PHEROMONE PERFORMANCE AS AN ATTRACTIVE COMPONENT IN BAITS FOR THE CONTROL OF THE LEAF-CUTTING ANT *Atta sexdens rubropilosa* FOREL, 1908 (HYMENOPTERA: FORMICIDAE)

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ABSTRACT

In an attempt to improve the attractiveness of baits to ants, first in the laboratory, vermiculite particles were impregnated with an extract of *Atta sexdens rubropilosa* Forel, 1908 whole abdomens. This increased the pick-up ratio *A. sexdens rubropilosa*, but not in *A. sexdens sexdens*. 3-ethyl-2,5-dimethylpyrazine seems to be the component responsible for the increase in pick-up. However, despite more particles being picked up, only a small percentage of them was taken into the nest. In the field trials, using citrus-pulp bait with pheromones, an increase in pick-up was not detected. The pheromone appeared to excite the ants but did not increase pick-up of the food-bait, which is itself attractive to the ants.

RESUMO

Feromônios como um componente de atração em iscas para o controle da formiga cortadeira *Atta sexdens rubropilosa* Forel, 1908 (Hymenoptera: Formicidae)

Na tentativa de incrementar a atratividade de iscas para o controle de formigas cortadeiras, primeiramente em laboratório, partículas de vermiculita foram impregnadas com extratos de abdomens de *Atta sexdens rubropilosa* Forel, 1908. Este procedimento aumentou a taxa de carregamento das particu-

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las tratadas em relação as não tratadas (controle). Utilizando componentes do feromônio de trilha e de outros feromônios das formigas cortadeiras, encontrou-se evidências de que a substância 3-etil-2,5 dimetilpirazina foi a responsável pelo incremento da atratividade das iscas de vermiculita. No entanto, apesar do maior número de partículas carregadas, somente uma reduzida percentagem delas foi transportada para o interior dos ninhos. No campo, utilizando iscas granuladas à base de polpa de laranja, sem inseticidas, impregnadas com componentes dos feromônios de trilha e de outros feromônios das formigas cortadeiras, não se detectou aumento na taxa de carregamento das iscas tratadas em relação as não tratadas. A adição de feromônio, principalmente o 3-etil-2,5-dimetilpirazina, parece excitar as operárias de *A. sexdens rubropilosa*, mas não aumenta a atratividade de iscas à base de alimento, as quais são por si só atrativas às formigas da mencionada espécie. Assim, a adição de feromônio às iscas parece justificar-se somente quando estas forem confeccionadas à base de material não alimentar, como exemplos, plásticos.

INTRODUCTION

The leaf-cutting ant *Atta sexdens rubropilosa* Forel, 1908 has the most widespread distribution in central Brazil (GONÇALVES, 1945) and is the most important in the state of Minas Gerais, which has the largest reforestation programs of all the Brazilian forestry organizations.

Control of these ants is best achieved by insecticide formulated in a bait that foraging workers pick up and carry into the nests. The active ingredient is spread throughout the fungus garden inside the nest. Any improvements in the bait that increase bait pick up rate would make possible the use of smaller quantities of insecticide, reducing the amount spread into the environment, the danger to wild life, and the cost.

Since the first reported successful use of pheromones in insect control by GASTON *et al.* (1967), interest in their use has been growing steadily. Many pheromones of leaf-cutting ants have been identified and the possibility of using them as bait components to increase attractiveness has been suggested by MOSER (1967) and LEWIS (1972).

TUMLINSON *et al.* (1972) identified methyl-4-methylpyrrole-2 carboxylate (M4MP2C) as a trail pheromone from abdomens of *Atta texana*. Later, RILEY *et al.* (1974) concluded that this same compound was also utilized by *Atta cephalotes*. *Acromyrmex octospinosus* followed a trail of M4MP2C, but *A. sexdens* did not (ROBINSON *et al.*, 1974). This pheromone was found to be of high behavioural efficiency having a detection threshold of 0.08 pg.cm^{-1}, so that 0.33 mg would be theoretically

sufficient to lay a detectable trail around the world (TUMLINSON *et al.*, 1971). In the laboratory, *A. texana* followed artificial trails made with M4MP2C, but high concentrations, above about 8 ng.cm^{-1} of trail were somewhat repellent (TUMLINSON *et al.*, 1972).

