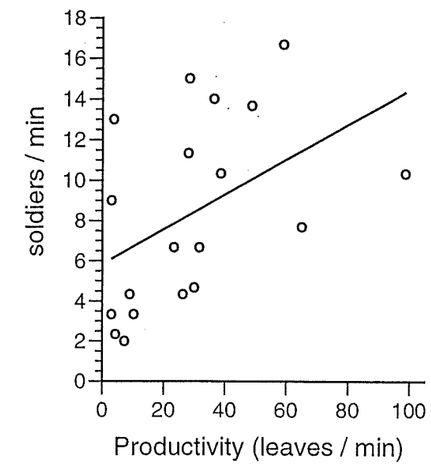

FIG. 1. Average number of patrolling soldiers as a function of productivity per time interval (y = 0.09x + 5.83).