Competition for Insects Between *Formica rufa obscuripes* and *Pogonomyrmex occidentalis*

A Thesis Submitted to
The University of Colorado Honors Committee

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March 1985

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Abstract: This study investigates the possibility of competition between two sympatrically occuring species: Formica rufa obscuripes and Pogonomyrmex occidentalis. Both rely heavily on insect prey as a food source. Colonies of both species less than 7 m apart are more likely to be competing than colonies farther than 11 m from each other. Colonies 11 m apart were designated as non-competitive, while colonies 7 m apart were designated competitive. Forage material was collected from both types of colonies, dried and weighed to determine if there were significant differences between competitive and non-competitive colonies. There were significant differences in amounts of insects collected by the two types of colonies. Significant differences also occured among amounts of seeds collected by P. occidentalis colonies of both types. These data suggest that F. rufa and P. occidentalis compete for insect prey.

Introduction: Formica rufa obscuripes is a type of "thatching" ant found in both the United States and Canada (Gregg, 1963). The term thatching refers to the large dome-shaped nests which it constructs from twigs. Weber (1935) found that the average height of a F. rufa nest is 20 cm., and the average diameter is 43 cm. In one typical colony, he found the population to be about 19,000 ants.

F. rufa has relatively flexible feeding habits. According to Weber (1935), these colonies subsist largely on insect prey. Aphid honeydew is the next important food source, but he also states that "In some cases these secretions are the primary source of food" (p. 197). Finnegan (1977) noted that F. rufa changes its primary food source from insects to aphids or vice-versa, depending on the availability of insects.

Their predatory habits and breadth of acceptable food have caused foresters to look to ants in the F. rufa group as a possible insect pest controller (Finnegan 1977). Finnegan states: "The ability of the rufa group to change from aphid honeydew to living prey (when present in abundance) as a food source, is paramount in its potential effectiveness as a limiting agent of certain insect pests. By being present in the forest in large numbers at all times, the ants are capable of vigorously attacking pest species at a most critical time...." (p. 1145). Any information collected on food and competition in the F. rufa group could be valuable to this sort of application.

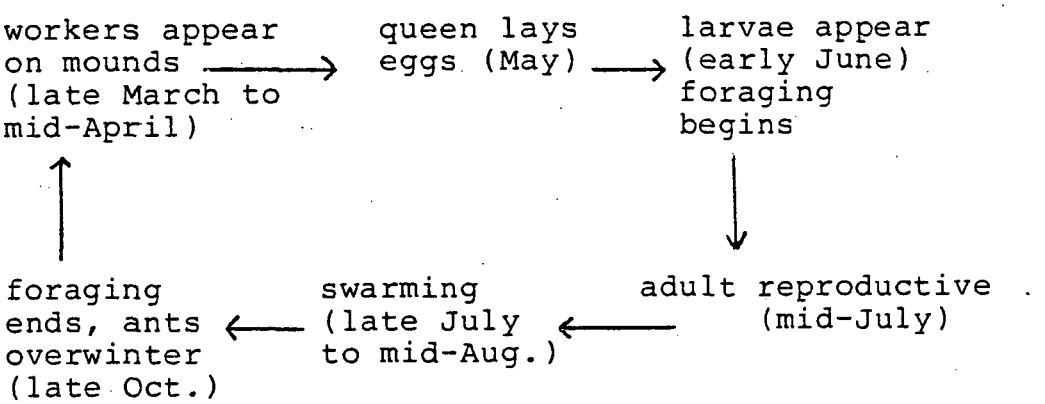
Pogonomyrmex occidentalis, the western harvester ant, is

often found in the same habitats as F. rufa. Its gravel mounds are a conspicuous characteristic of the western plains (Gregg 1963). This is probably one reason why this species has been so well studied, starting with McCook's work in 1882.

Lavigne (1969) excavated twenty P. occidentalis colonies in Wyoming and found that their nest heights varied from 1 to 10.5 inches, their nest diameters from 10 to 44 inches and their worker populations from 254 to 7506 ants.

Below is a chart showing the life cycle of P. occidentalis which begins in late March when the workers appear on the mounds.

Life-Cycle of P. occidentalis



As can be seen from the above chart, the ants forage from June to late October. During this time, P. occidentalis workers gather a variety of seeds, insects, and nest material. At one site, Cole (1932) found that P. occidentalis gathered seeds from 29 plant species. Seeds are P. occidentalis' primary food source, and insects are their secondary food source.

Both P. occidentalis and F. rufa forage for insects opportunistically. Finnegan (1977), Bradley (1972), and Weber (1935) found that F. rufa preys heavily on insects. Rogers (1972) found that at a site in Wyoming, insects made up 10% of the material collected by a P. occidentalis colony (seeds made up 39% and non-food items made up the rest). Holldobler and Wilson (1970) mention that Pogonomyrmex workers collect insects.

