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The Ants of Arizona: An Ecological Study of Ants in the Sonoran Desert

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THE ANTS OF ARIZONA: AN ECOLOGICAL STUDY OF ANTS IN THE SONORAN DESERT

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ABSTRACT

The ant fauna at three sites situated in the desert surrounding Tucson, Arizona, were studied. Thirty-seven different ant species were found; 18 at Silverbell, 21 at Santa Rita treated and 33 at Santa Rita control. The qualitative and quantitative analyses of the ant fauna showed that these three sites were differentiated by a dense community of *Pheidole xerophila tucsonica* and *Pogonomyrmex pima* at Silverbell; by a significant community of *Pheidole xerophila tucsonica, Pheidole pilifera artemisia, Iridomyrmex pruinosum analis, Pheidole spadonia* and *Pogonomyrmex desertorum* at the Santa Rita treated site; and by an elevated community of *Crematogaster coarctata vermiculata* and *Forelius foetidus* at the Santa Rita control site. The sites are also differentiated by the number of nests present per hectare: Silverbell, 492; Santa Rita treated, 1926; and Santa Rita control, 1753. By an indirect method, used for the first time, we estimated the biomass of six dominant species at Silverbell. The total biomass of the workers is 586 g, equivalent to 3696 kcal/ha for 1,600,000 workers. The biomass is about 105 g for *Veromessor pergandei*, 1 g for *Pheidole xerophila tucsonica*, 159 g for *Novomessor cockerelli* and 305 g for *Pogonomyrmex rugosus*. The study of nesting methods of the species has also shown a difference in the three sites. The dissimilarities of the ant fauna at the three sites are, in our opinion, due to differences in macroclimate, vegetation, soil structure and texture of the three biotypes.

INTRODUCTION

Ants play a significant, although discrete, role in the management of a landscape. This activity is manifest at the level of the fauna, flora and soil. This discrete role, known in temperate regions, becomes more and more important in desert or semidesert areas, due not only to the absence of active soil-fauna agents (those which represent the family Lumbricidae), but also to the specific and quantitative importance which ants assume by their interaction with other invertebrates populating these regions.

The myrmecologic fauna at three US/IBP sites were studied for six months in an attempt to illuminate the importance and the role of ants at these sites, located in the desert area around Tucson, Arizona.

The Silverbell site represents a typical biotype of the Sonoran Desert. The vegetation is dominated by *Cercidium microphyllum, Olneya tesota, Prosopis juliflora, Larrea tridentata, Acacia constricta, Ambrosia deltoidea* and some cacti, among them *Cereus giganteus* and *Opuntia versicolor*.

The other sites studied were located at the Santa Rita Experiment Station. Santa Rita is a grassy desert type that, after wildfires and especially after overgrazing, was invaded by mesquite (*Prosopis juliflora*) and acacias (*Acacia constricta*).

A portion of the Santa Rita Station was disturbed by the uprooting of the woody plants and their stumps (Santa Rita treated), whereas the other portion of the station remained untouched (Santa Rita control).

METHODS

At each site the exact sample points were determined in terms of the local landscape and care was taken to obtain representative samples. The fauna of both the soil and the shrub vegetation were studied. The method consisted of taking specimens in the nests or the area immediately surrounding the nests. By sampling, we mean that several individuals of the same species were separated from the nest and placed in a tube containing alcohol and marked with a specimen number.

The species were determined at the laboratory with the aid of the works of Cole (1968), Creighton (1950, 1952), Gregg (1958), Smith (1947, 1963) and Snelling (1963).

The method known as the "quadrat or standard area technique" was used in the quantitative surveys. This consists of counting the number of nests found in a predetermined area. This technique was chosen because of its ease and precision: each time we completed an inventory of the standard area, we were certain to have discovered all the nests present.

As the nests were counted on a 4 x 4 m area at Silverbell, we set apart some known specimens for identification. We chose a large reference area on this site because the herbaceous layer of vegetation is very poor, making it easy to locate the nests. Searching for the nests of *Pogonomyrmex pima* required a great deal of attention as these nests are marked only by a small opening of several millimeters.

At Silverbell, 156 areas of 16 m^2 were sampled. Each sampled area was randomly chosen and located approximately 10 steps from the preceding area.

At Santa Rita, because of the presence of a more dominant herbaceous layer, we chose a reference area of 1 m^2 (1 x 1 m). On the treated site, we sampled 950 squares and on the control site, we sampled 850 such squares. Each sample was taken at random and consecutive samples were spaced approximately 10 steps apart.

The activity of the ants, measured in relation to temperature, was accomplished by counting the number of workers entering and leaving the nest during a 30-sec time period. The counting occurred as close to the principal nest opening as possible. The hour and the temperature at ground level were also recorded. The soil surface temperature was measured with a Pacific Transducer Corp. model 310C surface thermometer.

The study of biomass of workers was conducted only at Silverbell. The method which was used initially was to estimate the total number of openings per hectare for each species, rather than estimating the population of one or two nests and then transposing that into weight per hectare. This method required the following: 1) a knowledge of each species whose biomass was to be estimated and the relationship between worker activity and ground-level temperature; 2) an estimate of the number of workers in search of food by species and per hectare; 3) an estimate of the biomass of the workers by species and per hectare. Finally, knowing the preceding values, one can estimate the biomass of the workers per hectare and express that figure by weight or in kcal per hectare.

In order to estimate the number of workers in search of food per hectare, we sampled 1025 squares, 50 cm on a side. At each sampling point we examined four squares and noted the soil temperature at the time in the same way as at the home nest where the workers were seen or collected.

Each sampling point was taken at random and spaced approximately 10 steps apart. On each sampled surface, the ants were counted with care and numbers determined either directly or in the laboratory.

Knowing the number of ants (by species) found per surface sample and knowing temperature of the soil, it was then possible to estimate a *potential number* of ants. By *potential number*, we mean the number of ants that could be found if the sample had been taken during a maximum activity period for the workers. This potential number, for a given temperature and given species, is calculated by taking into consideration the percentage of activity of the workers at that temperature in relation to the activity of the workers at the optimal temperature.

The number of workers in search of food per hectare is then obtained by first multiplying the potential number by the ratio of the number of nests per hectare (quantitative survey) to the number of nests seen, and then dividing by the fraction of a hectare sampled.

Several authors (Ayre 1962; Chew 1959, 1960) have shown that for diverse species the number of workers in search of food represents only a certain percentage of the total number of workers present in the nest. For all ant species, Ayre (1962) estimates that this is less than 20%.

Knowing the number of workers of each species searching for food, it is then possible to use a specific percentage to calculate the number of workers present per hectare. By calculating the number of workers per hectare several times during the year, one can estimate their biomass.

