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Effects of Nesting *Acanthomyops claviger* on Soil in Re-created Tallgrass Prairie

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by Allan Norgaard

(Honors Biology 103)

The Assignment: Conduct original research and write a paper about the research that follows a format in a particular scientific journal.

Abstract

Habitat loss and disturbance have been significant contributors to the loss of nearly all native North American mesic tallgrass prairie. Through comparison of basic soil conditions and macroinvertebrate diversity comparisons of sites controlled from and influenced by the ant species *Acanthomycops claviger*, correlations between this species and the above factors were determined. In the following study, there appeared to be a strong positive correlation between distance from nest sites and increasing soil moisture. A more homogeneous macroinvertebrate community within nests was also suggested by cluster analysis. The noticeable effects of *A. claviger* nesting behaviors upon macroinvertebrate populations points to new ways of viewing tallgrass prairie restoration. These include hypothesis concerning entire system transplants and ecosystem seeding methods.

Introduction

The tallgrass prairie ecosystem of North America's eastern and central Great Plains and adjacent lowlands is virtually nonexistent and anthropomorphic alteration of this system type has reduced its total area to less than one percent of its geographical extent of a century ago (Madson and Oberle 1993, Knapp et al. 1998). Recently, greater scientific awareness of this highly diverse and complex system has motivated restoration and preservation efforts, mostly on a small or experimental scale (Knapp et al. 1998, Tilman 1988). As these efforts continue to grow in number and size, our understanding of the delicacy, intricacy, and geographical reach of these communities increase in scale. It has become widely accepted that certain inorganic contributors, such as fire, contribute within these systems as significantly as twenty million bison once did (Loreau 2000, Odum 1969, Hayes and Seastedt 1989), but exploration into the microcommunities and climates which combine to perpetuate and mature these greater systems has just begun. Significant among these is the community of macroinvertebrates which inhabit and this ecosystem.

The immense variety of survival strategies employed by this array of organisms is integral to the functioning and progression of a tallgrass-type system (Tilman 1988, Benizri and Amiaud 2005, Collins 2000). Soil building, nutrient cycling, and decomposition are but several of the integral, vital functions performed by these organism types (Dugas et al. 1997, Foster and Gross 1998,). The shear number of these organisms, in terms of biomass and diversity makes them obvious areas of study. Among these, perhaps the most visually conspicuous in the prairie landscape are certain genera of ants.

There are more than 150 recorded species of ants from the tallgrass prairie. Among these, *Acanthomycops claviger* may be located by its prominent mound building activity at the base of certain species of tall grasses. Subterranean ant activity has been noted as correlating significantly with nutrient flow and system progression/diversity in varied ecosystems (Grahammer et al. 1998, Hayes and Seastedt 1989, McNaughton and Wolf 1970, Woodcock et al. 2005), however this behavior's significance to the organization of the tallgrass-type system is virtually unexplored.

Ecosystem restoration efforts can be hampered significantly due to the lack of keystone species which allow for progression of these systems towards a sustainable biogeographical unit **(**Woodcock et al. 2005, Ulanowicz 1980). The many symbiotic and subsystem relationships between organisms of the tallgrass prairie systems make the understanding of these subtle interactions foremost in any restoration or re-creation effort (Knapp et al. 1998). The lack of significant undisturbed system types for study lends even more significance to this understanding, as there is no "model" from which to pattern these efforts (Madson and Oberle 1993, Smith and Knapp 2003). Through statistical analysis of macroinvertebrate populations and soil conditions and their proximity to mounds excavated by *A. claviceps,* significance if any, of this species in terms of restoration efforts may begin to be determined.

Methods

The study site was the Russell R. Kirt Prairie, a 7.1 ha re-created tallgrass prairie located on the campus of College of DuPage, Illinois (41° 45' 00" N, 88° 00' 00" W). The site was farmed prior to 1965, left fallow until 1975, and then turned into a temporary parking lot with the addition of about 20cm depth of gravel (Kirt 1996**)**. Through the next twenty years additions to the site included clay and black organic top soils, culminating in a restoration effort including 150 species of seeded and transplanted forbs and graminoids (Kirt 1996). Common grasses in the plot include big bluestem (*Andropogon gerardi* Vitman) and prairie dropseed (*Sporobolus heterolepis* Gray). To encourage natural reproduction, periodic burnings have been performed since 1987.

