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Analysis of the Collection and Diversity of Spiders in the Sandhills State Park

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ABSTRACT

Although spiders are very common organisms in all parts of the world, we lack important knowledge pertaining to their habitat and behaviors. We know the various spider species that exist, but we do not know the necessary habitat needed for each spider's survival and also ways in which various spiders can be successfully collected. Spiders found in sand hill prairies are just some of the spiders that are not fully understood. This study aims to gather important knowledge on spiders that live in sandy areas, such as the habitat each species prefer and the best ways to capture these spiders for study purposes. Pit fall traps, sweep netting and litter sorts were used to gather spiders at the Sandhills State Park, which were analyzed to conclude important information. The distribution and success of various sampling techniques were analyzed for 16 different spider families. It was found that the success of the trapping method depends on the type of spider collected. It was also concluded that the location of the spiders throughout the park depends on their characteristics. It was shown that many spiders found at the park depend on sand habitats for survival, so it is important to conserve their habitats to prevent extinction. Using this knowledge, we know what spiders are found in these locations, what habitats they prefer and ways in which we can collect them most efficiently in future studies.

Keywords: *Sweep Netting, Litter Sort, Pit Fall Trap, Spider Diversity, Spider Collection, Habitat, Sand Prairie*

INTRODUCTION

Maintaining environments crucial for survival of different organisms is an essential task in protecting various species. In order to conserve different habitats, data needs to be abundant in order to draw accurate conclusions about the needs of each species. However, data for many "non-game" species is lacking, such as for arachnids (Fernandez-Montraveta & Cuadrado, 2008). In order for us to develop an understanding of these species, it is important for us to be able to find these spiders in the wild. There are many ways to find and collect spiders, but the success of each method may differ for collecting different species of spiders. With the understanding of the methods needed to collect different spider families, more successful collections can lead to improved studies and research on spiders.

Although spiders are very common, very little knowledge exists about their abundance and distribution in sand hill prairies. This was also the case for cave areas in Georgia until they conducted a thorough survey of invertebrates living within the caves. Researchers used pit fall traps as well as visual surveys to locate and collect invertebrates throughout the area. The results gave them an increased understanding of what invertebrates are living in the cave and their distribution within the cave, which was influenced by moisture and light concentrations (Campbell et al.).

A study in California used collection methods to determine characteristics and behaviors of various spiders. Spiders within a vineyard were more often found in aerial collections than those on the ground, showing that they are more greatly distributed off of the ground and that they may come into the vineyard through the air and not on ground (Hogg & Daane, 2010). While trapping methods can show the distribution and abundance of spiders in different areas, it can also be used to infer other characteristics about them.

By investigating which collection method is best for various spider families, better studies can be conducted, leading to an increased amount of knowledge we have on spiders. By knowing how to more efficiently collect and quantify various spider groups better, we can further find ways to protect numerous spider species.

In particular, spiders living in the sandhill prairie habitats in Kansas are poorly understood. This study aims to collect multiple spider species at the Sandhills State Park in Hutchinson, KS. The abundance and location of each species will be analyzed as well as the methods used to collect each family. Pit fall ramp traps, sweep netting and litter sorting are the techniques used to collect the spiders in this experiment. Pit fall ramp traps provide a cheap and non-invasive technique to collect spiders wandering on the ground while sweep netting provides a good technique for collecting spiders in trees and taller ground cover (Patrick & Hansen, 2013). Overall, this study will show the habitats of various spider families and in what areas they are most often found as well as the methods to best capture them for study purposes. This will further our ability to understand and better conserve spiders.

MATERIALS AND METHODS

Spider Collection

Spiders were collected from the Sandhills State Park from June 5th to July 17th of 2013. Spiders were collected at nine locations at various areas throughout the park. Three of the locations surveyed were characterized by brush and tree covering while other areas were covered with sand and tall grass. Spider collections were conducted on every Monday, Wednesday and Friday within the two-month period.

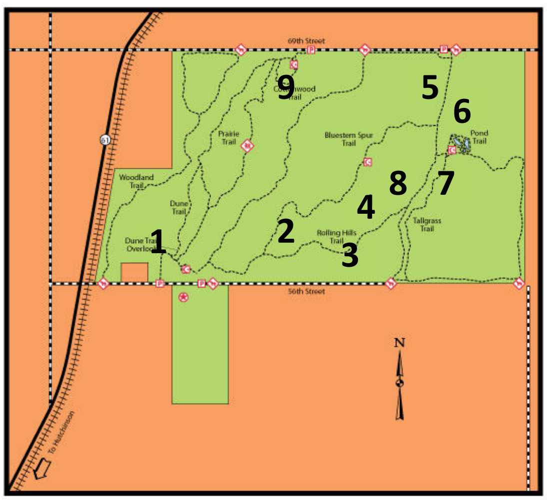

Figure 1. A map of the sampling locations at Sandhills State Park in Reno County, KS.

