Patterns and Changes in *Formica Obscuripes* Ant Trails

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Abstract

We observed ant trails at The Evergreen State College and looked for drift in location over time, and if their pathways are organized into separate lanes for different directions. Two trails each from three colonies were observed over two days, and each trail was observed at three spaced points for 20-minute intervals. Patterns found in the data may indicate other aspects of the organization and overall structure of these and other ant colonies.

KEY WORDS: Insect pheromones, pheromone trails, ant trails, colony organization.

Introduction

Most ant species release a pheromone when they locate a food source which is too large for that ant to retrieve on its own. As it returns to the colony, it continues to release that pheromone onto the ground in a broken-line pattern, leaving a trail that subsequent ants can follow to find that food source. Depending on how desirable the food source is, and how difficult it would be for that ant to retrieve the food source, the subsequent ants leave their own trails of varying strengths to indicate those variables to other ants. The trails to plentiful, nutritious foods tend to be larger than the trails to less desirable foods, and as a plentiful resource dwindles in availability, the ant's pathway back to the food source dwindles also.(Vander Meer 1983).

At several sites containing ant colonies, we observed that the paths of ants leading to and from the ant colonies appeared to have discernable organization. In fact, observations suggested the ants had arranged themselves in such a way that there was a degree of separation between ants moving towards and ants moving away from their colony, forming different general lanes.

Our questions for this study were: 1) Are ant trails directional? And 2) do ant trails drift over short periods of time? Studies have shown that worker ants leave trails for other worker ants to follow by excreting specific pheromones that lead towards food sources (Mailleux 2003). We hypothesized that those pheromones could be direction-sensitive. For example, the ants may use different signals to indicate "towards the colony" as opposed to "away from the colony". We also hypothesized the trails might be subject to radial shift over time due to wind or inefficiencies, or errors in subsequent attempts by ants at re-marking the original pheromone trails.

Materials and Methods

Data Collection

Formica Obscuripes, also known as the Western Thatching Ant, was chosen as the object of this study for its local abundance. Three colonies were observed on the campus of The Evergreen State College. They were located at the college's Organic Farm, parking lot 'F', and parking lot 'C', hereby referred to as Site A, Site B, and Site C, respectively.

At most of the colonies, two or more high-traffic pathways of ant movement were observed leading away from the central mound. At colony C however, only a single, less coherent trail was observed. At all sites it was inferred that such high-traffic pathways were indicative of pheromone trails.

Along each pheromone trail, three measurement strips were placed on the ground perpendicularly to the line of ant travel. Each measurement strip was 210mm long, and marked in increments of 7mm. Strips were positioned at distances of one, two, and three meters from the edge of the central mound. At Site C, the colony without a second discernable trail, this procedure was done a second time along a line pointing in a random direction from the central mound.

Every time the above procedure was done, three observers watched separate strips simultaneously for a continuous span of 20 minutes, divided into 5-minute intervals.

Whenever an ant crossed a measurement strip, the location of its crossing, its direction, and the present time interval was recorded. Ant crossing locations were rounded to the nearest 7mm unit. In most cases, ground cover prevented the strips from laying directly on the soil, and as a result, ants mostly moved under the strips.

Explanation of Methods

By recording locations of ant crossings, concentrations of traffic within individual pathways could be observed. Recording ants' direction of travel at each crossing made it possible for directional trends to be seen and compared with traffic trends. Dividing the twenty-minute time spans into five-minute increments allowed analysis of changes in traffic or directional trends over time. Simultaneously observing the same pathway of traffic in three locations allowed observation of variation in traffic trends over larger distances. High-traffic positions along measurement strips were inferred to indicate higher concentrations of pheromones.

Results

The data collected is represented by graphs (fig. 1-3) depicting individual observation periods. These graphs show how many ants crossed the measurement strips, where they crossed, and what direction they crossed. The downward direction depicted on each graph indicates movement away from the nest and the upward direction represents movement toward the nest. Some paths show very distinct high-traffic areas, but directional trends are much less clear. Although ant trails were variable in width and intensity of use, we did not detect discernable shifts in ant trail location during the sampling periods.