CROSS *et al.* (1979) found that 3-ethyl-2-5-dimethylpyrazine (3E25DMP) is the major component of the trail pheromone of *A. sexdens rubropilosa*. They also indentified methyl-and ethyl-phenylacetate and M4MP2C as minor components from the same source (the poison gland). *A. sexdens sexdens* also responded strongly to the pyrazine, which in large amounts evoked a weak response from *A. texana*, *A. cephalotes* and *A. octospinosus*. CROSS *et al.* (1979) estimated that 4.2 kg of *A. sexdens rubropilosa* workers (= 280,000 ants) contain 100µg of 3E25DMP (an average of approximately 0.4 ng per ant).

EVERSHED & MORGAN (1980, 1981) investigated the Dufour's gland contents of four species of attine ant and found (Z)-9-nonadecene to be the major component in *A. sexdens rubropilosa* and (Z)-9-tricosene to be the most abundant component in *A. sexdens sexdens*, these chemicals occuring in microgram amounts. (Z)-9-nonadecene and n-heptadecane were the most abundant in *A. cephalotes*, occuring in nanogram amounts; and homofarnesene was the major component in *A. octospinosus*. The Dufour's gland of *A. sexdens sexdens* was said to have a volume of 9.72 nl, being completely filled with volatile hydrocarbons (linear alkanes and alkenes). No behavioural function for these hydrocarbons was suggested.

GLANCEY *et al.* (1970) suggested that in the fire ant, *Solenopsis saevissima*, pheromones may control brood recognition, and they demonstrated that hexane extracts of brood added to corn grit caused these materials to be returned to the nest and treated as brood for a period of several hours.

ROBINSON & CHERRETT (1974) evaluated the use of brood pheromone of *A. cephalotes* as a component of an attractive bait. However, in no case did the response suggest that this pheromone could be used as an arrestant in baits. Later, ROBINSON & CHERRETT (1978) found that synthetic M4MP2C, when impregnated onto paper discs, increase pick-up of the discs by *A. cephalotes*, *A. sexdens* and *A. octospinosus*, in the laboratory. It also increased pick up by *A. sexdens* of a citrus pulp bait, which remained attractive for about four days. Addition of the pheromone made the baits easier to find, although it was repellent at high concentrations. The average number of investigations by the ants before the bait was picked up was not affected by the addition of the pheromone. CROSS *et al.* (1979) made an attempt to enhance bait pick-up with the *A. sexdens rubropilosa* trail pheromone components, 3E25DMP + 2E25DMP. They concluded that Paraguayan field colonies of this species did not preferentially pick up baits impregnated with the pyrazine mixture. ROBINSON *et al.* (1982) found that, in the laboratory, the trail pheromone M4MP2C acted as an attractant to leaf-cutting ants when added to soybean baits,

increasing the percentage of pick up of pheromone-impregnated bait compared with the plain bait.

The present study was undertaken in an attempt to evaluate the performance of leaf cutting ant pheromones in increasing bait attractiveness.

MATERIALS

The bait was a new improved Aldrin bait*, chosen from a series of laboratory trials carried out by the Chemical Entomology Unit, Southampton University (U.K.). Bait particles had a mean weight of 0.1 g and a mean volume of 0.1 ml, which corresponds to the amount of solvent used. The following synthetic pheromones were tested: M4MP2C, 3E25DMP, MPA and EPA, and (Z)-9-nonadecene. Methylene chloride was the solvent and it was used alone in the control bait.

