

COMPETITIVE DISPLACEMENT OF *PARATRECHINA LONGICORNIS*
(LATREILLE) (HYMENOPTERA: FORMICIDAE)
FROM BAITS BY FIRE ANTS
IN MATO GROSSO, BRAZIL

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ABSTRACT

Studies of competitive foraging for three baits by *Paratrechina longicornis* Latreille, and *Solenopsis invicta* Buren were conducted in Brazil. *Paratrechina longicornis* discovered the foods, honey, meat, and cookie, first and recruited large numbers of foragers, dominating the baits for the first 20-30 min of the tests. *Solenopsis invicta* was slower to discover the baits but their ability to recruit additional foragers and their aggressive behavior resulted in displacement within 45-60 min of most *P. longicornis* and other ants from the baits and foraging arena. Four other species of ants observed in the study site: a *Mycocepurus* sp., an *Acromyrmex* sp., and two *Conomyrma* spp. occasionally fed on the baits but were not effective competitors for the former two species.

Key Words: Fire ants, foraging, baits, *Paratrechina*, *Solenopsis invicta*.

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INTRODUCTION

The red imported fire ant (RIFA), *Solenopsis invicta* Buren, was accidentally introduced into the southern United States at Mobile, Alabama in the late 1930s to early 1940s (Buren 1972). Through natural means and the aid of man, the ants have spread from that point of introduction to infest more than 10^8 ha of land in 11 southern states and Puerto Rico. Research has been conducted for more than three decades to find suitable methods of control to alleviate the medical and agricultural problems caused by the ants.

The RIFA have become widespread in the United States by flooding disturbed habitats with large numbers of reproductives and then outcompeting the native ant species for food and nesting space. Foraging and recruitment strategies of fire ant workers are efficient enough to ensure their domination of a large proportion of available food resources (for details see Wilson 1962, 1971; Horton et al. 1975; Lofgren et al. 1975; Kidd and Apperson 1984; Kidd et al. 1985; Porter and Tschinkel 1987).

Solenopsis invicta has been characterized as less abundant in its homeland in Mato Grosso, Brazil than in the southern United States (Buren et al. 1978; Williams and Whitcomb 1974). Allen et al. (1974) reported that the general ant fauna is rich and varied in Mato Grosso and suggested that direct competition for food between *S. invicta* and other predacious ants may be very important in population regulation. Buren (1983) suggested that augmenting or supplanting the

ant fauna of the southern United States with a complex of such competitive ant species may be a means of permanently suppressing the RIFA. He listed a number of candidate species in several genera, including *Paratrechina*.

Introduction of other ant species into the United States would require evaluation of a variety of factors, one of which would be their effectiveness in competing with *S. invicta*. We were afforded an opportunity to study the foraging competitiveness of *S. invicta* and *Paratrechina longicornis* (Latreille) with respect to three food baits when we observed the two species foraging on a common site in Brazil. We report here the results of those studies.

MATERIALS AND METHODS

The studies were conducted during April and May of 1985 on the experimental farm of the Mato Grosso Agricultural Research Organization, EMPA, at Caceres, Mato Grosso. The farm is located on the banks of the Paraguai River and, in large measure, was cleared of native vegetation 25 or more years ago.

A foraging arena (Fig. 1) was established by outlining squares on the soil surface in an area where a number of ants were observed foraging. The arena was comprised of three squares, 15, 30, and 60 cm²; each smaller square was centered within the next larger. The arena was free of vegetation, but was surrounded on all sides (within 0.5 - 1.0 m) by leaf litter, weeds, and native grasses, 10 - 30 cm in height. It was shaded during most of the morning and early afternoon.

The number of ants of each species present in each square of the foraging arena was recorded at the start of each test. Representative samples of all ant species visiting the baits or the arena during each test were preserved in alcohol for identification. The ambient air temperature at 120 cm above the soil and soil temperature at the 5 cm depth were recorded at the start of each test.