Discussion

The three ant colonies studied on the Evergreen campus were located at the college's Organic Farm, F-lot, and C-lot, hereby referred to as Colonies A, B, and C, respectively. The colonies A and C were approximately equal in size and shape; each was cone shaped, between two and three feet tall, and around three feet in diameter. The colony B was a shorter mound, only one foot tall, and one to two feet in diameter. Colony A was located at the edge of a well-traveled footpath along a wooded area. Colony B was between a wooded area and a parking lot. Colony C was built on a grass island in the parking lot.

Mathematical models have been developed that describe trail laying behavior in other studies. Ant pheromone deposition and signaling processes is complex, and different varieties of pheromone are used within single colonies, achieving a mix of purposes (Holldobler 1995). One of those purposes is to lead members of the population to food sources. When a scouting ant finds a food source, it may consume a portion of it. If more than a certain threshold is consumed, it most often triggers the ant to deposit a pheromone trail leading back to the nest. Scouts that don't find food or consume beyond the threshold continue searching. (Holldobler 1995). Trails are deposited through an organ called the gaster, located at the tip of the abdomen (Mailleux 2003). The gaster is dragged on the ground while the ant walks, resulting in a series of scent smears on the terrain (Vander Meer 1983). Workers are equipped with pheromone sense receptors on their antennae, which are stimulated by varying concentrations of pheromone.

Ant pheromones are known to evaporate or decompose, often in short periods of time. According to one model, workers following pheromone trails find their way via to the sensations received through their antennae – following the direction of greatest stimulation (Couzin, Franks 2003). If workers follow previously laid trails away from the nest toward food sources, then the concentration of pheromone must increase with distance from the nest. Thus, assuming a constant rate of pheromone decomposition, a returning ant must decrease its secretion the further it gets from the food source.

Directionality

We expected at least some bias in directionality of trails, and some shift in trail structure over time. Our data indicated that often, where there is a concentration of ant traffic, travel is predominantly one-directional (see figs 1(A, E, H) and 2(A, G, I, K). However, we did not observe this to be the general case. In many cases, single pathways were divided into somewhat ordered, directional lanes. This is most apparent in figures 2(A, E) and 3(A-F).

In each case where a concentration of ant traffic moved exclusively in one direction, ants did not seem to continue their one-way movement over distances larger than two meters. This is especially clear in fig 2(J-L), where ants at a distance of two meters nearly all appeared to be moving toward the nest, yet ants three meters away nearly all appeared to move away from the nest. It was not directly observed at the site, but this data seems to suggest that between two and three meters away from the central mound along the travel pathway show in fig. 2(J-L), ants were joining the major traffic heading back to the mound. Such a trend was not present the previous day at the same site, at the same time of day.

In fig. 2(A-C), significantly denser traffic can be seen at one meter and three meters away from the central mound than at a distance of two meters away. This could be due to a similar dynamic of ants leaving the main traffic-way between one and two meters, and joining it between two and three meters. However, here, at each successive distance from the mound, traffic flowed in both directions. At the site shown in 2(A-C), ground cover prevented a clear view of much area of the terrain. It's also possible that we failed to notice that there was a bend in the pathway between one and three meters extending beyond our sampling range.

If the data collected in fact reflects the event of ants joining the midpoint of a major travel pathway on their path back toward the nest, the question remains as to why they are attracted or pulled to it when they are theoretically capable of finding their way back from wherever they go.

It may be that the phenomenon of one-directional ant traffic is unrelated to a mode of signaling and simply the result of many ants following the same scent trail, making it difficult for travelers in the opposite direction to walk along the same path. A future study could address this question by transporting ants from areas where they don't seem to be actively following trails, to areas near active trail pathways and observing which direction they choose to go in.

The Unexpected

While two meters away from Colony B in the first direction, one incidence of repeated use of the same exact line of travel over large periods of time was suggested. In a patch of moss that the ants' pathway crossed over, there was actually a small trench worn in, perhaps by ants, about an inch wide. Data from this area can be seen in fig. 2(B-E), which does not indicate a strong trend in a single direction. The phenomenon wasn't noticed in the other five ant pathways that were observed.

