Transactions of the Illinois State Academy of Science received 3/23/07
(2009), Volume 102, #3&4, pp. 225-232 accepted 8/16/08

Annual Occurrence and Abundance of Araneae Families in a Tall Grass Prairie in Illinois Before and After a Controlled Prairie Burn

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ABSTRACT

We examined how simulated natural disasters affect spider populations on a conserved, re-planted prairie at Rock Springs Center for Environmental Discovery in Macon Co., Decatur, Il. We created 15 plots evenly spaced on the prairie and sampled them by sweep netting from 1 June 2005 - 12 October 2006. This allowed us to obtain 10 months of data before the prairie burned on 9 March 2006 and 7 months of data afterwards. A Simpson Index found the spider community more diverse after the burn than before. A t-test also determined that there was a significant decrease in the families Salticidae and Araneidae between the pre-burn and post-burn periods. Although there was no statistical difference in the number of tetragnathids in the pre-burn period versus the post-burn period, we did note that the number of pisaurids increased at the same time the tetragnathid numbers decreased, indicating a possible interaction between these two families.

INTRODUCTION

Modern conservation planning increasingly relies on the use of ecological restoration techniques to simulate previous communities. Many studies in these sites focus only on the vegetation while the rest of the ecosystem is overlooked. Studying arthropods in these areas is beneficial because arthropods have short generation times, small size, diversity of microhabitats and niches, and play very important ecological roles (Longcore, 2003). Additionally, their large population sizes allow for statistically significant analysis. Therefore, arthropods have been used to track ecological changes in a multitude of studies (Niwa and Peck, 2002).

Simulated wildfires are a popular management practice in many conservation areas. Controlled wildfires clear much of the dead plant matter that could cause a devastating fire and are thought to help to create a higher diversity level. However, this diversity hypothesis has not been adequately tested with spiders, because few spider surveys have been conducted before and after a simulated disturbance. Evidence suggests that the number and identity of species in an ecosystem correlates directly to the stability and resilience of the ecosystem itself (Buddle et al., 2006). We hypothesized that the spider diversity after a prairie burn at the Rock Springs Center for Environmental Discovery would increase as has been indicated for other species of spiders after a wetland burn (Johnson, 1995).

Survey studies are reliable tools when assessing conservation priorities because they can provide an indication of diversity level and can be used to help assess how human influence affects the diversity of an area (Cardoso et al., 2004). It is important to keep high priority areas conserved and protected from human influences, such as residential development and pesticides, in order to maintain a high diversity level. Areas with increased human influence show less diversity than areas with less human influence (Cardoso et al., 2004).

We conducted this study to examine how a simulated natural disaster affects the spider populations on a conserved prairie. We sampled the prairie for 10 months prior to a simulated burn to collect baseline data. We then sampled for 7 months after the prairie was burned to examine spider family succession. The data were analyzed to determine whether there was a significant difference between the pre-burn and post-burn spider community in number and types of spider families present.

MATERIALS AND METHODS

Our study was conducted at the Rock Springs Center for Environmental Discovery in Macon Co., Decatur, Il. Five sample plots on three transects (Fig. 1) were sampled weekly from 1 June 2005 until the prairie experienced its first frost on 15 November 2005. After the first frost, we sampled biweekly. We resumed sampling weekly when the Macon County Conservation District burned the prairie on 9 March 2006 and sampled weekly until the first frost on 12 October 2006; the prairie was also checked after this date to verify that spiders were no longer on vegetation.

