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Perspectives on Control of the Little Fire Ant *(Wasmannia Auropunctata)* on the Galapagos Islands

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Introduction

The little fire ant, *Wasmannia auropunctata* (Roger), was discovered on the Galapagos Islands (Ecuador) by Silberglied (1972), but according to Clark et al. (1982) its arrival in the archipelago probably predates that time. In the humid conditions of Santa Cruz Island, it spread at a rate of about 170 m a year (Lubin 1984), but during "El Niño" years its expansion may reach 500 m a year. During these years the ants experience conditions of temperature and humidity that are optimal for their development and reproduction (Lubin 1985). Numerous ecological and behavioral studies have demonstrated the impact of *W. auropunctata* on native and endemic invertebrate fauna (ants, scorpions and spiders) of the Galapagos Islands (Clark et al. 1982). Moreover its presence is linked with outbreaks of other pest species (Homoptera, Coccidae) in cultivated areas of Santa Cruz Island (Lubin 1984, P. Ulloa-Chacon, pers. obs.).

On colonized Galapagos Islands, as well as other invaded areas around the world, control of this pest ant species was based on "classical" methods such as the use of highly poisonous and persistent chemicals. Tests were made with different organo-chlorinated substances, e.g. DDT (Fernald 1947, Osburn 1948) and phosphorylated chemicals such as malathion, parathion (Nickerson 1983), mirex (Sacoto 1981), endosulfan, fenthion and malathion (Delabie 1989). Mechanical control measures, i. e. the use of sticky strips (Spencer 1941, Delabie 1989), destruction of the nests (Spencer 1941) or the washing of infested fruits (Carjaval 1983) were also tested. In view of the special circumstances of the Galapagos Islands, Williams (1987) proposed that insect growth regulators (IGR) might be effective. Before starting a field assay we tested the effect of the juvenile hormone analog, methoprene, on laboratory colonies (Ulloa-Chacon and Cherix 1992). Our results showed that it had little effect on the adult worker population (Ulloa-Chacon and Cherix 1990a), but an important one on brood development and queen fecundity (Ulloa-Chacon and Cherix 1990a, 1990b, 1992; Ulloa-Chacon et al. 1991).

We present here the results of a field test using methoprene against *W. auropunctata* on Santa Cruz island.

Material and Methods

A site close to the village of Bellavista was selected. It was located within the transition zone (humid zone) in a cultivated area at about 194 m above sea level. The study was conducted from November 1989 to January 1990, which marked the end of the dry season. We used the same bait as used in our prior studies (Ulloa-Chacon and Cherix 1992) which contained 0.4% methoprene (Pharorid™). In the agricultural zone of Bellavista, the population density of *W. auropunctata* was very high (we found only one other species of Formicidae which belonged to the subfamily Ponerinae, but never on baits and very discrete). The nest density was about 9.0 $\pm$ 4.5 per square meter (Ulloa-Chacon 1990). Within this area we selected four stations (A, B, C and D), and within each of these we marked either three or four 5 m^2 plots. Two or three of these plots were treated (TR) and the other served as a control (T) (see Table 5.1). Each plot was subdivided into 1 m^2 quadrats and marked with colored sticks. At the base of each stick, a bait either with or without methoprene was placed depending on the area.

The ants consumed the baits in about 48 hours (1 cm^3). The bait was renewed in some plots at weekly intervals up to four weeks.

Twenty-four and 48 hours after distribution of the baits, we counted the number of baits with *W. auropunctata* workers and/or other invertebrates in all plots (T and TR). This was also performed at night in order to see if other animal species were attracted to the baits. One week after the beginning of the treatment, and for six weeks thereafter, a weekly evaluation of the ant population was done in randomly selected 1 m^2 subplots by scoring the number of nests, the number of workers, the

TABLE 5.1 Composition of experimental areas in the 4 stations at Bellavista, within the humid zone of Santa Cruz.

Station	Experimental plots Control	Treated	No. of applications
A	T 1	TR 1	4
		TR 2	2
B	T 2	TR 3	2
		TR 4	4
C	T 3	TR 5	3
		TR 6	3
		TR 7	1
D	T 4	TR 8	3
		TR 9	1
		TR 10	1

FIGURE 5.1. Occupation of baits by workers of *W. auropunctata* after 24 hours.

