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Ground Arthropod Abundance in Switchgrass and Diverse Prairie Agroenergy Crops

Stephanie Paape

Libby Torresani

Mark C. Myers

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Stephanie Paape, Libby Torresani, and Dr. Mark C. Myers
Biology Department, University of Northern Iowa

Abstract

The University of Northern Iowa's Tallgrass Prairie Center converted corn and soybean fields in the Cedar River Natural Resource Area to four mixes of perennial tallgrass prairie species. Research plots were randomly seeded with one of four treatments of native prairie vegetation including a switchgrass monoculture and a 32-species prairie mix. We studied ground arthropod abundance in Switchgrass and the 32-species prairie mix at various distances from the nearest woody edge using pitfall traps. We hypothesized that a 32-species Prairie mix would support greater numbers of ground arthropods than a Switchgrass monoculture and that ground arthropod abundance would be greater in traps set closer to a woody edge. Our results indicated little difference in arthropod abundance between the Switchgrass and Prairie plots. Arachnid captures were greater nearer to a woody edge, but catch rates of other arthropods studied did not vary with distance from a woody edge.

Background

In 2009 the University of Northern Iowa's Tallgrass Prairie Center initiated a field experiment that converted seven agricultural fields with a >20-year history of corn and soybean cultivation to various mixes of perennial tallgrass prairie species managed as agroenergy crops. Each research plot was randomly seeded with one of four treatments of native prairie vegetation including a switchgrass monoculture, a 5-species grass mix, and 16- and 32-species prairie mixes. Since then, countless surveys have been preformed to monitor plant, bird, and butterfly biodiversity in the plots; however, to date there have been no studies of ground arthropods at the site. Ground arthropods are indicators of habitat quality, can be inexpensively surveyed, and respond quickly to environmental and agricultural disturbances (Ulyshen *et al.* 2006).

We studied ground arthropods abundance in switchgrass and 32-species prairie mix plots at the Cedar River Natural Resource Area using pitfall traps. We sought to answer the following questions:

1) Is ground arthropod abundance greater in diverse prairie compared to switchgrass?
2) Does ground arthropod abundance vary with distance from the nearest woody edge?

Some studies suggest that arthropod species richness and plant diversity share a positive relationship (Siemann *et al.* 1998).

Materials & Methods

Trapping. We sampled ground arthropods in 8 plots (4 Switchgrass and 4 Prairie). In each plot, we installed 4 pitfall traps, one in each of four distance intervals (2-16 m, 18-32 m, 34-48 m, and 50-64 m) from the nearest woody edge. Each trap was randomly assigned a distance within its assigned interval. This resulted in a distance gradient from 2-64 m with one trap placed at every 2 m interval.

Traps were installed using a 2" soil auger to drill holes to a depth of 10". PVC sleeves (1 ¼") were placed in the holes to lay flush with the ground, and a 200 mm borosilicate test tube half filled with a 50% polypropylene glycol solution was placed in the sleeve. The traps were active for a total of 2 weeks (July 14-28) and specimens were collected every 7 days. Specimens were rinsed, sorted, counted, and stored in 70% ethyl alcohol for later identification.

Data analysis. We used generalized linear models to assess the relationship between total arthropod, ant, arachnid, and beetle abundance and vegetation treatment and distance from the nearest woody edge. Models employed a negative binomial distribution with a log-link function to account for overdispersion.

