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ANT-PLANT RELATIONSHIPS IN A RE-CREATED TALLGRASS PRAIRIE

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ABSTRACT

Relationships between the distributions of nesting ants and flora were investigated in a re-created tallgrass prairie located in northeastern Illinois. One-third of 167 randomly selected $1m^2$ quadrats in the prairie contained ant nests. Basal coverage of ground by tall grass shoots was greater in quadrats having ant nests than in those lacking ant nests. In addition, clumps of big bluestem (*Andropogon gerardii*) that were inhabited by the ant, *Acanthomyops clavigera*, had higher median rank densities than adjacent clumps lacking nests. The clumps also showed a negative correlation between big bluestem shoots/cm^2 and area occupied by the clump at ground level. These significant findings relating to the distribution of nesting ants and tall grasses indicate ants have ecologic importance in re-created prairie that warrants greater scrutiny among restoration scientists.

Ants (Formicidae) have profound effects on most terrestrial systems as soil movers (Baxter and Hole 1967), modifiers of the physical and chemical properties of soil in which they nest (Baxter and Hole 1967, Culver and Beattie 1983, Lesica and Kannowski 1998, Newman and Wolff 1990), consumers (Soule and Knapp 1996), protectors of certain plants and herbivorous insects (Hammond 1995, Huxley 1980), and seed dispersal agents (Handel et al. 1981). Through these effects, ants influence the composition of and succession within plant communities (Beattie and Culver 1977, Rissing 1986). Despite their recognized importance in natural systems, the ecological importance of ants in restored systems has received little attention.

Restoration offers to conserve biodiversity by the recovery of degraded land through the reintroduction of its former components i.e., species and ecological processes (Dobson et al. 1997). Too often, the term "restoration" is used to describe re-creation projects, in which the original substrate has been destroyed and recovery of the natural system must begin anew. In DuPage County, Illinois, the location of the following study, re-creation projects have offered to preserve biodiversity of tallgrass prairie that once covered much of the county. Today, only 3.5 hectares of the original 74,000 hectares of tallgrass prairie remains in the county (IDENR 1994), similar to the demise that has occurred throughout the historic range of the ecosystem (Samson and Knopf 1994). With the amount of remnant prairie being so small, species preservation has undoubtedly been compromised giving significance to re-creation efforts. However, these efforts have been biased to recovery of tallgrass prairie vegetation. This is unfortunate as the establishment and successional change of tallgrass prairie vegetation is influenced by other organisms such as ants (Howe 1994, IDENR 1994, Hammond 1995, Newman and Wolff 1990).

Over 100 species of ants have been found in tallgrass prairie (Trager 1998). Ants are so abundant in the prairie that they can surpass grasshoppers in total insect biomass. Their presence in restored and re-created sites is apparent in the form of visual observation of individuals and mounds even within a few

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years of initial recovery (Petersen et al. 1998, Trager 1990). The objective of this study was to explore relationships between the distributions of nesting ants and tallgrass prairie flora. Our study was intended to be preliminary in scope and provide a baseline for more discriminating studies in the future.

MATERIALS AND METHODS

The study site was the Russell Kirt Tallgrass Prairie located on the campus of College of DuPage, Illinois. Re-creation efforts of the 7.5-hectare preserve began in 1984 with seed broadcasting and seedling transplant on top of clay and construction debris deposited from campus construction. The flora consists of some 150 species that are characteristic of the mesic prairie and wetlands that once covered the area (Swink and Wilhelm 1994). Grasses most frequently encountered at this site are big bluestem (*Andropogon gerardii* Vitman), Indian grass (*Sorghastrum nutans* (L.) Nash), and prairie dropseed (*Sporobolus heterolepis* Gray). Kirt (1989) provides a comprehensive listing of plants found within the preserve that has been burned each spring.

