

Termite Trail Following Behavior



Termites are a group of eusocial insects that are usually placed in the order Isoptera. Eusociality is a condition in which members of the colony have the following traits: cooperative care of the young; some individuals give up reproduction and there's an overlap of at least two generations of life stages that contribute to colony labor. Other examples of eusocial insects include bees, ants, and wasps; all of which are in the order Hymenoptera.

Termites live in colonies that, when mature, can number from a few hundred to millions of individuals. Typical colonies contain nymphs (young), workers, soldiers, and reproductives. They are detritivores and feed mainly on dead plant material and can become major pests causing damage to buildings, crops, and forests. Until recently it was thought that termites could not digest wood on their own and instead rely on intestinal microflora to break down the cellulose for them. Recent research, however, indicates that termites can produce their own cellulase enzymes although their role in digestion is still being explored.

Termite societies are arranged into a caste system with individuals of the separate casts having particular "jobs" within the nest. Reproductive males and females are often called the "king" and "queen", although multiple pairs of reproductives seems to be the case for many termite species. Members of the worker caste are involved in foraging, food storage, nest maintenance and some of the colony defense. The soldier caste has anatomical and behavioral adaptations for the defense of the nest. Some soldiers have mandibles that are so enlarged that they cannot feed themselves and must be fed by workers. The soldier caste can be very diverse with several distinct mandible and body sizes, each specialized for a different battle. In some species castes of soldiers may have enlarged heads used to block breaches in the nest while others have their heads formed into a nozzle that is used to exude a gluey chemical defense (you can see the nasute soldiers and some other castes here).

Chemical signals called "pheromones" are the primary means of communication among colony members. The king and queen produce dozens of pheromones that control everything from reproduction, numbers of individuals in each caste and mound structural characteristics. Soldiers communicate among themselves during battle using chemical cues and the day-by-day colony maintenance by workers is mediated by chemical communication.

In this laboratory you will explore the trail-following behavior by the worker caste. Two pheromones have been identified as being used during trail-following behavior. The trail pheromone is produced by a gland at the tip of the abdomen and is deposited by the worker by dropping the tip of her abdomen to the substrate.

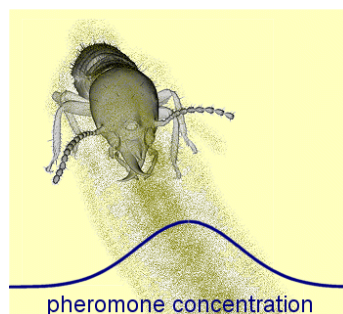


Figure 1. Termite following an odor trail (actually, this is a soldier

Although the trail is deposited on the substratum, workers move through an odor plume as the trail volatilizes. Near the center of the odor tunnel the pheromone is in high concentration so as the worker moves her head from side to side the antennae move in and out of the higher concentrations to keep the termite over the stimulus (Fig 1). The volatile compounds in some ink pens are similar in chemical composition to the natural trail pheromones. Workers can be fooled into following these artificial trails. We will take advantage of this behavior to explore trail-following in the laboratory.

1. Work in groups of 2-3. You will need the following:
 - Bic pen and several of your group's pens.
 - Small paint brush for handling the workers.
 - Paper.
 - Container with several worker termites.
2. Transfer several of your termite workers to a Petri dish and observe their behavior under a dissecting microscope.
 - Draw and label a typical termite worker.
 - Describe their behavior. What happens when they touch one another?
 - What is their response to a light touch with the brush on the antennae? Is the response different when they are brushed on the abdomen? What other behaviors have you seen?
 - Cover a portion of the Petri dish with some construction paper. Give them several minutes to see if they eventually move into the darker areas.
 - Determine their response to nest material. Place a small amount of their wood nest (use powdery portions of the nest, not chunks) in one half of the Petri dish. Cover with a piece of filter paper (or cut out a circular piece of paper towel) to remove stimuli other than possible pheromones.
3. If termite soldiers are available, draw and label a typical soldier. What happens when they contact a worker (brush the worker over to the soldier, not the other way around). What happens when you touch their antennae with the brush? How does their behavior differ from that of a worker?
4. Using a Bic pen provided by your instructor and your own pens, duplicate the paths shown in figures 4 and 5. NOTE: Draw only one at a time. For the first figure, record the time when you drew it. The termites are following the volatile compounds that are released as the ink dries, NOT the pen color. How can you test that? Make sure you test that it's the odor, not the color. If your group's pens all elicit a response, your instructor has some colored pencils that can be used. It's most efficient if you write the results of each trail on the paper with the trail.
5. Choose one of the suggested trails and determine if the following behavior and/or recruiting is affected by the amount of pheromone. Start with a single-line and test several animals. Increase the width of the line by drawing a second as close as possible to the first and test again. Continue to increase the line width another two or three times and describe what you have seen.
6. Return to your first trail and write down the new time. Test the response of the workers to the older trail. Did they follow? Explain.

