SPIDER BIODIVERSITY AT OAK LAKE FIELD STATION, BROOKINGS COUNTY, SOUTH DAKOTA

Katherine E. Okins
Biology Department

Paul J. Johnson
Plant Science Department

South Dakota State University
Brookings, SD 57007

ABSTRACT

A spider biodiversity study was conducted at Oak Lake Field Station, Brookings County, during the summers of 2003 and 2004 in order to collect and inventory spider families found in eastern South Dakota. Pitfall traps were set at nine site locations with the following categorized habitats: lakeside elevated woodland, midslope woodland, mesic meadow, xeric prairie, xeric exotic-grass prairie, and coniferous windbreak. A total of 1053 specimens were identified, representing 49 genera in the following 21 families: Agelenidae, Amaurobiidae, Araneidae, Clubionidae, Corinnidae, Cybaeidae, Dictynidae, Gnaphosidae, Linyphiidae, Liocranidae, Lycosidae, Micryphantidae, Nesticidae, Oxyopidae, Philodromidae, Pholcidae, Pisauridae, Salticidae, Tetragnathidae, Theridiidae, and Thomisidae. The ratio of males (47.2%) to females (47.4%) collected was near equal. The mesic meadow was sampled both years, and in 2004 the area was subjected to a prescribed burn resulting in a lower number of spiders collected and a lower diversity of spider families. The coniferous windbreak site yielded high numbers of wolf spiders (Lycosidae) relative to other sites. Combined data show a clear pattern in weekly capture rates, with numbers steadily decreasing throughout the summer. Nine families previously unrecorded from South Dakota were collected. The spider fauna of eastern South Dakota is considered incompletely inventoried, even at the family level, and continued efforts are expected to prove productive and informative.

INTRODUCTION

Peterson (1939) conducted the first and only known spider biodiversity study in South Dakota. As part of his study he recorded 13 families from two locations in Brookings County: Oakwood Lakes and the Brookings area, neither of which currently resemble native prairie. Due to limited sampling, Peterson's survey was a poor estimation of the diversity of the spider fauna in eastern South Dakota; furthermore, it is unpublished and taxonomically obsolete. As shown here, a much broader range of spider families exists within South Dakota than is mentioned in Peterson's study, even when correcting for taxonomic changes, and this clearly illustrates a need for more spider research in the area.

This study's main objectives were to develop a catalog of spiders, identified to family and when possible, genus and species, occurring at the Oak Lake Field Station and to identify spiders occurring in the abstract prairie of Eastern South Dakota. It was also intended to broaden the scope of known spider families occurring in South Dakota and provide a baseline for future statewide spider inventory studies.

Sampling was conducted at the Oak Lake Field Station, Brookings Co., South Dakota during the summers of 2003 and 2004. The Oak Lake Field Station (OLFS) is a 230 ha research facility owned and operated by South Dakota State University (Troelstrup 2005) (Fig. 1). The OLFS is situated in a prairie pothole and is a prime study area due to a wide variety of habitats, which optimizes the collection of different types of spiders.

Figure 1. GIS-generated map of Oak Lake Field Station, Brookings Co., SD, with locations of numbered sites shown.

METHODS

Nine sites were sampled. Specific habitats sampled were: lakeside elevated woodland, midslope woodland, mesic meadow, xeric prairie, xeric exotic-grass prairie and coniferous windbreak. Brief descriptions of each site can be found in Table 1. Five sites of these habitats were sampled in 2003: lakeside elevated woodland, xeric prairie A, xeric prairie B, mesic meadow, and midslope woodland. Four sites were sampled in 2004: mesic meadow, xeric prairie C, xeric exotic-grass prairie, and coniferous windbreak. The mesic meadow was the only site sampled both years. Visual differences in flora and their distinction from surrounding predominant vegetation, as well as discernible soil aridity, were incorporated in site selection and recorded. Aspect was recorded and unique incidences noted, such as the occurrence of a thatch ant mound within a site (Table 1). Sites are numbered as presented on Table 1 and appear on a GIS-generated map of the OLFS (Fig. 1).

