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# DEPENDENCE OF NECROPHORIC RESPONSE TO OLEIC ACID ON SOCIAL CONTEXT IN THE ANT, *Pogonomyrmex badius*

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**Abstract**—The response of the southern harvester ant, *Pogonomyrmex badius*, to oleic acid was found to depend on social context. Social context was specified as the number of ants engaging in each of five categories of behavior. When a large percentage of the colony is doing midden work or nest maintenance, papers treated with oleic acid are taken to the midden, as previously reported. However, when a large percentage of the colony is foraging or convening, treated papers are taken into the nest as if they were food items.

**Key Words**—*Pogonomyrmex badius*, Hymenoptera, Formicidae, oleic acid, social context, midden, pheromone, harvester ant, necrophoric.

## INTRODUCTION

This study reports upon the response of the southern harvester ant, *Pogonomyrmex badius*, to oleic acid. Wilson et al. (1958) reported that objects treated with oleic acid were "invariably" carried to the colony's refuse pile, or midden. Experiments by Haskins and Haskins (1974) suggested that oleic acid produces this necrophoric effect in the ant *Myrmecia vindex* also. Blum (1970) concluded from similar experiments that oleic acid evokes necrophoric behavior in the ant *Solenopsis saevissima*. The idea that oleic acid is the primary releaser of the necrophoric response in *P. badius* occurs elsewhere in the literature (Wilson, 1963; Howard and Tschinkel, 1976; Howard et al., 1982).

It is well known that social factors can affect the response of an animal to a chemical cue. For example, honeybee "queen substance" (9-oxodec-*trans*-



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enoic acid) attracts a retinue of workers inside the nest, but attracts only drones during mating flights outside the nest (Gary, 1970). Also, readiness to mate is a significant factor in the response of male moths to sex attractant pheromones (Jacobson, 1972).

In an effort to continue the work of Wilson et al. (1958), I examined the effect of social context on the response of *P. badius* colonies to oleic acid. By "social context," I mean the social activities of the colony at a given time. I found that colonies responded differently to oleic acid in different social contexts, carrying it to the midden only in certain situations.

## METHODS AND MATERIALS

Experiments were performed in the laboratory using four colonies of *P. badius*, each containing a queen, and ranging in size from about 350 to 650 workers. The experimental procedure followed that of Wilson et al. (1958). In each trial ten pieces of filter paper, each 2 × 2 mm, were placed within 10 cm of the main nest entrance of the colony. Of the ten pieces, five were treated with 1 $\mu$l each of oleic acid (Sigma Chemical Co., 99%), while five were left untreated as controls. The treated and untreated papers were placed in the terrarium in two separate piles about 3 mm apart. In each trial, the colony was observed for one hour, and the time of removal from the original site and the destination of any removed papers were recorded. Twenty-two trials were made.

After the first six trials, all of the colony social activities observed thus far were classified into five groups (Table 1): (1) midden work, (2) feeding and drinking, (3) nest maintenance, (4) patrolling, and (5) convening. In the subsequent 16 trials, the activities of the ants were recorded at the beginning of the trial and at 5-min intervals throughout the hour. Only ants on the terrarium surface could be observed; the activities of the ants inside the nest were not considered. Colony activities were recorded by noting the number of ants engaging in each of the five categories of behavior. The five numbers together operationally specify "social context."

## RESULTS

The control papers were left in place significantly longer than those treated with oleic acid (Wilcoxon's signed-ranks test, $P > 0.005$). The mean time for removal of control papers was 37.9 min, and for treated papers, 15.3 min. The controls were invariably taken to the midden. Only 45% of all treated papers offered to the colonies were taken to the midden. Forty-nine percent were taken into the nest, while 6% were left in place during the hour trial.

TABLE 1. CLASSIFICATION OF COLONY ACTIVITIES

| Midden work | Feeding | Nest maintenance | Patrolling | Convening |
|---|---|---|---|---|
| Repiling midden | Taking hold of food bits | Carrying sand out of nest | Patrolling edges | Standing together under lamp |
| Carrying objects to midden | In water tube | Relocating sand on terrarium surface | Walking around quickly | Grooming each other |
| Carrying dead ants | Piling sand on food | | Pawing at sand and inspecting it with antennae | Standing together wiping off antennae |
| | Taking food into nest | | | |

The data were analyzed using multivariate analysis of variance, with the percentages of ants in all five activity types as observation variables. The data were classified into two groups according to the destination (midden or nest) of treated papers. The mean activity vector when treated papers were taken to the midden was found to differ highly significantly ($P > 0.001$) from the mean activity vector when treated papers were taken into the nest. Except in the case of patrolling, the percentages of ants in each activity when treated papers were