Laboratory experiments were performed on nests of *A. sexdens rubropilosa* and *A. sexdens sexdens* cultured in the laboratory at 27 ± 2°C and 75-80% R.H. Vermiculite particles were impregnated with the compounds. PEREGRINE & CHERRETT (1976) considered vermiculite to be the best matrix for leaf-cutting ant baits from results of a series of tests for suitable carriers. Field experiments were performed on nests of *A. sexdens rubropilosa*, during the spring (wet) season in the state of Minas Gerais, Brazil.

METHODS AND RESULTS

Laboratory experiments

Whole abdomens of *A. sexdens rubropilosa* were analysed by GLC. The fractions were soaked in vermiculite baits and tested against nests of *A. sexdens rubropilosa* and *A. sexdens sexdens*. Later, the pheromones 3E25DMP and M4MP2C identified in the extract were tested separately against the same nests.

Five vermiculite particles of about the same size were soaked with the chemicals using a microapplicator and ether as a solvent. The amounts of chemical used were decided upon after a series of preliminary test carried out with amounts ranging from 0.001 ppm to 2000 ppm (0.04 ng to 2µg in the

* Shell, ES-5856, freshly-prepared.

case of M4MP2C). The selection of dose ranges was based on previous results of other authors. ROBINSON & CHERRETT (1978) tested M4MP2C - impregnated paper discs with doses of the pheromone ranging from 0.4 pg to 40 µg per disc. They found that discs containing 8 ng were picked up by *A. sexdens sexdens* in significantly greater numbers. Experiments with citrus-pulp baits gave similar responses. ROBINSON *et al.* (1982), investigating the effect of M4MP2C on the location and pick-up of soybean baits by *A. sexdens rubropilosa*, used a pheromone concentration ranging from 40 pg to 4 g. The pheromone appeared to have some effect on bait pick-up at 0.4 to 4.0 ng per bait, although none the individual results showed a significant difference between baits with or without the pheromone.

Treated particles were left for 4 min at a room temperature of around 27°C to allow for evaporation of the solvent. Five test particles were placed in a group 5 cm to one side of an active foraging trail, and five control (solvent treated) particles placed 5 cm to the other side. There were ten replicates of this test, and in half of these the positions of the thest and control particles were changed. Only one test per day was done with each colony.

The number of ants investigating the particles with their antennae and the number of particles picked up were recorded. Counting was stopped either when only one particle of any type remained or after 15 min had elapsed after the baits had been touched by the first ant.

Counts were made of the number of particles picked up, taken into the nest, dropped around the nest jars or thrown off the table. Ants that retained the particle for a considerable time were ignored. The data refers to the first detectable change in behaviour of the ants. To distinguish the treated and control particles, Sudan red and black dyes were added to them. The dyes were changed between test and control so as to give equal number of trials with each, and to offset any possible effect of the dye on their acceptability to the ants.

Workers of *A. sexdens rubropilosa* picked up significantly more particles treated with 5 ppm of the whole extract than control particles (Table 1). There was also an increase in the average number of ants investigating the particles before taking tem away. In all experiments, only a very small percentage of all the particles picked up was taken into the nest jars. The great majority were dropped near to the nests, and almost all of these were used later to seal gaps that existed between the jars and the plaster bases.

A. sexdens sexdens (Table 2) showed no attraction to particles treated with the lower concentration, and higher amounts of extract had a repellent effect, shown by the ants picking up more particles, but then throwing them immediately over the edges of the foraging table or even dropping them

around the nest jars, with few being taken into the nests.

In tests with the synthetic pheromones, *A. sexdens rubropilosa* workers took significantly more particles treated with 5 ppm of 3E25DMP and the average number of contacts was greater than with the control (Table 3). M4MP2C failed to attract the ants (Table 4), and produced a repellent effect in high amounts. In toth instances the behaviour towards the treated particles was as described above with a very small percentage of the particles being taken into the nest.

