

Impact of the Imported Fire Ant on Biodiversity: Standardized Spatial Monitoring of Foraging Interactions

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The imported fire ant is an invasive species that has gradually spread to all or parts of 13 states. In recent years, the negative impact of this species on biodiversity has been recognized. We are developing methods to quantify the impact of fire ants on biodiversity using spatial analysis and precision targeting to develop and implement reduced-risk management strategies. Herein, we compare two bait/monitoring approaches, used in combination with spatial statistical analysis, to assess relative abundance and foraging profiles of several species of ants, setting the stage for future comparisons with the introduction of interventions to mitigate fire ant populations and enhance/safeguard biodiversity of the ecosystem.

Previous studies on monitoring foraging of ants have utilized a wide variety of bait materials, including ground meat and honey (Wojcik 1994), tuna fish (Levins et al. 1973), peanut butter (Oi et al. 1994), beef or chicken sausage (Porter et al. 1992), creme sandwich cookies (Banks & Williams 1989), and cookie crumbs (Human & Gordon 1996). Each of these and other food materials that have been used to sample ants, have disadvantages that include availability, suitability, sanitation, and reproducibility. One of the major problems with most of these bait materials has been the range of species attracted to a specific bait. Species readily attracted to meat baits may not be as readily attracted to sweet baits, and visa versa. Meat and honey baits used simultaneously often produce dramatically different results (Glancey et al. 1976). Recently Vail et al. (1997) submitted a patent application for a attractant bait formulation which was attractive to a variety of ant species, including those attracted to meat or sugars. The logistical simplicity of the new attractant formulation appeared to present a large enough improvement over our standard hamburger bait to warrant testing.

Methods

Avon Park Studies: In conjunction with other studies on the effects of fire ants on endangered species, a comparison test was conducted using our standard hamburger (ground meat meatball) and the new multiple species ant attractant bait (MSAA), at the Avon Park Air Force Range at 9 AM on 30 May 1997. An 81-station grid was marked out with flags with approximately 6 feet (2 meters) between flags and approximately 6 feet between rows. After bait placement, GPS was used to verify actual locations of each station. The standard hamburger bait (3/4-inch diameter meatball on 1-inch square heavy aluminum foil) was placed on the soil surface. For pickup, the hamburger on the foil was scooped up into disposable plastic souffle cups and placed in a plastic

bag for storage. The MSAA bait was previously pipetted onto a flattened cotton ball placed in a 50 mm diameter X 9 mm self-sealing petri dish (Gelman Sciences Inc.). For bait placement, the lid is removed from the petri dish and the base containing the saturated cotton is placed on the soil surface. For pickup, the lids were placed on the bottoms on the dish bottoms, sealing them against ant escape and the sealed numbered dishes returned to the original plastic shipping tray. Both baits were placed on the soil surface simultaneously by 2 participating researchers, about 1 foot (30 cm) on either side of the flag marker. The hamburger bait was always placed to the left of the flag while the MSAA was always placed to the right. Both baits were left in place for 1 hour, after which the samples were collected and refrigerated for return to the laboratory. Upon return to the laboratory, the samples in the dishes were frozen overnight to kill the ants, and processed for identification and counting.

Gainesville Studies: Additional tests were conducted at CMAVE, Gainesville, FL, on 16-17 July 1997. These tests were conducted to ensure that one bait did not interfere with the collections on the other bait. A 49-station grid, marked out with flags with 6 feet (approximately 2 meters) between flags and 6 feet between rows, was measured out in the grassy field behind the laboratories. The hamburger baits only were put out commencing at 9 AM, 16 July 1997, and the MSAA baits only were put out commencing at 9 AM 17 July 1997. The hamburger and MSAA baits were handled as previously described.

Spatial distributions of ants were assessed for each bait separately (Brenner et al. 1998). Contour maps were prepared for absolute counts and for "indicators" (presence/absence) using the default kriging algorithm in SURFER for Windows (ver. 6.04, Golden Software, Golden CO). Differences in estimated areas were determined by subtracting indicator "grids" of MSAA from those of HAMB (Brenner et al. 1998).

Results and Discussion

The species collected and distributions the differences in the indicators for each species of the Avon Park collections are given in Table 1. For red imported fire ants, *Solenopsis invicta*, the hamburger resulted in more specimens, but 71.2 % of the locations showed no differences between the occurrence of RIFA on the baits. The other species were collected in much fewer numbers on either bait. Both baits collected 6 species in common. *Pheidole moerens* and *Solenopsis littoralis* were only collected on hamburger bait. *Pheidole morrisi* and *Dorymyrmex bureni* were only collected on MSAA bait.

The species collected and the differences in the indicators for each species of the Gainesville collections is given in Table 2. For red imported fire ants, the hamburger resulted in more specimens, but 87.4 % of the locations showed no differences between the occurrence of RIFA on the baits. *Pheidole dentata* and *Dorymyrmex bureni* were only collected on MSAA bait.

