Quantitative and Qualitative Approaches to Study the Effects of Plains Pocket Gopher (Geomys bursarius) Mound Building on Vegetation

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ABSTRACT—We explored qualitative and quantitative approaches to evaluate the impact of the plains pocket gopher (Geomys bursarius) mounds on the plant community. We hypothesized that plant species richness would be higher on mounds than surrounding areas and that the mounds would create significant impacts on plant diversity. We categorized mounds as “new,” “abandoned,” or “old,” measured the width of the abandoned mounds, and noted the different plant species present on the mounds and the control plots. Our results indicated that species richness is significantly increased on and near gopher mounds, and overall, gopher mounds significantly alter local plant community. This study demonstrates that the impacts of Geomys bursarius activities are just as critical as its role in the trophic web.

INTRODUCTION

The significance of an animal within an ecosystem cannot be judged solely by its position in the tropic web; its immediate and long-lasting effects on the surrounding biotic community must also be considered. Owing to their mound building activities, fossorial mammals such as the plains pocket gopher (Geomys bursarius) are important modifiers to the structure of a prairie ecosystem. In our research we employed quantitative and qualitative approaches to investigating the effects of the plains pocket gopher mound building on open vegetation in an abandoned field in Lake Itasca, Minnesota.

Past studies have indicated several trends relating to the effects of plains pocket gopher mounds. The subsurface soil dug up by gophers is significantly lower in nutrient content than the surface soil (Spencer et al. 1985, Inouye et al. 1987). The excavated soil is piled on top of the current vegetation and creates a mound, a bare distinct patch in the plant cover. Water infiltration, bulk density, and soil structure are noticeably different in mounds than in nearby undisturbed areas, although the average volumetric soil water content apparently is not
significantly affected (Grant et al. 1980). The exposed mounds possibly increase plant species richness since they frequently serve as colonization sites for early successional species (Laycock 1958). Reichman et al. (1993) observed that gopher mounds may initiate competition-induced waves of plant biomass, again furthering the heterogeneity of the landscape.

Our overall goal was to expand upon the current understanding of the ecological impacts of *Geomys bursarius* by evaluating and describing the physical modifications in the soil and plant community created by the mounds. Two questions were asked in this study: 1) Do the mounds create considerable differences to the composition of the surrounding plant community? and 2) Is plant species richness significantly altered by the mounds created by *Geomys bursarius*? We hypothesized that the mounds would contribute significantly to the varied composition of the plant community because they create microhabitats for secondary plant species (e.g. early successional colonizers), as well as a uneven resource distribution for all plant species present. We also hypothesized that plant species richness would be greater on gopher mounds because the barren mound is a site of increased competition as colonizing species invade.

**MATERIALS AND METHODS**

The site for this experiment was at an open, grassy field just beyond the north entrance of the Itasca State Park in Lake Itasca, Minnesota (47°15’14.45” N 95°13’54.98” W). This location and its population of plains pocket gophers (*Geomys bursarius*) have been previously studied, and had obvious old, abandoned, and new mounds visible. Data were conducted in a single day in 2010 with seven groups working simultaneously. Materials included seven 100-meter tape measures, compasses, meter ruler sticks, and paperwork for documentation. The data were later pooled together and analyzed. There are three components to this study.
First, we walked in a straight line in a random direction noting and identifying distinct patches of vegetation near our transect line. A difference in the vegetation, the height of the patch, or the density of the patch was taken into consideration as being distinct. If the patch was associated with a gopher mound, the mound was then noted as being either “new,” “abandoned,” or “old,” and if it did not, then it was labeled as “not associated.” A “new” mound would have fresh, soft soil on the surface of the mound with no plants present on it. An “abandoned” mound should be recognizable with little vegetation on it and visible gravel. An “old” mound is much harder to recognize since much vegetation has grown over it and little soil may be visible, but it is distinguishable based on the soil structure and presence of gravel. “Not associated” meant the patch was distinct, but not associated with a discernable mound. Each observer (21 total) noted 12 distinct patches, and a Chi-square goodness of fit test was used to analyze data.