From June 14 until July 8, 2001, the area covered by plant shoots at ground level and the presence of ant nests were recorded from each of 137 1-m^2 square quadrats taken along randomly selected transects. Three to five evenly spaced quadrats were sampled along each of the 28 transects that ranged from 10m to 30m in length. A quadrat was only visited once. Mann-Whitney tests were used to compare surface coverage of grasses, forbs, and all plants (grasses and forbs) within quadrats having ant nests to those without. Significant differences ($\alpha \leq 0.05$) in median rank contribution were expected where interactions in some form occur between nesting ants and plants growing upon and immediately around the nests.

Relationships between plant distribution and nesting ants were also explored with two mound-building species, *Acanthomyops clavigera* (Roger) and *Formica nitidiventris* Emery. The nests of these species were integrated with and inseparable from clumps of big bluestem in which the nests were located. Clumps were distinguished as aggregates of tall grasses separated by at least 20 cm of bare substrate from other clumps. The clumps of big bluestem inhabited by these ants were distinguished by the added height (up to several centimeters) and loose texture of the soil as compared to clumps lacking ant nests. The number of shoots of big bluestem projecting from a clump, and also the area of the clump, were measured in each ant-inhabited clump and the closest clump of big bluestem without ant nests. It was assumed one shoot emerging from the ground was one individual, although perhaps a genetic clone of others in the clump. Wilcoxon paired-sample tests were used to compare median ranks of big bluestem counts/cm^2 between clumps having nests and those without. Again, significant statistical results were expected where ant-big bluestem interactions occur. Spearman rank correlation was used to test for relationships between clump area and the count of big bluestem shoots/cm^2. Big bluestem is known to self-shade (Jurik and Kliebenstein 2000), leading to the expectation that clump area would be negatively correlated to density. Our interest was how the presence of ant nests affects the correlation.

RESULTS

Nests of six ant species were found in a third of the 137 quadrats (Table 1). Nests of *Lasius alienus* (Foerster) were the most common, being either located in close proximity of one another (within centimeters) or possessing multiple entrances spread over several meters. *L. alienus* was not found to nest within clumps of vegetation, but only on barren ground. In contrast, nests of the next most common species, *A. clavigera* and *F. nitidiventris*, were found within clumps of big bluestem, Indian grass, and prairie dropseed. Coverage of ground

Table 1. Percent of 137 quadrats having ants according to species of ant.

Nesting species	%
Ants nests were absent	67.9
Acanthomyops clavigera (Roger)	5.1
Formica nitidiventris Emery	5.1
F. subsericea Say	2.9
Lasius alienus (Foerster)	16.8
Solenopsis molesta (Say)	1.5
Tetramorium caespitum (Linnaeus)	0.7

Table 2. Mean ($\bar{x} \pm$ SD; n) coverage of ground by plants among quadrats having ant nests and quadrats lacking ant nests. The Z and *P* values from Mann-Whitney tests indicate degree of significance between quadrat types.

Plant Category	Coverage of ground by plants (cm^2 plant shoot/cm^2 ground) Quadrats with nests	Quadrats without nests	Z	*P*
Tallgrass	0.14 ± 0.13 (44)	0.11 ± 0.12 (93)	2.28	0.02
Forbs	0.01 ± 0.02 (44)	0.02 ± 0.04 (93)	1.12	0.26
Tallgrass + Forbs	0.15 + 0.13 (44)	0.13 + 0.12 (93)	1.55	0.12

Table 3. Summary ($\bar{x} \pm$ SD, n) of counts of big bluestem shoots/cm^2 and size of clumps (cm^2) for clumps having ant nests and adjacent clumps lacking ant nests according to ant species. The Z and *P* values from Wilcoxon paired-sample tests indicates degree of significance between clump types.