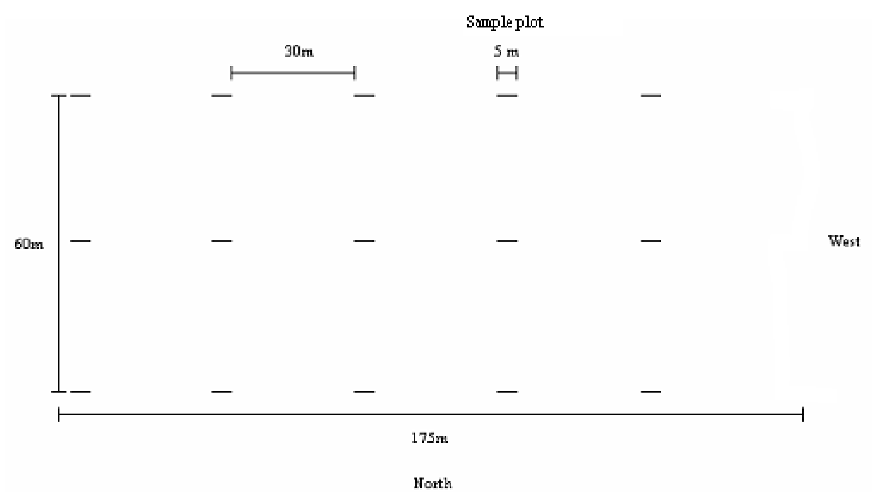

Figure 1. Rock Springs Center for Environmental Discovery study site divided into 15 sampling plots (5.0 m) in 3 transects with 30 m between each plot.

We used sweep net sampling to collect spiders in each plot. For each of the 15 plots, we began sampling at the beginning of the plot and performed 10 sweeps on both sides of the plot to ensure that the plot was evenly sampled. After 20 sweeps in each plot, we sorted the net litter, removed all spiders, and preserved them in 80% ethanol.

While there are a variety of sampling options, we chose sweep net sampling for several reasons. First, sweep net sampling collections represent a large variety of the total flora because different heights can be swept (Standen, 2000). In addition, this sampling method did not cause extreme damage or disturbance to the prairie. Pitfall traps (another frequently used sampling method) can damage the environment and can have misleading results due to grass density. We performed a large number of sweeps per plot (n = 20) and sampled over a lengthy time period to ensure effectiveness in capturing spiders despite heterogeneity of habitat. Pitfall traps are also limited to ground-dwelling spiders and exclude many web-building spiders and spiders that dwell on higher foliage (Johnson, 1996), while sweep net sampling covers a sufficient degree of habitat stratum (Dobyns, 1997). It is important to collect foliage dwellers because spiders in higher strata might play a more important role in biological control than those of other strata (Ludy and Lang, 2004).

After sampling, we transferred the spiders to Millikin University, where we identified each spider to the family level following Roth (1985). After our 1.5 years of sampling, we analyzed the data using a two sample t-test assuming unequal variances to compare the number of individuals within each family from the pre-burn versus post-burn community (Press, 1992). We performed t-test analyses on the data collected from June - October to ensure consistency between each period.

We used a Simpson Index (Simpson, 1949) to determine the level of species diversity in the pre-burn and post-burn community. The Simpson Index is used to measure diversity and is often used to quantify biodiversity in ecological habitats. This index focuses on the number of species as well as the abundance of each species, and represents the probability that two randomly selected individuals of a given habitat belong to the same species.

RESULTS

The number of individual spiders was separated by month collected and family for the pre-burn and post-burn years (Tables 1 and 2). The number that was collected each month was then divided by the number of collections for that month to provide consistency since some months had more sampling periods than others.

There was a significant decrease in the number of individuals in the families Salticidae (Fig. 2) and Araneidae (Fig. 3) from pre-burn to post-burn period ($P < 0.01$). The Simpson Index value ($D = 0.36$) obtained for the pre-burn community indicates a moderate level of spider family diversity. For the post-burn community the Simpson Index ($D = 0.26$) indicates greater diversity (9 families collected) when compared to the pre-burn community (6 families collected) (Tables 1 and 2).

Even though there was no statistical difference from the pre-burn to post-burn period in tetragnathids, there were no tetragnathids in the pre-burn period and 43 in the post-burn period. There was also an increase in the number of pisaurids as tetragnathid numbers began to decline (Table 2 and Fig. 4).

Table 1. Spiders collected in the pre-burn period separated by month and family from June – October 2005. Spiders were not present from November 2005 – March 2006. The prairie was burned on 9 March 2006.

