Food Exchange Between Mounds of the Red Imported Fire Ant[1,2]

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ABSTRACT

Field studies in Hillsborough County, Fla., in 1971–72 and in Grimes County, Tex., in 1973 showed that extensive exchange of food occurred between adjacent mounds of the red imported fire ant, *Solenopsis invicta* Buren. Slightly less exchange between mounds occurred at the Texas sites during winter, but the difference may have been caused by variation between sites and not by season.

The exchange of food between the members of colonies of social insects is well known. According to Wilson (1971), such exchanges between social wasps were described by Reamur as early as the mid 1700's. Since that time the phenomenon has been studied in detail by numerous scientists, and Wilson (1971) summarized much of what is known about food exchange among social insects. He indicated that food exchange is common among ants but varies considerably from 1 species to another. He further indicated that most species of myrmicine ants, including the fire ants, engage in frequent oral exchange (trophallaxis). Apparently such exchanges provide nourishment for the colony members and also have a highly important role in the social organization of the colony.

Several investigators showed that trophallaxis is common in the fire ants. Eisner and Wilson (1958) found that a single worker of *Solenopsis saevissima saevissima* (Smith)[6] laden with radioactive honey distributed the honey to 65% of the 72 workers within 3 days. Vinson (1968) found that oil, carbohydrate, and protein were distributed to all castes in the colony when the worker ants were allowed to feed on these materials. Stringer et al. (1964) found that workers of *Solenopsis invicta* Buren, fed on soybean oil containing mirex, transferred sufficient amounts of the toxic oil to individual ants to cause the mortality of the recipient.

Likewise, food exchange is known to occur between adjacent nests of some species of ants. Kannowski (1959) demonstrated that when honey labelled with ^{32}P was fed to *Lasius minutus* Emery in 1 mound, ants of the same species in adjacent nests became radioactive. Gosswald and Kloft (1963) and Markin (1968), working, respectively, with *Formica polyctena* Forster and *Iridomyrmex humilis* (Mayr), discovered that food exchange occurred between adjacent nests of these species.

Exchange of food between the ants of adjacent mounds of imported fire ants has not been reported, though some investigators have felt that it probably occurs. Others do not agree. For example, when Wilson et al. (1971) fed peanut butter containing mirex to ants in selected mounds of *S. invicta*, gas chromatographic analysis of ants from adjacent mounds showed essentially no mirex. Thus, these investigators concluded that each mound of this ant is a separate entity and that there is little or no communication or movement of ants between adjacent mounds.

Nevertheless, in late 1971 we found indications that some exchange of food and possibly an exchange of workers was occurring between mounds of the red imported fire ant in west central Florida. The areas had previously been cleared of fire ants with mirex bait and had become reinfested with heavy concentrations of mounds (2–3 times pretreatment numbers). We therefore conducted 4 tests in this area of Florida from November 1971 to January 1972 and a 5th test in an area of east Texas from January to March 1973 and again in August 1973. Also in the Texas study intermound activity in summer and winter was compared.

METHODS AND MATERIALS

Test 1.—Test 1 took place in November 1971 at each of 10 study sites in Hillsborough Co., Fla. The fire ant mounds at these sites were relatively concentrated (36–186 mounds/ha). Thus, at each site, 1 mound, generally the largest, could be selected as the core mound and marked with a wooden stake. Then a circular plot (radius of 22.86 m) was established at each site with the core mound as the center. All mounds within the plot were marked and numbered, and the location was indicated on a map.

Puffed cereal was impregnated with once-refined soybean oil containing Calco® red dye and placed in 20-dr vials prepared for ant entry by drilling 3 or 4 small holes (1 mm diam) in the bottom of each vial. On Nov. 16, 1 vial was buried 5–10 cm deep in the center of each core mound. Random collections of worker ants were made after 2 and 7 days at sites 1–5 and after 3 and 8 days at sites 6–10. Collections were taken from all mounds in each plot. The collections were taken into the laboratory where 100 randomly selected ants from each collection were crushed on a sheet of absorbent paper to determine whether dye was present in the gut. The presence of dye was detected by examining the paper over a bright light.

Test 2.—In December 1971, 5 new test sites were chosen in Hillsborough Co., and the mounds were staked and numbered as in Test 1. A portion of the ants and soil from the core mound at each site were

[1] Hymenoptera: Formicidae.

