ARACHNID COMMUNITIES IN MESQUITE GRASSLAND AND SHINNERY OAK SCRUB AT YOAKUM DUNES WILDLIFE MANAGEMENT AREA, COCHRAN COUNTY, TEXAS

by

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ABSTRACT

A taxonomic survey of the arachnid fauna was conducted at the Yoakum Dunes Wildlife Management Area (WMA) Cochran County, Texas during the years of 2017, 2018, and 2019. Yoakum Dunes WMA was established by Texas Parks & Wildlife Department in 2014. No surveys of its invertebrate fauna have been undertaken at Yoakum Dunes to date. Arachnids were sampled using a combination of pitfall trapping, sweep netting, and general collecting. Eight pitfall arrays were deployed, four in mesquite habitat and four in shinnery oak habitat and were used to capture arachnids for one-week periods. Eight sweep samples and eight general collecting samples were also gathered during each sampling period.

Members of five arachnid orders were captured at the site: spiders (Araneae), scorpions (Scorpiones), sun spiders (Solifugae), pseudoscorpions (Pseudoscorpiones) and mites (Acari). A total of 31 families, 68 genera, and 100 species of arachnids were identified, broken down as follows: Acari, four families, eight genera (species were not identified); Araneae, 20 families, 53 genera, and 85 species; Scorpiones: two families, three genera, and four species; Pseudoscorpiones: two families and two genera; Solifugae: one family, two genera, and two species. All identified species of non-scorpion arachnids collected represent new records for Cochran County. Most notably, three species of spiders, *Agyneta fratrella* (Chamberlin, 1919; Linyphiidae), *Piabuna pallida* (Chamberlin & Ivie, 1935; Phrurolithidae), and *Allocosa morelosiana* (Gertsch & Davis 1940; Lycosidae) were documented in Texas for the first time.

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ARACHNID COMMUNITIES IN MESQUITE GRASSLAND AND SHINNERY OAK SCRUB AT YOAKUM DUNES WMA

Introduction

The Texas Parks and Wildlife Department created Yoakum Dunes Wildlife Management Area (WMA) in November of 2014. Land acquisition was made possible by the combined efforts of The Conservation Fund, The Nature Conservancy, and Concho Resources, Inc., an oil and gas company. The WMA, located 77.2 km (48.5 mi) WSW of Lubbock, covers an area of 5611 hectares (13,866 acres) spread across portions of Cochran, Terry, and Yoakum counties in the Texas Panhandle (Fig. 1). It was established primarily as a haven for the lesser prairie-chicken (*Tympanuchus pallidicinctus*; Ridgway, 1973), a state threatened species, and endemic grassland wildlife (Texas Parks & Wildlife and U.S. Fish & Wildlife Service 2016).

As a recent acquisition for TPWD, no diversity assessments of the flora and fauna of Yoakum Dunes WMA have been performed. In a broader geographic context, the arachnid community in this region of the Llano Estacado is understudied. Yoakum Dunes WMA is composed of two contrasting habitats, mesquite grassland and shinnery oak scrub. As prior studies (Bultman et al. 1982; Cokendolpher et al. 2008) have shown that arachnids tend to partition themselves by habitat, I hypothesize that species compositions of mesquite grassland and shinnery oak scrub will exhibit minimal overlap due to their contrasting natures.

This research venture sought to fulfill two objectives:

- Objective 1: Survey the arachnid communities inhabiting mesquite grassland and shinnery oak scrub of Yoakum Dunes WMA and develop a preliminary species list.
- Objective 2: Determine whether the arachnid communities supported by mesquite and shinnery oak habitats are distinct or exhibit overlap, and if they do, to what degree.

