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THE IMPACT OF SEED CONSUMERS IN A DESERT ECOSYSTEM

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ABSTRACT

The importance of ants and rodents as desert seed predators was studied on the Jornada Validation Site near Las Cruces, New Mexico, from 1974 to the present. Studies were conducted in eight 20 x 20 m enclosures: two with ants and rodents, two with ants only, two with rodents only and two excluding both ants and rodents. The exclusion of both ants and rodents resulted in a marked increase in density of ephemeral vegetation. The inclusion of either ants or rodents caused no significant difference in the density of these plants. Rodent exclusion appeared to influence density of ants, as ant density was greatest in enclosures where only ants were present. The most abundant ant species in the enclosures were *Pheidole* spp. Relative abundance of these ants increased from May, peaking in mid-July and throughout August and September. This increase in abundance, as well as an increase in activity, was directly correlated to precipitation events in July through September. Activity of these seed consumers, both diurnal and nocturnal, corresponded to periods of moderate temperature (22-27 C) and high relative humidity (greater than 50%). Forage by these species was 74% grasses, 24% forbs and 2% inedible matter.

INTRODUCTION

Brown et al. (1975) demonstrated that both rodents and ants are important seed predators in a variety of desert habitats. In the Chihuahuan Desert it was concluded that only a small fraction of the total seed crop was removed by seed consumers (Whitford et al. 1973; Whitford and Kay 1974). J. A. Brown, O. J. Reichman and D. W. Davidson, in experiments in the Sonoran Desert, found that excluding rodents and/or ants resulted in marked increases in soil seed reserves. We had hypothesized that the major effect of rodent and/or ant exclusion would be a shift in composition of vegetation and not a quantitative response. Our studies were designed to test the hypothesis that differing regimes of seed predation sufficiently alter plant dispersion patterns which should be measurable. A second hypothesis to be tested is that altered vegetation composition should result in differences in key animal species.

OBJECTIVES

1. To determine the impact of seed consumers (harvester ants and rodents) and their interactions as consumers on the structure of a Chihuahuan Desert plant community, with emphasis on dispersion patterns of annual forbs and grasses.
2. To examine the effects of rodent exclusion on harvester ant density.
3. To examine the ability of rodents to locate subterranean seed caches.
4. To estimate the influence of *Pheidole* spp. as seed consumers.

Since we had observed that many seeds (particularly late in the summer growing season when heavy rains are common) are buried by soil and debris soon after falling from plants, we hypothesized that these seeds may escape predation by ants and rodents. Since we have not observed digging by foraging harvester ants, we tested the ability of heteromyid rodents to locate seed caches at varying depths.

METHODS

IMPACT OF SEED CONSUMERS

Experimental Enclosures

The methods and enclosures used are described in Whitford (1975). In April and May 1975, Pens I, II, VII and VIII were treated with chlordane. Commercial chlordane was diluted to a 1% solution and applied to all identifiable ant mounds at a rate of 2-3 quarts/mound, which resulted in coverage of nearly 50% of the 400-m² area of each pen. Two *Dipodomys merriami* and two *Perognathus penicillatus* were introduced into Pens III, IV, VII and VIII. Pens I, III, V and VII received supplemental watering every other week during June and July. Each pen received 500 gallons per treatment. Application was by a hand-held spray applicator.

Rodent Seed Caches

The land within a 20 x 20 m rodent-proof fence was cleared of all plant material except for two large yuccas (*Yucca elata*). First the land was rototilled, then raked twice to remove debris. All plants missed by the Rototiller were removed by hand and the land was raked smooth. The plot was weeded periodically to remove new plant growth.

Four *Dipodomys merriami* were trapped from hills between the enclosures and Mt. Summerford, and from the outskirts of the bajada. Sherman live-traps were set on the plot every week to make sure the animals remained in the plot. Whenever there was an escape, new animals were used to replace those that escaped in order to keep the number of animals (four) in the plot constant.

Twenty wire baskets (1 x 1 x 2 inch) were filled with 26 ± 2 g of cracked milo (dyed red with vegetable dye), weighed and then buried in the ground at four depths ranging from 2.5 to 10 cm. These baskets were randomly spaced within the plot and circles drawn on the surface to mark them. This was done between 1500 and 1800 hr MDT.

In the morning (0600 to 0800 hr) the milo caches were excavated, the excess dirt carefully brushed off or blown away and the basket reweighed. Prior to excavating the caches each morning, all of the circles were examined to see if there were signs of rodent activity (specifically, digging) around the buried caches.

Pheidole FORAGING ECOLOGY

Harvester ants of the genus *Pheidole* are the most abundant seed harvesters in the area of the enclosures. We had little information on the ecology of these species except for that in Schumacher and Whitford (1976). To complement studies of seed consumers in the enclosures, we initiated studies on activity, forage preference and foraging rates in *Pheidole* spp.

Grass and forb cover were obtained by the nearest-neighbor modification of the point-quarter method (Greig-Smith 1964). Distance measurements from a random point to a species provide a density estimate and the distance from a plant to the nearest neighbor of the same species provides a measurement used in analyzing dispersion, i.e., PD^2/ND^2, where PD^2 is the square of the mean distance from the point to colonies of a species and ND^2 is the square of the mean distance from the colony to the nearest neighbor of a species. If PD^2/ND^2 is 1, clumped distribution is indicated, while 0 indicates even distribution.