[2] Mention of a commercial or proprietary product does not constitute endorsement by the USDA. Received for publication Aug. 10, 1974.

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[6] The locations from which Wilson's specimens were collected make it likely that his *Solenopsis saevissima saevissima* were actually *S. invicta* Buren.

dug up, put in plastic pails, and brought into the laboratory, where the captured ants were allowed to feed for 10 days on soybean oil containing red dye. Then the ants were separated from the soil and returned to their original field mounds. Collections of ants were taken from all the mounds on these plots 2, 9, and 21 days after the ants were returned to the mound and examined for the presence of dye as in Test 1.

Test 3.—In January 1972, 2 of the original study sites (Nos. 5 and 7) included in Test 1 were used for further tests. These 2 sites had shown considerable distribution of the dye oil between adjacent mounds, but several mounds at each of the 2 sites did not receive any of the dyed oil. The 3rd test was therefore designed to determine whether the mounds in an area were interrelated in some way. The original core mound at each site was rebaited by the method used in Test 1 except that a plentiful supply of the dyed oil was made available to the ants by replenishing the core mound 3 times at 2-day intervals. Collections of ants for determination of the presence of dye were made at 3, 7, 21, and 28 days after the 3rd baiting. The dye determination was made as in the previous tests. Also, when 6 of the 23 mounds at site 5 and 5 of the 13 mounds at site 7 had no ants marked by the red dye after 28 days, 1 of these mounds was selected at each site and baited as before but with oil containing blue dye. Ants were collected from all mounds within these plots and examined for the presence of dye.

Test 4.—The 4th test was made immediately following Test 3 in an original study site, (No. 5—see Test 3), to determine whether ants from a given mound within a plot would be hostile to the ants from all other mounds within the plot, to only those from certain mounds, or to none of those from other mounds. Six mounds (3 that had received dyed oil in the Test 3 distribution and 3 that had not) were selected and a portion of the ants and soil from each mound was brought into the laboratory in plastic pails. Then the ants were separated from the soil by spreading it in a thin layer over the bottom of a 50× 115×10-cm plastic tray, the sides of which were dusted with talc to prevent escape of the ants. As the soil dried, the ants moved into a 20-cm diam plastic ant nest (see Wilson 1962) placed at 1 end of the tray.

Once the ants had become established in the plastic nests, confrontations of ants from the different mounds were arranged by connecting the separate nests with plastic tubing. The confrontations set up involved ants from 2 mounds that had both received dyed oil, ants from 2 mounds that had both received no dyed oil, ants from 2 mounds, 1 of which had received dyed oil and 1 of which had not. The behavior of the ants during these confrontations was observed for 30 min.

Test 5.—The 5th test was conducted in Grimes Co., Tex., during 1973 to determine (1) whether the same intermound relationship existed in *S. invicta* in east Texas as observed in Florida, and (2) whether the intermound food exchanges were the same in summer and winter.

Three study sites with large numbers of fire ant mounds (> 250 mounds/ha average) and in close proximity were selected in January 1973. Test procedures were essentially the same as those used in the 1st Florida test. Thus, two 5-dr vials containing puffed cereal impregnated with peanut oil containing Pylakhrome® red dye were buried 5–6 cm deep in each core mound. Collections of ants were made at 2, 6–8, 20, 44–49, and 74 days after introduction of the bait, and examinations were made for the presence of dye in the ants.

In July 1973, 3 additional study sites were selected in Grimes Co., and the test was repeated. Collections of ants for determination of the presence of dye was made from all plots at 7 and 21 days, at 14 days on plot 3, and at 28 days from plots 1 and 2.

RESULTS

Test 1.—In Test 1, distribution of dye from the core mound to adjacent mounds was noted at 8 of the 10 test sites (Table 1). The percentage of mounds receiving the dyed oil varied (11–90%) from 1 site to another. An average 12% of the 100 ants examined from mounds that had obtained some dyed oil had oil in the crop. Fig. 1 shows a typical pattern of distribution; often many mounds near the edge of the site had obtained dyed oil though others nearer the core mound had not. The rapidity of spread and the pattern of distribution noted in the 1st test seemed to indicate that the distribution was deliberate though there was a slight possibility that worker ants from the other mounds might be sneaking into the core mound and feeding on the food source.