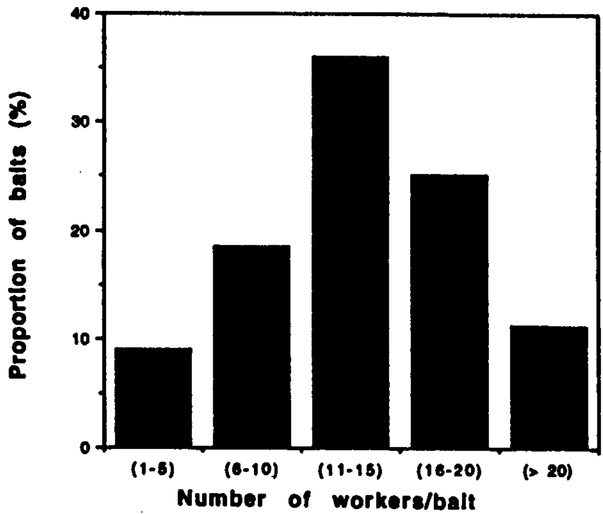


TABLE 5.2. General results of the survey of stations A, B, C and D from week 2 to week 6 after first bait application.

Time weeks no.	No. of nests / m^2 Control (n = 3)	Treated (n= 9)	No. of queens / m^2 Control (n= 3)	Treated (n = 9)	No. of workers / m^2 Control (n = 3)	Treated (n= 9)
2	6.3 ± 1.2	6.5 ± 1.1	11.3 ± 1.3	8.2 ± 1.9	1400 ± 208	1455 ± 304
3	8.3 ± 4.7	12.1 ± 1.5	7.5 ± 4.3	11.2 ± 2.1	1933 ± 1109	2844 ± 443
4	10.3 ± 2.7	10.8 ± 1.9	8.7 ± 5.2	12.4 ± 2.7	1866 ± 481	1988 ± 325
5	13.3 ± 1.4	9.9 ± 1.2	14.0 ± 5.6	8.8 ± 1.6	2367 ± 467	1644 ± 319
6	12.5 ± 3.5	9.0 ± 1.5	8.0 ± 3.0	11.3 ± 5.5	2300 ± 900	1600 ± 458
Mean/weeks	10.3 ± 1.3	9.8 ± 0.7	9.9 ± 1.8	10.2 ± 1.0	1950 ± 274	1954 ± 179

number of queens and the state of the brood. All queens were kept for further studies. Queens collected during each evaluation of the ant populations were taken to the laboratory for an oviposition test. Each queen was isolated in a small nest for 14 hours without workers and then the number of eggs laid during this period was counted. A sample of queens was dissected in order to estimate ovarian development (mean number of oocytes per queen).

Statistical analyses were performed on population density, egg laying and ovarian development. When the data were not normally distributed, we used the logarithm transformation (number of individuals) or the square root transformation (oviposition tests), followed analysis of variance (Anova) and t-tests.

Results

In Bellavista, *W. auropunctata* occupied 81% of all the baits (Figure 5.1). For the rest, a number of beetles (Nitidulidae) and cockroaches were seen, but constituted less than 10% of the total. Additionally 4.5% of baits were not visited or were lost.

The results for the entire study area are presented in Table 5.2 (mean calculated on 6 weeks). An Anova-test (log transformation) showed no significant differences between the treated and the untreated areas in relation to numbers of nests, ($F_{1,3}$=0.46; P=0.71), numbers of queens ($F_{1,3}$=1.59; P=0.20) and numbers of workers ($F_{1,3}$=1.93; P=0.14). Moreover, a comparison after 6 weeks showed there were still no significant differences between T and TR at that time.

A total of 127 oviposition tests were conducted. The mean number of eggs laid by queens from control areas was 9.7 $\pm$ 6.6 eggs per queen in 14 hours. This was significantly different (t-test: t = 6.11; df 126; P< 0.0001) from the queens of treated areas (4.1 $\pm$ 2.4 eggs). These results showed that the egg-laying rate was reduced by about 53% in treated queens. Table 5.3 shows the change in egg-laying from week three to week six. There was a progressive diminution from 7.4 $\pm$ 2.9 eggs per queen at the end of the third week to 2.7 $\pm$ 0.9 eggs by the end of the sixth week. Significant differences between treated and untreated queens first appear in week 4 (t-test, P< 0.01).