Results

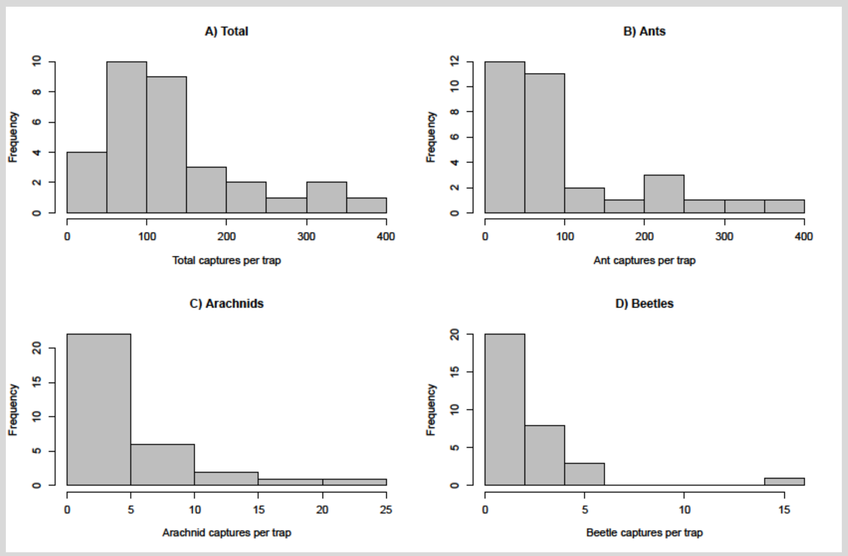

Figure 1: Histograms of A) total, B) ant, C) arachnid, and D) beetle captures during 2 one week trapping periods.

A) Total				
Term	Coefficient	SE	Z	P-value
Intercept	4.71	0.24	19.6	<0.001
Vegetation Treatment	0.16	0.21	0.73	0.47
Distance	0.0037	0.0058	0.63	0.53

B) Ants				
Term	Coefficient	SE	Z	P-value
Intercept	4.24	0.32	13.2	<0.001
Vegetation Treatment	0.059	0.29	0.21	0.84
Distance	0.0094	0.0077	1.22	0.22

C) Arachnids				
Term	Coefficient	SE	Z	P-value
Intercept	1.93	0.40	4.88	<0.001
Vegetation Treatment	0.41	0.36	1.14	0.26
Distance	-0.023	0.0099	-2.35	0.019

D) Beetles--All Data				
Term	Coefficient	SE	Z	P-value
Intercept	1.08	0.33	3.23	0.0012
Vegetation Treatment	0.51	0.31	1.67	0.094
Distance	-0.015	0.0083	-1.78	0.076
Beetles--Outlier Truncated				
Term	Coefficient	SE	Z	P-value
Intercept	0.90	0.27	3.38	0.00073
Vegetation Treatment	0.30	0.25	1.24	0.22
Distance	-0.0089	0.0066	-1.35	0.18

Table 1: Generalized Linear Models of A) total, B) ant, C) arachnid, and D) beetle captures as a function of vegetation treatment and distance to nearest woody edge. Models employed a negative binomial distribution and log-link function. In D) results are presented first using all data and then with an extreme outlier truncated.

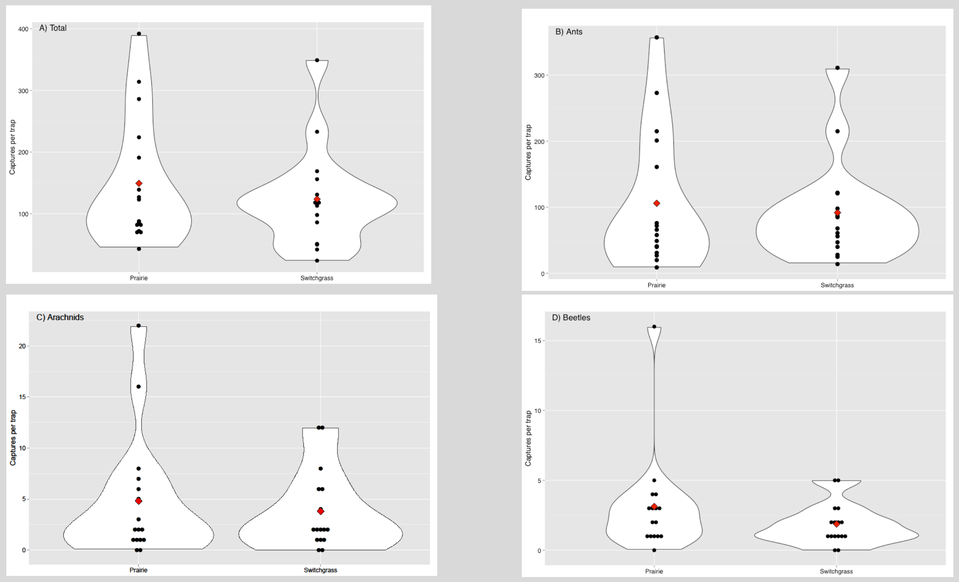

Figure 2: Violin plots of A) total, B) ant, C) arachnid, and D) beetle captures in relation to prairie or switchgrass vegetation. The black dots represent total capture numbers per trap and the red diamond represents the mean of total captures and of total specimen captures when exposed for 2 one week periods.

