AN ECOLOGICAL STUDY OF *FORMICA FORMICA EXSECTOIDES*[1]

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The mound building ant, *Formica formica exsectoides* Forel, is found in isolated villages and in a few isolated colonies in the state of Illinois. Talbot ('34) and Gregg ('44), in studies made of the Chicago region, found the *F. exsectoides* colonies there to be in isolated areas. A study made by Buren ('43) in the bordering state of Iowa revealed *F. exsectoides* occurring as individual colonies. These Iowa colonies were usually a great distance from each other.

A group of mounds of *F. exsectoides* is located one mile north of Macomb, Illinois, on U. S. highway 67. This ant village is distributed over an area of about 100 by 350 yards. In 1948, 288 ant mounds in this area were counted. There were also 53 mounds north and 3 south of the area mapped. Of these 225 were *F. exsectoides* mounds and 7 were *Formica formica fusca* mounds. The *F. exsectoides* mounds were distributed from 610 feet to 690 feet elevation, while the *F. fusca* mounds occupied an area from 650 feet to 660 feet elevation.

The mounds varied in size, the smallest being 8 cm. high by 20 cm. in diameter and the largest, 61 cm. high by 150 cm. in diameter. A noticeable feature of these mounds was the characteristic extended southern slope found in each.

The mounds were all located on sites which were well drained. Some low ground was found in the south central portion of the area studied. This area was evidently quite moist during a large portion of the year. No mounds were found in this area (fig. 1).

The purpose of this investigation was to map the distribution of the mounds of this group of colonies of *F. exsectoides,* to study the structure of these mounds and certain behavior characteristics of the colonies in each, and to attempt an analyses of the significance of certain environmental factors.

General Description of the Region

The vegetation[2] of the area is primarily composed of oak-hickory woods, but the cover on the higher elevations is predominantly *Maclura pomifera* Schneid. The trees identified were: *Carya ovata* Koch., *Catalpa speciosa* Warder., *Corylus americana* Walt., *Gleditsia triacan-*

[1] The writer wishes to acknowledge his indebtedness to R. M. Sallee for his assistance in identifying the ants and his many helpful suggestions.

[2] The nomenclature of Jones ('45) is used for the flora mentioned in this paper.

