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Bait Attraction of the Introduced Pest Ant, *Wasmannia auropunctata* (Hymenoptera: Formicidae) in the Galapagos Islands[1,2]

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ABSTRACT In laboratory studies with 14 food substances, peanut butter and honey were the most attractive substances to workers of the ant *Wasmannia auropunctata*. In tests with 6 oils, soybean oil (once refined) was the most attractive to the workers; however, it was not significantly more attractive than tuna oil and sunflower oil. A comparison of the attractiveness of the commercial fire ant baits Amdro (hydramethylnon) and Logic (fenoxycarb) with a peanut butter standard indicated that Amdro was not significantly different; however, Logic was significantly less attractive. Field bait acceptance studies of *W. auropunctata* were conducted in the Galapagos Islands with the following: the fire ant baits, Amdro and Logic; the Pharaoh's ant baits, Raid Max Ant Bait (N-ethyl Perfluorooctanesulfonamide) and Maxforce Pharoah Ant Killer (hydramethylnon); and lard, peanut butter, peanut butter oil, honey, and honey:water (1:1). Results indicated that the most attractive substance to workers was Amdro; however, it was not significantly different from peanut butter, lard or Raid Max Ant Bait.

KEY WORDS Baits, acceptance, *Wasmannia auropunctata*, Galapagos Islands.

The little fire ant, *Wasmannia auropunctata* (Roger), was introduced onto the Galapagos Islands in the early part of this century (Silberglied 1972; Clark et al. 1982). These ants are serious pests on several of the islands and are now found on 6 of the 13 major islands in the Galapagos and appears to have been successfully eradicated recently from a seventh island. Where *W. auropunctata* densities are high, few native ants or other invertebrates exist (Clark et al. 1982; Lubin 1984). Because of their painful sting and their occurrence in high densities, the little fire ant has become a human pest species in many areas such as in homes, yards, and gardens and along National Park trails in the Galapagos. *W. auropunctata* also causes severe problems to workers harvesting coffee beans. One of the toughest ways to earn money in the Galapagos Islands is to pick coffee beans. The "rain" of these ants down on top of the workers is considered hazardous and the pay is considerably higher than other agricultural contract wages because of this. On several areas, coffee plantations lie abandoned because of the problems with this ant. They are considered to be a severe pest problem by the scientists, staff and residents on the Charles Darwin Station and in the town of Puerto Ayora.

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[2] This article reports the results of research only. Mention of a proprietary product does not constitute an endorsement or the recommendation for its use by the United States Department of Agriculture.
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Previous attempts to control *W. auropunctata* in the Galapagos Islands have been unsuccessful. Eradication of *W. auropunctata* from the inhabited islands seems highly unlikely and is probably not feasible because it is so widespread on the Islands and because of the regular movement of people and their goods between the continent and the islands. People also move plants with soil from one farm to another. However, it should be possible to reduce the existing heavy populations and control this ant in specific areas by utilizing available methods of control used on other pest ants. For example, several commercial baits such as Affirm (Avermectin B_1, Merck and Company, Rahway, New Jersey, USA), Amdro (hydramethylnon, American Cyanamid Co., Princeton, New Jersey, USA) and Logic (fenoxycarb, Ciba-Geigy Corp., Greensboro, North Carolina, USA) are presently available for the fire ant, *Solenopsis invicta* Buren, in the USA. Other commercial baits such as Raid Max Ant Bait (N-ethyl Perfluorooctanesulfonamide, S.C. Johnson & Son, Inc., Racine, Wisconsin, USA), Maxforce Pharaoh Ant Killer (hydramethylnon, Clorox Co., Pleasanton, California, USA), and Pharorid (methoprene, Zoecon Corporation, Dallas, Texas, USA) are available for use against other pest ants such as the Pharaoh's ant, *Monomorium pharaonis* (L.), and other house-infesting ants. The attractant in baits (Affirm, Amdro and Logic) designed for fire ant control is soybean oil, while those used in the Pharoah's ant baits, such as Raid Max and Maxforce, are peanut butter and insects, respectively. An important point is whether *W. auropunctata* would be attracted to any of these baits. If not, what types of foods that are economically feasible and readily available could be formulated with the available ant toxicants to be used in a bait? The little fire ant, *W. auropunctata*, is a polyphagous and opportunistic species that consumes a variety of foods in nature with the most important being honeydew (Clark et al. 1982; Ulloa-Chacon and Cherix 1990). However, they have also shown a preference for cooked fat, meats and vegetable oils, such as olive and cottonseed oils (Spencer 1941). Because the oil used in the fire ant baits (soybean oil) is a vegetable oil, then *W. auropunctata* might be attracted to these baits.