Two pit fall ramp traps were placed in all nine locations around the park (see Figure 1). Litter sorts were conducted at the two forested areas (Location #1 and #9) while sweep nets were used to collect spiders at the remaining seven (Location #2- #8). A pit fall ramp trap is made up of a covered container with two metal ramps leading up from the ground to inserts in the side of the container. A solution is placed in the container to kill and preserve organisms that crawl into the container. The ramps are metal, but coated in sand for camouflage and blended into the ground cover. The spiders that were collected in each pit fall trap were removed and placed in glass vials labeled with the trap's identification (location, A/B). Seventy percent alcohol was placed in the vials to preserve the spiders. The litter sorts at the forested location sites were conducted in a 1 m^2 transect. Each spider collected in the litter sort was placed in individual plastic vials and placed into a ziploc bag labeled with the date and collection site number. At the remaining locations, a sweep net was swept across grass and tree leaves for 50 m. The spiders caught in the net were placed into individual vials. All the spiders collected were organized and placed in a freezer at McPherson College to be preserved until they were categorized.

After the spiders were removed from the freezer, labels were placed into each vial with the spider's information, including the location within the park they were collected, the date of collection, the collection method used and the names of the collectors. All the spiders were preserved in 70% alcohol. The spiders were then identified to family.

Statistical Data Analysis

An ANOVA test was then conducted to compare the total number of spiders collected from each trapping method. A multiple comparisons test was conducted to see a more detailed comparison within trapping method success.

A Chi-squared test of independence was used to see what spider families were most often found in certain locations. A residual analysis was conducted to see where proportions of spiders found were significantly different than expected proportions.

Another Chi-squared test was used to see if a correlation exists between spider family and the success of each trapping method. A residual analysis showed exactly where the correlation existed.

RESULTS

655 spiders from 16 different families were collected at the Sandhills State Park. 625 of these spiders were collected by litter sorting, pit fall traps and sweep netting.

After standardizing the overall number of spiders collected for each sampling type by effort (# collected/# sampling events), each trapping method to collect spiders was equally successful in terms of total spiders collected (ANOVA, $F_{2,15}$ = 1.06, P = 0.37; See Table 1 for unadjusted collection numbers). However, the success of the various methods differed depending on the spider family being collected (χ^2_{34} < 0.001; Table 1). The adjusted residual values indicated that Agelenidae, Linyphiidae and Pisauridae families were more likely to be collected by litter sorting, while Clubionidae, Corinnidae, Gnaphosidae, Opiliones and Lycosidae families were more likely to be collected using pitfall traps and Araneidae, Oxyopidae, Salticidae and Thomisidae families were more likely to be collected by sweep netting.

The residual values also indicated that Thomisidae were not likely to be collected by using litter sorts and that Oxyopidae, Salticidae, Theridiidae and Thomisidae were not likely to be collected using pit fall traps. Sweep netting is not likely to collect Clubionidae, Corinnidae, Gnaphosidae and Lycosidae (Table 1).

Table 1. Effectiveness of different sampling techniques collecting various spider families.

		Sampling Technique[a]		
Family	Total #	Litter Sort	Pitfall	Sweep Net
Agelenidae	2	1 (2.1)	1 (0.1)	0 (-1.3)
Araneidae	14	2 (0.8)	1 (-2.9)	11 (2.5)
Clubionidae	26	0 (-1.6)	25 (5.3)	1 (-4.4)
Corinnidae	6	0 (-0.7)	6 (2.7)	0 (-2.3)
Gnaphosidae	93	11 (1.3)	79 (8.3)	3 (-9.0)
Linyphiidae	13	9 (8.0)	1 (-2.8)	3 (-1.7)
Lycosidae	158	18 (1.5)	136 (11.8)	4 (-12.7)
Opilione	4	0 (-0.6)	4 (2.2)	0 (-1.8)
Oxyopidae	42	2 (-0.9)	3 (-5.2)	37 (5.7)
Philodromidae	27	1 (-0.9)	12 (-0.1)	14 (0.6)
Pisauridae	1	1 (3.3)	0 (-0.9)	0 (-0.9)
Salticidae	92	6 (-0.7)	11 (-7.0)	75 (7.4)
Sicaridae	1	0 (-0.3)	1 (1.1)	0 (-0.9)
Tetragnathidae	1	0 (-0.3)	0 (-0.9)	1 (1.1)
Theridiidae	11	2 (1.2)	1 (-2.5)	8 (1.8)
Thomisidae	134	0 (-4.0)	5 (-11.0)	129 (13.2)
Overall	625	53	286	286

[a] Results are presented as # collected (adjusted residual value from chi-square test).
*Residual values larger than +/- 2 are considered significant

The allocation of spiders also differed depending on the spider family (χ^2_{120} < 0.001; Table 2). Locations #1 and #9 are both forested areas. At these locations, Agelenidae, Gnaphosidae, Araneidae, Linyphiidae, Pisauridae, Sicaridae and Theridiidae are more likely to be found. The spiders not likely found at these locations include Oxyopidae, Salticidae and Thomisidae.