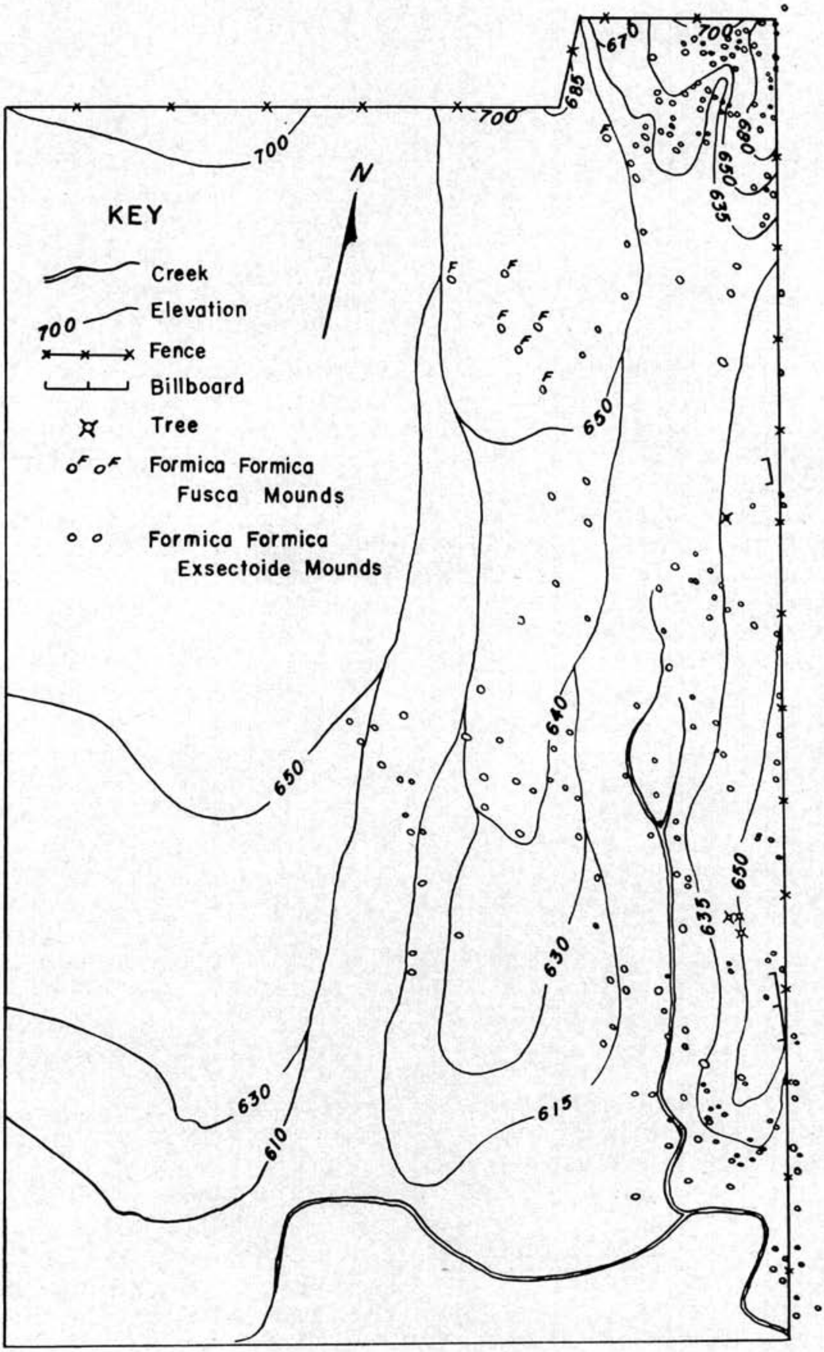

FIG. 1.—Map of area studied.

thos L., *Maclura pomifera* Schneid., *Malus ioensis* Britt., *Quercus velutina* Lam., *Quercus Marilandica* Muench., *Quercus macrocarpa* Michx., *Quercus stellata* Wang., *Quercus borealis* Michx., *Quercus alba* L., and *Robinia pseudoacacia* L.

The undergrowth vegetation is typical of that found in over-grazed pasture land.

The flora growing on various mounds was primarily Kentucky blue grass. Some mustard, shepherd's purse, sedge, peppercress, and bracted plantain were also observed. Some mosses and lichens were found growing on the lower elevations, which may indicate an acid soil.

Methods

The locations of the various mounds were plotted on a map (fig. 1). When the boundaries of the ant village were established, the area was measured and was found to be 100 yards east and west and 350 yards north and south. With the boundaries of the area measured, a scale map was prepared. Upon this map, contour lines were drawn in. Elevations were determined with the aid of an aneroid barometer. The aneroid barometer was checked at a bench mark which is 50 yards north of the Laboratory School of Western Illinois State College. The elevation at the bench mark is 702.3 feet above sea level.

The elevation readings were recorded in two hours on three different days. Several readings were made in order to compensate for humidity and temperature variation, factors which may affect the action of the barometer.

After the contours and the course of a creek were drawn on the map, the various mounds of *F. exsectoides*, together with the few mounds of *F. fusca* found, were plotted (fig. 1). All of the Formica mounds which occurred in the mapped area and in the immediate vicinity were counted.

From March 17 through April 7, 1949, daily observations were made between 3 and 4 P.M. These observations were primarily devoted to the general activity of the workers as it was related to general behavior outside of a mound. An attempt was made to measure humidity, air temperature, and the temperature inside the mound being studied to see if these factors might influence activity. A sling psychrometer was used to measure the relative humidity, and standard Centigrade mercury thermometers were used to measure the temperatures in the air and inside of the mound. Two measurements of mound temperature were made, three inches and 12 inches inside of the mound.