Colony densities and relative seasonal abundance (estimated by the number of colonies active at a given time of the year) were estimated by the point-quarter method (Greig-Smith 1964), by square meter quadrats and a modification of the line intercept method (Phillips 1959).

The line intercept method was used only for estimating nocturnal relative abundance. A modified belt transect was initiated August 1. Four belts were established on each site. Each belt was 100 m long and 4 m wide and all *Pheidole* colonies in the belt were recorded. On August 13, cattle were turned loose on the playa. The cattle trampled the playa transects to the extent that nests could no longer be distinguished. As a result, two belt transects were set up south of the validation site. These, as well as the southernmost transect on the playa, were surveyed twice a month.

Transects on both the playa and bajada were surveyed twice monthly; i.e., diurnal and nocturnal surveys were taken (Figs. 1 and 2).

Foraging activity was measured weekly. Surveys were initiated on the playa on July 10 and at the seed consumer enclosures on the bajada on August 14. Measurements were taken in the evening for 2 hr before sunset. Five nests of each species (*Pheidole militicida*, *Ph. xerophila* and *Ph. rugulosa*) were studied on the playa and five nests of *Ph. xerophila* and *Ph. rugulosa* were studied at the bajada. *Ph. militicida* was not sampled at the bajada because of its very low abundance at that site.

Foraging activity was measured by counting the number of ants returning to the nest during a 3-min period. The number of ants returning with forage out of the total number returning was noted; i.e., the percentage of ants foraging versus the total number of ants on the surface for a given nest was also noted. Ambient and soil surface temperature as well as relative humidity and approximate wind velocity were recorded at each sampling point.

We noted that ants forage on seeds and, upon returning to the nest, they bring the seeds inside and discard the seed hulls on the nest disc. This justified collecting litter piles from ant nests for determining forage composition.
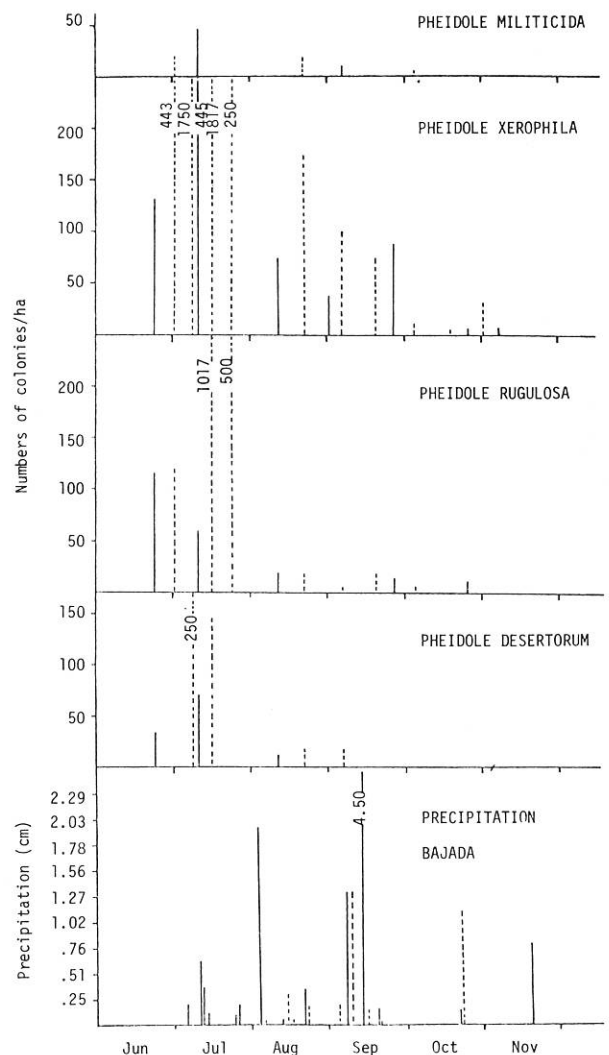

Figure 1. Variation in numbers of active colonies of *Pheidole* spp. on the bajada site and bajada rainfall for June through November 1975.