When a travel pathway remains in the same general position over a longer period than the time required for a single pheromone trail to evaporate or decompose, it may be assumed that the actual scent smears themselves are repeatedly deposited by multiple ants. This creates a situation where the position of the trail "moves" chaotically over time, but stays anchored within the same general pathway.

Apparently, it is possible for trails to become structured to the degree that the ants traveling them walk (relatively) single file. If such behavior continued in the same spot long enough to wear a trench in a patch of moss, it likely happened for longer than the normal decomposition time of a single ant's pheromone trail. It would probably also have moved in only one direction at a time, due to space constraints.

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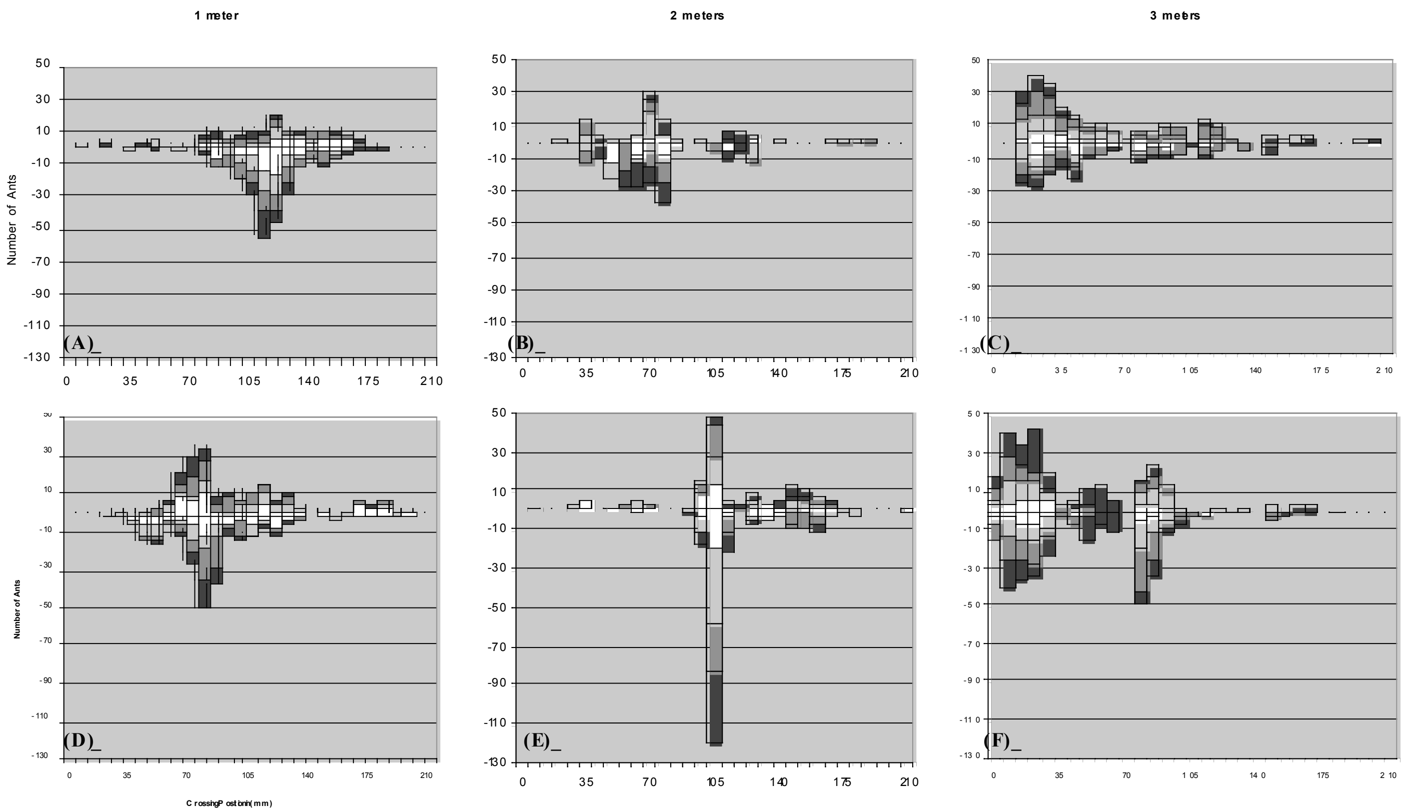
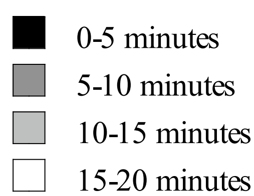
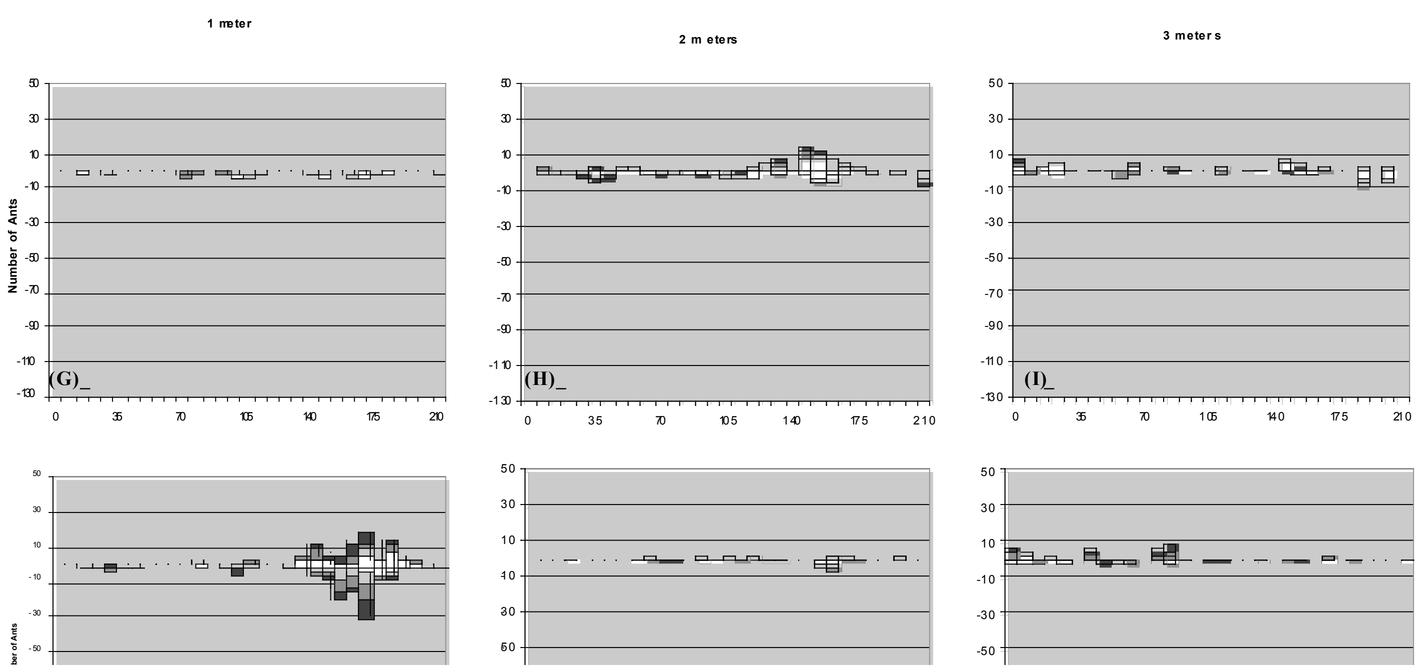




Data for Figures 1(A-C) were taken starting L:55PM 10-May
1(D-F) were taken starting 1:05PM 11-May
1(G-I) were taken starting 1:30PM 10-May
1(I-L) were taken starting 1:30PM 11-May