Observations

During the early fall months, September and October 1948, a great amount of the activity of the *F. exsectoides* was found to be devoted to gathering nectar from plants and aphids. The greatest numbers of ants were seen on *Q. alba, borealis, macrocarpa, marilandica, stellata,* and *velutina; Liatris clyindracea* Michx. (Blazing-star); and *Triosteum perfoliatum* L. (Horse-gentian). Herbaceous plants of *L. cylindracea* and *T. perfoliatum* seemed to be the hosts for the aphids, about which the ants were gathered in great numbers. Once in September a group of seven *F. exsectoides* were observed feeding on the remains of a monarch butterfly.

In late October little activity was observed on the mounds of either the *F. exsectoides* or the *F. fusca*. At this time it was noted that the entrances of thirty of the *F. exsectoides* mounds had been enlarged. Each of the entrances was 3 cm. across at the surface and tapered nearly to a point, 4 cm. inside of the mound. One *Colaptes auratus luteus* Bangs (Northern flicker) was observed pecking at the side of a *F. exsectoides* mound. After the *C. auratus luteus* had flown away, the investigator found the same type of opening in the side of the mound as had been seen on the other mounds.

From November until December no activities were observed. After four consecutive days of above freezing, sunshiny weather in January, the ants were slightly active. This type of intermittent activity was observed until March.

From March 17 through April 7, 1949, daily observations of the activities of the ants on and around the mounds were made. For the first week of the period, activity occurred entirely in one or two main opening burrows near the bases and on the extreme southern sides of the mounds. In all cases the activity seemed to be devoted to the carrying of pellets of earth from inside the mounds. On March 24, 28, and 29 some *F. exsectoides* were engaged in getting food. During this time four insect larvae and the rear thoracic leg and abdomen of a *Gryllus assimilis* Fab. (field cricket) were dragged into entrances of a mound. None of the *F. exsectoides* were seen moving about beyond the mounds. In the second week of the observation period, openings were made over the entire peripheries of the mounds, with pellets of earth being deposited around each of these openings. Some of the *F. exsectoides* were observed about five yards out from the mounds. This was the greatest distance, since the preceding September, that any ants had been seen ranging from the mounds.

The older mounds, those which were partially sodded over by *P. pratensis,* were located along a branch of the creek at the southeastern edge of the area. In general the newer mounds, those showing the least evidences of being sodded over, were found to be on the higher elevations to the northwest of the area studied.

Discussion

The ecological conditions surrounding the ant village studied by the investigator are somewhat similar to those described by Gregg ('44) and Talbot ('34). The area which was mapped, and in which most of this study was made, had been a pasture for over 30 years. It is a wooded area of mixed species of *Quercus* and *Carya ovata* in soil, predominantly clay, with some black subsoil at the lower elevations.

Price ('45) states, "It was found that the main opening burrows were near the bases of the mounds," primarily on the southern side. Nearly all the ants coming to and leaving the mounds used these openings. There were, however, openings "over the entire peripheries of the mounds where fresh pellets of earth had been brought up from inside and deposited." This investigator's observations support those of Price ('45) regarding the openings over the entire peripheries of the mound.

The old, partially sodded-over mounds and the new mounds which had debris deposited on them from the year before were covered with a characteristic blanket of litter that was made up primarily of broken pieces of stems, leaves, and bits of grass, intermingled with rodent feces and fresh pellets of earth.

The internal structure of the *F. exsectoides* mounds was quite similar to that described by Price ('45). Price found that a mound 18 inches in height, when excavated, revealed a nest shaped like an inverted cone. This cone was 3 feet in diameter at the top and extended into the ground 5½ feet. The interior of the mound and nest was permeated with "smooth-lined tunnels" ranging from ¼ inch to ⅜ inch in diameter.

