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EFFECT OF MOUND DIAMETER ON MOUND SPACING IN A *FORMICA EXSECTIODES* POPULATION IN CENTRAL PENNSYLVANIA

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ABSTRACT

Several studies have suggested the existence of a "kill zone" around ant colonies that prevents other colonies from settling within it. In this study, data were collected on mound diameter (assumed to be a measure of colony size) and mound spacing in an attempt to assess the existence and strength of any relationship between colony size and size of "kill zone" in *Formica exsectiodes*. Sampling was conducted exhaustively in a clearing in Huntingdon, PA, in an area of dense *F. exsectiodes* population. A regression test was run on the data, and produced a non-significant p-value of 0.088. This provides no evidence to suggest the existence of a relationship between colony size and spacing.

Keywords: Formica exsectiodes, *territoriality, ant mounds*

INTRODUCTION

Formica exsectiodes, a mound-building ant found in Pennsylvania, can occur quite densely in certain areas. Previous research on other mound-building species indicates that ant mounds can have a significant effect on the vegetation of an area (King 1977, Coffin and Lauenroth 1990). Ants appear to affect the distribution of certain species of plants by hoarding their seeds, which, in turn, causes these plants to grow on ant mounds (Howe and Smallwood 1982). The effects of ants at the autotrophic level are potentially significant, as the secondary and tertiary trophic levels are influenced by the composition of the autotroph level. Therefore, the factors that influence ant communities are significant to the understanding of the ecosystems of which they are a part.

Previous research on other ant species suggests that established colonies affect population density by creating a "kill zone" around the nest, in which new colonies cannot settle (Ryti and Case 1992, Gordon and Kulig 1996). The size of this kill zone should, we hypothesize, be linked to the territory size of the colonies. In a study on fire ants, Tschinkel et. al (1995) showed that larger colonies control a larger territory. Therefore, we hypothesized that the size of the colony should be proportional to the distance to its nearest neighbor.

To conduct this study, however, a measure of colony size was needed. Several studies have dug up entire colonies and counted individuals. This was judged as far too labor-intensive and disruptive, and so some of the conclusions from these other studies have been utilized to provide an easier measure of colony size. In the fire ant study cited above, and in another study conducted on *Formica ulkei*, it was observed that larger mounds tended to contain larger ant colonies (Dreyer 1942). Although Andrews (1929) has disputed this link, it was based on a very small sample size taken under a variety of conditions. It should be noted, however, that no study assumes a perfect correlation between mound size and colony size, as large colonies sometimes suffer die-backs without a resulting decrease in mound size. This will not always affect the visible results of the kill zone, as it may take time for new colonies to take advantage of the reduced kill zone.

Taking all of these factors into account, we hypothesize that the spacing of *Formica exsectiodes* colonies (and, consequently, mounds) is influenced by the size of the colony, such that the size of an ant mound should be directly proportional to the distance from it to the nearest other ant mound. Furthermore, this effect should be most noticeable under higher population densities. This conclusion is drawn from studies on a variety of different organisms, including foxes (Trewhella et al. 1998), bluehead wrasses (Warner and Hoffman 1980), and a general paper on territory and its relationship to population density and food availability (Hixon 1980). All of these studies agree that territorial interactions are increased by population density.

METHODS AND MATERIALS

We tested our hypothesis on a population of *Formica exsectiodes* in Huntingdon, PA. During November 2003, the population was located in a section of a field (about 30 m wide) which had been cleared from the surrounding forest, in order to put up electrical poles. Ant mounds were scattered throughout the area at varying densities. As we could not determine the reason for these differences, which may have included food density or soil characteristics, we chose as our population of study the colonies in an area where the mounds were most densely distributed. Sampling across an even ant food gradient is desirable so that, if territory size is effected by food availability, mounds in an area with less food, and correspondingly larger territories for their size, are not being compared to mounds in food-rich habitats with smaller territories. By exhaustively sampling where the mound distribution was densest, we hoped to avoid sampling across such random, unmeasured fluctuations in habitat, or sampling across areas that ants could not colonize for other reasons. Our chosen population of study was composed of 50 active ant mounds in an area approximately 150 meters long. Active mounds were determined by the presence of ants on the mound.

In sampling a mound, we measured the diameter of the base of the mound and the distance from the center of that mound to the center of its closest neighbor using a 35 meter measuring tape. Both measurements were estimated within 5 cm, because of the difficulty in locating a precise edge to an ant mound and the difficulty of keeping the tape absolutely straight across long distances and around obstacles like shrubs. Each data point included the diameter of a mound, and the distance to that mound's closest neighbor (regardless of size). If mounds were not circular, we tried to measure a diameter that we estimated to be between the widest and the narrowest measurement of the mound.

Because we assumed that, if a relationship existed, the distance between mounds would depend on the diameter of the mound, we plotted distance to nearest neighbor versus diameter of mound, and used the regression test to determine if the dependence of distance to nearest mound on the diameter of the mound was significant.