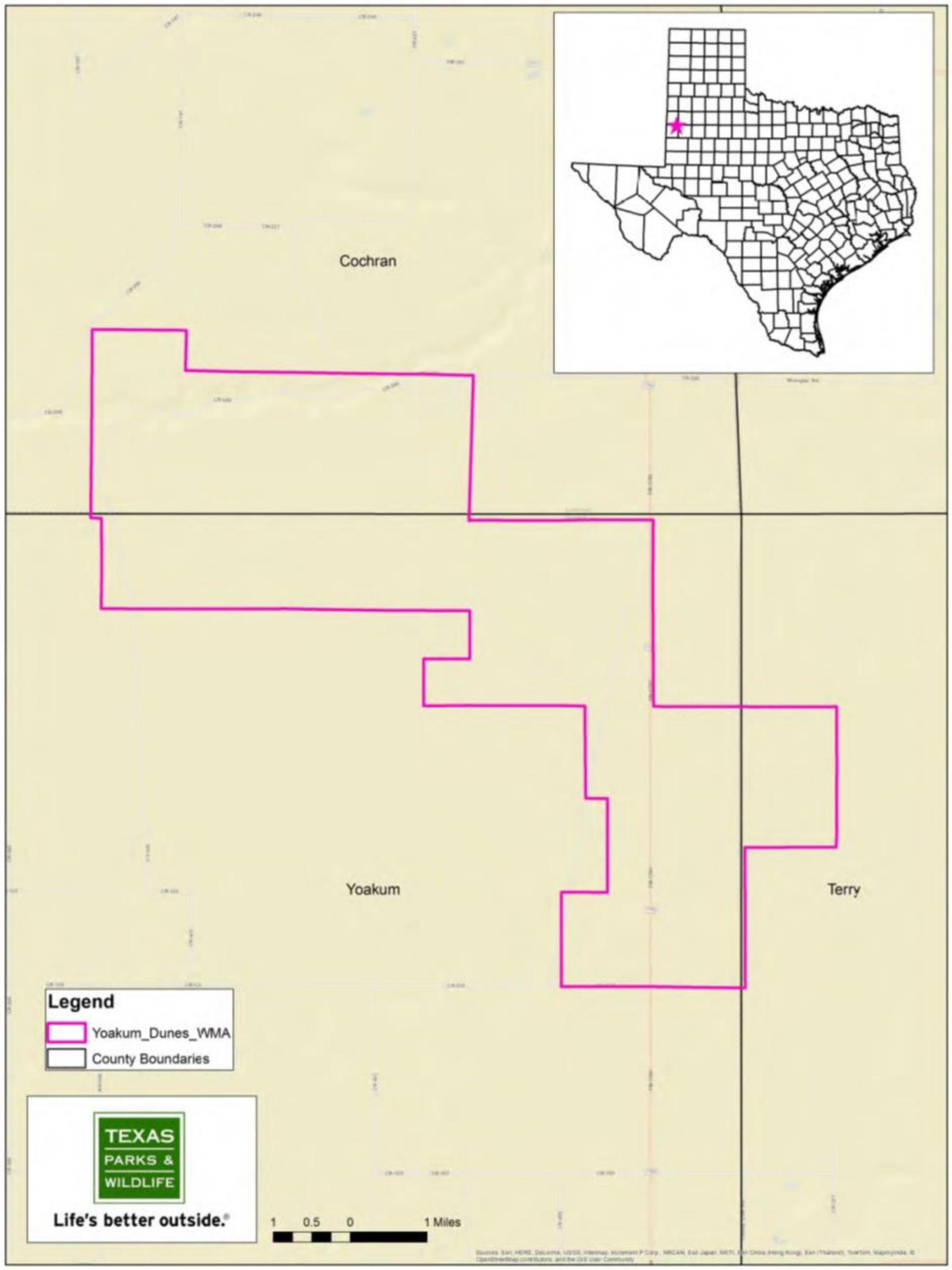

Figure 1. Location of Yoakum Dunes WMA in the Texas Panhandle and boundary of property (Texas Parks & Wildlife and U.S. Fish & Wildlife Service 2016).

Literature Review

Knowledge regarding the distributions of arachnid species in the Southern High Plains has largely been accumulated via scrutiny of a single taxon (Hamilton, Hendrixson and Bond 2016) or group of taxa (McWest, Valois and Sissom 2015). This was often achieved as part of revisionary works (Platnick and Shadab 1975) or constituted one facet of projects investigating other biological aspects such as cladistics (Ayoub, Riechert and Small 2005).

Given the interplay between arachnids and the habitats they occupy, ecological papers have also contributed to more accurate delimitations of species' ranges. Diversity studies accomplishing this include those carried out in Colorado grasslands (McIver 1984), Illinois prairies (Wolff 1990), and the Pantex Plant (Cokendolpher et al. 2008).