RESULTS AND DISCUSSION

IMPACT OF SEED CONSUMERS

Ant Colony Densities in Enclosures

Ant colonies were counted and mapped August 9-20 following rains to obtain peak numbers of active colonies and to ensure that colonies were not missed because they were closed (Schumacher and Whitford 1976). Enclosure I had two active nests of *Pogonomyrmex desertorum* and five active nests of *Pheidole* spp. Enclosure II had one active *P. desertorum* colony and three active *Pheidole* spp. Enclosure VIII had no active ant colonies and Enclosure VII had some foragers of a *P. rugosus* nest located in the corner of Enclosures V and VII which had climbed the lawn edging barrier and four *Pheidole* nests. Colonies of *Pheidole* were identified to species if major workers were on the surface at the time the enclosure was mapped. The data are summarized in Table 1.
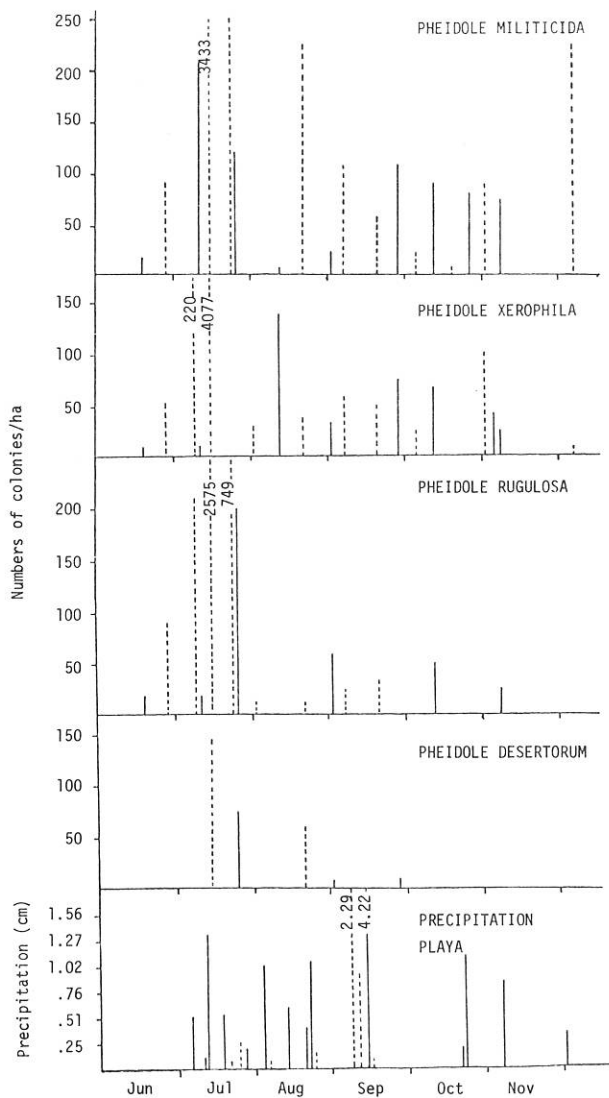

Figure 2. Variation in numbers of active colonies of *Pheidole* spp. on the playa site and playa rainfall for June through November 1975.

There were more colonies of *Pheidole* spp. in the enclosures having ants only than in enclosures having both ants and rodents. These data directly support the findings of Brown et al. (1975), who concluded that this is evidence of competition between ants and rodents.

Although treatment with chlordane did not eliminate all harvester ant colonies, the numbers of colonies were greatly reduced. There was little evidence of foraging activity by ants in the enclosures after treatment with chlordane.

Rodents in Enclosures

The enclosures were trapped every two weeks to assess the efficacy of the enclosure fencing. Throughout the summer we encountered problems with rodents entering and/or escaping from enclosures. *Perognathus penicillatus* were observed scaling the fencing and we were unable to keep rodent densities adjusted according to the research plan. Although rodents entered and escaped from the enclosures, the experimental numbers and "rodent-free" enclosures were in the desired condition for more than half of the growing season. Fences were patrolled regularly and the soil areas where rodent burrowing was seen were packed hard in an attempt to discourage additional burrowing.

Plant Responses

The erratic distribution of rains (Table 2) resulted in late growth of "summer annuals" which may be responsible for the large differences seen between the ephemerals surveyed on September 27, 1975, when compared with the "summer annuals" surveyed on August 14, 1974 (Whitford 1975). In addition, although plant data were not collected until late in the season, large numbers of plants were in early vegetative stages which we could not key to species. These are listed in Table 3 as "unknowns." If these early vegetative stage plants had been excluded from our estimates, plant densities in 1974 would have been considerably higher than in 1975. We noted that some species were absent, i.e., *Kallstroemia parviflora*, *Euphorbia* sp., *Tidestromia lanuginosa* and *Proboscidea parviflora*; others were recorded in 1975 for the first time, i.e., *Malacothrix fenderli* (Table 3).

The most interesting and unexpected result was the marked difference in density of annuals in the enclosures in which rodents and ants were excluded (Enclosures I and II, Table 3). There were no significant differences in enclosures with both rodents and ants, with rodents only, or with ants only (Table 3). These data strongly suggest a quantitative response of annual plants to the exclusion of seed-eating ants and/or rodents.

Location of Subterranean Caches

These experiments were designed to evaluate the ability of *Dipodomys merriami* to locate seed caches in a natural environment but in the absence of other seed-gathering heteromyids. The data of Lockard and Lockard (1971) for *D. deserti* were collected in an area where *D. deserti* was common. They found that rodents were able to recover approximately 50% of the seed caches at depths up to 6 cm but none greater than 12 cm. Reynolds (1958) found that rodents recovered seeds up to 25 cm in depth but could not

specify which heteromyids found the caches. In this experiment, *D. merriami* was the only species present. *D. merriami* uncovered caches at 2.5 cm most frequently. Apparently, when a single cache was located, sufficient grain was available to satisfy the animal. Variation on this approach could prove useful in further evaluating the influence of rodents on seed reserves.

The effectiveness of *D. merriami* in locating milo caches (25-g cache) at various burial depths is shown below. These data are from 60 replicates at each depth.

Depth (cm)	% of caches located	x̄ weight of grain removed (g)
2.5	10.0	14.0
5.0	6.6	11.0
7.5	3.3	14.6
10.0	3.3	12.1

Ecology of *Pheidole*

Very few colonies of *Pheidole* were active in the colder months but numbers of active colonies gradually increased in May. Relative abundance continued to increase through June and peak abundance occurred in mid-July. August through October there were occasional peaks but a general decrease in numbers of active colonies. Number of active colonies per unit area was used as an estimate of relative abundance and population activity.