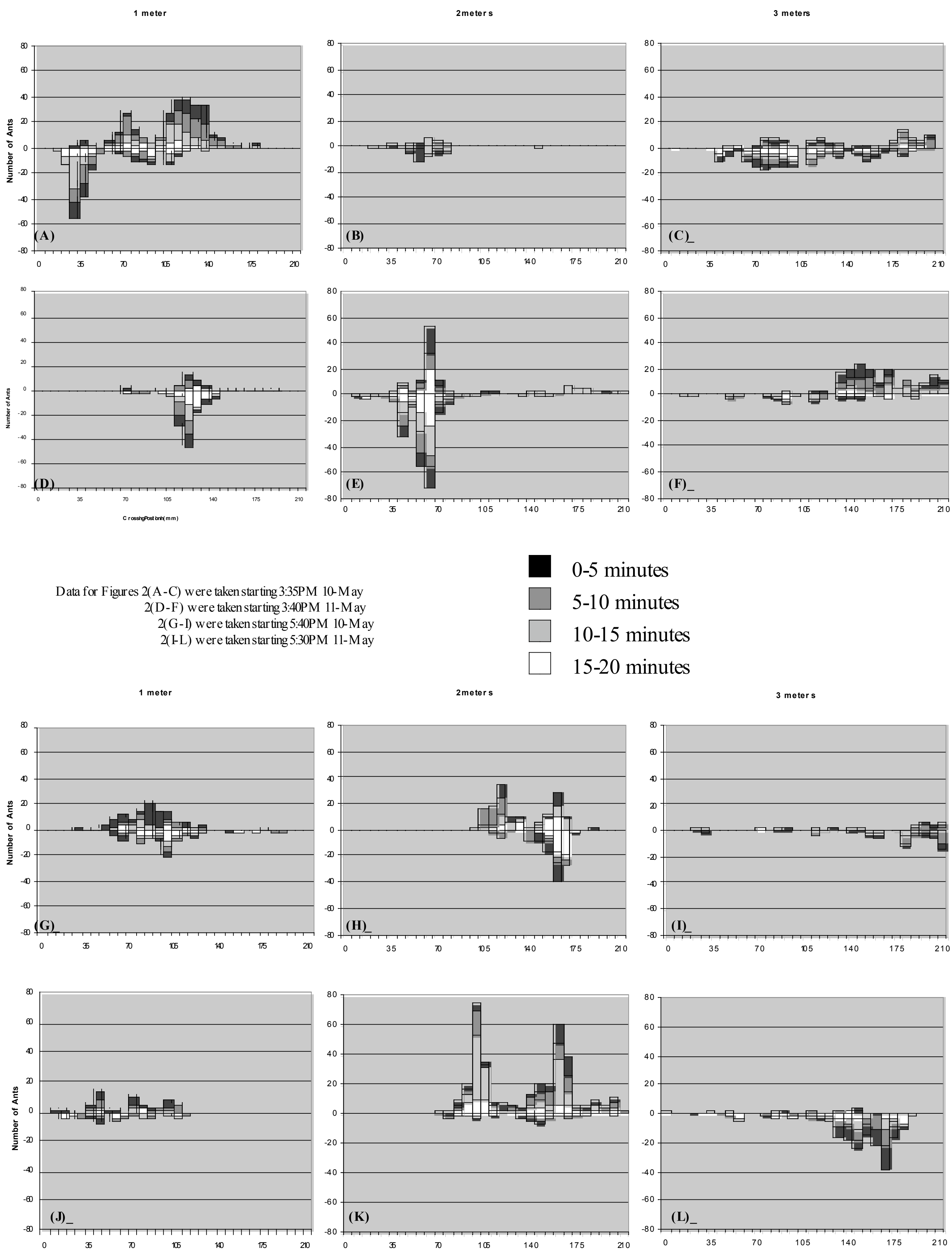
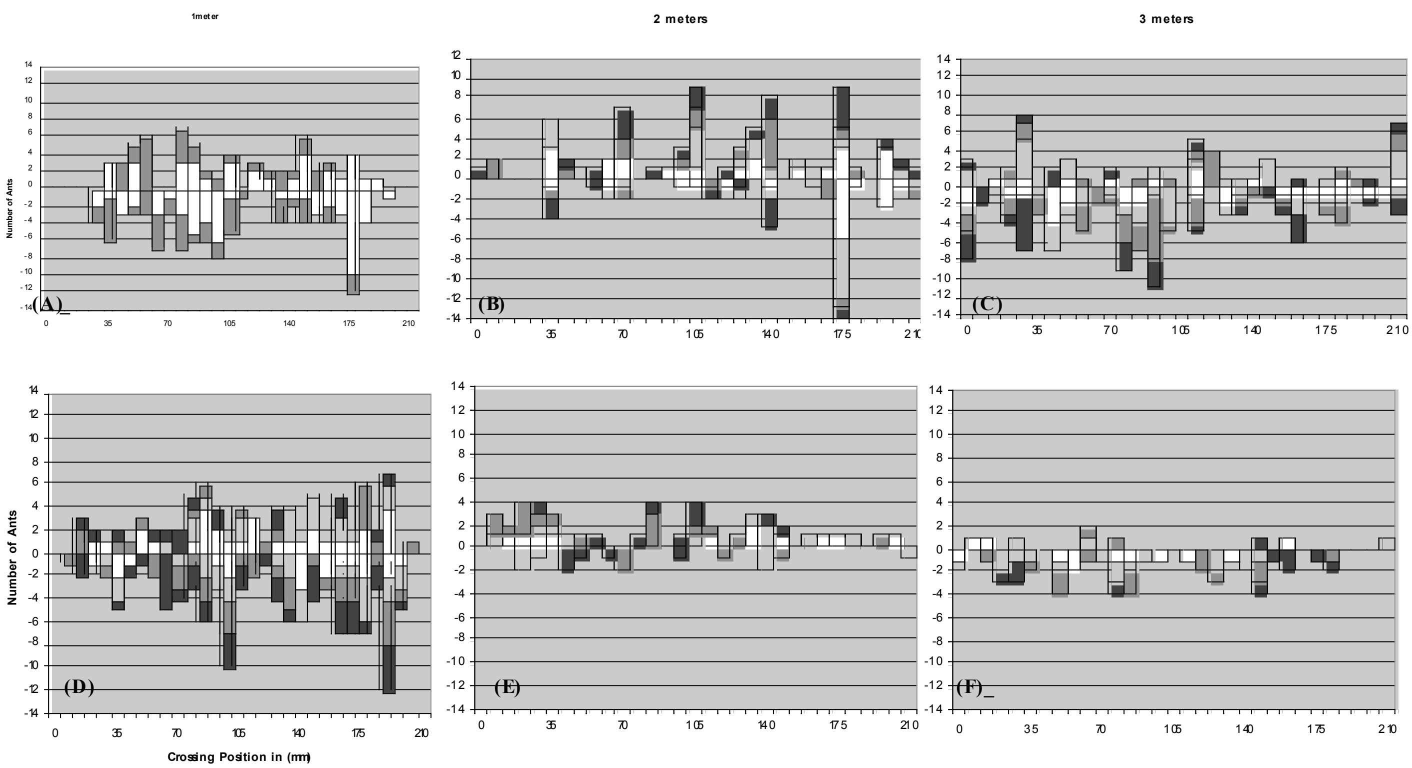
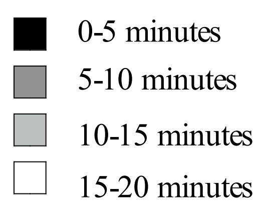