With this in mind, tests with several attractants and commercially available ant baits were conducted against laboratory colonies of *W. auropunctata* in Florida and against field colonies of this species in the Galapagos Islands to determine the acceptance of these substances. This report is the results of these studies.

Materials and Methods

The laboratory studies were conducted at the USDA-ARS, Medical and Veterinary Entomology Research Laboratory in Gainesville, FL. Three tests were performed in the laboratory to determine attractive food substances to *W. auropunctata*. The first test was conducted with the following 14 food attractants: peanut butter, honey, honey-water, pineapple juice, tuna oil, mint jelly, dark karo syrup, light karo syrup, soybean oil (once refined), orange juice, molasses, apple juice and Coca Cola syrup. Observations were conducted on at least 10 test colonies at 10 min intervals for 40 min. The following 6 oils were tested in the second test: soybean oil (once refined), tuna oil, sunflower oil, peanut oil, safflower oil, and cod liver oil. Observations in these tests were made at two 30 min intervals with seven test colonies. The third laboratory tests consisted of testing the attractancy of one of two commercial fire ant baits, Amdro or Logic, which are formulated in soybean oil (once refined) against a peanut butter standard. This was a two choice test with observations taken at 10 min intervals for 40 min using three test colonies. Each test was repeated and positions of the bait reversed.

The test colonies consisted of several queens, ca. 500 workers, and ca. 0.1 grams of brood. The ants were allowed to orient for one hour before initiating the tests. Six foods (attractants) were tested at one time for each test except test three. Each food was placed on a 1.27-cm filter paper square which was then put on a 2.54-cm aluminum foil square so that the food did not spill or contaminate the bottom of the test chamber. Three test foods were placed at each end of the rectangular chamber. Once all of the foods were in place, the number of ants feeding on each was counted at the previously described intervals. The number of workers feeding at each bait was totalled for each test colony. In tests one and two, the mean total number of workers feeding was analyzed using general linear models (GLM) and means were separated using the Ryan-Einot-Gabriel-Welsch Q Test ($P = 0.05$; SAS Institute 1988). If less than ten ants responded in a test colony, the data were not used in the analysis. For test three, a t test was used to determine if the number of workers feeding on peanut butter was different from those feeding on Amdro and if the number feeding on peanut butter was different from Logic.

The field studies were conducted at the Charles Darwin Research Station on the island of Santa Cruz in the Galapagos Islands. The following commercial baits and food substances were tested: Amdro, Logic, Raid Max Ant Bait, and Maxforce Pharaoh Ant Killer, lard, peanut butter oil, honey, honey-water (1:1), and water (control).

A 0.1-g sample of each test substance was weighed and placed in a vial cap (1 mm dia. × 1 mm high). Solid materials were placed directly in the cap while liquid materials were placed on a small piece of blotter paper fitted in the bottom of the caps. All tests ($n = 6$) were conducted outdoors in areas where *W. auropunctata* workers were foraging. Vial caps containing the test substances were placed in random positions in a straight line 5 cm apart in the line. Water was used as the control. When all of the vial caps with the substances were in position, a 5-min orientation period was allowed before beginning the test. The numbers of workers of *W. auropunctata* were counted at 5-min intervals for 45 min. The number of workers feeding at each bait for the nine readings was totalled. Tests were started in the morning ca. 09:00 h and ended in the afternoon around 17:30 h. Data were analyzed by GLM procedures (SAS Institute 1988). Mean values were separated by Ryan-Einot-Gabriel-Welsch Q Test ($P = 0.05$; SAS Institute 1988).