By totaling the number of workers calculated for each species, the total biomass of the workers is obtained. This figure can be expressed in numerical terms by grams or in cal/gram per hectare.

According to Petal (1966), 1 g dry wt of ants corresponds to 6308.52 cal.

Let us note that the values obtained at the time of this study are valid only for the period of September-October. It is known that the biomass of workers varies during the year in relation to the increase of breeding chambers, which implies a loss of food for the workers.

RESULTS

The statistical analysis of our results is based on the use of relative methods, realizing that the utilization of these methods is dependent upon two conditions: 1) the normality of the populations, which is not always essential when the number of samples is large; and 2) the uncertain and simple character of the samples. With these conditions being satisfied, we then used the formula:

$$n = (t_1^2 - \alpha/2\, V^2)/dr^2$$

where

- n = number of samples
- V = a coefficient of variation expressed in percentage of the average
- dr = the relative maximum error or the relative margin of error

When n is greater than 30, the formula becomes

$$n = 7V^2/dr^2$$

For more information, see Dagnelie (1970).

Analyses and Interpretation of the Ant Population of the Three Sites

The Subfamilies and the Genera

Let us consider the fauna at the supraspecific level and show what is represented by each taxon for each sampling site (Table 1).

Table 1 shows the distribution of species in the subfamilies of Formicidae at the three sites. The fauna of the Santa Rita sites seems richer in Myrmicinae compared to that of the Silverbell site. Other characteristics of the populations appear if one considers the numbers of individuals in each subfamily.

Table 2 shows the number of samples per subfamily as percentage of total sampling.

Table 1. Frequency of subfamilies of Formicidae

Subfamilies	Silverbell	Santa Rita treated	Santa Rita control
Ponerinae	-	-	1
Dorylinae	1	-	-
Pseudomyrminae	-	-	1
Myrmicinae	11	15	19
Dolichoderinae	3	4	4
Formicinae	3	2	8

Table 2. Number of samples per subfamily sampled as percentage of total sample

Subfamilies	Silverbell (%)	Santa Rita treated (%)	Santa Rita control (%)
Ponerinae	-	-	1
Dorylinae	2	-	-
Pseudomyrminae	-	-	4
Myrmicinae	65	88	49
Dolichoderinae	28	9	23
Formicinae	5	3	23
100	60	61	93

Here the distinct differences are apparent between the three sites: at Silverbell, the Myrmicinae and the Dolichoderinae are dominant; at Santa Rita treated, the Myrmicinae alone are clearly dominant; whereas at Santa Rita control, if the Myrmicinae are always dominant, then the Formicinae, on the contrary, are more important than at the other two sites.

Table 3 shows the distribution of the species in the genera of the Formicidae family. No genera are clearly dominant. *Pogonomyrmex* is dominant at the three sites. The two sites situated at Santa Rita differentiate themselves from the Silverbell site by the presence of *Pheidole* as a dominant genus.

The *Camponotus* genus is characteristic of the Santa Rita control site, relative to the treated site. This is due to the shrubby strata present at this station, which permits the establishment of these colonies.

The character of the population of each site is more apparent if one takes into account the sampling number for each genus (Table 4).

While *Pogonomyrmex* is dominant at the three sites, the sites are nevertheless differentiated by dense communities of *Novomessor*, *Pheidole* and *Forelius* at Silverbell; by an elevated density of *Pogonomyrmex* and an absence of *Forelius* at the Santa Rita treated site; whereas the Santa Rita control site is unique in relation to the other two sites by its dense community of *Forelius*, *Camponotus* and *Myrmecocystus*.

Table 3. Frequency of genera

Genus	Silverbell	Santa Rita treated	Santa Rita control
Odontomachus	-	-	1
Neivamyrmex	1	-	-
Pseudomyrmex	-	-	1
Pogonomyrmex	3	4	5
Acromyrmex	1	1	1
Novomessor	2	1	2
Pheidole	2	5	5
Veromessor	1	1	1
Solenopsis	1	2	2
Crematogaster	1	1	2
Trachymyrmex	-	-	1
Forelius	1	1	1
Iridomyrmex	1	1	1
Dorymyrmex	1	2	2
Camponotus	1	-	3
Myrmecocystus	2	2	3
Formica	-	-	1
Colobopsis	-	-	1

Table 4. Number of samples per genus as percentage of total sample

Genus	Silverbell (%)	Santa Rita treated (%)	Santa Rita control (%)
Odontomachus	-	-	1
Neivamyrmex	2	-	-
Pseudomyrmex	-	-	4
Pogonomyrmex	26	50	25
Acromyrmex	-	5	7
Novomessor	14	10	5
Pheidole	17	5	4
Veromessor	3	12	3
Solenopsis	3	3	2
Crematogaster	-	-	3
Trachymyrmex	-	-	-
Forelius	20	-	18
Iridomyrmex	7	5	2
Dorymyrmex	2	4	2
Camponotus	2	-	11
Myrmecocystus	4	5	10
Formica	-	-	1
Colobopsis	-	-	1

The presence of *Forelius*, represented by a single species at the Silverbell site and the Santa Rita control site, is correlated with the presence of a shrubby strata, as with *Camponotus*. But contrary to *Camponotus*, which nests in trees, *Forelius* would seem to be more abundant due to the fact that the workers are quite often in search of honey on the shrubs -- honey which can be the basis of their nourishment.

The Ant Species and Their Relative Frequency at the Three Sites

Silverbell

We used the abundance criteria of the species in order to classify them; that is to say, the number of samples taken, expressed in percentage of the samplings for the site. Our

Table 5. Survey of ant species at the Silverbell site

Species	Number of samples (n = 60 **)	Number of samples (%)
1. *Forelius foetidus* (Buckley)	102	20
2. *Pheidole xerophila tucsonica* Wheeler	10	17
3. *Novomessor cockerelli* (E. André)	7	12
4. *Pogonomyrmex pima* Wheeler	7	12
5. *Pogonomyrmex rugosus* Emery	7	12
6. *Iridomyrmex pruinosum analis* (E. André)	4	7
7. *Veromessor pergandei* (Mayr)	2	3
8. *Solenopsis xyloni* McCook	2	3
9. *Acromyrmex versicolor* (Pergande)	2	3
10. *Neivamyrmex nigrescens* (Cresson)	1	2
11. *Myrmecocystus melliger* Forel	1	2
12. *Myrmecocystus semirufa* Emery	1	2
13. *Camponotus fumidus festinatus* (Buckley)	1	2
14. *Pogonomyrmex maricopa* Wheeler	1	2
15. *Novomessor albisetosus* (Mayr)	1	2
16. *Dorymyrmex pyramicus bicolor* Wheeler	1	2
17. *Pheidole pilifera artemisia* Cole *	+	-
18. *Crematogaster clara* Mayr *	+	-

* species found only by the quantitative method.
** n = number of samples collected.