Bursts of nest openings came after frequent rains, followed by routinely warm weather. During periods of high activity, relative humidity was very high (50-80 %) and temperatures were moderate (22-27 C).

Relative density of *Pheidole* on the playa was much higher than on the bajada (10,513 nests/ha vs. 3750 nests/ha). This was consistent throughout the season. On the bajada, numbers decreased significantly when the temperatures started dropping (Figs. 1 and 2). After early November, active colonies were recorded only once and this was after a rain. *Ph. xerophila* was the most abundant species on the bajada. They were also the most active species in late fall. *Ph. rugulosa* was the second most abundant species of *Pheidole* on the bajada; however, this species did not exhibit as many high peaks in later months. *Ph. desertorum* was encountered at times in July but very infrequently in August through October, thus indicating low abundance. *Ph. militicida* was virtually nonexistent on the bajada, which is probably due to habitat limitation. The most abundant species on the playa were *Ph. militicida* and *Ph. xerophila*. After the rains in July, *Ph. militicida*, *Ph. xerophila* and *Ph. rugulosa* were very abundant, but *Ph. militicida* was most abundant and was more active in colder months than the other species. *Ph. desertorum* was not encountered often and exhibited only three major peaks (Fig. 2).

Foraging Activity

The foraging activity of the species studied on the playa was compared with saturation deficit and soil surface temperature (Fig. 3). Saturation deficit is the drying power of the air, or, more precisely, it is the water vapor pressure at saturation minus the observed water vapor pressure. This can be calculated using temperature and relative humidity. Points in Figure 3 that had zero activity due to wind were omitted from the graph. *Pheidole* had a lower critical thermal maxima than did *Pogonomyrmex*, the other major genus of harvester ants in the area. *Pheidole* maxima was 46 C, whereas *Pogonomyrmex* maxima was around 55 C (Whitford and Ettershank 1975). This was more apparent as a factor in *Pheidole* response to soil surface temperature. No foraging occurred at soil surface temperatures greater than 34 C and activity was also curtailed at a saturation deficit of 17 g/m³. There might have been activity at lower soil surface temperatures and saturation deficits, but we did not observe it.

Table 1. Numbers of active ant colonies in the experimental enclosures, August 9-20, 1975. Enclosures III and IV having both ants and rodents; Enclosures V and VI having ants only

Genus species	Number of active colonies in enclosures			
	III	IV	V	VI
Pogonomyrmex desertorum	8	6	5	3
Pogonomyrmex rugosus	0	0	2	0
Pogonomyrmex californicus	2	0	0	0
Pheidole xerophila	3	5	1	4
Pheidole desertorum	1	2	0	0
Pheidole rugulosa	0	3	0	3
Pheidole sp.	22	17	48	37
Totals	36	33	56	47
Density (#/ha)	900	825	1400	1175

Table 2. Precipitation data from the Jornada bajada site in 1975. Monthly total precipitation is shown as well as amount per event

Month	Total	Events (centimeters)
Jan	1.88	0.23, 0.71, 0.94
Feb	0.69	0.69
Mar	1.07	0.10, 0.96
Apr	0.05	0.05
May	0.30	0.15, 0.15
Jun	--	--
Jul	1.65	0.20, 0.63, 0.38, 0.13, 0.10, 0.20
Aug	2.95	1.96, 0.05, 0.05, 0.30, 0.05, 0.36, 0.18
Sep	7.67	1.50, 1.32, 4.50, 0.15, 0.05, 0.15
Oct	1.27	0.15, 1.12
Nov	0.81	0.81
Dec	0.30	0.30

Table 3. Density and frequency of ephemeral plants in experimental enclosures. Enclosures I and II having no ants and no rodents; Enclosures III and IV having both ants and rodents; Enclosures V and VI having ants only; Enclosures VII and VIII having rodents only

Genus and species	Relative Density	Density	Frequency
ENCLOSURE I			
Eriogonum abertianum	28.75	31.31	0.288
Aristida purpurea	5.00	5.43	0.050
Malacothrix fenderli	11.25	12.21	0.113
Bouteloua aristidoides	13.13	14.26	0.131
Bouteloua eriopoda	13.13	14.26	0.131
Bahia absinthifolia	3.75	4.07	0.038
Allionia incarnata	0.63	0.68	0.006
Solanum elaegnifolium	6.88	7.47	0.069
Erioneuron pulchellum	2.50	2.71	0.025
Unknown 1	1.88	2.04	0.019
Unknown 2	2.50	2.71	0.025
Unknown 3	0.63	0.68	0.006
Unknown 4	0.63	0.68	0.006
Unknown 5	1.25	1.36	0.013
Unknown 6	2.50	2.71	0.025
Unknown 7	1.25	1.36	0.013
Unknown 8	0.63	0.68	0.006
Unknown 9	1.25	1.36	0.013
Unknown 10	1.25	1.36	0.013
Unknown 11	3.13	3.40	0.031