TABLE 5.3. Results of oviposition tests from week three to week six after first bait application (n = number of queens).

Week No	No of eggs /queens (mean ± standard error) control	treated	t-test (P<0.01)
3	9.2±4.1 (n=10)	7.4±2.9 (n=10)	NS
4	12.4±2.3 (n=10)	4.7±1.0 (n=35)	t=3.31; df 43
5	7.3±1.7 (n=10)	3.3±0.5 (n=40)	t=2.67; df 48
6	9.8±2.0 (n=10)	2.7±0.9 (n=10)	t=3.20; df 18

FIGURE 5.2. Influence of number of bait applications on queen fecundity; n = number of queens used for oviposition test, when the letters above the columns are different, there are significant differences (t-test; P<0.001).

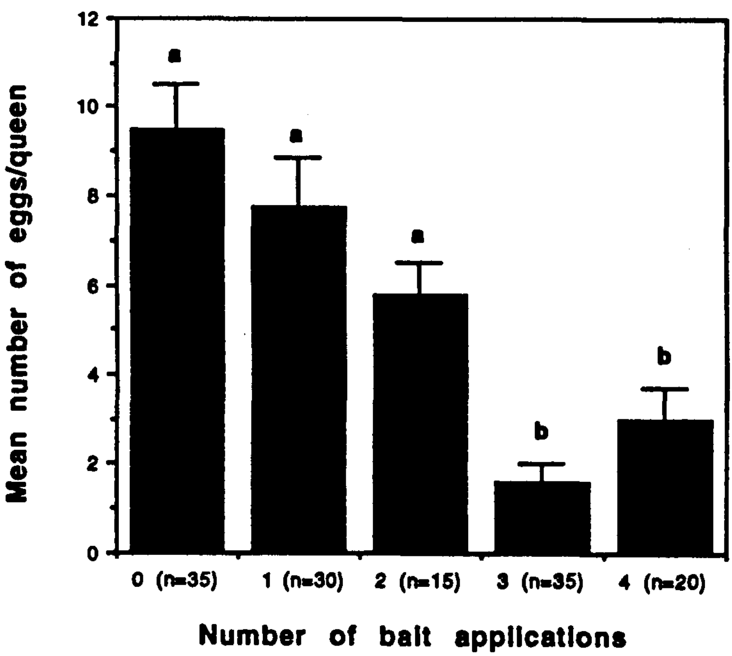
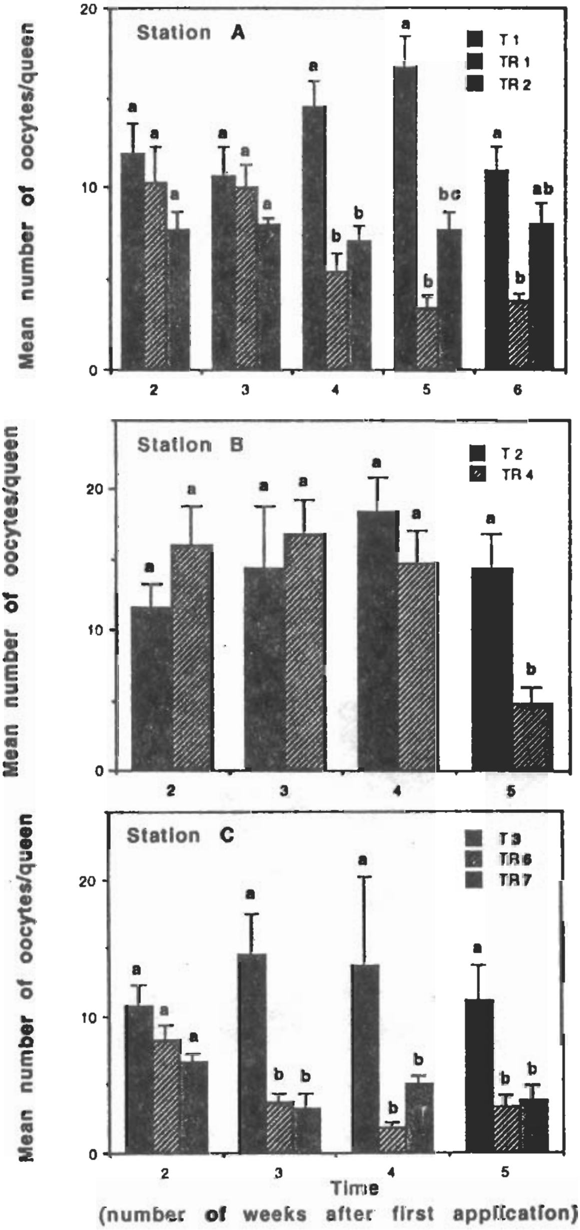