Results and Discussion

The results of the laboratory test with 14 sugars and oils demonstrated that peanut butter was significantly more attractive to workers of *W. auropunctata* than all other substances except honey (Table 1). Honey however, was only significantly more attractive than three other substances, molasses, apple juice and Coca Cola syrup. The next laboratory test was conducted with 6 oils and the results showed that soybean oil (once refined) was the most attractive to the workers however it was not significantly different than tuna oil and sunflower oil (Table 2). Soybean oil (once refined) is the attractant used in the commercial fire ant baits Amdro and Logic. Because this oil was the most attractive to the workers of *W. auropunctata*, the results of the third laboratory test conducted to compare the attractiveness of

Table 1. Acceptability of sugars and oils to the little fire ant, *Wasmannia auropunctata*.

Food substance	*n*	Mean (± SEM) no. workers feeding*
peanut butter	38	35.2 (6.80) a
honey	48	27.6 (4.91) ab
honey:water	10	10.3 (4.32) bc
pineapple juice	20	7.5 (2.66) bc
tuna oil	20	7.4 (2.56) bc
dark karo syrup	38	6.2 (1.86) bc
mint jelly	28	6.1 (1.66) bc
light karo syrup	18	5.5 (2.77) bc
soybean oil	20	4.2 (2.49) bc
orange juice	10	2.8 (1.55) bc
molasses	18	1.8 (0.70) bc
apple juice	10	0.4 (0.16) c
Coca Cola syrup	10	0.3 (0.21) c

* Means followed by different letters are significantly different using GLM and Ryan-Einot-Gabriel-Welsch Q Test ($F = 7.04$; df = 12, 275; $P \leq 0.05$ [SAS Institute 1988]).

Table 2. Acceptability of some oils to the little fire ant, *Wasmannia auropunctata*.

Oil	*n*	Mean (± SEM) no. workers feeding*
soybean oil	7	7.3 (2.01) a
tuna oil†	7	5.4 (1.97) ab
sunflower oil	7	4.7 (1.11) ab
peanut oil	7	2.0 (0.85) b
safflower oil	7	0.9 (0.55) b
codliver oil	7	0.3 (0.18) b

* Means followed by different letters are significantly different using GLM and Ryan-Einot-Gabriel-Welsch Q Test ($F = 4.59$; df = 5, 36; $P \leq 0.05$ [SAS Institute 1988]).
† tuna oil is vegetable oil removed from can of tuna.

Amdro and Logic to a standard such as peanut butter, indicated that the Amdro formulation was not significantly less attractive than the peanut butter and therefore not repellent. Logic however, was significantly less attractive than the standard (Table 3). This is an indication of the repellency of the active ingredient, fenoxycarb. We saw this indicated again in the field tests described herein. If the concentration of fenoxycarb in the bait was reduced from 1.0% to 0.5 or 0.25%, then the bait might be as attractive as the Amdro and/or peanut buter.

Although the most attractive substance to workers of *W. auropunctata* was the commercial fire ant bait, *Amdro* (Table 4), it was not significantly different ($F = 4.61$; df = 9,50; $P = 0.05$) from peanut butter, lard or the commercial bait, Raid Max Ant Bait. Lard, Raid Max, Maxforce, honey-water (1:1), peanut butter

Table 3. Laboratory tests of workers of the little fire ant, *Wasmannia auropunctata*, feeding on the commercial baits Amdro and Logic.

	Mean (±SD) no. workers feeding		df	*t*	*P*
Bait	peanut butter vs. Amdro				
	42.3 ± 36.72	19.7 ± 5.90	10.0	-1.4069	0.190
Bait	peanut butter vs. Logic				
	43.5 ± 26.92	9.5 ± 9.27	6.2	-2.925	0.026*

* Means are significantly different using a *t* test ($P \leq 0.05$, SAS Institute 1988).

Table 4. The acceptability of some baits and foods to foraging workers of the little fire ant, *Wasmannia auropunctata*, on the island of Santa Cruz in the Galapagos Islands.

Food substance	*n*	Mean (± SEM) no. workers feeding*
Amdro	6	64.0 (16.71) a
peanut butter	6	59.8 (24.50) a
lard	6	41.2 (20.22) ab
Raid Max	6	26.0 (11.74) ab
Maxforce	6	4.0 (2.33) b
honey:water (1:1)	6	4.0 (3.07) b
peanut butter oil	6	2.3 (1.50) b
honey	6	1.0 (0.82) b
Logic	6	0.0 (0.00) b
control (water)	6	0.0 (0.00) b

* Means (± SEM = standard error of the mean) followed by the same letter are not significantly different ($F = 4.61$; df = 9, 50; $P \leq 0.05$; Ryan-Einot-Gabriel-Welsch Q Test [SAS Institute 1988]).

oil, honey, and Logic were not significantly different from the control (water). Logic was the numerically least attractive bait substance tested with results identical to the control (water); no workers were attracted to it during the entire study.