Spiders were collected primarily by the use of pitfall traps, with six traps per site, collected weekly. Pitfall traps were glass culture tubes containing a 1:1 solution of 80% ethyl alcohol and propylene glycol and were slipped inside of 12" sections of PVC pipe, its purpose to protect the inserted test tubes. While pitfall

Table 1. Site number, habitat type and description at Oak Lake Field Station, Brookings County, SD.

Site Number		Habitat Type	Habitat description (predominant vegetation, discernible soil aridity, aspect)
2003	#1	Midslope Woodland	Green ash (*Fraxinus pennsylvanica*); moist; easterly
	#2	Lakeside Elevated Woodland	Bur oak (*Quercus macrocarpa*), green ash; very moist; northeasterly
	#3	Xeric Prairie A	Smooth brome (*Bromus inermis*), leadplant (*Amorpha canescens*), purple coneflower (*Echinacea purpurea), groundplum milkvetch (Astragalus crassicarpus*); dry; southerly
	#4	Xeric Prairie B	Smooth brome, surrounded on three sides by bur oak and green ash; dry; southwesterly
	#5	Mesic Meadow	Smooth brome, green ash (saplings), abuts wetland; moist; southwesterly
2004	#6	Mesic Meadow	Smooth brome, green ash, abuts wetland, post-prescribed burn; moist; southwesterly
	#7	Xeric Prairie C	Smooth brome, large thatch ant (*Formica* sp.) mound on north side; dry; southeasterly
	#8	Coniferous Windbreak	Pine Trees (*Pinus ponderosa*), woodbine (*Parthenocissus vitacea*); moist; easterly
	#9	Xeric Exotic-Grass Prairie	Kentucky bluegrass (*Poa pratensis*), large incidence of Canada goldenrod (*Solidago canadensis*); dry; easterly

trapping is recognized to afford a close estimate of the total number of species in a community, especially of wandering spiders, sole reliance is not recommended (Uetz et al. 1976). Thus sweep nets (for catching grass-dwelling spiders), beating sheets (for collecting tree- and shrub-dwelling spiders) and hand collections were also performed.

Spiders were sorted and placed in separate vials with 80% ethyl alcohol. Spiders were sexed and separated to morphospecies, then keyed to the family level and, where possible, genus and species. All spider data were entered onto a spreadsheet and submitted to the OLFS database. Voucher specimens were placed in the OLFS collection.

RESULTS

A total of 1053 specimens were identified that represent 49 genera in 21 families (Table 2). The percent of females to males collected within families varied little with the overall percentages being 47.4% female and 47.2% male. Immatures (5.3%) could not be sexed.

The site with the highest number of families collected (16) was the xeric prairie B. Those with the lowest numbers of families collected (8) were the coniferous windbreak and xeric exotic-grass prairie sites (Fig. 2). The mesic meadow site was sampled both years; in 2003 a higher number of specimens (88) and families (13) were collected as compared to 2004 (54 and 9, respectively). The mesic meadow site was subjected to a prescribed burn one month prior to sampling in 2004, which affected spider density and diversity here.

The majority of spiders (41%) collected were Lycosidae (wolf spiders). Out of a total of 435 lycosid specimens, 141 were caught at the coniferous windbreak. This is nearly 33% of all lycosids captured. These specimens represent only two or three morphospecies.

Collecting began later in 2004 than in 2003 (week 3; roughly 27 June) and extended past the previous year's ending date (week 9; roughly 12 August), but

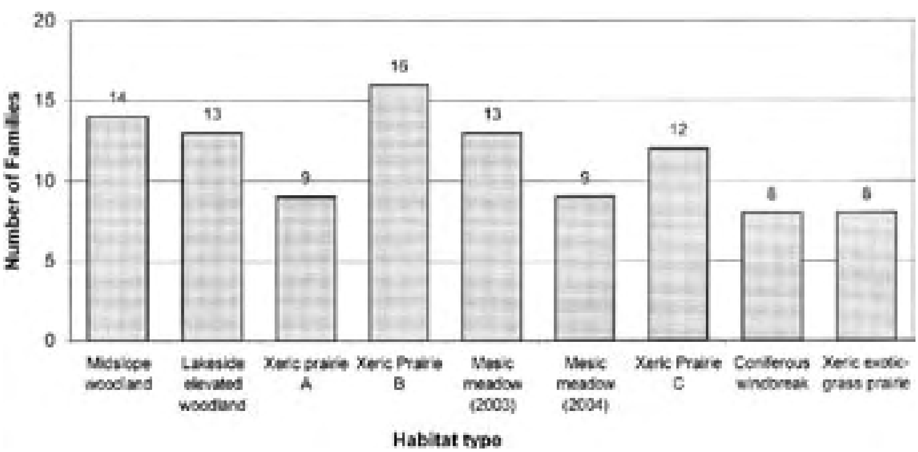

Figure 2. Spider family richness per site.