Total Density - 1,085,700 per hectare
Total Dispersion* - 0.00034

Genus and species	Relative Density	Density	Frequency
ENCLOSURE II			
Eriogonum abertianum	15.91	187.53	0.159
Malacothrix fenderli	12.12	142.89	0.121
Baileya multiradiata	1.52	17.92	0.015
Bouteloua eriopoda	0.76	8.96	0.008
Opuntia sp.	0.76	8.96	0.008
Solanum elaegnifolium	0.76	8.96	0.008
Unknown 1	8.33	98.21	0.083
Unknown 2	1.52	17.92	0.015
Unknown 3	21.21	250.07	0.212
Unknown 4	23.48	281.06	0.235
Unknown 5	8.33	99.71	0.083
Unknown 6	1.52	17.92	0.015
Unknown 7	0.76	8.96	0.0008
Unknown 8	0.76	8.96	0.0008

Total Density - 11,792; Total Diversity - 0.00175

Genus and species	Relative Density	Density	Frequency
ENCLOSURE III			
Eriogonum abertianum	26.5	35.0	0.2600
Bouteloua aristidoides	10.6	13.2	0.0100
Bouteloua eriopoda	18.9	24.9	0.1800
Malacothrix fenderli	12.1	16.0	0.1200
Solanum elaegnifolium	0.76	1.0	0.0070
Allionia incarnata	2.27	3.0	0.0200
Eriogonum rotundifolium	0.76	1.0	0.0070
Baileya multiradiata	0.76	1.0	0.0070
Zinnia grandiflora	0.76	1.0	0.0070
Unknown 1	3.03	4.0	0.0300
Unknown 2	0.76	1.0	0.0070
Unknown 3	2.27	3.0	0.0200
Unknown 4	0.76	1.0	0.0070
Unknown 5	6.06	8.0	0.0060
Unknown 6	1.51	2.0	0.0150
Unknown 7	0.76	1.0	0.0070
Unknown 8	0.76	1.0	0.0070
Unknown 9	0.76	1.0	0.0070
Unknown 10	0.76	1.0	0.0070

Total Density - 457,000; Total Diversity - 0.00066

Genus and species	Relative Density	Density	Frequency
ENCLOSURE IV			
Malacothrix fenderli	20.4	31.0	0.2000
Bouteloua aristidoides	29.6	45.0	0.2900
Bouteloua eriopoda	8.6	13.1	0.0800
Erioneuron pulchellum	6.6	10.0	0.0700
Croton pottsii	13.8	21.0	0.1300
Baileya multiradiata	0.65	1.0	0.0060
Allionia incarnata	0.65	1.0	0.0060
Zinnia grandiflora	2.6	4.0	0.0260
Eriogonum abertianum	14.4	21.9	0.1400
Unknown 1	1.31	2.0	0.0130
Unknown 2	0.65	1.0	0.0060

Total Density - 706,000; Total Diversity - 0.00075

Genus and Species	Relative Density	Density	Frequency
ENCLOSURE V			
Croton pottsii	3.12	5.0	0.0300
Malacothrix fenderli	16.2	25.9	0.1600
Eriogonum abertianum	7.5	12.0	0.0700
Bouteloua aristidoides	20.6	33.0	0.2100
Bouteloua eriopoda	6.87	11.0	0.0700
Erioneuron pulchellum	17.5	28.0	0.1800
Aristida purpurea	6.25	10.4	0.06
Allionia incarnata	1.87	3.0	0.02
Eriogonum rotundifolium	1.87	3.0	0.02
Baileya multiradiata	0.62	1.0	0.006
Zinnia grandiflora	0.62	1.0	0.006
Bahia absinthifolia	1.25	2.0	0.01
Unknown 1	6.87	11.0	0.07
Unknown 2	0.62	1.0	0.006
Unknown 3	0.62	1.0	0.006
Unknown 4	0.62	1.0	0.006
Unknown 5	1.25	2.0	0.006
Unknown 6	0.62	1.0	0.006

Total Density - 694,000; Total Dispersion - 0.00210

Genus and Species	Relative Density	Density	Frequency
ENCLOSURE VI			
Erioneuron pulchellum	21.2	28.0	0.021
Eriogonum abertianum	19.6	25.9	0.20
Bouteloua aristidoides	3.78	5.0	0.04
Malacothrix fenderli	21.2	28.0	0.21
Bahia absinthifolia	2.27	3.0	0.02
Aristida purpurea	1.51	2.0	0.02
Croton pottsii	5.30	7.0	0.05
Bouteloua eriopoda	2.27	3.0	0.02
Baileya multiradiata	0.75	1.0	0.008
Unknown 1	0.75	1.0	0.008
Unknown 2	0.75	1.0	0.008
Unknown 3	0.75	1.0	0.008
Unknown 4	0.75	1.0	0.008
Unknown 5	0.75	1.0	0.008
Unknown 6	23.4	30.9	0.23
Unknown 7	3.78	5.0	0.04

Total Density - 444,000; Total Dispersion - 0.00069

Genus and Species	Relative Density	Density	Frequency
ENCLOSURE VII			
Malacothrix fenderli	43.0	58.9	0.43
Erioneuron pulchellum	11.8	16.1	0.12
Eriogonum abertianum	9.5	12.9	0.09
Allionia incarnata	5.9	8.0	0.05
Bahia absinthifolia	0.73	1.0	0.007
Unknown 1	1.47	2.0	0.01
Unknown 2	2.3	3.1	0.02
Unknown 3	2.3	3.1	0.02
Unknown 4	1.47	2.0	0.09
Unknown 5	1.47	2.0	0.09
Unknown 6	1.47	2.0	0.01
Unknown 7	1.47	2.0	0.01
Unknown 8	0.73	1.0	0.007