Materials & Methods

Site Characteristics

Yoakum Dunes WMA is located approximately 45 km NE of Brownfield, Terry County, hence their climactic conditions can be considered identical. Brownfield experiences a temperature range from -3.67° C in January to 33.8° C in July. Rainfall amounts range from 13.2mm in January to 64.7mm in July. (The Climate Explorer, accessed 16 November 2022).

Nine soil varieties are present in the area surrounding the study site, five of which were sampled in. Patricia and Amarillo loamy fine sands (PAB) form the substrate for the mesquite grassland. Gomez loamy fine sand (GoB), Nutivoli fine sands (NtC and NtD), and Yoakran-Plains-Nutivoli complex (YpN), in varying proportions, form the substrate for the shinnery oak scrub. (USDA Web Soil Survey, accessed 21 September 2021).

Mesquite grassland habitat, markedly flatter in terms of topography, was characterized by the presence of honey mesquite (*Prosopis glandulosa* Torr.), with individuals being either isolated or clustered into stands. As chemical and mechanical control of this species is underway, habitats contain various numbers of live and dead plants. Prickly pear cactus (*Opuntia* spp.) was sometimes present, along with sand and a variety of grasses and forbs.

Figure 2. General appearance of mesquite grassland habitat. Honey mesquite can grow in clusters as shown here, or as isolated individuals. The habitat also sports cacti and a range of herbaceous/non-woody plant species such as grasses and forbs. The substrates are various types of silty clay loam.

Shinnery oak scrub habitat consisted of gentle to steep rolling sandhills densely vegetated with shinnery oak, *Quercus havardii* Rydb. Also present were little bluestem, *Schizachyrium scoparium* (Michx.) Nash, sand sagebrush, *Artemisia filifolia* Torr., and other species of grasses and forbs. Some habitats featured excavated sand pits with sparse plant growth and scattered plant material such as leaves and branches.

Figure 3. General appearance of shinnery oak scrub habitat. The high density of shinnery oak exhibited here is typical, with individuals growing so close together that their leaves touch. Other plant species are only capable of growing at the edges of the swaths, as seen

in the foreground. The substrate is soft, loose sand readily blown about by the wind.

Figure 4. Shinnery oak scrub habitat near the property's western edge. Sand pits like this were scattered across some of the habitats. Several little bluestem (*Schizachyrium scoparium*), a perennial bunchgrass common at the study site, can be seen in the foreground. A single sand sagebrush (*Artemisia filifolia*), occasionally present in shinnery oak habitat, can be seen at lower right.

Sampling Locations

Eight pitfall arrays were established adjacent to County Road 260, an unpaved east-west path in the northern portion of the property, which becomes oriented north-south near its western edge. Four arrays were set up per habitat: shinnery oak arrays were labeled A1, A2, A3 and A4; similarly, mesquite arrays were labeled B1, B2, B3, and B4. Each array was at least 35 meters from the road. Sites were restricted to areas of homogenous habitat to avoid negative impacts on sampling data caused by mesquite-shinnery oak ecotones.

Arachnid Sampling

Two methods commonly employed to sample arachnids, especially for ecological studies, are quadrat sampling and pitfall trapping. As with any method, there are certain drawbacks to their use. Quadrat sampling has its own fair share of negatives. Prior to a 1976 publication he co-authored, Uetz elected to sample via pitfall trapping in place of quadrat sampling. One reason was the observation that abundant spider species were being collected in lower-than-expected numbers or failing to be collected entirely. Another was that, during the act of sampling itself, spiders were fleeing from the disturbance and not being caught and accounted for.

Error stemming from the use of pitfall traps can be attributed to one of two sources: 1) less-than-ideal trap placement/distribution and/or 2) flawed trap design. The number of traps utilized for sampling, and even the chemical nature of preservatives added to traps, can contribute additional error (Uetz and Unzicker, 1976).

The weaknesses of pitfall trapping are countered by several advantages. It provides the best measure of species richness in a community, as well as allowing for uninterrupted sampling of species exhibiting temporal variation in activity levels. As pitfall trapping excels at sampling *only* cursorial arachnids, it is touted as the most reliable method available for this purpose (Uetz and Unzicker, 1976).

Furthermore, identification of arachnids, particularly to the species level, is not possible based on field observation in many cases. This limitation necessitates capture by pitfall trapping so that microscopic examination of morphology can be performed, and specimens identified.

