Demography, Foraging Activity of Leaf-Cutter Ants, Acromyrmex Versicolor, in Relation to Colony Size and Location, Season, Vegetation and Temperature

F. G. Werner
S. L. Murray

Follow this and additional works at: https://digitalcommons.usu.edu/dbiome_memo

Part of the Earth Sciences Commons, Environmental Sciences Commons, and the Life Sciences Commons

Recommended Citation

This Article is brought to you for free and open access by the US/IBP Desert Biome Digital Collection at DigitalCommons@USU. It has been accepted for inclusion in Memorandum by an authorized administrator of DigitalCommons@USU. For more information, please contact digitalcommons@usu.edu.
RESEARCH MEMORANDUM

RM 72-33

DEMOGRAPHY, FORAGING ACTIVITY OF LEAF-CUTTER ANTS, ACROMYRMEX VERSICOLOR, IN RELATION TO COLONY SIZE AND LOCATION, SEASON, VEGETATION AND TEMPERATURE

F.G. Werner & S.L. Murray

DESKET BIOME
U.S. INTERNATIONAL BIOLOGICAL PROGRAM
1971 PROGRESS REPORT

DEMOGRAPHY, FORAGING ACTIVITY OF LEAF-CUTTER ANTS, *ACROMYRMEX VERSICOLOR*, IN RELATION TO COLONY SIZE AND LOCATION, SEASON, VEGETATION, AND TEMPERATURE

F.G. Werner

And

Steven L. Murray

Department of Entomology
University of Arizona

Tucson, Arizona

MARCH 1972

The material contained herein does not constitute publication. It is subject to revision and reinterpretation. The authors request that it not be cited without their expressed permission.
ABSTRACT

Foraging activity was monitored at variable times during the period from April 15, 1971, to December 31, 1971, at 39 foraging entrances of 33 colonies. The observed colonies were all on one 0.36 ha subplot of the undisturbed Santa Rita Validation Site. Visual methods were used to collect data, and incidental observations on nest structure, flights of alates, and colony maturity are included.

The workers foraged in columns along trail routes, and used different trails to different forage sources through the monitored seasons. Foraging period was nocturnal in the summer, crepuscular in spring and fall, and diurnal in winter. Initiation and cessation of daily foraging was influenced by nest location; summer rainfall induced maximum foraging.

*Prosopis juliflora* was the most abundant forage source, and *P. juliflora* leaflets were the most often taken forage material. When prostrate annuals, *Allionia cordata* and *Euphorbia melandenia*, were foraged, the entire plant was sectioned and removed. The flower parts of all plants taken were favored over vegetative material.
I N T R O D U C T I O N

Leaf-cutter ants remove both fresh-cut and dry plant parts from their foraging area, with resulting impact on the living plants they select and on surface accumulation of detritus. The material gathered is utilized by the ants to culture a fungus in deep chambers. The fungus is apparently the ants' only food.

The favored plant species may be very heavily consumed in this way, the chance for consumption apparently being dependent on attractiveness, location, and season. The original research design was based on the assumption that one could arrive at an estimate of consumption by calculating colony size (and therefore demand for plant material), attractiveness of individual plant species, and foraging intensity in relation to distance from the nest entrance.

With the realization that obtaining a measurement of colony size by direct methods was not a reasonable assumption, attention was given to the concept of regarding colonies as units and nest entrances as holes that consume plant parts. The intention now is to obtain information about the effects of weather conditions and related factors, availability of suitable plants, and perhaps time of year, on intensity of foraging activity (or rate of consumption of plant parts by the nest entrances).

Once these factors can be calculated, it should be possible to ascertain foraging intensity on a site at a relatively few points in time and to extrapolate to cover a longer period by the use of weather records made at the site. Effects on individual plant species would depend on when they produced favored parts, and on their location in relation to established colonies.