Pre-burn	Jun	Jul	Aug	Sep	Oct	**Total**
Salticidae	20	37	39	30	7	133
Pisauridae	7	6	5	11	21	50
Thomisidae	4	1	2	1	0	8
Clubionidae	7	0	1	2	0	10
Araneidae	7	8	3	12	5	35
Oxyopidae	1	6	1	0	0	8

Table 2. Spiders collected in the post-burn period separated by month and family from April – October 2006. Spiders were not present from November 2005 – March 2006. The prairie was burned on 9 March 2006.

Post-burn	Apr	May	Jun	Jul	Aug	Sep	Oct	**Total**
Salticidae	2	2	5	15	7	7	1	39
Pisauridae		1	4	5	7	12	3	32
Oxyopidae			1	2		4		7
Tetragnathidae				25	17	1		43
Lycosidae				1		1		2
Thomisidae				1		1		2
Theridiidae						1		1
Linyphiidae				2				2
Araneidae						1		1

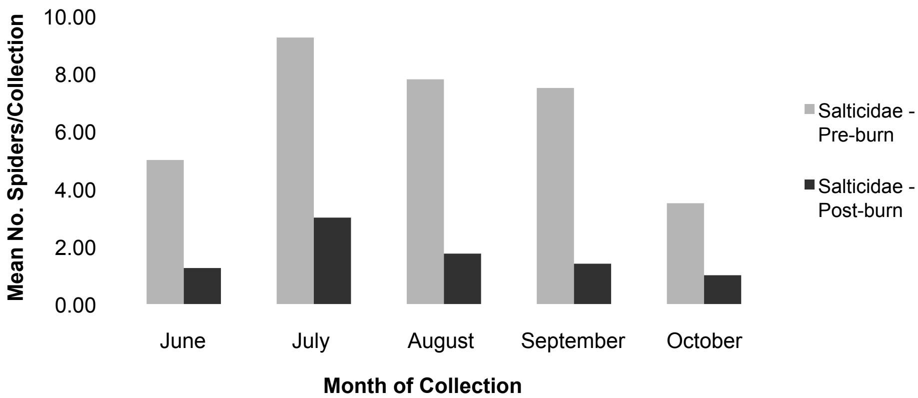

Figure 2. The mean number of salticids per collection between the pre-burn and post-burn periods separated by month. A two-tailed t-test assuming unequal variances showed a significant decrease in numbers after the burn (t = 2.7, df = 5, $P < 0.01$).

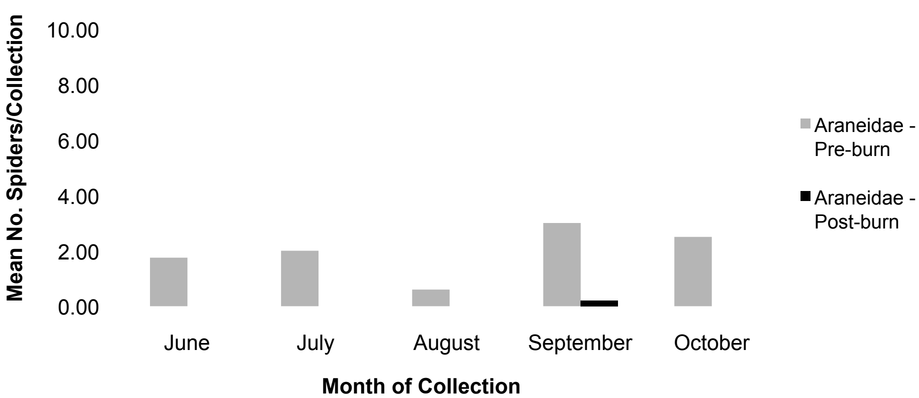

Figure 3. The mean number of araneids per collection between the pre-burn and post burn periods separated by month. A two-tailed t-test assuming unequal variances showed a significant decrease in numbers after the burn (t = 2.7, df = 4, $P < 0.01$).