Table 2. A list of spider families collected during the summers of 2003-2004 at Oak Lake Field Station, Brookings County, SD.

Families are listed in approximate phylogenetic order (Kaston 1978, Roth 1993, Dean 2005). Genera are listed alphabetically within the family. Numbers following family names are numbers of specimens collected per family.

- Dictynidae (3)
  - *Cicurina* sp.
  - *Dictyna* sp.
- Amaurobiidae (2)
  - *Wadotes* sp.
- Pholcidae (1)
- Theridiidae (65)
  - *Robertus* sp.
  - *Steatoda borealis* (Hentz)
  - *Theridion frondeum* Hentz
  - *Theridion* sp.
  - *Tidarren* sp.
- Nesticidae (3)
- Linyphiidae (76)
  - *Bathyphantes* sp.
  - *Microneta viaria* (Blackwall)
  - *Microneta* sp.
- Micryphantidae (135)
- Araneidae (46)
  - *Acanthepeira* sp.
  - *Argiope aurantia* Lucas
  - *Drexelia* sp.
  - *Eustala* sp.
- Tetragnathidae (26)
  - *Leucauge* sp.
  - *Pachygnatha* sp.
  - *Tetragnatha* sp.
  - *Zygiella* sp.
- Agelenidae (23)
  - *Agelenopsis* sp.
- Pisauridae (1)
- Lycosidae (435)
  - *Alopecosa* sp.
  - *Arctosa* sp.
  - *Hogna helluo* (Walckenaer)
  - *Hogna* sp.
  - *Lycosa* spp.
  - *Pardosa distincta* (Blackwall)
  - *Pardosa xerampelina* (Keyserling)
  - *Pardosa* sp.
  - *Pirata insularis* Emerton
  - *Pirata minutus* Emerton
  - *Pirata* sp.
  - *Schizocosa avida* (Walckenaer)
  - *Schizocosa bilineata* (Emerton)
  - *Schizocosa crassipes* (Walckenaer)
  - *Schizocosa* sp.
  - *Trochosa* sp.
- Oxyopidae (1)
- Gnaphosidae (63)
  - *Drassylus* sp.
  - *Haplodrassus* sp.
  - *Micaria longipes* Emerton
  - *Sergiolus* sp.
  - *Zelotes* sp.
- Clubionidae (24)
- Thomisidae (74)
  - *Bassaniana versicolor* (Keyserling)
  - *Bassaniana utahensis* (Gertsch)
  - *Bassaniana* sp.
  - *Misumena* sp.
  - *Misumenops* sp.
  - *Xysticus alboniger* Turnbull, Dondale & Redner
  - *Xysticus transversatus* (Walckenaer)
  - *Xysticus* sp.
- Philodromidae (23)
  - *Philodromus vulgaris* (Hentz)
  - *Tibellus oblongus* (Walckenaer)
  - *Tibellus* sp.
- Salticidae (47)
  - *Attidops youngi* (G. & E. Peckham)
  - *Eris militaris* (Hentz)
  - *Habrocestum pulex* (Hentz)
  - *Habrocestum* sp.
  - *Icius* sp.
  - *Pelegrina protervus* (Walckenaer)
  - *Phidippus audax* (Hentz)
  - *Plexippus* sp.
- Corinnidae (1)
  - *Trachelas* sp.
- Cybaeidae (2)
  - *Cybaeus* sp.
- Liocranidae (2)
  - *Agroeca* sp.
  - *Phrurotimpus* sp.

within the correlating weeks for both years spiders collected peaked at the end of June then steadily decreased over the course of the summer (Fig. 3).