Total Density 541,000; Total Dispersion 0.00016

Genus and Species	Relative Density	Density	Frequency
ENCLOSURE VIII			
Eriogonum abertianum	17.1	26.0	0.17
Malacothrix fenderli	32.2	48.9	0.32
Bouteloua aristidoides	18.4	28.0	0.18
Bouteloua eriopoda	0.65	1.0	0.007
Bahia absinthifolia	1.31	2.0	0.013
Allionia incarnata	11.8	17.9	0.12
Erioneuron pulchellum	7.9	12.0	0.08
Croton pottsii	0.65	1.0	0.007
Unknown 1	3.9	5.9	0.04
Unknown 2	1.31	2.0	0.013
Unknown 3	1.31	2.0	0.013

Total Density - 510,000; Total Dispersion - 0.00147
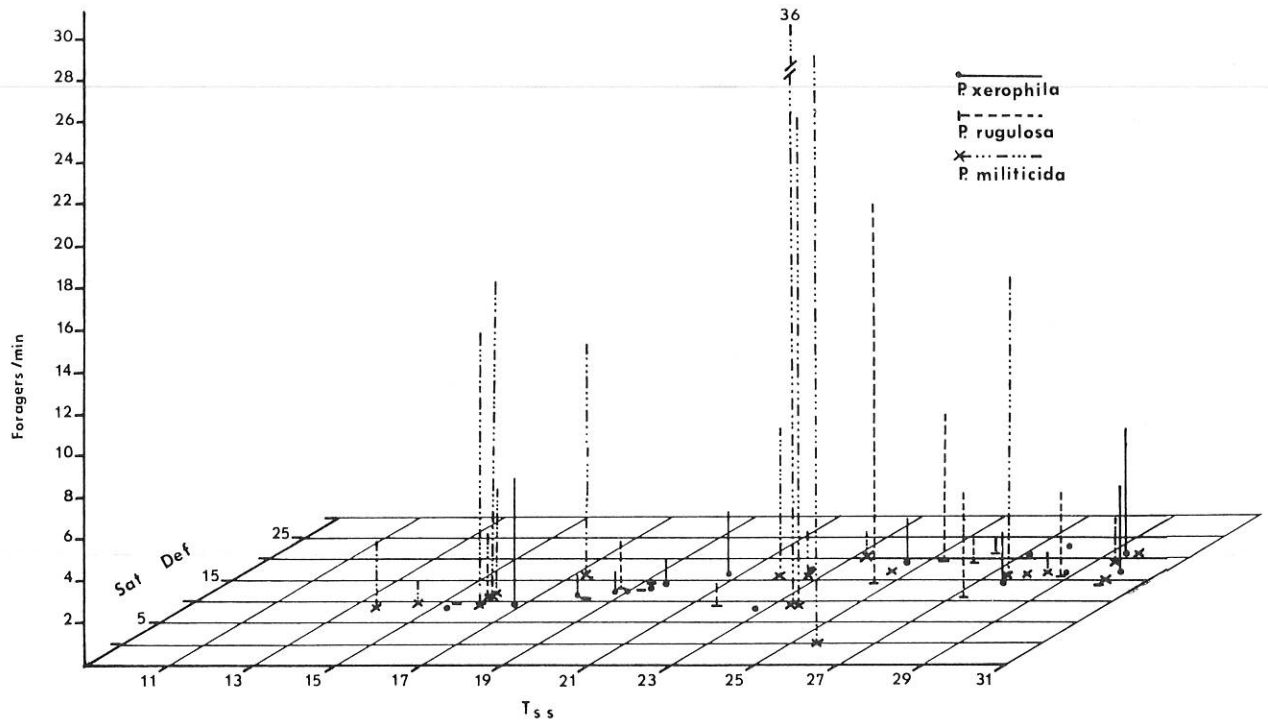
*Southwood 1966, p. 40