Table 6. Survey of ant species at the Santa Rita treated site

Species	Number of samples (n = 61)	Number of samples (%)
1. *Pogonomyrmex rugosus* (Buckley)	12	20
2. *Pogonomyrmex desertorum* Wheeler	9	15
3. *Veromessor pergandei* (Mayr)	7	12
4. *Novomessor cockerelli* (E. André)	6	10
5. *Pogonomyrmex maricopa* Wheeler	5	8
6. *Pogonomyrmex pima* Wheeler	7	7
7. *Myrmecocystus mexicanus hortideorum* McCook	3	5
8. *Iridomyrmex pruinosum analis* (E. André)	3	5
9. *Acromyrmex versicolor* (Pergande)	3	5
10. *Pheidole pilifera artemisia* Cole	2	3
11. *Pheidole xerophila tucsonica* Wheeler	2	3
12. *Solenopsis aurea* Wheeler	2	3
13. *Pheidole spadonia* Wheeler	1	2
14. *Dorymyrmex pyramicus* (Roger)	1	2
15. *Dorymyrmex pyramicus bicolor* Wheeler	1	2
16. *Pheidole vallicola* Wheeler **	+	-
17. *Pheidole desertorum* Wheeler **	+	-
18. *Solenopsis xyloni* McCook **	+	-
19. *Crematogaster coarctata vermiculata* Emery **	+	-
20. *Forelius foetidus* (Buckley) **	+	-
21. *Myrmecocystus mimicus* Wheeler **	+	-

** species found only by the quantitative method.

data show that *Forelius foetidus* and *Pheidole xerophila tucsonica* are the dominant species, followed by a list of progressively rare species, among which we have distinguished three classes: 1) the species from *Novomessor cockerelli* up to *Iridomyrmex pruinosum analis*, the latter representing 43% of the population; 2) species from *Veromessor pergandei* to *Acromyrmex versicolor*, which represent 9% of the ant fauna; 3) the species found only one time -- those from *Neivamyrmex nigrescens* to *Crematogaster clara* -- which represent only 14% of the population (Table 5).

Santa Rita Treated Site

Table 6 shows how the 21 species found at this site were distributed.

Our abundance data show that two species, *Pogonomyrmex rugosus* and *Pogonomyrmex desertorum* are dominant. These two species are followed by other, increasingly uncommon, species among which three classes are recognized: 1) the species from *Veromessor pergandei* to *Novomessor cockerelli*, which make up 22% of the ant fauna; 2) the species from *Pogonomyrmex maricopa* to *Acromyrmex versicolor*, which represent 30% of the population; 3) the species from *Pheidole pilifera artemisia* to *Myrmecocystus mimicus*, totaling 15% of the nests.

For Silverbell, the very numerous species of ants (12 species representing more than 50%) were found only in one or two cases.

Comparing the pattern of the Silverbell fauna to that at the Santa Rita treated site shows that the Santa Rita site is specifically richer.

Twelve species make up the dominant fauna and are common to the two sites. Among these 12 species, the dominant species at Santa Rita, *Pogonomyrmex desertorum*, is not found at Silverbell, whereas *Pogonomyrmex maricopa* and *Myrmecocystus mexicanus hortideorum* represent a clearly smaller percentage of the fauna at Silverbell compared to Santa Rita. On the other hand, *Forelius foetidus*, the dominant species at Silverbell, and *Solenopsis xyloni* represent a very small percentage of the population of Santa Rita.

Santa Rita Control Site

Table 7 shows how the 33 species found on this station are distributed. This distribution is a good example of application of Williams Rule (Williams 1964) which demonstrated that species are normally rare. This phenomenon is shown at the other two sites, but especially well at this last site. In short, 17 species (50% of the fauna) were found only once, and 21 species (64% of the fauna) represent only 19% of the nests found. On the other hand, 6 species (18% of the fauna) total 57% of the samples.

The clearly dominant species is *Forelius foetidus*, which is then followed by a long list of species among which three classes are distinguished: 1) species from *Pogonomyrmex desertorum* to *Myrmecocystus mimicus*, which represent 39% of the population; 2) species from *Pogonomyrmex pima* to *Veromessor pergandei*, which represent 23% of the population; 3) species from *Solenopsis xyloni* to *Trachymyrmex desertorum*, which represent 19% of the nests.

When the pattern of the fauna of this site is compared to the patterns of the other two sites, one finds that it is composed of many more species.

Table 7. Survey of ant species at the Santa Rita control site

Species	Number of samples (n = 93 *)	Number of samples (%)
1. *Forelius foetidus* (Buckley)	17	18
2. *Pogonomyrmex desertorum* Wheeler	8	9
3. *Camponotus mina zuni* Wheeler	8	9
4. *Pogonomyrmex maricopa* Wheeler	6	7
5. *Acromyrmex versicolor* (Pergande)	6	7
6. *Myrmecocystus mimicus* Wheeler	6	7
7. *Pogonomyrmex pima* Wheeler	4	4
8. *Novomessor cockerelli* (E. André)	4	4
9. *Pogonomyrmex rugosus* (Buckley)	4	4
10. *Pheidole xerophila tucsonica* Wheeler	4	4
11. *Pseudomyrmex apache* Creighton	4	4
12. *Veromessor pergandei* (Mayr)	3	3
13. *Solenopsis xyloni* McCook	2	2
14. *Crematogaster arizonensis* Wheeler	2	2
15. *Myrmecosystus semirufa* Emery	2	2
16. *Iridomyrmex pruinosum analis* (E. André)	2	2
17. *Dorymyrmex pyramicus bicolor* Wheeler	1	1
18. *Dorymyrmex pyramicus* (Roger)	1	1
19. *Formica rufibarbis gnava* (Buckley)	1	1
20. *Camponotus sayi* Emery	1	1
21. *Camponotus fumidus festinatus* (Buckley)	1	1
22. *Novomessor albisetosus* (Mayr)	1	1
23. *Pogonomyrmex californicus* (Buckley)	1	1
24. *Crematogaster coarctata vermiculata* Emery	1	1
25. *Colobopsis papago* Creighton	1	1
26. *Odontomachus haematoda desertorum* Wheeler	1	1
27. *Myrmecocystus mexicanus hortideorum* McCook	1	1
28. *Solenopsis aurea* Wheeler **	+	-
29. *Pheidole spadonia* Wheeler **	+	-
30. *Pheidole pilifera artemisia* Cole **	+	-
31. *Pheidole hyatti* Emery **	+	-
32. *Pheidole desertorum* Wheeler **	+	-
33. *Trachymyrmex desertorum* (Wheeler) **	+	-

* n = number of samples.
** species found only by the quantitative method.

