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FOOD PREFERENCE IN COLONIES OF THE FIRE ANT *SOLENOPSIS INVICTA* (1)

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SUMMARY

When ten colonies of the fire ant, *Solenopsis invicta* Buren, were each offered three liquid foods (sugar, rat serum, oil), their preference as measured by recruitment showed seven significantly different patterns. Similarly, 16 different food preference patterns emerged when 31 standardized laboratory colonies were tested with three foods. Serum caused almost as much recruitment as oil in field colonies, while sucrose was more frequently preferred in laboratory nests, indicating fire ants are more than simply " grease-loving " ants. For equal recruitment, oil is returned to the colony at a much lower rate than aqueous foods. Overnight *ad libidum* oil feeding greatly modified colony preference the next day.

ZUSAMMENFASSUNG

Nahrungspräferenz bei der Kolonien der Feuerameise Solenopsis invicta

Zehn Kolonien der Importierten Feuerameise, *Solenopsis invicta* Buren, wurden drei verschiedene Typen von Flüssigfutter (1 molare Zucker = lösung, Serum von Ratten, ungereinigtes Sojabohnen-öl) angeboten. Dabei ergaben sich für die Nahrungspräferenz (gemessen in der Zahl der angeworbenen Arbeiterinnen) sieben stark voneinander verschiedene Vorzugsmuster. Beim Austesten von 31 standardisierten Laborkolonien mit diesen 3 Typen von Flüssigfutter ergaben sich sogar 16 unterschiedliche Vorzugsmuster. In Feldversuchen führte Serum annähernd zu gleichen Rekrutierungszahlen wie öl, während bei den Laborkolonien Zuckerlösung am stärksten bevorzugt wurde. Man kann also Feuerameisen nicht mehr vereinfachend als « fettliebende » Ameisen bezeichnen. Bei gleichstarker Rekrutierung wird sehr viel weniger öl in die Kolonie eingetragen als von den wässrigen Futterlösungen. Wurde über Nacht öl *ad libidum* angeboten, so änderte dies sehr stark die Futterpräferenz der betreffenden Kolonie am darauffolgenden Tage.

(1) This is publication N° 3 of the Fire Ant Research Team

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INTRODUCTION

The fire ant, *Solenopsis invicta* Buren, has stimulated a number of studies on its food preference (HAYS and HAYS, 1959; LOFGREN *et al.*, 1961; LOFGREN *et al.*, 1964; VINSON *et al.*, 1967; RICKS and VINSON, 1970), but due to the applied nature of these studies, certain biological aspects may have been overlooked. In related investigations, we noticed great variability of food preference among colonies, and therefore set out to test for such individual preferences in both natural field colonies and laboratory colonies.

MATERIALS AND METHODS

HANGARTNER (1969) showed that the rate of application of pheromone to a recruitment trail, and therefore worker recruitment, increases with sucrose concentration and is a reflection of food quality. We thus reasoned that the rate at which foraging ants accumulate (recruitment rate) at different liquid foods will indicate a colony's preference for each of the foods. For field tests, 1M sucrose, rat serum, and unrefined soy oil were chosen to roughly represent carbohydrate, protein, and lipid foods, respectively. The foods were presented in depression slides covered with a circular 15 mm cover slip so that the liquid was available only under the perimeter of the cover slip. In this way, the effect of food area, shown by WILSON (1962) to be important to recruitment level, was kept constant for all foods. Food was replenished as necessary during tests by placing a small droplet at the edge of the cover slip without disturbing the ants.

The slides were presented one at a time on index cards 6 in. apart and 6 to 8 in. from the mound. The order of presentation - sugar first, then serum, then oil, was repeated without interruption three times for each colony (thus, there were a total of 9 tests per colony). Observations were begun after foragers had discovered the food and subsequent workers began arriving. The number of ants at the slide was monitored during each one-minute interval for the next fifteen minutes. This was done by direct counts, or when numbers at the bait were large, by calculating the net change in arriving and departing workers. Ants recruited in individual replicates usually emanated from foraging exits 12 to 20 in. apart, and the replicates are therefore likely to be reasonably independent.

Since the time-recruitment curves appeared approximately linear and seldom reached a plateau during the observation period, we calculated a regression slope for the recruitment to each replicate food. These slopes, grouped within each nest according to food-type, were then subjected to single factor analysis of variance, and for those which differed significantly from random ($p < .05$), the Student-Newman-Keuls test was used for multiple comparisons.

Field tests were carried out on 10 colonies between April and May, 1976, during the mornings or late afternoons, in a sandy trailer park near Tallahassee, Florida. Temperatures ranged from 75 to 85° F. Test mounds were located along the edges of vacant concrete trailer pads and were large and elongated (nest sizes were similar, with dimensions of about 1 by 0.5 m by 0.3 m high).

In a preliminary attempt to test the effect of *ad libidum* feeding on subsequent food preference, we first tested the preference of three field colonies and then offered them an abundant supply of absorbent paper saturated with soy oil. After 24 hrs. the papers were removed and food preference tested once again.