Field experiments

Attractiveness of pheromone-impregnated bait

The response of ants to the test-bait was assayed using a technique described by CHERRETT & SEAFORTH (1970). Three different materials were tested together in competition, so that on a clean cardboard plate (20x20 cm) 33 pieces of bait (without toxicant) of each treatment were laid out randomly in the form of a grid. Each ant was then presented with a choice of baits. Fifteen replicates were done for each treatment, always using a new plate. One to two hours after the preparation of the baits these plates were placed on the ground near an *A. sexdens rubropilosa* nest, 20 cm away from an active foraging trail. The ants were allowed to walk over the plate and take back to the nest any bait they chose. The number of each type of bait remaining was recorded when either more than half the total number had been taken or 30 min after the first ant had appeared on the plate.

In a preliminary series of tests, four concentrations of different pheromones were offered to the ants together with a similar number of control baits. The ants were allowed to forage over the cardboard plate for 15 to 30 min before the final counts were made. No precise indications of preference by the ants came from these trials, which led to the choice of intermediate amounts for subsequent trials.

No significant differences among the baits were apparent for pick ups (Table 5) compared with the control. As CAMPION *et al.* (1978) pointed out, the successful application of pheromones to insect pest control depends critically upon the method of formulation of the active chemical. Thus, it was decided to incorporate the pheromones in a controlled-released formulation. The high volatility and low persistence of the pheromones could explain the inconclusive results obtained in the above experiments.

Attractiveness of pheromone-impregnated bait, using a pheromone release substrate

Inclusion of Florisil as a filler in polyethylene vials has been shown to increase substantially the life of lepidopteran pheromones, protecting them from environmental factors (KUHR *et al.*, 1972).

Florisil (ca 100-200 US mesh, BDH) was used as a slow release substrate; 10% weight is recommended for addition to the bait with a 10-fold increase in the quantity of pheromone (C. Longhurst, personal communication). The pheromone was dissolved in the solvent Florisil added and then the slurry was mixed with the baits. The test-bait was then left in a room at 25-27°C and about 70% R.H. for 6 h before the field trials. In practice, to formulate larger quantities, a higher proportion of solvent was required, which was evaporated off before use.

Florisil did not increase bait pick up (Table 6). On the contrary, the 1 ppm 3-ethyl-2,5-dimethylpyrazine bait was picked up significantly less than others, which seems to indicate a repellent effect ot the high concentration within the bait. With the addition of the minor components of the *A. sexdens rubropilosa* trail pheromone the results were not different from those above, with ants taking less baits of the higher concentrations. For the other treatments no significant difference was found between the treated baits and the control.

Effectiveness of the new aldrin bait in the control of *A. sexdens rubropilosa*

Plain and pheromone-impregnated Aldrin baits were used. The latter included 0.1 ppm of 3-ethyl-2,5-dimethylpyrazine. This impregnated bait was prepared on the same day as the field trials. The bait sizes were selected in the range 4 to 7 mm in lenght, about 4.2 mm in diameter and with an average weight of 0.1 g. The baits were applied at a rate of 5 g m^{-2} of nest surface. To obtain an approximate estimate of the influence of the soil humidity on the life of the bait, the bait was laid out on the ground, as in the practice with farmers, within 20 cm of a hole in active use and on the trail leading to the hole. After 1-3 h the amount taken by the ants was estimated.

In these experiments, the colonies started their above-ground activity 1-2 h after the onset of dark. As the nests were far from the laboratory, baits were applied 1-3 h before dark and assessment of the amount taken was made at night. Only those treated nests upon which rain did not fall between bait application and the first assessement were considered in analysis. The next day, the nests were checked for rejection of the baits taken.

The following assessments of bait effects were made 20 to 130 days later. Nest sites were examined for foraging ants, freshly-cut leaves and presence foraging trails. During the final check, a 3 m long metal rod was driven into each nest at a central point to check activity. Worker and soldier castes stream out of holes when a healthy nest is disturbed. Nests were then categorised as active (A), not very active

(NVA) or dead (D). The NVA nests may either have been dying or recovering from a sublethal dose of the insecticide. Fifteen nests were treated with plain Aldrin bait and 13 others with pheromone-impregnated Aldrin bait.