The feeding habits of *F. exsectoides* vary from honeydew to insects. The investigator found that the *Quercus* (Oak trees), *Liatris cylindracea* (Blazing-star), and *Triosteum perfoliatum* (Horse-gentian) were the most common hosts for the aphids which produce the honeydew. Cory and Haviland ('38) observed that "honeydew secured from aphids on Black locusts (*Robinia pseudoacacia* L.), Tulip trees (*Liriodendron tulipifera* L.), and Oaks (*Quercus*) was more than that from other sources."

Apparently any insects which can be overcome are used as food by the *F. exsectoides*. One study (Cory and Haviland, '38) revealed that Japanese beetles, May beetles, small ground beetles, grasshoppers, and monarch butterflies were common food of the ants. In these mounds it was observed that in addition to these insects, spiders, honeybees, flies, insect larvae, and crickets also were included in the diet of *F. exsectoides.*

Not only are *F. exsectoides* predaceous on other insects, but they themselves are preyed upon by some species of birds, such as the Northern flicker (*Colaptes auratus luteus* Bangs).

In attempting to analyze environmental factors which may have effects upon *F. exsectoides* workers, the investigator observed and recorded air temperature, mound temperatures at different depths, and relative humidity. It was found that the temperature three inches inside of a mound seemed to correlate closely with the general activity (fig. 2).

The temperature readings three inches inside the mound were relative measures of the heat absorbed from the sun. On sunshiny days the readings were high as compared with cloudy days. The temperature 12 inches inside was more constant than at the surface of the mound, and the fluctuation of ant activity was not so closely correlated with this temperature as with that at three inches. The same was true of air temperature as with that at 12 inches (fig. 2). Relative humidity seemed to be an influencing factor in regulating activity. In general, when the relative humidity was low, the activity of the ants was increased. It appears that fluctuations of ant activity are fairly closely correlated with relative humidity. Dennis ('37) and Talbot ('34) report that relative humidity was an influencing factor in the activity and distribution of the *F. exsectoides.*