O B J E C T I V E S

The stated over-all objectives of the project are: "To measure the quantity and composition of plant parts moved into nests and relate them to colony size, location, and plants available. To establish rate of development of immature stages and longevity of adults under known conditions."

The first objective in 1971 was to excavate enough nests to obtain a base figure for colony size, and to obtain adults, larvae, and fungus for the establishment of observation nests in the laboratory. This objective was only partly achieved. Its lack of success influenced a realignment of objectives toward a more detailed analysis of patterns of surface activity.

The principal objective in 1971 became a careful monitoring of all aspects of surface activity, in relation to weather, soil, and plant cover variables.

M E T H O D S

Observations were concentrated on surface activity on a 0.36 ha subplot of the undisturbed Santa Rita Validation Site. In 1970 the nest entrances of all of the larger ant species had been marked on this subplot and two other plots. This subplot was found to have a large number of leaf-cutter ant colonies. It is located near the weather-monitoring tower; weather records made at the tower would obviate the need for keeping and processing independent records. Studies of soil moisture and structure carried out in the near vicinity would provide additional information. Personal observations of vegetation patterns could be related to a broader pattern on the site as a whole.
The methods of observation used are indicated in the Informative Abstract of DSCODE A3UWH04 (leaf-cutter ant foraging), as follows: "Visual observation for: light conditions, entrance conditions, activity pattern, food taxon, part and state. Mechanical hand Veeder for number of individuals, compass for direction. Metal metric tape for distance. Estimate for surface area." Experimental design: "Weekly visits to marked nests for the duration of the daily activity period."

The study period visits were variable in length, especially through June 3, 1971, as interest was in the initiation and cessation of foraging activity more than in a total description of the foraging period. Full foraging period data were taken starting June 9-10, 1971, to get a picture of foraging pressure in the dry season, before much plant material was available. Full foraging period data were continued for the duration of the study, ending December 2, 1971.

During each study visit, a complete circuit was made, with an observation at each colony entrance. Every circuit followed the same route and order of colony sampling. The time consumed varied from 15 minutes to 2 hours. The number of circuits made during a study visit varied also with the amount of activity. At the start and end of foraging, they were made more frequently, in order to delimit the beginning and the end with some precision. Observation circuits were therefore from 1 to 5 hours apart.

Each sample shows the number of colony foraging entrances active at the time of the sample circuit. For every active entrance there is a record of the maximum distance workers were from the entrance, and the direction and area of the foraging. The number of workers leaving and the number returning to the entrance were counted for a period of 1 minute. Over 10,000 observations were made at 39 foraging entrances, but this figure includes many records of no activity.

When there was activity, it was classed as being either at the entrance, around the entrance, or as foraging. If it was foraging, the traffic count was always made at the same location close to the entrance. The kind of material being brought in was determined, as well as its condition. After the observations near the entrance were completed, the distance to which foraging proceeded was measured as a straight line, and the compass angle noted. An estimate of the area foraged was made by tracing the foraging group back to the entrance.

**FINDINGS**

**Activity Period**

The data obtained from the foraging observations have not been fully analyzed as yet, but there are some obvious trends that can be reported at this time.

During the extremely dry period of June, there was foraging by some of the colonies during the night, with a peak number near dawn, when the temperature was lowest (and the RH presumably highest). Foraging started gradually after sunset and stopped abruptly soon after sunrise (Fig. 1).

Rainy weather and cloud cover changed this pattern dramatically, increasing not only the foraging period but the number of colonies involved. Figure 2 shows the activity pattern during a 24-hour period that includes an afternoon rain. Foraging started rapidly following the rain and stopped abruptly the following morning. Activity remained intense during the rainy season through the flight of alates from the nests.

Late in the season, cool nights limited foraging activity more and more, until all of it was diurnal. If the day was cool, there was no foraging at all.
Figure 1. A foraging period in the dry season.