Table 8. Quantitative analysis of species at the Silverbell site

Species	Number of nests sampled	Number of nests/m²	Number of nests/ha
Sample areas with nests *	81		
Number of nests	123	0.05	492
1. *Pheidole xerophila tucsonica*	48	0.0192	192
2. *Pogonomyrmex pima*	30	0.0120	120
3. *Solenopsis xyloni*	11	0.0044	44
4. *Forelius foetidus*	9	0.0036	36
5. *Veromessor pergandei*	8	0.0032	32
6. *Novomessor cockerelli*	5	0.0020	20
7. *Myrmecocystus melliger*	2	0.0008	8
8. *Pheidole pilifera artemisia*	2	0.0008	8
9. *Crematogaster clara*	2	0.0008	8
10. *Iridomyrmex pruinosum analis*	2	0.0008	8
11. *Pogonomyrmex rugosus*	1	0.0004	4
12. *Myrmecocystus semirufa*	1	0.0004	4
13. *Acromyrmex versicolor*	1	0.0004	4
14. *Dorymyrmex pyramicus bicolor*	1	0.0004	4

* number of surface sample areas containing at least one nest.

In comparing the principal fauna species at the Santa Rita site in relation to that of Silverbell, one especially notes the presence of *Pogonomyrmex desertorum*, *Pogonomyrmex maricopa*, *Myrmecocystus mexicanus hortideorum*, *Psuedomyrmex apache*, *Camponotus mina zuni*, *Myrmecocystus mimicus*, and the absence of *Solenopsis xyloni*.

The particular character of the Santa Rita control fauna, in relation to that at Silverbell, is determined by the presence of *Pogonomyrmex desertorum*, *Pogonomyrmex maricopa*, *Pseudomyrmex apache*, *Camponotus mina zuni* and *Myrmecocystus mimicus*, and by the absence of *Solenopsis xyloni* and *Iridomyrmex pruinosum analis*, which form the pattern of the Santa Rita fauna.

The particular character of the pattern of the Santa Rita control fauna in relation to that of the treated site is determined not only by the presence of *Forelius foetidus*, *Camponotus mina zuni*, *Pseudomyrmex apache* and *Myrmecocystus mimicus*, but also by the absence of *Myrmecocystus mexicanus hortideorum* and *Iridomyrmex pruinosum analis* from the species list which forms the basic pattern of its fauna. The presence of the first three of these species can be explained by the presence of the shrubby strata at the control site.

Ant Species and Their Abundance at the Three Sites -- Quantitative Analysis

Silverbell Site

After having surveyed the species qualitatively, we then sampled them quantitatively. This necessitated a sampling of 156 squares, 4 x 4 m, having a surface area of 2496 m².

The statistical study from our results shows that on the resulting "number of nests," with $\alpha = 0.05$, the margin of error of the counting is 14.7%, or dr = 14.7%.

The confidence intervals of the average are

$$0.674 \leqslant 0.788 \leqslant 0.904$$

The occurrence of at least one nest per area sampled for all nests, and the occurrence of at least one nest per species by sample area are shown in Table 8.

Tables 5 and 8 show that the species are not arranged in the same order in the two cases. This is explained by the following: 1) quantitative sampling did not include all the species actually present at the site; 2) by the quantitative sampling method, we would sample only those ants that nest in the soil; 3) to take inventory at random, one is less tempted, as in the qualitative sampling, to note the presence of the large species.

Let us again recognize that the two samplings were made at two different times of the year; the qualitative method during July and the quantitative in September.

Inspection of Table 8 shows that at Silverbell we have 492 nests per hectare and two species, *Pheidole xerophila tucsonica* and *Pogonomyrmex pima*, which comprise some very important populations.

In surveying the nests of *Veromessor pergandei*, *Pogonomyrmex rugogus*, *Novomessor cockerelli* and *Acromyrmex versicolor* on a surface of 3 ha, Professor Werner found a density per hectare of 6, 4, 14 and 6 nests, respectively.

These results are not different from those found by the quantitative method used, with the exception of *Veromessor pergandei*. At all times, this species constructs its nest in the soil and the entrance is generally a simple opening which is often very difficult to find.

Santa Rita Treated Site

The quantitative study necessitated sampling 950 squares, 1 x 1 m, with a surface area of 950 m^2. Statistical analysis of our data shows that, with regard to results on the number of nests, with $\alpha = 0.05$, the margin of error of the nest-counting is 14.4% (dr = 14.4%).

The confidence interval of the average is

$$0.179 \leqslant 0.193 \leqslant 0.207$$

The presence of at least one nest on the sampled area, the total number of nests and the occurrence of at least one nest per species and sampled area are shown in Table 9.

Table 9. Quantitative analysis of the Santa Rita treated site

Species	Number of nests sampled	Number of nests/m^2	Number of nests/ha
Sample areas with nests	171		
Number of nests	183	0.19263	1926
1. *Pheidole xerophila tucsonica*	23	0.02421	242
2. *Pogonomyrmex desertorum*	21	0.02210	221
3. *Pheidole pilifera artemisia*	19	0.02000	200
4. *Pogonomyrmex pima*	19	0.02000	200
5. *Iridomyrmex pruinosum analis*	19	0.02000	200
6. *Pheidole spadonia*	16	0.01684	168
7. *Dorymyrmex pyramicus*	11	0.01157	116
8. *Crematogaster coarctata vermiculata*	10	0.01052	105
9. *Solenopsis aurea*	10	0.01052	105
10. *Novomessor cockerelli*	8	0.00842	84
11. *Acromyrmex versicolor*	6	0.00631	63
12. *Pogonomyrmex rugosus*	5	0.00526	53
13. *Veromessor pergandei*	4	0.00421	42
14. *Solenopsis xyloni*	3	0.00315	32
15. *Forelius foetidus*	3	0.00315	32
16. *Pheidole vallicola*	3	0.00315	32
17. *Pheidole desertorum*	2	0.00210	21
18. *Myrmecocystus mimicus*	1	0.00105	11

Table 9 shows that there are 1926 nests per hectare. It also shows that two species, *Pheidole xerophila tucsonica* and *Pogonomyrmex desertorum*, are quite abundant. Also, *Pheidole pilifera artemisia*, *Pogonomyrmex pima*, *Iridomyrmex pruinosum analis* and *Pheidole spadonia* maintain abundant populations in this habitat.