Three food materials, undiluted honey, meat (vienna sausage), and creme sandwich cookie, were placed separately on 4.5 cm round snap caps (from 30 ml vials) and positioned ca. 5 cm apart in the center of the inner square. After food placement, the number of ants of each species present on each food and within each of the squares was recorded at 10 min intervals through 90 min with a final recording at 120 min. Five tests were run, one each in the mornings of April 19 and May 11, and in the afternoons of April 24 and May 12 and 15. Continuous observations of ant behavior were made for the first 90 min of the first three tests with periodic observations during the last two tests.

RESULTS AND DISCUSSION

Six species of ants were captured in the test arena, a *Mycocepurus* sp., *Acromyrmex* undescribed sp. - near *rugosus*, *Conomyrma* - undescribed sp. A, *Conomyrma* - undescribed sp. B., *Paratrechina longicornis*, and *Solenopsis invicta*. The first four species were observed relatively infrequently, and had little obvious interaction with other species. Although a few foragers of these species were occasionally seen on a bait they offered no obvious competition for food to either of the latter two species.

Paratrechina longicornis (PL) discovered the baits first and during the first 20 and 30 min of all five tests they constituted 99.3% and 93.1% respectively of all ants on the baits. Entrance holes for their nest were slightly more than 1 m from the foraging arena and their foragers were nearly always present in the area. The

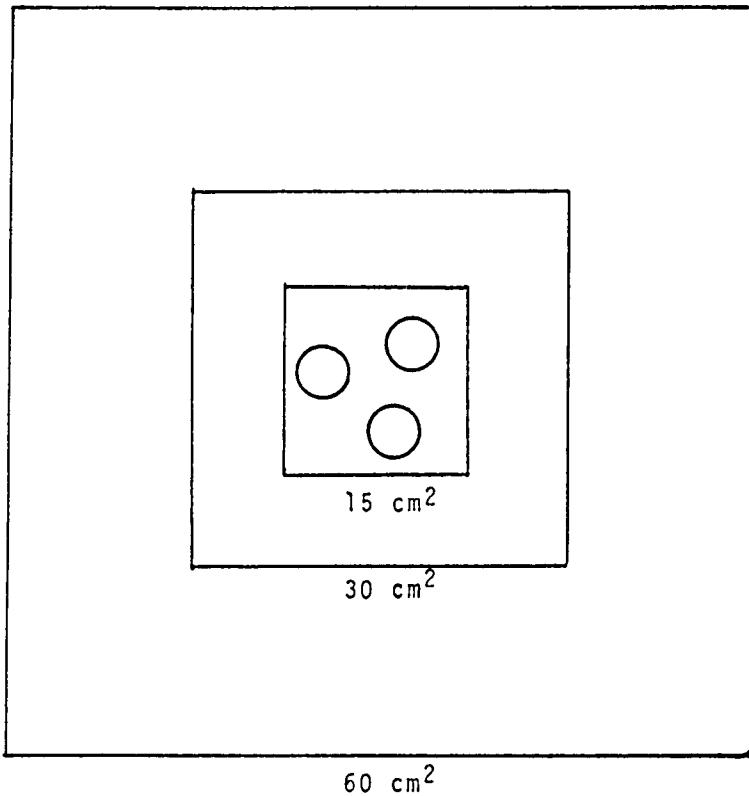


Fig. 1. Foraging arena for competitive studies. Boundaries scribed on soil surface with pointed marker. Foods placed on 4.5 cm snap caps as indicated by circles in inner square.

PL foragers discovered the baits within 5 min in every test and usually recruited other foragers very quickly; trail formation by PL did not require more than 10 min in any test. One or more foragers were present within the foraging arena at the start of three tests. Bait discovery, recruitment, and trail formation had occurred and feeding was in progress on all three baits by 3 min in one test in which two foragers were present in the 60 cm^2 square at the start. Foragers of PL were present within the 30 cm^2 square and feeding was in progress on at least two of the baits by 10 min in all tests.