Sampling began in late April, 2005. Nests were located at random and 18 sites were sampled. Soil temperature, soil saturation (water), and soil pH, were measured at nest mound sites and distances of one meter and four meters away from nest mound sites of *A. claviger*. A Kelway pH probe (Kelway Instrument Co., Japan) was used to measure soil pH at 5 cm depth and an Aquaterr Temp-200 probe (Aquaterr Instruments, Costa Mesa, CA) was used to measure soil saturation (%) and soil temp at 10cm depth. A 1 liter sample was collected from each site and used to extract macroinvertibrates using a Tullgren Funnel.

Wilcoxon Matched Pairs tests were used to compare means among the physical measurements and Shannon indices between nest sites of *A. claviger* and those sites removed. Significance was determined where $P \leq 0.05$. Cluster analysis using Euclidian distances was used to visually compare similarities in macroinvertebrate assemblages among sites. The *a priori* expectation is that if colonies of *A. claviger* do affect the assemblages of macroinvertebrates within the recreated plot, then the macroinvertebrate assemblages would be most similar within the nests of the ant.

Results

A list of macroinvertebrates inventoried from the study sites is available on request. Counts of macroinvertebrates revealed no statistically significant differences in the diversity of these organisms between the nest and non-nest sites (Table 1). Cluster analysis suggested close similarity between the types of macroinvertebrate species found at the nest sites, while the non-nest sites shows what appears to be a more significant diversity between the organisms found at 1m and 4m locations (Figure 1).

Chemical measurements are summarized in Table 1. Mean soil saturation appeared to be different between the nest and non-nest sites (Table 2).

Discussion

The study poses the question, among others, of if and how ant species, such as *A. Claviceps*, can influence soil conditions in re-created tallgrass prairie ecosystems. Direct measurement and analysis appears to show a significant correlation between moisture content of soil and the proximity to nest sites. This may be due to nesting activity, but the exact nature of the relationship remains unclear, and is perhaps a line of future study. The significantly lower soil moisture at the nest sites is something that may almost be expected. Recent weather trends, evapotranspiration, and the protective mat which is a maturing prairie are several factors which would contribute to this situation. The endemic grasses are also tolerant of extremes, including lack of water, employing this trait as a cornerstone of their survival strategies (Christian and Wilson 1999, Collins 2000, Foster and Gross 1998). It does appear however, that in some way the ants and or their nesting activities are contributing.

The communities of macroinvertebrates living in and around the soil of the actual nests show a distinct similarity when compared with that of 1m and 4m distant. The species counts at the nest sites appear more evenly dispersed in terms of species domination. Prairie energy systems are complex symbiosis with, sometimes, many vital participants (Dugas et al. 1997, Foster and Gross 1998, James 1992, Knapp et al. 1998). A number of flora species were unsuccessfully introduced to the study site during its initial formation and subsequent management (Kirt 1996). Several of these failures may now be attributed to a lack of the complete microcommunity necessary for the success of the more conspicuous plant species (Loreau 2000, Smith and Knapp 2003). In many of these mutualisms, ants and their byproducts are critical to the continued success of certain plant species (Knapp et al. 1998, Smith and Knapp 2003, Tilman 1988**).**

Findings here indicate the need to consider a multitrophic food web approach to restoration of mesic tallgrass prairie. Species and population failure are rather common in re-creations of this type and this may be expected due to the lack of micro and macro, floral and faunal systems required for their continued success (Knapp et al. 1998, Ulanowicz 1980, Bischoff 2005).

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Table 1: Comparison of mean and standard deviation (All N = 6) of soil conditions and calculated Shannon-Weiner Diversity Index of nest and non-nest sites.

	Nest site	1m from nest site	4m from nest site
Soil Temperature (°C)	21.0 (± 5.3)	20.2 (± 4.5)	21.1 (± 4.9)
Soil Saturation (%)	77.5 (± 6.0)	80.7 (± 7.8)	85.0 (± 12.3)
Soil pH	5.0 (± 0.9)	5.0 (± 0.8)	5.2 (± 1.0)
Shannon Diversity	1.56 (± 0.41)	1.29 (± 0.58)	1.40 (± 0.20)

Table 2: Wilcoxon Matched Pair comparisons between nest sites of *Acanthomyops claviger* and sites removed from nests.