Second, we began noting the numbers of different mounds located near our newly chosen transect. From any given point, we chose a random direction and stretched out a 20-meter transect line. We then tallied the number of new, abandoned, or old mounds located on our transect line separately, along with their greatest total width using a metric stick. We conducted nine more randomly chosen transect lines and recorded their information, totaling 10 lines for each of the 7 groups (70 lines total). The information gathered here will help us to determine total surface area constituting gopher mounds, because gopher mounds have been known to cover nearly 10% to 20% of a field’s surface area (Rezsutek et al., 2000).

Third, we randomly walked around this field to find 10 abandoned gopher mounds and 10 random “control” areas counting the different species of plants found on the mounds and on the control areas. The “control” mounds must not contain any mounds and must be within 2 to 3 meters of the chosen abandoned mounds. This information will determine the plant diversity
between disturbed soil (gopher mounds) and undisturbed soil (control soil), and will allow us to perform a t-test between the two.

RESULTS

There were a total of 61 no mound (24%), 28 new mounds (11%), 81 abandoned mounds (32%), and 86 old mounds (33%), totaling 256 observed distinct patches. The length of each mound was measured and resulted in a total length of 5.96m for new mounds with an average length of 0.596m, 39.89m for abandoned mound with an average length of 0.738m, and 109.28m for old mound with an average length of 0.815m and proportions of .426 %, 2.849%, and 7.806%, respectively. Of the three aging mounds, old mounds were far bigger in size than abandoned, which in turn is bigger than new mounds (Jones et al, 2007).

We observed that some distinct patches of vegetation were pocket gopher mounds while others were not associated with gopher mounds. We found that the number of observed patches with no mounds was 61 while 195 had mounds. After running the Chi-square goodness of fit test we found that our Chi-Square value was 70.14 and the critical value was 3.841 (df= 138; p-value <.0001). This led us to reject our null hypothesis that distinct patches of vegetation would be the same on and off mounds.

We observed and counted the number of plant species on abandoned mounds versus nearby non-mound areas. Our pooled results can be seen in Table 1 below:

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
<th>Mean</th>
<th>Variance</th>
<th>Std. Dev.</th>
<th>Std. Err</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>70</td>
<td>3.571</td>
<td>1.727</td>
<td>1.314</td>
<td>.157</td>
</tr>
<tr>
<td>Mound</td>
<td>70</td>
<td>5.471</td>
<td>4.948</td>
<td>2.225</td>
<td>.266</td>
</tr>
</tbody>
</table>
Our t-test results indicated a significant difference in the plant species found on abandoned mounds to that of adjacent control areas (mean difference = -1.900, df = 138, t-Value = -6.153 and P-value <.0001).

DISCUSSION

Our results corresponded to our expectations, as well as those found in past research. The gopher mounds substantially alter the composition of vegetations – 73% of the observed distinct patches were associated with a gopher mound. Mielke (1977) found that gopher mounds change the biogeochemical makeup of soil and the soil texture within it, creating a distinct patch that consequentially allows for other plant species to grow where they are not usually found. The significant difference in species richness was also indicated by the data. There were more plant species found on the gopher mounds than on non-mound areas. This contradicts findings by Rogers et al (1985), who concluded that although gopher mounds and activity do impact the overall community richness through increased habitat heterogeneity, the mounds themselves do not have significant effects on nearby vegetation, probably due to the disturbed conditions. Furthermore, as suggested by Reichman et al. (1993) the richness of plant species could be due to competition-induced wave of biomass initiated by the gopher mounds.

There is, however, a downfall to mound building as concluded by Kyle et al. (2008) that changes in soil makeup on these mounds not only allows for native plant species to grow, but invasive plant species as well, which can degrade species richness and delay the rate of succession in the plant landscape (Inouye et al. 1987). Spencer et al. (1985) also found that early in the season plant species richness was dominant at first, but later decreased. In sum, the plains pocket gopher serves as a preserver of current prairie status by maintaining a slower rate of plant succession in its habitat.
LITERATURE CITED