The remaining locations were characterized by sand and grass covering. Spiders more likely to found in these locations include Oxyopidae, Opiliones, Thomisidae, Philodromidae, Salticidae and Clubionidae. Gnaphosidae, Theridiidae and Lycosidae are not as likely to be found in these areas (Table 2).

DISCUSSION

All trapping methods used were equally successful at catching spiders in general. However, each trapping method collected different types of spider families more successfully.

It was found that sweep netting captures Thomisidae, Salticidae, Araneidae and Oxyopidae spider families better than the other sampling methods. There are some possible reasons why

Table 2. Distribution of spider families across sampling locations in Sandhill Prarie State Park, KS.

		Trap Location[a b]								
Family	Total #	1	2	3	4	5	6	7	8	9
Agelenidae	7	5 (3.9)	0 (-1.0)	0 (-1.0)	0 (-1.0)	0 (-1.0)	0 (-0.8)	0 (-0.7)	0 (-0.6)	2 (1.7)
Araneidae	24	4 (0.0)	1 (-1.3)	1 (-1.3)	2 (-0.7)	5 (1.0)	3 (0.7)	1 (-.06)	1 (-0.1)	6 (2.6)
Clubionidae	26	3 (-0.7)	2 (-0.9)	1 (-1.4)	2 (-0.9)	4 (0.2)	7 (3.4)	0 (-1.5)	3 (1.7)	4 (1.0)
Corinnidae	6	2 (1.1)	0 (-1.0)	0 (-0.9)	2 (1.5)	0 (-1.0)	1 (0.7)	0 (-0.7)	0 (-0.5)	1 (0.6)
Gnaphosidae	93	32 (5.0)	15 (0.9)	6 (-2.0)	3 (-3.1)	18 (1.6)	1 (-2.8)	1 (-2.5)	3 (-0.7)	14 (1.9)
Linyphiidae	13	3 (0.7)	0 (-1.4)	1 (-0.6)	0 (-1.4)	1 (-0.7)	0 (-1.1)	1 (0.1)	0 (-0.8)	7 (5.4)
Lycosidae	160	32 (1.4)	23 (0.5)	26 (1.5)	27 (1.6)	16 (-1.7)	16 (0.8)	1 (-3.7)	1 (-2.7)	18 (0.7)
Opilione	4	0 (-0.9)	0 (-0.8)	2 (2.2)	0 (-0.8)	0 (-0.8)	2 (3.0)	0 (-0.6)	0 (-0.4)	0 (-0.7)
Oxyopidae	43	2 (-2.2)	11 (2.5)	8 (1.2)	11 (2.5)	2 (-1.8)	4 (0.2)	3 (-0.1)	2 (0.0)	0 (-2.20
Philodromidae	28	4 (-0.3)	1 (-1.5)	5 (0.8)	4 (0.2)	5 (0.6)	0 (-1.7)	5 (2.2)	0 (-1.2)	4 (0.8)
Pisauridae	1	0 (-0.4)	0 (-0.4)	0 (-0.4)	0 (-0.4)	0 (-0.4)	0 (-0.3)	0 (-0.3)	0 (-0.2)	1 (3.0)
Salticidae	95	11 (-1.4)	13 (0.1)	13 (0.3)	11 (-0.5)	16 (0.8)	6 (-0.8)	15 (3.4)	8 (1.9)	2 (-2.7)
Sicaridae	1	0 (-0.4)	0 (-0.4)	0 (-0.4)	0 (-0.4)	0 (-0.4)	0 (-0.3)	0 (-0.3)	0 (-0.2)	1 (3.0)
Tetragnathidae	2	0 (-0.6)	1 (1.5)	1 (1.6)	0 (-0.6)	0 (-0.6)	0 (-0.4)	0 (-0.4)	0 (-0.3)	0 (-0.5)
Theridiidae	20	8 (2.9)	1 (-1.1)	3 (0.3)	0 (-1.8)	3 (0.1)	1 (-0.6)	0 (-1.3)	1 (0.1)	3 (0.8)
Thomisidae	132	2 (-5.2)	19 (0.4)	17 (0.0)	25 (2.1)	23 (1.1)	15 (1.2)	21 (4.2)	11 (2.3)	1 (-3.9)
Overall	655									

[a] Trap locations 1 & 9 were characterized by forested habitats, while trap locations 2-8 were characterized by sandy grassland habitats

[b] Results are presented as # collected (adjusted residual value from chi-square test).