Sweep netting is another method commonly used to sample arachnids. It targets arachnids occupying or inhabiting vertical plant structure, which pitfall traps would not necessarily be expected to catch. They include species that actively stalk prey from within vegetation, a prime example being jumping spiders, those that require anchor points for webs in the case of orb-weaving spiders, or flowers in the case of sit-and-wait/ambush hunters such as crab spiders. This method was therefore utilized to sample a broader range of arachnids and provide a more accurate assessment of their diversity.

Pitfall Trapping Regime

Each pitfall trap consisted of a plastic 473 ml Solo® brand cup nested inside a 130.5 mm deep plastic coffee can bearing an opening 91.5 mm in diameter; the plastic cups fit snugly inside the coffee can. The plastic cups were filled approx. two-thirds full of a 50/50 blend of propylene glycol and water to act as the preservative. Each trap was buried so that the rim of the cup was flush with the ground surface (Fig. 5). This was necessary to enhance capture success, as arachnids encountering an edge are prone to halting and navigating around the perceived drop-off to avoid a fall.

Figure 5. Example of a newly deployed pitfall trap in mesquite habitat. Note that the lip of the cup is flush with the ground surface. This was necessary to enhance arachnid capture success.

To reduce sunlight-induced evaporation and discourage entry by non-target creatures, each trap was covered square piece of linoleum floor tile measuring 15.24 by 15.24 cm. The tile was supported by a nail driven through each corner and into the ground at an angle to prevent it from sinking. The nails were pushed into the substrate until the tile was elevated about 2.5 cm above the trap (Fig. 6).

Figure 6. A deployed and covered pitfall trap in shinnery oak habitat. The cover was made from a lineolum floor tile, its purpose being to reduce evaporation of the preservative by providing shade and discourage entry by small vertebrates.

Each array consisted of a center trap and four radiating arms spaced 90° apart, with two traps per arm. The distance between adjacent traps was 10 m. (Fig. 7). A random location for the center pitfall trap was obtained by tossing a shovel over the shoulder. The pitfall trap was deployed wherever the shovel landed. The remaining traps were then set up around it.