The reliance of both species on insect prey as a food source suggests that competition for food could occur when they are found in close proximity. This hypothesis is interesting in regard to current controversy on competition. The prevalence of competition as a structuring force in biological communities has been questioned (Simberloff and Connor 1981; Connor and Simberloff 1979; Strong et al. 1984). It is possible that competition is less important in shaping community structure than previously thought. On the other hand, co-existing species of Pogonomyrmex partition seeds according to seed size (Davidson 1977; Hansen 1978). This, according to Schoener (1974), is an indication of competition.

In this paper, I report the identity and amounts of forage material collected by both P. occidentalis and F. rufa and determine whether their proximity to each other affects what they collect. This should give an indication of whether competition for insects is occuring between the two species.

Methods and Materials: Two study sites were chosen in Boulder County: Sawhill Ponds and Whiterocks. Sawhill ponds

is a recreational area located 7 miles east of Boulder, Colorado. It was at one time mined for gravel, and has since been restored. The vegetation in the study area consists mostly of grasses, thistles, and some cottonwoods. Whiterocks is also 7 miles east of Boulder. The study site is a cattle pasture bordered by thistles.

Colonies defined as under competitive conditions were closer than 7 m apart (from center to center). I concluded from personal observation that the majority of foraging for both species occurs within 7 m. Control colonies under non-competitive conditions were more than 11 m apart. Two pairs of competitive colonies and two non-competitive colonies of each species were located at each site.

The distances were chosen based on circumstance, it was hard to find enough of both colonies isolated by more than 11 m, and it was also difficult to find colonies closer than 7 m, though some were found in both cases. The number of sites and colonies chosen were limited due to time. There was only one summer to collect data.

Foraged material was collected from each colony by placing a small vial over returning foragers, as described by Rogers (1972), and then lightly chilling the ants. This causes the ants to drop their forage and does not seem to harm them. For the P. occidentalis colonies, 200 pieces of material were collected per colony. For F. rufa, because their major food source was nectar, 700 ants returning to the nest were counted, and any material they returned with was taken.

Data from colonies to be compared were collected within two weeks of each other, and all collected insects were identified to order. The data consisted of number, order, and weight of insects collected by F. rufa colonies within 7 m of P. occidentalis colonies, insects collected by F. rufa colonies at least 11 m from P. occcidentalis colonies, insects and seeds collected by P. occidentalis colonies at least 11 m from F. rufa colonies, and insects and seeds collected by P. occidentalis within 7 m of F. rufa colonies. Data collected each day were treated separately. These data were used to determine mean foraging yields, which then were tested statistically to compare competitive to non-competitive colonies.

The Mann-Whitney U test was used on data dealing with insect and seed weights. Weights from competitive and non-competitive colonies were compared within species. Spearman's rho test was used to determine if there was a correlation between the distances the colonies were from each other and the amount of insects and seeds they collected.

Results: The weights of insects collected by both types of colonies (competitive and non-competitive) were compared for both species. At Sawhill Ponds, the within species comparison of weights of insects collected was not significantly different for P. occidentalis, but was significant for F. rufa (Mann-Whitney $U=22$, $p=0.025$). At Whiterocks, the within species comparison of insect prey weight was not significantly different for F. rufa, but was

significant for P. occidentalis (Mann-Whitney U=144, p=<0.05).

Distance of F. rufa colonies from P. occidentalis colonies, and weights of insects collected by F. rufa was shown to be correlated (Spearman's r_s =0.7595, p=0.05). However, there was no correlation between distance of P. occidentalis colonies from F. rufa colonies and weights of insects or seeds collected by P. occidentalis (Spearman's r_s =0.29 for seeds, 0.207 for insects).

There were differences found in the orders of insects collected by both species. F. rufa collected 49.5% more Hymenopterans than P. occidentalis, and P occidentalis collected 68.4% more Coleopterans, and 96.2% more Dipterans than F. rufa. P. occidentalis and F. rufa overlapped in orders of insects collected: Hymenopterans, Coleopterans, and Dipterans were collected by both. Other orders did not differ as greatly.

Both species collected nest material more than any other type of forage. P. occidentalis collected 15.48% seeds and insects, while F. rufa collected 9.87% insects. The remainder of foraging trips by P. occidentalis resulted in pebbles and miscellaneous non-food items carried back to the nest. F. rufa brought 90.13% by weight twigs and miscellaneous non-food items back to the colony.