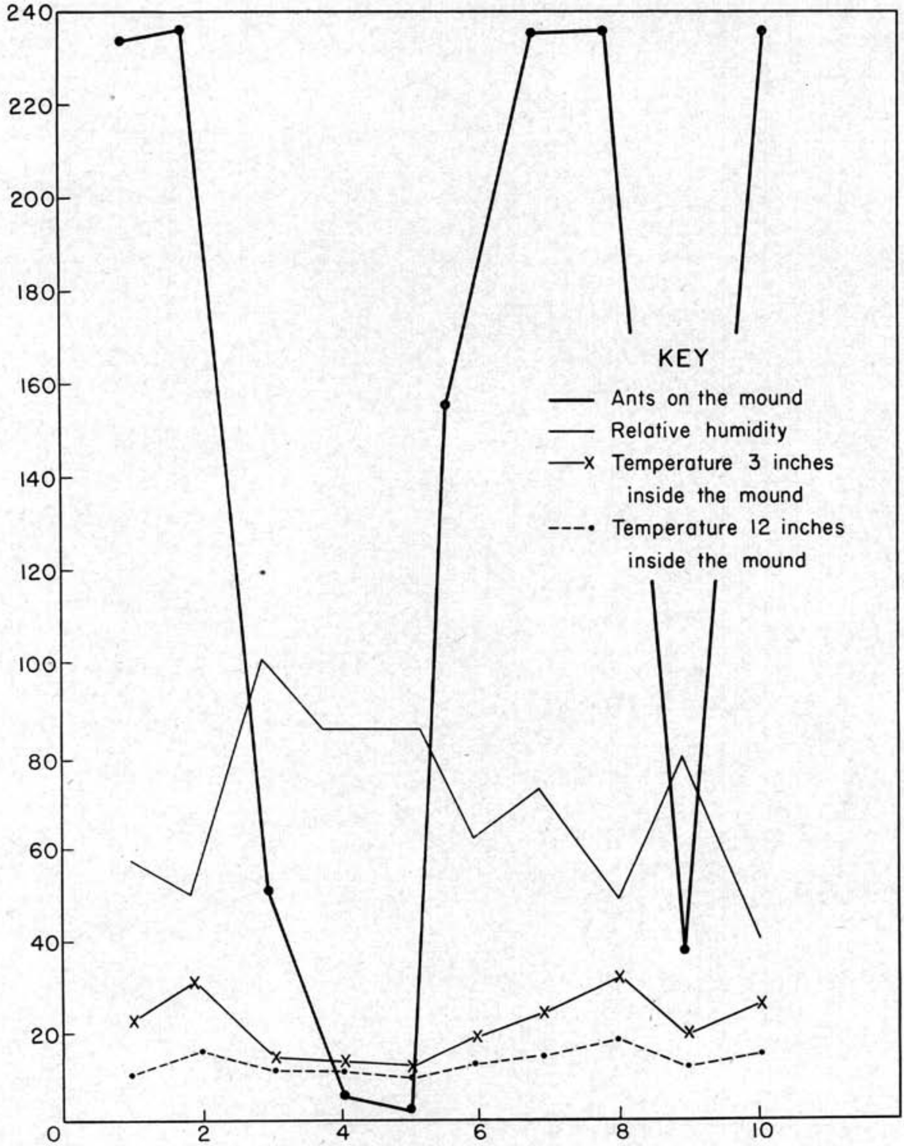

Fig. 2.—The abscissa indicates the days; the ordinates relative humidity, temperature in Centigrade degrees, and number of ants on the mound.

Sunshine may be an influencing factor in ant activity (Andrews, '27, Dreyer and Park, '32). It is probable that, with lack of sunshine, moisture increases to a degree which checks ant activity.

This investigator has not been able to find in the literature related to mound-building ant activities any satisfactory answer as to why the mounds of *F. exsectoides* tend to have the longest slope on the southern side. Andrews ('27) gives a partial explanation for this as being found in the effects of sunlight upon the temperature of the mound. It was found in the present study that on days when activity was restricted, the greatest activity of the workers was usually confined to the main opening burrows on the extreme south side of the mounds. Nearly all the activity of the workers in the spring and fall was devoted to carrying pellets of earth from inside of the mound. In middle and late summer, July, August, and September, the activity was primarily devoted to getting food. This activity seems to center around gathering nectar from aphids and eating insects. From this information it seems that the long southern slope of the ant mound is directly affected by ant activity only a part of the year. Whether this activity is influenced by temperature, relative humidity, other factors, or some combination of many factors has not been determined.

An interesting problem, applicable to this village and possibly others, is that of the relationship of nuptial flights and winds to mound locations. As was mentioned previously, all old and uninhabited mounds were located at the southeastern edge of the area studied. In general, the smallest and most recent mounds were found to be at the extreme northeastern edge of the group of colonies. A possible explanation is that south and southwestern prevailing winds (Holcomb, '41) may be an influencing factor when the nuptial flights occur.

Summary

General behavior patterns of *F. exsectoides* seem to be influenced by various environmental factors. On the basis of the observations of this colony, the data obtained support the conclusions of earlier investigators that ecological factors influence the location and composition of the colony; that the main opening burrows are located on the southern side at the base of the mound; that the composition of debris deposited on the mound by the ant workers is quite uniform in composition; that the interior shape of the mound is like an inverted cone which is permeated with smooth lined tunnels; that the feeding habits vary from honeydew producing aphids to any insect which can be overcome; and that predatory activities of flickers deplete colony numbers.

There is little correlation between ant activity and the temperatures recorded in the air above the mound and 12 inches inside of the mound.

There seems to be a close correlation between ant activity, relative humidity and temperature three inches inside the mound.

In this region the southern slope of an ant mound is observed to be the longest. It seems logical to conclude that an important factor in the development of this longer slope is that of the greater soil deposition occurring when worker activity is restricted to the main opening burrows at the base on this southern side of the mound.

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