Figure 3. The relationship of foraging rate to soil surface temperature and saturation deficit in *Pheidole* spp. on the playa site.
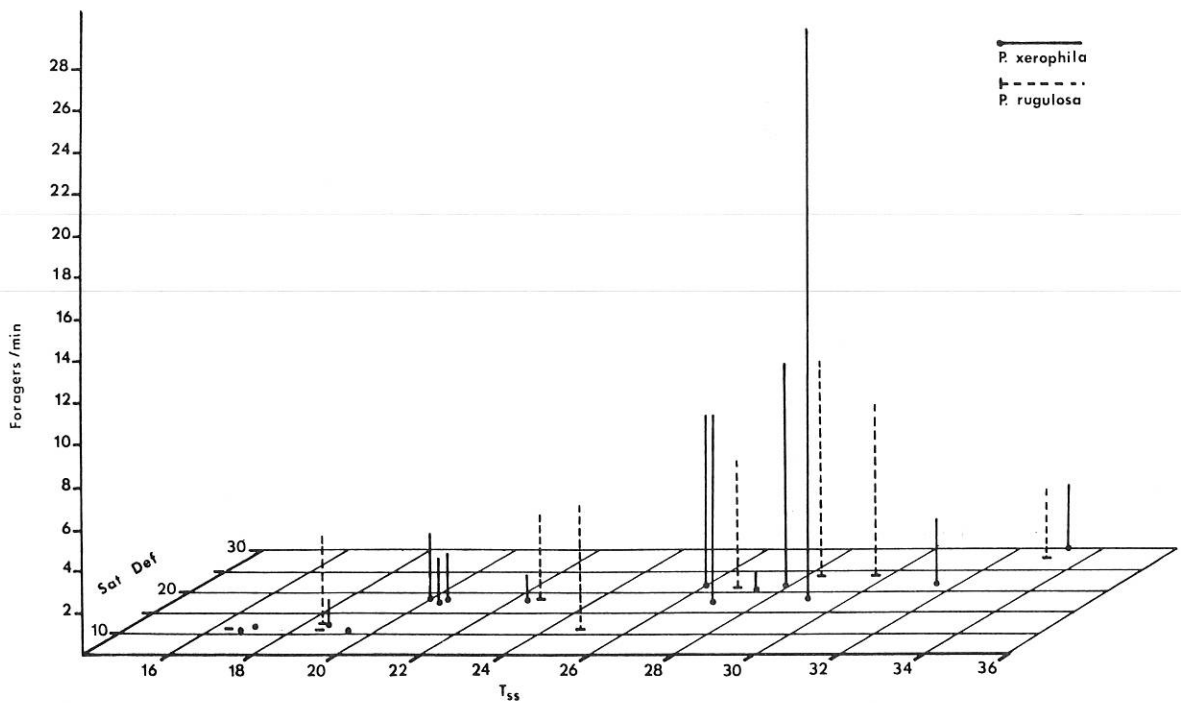

Figure 4. The relationship of foraging rate to soil surface temperature and saturation deficit in *Pheidole* spp. on the bajada site.
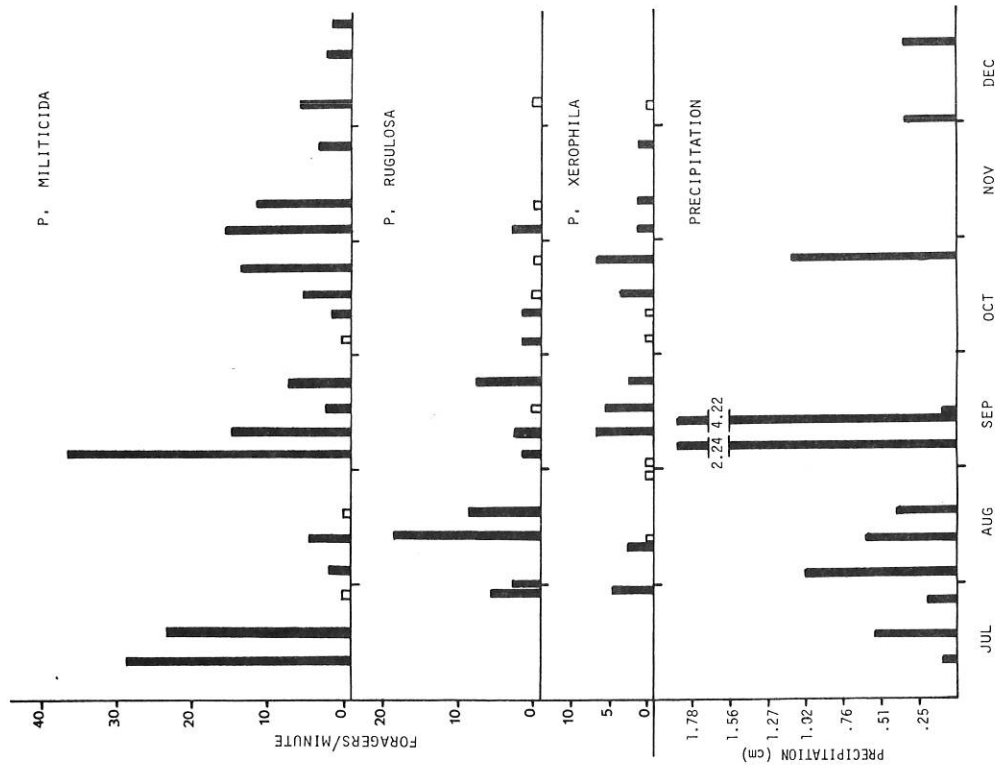
Figure 6. The influence of precipitation events on the foraging rate of *Pheidole* spp. on the bajada site.