Comparison to nest	z	p
1m soil temperature	1.10	0.27
4m soil temperature	0.40	0.69
1m soil saturation	2.02	0.04
4m soil saturation	1.57	0.12
1m soil pH	0.73	0.47
4m soil pH	1.83	0.07
1m soil diversity	0.73	0.46
4m soil diversity	0.94	0.35

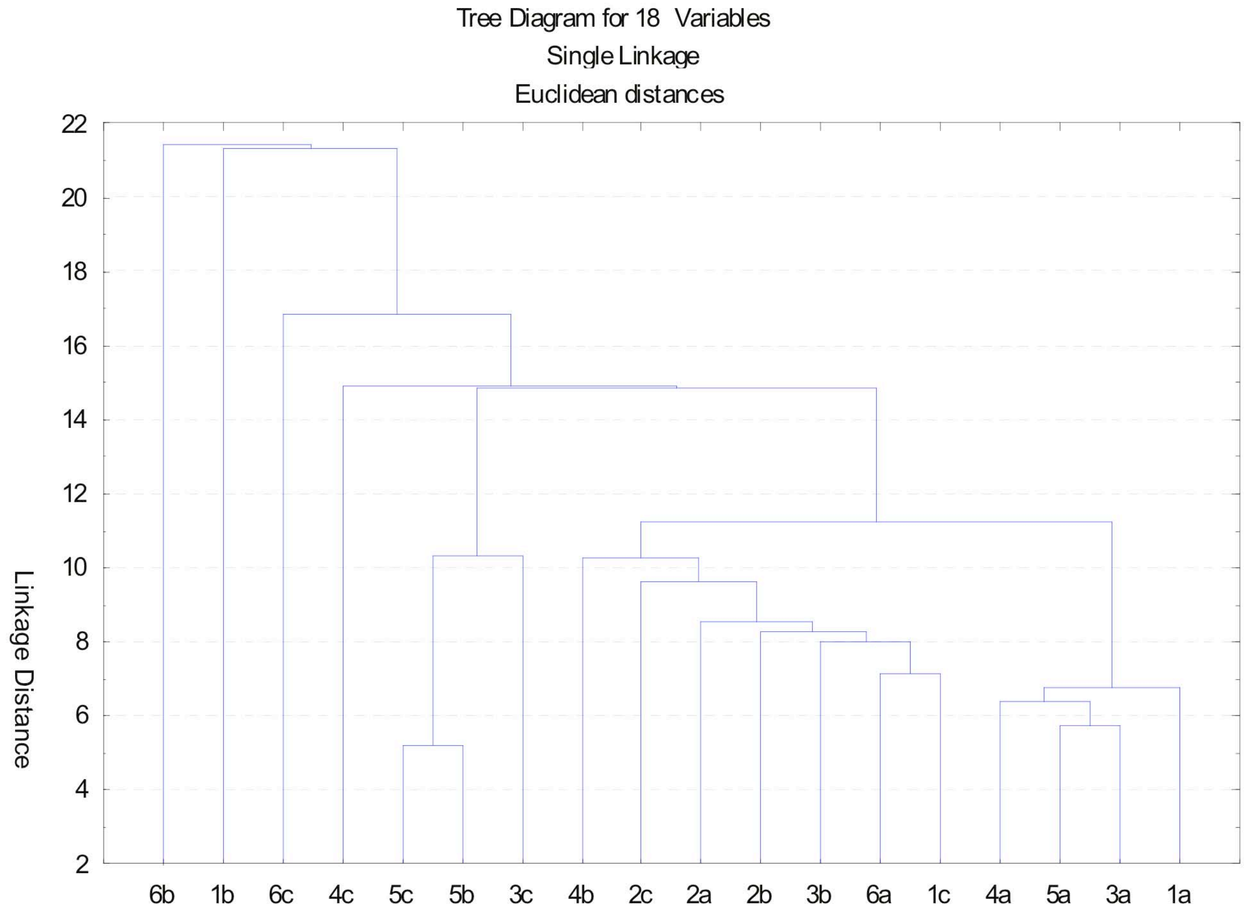

Figure 1. Cluster diagram for individual study sites (single-linkage Euclidean distances). Symbols: a=nest site, b=1m from nest site, and c=4m from nest site.