The most likely reason that Logic, a bait formulated similar to Amdro (soybean oil as the attractant and extruded corn grit as the carrier), showed no attractancy is the repellency of the active ingredient, fenoxycarb. When the concentration of fenoxycarb was increased in laboratory tests against *S. invicta* workers, they fed on the bait more slowly indicating a possible repellency of fenoxycarb at the higher concentrations (Banks et al. 1988). Also, 0.5% concentration of fenoxycarb was less repellent and gave better control than 1.0% in baits used against the Pharaoh's ant, *M. pharaonis*, (Williams 1990). Finally, because workers of *W. auropunctata* are much smaller than workers of fire ants and Pharaoh's ant, it may be necessary to reduce the concentration of the toxicant, especially one that is repellent such as fenoxycarb, in any bait used against the little fire ant.

Also, it is important to mention that we tested Amdro and Logic against small (350-1000 worker size) laboratory colonies of *W. auropunctata* and the preliminary results showed that Amdro caused 100% mortality in all colonies within 20 days whereas Logic, as expected, took much longer to affect the colonies. In two of the colonies, 99% mortality occurred 3 months after treatment while one colony was normal and not affected by the treatment.

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N O T E

Evaluation of Flotation as a Method for Determining Infestation of Multiflora Rose Seeds by *Megastigmus aculeatus* var. *nigroflavus* (Hymenoptera: Torymidae)[1]

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KEY WORDS *Megastigmus aculeatus*, rose seed chalcid, flotation, multiflora rose.

Radiography is an effective alternative to dissection for detecting multiflora rose (MFR) seeds infested with the rose seed chalcid *Megastigmus aculeatus* var. *nigroflavus* (Nalepa, 1989. J. Entomol. Sci. 24(4): 413-416), but is time consuming and requires specialized equipment. Flotation has been used successfully in detecting seed infestation by wasps of this group; *Pistacia* sp. seeds infested with *Megastigmus pistaciae* float on water, while sound seeds sink (Milliron, 1949. Amer. Midl. Nat. 41(2): 257-420). Flotation was therefore evaluated as a method for determining seed infestation by *M. aculeatus*.

Mature rose hips were collected during January and February of 1989 from a single plant of *Rosa multiflora* located in Raleigh, North Carolina; *M. aculeatus* is overwintering in the fifth instar within the seed at that time (Balduf, 1959. Ill. Biol. Mono. 26: 1-194). Seeds (achenes) were removed from the hips, rinsed free of attached material and mixed into a volume (approx. 2 liters) of tap water. Seeds that rose to the surface of the water were collected. Resuspension and collection were repeated 3 times; at that point all remaining seeds sank. All seeds (floaters and sinkers) were dried on paper towels overnight, glued to 3 × 5″ index cards, then radiographed using a Faxitron 43805N. The X-ray film was placed on a light table, inspected using an 8× lens, and the seeds categorized as good (filled), infested, or empty. A total of 2621 seeds were processed.

Overall, 39.1% of the seeds from the sampled host were categorized as empty, 29.3% as infested with *M. aculeatus*, and 31.6% as filled (Table 1). Empty seeds can be reliably removed by flotation; virtually 100% of the unfilled seed were skimmed from the surface of the water. Distinguishing between good and infested seed by this method, however, is less clear cut. Sixty-six percent of seeds infested with *M. aculeatus* remained suspended on the surface of the water, while 77% of good seeds sank. Varying seed characteristics (ex., size of seed, thickness of seed coat) of other plants, varieties or species of *Rosa* may further affect the outcome of the floation method for determining infested seed. It seems clear, then, that radiography remains the best method for detecting *M. aculeatus* in MFR seed.

These results have implications for the dispersal of both MFR and *M. aculeatus* by water. It is known that branches and hips of *Rosa* sp. can be water dispersed

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