Tables 8 and 9 show that ants support four times more colonies at Santa Rita than at Silverbell.

The Santa Rita treated site is characterized specifically by the much higher populations of *Pheidole spadonia*, *Pogonomyrmex desertorum*, *Dorymyrmex pyramicus*, *Crematogaster coarctata vermiculata* and *Solenopsis aurea*. *Pheidole pilifera artemisia* and *Iridomyrmex pruinosum analis* also differentiate the two sites.

Solenopsis xyloni, *Forelius foetidus* and *Veromessor pergandei*, although supporting identical populations at the two sites, are, relative to other species, much more important at Silverbell than at Santa Rita.

Santa Rita Control Site

The quantitative study required the sampling of 850 squares, 1 x 1 m, and a total surface area of 850 m^2.

Statistical analysis of our data shows that, with regard to results of the number of nests, with $\alpha = 0.05$, the margin of error of the nest counts is 15.5% (dr = 15.5%).

The confidence interval of the average is

$$0.146 \leqslant 0.173 \leqslant 0.2000$$

The presence of at least one nest per sample area, the total number of nests and the occurrence of at least one nest per species and sample area, are shown in Table 10.

Inspection of Table 10 shows that there are 1753 nests per hectare and that *Crematogaster coarctata vermiculata* supports very high populations, as does *Forelius foetidus.*

Is there a difference in the quantitative study between the two sites at Santa Rita? There are no quantitative differences based on the number of nests (1926/1753). On the other hand, at a specific point, the pattern of the fauna is very different at the two sites. The Santa Rita control site is characterized by the presence and abundance of *Crematogaster coarctata vermiculata* and *Forelius foetidus* nests, whereas the Santa Rita treated site is differentiated by the presence and abundance of *Pheidole xerophila tucsonica*, *Pheidole pilifera artemisia*, *Iridomyrmex pruinosum analis*, *Pheidole spadonia* and *Pogonomyrmex desertorum* nests.

Conclusion

In a very general way, and from a quantitative viewpoint, the ant populations differ significantly from one site to another. The three sites are differentiated from each other not only by the presence of very numerous nests at Santa Rita compared to Silverbell, but also by a well-developed community of *Pheidole xerophila tucsonica* and *Pogonomyrmex pima* at Silverbell; by a dense population of *Pheidole xerophila tucsonica*, *Pheidole pilifera artemisia*, *Iridomyrmex pruinosum analis*, *Pheidole* *spadonia* and *Pogonomyrmex desertorum* at Santa Rita treated; and by an elevated community of *Crematogaster coarctata vermiculata* and *Forelius foetidus* at the Santa Rita control site.

From a qualitative viewpoint, Santa Rita sites are distinguished from the Silverbell site by a fauna which especially includes *Pogonomyrmex desertorum*, *Pogonomyrmex maricopa*, *Myrmecocystus mexicanus hortideorum*, *Pseudomyrmex apache*, *Camponotus mina zuni* and *Myrmecocystus mimicus*. The Santa Rita control site is differentiated from the treated site by the presence of *Forelius foetidus*, *Camponotus mina zuni*, *Pseudomyrmex apache* and *Myrmecocystus mimicus*, and the absence of *Myrmecocystus mexicanus hortideorum* and *Iridomyrmex pruinosum analis*.

Is it possible to explain the differences between the ant communities on the three sites? Several factors can be advanced to explain these differences: 1) the macroclimate, which is much colder and more humid at Santa Rita; 2) geologic nature of the soil; the soil at Silverbell being very rocky and compact, and less rocky and sandier at Santa Rita; 3) the vegetation; the herbaceous stratum being more important at Santa Rita and the shrubby vegetation also very different, not only in density but also in species composition. It is absent from the Santa Rita treated site.

Estimation of the Workers' Biomass

Relation Between the Daily Activity of Ants and Temperature

The results relative to the relation between temperature and workers' activity must be treated in the same manner as those relative to the biomass estimation; they must be confirmed by other observations made during several periods in the year and must be assigned only provisional values.

The method we propose, and which we used to estimate the biomass of the workers, necessitates a knowledge of the relationship between activity of the workers and temperature at ground level.

In general, at the sites we studied, the activity of the workers searching for food can be classified as: solely nocturnal activity: *Myrmecocystus mexicanus hortideorum*, *Camponotus fumidus festinatus;* nocturnal and dirunal activity: *Novomessor cockerelli*, *Crematogaster clara*, *Solenopsis xyloni;* only diurnal activity: *Veromessor pergandei*, *Pheidole xerophila tucsonica*, *Pogonomyrmex rugosus*, *Pogonomyrmex pima*, *Pheidole pilifera artemisia*.

This list is not restrictive: we have reliable information only for these species. We could not prove whether the nocturnal activity of the aforementioned species was due to temperature or to light.

Table 11 shows the relationship between the activity of workers of five ant species and temperature.

Table 10. Quantitative analysis of the Santa Rita control site

Species	Number of nests sampled	Number of nests/m^2	Number of nests/ha
Sample areas with nests	144		
Number of nests	149	0.17529	1753
1. *Crematogaster coarctata vermiculata*	54	0.06352	635
2. *Forelius foetidus*	15	0.01764	176
3. *Pogonomyrmex pima*	11	0.01294	129
4. *Solenopsis aurea*	10	0.01176	118
5. *Pogonomyrmex desertorum*	10	0.01176	118
6. *Acromyrmex versicolor*	9	0.01058	106
7. *Dorymyrmex pyramicus*	9	0.01058	106
8. *Pheidole xerophila tucsonica*	6	0.00705	71
9. *Novomessor cockerelli*	4	0.00470	47
10. *Pheidole desertorum*	4	0.00470	47
11. *Pheidole pilifera artemisia*	3	0.00352	35
12. *Iridomyrmex pruinosum analis*	2	0.00235	24
13. *Solenopsis xyloni*	2	0.00235	24
14. *Myrmecocystus mexicanus hortideorum*	2	0.00235	24
15. *Pheidole spadonia*	2	0.00235	24
16. *Veromessor pergandei*	1	0.00117	12
17. *Pogonomyrmex maricopa*	1	0.00117	12
18. *Pheidole hyatti*	1	0.00117	12
19. *Camponotus fumidus festinatus*	1	0.00117	12
20. *Myrmecocystus semirufa*	1	0.00117	12
21. *Trachymyrmex desertorum*	1	0.00117	12

Veromessor pergandei, *Pheidole xerophila tucsonica* and *Pogonomyrmex pima* react in the same manner to temperature; their maximum activity is found between 34-36 C.

