trail lengths ranged from 0.4 to 63.4 m. Ant activity for these 13 trees, however, did not vary significantly with either trail length (r^2 = -0.013, df = 1,11, P = 0.377) or DBH (r^2 = -0.021, df = 1,11, P = 0.406).

Comparing the two colonies with five trails each, average trail length to trees was over twice as great for one as for the other (mean ± 1 SE: 1665 ± 170.0 vs. 4516 ± 353.2; ANOVA, F = 8.82, df = 1, 8, P = 0.018), yet there was no significant difference in average ant activity between these two colonies (ANOVA, F = 0.91, df = 1, 8, P = 0.368).

Discussion

Atta colombica ants seem to invest similar effort in harvesting trees regardless of their size and distance from the nest. This indicates that other factors, such as tree species, leaf accessibility and nutritional quality, time since harvesting began at a tree (newly discovered trees may have less activity than more established routes) and tree distribution in relation to ant nests, may be more important than simply size and distance in determining ant foraging activity. Our limited number of replicates may account for the lack of measurable patterns and therefore we cannot exclude distance and DBH of trees as possible factors influencing levels of ant activity. Furthermore, our measure of ant activity (# ants/min) may not be an accurate indicator of harvesting effort, i.e., if the number of ants going up and down the tree varies throughout the day. In addition to sampling more colonies and trees, further study could examine other factors that may influence the amount of effort (time and energy) placed into harvesting by *A. colombica*.

Observations of a column-raiding army ant colony

Justin E. Campbell, Christopher M. Leander, Gabrielle Miller-Messner, and Dora J. Sugar

Abstract: We observed a colony of the army ant, *Eciton hamatum*, during a morning and afternoon at Corcovado National Park, Costa Rica to document the biology of these ants and assess the feasibility of studying army ants in future Dartmouth projects. Here we describe what appeared to be communication among ants, bridging behavior, foraging on termites and other ant species, a lack of interspecific interaction with leaf-cutter ants, and possible bivouac formation. Future study of the following topics could explain the competitive advantage of the processes we observed: prey preference, effects of brood movement, variance in the occurrence of ant bridges, and relationships between foraging dynamics and both booty cache and bivouac formation.

Key Words: bivouac, booty cache, column-raiders, termite predation

Introduction

We conducted an observational study on a column-raiding army ant species that we tentatively identified as *Eciton hamatum* (see below). In addition to gaining familiarity with the species, our objective was to provide a body of knowledge upon which to base future army ant field projects. Observations we made on ant behavior, direction of ant movement, larval transport, and bivouacs should aid the development of future study.

Methods

On 1 February 2001 we located an army ant colony on the Sendero Rio Claro of Corcovado National Park, Costa Rica. Observations were conducted during the hours of 09:00-11:30 and 13:30-16:30. We mapped some of the army ant columns and grouped observations into four categories: ant behavior, direction of ant movement, larval transport, and bivouacs.

We mapped the army ant trail by taking compass bearings along flagged points on the trail and measuring distances between adjacent flags. Distances and compass readings were used to create a scaled rendering of the army ant columns (Fig. 1).

At each flagged point, we noted the direction in which the majority of ants were moving and made observations on ant activity, such as the transportation of larvae. We collected and preserved samples of the ants and the larvae for observation and identification under a dissecting microscope, using information on army ant species given by Rettenmeyer (1983) and Swartz (1997). We also recorded descriptive information about two putative bivouac sites.

Observations and Discussion

Ant behavior and identification

Swartz (1997) stated that *E. hamatum* and *E. burchelli* are the two most common army ant species near Estacíon Sirena in Corcovado National Park. We noted a number of behaviors that led us to believe that the species observed was *E. hamatum*. The most apparent were the presence of narrow ant columns and the absence of a foraging ant swarm. Rettenmayer (1983) noted that all species of army ants excluding *E. burchelli* have smaller swarm raids or lack them completely and most have two or three narrow raid columns going in different directions from the bivouac. Some ants appeared to be foraging from a termite colony, while other areas of the column foragers were carrying small black ants. Rettenmeyer writes that column raiders specialize by foraging on other ant species, but sometimes raid social wasps or termites.

These column raiding ants displayed two distinctive behaviors that we will call

bumping and bridging. In the bumping behavior, we noticed that ants traveling against the net flow of a column tended to be bumped more frequently than ants in the column, and seemed to change direction of travel as a result. Perhaps a form of communication, the collision between ants was head-on and caused ants to pause before resuming travel. In the bridging behavior, we noticed that an individual or group of individuals would span a gap between leaves or branches for a period of time, allowing other ants to cross over them.

A number of ant columns crossed the active trails of leaf-cutter ants (*Atta colombica*) with a lack of any interspecific agonistic interactions. Either the ants simply passed each other with some unavoidable bumping or the army ants avoided the leaf-cutters by crossing over them on a branch. Since the two species occupy different resource niches and the leaf-cutters, having larger soldiers and colonies (Stevens 1983), seem to be too well-defended a food item for the army ants, it is probably more efficient to avoid contact.

Larval Transport

We noticed ants carrying white larvae along the trails. The preserved larvae that we examined under a dissecting microscope appeared to be ant larvae that we assumed were larvae of the colony. If so, this suggests that the ants were in their nomadic stage, carrying their brood to a new bivouac (Swartz 1997). The larvae, however, could have been from the colony of another ant species upon which the *E. hamatum* were feeding.