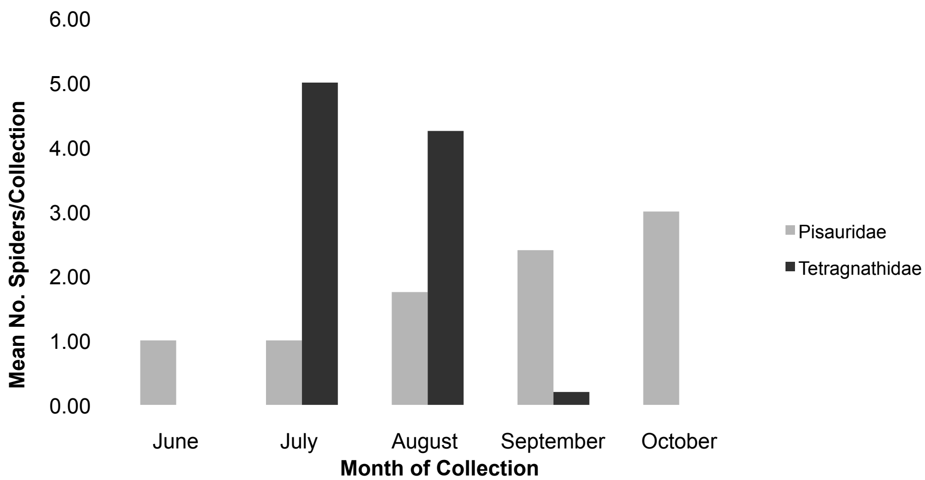

Figure 4. The mean number of pisaurids and tetragnathids per collection in the post-burn period separated by month.

DISCUSSION

During the pre-burn period, we collected 244 spiders, while in the post-burn period, we collected 129 spiders. A higher abundance of arthropods in an indigenous prairie, compared to that of one with a controlled burn, was also shown by McIntire and Thomson (2002).

There was a significant decrease in the number of salticids and araneids present after the prairie burn. In the pre-burn period, both vegetation and the insect populations were likely more stable and able to support the carnivorous spiders. This may have affected the salticids in particular because in the pre-burn period, we noted an abundance of salticids earlier in the season, starting in July, and spiders active in the early summer are affected by fires because the indigenous plants have not had sufficient time to renew growth (Johnson, 1995). Salticids reach their maturity and breeding season in earlier summer months, having larger numbers in July, while many other families reach maturity in September and October.

There were differences in family diversity between the two years. The Simpson Index for the post-burn year was lower than for the pre-burn year, indicating a greater diversity after the burn than before. The family Clubionidae was the only family found before, but not after the prairie burn. However, after the burn, we collected four families (Tetragnathidae, Lycosidae, Theridiidae, and Linyphiidae) not found in the pre-burn community. It is plausible that when the prairie was burned, it destroyed some families that had monopolized resources before and thus hindered other families from becoming established. When new vegetation emerged, each family had an opportunity to colonize it, leading to greater diversity, as observed in a forest system after a burn (Buddle et al., 2006). Additionally, when a hurricane destroyed the spider community on a small island, a similar trend of a decrease in the number of spiders, but an increase in species diversity was observed (Schoener and Spiller, 2005).

With tetragnathids, we did not note any statistical difference in numbers from pre-burn to post-burn; however, we do feel the differences are notable because we observed a decrease in tetragnathids as pisaurids increased after the burn. This could be because as the pisaurids reached maturity and bred in the later months, they preyed on tetragnathids, in addition to insects. This could also explain the absence of tetragnathids in the pre-burn year.

Dramatic changes in prairies have been shown to have effects on multiple trophic levels. When plants (primary producers) are destroyed, it affects primary consumers. This in turn affects the secondary and tertiary consumers, the focus of our study. While the community from the pre-burn year was also a result of secondary succession, we still noted differences between the community before the burn versus after the burn. This may be because as previously dominant families were destroyed, it enabled other families to become established in the new environment.

Succession has dramatic implications in terms of community composition, and it is important to understand the effects of human disturbances on established communities. More research with different habitats and organisms is necessary to determine the impacts of simulated wildfires and human influence on community composition.

ACKNOWLEDGEMENTS

We would like to thank Ryan Hodge for help with sampling the pre-burn spider community and John Miller for his help with sampling the post-burn spider community. We are also grateful to Dr. David Horn for his help with the statistical analyses. We acknowledge financial support from the Millikin University Summer Undergraduate Research Fellowship. We also thank Paul Marion at the Macon County Conservation District for allowing us to sample the prairie at Rock Springs Center for Environmental Discovery.

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