Although no *S. invicta* (SI) mound was apparent within 10 m of the foraging arena, fire ant workers were observed to emerge from a tunnel exit in the ground ca. 3 m from the arena, and frequently foraged the arena area. No SI foragers were present in the foraging arena at the beginning of any test, however, initial discovery of the honey and cookie baits in test 1 and of the cookie bait in test 2 by single SI foragers occurred after 5 and 10 minutes, respectively. Recruitment of additional SI foragers and trail establishment after discovery of the food was

somewhat slower than by PL. The first substantial influx of additional SI foragers into the arena occurred at 20 min in tests 1 and 2 when 15 and 10 foragers, respectively, were present (Tables 1 and 2). Definite trail formation did not occur until 50 and 80 min, respectively. Nevertheless, SI numbers continued to increase after 20 min attended by a corresponding decrease in the number of PL foragers (Fig. 2).

Direct competition between PL and SI for the baits was observed in only two of the tests. No SI entered the foraging arena during test 3. Seven foragers entered during test 4, and two during test 5, but none fed on any of the baits. Although the reasons for these reduced levels of foraging activity were uncertain, they were probably temperature-related. Although the respective air and soil temperatures of 23.8° and 25.5°C, 28.9° and 28.3°C, and 30.6° and 37.8°C for tests 3-5 were, with the exception of the last soil temperature, all within the range of maximal SI foraging in the southern United States (Porter and Tschinkel 1987), foraging in the Brazil test was severely reduced. Direct sunlight on the foraging arena during tests 4 and 5 also may have been a factor. Glancey et al. (1983) found that RIFA workers failed to respond to queen extracts in field tests unless shaded from direct sunlight. The influence of direct sunlight and/or high soil temperature in our study was borne out in test 5; the baits were left in place after the conclusion of the test and heavy SI foraging was observed on all baits after sunset when the soil temperature had declined. Each bait was literally covered with SI workers.

In the two tests where competition occurred, SI evicted the PL foragers from the baits by two methods. The first and most effective of these was gaster-flagging (Obin and Vander Meer 1985). Reactions by PL suggested that venom dispersal was associated with the gaster-flagging, although other actions by SI, such as stridulation, may have been involved. In the early stages of SI incursion into the foraging arena, when SI was often outnumbered > 20:1, one or two minor or intermediate SI workers approached to within 1.0-2.0 cm of the group of PL workers surrounding a bait and, turning their gaster toward the group, initiated gaster-flagging. The posture typically assumed by these SI workers was that characterized by Obin and Vander Meer (1985) as the "headstand." This stance corresponds to that described for agonistic encounters between SI and other species. PL foragers within 3-4 cm of a gaster-flagging SI quickly broke ranks and moved at least 5-10 cm away. Each SI worker usually performed the gaster-flagging action two or more times near each bait causing a substantial number of PL to move and allowing other incoming SI to assume feeding positions on the bait. These workers also initiated gaster-flagging that continued as long as ants of the other species were on or near the baits.

The other method SI used against PL foragers involved mandible gaping when an intermediate or major worker of SI on a 1:1 basis would dart at a PL worker with mandibles agape. No actual attacks occurred during these encounters because the PL worker invariably turned and fled before actual contact by the SI.

These aggressive actions by SI were effective enough to quickly switch the initial domination of the baits by PL to domination by SI. In test 1 (Table 1), composition of ants occupying the baits changed from 98.3% PL, 1.7% *Acromyrmex*, 0% SI at 20 min to 31.7% PL, 68.3% SI at 40 min, and 1.5% PL, 98.5% SI at 60 min. SI totally dominated all baits in test 1 after 60 min. Displacement of PL was similar in test 2 (Table 2) although SI never totally dominated the baits during the

Table 1. Distribution of foraging ants on baits and squares of a foraging arena in Mato Grosso, Brazil. Test 1, April 19, 1985.