DISCUSSION

Lycosidae account for 82.5% of all spiders collected at the coniferous windbreak site, and 32.4% of the total number of lycosids were caught here, represented by only two or three morphospecies. The pitfall traps at this site caught little else than wolf spiders. In a study of a subnivean fauna Schmidt et al. (1992) showed that spiders were significantly more numerous in stands of conifer than in stands of meadow or sagebrush. Gunnarsson (1990) showed the importance of needle density for spruce-living spiders, noting that reduced needle density correlated with a reduced spider population. In a later paper (Gunnarsson 1996) he showed that in the presence of bird predators, abundance of spiders was greater on spruce branches with high needle density. Though Gunnarsson's observations alone do not explain the abundance of the largely ground-dwelling Lycosidae, the greater protection afforded by conifers could contribute to a high lycosid population.

Space is an important limiting factor of population size in the genus *Pardosa* (Lycosidae) (Vogel 1971), and *Pardosa* species dominated in the coniferous windbreak. Lycosids are highly territorial, defending an inter-individual space of about 3" in diameter (Vogel 1972), and if spider density is high, will exhibit cannibalistic tendencies even in areas of high prey density (Riechert 1974), though cannibalism is more frequent when prey is scarce (Wagner et al. 1996; Samu et al. 1999). The pitfall samples consisted primarily of spiders and secondarily of a small number of crickets and millipedes that may be potential prey. This does not suggest a high prey density, yet even if prey densities were higher competition among individual lycosids may suppress the lycosid population.

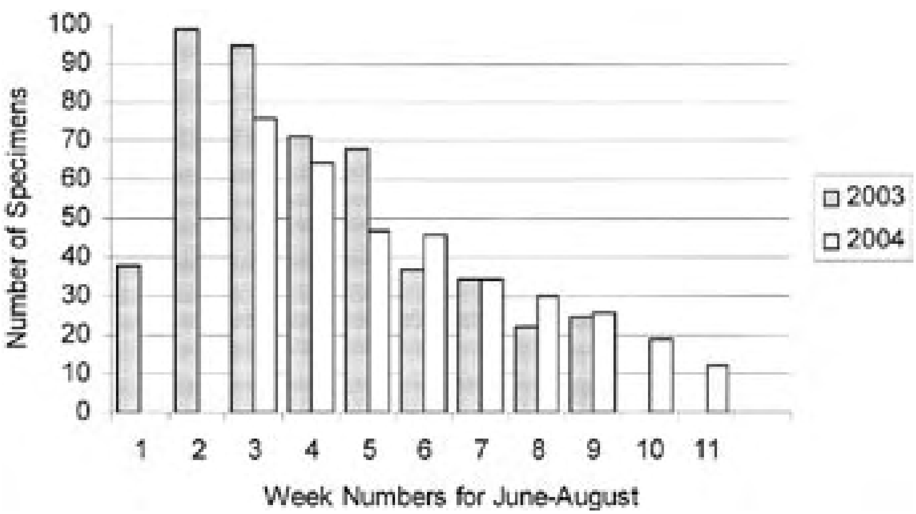

Figure 3. Weekly capture rates for pitfall traps, 2003-2004.

Rypstra et al. (1999) and Bultman et al. (1984) showed that the diversity of the spider community is closely tied to the structural complexity of the local environment. Abundance of spiders in general increases with greater structural diversity of ground litter (Bultman et al. 1984), suggesting perhaps that coniferous tree stands have a complex litter structure suitable for a large population of cursorial spider. At the windbreak site the space beneath the lowest branches was crowded with vegetation, adding complexity to the layers of pine needle litter. The findings of Vogel (1971, 1972), Riechert (1974), Wagner et al. (1996) and Samu et al. (1999) are somewhat contradictory to what was found in this study at the coniferous windbreak site, and it is unclear that cannibalism plays a greater role in this population of lycosids than does habitat complexity.