FIGURE 5.3. Comparison of ovarian development among queens from control areas (T) and treated areas TR) at stations A, B and C during five or six weeks after first bait application. When letters above columns are different, there are significant differences (P<0.01).



Moreover, we found that the number of bait applications was also of great importance. An Anova test showed significant differences between the egg-laying rates of queens in relation to the number of applications ($F_{4,130}$ = 16.14; P<0.01). Comparisons between the number of applications and the control showed no statistically significant differences between the control and one or two applications, but high significance with three applications (t= 6.971; df 68; P<0.001) and four applications (t= 4.02; df 53; P<0.001) (Figure 5.2). We also compared the ovarian development of treated and untreated queens. A weekly estimation of the number of oocytes per queen is shown in Figure 5.3. These comparisons showed that there were small differences between each station (A, B and C). A significant reduction in oocytes occurred after three weeks at station C ($F_{3,36}$ = 14.8; P<0.0001), after four weeks at station A ($F_{2,36}$ = 10.74, P<0.001) and five weeks at station B ($F_{1,20}$ = 14.90; P<0.001).

Discussion

The first important aspect when attempting to control a pest species by means of IGR baits is the attractiveness of the bait itself. In our case, more than 80% of the baits were visited and taken by the ants. This is comparable to the results obtained by Clark et al. (1982) who found 81.9% of sucrose baits visited by workers of *W. auropunctata*. Meier (1985) presented evidence that *W. auropunctata* dominates other species of ants on baits consisting of tuna fish or other high proteins. This is of great help, especially when effective control requires that the target species should feed for a protracted period on baits that might attract other species. In our case some baits disappeared, probably eaten by animals such as lava-lizards of the genus *Tropidurus*, rats, cats, or dogs. The low toxicity of methoprene to vertebrates (LD50 = 34,500 mg/kg, Siddall and Slade 1974) is a good argument to pursue these studies even if there are some negative affects on non-target invertebrate fauna (Retnakaran et al. 1985 and Pihan 1975).

Our field results confirmed those obtained under laboratory conditions (Ulloa-Chacon and Cherix 1992) insofar as the egg-laying rate of queens was reduced. Moreover, dissection of queens showed that there was also an important reduction in oocyte numbers after only three weeks. At the end of the first part of our investigation (six weeks) we could not see any diminution in the ant population, but our continuing observations demonstrated that populations were highly affected after three months without further treatment and have reached 50 to 75% reduction within the treated area (D. Cherix and P. Ulloa-Chacon, unpublished). It is important to note that effectiveness depends upon the number of treatments. One or two treatments were not enough tó affect queens in our six week experiment. This substantiates results obtained with IGR's against other ant species, e.g. *Monomorium pharaonis* in which population reductions appeared eight to ten weeks following treatments (Edwards 1975, Edwards and Clarke 1978, Edwards et al. 1981, Rupes et al. 1988) or after six to ten weeks in *Pheidole megacephala* (Edwards et al. 1981, Horwood 1988). Field experiments conducted on *Solenopsis invicta* showed important population reduction occurred only after three to six months following treatment (Banks et al. 1983, 1986).

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Resumen

Cebos conteniendo metopreno a 0.4% fueron probados para el control de la pequeña hormiga de fuego u hormiga colorada, *Wasmannia auropunctata*, en Islas Galápagos (Santa Cruz). Seis semanas después de la primera aplicación de los cebos, no se observó reducción en el número de nidos, de reinas y de obreras, pero la fecundidad de las reinas se afectó significativamente. El número de huevos puestos por reina se redujo en aproximadamente un 53%, como tambien el número de oocitos por reina, en las áreas en las que se colocaron cebos 3 ó 4 veces.

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