Time (min)	Ant Species*	Number of ants and percent of total on indicated bait or arena square											
		Meat	Cookie	Honey	15 cm	30 cm	60 cm						
0	PL	0	0.0	0	0.0	0	0.0	0	0.0				
	SI	0	0.0	0	0.0	0	0.0	0	0.0				
10	PL	4	100.0	1	100.0	5	100.0	0	0.0	1	100.0		
	SI	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0		
20	PL	15	100.0	3	75.0	39	100.0	5	71.4	4	40.0	15	62.5
	SI	0	0.0	0	0.0	0	0.0	2	28.6	6	60.0	7	29.2
	AC	0	0.0	1	25.0	0	0.0	0	0.0	0	0.0	2	8.3
30	PL	5	62.5	3	14.3	80	100.0	6	33.3	7	70.0	4	44.4
	SI	3	37.5	18	85.7	0	0.0	9	50.0	2	20.0	2	22.2
	AC	0	0.0	0	0.0	0	0.0	3	16.7	1	10.0	3	33.3
40	PL	0	0.0	0	0.0	26	54.2	6	17.6	15	93.8	15	62.5
	SI	9	100.0	25	100.0	22	45.8	25	73.6	1	6.2	5	20.8
	AC	0	0.0	0	0.0	0	0.0	3	8.8	0	0.0	4	16.7
50	PL	1	14.3	0	0.0	1	4.0	4	12.5	3	20.0	10	50.0
	SI	6	85.7	25	100.0	24	96.0	26	81.3	10	66.7	9	45.0
	AC	0	0.0	0	0.0	0	0.0	2	6.2	2	13.3	1	5.0
60	PL	1	11.1	0	0.0	0	0.0	2	9.1	7	35.0	9	50.0
	SI	8	88.9	30	100.0	29	100.0	20	90.9	13	65.0	8	44.4
	AC	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	5.6

Table 1. Continued.

70	PL	0	0.0	0	0.0	0	0.0	1	2.9	1	4.2	1	3.8
	SI	10	100.0	40	100.0	33	100.0	34	97.1	23	95.8	23	88.5
	AC	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	7.7
80	PL	0	0.0	0	0.0	0	0.0	2	6.9	2	11.1	5	14.7
	SI	12	100.0	55	100.0	36	100.0	27	93.1	15	83.3	26	76.5
	AC	0	0.0	0	0.0	0	0.0	0	0.0	1	5.6	3	8.8
90	PL	0	0.0	0	0.0	0	0.0	1	2.4	0	0.0	4	11.1
	SI	25	100.0	70	100.0	36	100.0	40	97.6	25	100.0	30	83.3
	AC	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	5.6
120	PL	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	3.1
	SI	4	100.0	80	100.0	30	100.0	25	100.0	20	100.0	31	96.9

* PL = *Paratrechina longicornis*, SI = *Solenopsis invicta*, AC = *Acromyrmex* sp.

Table 2. Distribution of foraging ants on baits and squares of a foraging arena in Mato Grosso, Brazil. Test 2, April 24, 1985.