In 2003, 88 spiders were recorded from the mesic meadow. In 2004, however, only 54 were recorded. This was the lowest number of spiders collected of all sites for both years. A possible reason for this was a prescribed burn that occurred in 2004 at that site one month prior to sampling. The number of families caught between both years also varied with 13 recorded in 2003 and nine in 2004. The families absent from second-year collection were Agelenidae, Micryphantidae, Nesticidae, Oxyopidae, and Philodromidae. Siemann et al. (1997), Anderson et al. (1989), and Dunwiddie (1991) suggest that arthropods are not significantly affected by burns, though in one instance the numbers of Arachnida were lower in a burned plot than in an untreated plot (Dunwiddie 1991), and Rice (1932), Riechert et al. (1972), and Nagel (1973) reported similar declines in spider numbers following spring burning. Riechert et al. (1972) showed that spiders active on the surface at the time of a burn would be destroyed, while those under the surface or in dense clumps of vegetation may escape heat-caused damage. Invertebrate composition and population density are influenced by microclimatic and vegetational structural changes caused by burning (Riechert et al. 1972). Warren et al. (1987) suggested that changes in prey density and diversity will directly affect spider populations. If prey was either killed during the burn or left the area post-burn, it is likely that spider populations would have to move to areas of higher prey density. It can be hypothesized that the lower numbers of spiders following the 2004 burn at OLFS were the result of a temporary habitat change, with surviving spiders moving away from the area post-burn in search of better cover for protection from predation, structural differences (in unburned areas) for web-making, and prey.

Barnes et al. (1955) discussed the extent to which spider populations exist in an abstract sense within a community. A ‘concrete community’ is a particular stand of vegetation (e.g. pine trees) at a specific location. The ‘abstract community’ would be a general reference to all stands of pine trees. They found that an abstract plant community would support an abstract spider population. From Barnes’s study, it can be inferred that the spiders found within particular plant communities at Oak Lake Field Station will also be found in similar plant communities elsewhere in Eastern South Dakota.

This spider study brings the number of known spider families in eastern South Dakota to 21, though this would undoubtedly rise again upon further study. The family Mimetidae was reported by Peterson (1939) but was not found in this effort. Conversely, the families Amaurobiidae, Corinnidae, Cy-

Table 3. Number of specimens caught per family by site at Oak Lake Field Station, Brookings Co., SD.

	2003					2004				
	Midslope woodland	**Lakeside elevated woodland**	**Xeric prairie A**	**Xeric Prairie B**	**Mesic meadow**	**Mesic meadow**	**Xeric Prairie C**	**Coniferous windbreak**	**Xeric exotic-grass prairie**	**General sampling**
Dictynidae	-	-	-	2	-	-	-	-	-	1
Amaurobiidae	-	-	-	2	-	-	-	-	-	-
Pholcidae	-	-	-	-	-	-	1	-	-	-
Theridiidae	12	8	-	11	2	3	9	2	13	5
Nesticidae	-	-	-	-	2	-	-	-	-	1
Linyphiidae	2	50	-	1	2	4	-	15	2	-
Micryphantidae	46	74	1	7	6	-	1	-	-	-
Araneidae	3	14	5	1	3	1	1	1	-	17
Tetragnathidae	3	7	-	1	-	3	3	-	-	9
Agelenidae	2	11	1	2	3	-	1	1	-	2
Pisauridae	-	1	-	-	-	-	-	-	-	-
Lycosidae	4	34	58	49	42	25	46	141	32	4
Oxyopidae	-	-	-	-	1	-	-	-	-	-
Gnaphosidae	4	6	6	8	5	6	7	5	16	-
Clubionidae	1	2	2	1	2	5	3	4	1	4
Thomisidae	5	12	5	17	9	5	5	2	7	7
Philodromidae	5	-	4	2	4	-	3	-	1	4
Salticidae	9	2	8	7	7	2	2	-	1	9
Corinnidae	1	-	-	-	-	-	-	-	-	-
Cybaeidae	1	-	-	1	-	-	-	-	-	-
Liocranidae	-	1	-	1	-	-	-	-	-	-
TOTAL	**98**	**222**	**89**	**113**	**88**	**54**	**82**	**171**	**73**	**63**

baeidae, Liocranidae, Linyphiidae, Micryphantidae, Nesticidae, Oxyopidae and Pholcidae were found in this study, but not represented in Peterson's inventory. The additional families reported here were due to the use of pitfall traps and a more intensive local study than that by Peterson. As stated previously, Peterson's study is incomplete in its representation of the spider families of South Dakota. Further studies should focus on detailed inventories of the spiders of South Dakota, subsequently leading to studies of individual species and communities. Complete spider diversity studies are dependent upon a variety of sampling methods in or among a wide variety of habitats.

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