Discussion: The data suggest that P. occidentalis and F. rufa compete for insects. A significant difference in amounts of insects collected by competitive and non-competitive colonies was seen in some, but not all sites. Colonies of P. occidentalis

within 7 m of colonies of F. rufa collected proportionately more seeds than colonies which were more than 11 m away from F. rufa colonies. This indicates that P. occidentalis colonies tended to rely more heavily on seeds as a food resource when located near F. rufa colonies than they did would when located farther from F. rufa colonies. This suggests that competition is occuring for insects, forcing P. occidentalis to collect more seeds. Conversely, Where significant differences in weights of insects foraged occured, colonies of F. rufa which were within 7 m of P. occidentalis colonies collected proportionately fewer insects than those which were farther than 11 m from P. occidentalis colonies. The correlation analysis was significant for F. rufa, but not for P. occidentalis. Had the sample size been larger, a significant correlation might have been obtained for P. occidentalis. There seems to be partitioning of insect prey resources between the two species. F. rufa collected 49.5% more individuals of Hymenoptera than P. occidentalis, while P. occidentalis collected 68.4% more Coleopterans and 96.2% more Dipterans. Both ant species were exposed to the same environmental conditions, and I assume that both species had equal access to prey insects. According to Schoener (1974), resource partitioning is a sign of competition.

The evidence for competition between the two species are the significant differences in amounts of seeds collected by competitive and non-competitive colonies of P. occidentalis, the significant differences in amounts of insects collected by P. occidentalis at Sawhill Ponds and by F. rufa at Whiterocks, the possible partitioning of resources indicated in Table 4, and the

correlation between weights of insects collected by F. rufa and distance from P. occidentalis colonies.

There are a number of other types of studies which could be performed on these two species, such as mapping of colonies, analysis of variation in competition intensity, and interspecific aggression studies. A mapping study could be done to determine if colonies of the two species are distributed randomly in relation to each other. If they are distributed uniformly, this would indicate that competition may be occuring. Bernstein and Gobbel (1979) did this sort of study with ten species of ants, including P. occidentalis, in the Mojave and Great Basin deserts, and found "little evidence of non-random dispersion patterns" (p.931). It would be interesting to see if the same results apply in this case.

It would be interesting to study situations in which the intensity of postulated competition varied. For example, if competition occurs at all, a F. rufa colony surrounded by P. occidentalis colonies would be exposed to more competition than a F. rufa colony near just one P. occidentalis colony (if there is competition occuring at all).

Another aspect to consider is aggression. If the two species are competing, then it is likely that they will be aggressive toward each other. In the process of this study, I collected some preliminary data which indicates that aggression occurs. Members of F. rufa colonies attacked P. occidentalis individuals placed on their nest 49 out of 50 times. P. occidentalis colonies only attacked F. rufa individuals 6 out of

50 times.

More study could be done on this aspect of *P. occidentalis* and *F. rufa* interaction. Questions which could be asked are:

Does it make any difference whether an individual is placed on the colony or on a foraging trail of the other species?

What happens when foraging trails from both species overlap?--I did observe this occuring, and *F. rufa* individuals tended to attack but not overcome *P. occidentalis* individuals (when the aggressive encounters occured on the nest itself, the *P. occidentalis* individuals tended to be dismembered).

What would happen if a large pile of insect bodies was placed within foraging range of two colonies of each species; would an ant "war" occur?

To discover if competition is occuring in this system, more study needs to be done. Larger sample sizes should be used, especially for the correlation analysis. More work should be done regarding types of insects collected, to determine whether partitioning of this resource is occuring. Aggression studies could be performed to determine if the two species are aggressive toward each other and why. Mapping, and investigations of more intensely competitive sites could be conducted. These types of studies would test and perhaps provide further support for my results, which indicate that competition may be occuring in this system.

Table 1. Comparison of amounts of insects collected by competitive and non-competitive colonies

Site	Species	Competitive $\bar{x}\pm SE$ (gm)	Non-competitive $\bar{x}\pm SE$ (gm)	U	p
Sawhills	*P. occidentalis*	0.0201±0.00040	0.0438±0.00192	141	ns
Whiterocks	*P. occidentalis*	0.0530±0.00872	0.0190±0.00073	144	<0.05
Sawhills	*F. rufa*	0.0020±0.00000	0.0297±0.00168	22	0.025
Whiterocks	*F. rufa*	0.0301±0.00042	0.0216±0.00017	27	ns

Table 2. Comparison of amounts of seeds collected by competitive and non-competitive colonies of *P. occidentalis*

Site	Competitive $\bar{x}\pm SE$ (gm)	Non-competitive $\bar{x}\pm SE$ (gm)	U	p
Sawhills	0.0750±0.00262	0.1243±0.00214	173	0.001
Whiterocks	0.0313±0.00010	0.0561±0.00034	166	0.01

Table 3. Correlations between insects collected and distance from the nearest colony of the opposite species