Time (min)	Ant Species*	Number of ants and percent of total on indicated bait or arena square											
		Meat	Cookie	Honey	15 cm	30 cm	60 cm						
0	PL	0	0.0	0	0.0	0	0.0	2	100.0				
	SI	0	0.0	0	0.0	0	0.0	0	0.0				
10	PL	15	100.0	35	97.2	50	100.0	7	100.0	5	83.3		
	SI	0	0.0	1	2.8	0	0.0	0	0.0	1	16.7		
20	PL	40	100.0	10	66.7	100	100.0	0	0.0	4	80.0	7	100.0
	SI	0	0.0	5	33.3	0	0.0	4	100.0	1	20.0	0	0.0
30	PL	5	45.5	0	0.0	8	57.1	4	19.0	13	59.1	20	87.0
	SI	6	54.5	20	100.0	6	42.9	17	81.0	9	40.9	3	13.0
40	PL	1	20.0	0	0.0	5	38.5	10	27.0	25	73.5	15	68.2
	SI	4	80.0	20	100.0	8	61.5	27	73.0	9	26.5	7	31.8
50	PL	3	50.0	0	0.0	2	33.3	4	10.3	10	50.0	17	63.0
	SI	3	50.0	30	100.0	4	66.7	35	89.7	10	50.0	10	37.0
60	PL	1	25.0	0	0.0	12	80.0	4	11.8	8	47.1	13	68.4
	SI	3	75.0	22	100.0	3	20.0	30	88.2	9	52.9	6	31.6
70	PL	2	40.0	0	0.0	3	60.0	2	3.8	15	42.9	12	44.4
	SI	3	60.0	28	100.0	2	40.0	50	96.2	20	57.1	15	55.6

Table 2. Continued.

80	PL	1	14.3	0	0.0	1	9.1	5	12.5	6	18.8	5	33.3
	SI	6	85.7	30	100.0	10	90.9	35	87.5	26	81.2	10	66.7
90	PL	1	20.0	0	0.0	2	28.6	1	3.8	6	21.4	7	36.8
	SI	4	80.0	35	100.0	5	71.4	25	96.2	22	78.6	12	63.2
120	PL	2	28.6	0	0.0	3	42.9	2	8.3	2	11.8	14	70.0
	SI	5	71.4	18	100.0	4	57.1	22	91.7	15	88.2	6	30.0

* PL = *Paratrechina longicornis*, SI = *Solenopsis invicta*.

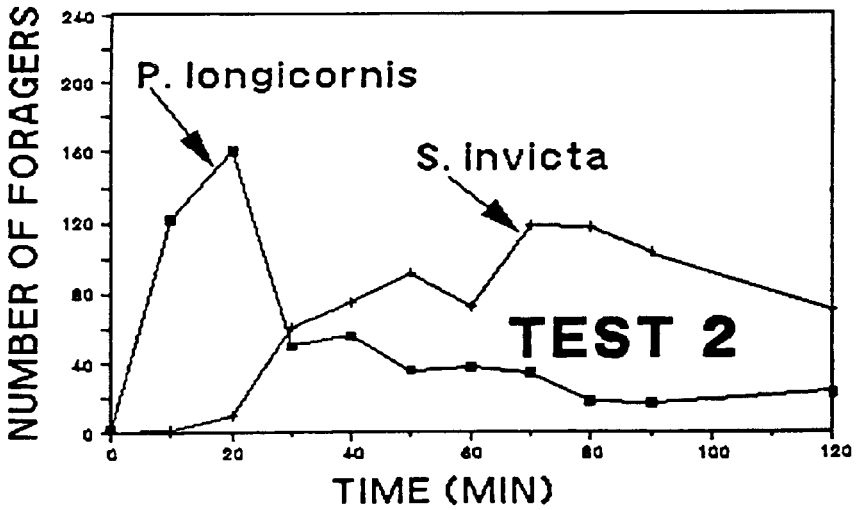
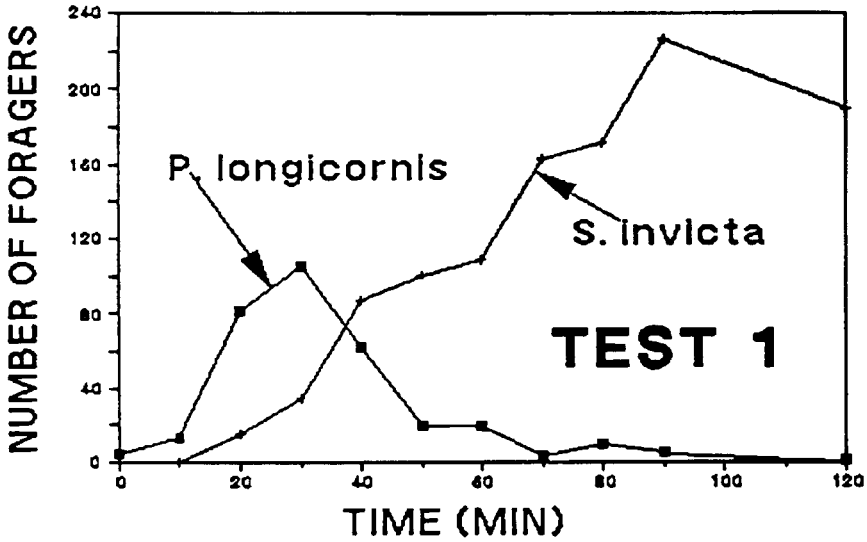