sweep netting is able to collect more numbers of these spiders than the other trapping methods. Thomisidae, or crab spiders, often position themselves on top of flowers in order to prey on flower pollinators. Flower blooms are off the ground, so they are not close to pit fall traps, but are at the perfect height to be collected by a sweep net. Because the hunting ground of the crab spiders is at sweep netting height, it is not surprising Thomisidae are commonly found within the nets (Heiling et al., 2004). Salticidae, or jumping spiders, easily climb their way up into taller areas, such as in trees and tall vegetation, placing them in the target areas for sweep netting (McGinley et al., 2013). Spiders within the Araneidae family are orb weavers that often create webs in tall and strong vegetation. When creating their webs, the stronger the structure is the more secure and safe they will be, leading to their selection of stronger vegetation off the ground (Brenes, 2012). Oxyopidae live strictly on plants with certain trichome characteristics, meaning they are up on taller vegetation as well (Jacobucci et al., 2009). It was also found that sweep netting did not capture Clubionidae, Corinnidae, Gnaphosidae or Lycosidae spider families well. Corinnidae spiders have adapted to mimic the behavior and appearance of ants, living on the ground and behaving like ants to guard off predators (Rubio et al., 2013). This means they are on the ground and not up high in the path of sweep nets. Gnaphosidae are known to be ground dwelling spiders, also away from the vegetation affected by sweep nets (Koponen, 1987). Lycosidae are ground dwellers as well, living in burrows or webs built around rocks on the ground surface, keeping them out of the way of sweep nets.

Pit fall traps successfully captured Clubionidae, Corinnidae, Gnaphosidae, Lycosidae and Opilione spider families. As mentioned before, Clubionidae, Corinnidae and Gnaphosidae all spend a majority of their time close to the ground, making them likely to crawl up into a pit fall trap. Lycosidae are also ground dwellers that chase their prey across the ground, making it likely for them to venture up into a pit fall trap. It was also found that pit fall traps do not capture many Araneidae, Oxyopidae, Salticidae, Theridiidae, and Thomisidae. These spiders all live in higher vegetation as previously mentioned, so they do not come in contact with the pit fall traps on the ground.

Agelenidae, Linyphiidae and Pisauridae families were most successfully captured by litter sorts. Linyphiidae are ground dwelling spiders, so they are often found within leaf litter on the ground (Koponen, 1987). Agelenidae spiders create webs in areas with a lot of leaf litter or fallen trees low to the ground to protect their egg sacs (Rojas, 2011). Thomisidae were not captured well by litter sorts, possibly due to their tendency to live higher up in vegetation and off the ground as mentioned previously.

While each trapping method may be equally useful when catching spiders, it is important to know what sampling technique to use when attempting to collect a certain type of spider. The characteristics of spiders and their habitat and hunting behaviors can be used to infer what sampling technique will be most successful to their collection.

The two main types of locations that were tested were forested area locations with soil and tree cover as well as sandy grasslands. Tests show that the two types of locations are inhabited by different types of spider families.

The spiders commonly found in the forested locations include Agelenidae, Gnaphosidae, Theridiidae, Araneidae, Linyphiidae and Pisauridae. A previous study shows that Linyphiidae and Gnaphosidae are common in shaded forested areas (Koponen, 1987). As mentioned previously, Araneidae tend to create webs in tall vegetation, such as trees in forested areas. Theridiidae, or black widows, also prefer to make their webs on shaded trees. All these characteristics make them likely to be found in forested areas. Oxyopidae, Thomisidae and Salticidae were not found often in the forested areas.

Within the sand and grassy areas, Oxyopidae, Opiliones, Thomisidae, Clubionidae, Philodromidae and Salticidae were often found. Thomisidae are attracted to flowers in order to catch their prey, which often grow best in open areas that have more sunlight. Forested areas with a lot of shade have small quantities of flowers compared to open fields, meaning fewer hunting grounds for Thomisidae. Spiders not found in these areas include Gnaphosidae, Theridiidae and Lycosidae.

Litter sorts were only performed in forested areas while sweep nets were only used in the non-forested areas, which cause this information to be confounded. The spiders not often found in the forested areas are the spiders most successfully caught by sweep netting, which was not performed in these areas. In the event that the experiment would be repeated, all sampling techniques should be used at all location sites to eliminate this confounding issue.

By using the data analyzed within this experiment, appropriate collecting methods can be utilized to help make spider collections more successful by indicating what technique will best capture the spider of interest. By using more efficient methods of collection, researchers can collect more spiders for experimentation in shorter amount of time, leaving more time for other aspects of the experiment. This data also shows the potential for determining the need for conservation of various spiders based on their habitat. While the data is confounded, it still shows what spiders thrive best in forested areas or sandy grassland areas. To best protect a certain spider family, the habitat preferred by that spider should be conserved.

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