Figure 2. A foraging period in the rainy season. There had been complete cessation of foraging at 1945 hrs on the morning of July 14. The 0.3 in. of rainfall occurred between 1400-1700 hrs, and there was a light sprinkle of rain at 0000 hours. Initiation of foraging was at ca. 1700 hrs.
Plant Parts Taken

Records were kept of materials taken in foraging; by taxon, anatomical part, and physical condition. These data have not been analyzed either, but they have the potential of providing estimates of the material taken into the entrances. Fresh-cut plant parts were usually carried by all but a few workers returning to the nest; dry and dead material were less consistently carried, with from 25 to 75% of the workers returning with nothing.

Of the plant parts taken, *P. juliflora* leaflets (both fresh-cut and dry) were the material most often foraged. Various grasses were heavily foraged as tender new shoots at the start of the rains, and some utilization continued of dry, mature stems and blades. *Cercidium microphyllum* and some *Acacia greggi* also proved consistent as sources of fresh-cut leaflets. Two prostrate annuals, *Allionia incarnata* and *Euphorbia milandiana,* were taken in their entirety as fresh-cut material, with the former also being taken as dry, dead material. Flower parts of all plants taken were a popular choice, as fresh or dry material.

Relating the material moved to available plants will be done by mapping. Figures 3-5 show the location of the observed colonies, major shrubs and trees, and drainage pattern, of the plot. The wash and cover plants, in turn, influence the distribution of smaller perennials and annuals.

![Figure 3. Colonies on study plot.](image)

- Foraging entrance or excavation
- A single colony.
- Numbers identify the foraging entrance or entrances.
- X Indicates activity not included in study.
Figure 4. Major trees and shrubs.
- Prosopis juliflora
- Cercidium microphyllum
- Acacia greggi

Figure 5. Watershed pattern.
Location of Nests

Colony foraging entrances were mapped at the start of the study; active entrances on April 22, 1971, are shown in Figure 6. Those active at the end of the season, December 2, 1971, are shown in Figure 7. There was some shifting of entrances, some moving as far as 4.5 m. An arbitrary original judgment had been that each colony had only one foraging entrance. This position was abandoned when it was discovered that several colonies definitely used two, and one three, simultaneously.

Incidental Observations

Nest Structure. The basic underground nest plan of two partially excavated colonies seemed to be similar. At shallow depth (ca. 5-15 cm), storage chambers for plant parts were found around the entrance, with a single large tunnel leading straight down to the larger fungus chambers below. These chambers were clustered together and connected by short tunnels. Not all of them had fungus in them at the time of excavation, but these common features were observed: any fungus cultures found were suspended from small, blackened gravel bits (primarily quartz) protruding from the ceiling; a small, dead-end tunnel, packed with workers, was off the end of the chamber. Fungus chambers were located at a depth of from 2 to 3 m, in one case under a solid layer of caliche nearly 0.5 m thick.

Flights of Alates. Observations of reproductive flights were made daily during the early part of the rainy season by George Austin, who was conducting bird studies in the area. His help is gratefully acknowledged. Part of the flights are included in the surface activity records also. Flights occurred mainly on July 22, 1971, and August 8, 1971, with minor flights between. Alates appeared at the surface on a cloudless morning with no more than a light breeze, after a rainfall of greater than 0.9 in. during the previous 24 hours. The alates were at the surface as early as 0300 hrs, but they did not fly until sunrise at ca. 0530. Mating swarms formed over or to the leeward of trees and large shrubs. Copulation started in flight and continued after the pair had fallen to the ground. Swarming continued for ca. 3 hours after sunrise, with groups consisting entirely of males persisting longest.

Some dealate females were digging by ca. 2 hours after sunrise. They showed a marked preference for sites under trees and in the shade of dense shrubs. An area of ca. 1 m² might have from 5 to 30 females digging simultaneously, despite the presence of established colonies. Digging continued during the night for 2 to 3 days after the flight, the digging period being similar to the foraging period of established colonies. These new queens discontinued surface activity entirely after the initial digging. At this time the "nest" consisted of a single unbranched tunnel, ca. 10-15 cm deep, plugged at the surface and ending in one small chamber ca. 2 cm in diameter, containing the queen.