Test 2.—In Test 2, we eliminated the possibility of thieving by introducing the dyed oil only in the crop of the ants. Then any distribution of the oil would take place by active transfer from 1 ant to another. Nevertheless, the dyed oil was distributed to all 5 sites and had appeared in from 35 to 61% of the mounds within 2 days after the dye-fed ants were returned to the core mounds (Table 2).

Table 1.—Observations on food exchange between mounds of imported fire ants after introduction of a dyed food substance in a designated mound. (10 study sites, Hillsborough County, Fla., November 1971)

Site no.	No. mounds in site	% of mounds (22.86 m radius) with ants containing dye after indicated days	
		2	7
1	31	70	55
2	20	55	90
3	23	17	13
4	18	5.5	11
5	23	35	40
6	26	35	12
7	13	31	15
8	20	15	34
9	6	0	0
10	12	0	0

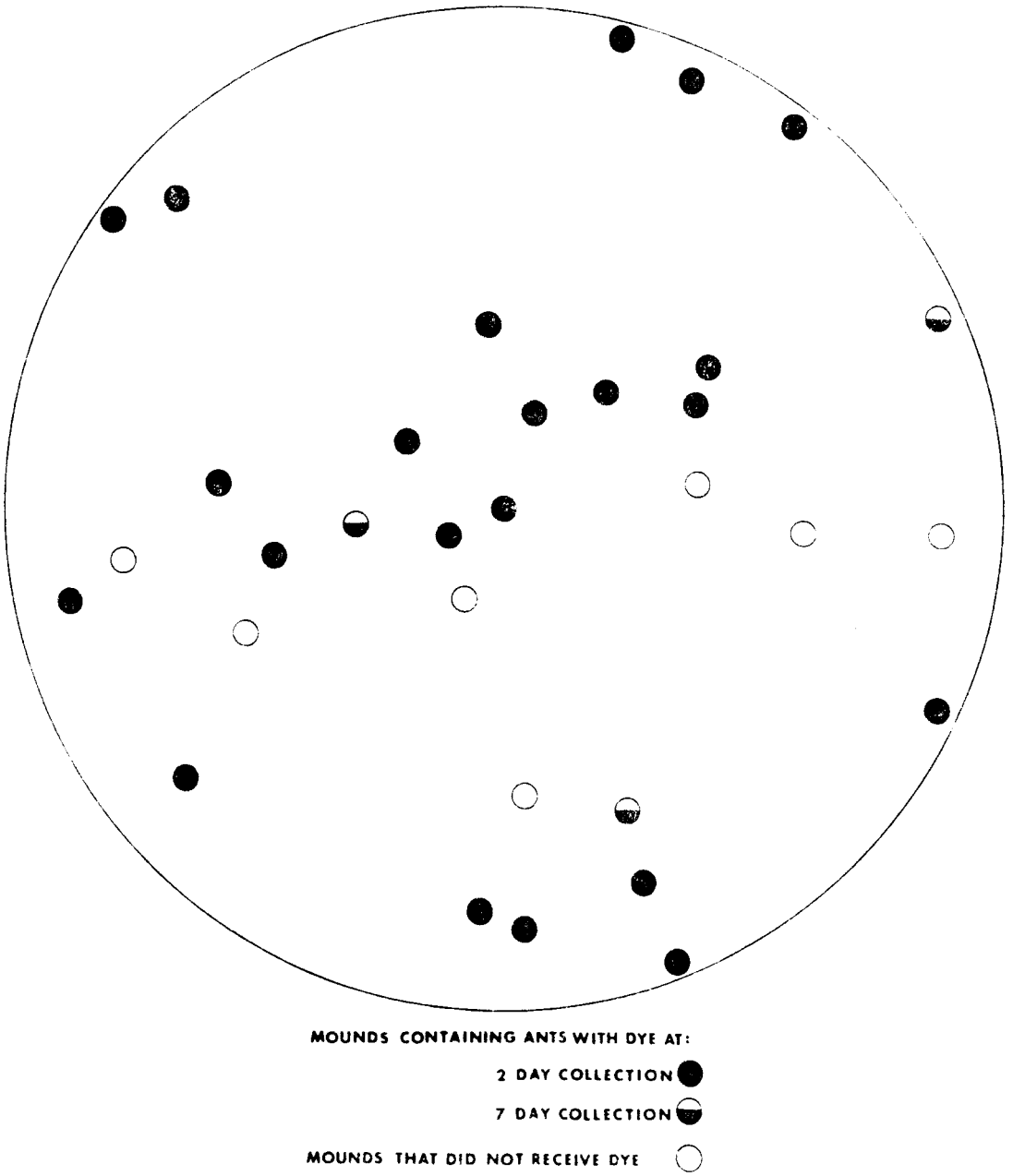

FIG. 1.—Intermound food exchange at study site 1—Test 1; Calco® red dye used as a tracer.

Test 3.—The results of the 3rd test were largely inconclusive. The pattern in the 2 previous tests seemed to indicate that food distribution was limited to certain mounds, perhaps those that were somehow interrelated. Test 3 further substantiated such a basis for the pattern because little distribution of the blue dye occurred at either site; it was found in only 1 mound other than the mound of introduction at each site. Thus, these blue-marked mounds were probably not related to any extent to other mounds within the site, though they may well have been related to other mounds outside the site. Only 1 mound showed evidence of both red- and blue-dyed oil.

Test 4.—If certain mounds were related, the ants from these mounds should mingle without hostility; ants from unrelated mounds should fight. We, as well as other investigators (Wilson et al. 1971), observed that workers from different mounds of *S. invicta* often fought fiercely when brought together. However, in Test 4, when confrontations were arranged in the laboratory, about the same degree of hostility was initially exhibited between ants from all

Table 2.—Observations on food exchange between mounds of imported fire ants after reintroduction of ants fed a dyed food substance. (5 study sites, Hillsborough County, Fla., December 1971)

Site no.	No. mounds in site	% of mounds (22.86 m radius) with ants containing dye after indicated days		
		2	9	21
1	36	56	42	53
2	47	61	43	40
3	51	51	53	75
4	40	43	40	55
5	26	35	54	50