Fig. 2. Comparative total numbers of *Paratrechina longicornis* and *Solenopsis invicta* foragers at various time intervals in two foraging tests in Brazil.

2 h test period. Composition of ant populations on the baits in test 2 was 96.8% PL, 3.2% SI at 20 min, 15.8% PL, 84.2% SI at 40 min, and 31.7% PL, 68.3% SI at 60 min. Maximum level of SI on the baits in test 2 was 95.8% at 80 min. The aggressive actions of SI were effective in evicting PL and other ants not only from the baits but also to a great extent from the entire foraging arena. By contrast, in the three tests when SI was essentially absent from the arena, PL remained on the baits or in the immediate vicinity, constituting 99.9% of all ants visiting the baits during the entire test period.

Major workers of SI on the baits or walking along the established foraging trails were attacked by phorid flies (Williams and Banks 1987). Although such attacks created confusion among the foragers, they were not sufficient to seriously deter foraging nor to change the ability of SI to dominate the foraging arena and the baits.

Buren (1983) suggested that *Paratrechina* spp. can successfully compete for food by finding the food first and then excluding fire ants from it. Our data show that although *P. longicornis* did find the foods first, they were unable to remain on the food in the presence of fire ants; whether other species of *Paratrechina* could do so is unknown. Our observations suggest that even though *Paratrechina* or other species with similar behavior may be overcome in direct confrontation, they can successfully compete with the fire ants for available food resources. This is accomplished through their ability to forage when soil temperatures are unsuitable for the fire ants; discover foods more rapidly; and recruit large numbers of foragers who can remove significant amounts of food before it is discovered and dominated by the fire ants. These abilities could conceivably permit such species to utilize sufficient food to have significant impact on population levels of the fire ants.

Buren (1983) also listed a number of species of *Conomyrma* as potential competitors with the fire ants for food. Since *Conomyrma* spp. are both scavengers and predators, they could be expected to utilize many of the same food materials as the fire ants. Foraging strategies that avoid direct confrontation with *S. invicta* may permit *Conomyrma* to utilize significant amounts of such foods. Most colonies of *Conomyrma* are very small and data from baiting transects (Roe 1973; Glancey et al. 1976; Adams et al. 1981) indicate that although the species of *Conomyrma* common in the southeastern United States will feed on both meat and honey-agar baits, they do not recruit to such foods in sufficient numbers to remove significant quantities before encroachment by the fire ants. We have not observed any species that can exclude SI from baits. Neither of the *Conomyrma* spp. encountered in this study appeared to offer much food competition to SI. While other studies (Nickerson et al. 1975) have shown that certain *Conomyrma* spp. prey on newly-mated RIFA queens and have impact on SI populations via this mode, there is little evidence to suggest that they are serious food competitors.

Although this study did not address other areas of competition that may be of equal or greater importance than food in the interrelationships of fire ants and other ants, it does clearly demonstrate the decided superiority of SI in exploiting food in confrontational situations with PL. While there are many other ant species in the homeland of the fire ants, as well as in other parts of the world, that remain to be studied in this context, it is evident that none of those observed in this study offered much competition in direct encounter.

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