Seeing Fire Ants Smell: Olfaction of *Solenopsis invicta*

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The red imported fire ant, *Solenopsis invicta* Buren (Hymenoptera: Formicidae), like other ants, "smell" with their antennae. Antennal structures and function have been analyzed (Ranthal et al. 2002, 2003). These structures have been documented to be capable of detecting communication chemicals called pheromones. Few efforts have been made, however, to study if fire ants can "smell" food resources from a distance and to observe olfactory reactions.

Current basic and applied field research uses food lures to measure fire ant relative population densities (Pereira 2003, Calixto 2008, Calixto et. al *in review*). Slices of hot dogs have become a "standard" method for assessing fire ant populations (**Fig. 1**). The technique consists on placing slices of hot dogs (~1 cm of Bar-S™ hot dogs, weighing ~2gr) in field plots in patterns or at random during periods of the day when foraging worker ants are randomly searching for food and other resources. The assessments are usually conducted before the hot, sunny part of the day or later in the afternoon, when ground temperatures are within the optimal foraging range (~18 degrees C - 30 degrees C or 64 degrees F to 86 degrees F). The hot dogs are left exposed for 45 to 60 minutes, then the number of ants on each hot dog is recorded (counted or relative estimate is given, typically used when conducting rapid assessments). This concept is developed around the discovery and dominance traits observed for all ants (Davidson 1998). After randomly foraging fire ants, crawling in circular loop patterns detect the food resource, they make a straight-line path back to the colony (or opening to a subterranean foraging tunnel radiating away from their mounds or nests). Chemical cues, known as pheromones, are deposited in a trail as they go recruiting additional foraging ants to the resource. The resource is quickly overrun by large numbers of ants. Leaving the food lure out for a short but definite period of time provides with information about population densities. This technique allows comparison between one treatment to another over time. Relative differences (or similarities) in numbers indicate the effect of any given treatment (e.g., an insecticide) on fire ants numbers (foraging workers that can be correlated to mound numbers per unit area).

The goal of this "laboratory" trial, conducted on a garage bench, was to document the ability of foraging fire ant workers to "smell" hot dog slices from a distance.

Figure 1. Food lure (hot dog) used to aid decision-making tool to evaluate fire ant relative density and determine treatment triggers.

Materials and Methods

One red imported fire ant polygyne colony was collected on April 6, 2006, from the USDA Pecan research station, Brazos Co, TX. The colony was removed by shoveling dirt and ants from the mound into a 5 gal. plastic bucket with the inner surfaces dusted with talcum powder to prevent ants to escape. Water was then dripped into the buckets slowly, causing the ants to float on the surface. Ants were removed and placed in a plastic tray (27 by 37 cm and 9 cm tall). One Petri dish (14 cm diameter and 2.5 cm tall) containing set Castone® moistened with water was used in each colony tray to house the queen, brood (eggs, larvae and pupae) and worker ants. This dish had a lid with holes to allow ants to enter and exit. The colony was provided with distilled water and a standard laboratory diet of dead insects (crickets or mealworms) and diluted honey water.

A second colony tray was used as a foraging arena. On April 24, 2006, tall cylindrical plastic containers (8 cm tall, 6.5 cm in diameter were placed in this tray upside down underneath skewers placed over there "towers" with hot dog slices (1 cm slices of Bar-S™ hot dogs) at distances varying from (0.7-5.0 cm) above the tops, with one tower having no hot dog slice over it as an untreated control (**Fig. 2**). Ants were allowed to forage and were videotaped as they passed underneath the hot dog slices to capture their reaction to proximity of this food resource. Visual responses of ants to near presence of hot dog slices at various distances were observed, described, videotaped and recorded. The trial was conducted three times and during Trial 3, the number of ants on top of each foraging tower was counted to see if more ants accumulated in the presence of the "smell" of the hot dog slices.

Results and Discussion

At first ants were aggressive and ran up to top of containers. As they settled down, they began to attenuate, i.e. raised head and outstretched antennae, under the hot dog slices (**Fig. 2**), but showed no such response on the control tower (no hot dog slice) (**Table 1**). Visual responses were obvious and confirmed under hot dog slices 1 to 3 cm above the foraging tower surface. In addition, more foraging ants accumulated over time underneath these as compared to the control (no hot dog slice) tower surface (Trial 3). At a distance from 3 to 5 cm, results were less consistent and may have been influenced by air circulation, which was minimal, or observation error.

The results support olfactory detection of this food lure from a distance of at least 3 cm and possibly up to 5 cm from the food lure. Presumable random foraging behavior is used to place ants in proximity to a food resource before olfactory responses attract ants to the source. Different food lures and attractants emanate different scents that may elicit responses from ants at different distances, and different pheromones may provoke reactions at variable and perhaps even greater distances. Research to find food lures that evoke foraging ant olfactory responses at greater distances would be helpful in recruiting ants at the lowest levels of foraging populations. An example of this need occurred in Australia where imported fire ant eradication program is currently conducted around Brisbane, and treatment regimes rendered the fire ant at undetectably low levels.

Figure 2. Apparatus used to assess foraging ant visual olfactory response to near presence of hot dog slice food lures with laboratory colony tray in background, foraging arena containing tall cylindrical plastic foraging towers in foreground and skewered hot dog slices positioned at various distances above foraging towers.

Fig. 3. Visual behavioral olfactory response of red imported fire ant to proximity of hot dog slice as evident by raised head and outstretched antennae underneath the food lure.

Table 1. Foraging red imported fire ant worker response; "yes" or "no" indicating visual response to hot dog slices placed at various distances above foraging platforms, 26-30° C, 13:00 – 20:00 hr., April 24, 2006.

	Trial 1	Time	**Trial 2**	Time	**Trial 3**	Time				
Station No.	**Height**	13:00 13:21	**Height**	13:21-13:32	**Height**	13:36	16:49	19:03	20:58	22:00
1	7 mm	yes	17mm	yes	10mm	yes	7	5	15	16
2	15	yes	23	yes	20	yes	4	4	4	5
3	16	yes	24	yes	29	yes	2	4	10	20
4	12	yes	control	no	control	no	5	1	1	4
5	27	no	30	yes	38	yes?	3	0	0	0
6	38	no	37	yes	50	yes?	3	1	1	3

Citations

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