Species	Food Type	Spearman's Coefficient (r_s)	p
F. rufa	insects	0.7595	0.05
P. occidentalis	insects	0.207	ns
P. occidentalis	seeds	0.29	ns

Table 4. Insect orders collected

	A. Number of Insects Collected by *P. occidentalis*	B. Number of Insects Collected by *F. rufa*	A–B
Araneae	1	8	- 7
Coleoptera	16	3	13
Dermaptera	1	2	- 1
Diptera	27	1	26
Hemiptera	15	8	7
Hymenoptera	23	68	-45
Isopoda	0	2	- 2
Isoptera	4	0	4
Lepidoptera	4	2	2
Orthoptera	7	4	3
Tricoptera	0	1	- 1

Table 5. Percentages of forage material collected

Species	Seeds	Insects	Nest Material
P. occidentalis	10.25%	5.23%	84.52%
F. rufa	———	9.87%	90.13%

Figure 1. F. rufa nest, the squares in the background are 2 cm.

Figure 2. P. occidentalis nest, the squares in the background are 2 cm.

Figure 3. P. occidentalis worker carrying a stone for nest construction

Figure 4. *P. occidentalis* worker picking up a stone

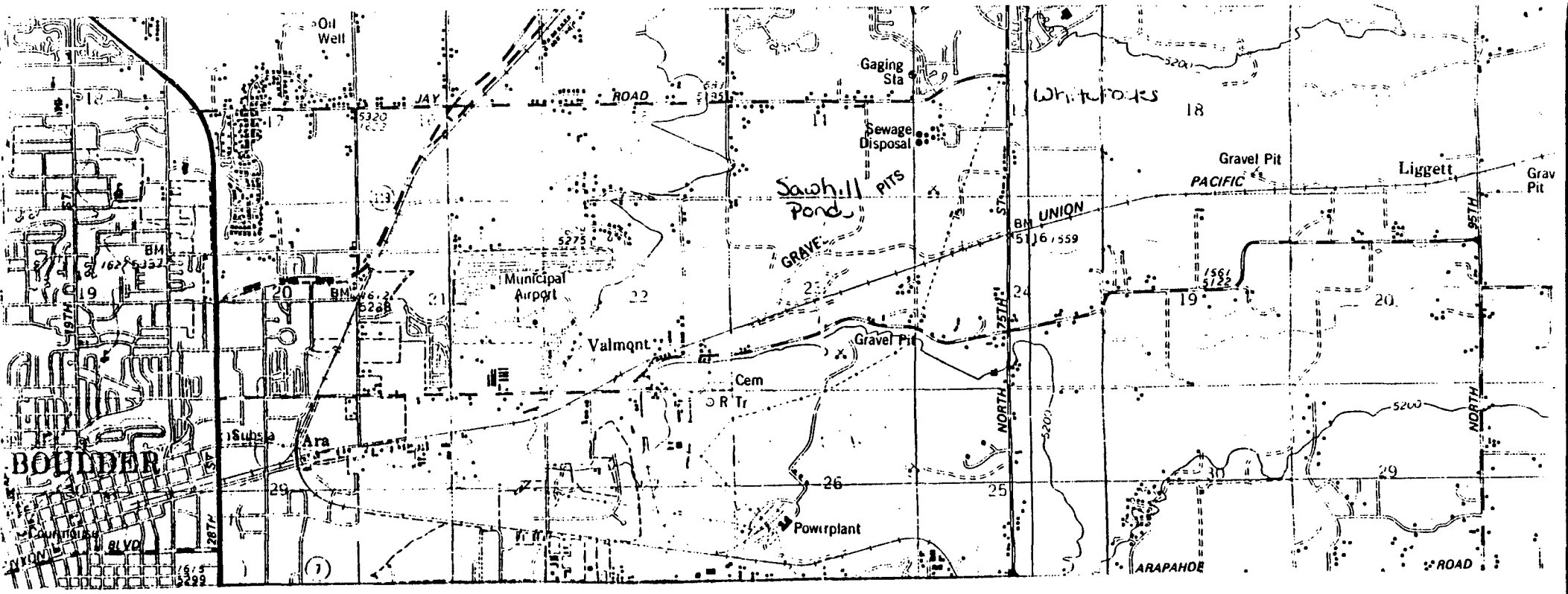


Figure 5. Map of study areas

Acknowledgements: I would like to thank Dr. Michael Breed for all of his assistance with this project. I would also like to thank Dr. Ruth Bernstein for suggesting the study. Finally, I would like to thank Jennifer Fewell for helping me get started, Tammy Stiller for identifying insects and teaching me how to use a word processor, Allen Moore for helping me survive the word processor, and Beth Bennett and Marco Rodriguez for proof-reading.

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