1 meter
2meter s
3 meters
Number of Ants
(A)
(B)
(C)_
(D)
(E)
(F)_
Crossing Position in (mm)
0-5 minutes
5-10 minutes
10-15 minutes
15-20 minutes
Data for Figures 2(A-C) were taken starting 3:35PM 10-May
2(D-F) were taken starting 3:40PM 11-May
2(G-I) were taken starting 5:40PM 10-May
2(I-L) were taken starting 5:30PM 11-May
1 meter
2meter s
3 meter s
(G)
(H)_
(I)_
(J)_
(K)
(L)_
Crossing Position in (mm)

Figure 2



Data for Figures 3(A-C) were taken starting 4:10PM 10-May
3(D-F) were taken starting 4:25PM 11-May
3(G-I) were taken starting 5:00PM 10-May
3(I-L) were taken starting 4:55PM 11-May



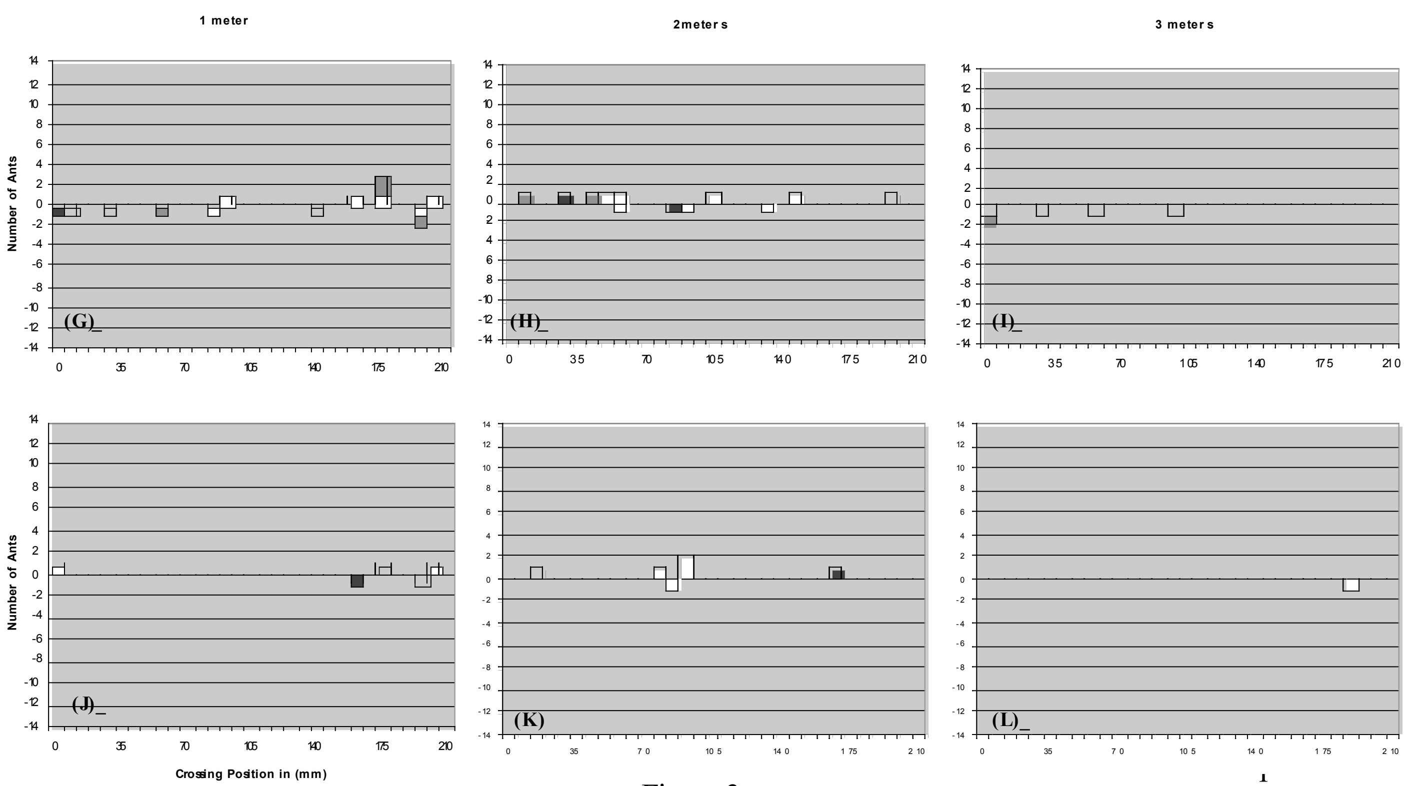


Figure 3