In laboratory tests, 31 mature fire ant colonies were each selectively thinned to

10,000 workers, 1,500 larvae and a physogastric queen. These colonies were established in artificial nests and received an abundant diet of sugar water and minced mealworms for at least one week. Following a 24 hr starvation period, each colony was given three foods (soy oil, 0.1 M sucrose, and 1 : 10 casein hydrolysate) and tested for food preference by a method similar to that used in field tests. These tests were conducted between December, 1976 and February, 1977.

Further laboratory work was carried out to determine the rate of feeding and subsequent volume of liquid foods taken by individual foraging ants. Foragers were offered each of the foods mentioned above labeled with a known amount of radioactive iodine-125. Volume ingested was ascertained by measuring the radioactivity of individual ants in a gamma counter. By noting the length of time each ant fed, it was also possible to calculate the feeding rate. A complete account of this work will be published elsewhere.

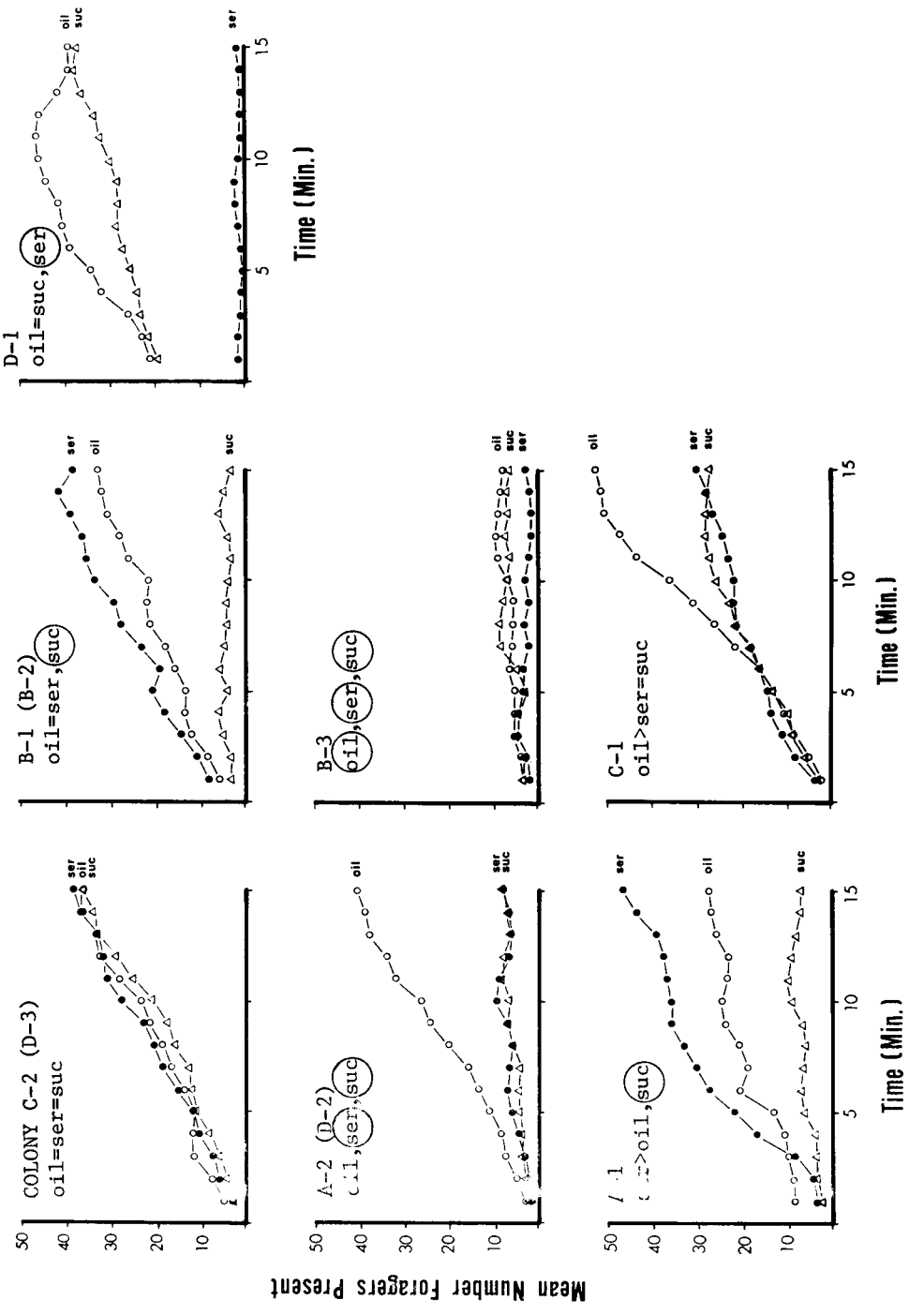
RESULTS AND DISCUSSION

The most striking feature of the food preference of the ten field-tested colonies is the heterogeneity of the preference patterns. In fact, there are seven different preference hierarchies among the ten colonies (fig. 1). Variability among a given colony's replicates was low and all the intra-colony recruitment differences we discuss hereafter are significant ($p < .05$) according to statistical analysis.