RESULTS

Preliminary tests on the data were run to ensure that the data fit the assumptions for regression testing. A plot of residuals versus fits was constructed, which indicated equal variance. A normality plot of residuals was also constructed, and the accompanying Anderson-Darling normality test gave a p-value of 0.284, indicating that our y-variable residuals were normally distributed. The regression test yielded an r^2 value of 0.059 and a non-significant p-value of 0.088. Furthermore, a visual examination of the scatter plot of our data does not suggest a strong dependence of distance between mounds on diameter of mound (Fig. 1).

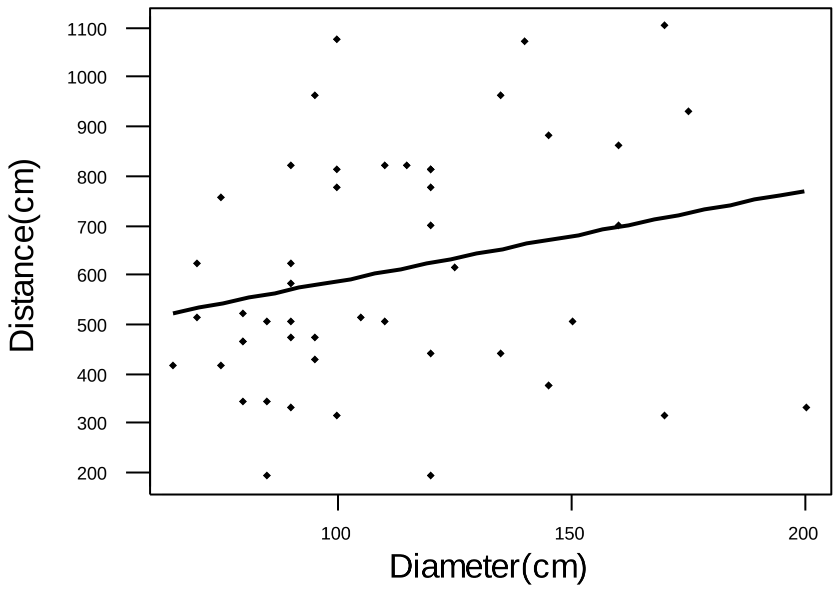

Figure 1. Regression of distance to nearest ant mound versus the diameter of 50 selected ant mounds.

DISCUSSION

Our hypothesis was that larger ant mounds would be farther from their neighbors. This, however, was not supported by our regression test. Because this research question was designed to examine possible territorial effects, the lack of significance in our results leads us to conclude that we have no evidence to support territoriality in *Formica exsectiodes*. However, several of our assumptions about the link between the data we collected and territorial effects can be questioned, and further research should investigate these assumptions.

We have assumed that there is a positive correlation between mound diameter and colony size. If this relationship does not exist, our research will not have addressed the question of territoriality. Furthermore, territorial effects should not occur between closely related colonies, or multiple mounds that are inhabited by a single large colony. We assumed that each mound was inhabited by separate, unrelated colonies when framing our research question. To properly correct for this, the genetic relatedness of ant mounds in the study should be examined. Both of these factors could be investigated in further research to ensure that we did not simply miss territorial effects in our study through poor design.

If, however, our assumptions are valid and our results are correct, further research is still recommended. As stated before, the factors that influence colony spacing in *Formica exsectiodes* are important to discover for a better understanding of the ecosystems in which the organism occurs. Therefore, further research should be directed at discovering what other factors may regulate mound spacing. Possible factors might include habitat differentiation or predation. Studies should be conducted on both of these factors.

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LITERATURE CITED

Andrews, E.A. 1929. Population of ant mounds. Quarterly Review of Biology **4**:248-257.

Coffin, D.P and W.K.Lauenroth. 1990. Vegetation associated with nest sites of Western Harvester Ants (*Pogonomyrex occidentalis* Cresson) in a semiarid grassland. American Midlands Naturalist **123**:226-235.

Dreyer, W.A. 1942. Further observations on the occurrence and size of ant mounds with reference to their age. Ecology **23**:486-490.

Gordon, D.M. and A.W. Kulig,. 1996. Found, foraging, and fighting: colony size and the spatial distribution of harvester ant nests. Ecology **77**: 2393-2409.

Hixon, M.A. 1980. Food production and competitor density as the determinants of feeding territory size. American Naturalist **115**:510-530.

Howe, H.F.and J. Smallwood. 1982. Ecology of seed dispersal. Annual Review of Ecology and Systematics **13**:201-228.

King, T.J. 1977. The plant ecology of ant-hills in calcareous grasslands: I. patterns of species in relation to ant-hills in southern England. Journal of Ecology **65**:235-256.

Ryti, R.T. and T.J. Case. 1992. The role of neighborhood competition in the spacing and diversity of ant communities. American Naturalist **139**:355-374.

Trewhella W.J., S. Harris, S. and F.E. McAllister. 1988. Dispersal distance, home-range size and population density in the red fox (*Vulpes vulpes*): a quantitative analysis. Journal of Applied Ecology **25**:423-434.

Tschinkel, W.R., E.S. Adams, and T. Macom. 1995. Territory area and colony size in the fire ant *Solenopsis invicta.* Journal of Animal Ecology **64**:473-480.

Warner, R.R. and S.G. Hoffman. 1980. Population density and the economics of territorial defense in a coral reef fish. Ecology **61**:772-780.