There was no difference in the effects of the two baits on the nests (Table 7). Analysing both results together, 5 out of 28 treated nests did not take any bait at all, and among those nests which took some baits into the nests only 72% of the available baits were taken. A high percentage of bait rejection occurred; about half of the bait pieces taken were subsequently rejected. Almost all nests showed signs of impaired health 1 or 2 days later, but only about 60% of nests were killed.

DISCUSSION AND CONCLUSIONS

A. sexdens rubropilosa workers picked up more vermiculite baits treated with 5 ppm of whole abdomenal extracts, and there was also an increase in the number of ants investigating these particles. The particles were not taken into the nest, but were dropped around the nest jars. The ants used small particles to seal gaps between the nest jars and the plaster bases.

When the same particles were offered to *A. sexdens sexdens*, they did not show the same attractiveness as the impregnated particles. With high loadings, the ants picked up more particles, but threw them away immediately possibly because the high concentrations retained in the baits were repellent.

When two of the abdominal extract components, 3E25DMP and M4MP2C, were tested separately against *A. sexdens rubropilosa*, similar increases in the pick ups and in the number of ants investigating the particles were observed using 5 ppm of 3E25DMP, but not with M4MP2C. 3E25DMP may thus contribute to the attractive effect of the whole abdomen extract, on the *A. sexdens rubropilosa* workers, and could be used to enhance pick up of baits.

From the field experiments, however, it seems that the incorporation into baits of M4MP2C, 3E25DMP, alone or in combination with MPAcetate + EPAcetate, and (Z)-9-nonodecene, did not produce more pick-ups. The pheromone-impregnated baits were used immediately after preparation, but trials with these chemicals in a controlled-release formulation did not enhance bait attractiveness. On the contrary, baits with the trail pheromone of the test species had a repellent effect at high concentrations.

TABLE 1 - Response of *Atta sexdens rubropilosa* Forel, 1908 workers to vermiculite particles treated with extract of their whole abdomens (laboratory tests). n = 10.

Amount of extract per particle	Mean number of ants contacting (± S.D.)	Total number of particles picked up	% of the particles taken		
			dropped around the nest	taken into the nest	thrown away
0.1 ppm	30.2 ± 5.2	20	90	0	10
Control	35.1 ± 8.6	16	100	0	0
	t = 1.5 (N.S.)	X^2 = .4 (N.S.)			
5.0 ppm	45.2 ± 10.2	30	83	14	3
Control	32.9 ± 10.4	10	90	10	0
	t = 2.7*	X^2 = 15***			
50 ppm	40.3 ± 11.2	14	78	7	15
Control	38.0 ± 5.0	10	80	0	20
	t = .6 (N.S.)	X^2 = .5 (N.S.)			
500 ppm	38.9 ± 8.7	13	77	8	15
Control	37.3 ± 6.5	11	82	9	9
	t = .5 (N.S.)	X^2 = .05 (N.S.)			

Student's t-test: *$p < .05$, Not Significant (N.S.) at $P = 0.05$. X^2 (2x2) contingency test (with Yates' correction): ***$p < 0.001$, Not Significant (N.S.) at $P = 0.05$, d.f. = 1.

TABLE 2 - Responde of *Atta sexdens sexdens* Forel, 1908 workers to vermiculite particles treated with the extract of *A. sexdens rubropilosa* whole abdomens (laboratory tests). n = 10.