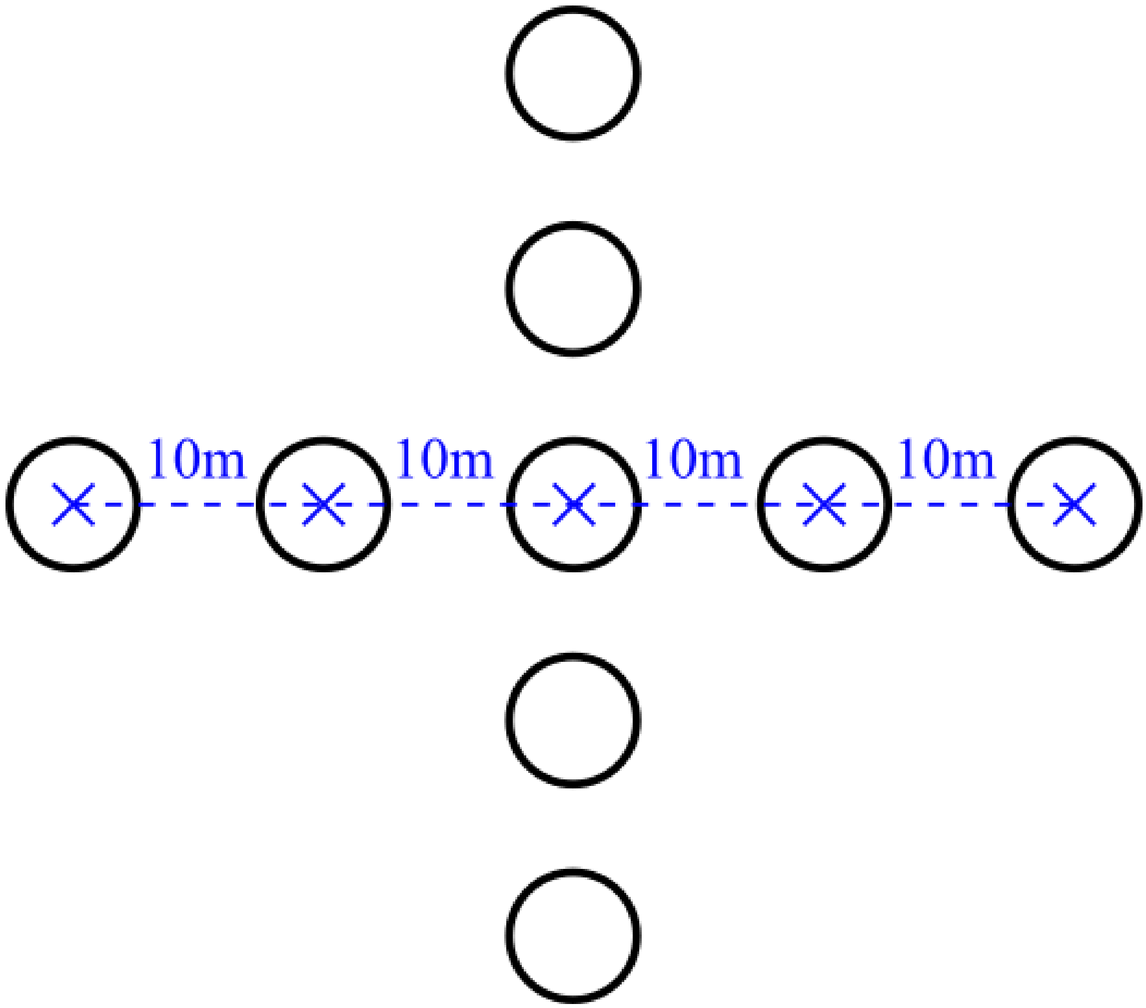

Figure 7. Diagrammatic representation of a pitfall array as seen from above. Created using Inkscape.

After all the traps in each array were deployed, a strip of bright orange flagging was tied to a nearby sturdy plant so they could be subsequently located (Fig. 8).

Figure 8. Example of a deployed and marked trap in shinnery oak habitat. The neon orange marker strip can be seen at lower left.

Each array was a minimum of 100 meters from its nearest neighbor. Trap locations were determined using a Garmin eTrex GPS receiver (Garmin Ltd., Olathe, KS). Measurement accuracy was 3-5 meters. Coordinates were recorded as degrees and decimal minutes (DMM) in the NAD83 datum. These were later converted to decimal degrees for location mapping.

After a sample was gathered, the Solo cups were removed, the coffee cans sealed with their matching lids, and the tiles pressed flat against the lids. The traps were left in this dormant state until the next sample was to be gathered, at which point they were reactivated.

Array locations remained unchanged for the 2017 and 2018 sampling periods (Fig. 9). For the June 2019 sample, array A1 was relocated, as some traps were discovered uprooted and/or missing, most likely due to wildlife tampering during dormancy. Array A4 was also relocated. (Fig. 10). Array locations remained unchanged for the September 2019 sampling period (Fig. 11). All array locations during the 2017, 2018 and 2019 sampling years are shown in superimposed fashion in figure 12.

Figure 9. Locations of pitfall arrays during the 2017 and 2018 sampling periods. A1-A4 indicate pitfall arrays in shinnery oak habitat; B1-B4 represent pitfall arrays in mesquite habitat.

Figure 10. Locations of pitfall arrays during the June 2019 sampling period. A1-A4 indicate pitfall arrays in shinnery oak habitat; B1-B4 represent pitfall arrays in mesquite habitat. Note that the A1 array was repositioned from the previous year due to uprooting of some dormant traps by wildlife.