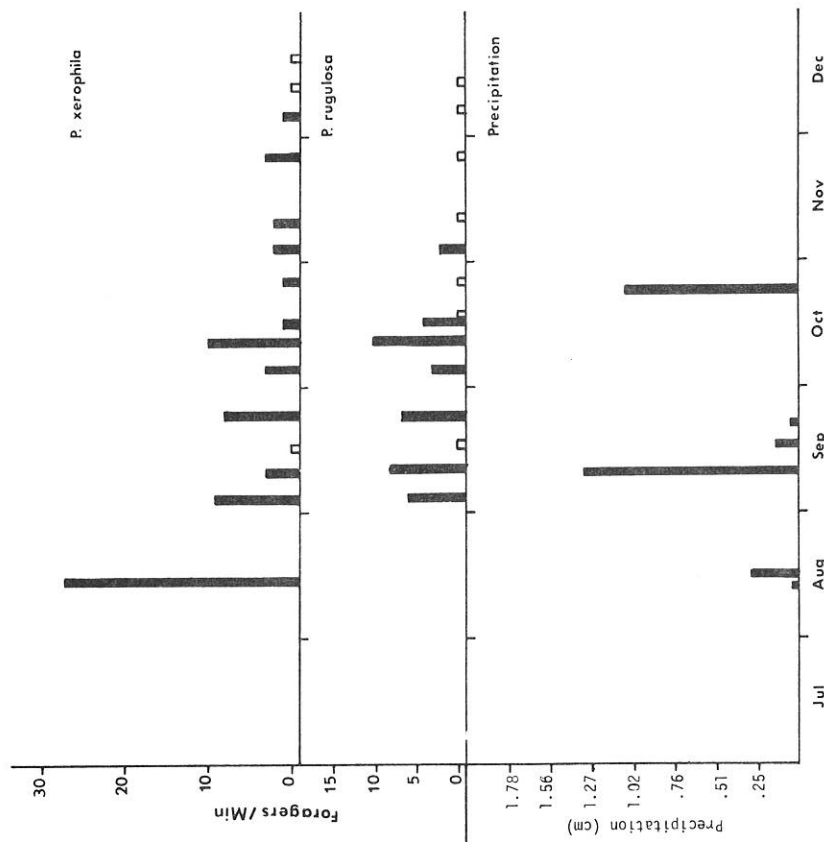**Figure 5.** The influence of precipitation events on the foraging rate of *Pheidole* spp. on the playa site.

All three species studied on the playa were active throughout the same range of soil surface temperature and saturation deficit, i.e., T_{SS} = 15-35 C and Sat. Def. = 5-20. This is consistent with observations of surprisingly low levels of interspecific competition despite considerable interspecific contact. In fact, *Ph. rugulosa* workers have been observed peacefully foraging on a nest disc of *Ph. militicida*. In another situation, foraging lines of *Ph. militicida* and *Ph. rugulosa* were observed crossing paths without aggressive interaction or confusion as to direction towards their respective nests. Nests of different species have also been observed in close proximity.

Foraging activity of *Pheidole* was compared in the same fashion at the seed-consumer enclosures (Fig. 4). The same general trends observed on the playa were evident except that the maximum soil surface temperature and saturation deficit for the ants there were slightly greater. *Ph. militicida* was not studied at this site because very few nests of this species were present.

Seasonal foraging activity was compared to the presence of precipitation on the playa (Fig. 5). Precipitation occurred intermittently throughout the sampling period with heavy rains in July and September. Rains usually occurred within two days prior to observations of high activity. The highest foraging activities were recorded in July and September. In December, *Ph. xerophila* and *Ph. rugulosa* nest entrances were closed.

Seasonal foraging activity at the seed consumer enclosures was compared in the same way as at the playa (Fig. 6). The trends were similar at the seed consumer enclosures; precipitation did not appear to have such a pronounced effect. September, the wettest month (Table 2) showed consistently greater activities than any other month except August. In August, intense foraging activity was recorded only once (Fig. 6).

Forage Preference

Forage preference was also studied but the data have not been totally analyzed because we have been unable to identify all of the seeds that were collected. Also, many unidentified samples from a vegetative survey in 1975 were destroyed in a fire.

Forage (by class) collected by *Pheidole* species from August-October 1975 is shown below.

	Grass	Forbs	Inedible
Ph. militicida (playa)	24.0	71.4	4.6
Ph. xerophila (playa)	74.2	19.4	6.4
Ph. xerophila (bajada)	74.3	24.1	1.6

Grass cover at the playa in 1975 was 29.3% and forb cover was 63.2%. At the bajada site, the grass cover was 80% with 20% cover for forbs. Despite this, *Ph. xerophila* forage on the playa consisted of 74.2% grasses. This suggests they may have a preference for grass species.

The amount of grass collected by *Ph. militicida* was low but this may be due to heavier than normal grazing by cattle in the vicinity of *Ph. militicida* nests. It is interesting to note that only 23.3% of all *Ph. militicida* foragers returned with forage and only 16.3 and 17.6% of *Ph. xerophila* and *Ph. rugulosa* foragers, respectively, returned with forage. Our data are not sufficiently complete to estimate the impact of *Pheidole* species on the seed reserves in the ecosystem. The study will be continued during 1976, including extensive nocturnal sampling.

Behavioral Notes

Ph. militicida was obviously the most active of the *Pheidole* species. *Ph. militicida* appeared to forage three times faster than other *Pheidole* species. The entire genus seems extremely responsive to high humidity under relatively moderate temperatures. For example, on August 21, 1975, rain in the early morning produced very humid surface and subsurface conditions. *Ph. militicida* majors were extremely active above the nest but with no apparent purpose. Surface activity by majors in any of the species is unusual except under humid conditions.

Major workers were rarely seen carrying any forage and often wandered a slight distance (10-20 cm) and remained until several minor workers attempted to redirect the ant.

During an all-night survey, all species were active from dusk until midnight although only *Ph. militicida* showed signs of definite foraging. At approximately 0300 hr, all species except *Ph. militicida* were reducing or ceasing activity. Conversely, *Ph. militicida* started foraging intensely throughout the dawn hours. They appeared to forage primarily on seed and litter piles washed up by the rains. *Ph. militicida* had the fewest majors outside of the nest during normal foraging activity, i.e., not after a rain. All species but *Ph. militicida* appeared to be "cleaning house."

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