Bivouacs

In the afternoon, we located two ant masses along the trails we were mapping. Both were in underground chambers open to the outside, one under a tree buttress and the other in a hole left by a fallen tree. The masses consisted of an approximately 10 cm diameter, 30 cm high pillar of ants spanning the chamber from top to bottom. The second mass seemed to be larger than the first and had white larvae on the floor. Around 16:00, which previous research has shown to be the time at which most bivouacs form, at least in *E. Burchelli*, (R.T. Holmes, pers. comm.), net movement of one trail was away from the first mass and toward a second mass. We returned the following day and observed that the first ant mass had disappeared and the second had become larger. This suggests that the ants were in their nomadic phase, the second ant mass was the forming bivouac, and the first ant mass was either a booty cache or the previous night's bivouac.

Direction of Ant Movement

We observed that the movement of ants in each column shifted over time. In one column, most ants were moving toward the termite nest in the morning and toward the first ant mass in the afternoon (Fig. 1). Many columns observed in the morning diminished in ant flow or vanished in the afternoon, while other columns, including the column leading to the second ant mass, did not exist until the afternoon. This suggests the ants forage out from the previous night's bivouac in search of prey and a new bivouac site, shift columns as prey or a bivouac site is found, and return to the new bivouac with prey and ant larvae in the late afternoon.

Suggestions for Future Investigation

Given our observations and Rettenmeyer's account that column-raiders are foraging specialists on other species of ants and sometimes raid termite nests, one could test army ant food preference by presenting a foraging column with termites and smaller species of ants. The use of ant bridges might also be examined, e.g., how often do they occur, do they increase rates of movement, and do they vary with time of day or intensity of foraging recruitment. Similarly, what effect does brood movement have on foraging intensity, does this task take place at predictable times of day, and how do rates of movement differ between foraging and brood-carrying ants? By recording rates of net movement towards bivouacs and booty caches in relation to foraging intensity, it would be possible to

determine the effects of foraging success and distance to a food source on booty cache formation. Finally, future study could investigate the effect of foraging success on time of bivouac formation.

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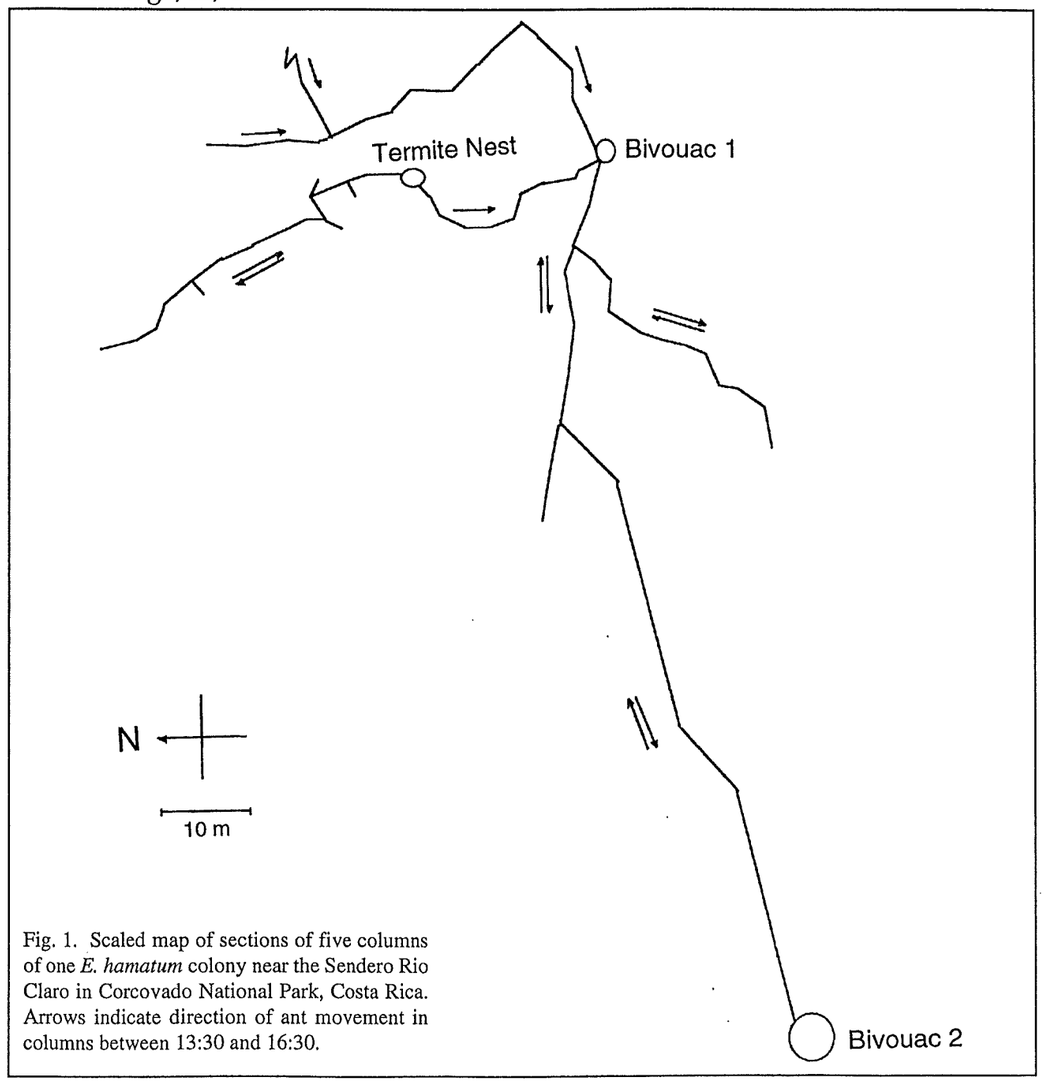

Fig. 1. Scaled map of sections of five columns of one *E. hamatum* colony near the Sendero Rio Claro in Corcovado National Park, Costa Rica. Arrows indicate direction of ant movement in columns between 13:30 and 16:30.