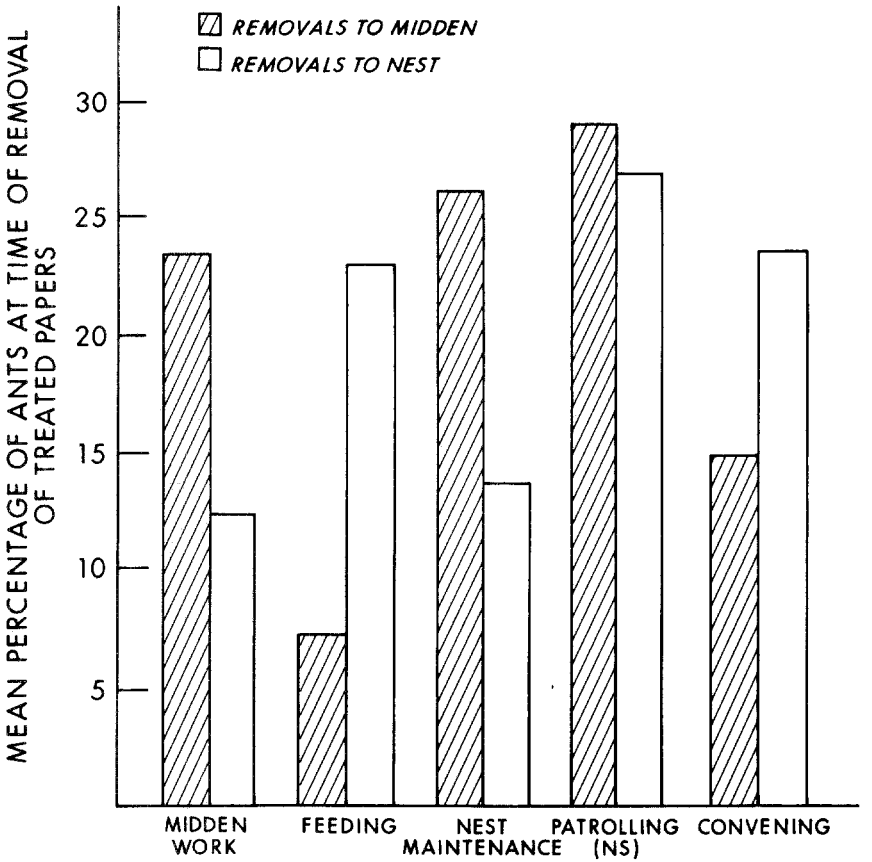


FIG. 1. The shaded bars show the distribution of ants among the five activities when treated papers were taken to the midden. The unshaded bars show the distribution of ants among the five activities when treated papers were taken to the nest. The ordinate displays the mean percentages of all ants on the terrarium surface engaged in a given activity. The percentages are averaged both over a 15-min time interval including the time of removal, and over all observations of treated papers transported to the same destination. The mean percentages represented by the shaded bars sum to approximately 100%, and similarly for the unshaded bars.

taken to the midden differed significantly ($P > 0.05$) from the percentages when treated papers were taken into the nest.

These results are shown in Figure 1. When a large percentage (>>15%) of the ants were doing midden work or nest maintenance, treated objects were usually taken to the midden. When a large percentage (>>15%) of the ants were feeding or convening, treated objects were usually taken into the nest. The percentages of ants patrolling were about the same regardless of the destination of the treated papers.

I attempted to duplicate the finding (Wilson et al., 1958) that live workers treated with oleic acid were taken directly to the midden. In 15 trials, a worker was chilled, then treated with a drop of pure oleic acid on the abdomen and replaced into the terrarium still thoroughly chilled.[1] In two of these trials, the treated worker was carried to the midden. In the remaining 13 trials, the treated ant revived, showed mild alarm behavior, was antennated by several nestmates, and then was left alone to groom herself or to go back into the nest. During the two trials in which treated workers were carried to the midden (as well as during six of the remaining 13 trials), more ants were doing midden and nest maintenance work than were feeding or convening.

## DISCUSSION

As stated, colony response to oleic acid depends on social context. However, long-term patterns of social activity are different from colony to colony. As a result, some colonies took treated papers more often to the midden, while others took them more often to the nest. For example, in one colony a tunnel collapse in the terrarium caused the ants to devote much of the next six weeks to rebuilding and other nest maintenance activities. Most treated papers offered to this colony went to the midden. It is possible that Wilson et al. (1958) studied a colony in which midden or nest maintenance work was the most common activity. If so, this may account for their observation that treated objects were always taken to the midden.

The main result of this study may be explained as follows. *P. badius* colonies respond to oleic acid by quickly relocating it to destinations that are appropriate to their current activities. It is assumed that if the percentage of the colony's outside work force doing a certain activity is large, the likelihood that an ant encountering a treated paper will be doing that activity is similarly high. Thus, if most of the ants on the mound surface are engaged in midden work, an object treated with oleic acid will probably be discovered by a

[1]This procedure was used at the suggestion of Dr. E.O. Wilson, in order to duplicate as closely as possible the procedure used in Wilson et al. (1958). In nine previous trials in which workers were not chilled when treated, no treated workers were taken to the midden.

midden worker. The worker will carry the object off to the midden as if it were refuse. On the other hand, if a large percentage of the ants outside the nest are feeding or are part of a group being recruited to a food source, a forager will probably discover the treated object and carry it into the nest as a food item.

There is some evidence that the distinction between food and refuse is not as sharp as previously thought. I have observed *P. badius* taking fresh food to the midden, and have also observed both dead ants and old and seemingly undesirable bits of food being brought into the nest. Finally, oleic acid has been shown to be attractive as food to other species of ants (Marshall et al., 1979).

The reactions to oleic acid of ants doing nest maintenance work require further explanation. In general, ants engaged in nest maintenance activities were relocating nest materials such as sand to some destination outside the nest. When they encountered treated papers, they took them to the appropriate outside-of-nest location, which in this situation is the midden.

Finally, when a large percentage of the ants are convening, treated papers are taken into the nest. Convening ants mill around slowly, grooming each other and themselves. There is no obvious explanation for their reactions to oleic acid.

Division of labor in *P. badius* is not yet understood. Several alternative mechanisms might account for the behavior observed in this study. First, if temporal polyethism exists in *P. badius*, a change in an individual's response to oleic acid could accompany its change in task. Alternatively, both particular tasks and response to oleic acid may vary according to size differences among *P. badius* workers (Wilson, 1978). I am currently investigating polyethism in *P. badius*, using labeled individuals. However, in the present study, observations of colony behavior are used to arrive at a prediction about colony response to oleic acid.

The response of *P. badius* to oleic acid depends on colony activities at the time treated objects are encountered. It is clear that it can be misleading to disregard social context as a factor in research on chemical communication.

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