Colony Maturity and Activity. What were thought to be new, or at least relatively young, colonies did not engage in surface activity until after the summer rains had begun. The colonies that were active during the dry month of June were likely to change foraging entrances at the start of the rains and to produce the cones that are characteristic of this species as by-products of nest excavation. Excavation and cone production continued into the fall, on a more extended schedule than foraging activity. The only contact with the surface the workers have in this activity is during a short period as they bring particles to the top of the cone and drop them over the side. There were marked differences in the number of entrance changes and excavation cones associated with the observed colonies.
Figure 6. Foraging entrances April 22, 1971: 29 colonies.

Figure 7. Foraging entrances, December 2, 1971: 31 colonies.
Activity Period

The most obvious and abrupt changes in the amount and duration of foraging were brought about by rainfall, as shown in Figures 1 and 2. The more gradual, seasonal variations in temperature and insolation brought about slower modifications of the foraging period and, to some extent, the number of colonies engaged in foraging. The unknown factors of colony development and colony metabolism must play a role in the extent to which suitable foraging conditions are utilized. Since the reproductive flights are tied to the summer rains, development of the larval stages of the alates must take place during the dry season, which was very dry in 1971. Development of alate larvae in the nest could have increased the internal demand for foraging and fungus culture at a time when surface conditions were limiting and comparatively little acceptable plant material was available.

Plant Parts Taken

The apparent preference for *Prosopis juliflora* could be due to the simple fact that it is the most abundant of the acceptable plants on the plot. As dry material, the *P. juliflora* leaflets seemed to retain their shape and consistency better than those of *Cercidium microphyllum* and *Acacia greggi*, which are smaller and dry more thoroughly. The larger, more active colonies were all located under *P. juliflora* trees, and the shade did seem to allow longer foraging periods than were possible in exposed locations.

The general rule seems to be that there is only one foraging entrance per colony. The exceptions noted were recognizable by proximity, common foraging target and route, or sequence of opening. Multiple entrances were usually less than 2 m apart. In some cases workers engaged in excavation and the formation of gravel cones turned to foraging. Multiple foraging entrances were always associated with conditions of maximum foraging activity.

There were also cases in which a colony maintained only one foraging entrance at a time, but would change its location. The number and type of entrance shifts, along with the distribution and relative amount of excavation and cone production, could probably be used to estimate colony age. Although the foraging activity information gives a picture of relative foraging activity of a colony, the addition of information on entrances and cone could provide another measure of colony vitality.

**EXPECTATIONS**

The largest remaining job associated with the activity studies is an analysis of the data gathered in 1971. This analysis will form the basis of an M.S. thesis by S. Murray. Another attempt will be made to establish laboratory colonies by digging into established colonies at Santa Rita. This time a back hoe will be used to start the excavation and may be more successful. There is particular interest in the immature stages in the nest before the summer rains. In 1971 there were no immature stages at all at the time of the excavation. If the use of a back hoe proves feasible, one should be able to obtain a better picture of what is going on below the surface in relation to surface activity.

Plant preference studies at the Silverbell Site have yet to be undertaken. The colonies there are much less numerous and are more unevenly distributed. It is likely that not only will quite a different list of plants be recorded but also an insight will be gained into the minimum conditions necessary for colony establishment and survival.
The need for automatic monitoring has somewhat diminished since the accumulation of a year's information on activity by other methods. However, work shall continue on this form of obtaining information as a potential way to determine the strength of individual colonies in validation areas and for similar studies of other ant species. An attempt will be made again to develop a system based on photocells. If this is unsuccessful, there is a possibility that a relatively inexpensive time-lapse photographic unit may become available before the middle of the year.

We expect to complete the project by the end of summer, 1972.