Amount of pheromone per particle	Mean number of ants contacting (± S.D.)	Total number of particles picked up	% of the particles taken		
			dropped around the nest	taken into the nest	thrown away
0.1 ppm	39.8 ± 6.2	3	67	0	33
Control	37.0 ± 4.0	6	50	0	50
	t = 1.2 (N.S.)	p = .2 (N.S.)			
5.0 ppm	38.9 ± 10.5	9	22	22	56
Control	41.7 ± 8.0	5	20	0	80
	t = .7 (N.S.)	p = .09 (N.S.)			
50 ppm	27.6 ± 5.7	23	13	0	87
Control	21.6 ± 9.3	15	13	7	80
	t = 1.8 (N.S.)	p = .03*			
1000 ppm	26.7 ± 6.5	28	0	0	100
Control	20.8 ± 6.9	16	0	0	100
	t = 2.0 (N.S.)	p = .006**			

Student's t-test: Not Significant (N.S.) at P = 0.05. Fisher exact probability test: *P < 0.05, **P < 0.01, Not Significant (N.S.) at P = .05.

TABLE 3 - Response of *Atta sexdens rubropilosa* Forel, 1908 workers to vermiculite particles treated with synthetic 3-ethyl-2,5-dimethylpyrazine (laboratory tests) n = 10.

Amount of pheromone per particle	Mean number of ants contacting (± S.D.)	Total number of particles picked up	% of the particles taken		
			dropped around the nest	taken into the nest	thrown away
0.1 ppm	36.9 ± 7.0	13	77	15	8
Control	32.9 ± 7.6	10	90	0	10
	t = 1.2 (N.S.)	X^2 = .2 (N.S.)			
5.0 ppm	43.7 ± 5.4	35	80	17	3
Control	30.3 ± 4.2	13	77	15	8
	t = 6.3***	X^2 = 17.7***			
50 ppm	35.1 ± 5,4	10	90	10	0
Control	36.0 ± 7.2	16	75	0	25
	t = .3 (N.S.)	X^2 = 1.3 (N.S.)			
1000 ppm	33.4 ± 7.0	8	63	12	25
Control	34.4 ± 8.0	11	73	9	18
	t = .3 (N.S.)	X^2 = 1 (N.S.)			

Student's t-test: ***p < 0.001, Not Significant (N.S.) at P = 0.5. X^2 (2x2) contingency test (with Yates' correction): *** < 0.001, Not Significant (N.S.) at P = 0.05.

TABLE 4 - Response of *Atta sexdens rubropilosa* Forel, 1908 workers to vermiculite particles treated with synthetic methyl-4-methylpyrrole-2-carboxylate (laboratory tests). n = 10.

Amount of pheromone per particle	Mean number of ants contacting (± S.D.)	Total number of particles picked up	% of the particles taken		
			dropped around the nest	taken into the nest	thrown away
0.4 ng	27.4 ± 6.8	10	80	10	10
Control	25.5 ± 11.4	9	66	0	34
	t = .4 (N.S.)	P = .2 (N.S.)			
4.0 ng	26.8 ± 6.3	7	72	14	14
Control	27.8 ± 6.8	11	73	0	27
	t = .3 (N.S.)	P = .1 (N.S.)			
40.0 ng	25.4 ± 8.0	7	57	14	29
Control	24.7 ± 6.2	12	50	0	50
	t = .2 (N.S.)	P = .09 (N.S.)			
400 ng	28.9 + 6.7	5	20	0	80
Control	28.0 ± 6.2	8	25	0	75
	t = .3 (N.S.)	P = .2 (N.S.)			
2000 ng	29.1 ± 8.0	4	50	0	50
Control	29.5 ± 8.5	15	34	0	66
	t = .1 (N.S.)	$P = 4.10^{-3}$**			

Student's t-test: Not Significant (N.S.) at P = 0.05. Fisher exact probability test: **p < 0.01, Not Significant (N.S.) at P = 0.05.

TABLE 5 - Comparative attractiveness of the pheromone - impregnated aldrin baits to *Atta sexdens rubropilosa*, Forel,1908 field nests, during a maximum period of 15 min since the first ant touched the baits. n = 15.