The higher number of workers of *Veromessor pergandei* at the temperature of 22 C comes from the fact that this temperature determines the massive exit of workers.

Forelius foetidus shows a maximum activity between 44 and 50 C; *Pogonomyrmex rugosus* at 44 C; *Novomessor cockerelli* becomes active only after the sun sets (1815 hr), with a maximum activity between 22-23 C.

Estimation of the Number of Workers in Search of Food (by Species and per Hectare)

The quantitative study of workers required the sampling of 1028 squares, 50 x 50 m.

The inclement weather did not permit a very large sampling regime.

Statistical study of these partial results shows that for the data on the number of workers, with $\alpha = 0.05\%$, the margin of error when counting is 27% (dr = 27%).

Table 12 shows the number of workers recorded for six species of ants presented in the same way as biomass per hectare.

The example of *Veromessor pergandei* allows us to explain the method we used.

Table 11. Relation between the activity of workers and the temperature at ground level

Veromessor pergandei September 25, 1972				*Forelius foetidus* September 25, 1972			
Time (hr)	Temp. at ground level (°C)	No. of workers during 30 sec	% activity	Time (hr)	Temp. at ground level (°C)	No. of workers during 30 sec	% activity
0700	20	0	-	0700	20	0	-
0730	22	43	-	0830	22	13	20
0745	22	8	16	0855	23	10	20
0800	23	12	25	0910	30	12	20
0825	25	32	65	0920	32	16	27
0840	30	39	80	0935	38	27	46
0845	31	47	95	1000	40	28	48
0900	34	49	100	1010	42	31	53
0905	36	49	100	1015	44	56	-
0925	38	48	98	1045	46	50	100
0950	42	15	35	1100	50	56	-
1000	43	17	35	1145	52	52	-
1020	44	0	0	1200	54	27	-
				1330	52	33	-
				1400	50	74	-
				1415	48	43	-
				1430	46	47	-
				1520	44	51	-
				1630	42	31	-
				1650	40	23	-
				1715	32	11	-
				1720	30	12	-
				1730	28	14	-
				1745	26	2	-
				1750	26	0	-

Table 12. Number of workers in search of food, September-October 1972, Silverbell site

Species	No. of workers found		No. of potential workers		No. of workers/nest		No. of workers/ha		Biomass (g dry wt/ha)	
	Without seeds	With seeds	Without seeds	With seeds	Without seeds	With seeds	Without seeds	With seeds	Without seeds	With seeds
1. *Veromessor pergandei*	224	82	410	186	24	11	30,030	13,623	10.8	4.9
2. *Forelius foetidus*	45	-	80	-	16	-	22,413	-	0.11	-
3. *Pogonomyrmex pima*	55	5	91	10	2.2	0.24	10,117	1,112	0.60	0.06
4. *Pheidole xerophila tucsonica*	223	256	313	371	8.7	10.3	64,955	76,991	0.72	1.0
5. *Novomessor cockerelli*	29	-	115	-	11.5	-	8,949	-	23.87	-
6. *Pogonomyrmex rugosus*	108	54	141	73	35.3	18.3	5,486	2,841	30.12	15.60
Total							141,950	94,567		

Workers of the species *Veromessor pergandei* (306 individuals) were counted in the following temperature distributions (temperatures in °C on the left of each column; individuals counted on the right):

22 — 145	30 — 3	40 — 40
24 — 22	32 — 3	42 — 62
26 — 6	34-36 — 9	44 — 1
28 — 3	38 — 11	

In taking into account the percentage of activity of the workers (Table 11), the number of potential workers at different temperatures (°C) is 22 C, 151; 24 C, 63; 26 C, 9; 28 C, 4; 30 C, 4; 32 C, 3; 34-36 C, 9; 38 C, 11; 40 C, 59; 42 C, 183; 44 C, 100.

In addition to counting the workers, we noted whether or not they had gathered seeds.

Workers of the *Veromessor pergandei* species came from 17 nests.

The number of workers per hectare is obtained by multiplying the potential number of workers by 32/17, and the number obtained by 10,000/257,

where

32 = the number of nests estimated per hectare of *Veromessor pergandei*
17 = the number of nests from which the ants were collected
10,000 = the surface area of a hectare (m^2)
257 = number of square meters sampled

A similar rationale for other species gives us the number to calculate the biomass of the workers in search of food: 236,517, which is around 250,000 for the species of *Veromessor pergandei, Forelius foetidus, Pogonomyrmex pima, Pheidole xerophila tucsonica, Novomessor cockerelli* and *Pogonomyrmex rugosus.*

Estimation of the Biomass of Workers

Ayre (1962) estimates that for *Formica exsectoides,* the number of workers which search for food represents only 11-18% of the population of workers in the nest; for *Camponotus herculeanus* it is only 4%. Chew (1960) estimates that for *Pogonomyrmex occidentalis,* this percentage varies between 6 and 17% (in one case 50%).

In view of these results, and as our study was conducted in only one habitat, the percentage we adopted to calculate the biomass of the workers is 15%.

Table 13 shows information on the biomass of workers of different species.

The biomass expessed as number of workers per hectare is around 1,600,000. *Pheidole xerophila tucsonica* has a biomass of 946,300/ha. It is the most important species numerically, whereas *Novomessor cockerelli* and *Pogonomyrmex rugosus* are less important numerically.

Table 13. Biomass of workers

Species	No. of workers/ha	g/ha *	kcal/ha
1. *Veromessor pergandei*	291,020	105	662
2. *Forelius foetidus*	149,420	1	6
3. *Pogonomyrmex pima*	74,860	5	32
4. *Pheidole xerophila tucsonica*	946,307	11	69
5. *Novomessor cockerelli*	59,660	159	1003
6. *Pogonomyrmex rugosus*	55,513	305	1923
Total	1,576,780	586	3696

* 1 g dry wt = 6308.52 cal (Petal 1967).

In order to express the biomass in dry weight, we weighed the workers and obtained the following results: 19 *Novomessor cockerelli* weigh 50.67 mg; 20 *Pogonomyrmex rugosus* weigh 109.80 mg; 30 *Veromessor pergandei* weigh 10.8 mg; 5 *Pogonomyrmex pima* weigh 0.30 mg; 27 *Forelius foetidus* weigh 0.13 mg; and 38 *Pheidole xerophila tucsonica* (36 workers, 2 soldiers, 5% proportion) weigh 0.42 mg.

The biomass of workers expressed in grams is 586 g/ha. More than half of this biomass comes from *Pogonomyrmex rugosus.*

The results obtained are of the same order as those obtained by W. Nutting (pers. comm.) for the biomass of termites.