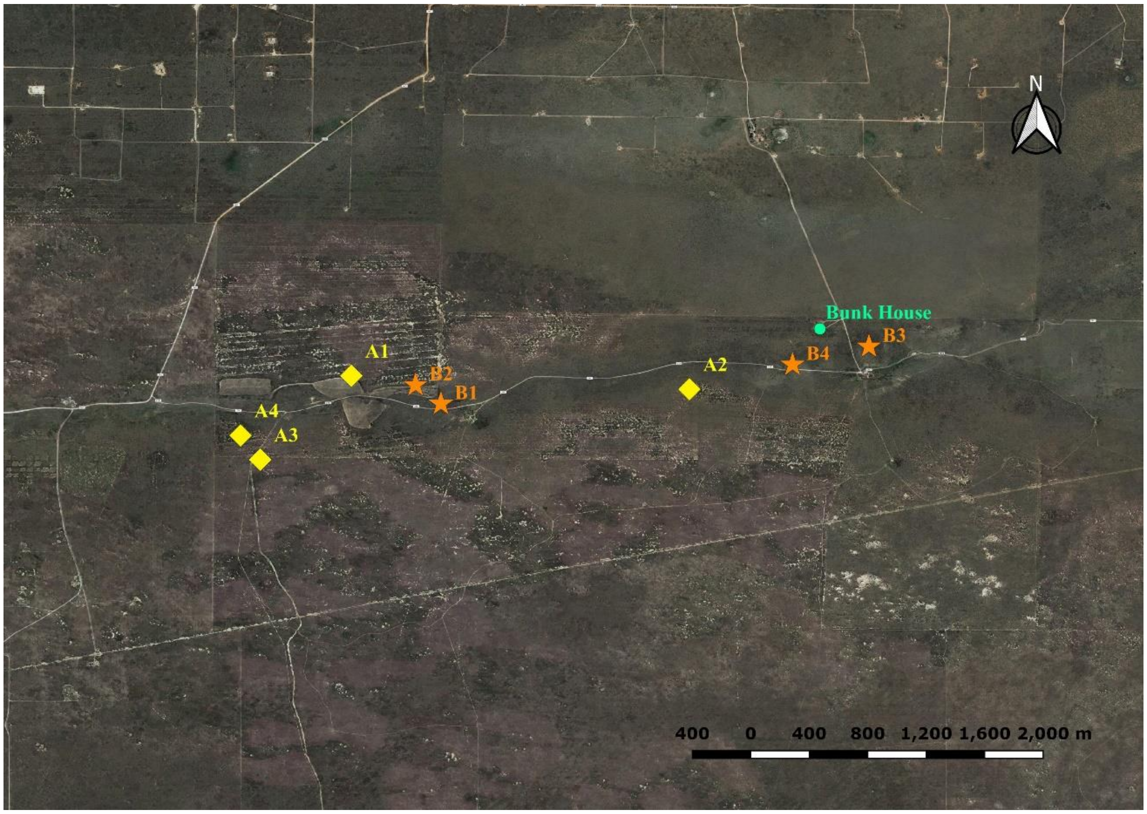

Figure 11. Locations of pitfall arrays during the September 2019 sampling period. A1-A4 indicate pitfall arrays in shinnery oak habitat; B1-B4 represent pitfall arrays in mesquite habitat. Note that array A4 was slightly repositioned from its June 2019 location.