Among the ten colonies, three preferred oil over all others, one preferred serum, while five preferred oil and serum equally, including one which recruited to neither. A total of six of the ten colonies recruited to both oil and serum. Sucrose was never the sole preferred food though it is equal to oil and/or serum in seven of the ten colonies, including three which did not recruit. An average of the recruitment slopes over all ten colonies showed the mean preference to be oil, serum, sucrose, in decreasing order.

It is clear from our work that colonies are quite idiosyncratic in food preference. Had we simply averaged the results for several colonies, an inadequate picture of food preference would have emerged. Fire ants are reported to be "grease-loving" ants (for example, see HORTON *et al.*, 1975; GREEN, 1967), but in only three out of ten field colonies was soybean oil actually preferred over all other foods. Serum caused heavy recruitment in 6 out of our 10 colonies and is equal to oil in 5 out of 10. Characterization of fire-ants as "grease-loving" can thus be seen as reflective of the control-oriented literature and not a biological realities. Indeed, early work (HAYS and HAYS, 1959) characterized fire ants as primarily insectivorous.

Heterogeneous food preferences were also characteristic of laboratory colonies, even though these colonies were similar in caste composition and short-term feeding history. Of 31 tested colonies, 16 significantly different preferences were noted. However, unlike the field tests, the overall order of food preference (declining) was sucrose, oil, and casein hydrolysate. In further contrast to field results sucrose was the sole food to elicit recruitment


COLONY C-2 (D-3)
oil=ser=suc
A-2 (D-2)
oil,ser,suc
A-1
ser->oil,suc
B-1 (B-2)
oil=ser,suc
B-3
oil,ser,suc
C-1
oil>ser=suc
D-1
oil=suc,ser
Mean Number Foragers Present
Time (Min.)
ser
oil
suc

in 5 of 31 colonies, and when oil was preferred, it was always taken in combination with one or both of the other foods.

In our laboratory experiments using radio-iodine labelled foods, we have found that forager feeding rate is about 7 to 10 times a high for aqueous solutions (sucrose, casein hydrolysate) as it is for oil. The time spent imbibing oil is only somewhat longer so that the ingested volume is about 2 to 13 times as great for aqueous solutions as for oil. The field experiments must be seen in this light. Although ants seemed to spend more time (up to 50 %) at oil baits in the field, it is likely that they are returning with much lee oil than either aqueous solution.

If the conclusions on food preference are now tempered in this new light, it is clear that for similar "preference" in the field, serum or sugar is probably returned to the nest at a much higher rate than oil, and this may be true even when oil seems to be "preferred" as measured by number of ants at the bait. The outcome obviously pivots on how preference is defined - relative number of individuals taking each bait, regardless of amount taken, or perhaps the total volume taken.

Each colony was tested only once, so we do not know the stability of the preference in time. It seems likely that preference does change with time, and this change itself could give rise to some of the observed heterogeneity. Other possible factors might be long-term feeding history, presence and stage of brood, colony age, colony caste composition and environmental factors such as weather. While we have little experimental evidence, we can offer two observations : 1) High rates of sucrose foraging (colonies C-1, C-2, D-3, fig. 1) occurred only the day after a heavy rain when a great deal of mound-rebuilding was going on. Perhaps the increased work output of the adult ants causes them to forage more for this primarily adult food. 2) When colonies of tested preference were fed oil *ad libidum* overnight, their preferences the next day were radically different and this extended to other foods

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Fig. 1. — Mean recruitment patterns (3 replicates) for the ten experimental colonies, showing the mean number of workers present as a function of time. All depicted patterns are significantly different. Colonies that showed similar patterns are indicated in brackets. The relative rank of feeding preference for the three foods is indicated under each colony number. A circle around a food indicates no recruitment to that food. All ranks were established by analysis of variance and the Student-Newman-Keuls test.

Abb. 1. — Durchschnittliche Zahl der Arbeiterinnen am Futter (Rekrutierung in 10 Kolonien, mit jeweils drei Wiederholungen), aufgetragen in Abhängigkeit von der Zeit in min. Alle dargestellten Vorzugsmuster sind statistisch signifikant voneinander verschieden. Kolonien mit ähnlichen Vorzugsmustern sind in der betreffenden Graphik jeweils in Klammern hinter der Koloniebezeichnung aufgeführt. Unter den Kolonienummern erscheint der relative Vorzugsrang für die drei Futtertypen. Ein Kreis um die Bzeichnung eines Futters bedeutet, daß dafür keinerlei Anwerbung vorlag. Alle Rangwerte wurden durch Varianzanalyse und den Test nach Student-Newman-Keul bestimmt.

as well as oil. In many cases, feeding on one to all foods was suppressed. Though these findings are preliminary, it is clear that ready availability of one food can have marked effects on food preferences and recruitment. What each colony is foraging at the time of testing may modify its preference.

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