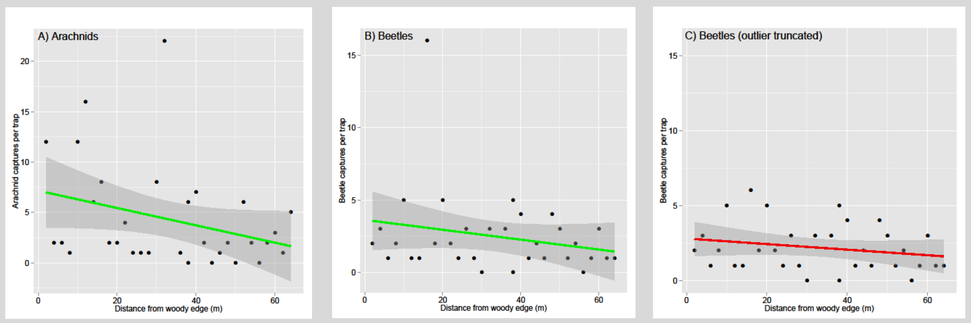

Figure 3: Scatter plots of A) arachnids, B) beetles, and C) beetles outlier truncated. Significance of distance from woody edge, more captures closer to edge.

Results & Conclusions

We collected a total of 4368 ground arthropods: 2389 in Prairie and 1979 in Switchgrass. Of the total collected, 72.5% were ants, 3.2% spiders, and 1.8% beetles. On average each trap captured 136.5 arthropods (range 24-392), including 98.9 ants (9-357), 4.3 spiders (0-22), and 2.5 beetles (0-16) (Fig. 1). In general, rate of arthropod captures was similar between Switchgrass and Prairie for all groups (Table 1; Fig. 2). There was some indication ($p = 0.094$) that beetle captures were greater in Prairie ($\bar{x} = 3.13$) versus Switchgrass ($\bar{x} = 1.88$); however, one extreme outlier strongly influenced results. When the outlier was truncated, our models indicate no significant difference in beetle captures among vegetation treatments (Table 1D).

Distance to the nearest woody edge had no effect on total arthropod or ant abundance (Table 1A-B); however, arachnid (Table 1C; Fig. 3A) and beetle (Table 1D; Fig. 3B) captures were greater closer to a woody edge, illustrated by the negative slope of the lines in Fig. 3. Again the beetle analysis was strongly influenced by an extreme outlier, and when that outlier was truncated the effects of distance to the nearest woody edge were less evident (Table 1D; Fig. 3C).

Future Research

We found few differences in ground arthropod abundance between Prairie and Switchgrass plots; however, to date we have only sorted specimens into broad taxonomic groups. We are in the process of identifying specimens to the family or genus level, which will allow us to explore additional hypotheses related to species richness, diversity, or community composition among the vegetation treatments.

Now that that permanent pitfall traps are installed at the Cedar River Natural Resource Area, sampling of ground arthropods can be initiated rapidly at any time. I recommend sampling at various times of year to determine temporal variation in arthropod communities. I would also increase the number and spatial distribution of pitfall traps to increase statistical power to detect subtle differences in abundance among vegetation treatments. Additionally, another study I would propose would be to compare arthropod abundance between an annual, commercial crop, such as corn or soybeans, to our perennial switchgrass and prairie crops.

References

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Siemann, E., D. Tilman, J. Haarstad, and M. Ritchie. 1998. Experimental tests of the dependence of arthropod diversity on plant diversity. *The American Naturalist* 152: 738-750.

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