Quantity of pheromones per 0.1 g of bait	Mean % of baits taken
M4MP2C	
Control	50.9
0.8 ng	60.0
8.0 ng	56.9
	$F = 3.01^{NS}$
3E25DMP	
Control	60.0
0.1 ppm	67.9
1.0 ppm	63.6
	$F = 0.74^{NS}$
3E25DM + MPA + EPA	
Control	57.2
0.1 + 0.01 + 0.01 ppm	66.3
1.0 + 0.01 + 0.01 ppm	56.9
	$F = 3.05^{NS}$
(Z)-9-nonadecene	
Control	61.6
0.1 ppm	64.0
1.0 ppm	57.0
	$F = 1.6^{NS}$

ANOVA (one-way analysis), using arcsin $\sqrt{\%}$ transformation.

NS = Not significant at P = 0.05.

TABLE 6 - Comparative attractiveness of the pheromone-impregnated aldrin baits, using a a pheromone-releaser, to *Atta sexdens rubropilosa*, Forel, 1908 field nests, during a maximum period of 15 min since the first ant touched the baits. n=15.

Quantity of pheromone + Florisil per 0.1 g of bait	Mean % of baits taken
M4MP2C	
Control	65.0
0.8 ng + 0.01 g	64.8
8.0 ng + 0.01 g	60.6
	$F = 2.15^{NS}$
3E25DMP	
Control	61.2a
0.1 ppm + 0.01 g	66.5a
1.0 ppm + 0.01 g	49.7b
	$F = 10.54^{**}$
3E25DMP + MPA + EPA	
Control	65.6a
0.1 + 0.01 + 0.01 ppm + 0.01 g	69.5a
1.0 + 0.01 + 0.01 ppm + 0.01 g	49.3b
	$F = 17.9^{**}$
(Z)-9-nonadecene	
Control	59.4
0.1 ppm + 0.01 g	63.3
1.0 ppm + 0.01 g	55.3
	$F = 3.1^{NS}$

ANOVA (one-way analysis), using arcsin $\sqrt{\%}$ transformation. Significance:

** $P < 0.01$, N.S. = Not significant at $P = 0.05$. Means followed by the same letter are not significantly different at $P = 0.05$, by Newman-Keuls' multiple range test.

TABLE 7 - Effects of baits on *Atta sexdens rubropilosa* Forel, 1908 field nests after 130 days. Spring 1981. Brazil.

Formulation	No. of nests treated	No.(%) of nests that did not take any bait	Mean % of baits taken into the nests*	% of nests that rejected baits	% of erradication
Plain Aldrin bait	15	3(20)	71.4	58.3	58.3
Pheromone-impregnated Aldrin bait	13	2(15)	72.9	45.4	63.6
Totals	28	5(18)	72.1	51.8	60.9

* The nests which did not take any bait at all were not considered.

Althoug 3E25DMP acts as an attractant in the laboratory, the disappointing field results suggested that this pheromone would not be a worthwhile addition to baits used for ant control. When the pheromone was added to baits with food odour, its effect was not additive. Similar conclusions were obtained by ROBINSON *et al.* (1982) working with M4MP2C and *A. octospinosus*.

The new Aldrin bait has the same problem as Aldrin baits already tested over the past years in Brazil. Small leaf-cutting ant nests can be readily controlled , but the large nests are much more difficult to kill. In the latter, the queen is mores likely to survive, and there are more chambers, increasing the likelihood of some of them being free of toxicant at the time the insecticide is detected by the workers. It is well-accepted in Brazil that any method of leaf-cutting ant control must kill at least 80% of the treated nests to be considered reliable (MARICONI, 1970).

Many studies have been carried out on the effectiveness of leaf-cutting ant baits, among them those of PEREGRINE & CHERRETT (1974) and ZANUNCIO *et al.* (1980). Most of those workers considered Aldrin to kill nests quicker than Mirex, although they found Mirex to be more effective in killing ants. Nevertheless, Mirex has been withdrawn from the market in the U.S.A.. It has been used on a large-scale in Brazil, and the development of an alternative bait with a hing effectiveness and lower environmental toxicity than Mirex has become a priority.

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