Advantages of MSAA bait over hamburger bait

1. MSAA bait is attractive to ant species which feed on sugars (honeydew from Homoptera or extra floral nectaries). i.e. *Dorymyrmex bureni* and *Solenopsis littoralis*.

2. MSAA is attractive to species which feed on protein (meat). i.e. *Solenopsis invicta* and *Pheidole* species.

3. MSAA is attractive to species which are usually not attracted to protein baits. i.e. *Cyphomyrmex rimosus* and *Odontomachus brunneus*.

4. MSAA has distinct logistical advantages over hamburger.

A. Simpler laboratory preparation: pipetting vs rolling meatballs.

B. Freezing or refrigeration not as critical for transportation or holding in field prior to use.

C. Easier handling for placement on soil surface, meatballs easily roll off foil.

D. Petri dishes can be pre-numbered on the bottom, eliminating confusion in the field during sample distribution and collection.

E. Eliminates the need for the additional container (souffle cups) required by the meatball baits.

F. Cleaner samples. MSAA components are soluble in alcohol. Hamburger fat often adheres to the ants, creating difficulties in identification.

G. Easier pickup of MSAA baits. The white cotton or filter paper is easier to see than a meatball covered with ants.

H. More compact storage. The petri dishes are returned to the original plastic shipping trays, eliminating the bulky souffle cups in plastic bags, requiring less ice chest space in the field and less freezer space in the laboratory.

I. Eliminates sample loss since the petri dishes are placed in the original plastic shipping trays as they are collected and there is no danger of the dishes popping open during transport or freezing.

J. Speeds sample processing since the petri dishes can be placed in numerical order as they are collected.

K. Less waste: Aluminum foil not required; petri dishes require simple soak and wash, as compared to a grease removal from souffle cups when hamburger is used.

L. No sanitation problems: the distribution of meat baits requires washing of hands after handling meat baits and disposal of used meatballs.

Given the versatility and specificity of this method, we propose this method be used as a standard monitoring program. Standard methods of monitoring will be essential for measuring survival and impact of candidate biological control agents throughout the proposed release sites in the United States.

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Table 1. Differences in indicators of ant abundance on the two baits from the Avon Park study site. The differences in area occupied by each species and corresponding percentages are given. Hamburger bait and multiple species ant attractant bait (= MSAA bait) tested simultaneously.

Ant Species	Bait	Area (sq.	Percent
<i>Solenopsis invicta</i>	Hamburger Only	114.1	26.6
	MSAA Bait Only	9.6	2.2
	No Difference	304.8	71.2
<i>Pheidole floridana</i>	Hamburger Only	23.0	5.4
	MSAA Bait Only	0	0
	No Difference	405.6	94.6
<i>Pheidole morrisi</i>	Hamburger Only	0	0
	MSAA Bait Only	4.2	1.0
	No Difference	424.4	99.0
<i>Pheidole moerens</i>	Hamburger Only	3.7	0.9
	MSAA Bait Only	0	0
	No Difference	424.8	99.1
<i>Solenopsis littoralis</i>	Hamburger Only	20.6	4.8
	MSAA Bait Only	0	0
	No Difference	407.9	95.2
<i>Dorymyrmex bureni</i>	Hamburger Only	0	0
	MSAA Bait Only	1.2	0.3
	No Difference	427.4	99.7
<i>Paratrechina faisonensis</i>	Hamburger Only	26.5	6.2
	MSAA Bait Only	187.9	43.9
	No Difference	214.1	49.9
<i>Cyphomyrmex rimosus</i>	Hamburger Only	2.5	0.6
	MSAA Bait Only	3.6	0.8
	No Difference	422.4	98.6
<i>Odontomachus</i>	Hamburger Only	35.7	8.3
	MSAA Bait Only	10.0	2.3
	No Difference	382.8	89.4
<i>Paratrechina concinna</i>	Hamburger Only	2.0	0.5
	MSAA Bait Only	13.8	3.2
	No Difference	412.7	96.3

Table 2. Differences in indicators of ant abundance on the two baits from the Gainesville study site. The differences in area occupied by each species and corresponding percentages are given. Hamburger bait and multiple species ant attractant bait (= MSAA bait) tested on consecutive days.

Ant Species	Bait	Area (sq.	Percent
<i>Solenopsis invicta</i>	Hamburger Only	21.9	11.2
	MSAA Bait Only	2.8	1.4
	No Difference	171.3	87.4
<i>Pheidole dentata</i>	Hamburger Only	0	0
	MSAA Bait Only	14.5	7.4
	No Difference	181.5	92.6
<i>Dorymymex bureni</i>	Hamburger Only	0	0
	MSAA Bait Only	97.5	49.8
	No Difference	98.5	50.2