Ant species	Plant measurement	Clump type with nest	Clump type without nest	Z	*P*
Acanthomyops clavigera					
	Count of big bluestem shoots/cm^2 of clump	0.14 ± 0.09 (21)	0.10 ± 0.08 (21)	2.31	0.02
	Size of big bluestem clump (cm^2)	325 ± 427 (21)	184 ± 130 (21)	1.01	0.31
Formica nitidiventris					
	Count of big bluestem shoots/cm^2 of clump	0.11 ± 0.07 (11)	0.10 ± 0.06 (11)	0	1
	Size of big bluestem clump (cm^2)	400 + 281 (11)	177 + 73 (11)	2.52	0.01

by these grasses was highest in plants having ant nests (Table 2). The median rank coverage of forbs which included lead plant (*Amorpha canescens* Pursh), white and red prairie clover (*Dalea candida* Michx. ex Willd. and *D. purpurea* Vent.), rattlesnake master (*Eryngium yuccifolium* Michx.), and beebalm (*Monarda fistulosa* L.), were not significantly different between quadrats having nests and those without.

Big bluestem clumps having nests of *A. clavigera* had significantly higher median rank counts of shoots/cm^2 than clumps lacking nests (Table 3). No difference in shoot counts/cm^2 was observed between clumps having nests of *F. nitidiventris* and those without. The area covered by big bluestem clumps tended to be larger when ant nests were present, and was significantly larger where *F. nitidiventris* nested. A significant negative relationship between counts of big bluestem shoots/cm^2 and clump area was found where *A. clavigera* nested (Table 4). In the same type of analysis, but with *F. nitidiventris*, significance was just missed.

DISCUSSION

All of the ant species observed in this study are widely distributed in North America and are known from a variety of habitats to include oak and pine forests, pasture, and natural tallgrass prairie (Gregg 1944, Talbot 1934, Trager 1998). The feeding habits of *A. clavigera, F. nitidiventris*, *F. subsericea* Say, and *L. alienus* include scavenging for dead macroinvertebrates and tending aphids (Burrill and Smith 1919, Greg 1944, Ross et al. 1971, Wheeler and Wheeler 1986). *A. clavigera* in particular is inclined to remain subterranean, tending and, at times, consuming root feeding aphids (Trager 1998). *Solenopsis molesta* (Say) and *Tetramorium caespitum* (Linnaeus) are scavengers and seed predators (Ross et al. 1971, Trager 1998). *S. molesta* is also known to live within mounds of larger ant species where it feeds on discarded matter and immature stages of host ants.

Greater coverage of ground by tall grasses where ant nests occur and the higher density of big bluestem shoots in clumps having nests of *A. clavigera* are evidence of a positive relationship between grasses and ants in the 16-year old re-created prairie. However, it remains unknown whether and how the tall grass or the ant community promotes the other. Nesting ants may loosen soil, promoting aeration, drainage, and thus tall grass growth. Seed predation and aphid tending by ant colonies may also function to restrict tall grass competitors, allowing greater tall grass growth in clumps. Alternatively, tall grass may provide food to nesting ants in the form of tissues and exudates via aphids. Growth may be limited in larger clumps of big bluestem due to self-shading and greater attraction of root-feeding aphids, accounting for the negative correlation between clump area and shoot density.

Table 4. Spearman Rank Order Correlation analysis of big bluestem clump area (cm^2) and counts of big bluestem shoots/cm^2 according to the presence of ant nests.

Ant species	R	*T*	*P*	*N*
Acanthomyops clavigera				
Clumps with nest	-0.59	3.17	<0.01	21
Clumps without nests	-0.29	1.31	0.21	21
Formica nitidiventris				
Clumps with nests	-0.56	2.05	0.07	11
Clumps without nests	-0.22	0.66	0.52	11

Clearly, more study is needed to scrutinize these hypotheses, including information about the presence and abundance of root-feeding aphids. Findings of significant relationships between the distribution of nesting ants and tall grasses indicate ants have ecologic importance in re-created prairie that may affect the process and outcome of floral establishment. Long-term studies should help identify patterns in ant-plant interactions, including the perennial nature of interactions within particular tall grass clumps.

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