Ants and the Vegetation

The herbaceous or shrubby vegetation not only furnishes a microclimate very different from the macroclimate, but is also utilized as a food source for certain species (*Novomessor, Pogonomyrmex, Pheidole*) or as a place for nesting (*Camponotus, Pseudomyrmex*).

Seeds of *Tridens pulchellus* Hitch. are particularly appreciated by *Pheidole xerophila tucsonica, Pogonomyrmex rugosus, Veromessor pergandei, Pheidole pilifera artemisia, Pogonomyrmex pima, Novomessor cockerelli, Forelius foetidus* and *Camponotus fumidus festinatus.* The first four species cited use this food resource almost exclusively. The shrubby vegetation is the basis of two food sources available to the ants; the leaves and the sap.

The leaves of *Larrea tridentata* are abundantly gathered by *Acromyrmex versicolor*, and occasionally by *Novomessor cockerelli.*

Table 14 shows the percentage of trees and shrubs visited by different ant species.

At Silverbell, half the *Cercidium microphyllum* are visited by *Iridomyrmex pruinosum analis,* whereas 80% of the *Prosopis juliflora* are visited by *Iridomyrmex pruinosum analis* and *Forelius foetidus.*

Table 14. Species visiting trees and shrubs

Formicidae	Silverbell			Santa Rita	
	Cercidium microphyllum	*Larrea tridentata*	*Prosopis juliflora*	*Prosopis juliflora*	*Cercidium* sp.
1. *Iridomyrmex pruinosum analis*	50% *	-	20%	-	-
2. *Forelius foetidus*	-	-	60%	33%	20%
3. *Camponotus mina zuni*	-	-	-	60%	7%
4. *Myrmecocystus semirufa*	-	-	-	20%	-
5. *Crematogaster coarctata vermiculata*	-	-	-	7%	-
6. *Crematogaster arizonensis*	-	-	-	-	13%
7. *Acromyrmex versicolor*	-	-	-	13%	-
8. *Pseudomyrmex apache*	-	-	-	27%	-
	5 = 50%	0	8 = 80%	14 = 93%	6 = 40%

* percentage shows number of trees visited by workers.

Table 15. Species nesting in plant roots

Plants	*Pogonomyrmex pima*	*Novomessor cockerelli*	*Pheidole hyatti*	*Pheidole desertorum*	*Pheidole vallicola*	*Solenopsis xyloni*	*Solenopsis aurea*	*Crematogaster coarctata vermiculata*	*Iridomyrmex pruinosum analis*	*Forelius foetidus*		
	Control											
Gramineae												
1. *Cottea pappophoroides* Khunth.							1				1	1
2. *Muhlenburgia porteri* Scribn.		1						6			2	7
3. *Aristida hamulosa* Henr.			1			1		10	1	6	5	19
4. *Aristida ternipes* Cav.								2			1	2
5. *Trichachne californica* (Benth.)								1			1	1
6. *Setaria macrostachya* K.H.B.								1		1	2	2
Malvaceae												
7. *Sida spinosa* L.									1		1	1
Compositae												
8. *Aplopappus tenuisectus* (Greene) Blake								13		1	2	14
9. *Zinnia pumila* Gray.								15		1	2	16
Species		1	1	-	-	1	1	7	2	4		
Nests		1	1	-	-	1	1	48	9	9		62
	Treated											
Malvaceae												
Sida spinosa L.		1								1	2	2
Compositae												
Aplopappus tenuisectus (Greene) Blake	1	1		1	1		1	2	1		7	8
Zinnia pumila Gray	1							1			2	2
Species	2	2	-	1	1	-	1	2	1	1		
Nests	2	2	-	1	1	-	1	3	1	1		12

At Santa Rita, *Prosopis juliflora* is intensively used by ants and less than half the *Cercidium* sp. are visited by three species. Furthermore, *Camponotus mina zuni* and *Pseudomyrmex apache* nest in *Prosopis*, and *Crematogaster arizonensis* in *Cercidium*.

Vegetation as a Nesting Microclimate

At the Silverbell site, few species nest in the roots of plants. *Iridomyrmex pruinosum analis* nests in the roots of *Aristida ternipes* Cav.; *Pheidole xerophila tucsonica* in the roots of *Ambrosia deltoidea* and *Tridens pulchellus* Hitch.; *Crematogaster clara* and *Solenopsis xyloni* nest in roots of *Ambrosia deltoidea* Torr and *Novomessor cockerelli* in those of *Ambrosia dumosa* Gray and *Larrea tridentata* Coville.

Table 15 shows the ant species nesting in diverse plants at Santa Rita and reveals that *Aristida hamulosa* Henr. is the grass which offers the most favorable nesting microhabitat to the ants.

Crematogaster coarctata vermiculata nests in almost all roots of plants observed and particularly in *Aristida hamulosa* Henr., *Aplopappus tenuisectus* Blake and *Zinnia pumila* Gray. The last two (Compositae) seem to offer very favorable nesting to that ant species.

Table 16. Nesting methods at sites (as percentage of total number per site)

Sites	Types of nesting													
	Crater * d≤5cm h:1-2cm	Crater d:5-7cm h:1-3cm	Crater d:8-10cm h:3-5cm	Crater d≥10cm	Crater d:10cm and plant debris	Crater in shade of plant	Under rock	Simple opening	Simple opening in shade of plant	Under dead plant	In plant roots	Dome	In trees	Number of nests
Silverbell	6	10	21	6	6	4	19	28	2	3	6	0	0	127
Santa Rita treated	11	5	7	7	3	3	0	41	4	1	13	5	0	202
Santa Rita control	3	4	6	6	1	3	3	28	1	7	33	3	3	191

* d = diameter; h = height.

Table 16, continued

Pheidole xerophila tucsonica September 30, 1972				*Pogonomyrmex rugosus* September 9, 1972				*Novomessor cockerelli* October 15, 1972			
Time (hr)	Temp. at ground level (C°)	No. of workers during 30 sec	% activity	Time (hr)	Temp. at ground level (C°)	No. of workers during 30 sec	% activity	Time (hr)	Temp. at ground level (C°)	No. of workers during 30 sec	% activity
0800	24	13	50	0730	22	0	-	0700	20	1	2
0830	26	14	50	0745	24	9	35	0815	25	1	2
0840	28	15	60	0800	26	10	40	0845	31	1	2
0850	30	19	76	0805	28	20	70	0955	44	1	2
0855	32	22	95	0810	30	19	70	1100	50	0	0
0900	34	24	100	0820	32	21	70	1730	28	1	2
0905	36	26	100	0830	34	18	70	1815	24	40	87
0930	40	13	50	0845	36	21	70	1830	24	40	
0945	42	9	36	0855	38	18	70	1900	24	39	87
1000	44	2	8	0905	40	22	90	1945	23	46	100
1015	45	0	0	0930	44	25	100	2015	22	44	100
				0945	46	18	70	2045	22	45	100
				1005	48	11	40	2110	21	42	93
				1010	50	10	40	2125	20	41	90
				1030	52	5	20	2230	20	40	87
				1050	53	1	4	2245	20	40	87
				1100	54	0	0	rain			

In the treated site, it seems that *Aplopappus tenuisectus* Blake offers the most favorable microhabitat for nesting to the ants.