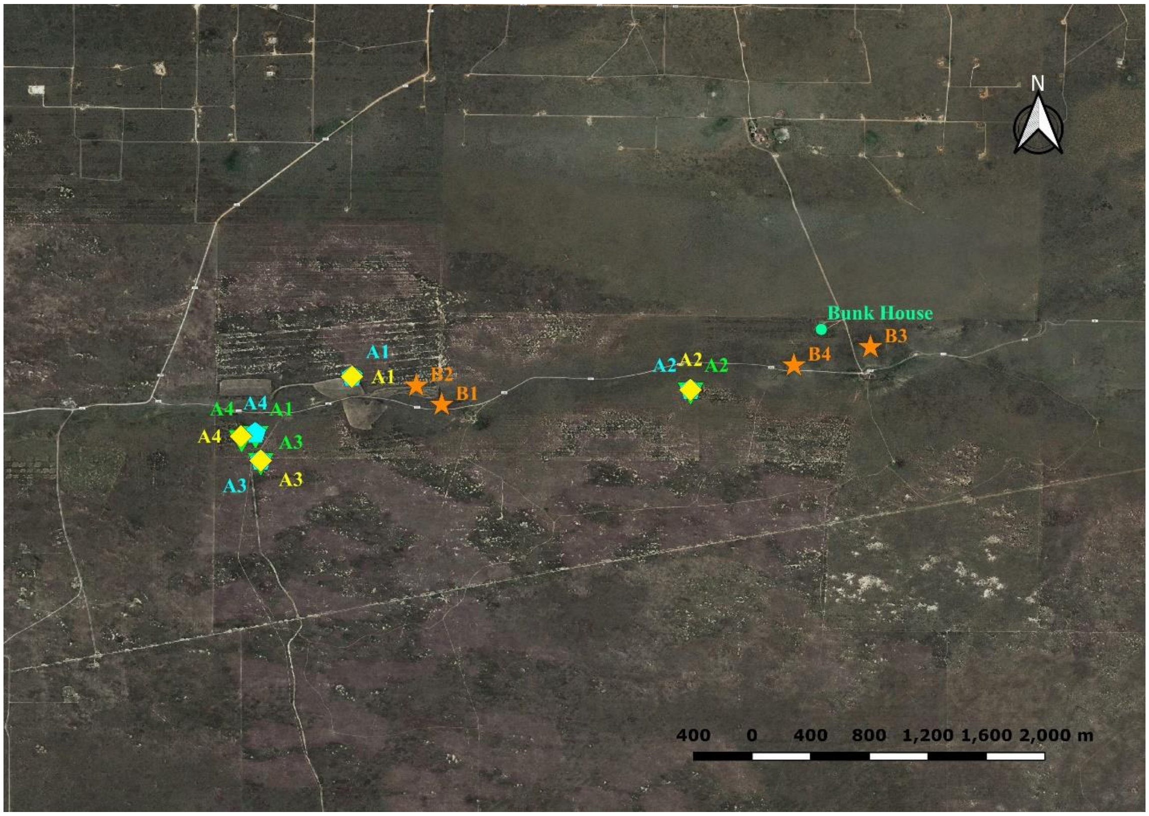

Figure 12. Superimposed locations of all pitfall arrays. A1-A4 indicate pitfall arrays in shinnery oak scrub habitat; B1-B4 represent pitfall arrays in mesquite grassland habitat.

Sweep Netting Regime

Collection of arachnids present in low-growing vegetation was accomplished by performing 100 sweeps while walking in a straight line in a randomly chosen direction. If obstructive vegetation preventing sweeping was encountered (for example, a patch of cactus or honey mesquite tree), sweeping was paused at the obstruction and resumed on the opposite side. One sweep sample was collected in the general vicinity of each array, but no closer than 20m to any trap, for a total of eight sweep samples per sampling period.

General Collecting Regime

Cursorial and stationary arachnids were gathered by hand through a visual search of the ground surface and vegetation. Each collecting session was time-constrained to one man-hour. Arachnid species collected in this manner were used to supplement the species list but excluded from the analyses due to the non-random nature of the sampling. Again, the sampling was not conducted within the area encompassing the arrays and was performed no closer than 20m to any trap.

Sampling Periods

The dates on which arachnids were sampled are detailed in Table 1. Pitfall traps were left open to collect arachnids for one week. In the September 2017 sampling period, I failed to locate the A2 array when the trap samples were due to be gathered. The traps were found on a return trip one week later, and hence this array collected arachnids for a two-week span rather than the intended one week.

Table 1. Dates on which pitfall trap, sweep net, and general collecting samples were gathered during the three-year study period. "A1-A4" refer to shinnery oak scrub arrays and surroundings; "B1-B4" refer to mesquite grassland arrays and surroundings.

Mesquite Pitfall Traps

2017	2018	2019
2 – 10 Sept: B1, B2	31 May – 7 June: B3, B4	15 June – 22 June: B1-B4
9 – 17 Sept: B3, B4	2 June – 9 June: B1, B2	20 July – 27 July: B1-B4

Mesquite Sweep Nets

2017	2018	2019
17 Sept: B1-B4	7 June: B3	22 June: B1-B4
	9 June: B1, B2, B4	26 July: B3
		27 July: B1, B2, B4
		7 Sept: B1-B4

Mesquite General Collecting

2017	2018	2019
No samples taken	7 June: B1-B4	22 June: B1-B4
	8 June: B4	27 July: B1-B4
	9 June: B1, B2	7 Sept: B1-B4

Shinnery Oak Pitfall Traps

2017	2018	2019
2 – 10 Sept: A1	31 May – 7 June: A1, A2, A3	15 June – 22 June: A2, A3, A4
2 – 17 Sept: A2*	2 June – 9 June: A4	16 June - 23 June: A1
9 – 17 Sept: A3, A4		19 July – 26 July: A1-A4
		1 Sept – 8 Sept: A1-A4