mounds. After 30-min hostility disappeared, and 2-way traffic was usually established between the nests. In several cases, brood from both nests was brought together in a common pile and mutually tended by ants from both nests.

Test 5.—The Texas studies substantiated the findings of the Florida tests—food exchange did occur between many adjacent mounds in an area. The results also confirmed the existence of some kind of relationship between mounds that exchanged food. The extensive food exchange occurred between the mounds during both winter and summer, but it appeared to be greater during the summer since the average maximum of all ants that contained dye was 17.6% in the summer and 5.6% in the winter. Likewise, intermound exchange was slightly higher during the summer. However, in all tests in Florida and Texas, the percentage of mounds that received the dyed oil varied considerably at the various sites. Thus the variation in winter and summer in Texas may not be related to time of year.

The results of the studies in Florida and Texas indicate that the situation reported by Wilson et al. (1971) is not representative of the usual situation for adjacent colonies of the imported fire ant. Some mounds of this ant may well be an independent unit; many others seem to be related to numerous other mounds. The evidence strongly suggests that many colonies of the red imported fire ant are polydomous.

Table 3.—Observations on food exchange between mounds of imported fire ants after introduction of dyed food substance in a designated mound. (3 study sites, Grimes County, Tex., January–February 1973, winter)

Site no.	No. mounds in site	% of mounds (22.86 m radius) with ants containing dye after indicated days								
		2	6	7	8	20	44	48	49	74
1	71	23		39				30		
2	28		39			50			68	
3	38				68		70			60

Table 4.—Observations on food exchange between mounds of imported fire ants after introduction of a dyed food substance in a designated mound. (3 study sites, Grimes County, Tex., July–August 1973, summer)

Site no.	No. mounds in site	% of mounds (22.86 m radius) with ants containing dye after indicated days			
		7	14	21	28
1	26	83		91	91
2	28	60		54	60
3	34	87	80	66	

The nature of the interrelationship between ant mounds and the exact mode of food exchange is undetermined. However, when multiple queens cooperate and found colonies (Markin et al. 1972, Glancey et al. 1973), these queens may divide up to form new units but remain interrelated to the parent mound and possibly to each other.

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