Nesting of the Ants at the Sites

At the three sites studied, is it possible to bring to light the differences in nesting technique of the ant species? We would like to respond to this question, as the study of nesting, in addition to its intrinsic value, is the logical complement of an ecological investigation.

Types of Nests at the Three Sites

Table 16 shows that workers constructing nests use the most abundant material in their biotype. Certain types of nests are found in all biotypes (in craters, in the soil with a simple ground-level opening, under dead plants).

On the other hand, certain types of nests are found only at one or two sites (dome-shaped nests, nests in trees, nests under rocks), or are found in a much greater proportion at one or another of the sites (in the roots of plants, under dead plant material). This difference in nesting is explained by the difference between both the vegetation type at the sites and the soil characteristics found in the first 10 cm.

Silverbell—The crater-like nests make up 55% of the total number of nests.

Pheidole xerophila tucsonica and *Pheidole pilifera artemisia* occupy more than 90% of the small crater-like nests. The average-sized, crater-like nests are mostly occupied by *Pheidole xerophila tucsonica* (30%), while the larger crater-like nests are generally the work of *Veromessor pergandei*, *Novomessor cockerelli* and *Acromyrmex versicolor*.

Nests under rocks (19%) are usually occupied by *Pogonomyrmex pima* (38%) and *Solenopsis xyloni* (33%).

Nests in the soil with a simple opening (28%) are occupied by *Pogonomyrmex pima* (31%), *Pheidole xerophila tucsonica* (26%) and *Forelius foetidus* (17%).

Acromyrmex versicolor (100%), *Novomessor cockerelli* (70%), *Veromessor pergandei* (60%) and *Pheidole xerophila tucsonica* build crater-like nests.

Solenopsis xyloni nests were generally under rocks (57%).

Nests of *Forelius foetidus* are recognized by a simple opening (55%). Those of *Pogonomyrmex rugosus* are also recognized by a simple opening (50%) or are constructed in crater form (50%). *Pogonomyrmex pima* builds crater-like nests (31%), nests under rocks (31%) or in the soil with a ground-level opening (38%).

Santa Rita treated site—Nests built in the soil are recognized by a simple opening (41% of nests found) and are occupied by *Pogonomyrmex rugosus* (9%), *Pogonomyrmex pima* (13%), *Pheidole xerophila tucsonica* (11%), *Pheidole pilifera artemisia* (18%), *Pheidole spadonia* (18%) and *Dorymyrmex pyramicus pyramicus* (12%).

Soil nests surmounted by a crater (36%) are occupied as follows: small nests by *Pheidole xerophila tucsonica, Pheidole pilifera artemisia* (65%); medium nests by *Pogonomyrmex pima* (20%) and *Pogonomyrmex desertorum* (70%); large nests by *Veromessor pergandei, Novomessor cockerelli* and *Acromyrmex versicolor.*

The nests built in plant roots (13%) are occupied by *Iridomyrmex pruinosum analis* (35%), *Crematogaster vermiculata* (20%) and *Pheidole vallicola* (11%).

Acromyrmex versicolor (100%) and *Novomessor cockerelli* (50%) build nests in the soil, surmounted by a crater.

Solenopsis aurea builds crater-like nests (10%) in the soil with a simple ground-level opening (40%), nests under plant debris (10%), nests in the roots of plants (20%) and nests in a dome-like shape (20%).

Pogonomyrmex pima, Pogonomyrmex desertorum, Pheidole xerophila tucsonica and *Pheidole pilifera artemisia* build nests in the soil with ground-level openings (60, 30, 60 and 20%, respectively), or surmounted by a crater (30, 65, 40 and 80%, respectively).

Pheidole spadonia (95%) and *Dorymyrmex pyramicus pyramicus* (8%) build nests in the soil with a ground-level opening. *Pheidole vallicola* (100%, only three nests), *Iridomyrmex pruinosum analis* (75%) and *Crematogaster coarctata vermiculata* (50%) nest in the roots of plants.

Santa Rita control site—Nests in the roots of plants (33% of the nests found) are generally occupied by *Crematogaster coarctata vermiculata* (75%), *Forelius foetidus* (15%) and *Iridomyrmex pruinosum analis* (5%).

Nests built in the soil that are recognized by a simple opening (28%), are occupied by several species including *Dorymyrmex pyramicus pyramicus* (17%), *Pogonomyrmex pima* (17%), *Pogonomyrmex desertorum* (7%), *Acromyrmex versicolor* (8%), *Pheidole xerophila tucsonica* (9%) and *Solenopsis aurea* (8%).

Nests built in the soil and surmounted by a crater (23%) are usually as follows: large nests, *Pogonomyrmex maricopa, Veromessor pergandei, Novomessor cockerelli, Acromyrmex versicolor;* average nests, *Myrmecocystus semirufa, Myrmecocystus mimicus, Myrmecocystus mexicanus hortideorum, Dorymyrmex pyramicus bicolor;* small nests, *Forelius foetidus, Pheidole xerophila tucsonica, Pheidole pilifera artemisia* and *Iridomyrmex pruinosum analis.*

Acromyrmex versicolor and *Pogonomyrmex desertorum* build nests in the soil, characterized either by a crater (60%, 60%) or with a simple ground-level opening (40%, 40%).

Solenopsis aurea nests either under rocks (20%), in dead plant material (30%) or in the soil with a ground-level opening (40%).

Pogonomyrmex pima (75%), *Pheidole xerophila tucsonica* (70%) and *Dorymyrmex pyramicus pyramicus* (100%) build nests in the soil with a simple ground-level opening.

Crematogaster coarctata vermiculata (95%) and *Forelius foetidus* (50%) nest in the roots of plants. *Pseudomyrmex apache* and *Crematogaster arizonensis* nest in trees.

Conclusion

Study of nesting methods of ants in the three sites showed that the ants are distinguished by nesting technique in addition to other factors. Vegetation structure, as well as structure and texture of the soil in the first few centimeters, help explain the differences in nesting methods.

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