Quilan, R. J., and J. M. Cherrett. 1977. The role of substrate preparation in the symbiosis between the leaf cutting ant *Actomyrmex octospinosus* (Reich.) and its food fungus. Ecol. Ent. 3: 161-170.

GET A CUE: THE EFFECT OF PHEROMONE AND DIRECTION ON RESOURCE LOCATION OF WORKERS OF *ATTA COLUMBICA*

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Abstract. We investigated the influence of pheromones and directional information on the selection of trails by worker ants leaving leaf cutter ant colonies in search of food resources. We disturbed ant trails of *Atta columbica* and presented the ants with an alternative pheromone laden trail leading in a different direction. We found that ants showed no preference when choosing between their former trail, cleared of pheromone, and a paper pheromone trail leading in a different direction. Our data suggest that workers locate selected food resources by utilizing a combination of pheromone and directional stimuli.

Key words: leaf-cutter ant, foraging, communication, path choice

INTRODUCTION

Previous studies on the leaf-cutter ant, *Atta columbica*, have shown that individual ants have a specific resource goal when they leave the colony. When given a choice between leaf types, individuals remain faithful to the resource found on their original trail (Stevens 1983).

Leaf-cutter ants communicate by use of pheromones, but it is not known if this is the only cue used by worker ants to locate food resources. Many eusocial insects also utilize directional information that is passed from the scouts that located the resource to foragers in the nest or hive. Dyhrman et al. (1993) found that leaf-cutter ants re-established their trail in the same position after a disruption in their pheromone trail, suggesting that ants may use directional information to help them maintain routes to chosen food resources.

We investigated how worker ants leaving the nest maintain routes to food resources. We proposed three alternative hypotheses to explain how leaf-cutter ants pursue the chosen food resource: 1) Ants are provided with directional information in the nest that allows them to locate the appropriate food resource and should quickly re-establish their original trail following a disturbance. 2) Ants are solely following a pheromone trail to food resources, and possess no prior knowledge about the direction of these resources. If true, ants should readily follow an alternate pheromone trail. 3) Ants use a combination of directional information and pheromone cues to locate selected food resources. If true, ants should exhibit a mixed response to trail disturbance, with some re-establishing the original trail while others follow an alternate pheromone trail.

METHODS

We selected 11 trails (10 - 25 cm wide) of *Atta columbica* running across the Sendero Rio Pavo and Sendero Rio Claro near Estacion Sirena, Corcovado National Park. We placed 10 (≈ 20 x 5 cm.) paper strips on a 2 m section of each ant trail to absorb ant pheromone from the ants passing on top of the strips.

After 1 - 2 hours, each paper strip was removed and shaken to remove ants. We experimentally cleared a trail pattern adjacent to the ant trail (Fig. 1) and placed the paper-pheromone strips on top. The original trail(e, Fig.1) of the ant trail was then swept (removing the top layer of soil, leaf debris, and any ants) to eliminate the previous pheromone path. We then recorded the number of ants traveling away from the colony that passed through gates (a) - (d) during a 12 min. interval. Each gate corresponds to ant decisions to follow direction knowledge or pheromones: (a) - ants turning onto paper pheromone trail (pheromone), (b) - ants continuing on their original path (directional), (c) - ants turning away from original ant trail on paper pheromone trail (solely pheromone), (d) - ants continuing on paper pheromone loop trail back toward original ant trail (pheromone and direction). These path options enabled us to analyze the relative effect of pheromones and directional information on ants moving toward food resources.

We observed 11 trails but excluded 2 trails from analysis because they contained less

then 20 ants while all other trails included > 60 ants. We claculated proportion of ants choosing each path bifurcation (a vs. b and c vs. d) and estimated 95% confidence intervals using the binomial probability distribution.

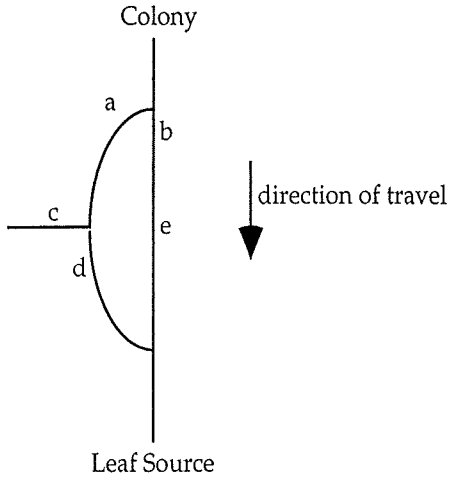

FIG. 1. Experimental setup: a-c-d represents a paper-pheromone trail which we constructed and b-e represents the original ant trail. The proportion of ants following trail: a = 0.42, b = 0.58, c = 0.50, d = 0.50 (the c/d bifurcation only applies to ants that choose a).

RESULTS

Leaf-cutter ants heading away from the nest chose their former trail , cleared of pheromone, 58% of the time (95% confidence interval = 30 to 75 %, n = 3108), and a paper pheromone trail leading in a different direction 42% (95 % confidence interval = 18 to 62 %, n = 3108; gates a vs. b in Fig, 1). Of those ants who chose the paper-pheromone trail, equal proportions chose a path leading back to the original trail (50 %, 95 % confidence interval = 23 to 69 %, n = 769)and one leading in the opposite direction (50 %, 95 % confidence interval = 24 to 69 %, n = 769; gates c vs. d in Fig. 1). Among 9 trails, ants choosing path A over B ranged from 18 - 77%, and those choosing C over D ranged from 28 - 77%.

DISCUSSION

Ants leaving the nest to forage apparently use a combination of directional information and pheromones to locate leaf resources. Leaf-cutter ants followed the paper-pheromone trail in the manner described by Hangartner (1967), clearly indicating that pheromone trails play a role in the direction choice of outgoing ants. However, 58% of the ants remained on the original trail. It is possible that all ant pheromone was not eliminated via our sweeping, leaving a faint trail which outgoing ants could still follow. A combination of sweeping and washing the original trail with water might more completely eliminate the pheromone trail.

An alternative explanation for the behavior we observed is that returning ants provide visual, tactile, and/or chemical cues to outgoing ants. If so then outgoing ants which do not encounter their leaf-carrying counterparts might not have a reliable cue, resulting in the haphazard path selection. which we observed. This could be examined in future studies by a similar experimental design that also contorls for returning ants on the ant trail. This would allow analysis of the relative importance of direct ant-ant communication as well as that of pheromone trail adn directional control in influencing the decision of outgoing ants.

LITERATURE CITED

Dyhrmann, Sonya T., Ingram, McLanahan, O'Hara. 1993. A Behavioral Study of Trail Re-establishment Following Disturbance in Leaf-Cutting Ants. pp. 69-72. Dartmouth Studies in Tropical Ecology. Dartmouth College, Hanover, NH.

Hangartner (1967), worksheet.

Stephens, G. C. 1983. Atta columbica (Zompopas, Leaf-cutting Ants). Pages 688-690 *in* D.H. Janzen, ed. Costa Rica Natural History. Chicago: University of Chicago Press, Chicago, USA.