Shinnery Oak Sweep Nets

2017	2018	2019
17 Sept: A1-A4	7 June: A1-A4	22 June: A2, A3, A4
	9 June: A4	23 June: A1
		26 July: A1-A4
		8 Sept: A1-A4

Shinnery Oak General Collecting

2017	2018	2019

No samples taken	8 June: A1-A4	22 June: A1-A4 26 July: A1-A4 8 Sept: A1-A4

Arachnid Identification

Specimens were identified by the author Zechariah Saavedra, Dr.W. David Sissom (WTAMU); Dr. Ray Fisher (University of Arkansas, Fayetteville, mites) and Dr. Garrett Hughes (USDA APHIS, Yuma, AZ, pseudoscorpions). Sources used to identify members of the orders Araneae, Scorpiones, and Solifugae are given in Table 1.

Table 2. Published references consulted for the identification of arachnid taxa. These sources contained taxonomic keys that enabled species identification, where possible. Spider publications were obtained from the World Spider Catalog.

Taxon	Author(s)/date
Acanthepeira	Levi 1976
Agelenopsis	Whitman-Zai et al. 2015
Allocosa	Dondale and Redner 1983
Callilepis	Platnick 1975a
Castianeira	Reiskind 1969
Cesonia	Platnick and Shadab 1980a
Chihuahuanus	McWest, Valois and Sissom 2015

Cicurina	Chamberlin and Ivie 1940
Dictyna	Chamberlin and Gertsch 1958
Drassodes	Platnick and Shadab 1976a
Drassyllus	Platnick and Shadab 1982
Eremobates	Brookhart and Muma 1981
Euryopis	Levi 1954
Geolycosa	Dondale and Redner 1990
Gnaphosa	Platnick and Shadab 1975b
Habronattus	Griswold 1987a
Hemerotrecha	Muma 1951
Herpyllus	Platnick and Shadab 1977
Hesperocosa	Ubick et al. 2017
Hogna	Dondale and Redner 1990
Hypsosinga	Levi 1972
Lathys	Chamberlin and Gertsch 1958
Latrodectus	Kaston 1970
Masoncus	Chamberlin 1949
Mecaphesa	Dondale and Redner 1978b
Metepeira	Levi 1977
Micaria	Platnick and Shadab 1988

Mimetus	Gertsch and Mulaik 1940
Neoanagraphis	Vetter 2001
Nodocion	Platnick and Shadab 1980b
Oxyopes	Brady 1964
Pardosa	Vogel 2004
Paruroctonus	McWest, Valois and Sissom 2015
Phidippus	Edwards 2004
Phlegra	Ubick et al. 2017
Phrurotimpus	Dondale and Redner 1982
Physocyclus	Valdez-Mondragon 2010
Piabuna	Chamberlin and Ivie 1935b
Psilochorus	Slowik 2009
Schizocosa	Dondale and Redner 1990
Scotinella/Phruronellus	Ubick et al. 2017
Septentrinna	Bonaldo 2000
Sergiolus	Platnick and Shadab 1981
Thanatus	Dondale and Redner 1978b
Tibellus	Dondale and Redner 1978b
Tutelina	Kaston, 1948
Xysticus	Gertsch 1953

Zelotes	Platnick and Shadab 1983

Samples were first deposited in a 20.32 cm (8-in) diameter glass culture dish and examined through a Chicago Electric model #66384 fluorescent magnifying lamp. Arachnids were subjected to an initial crude sort by taxonomic order, transferred to plastic specimen jars, and submerged in 70% isopropyl alcohol. Specimens were then examined under an Olympus VMZ stereomicroscope. A Leica K3650 Illuminator served as an external light source. Arachnids were subjected to a second fine sort and partitioned out as individuals or series of the same species. These lone specimens or series were deposited in glass shell vials filled to the top with 70% isopropyl alcohol. A label with the catalogue number was inserted and the vial plugged with cotton. Specimens in vials were grouped by family and placed into the corresponding specimen jars. Isopropyl alcohol was added to the specimen jars until all shell vials were submerged.

In a couple of arachnid orders, inspection of genitalia from multiple angles either aids identification or is required. Rather than manipulating the entire specimen, the genitalia zwere detached in a manner dependent on the arachnid being examined. By convention in male spiders, the left pedipalp was severed as basally as possible, preferably at the trochanter-femur joint, allowing the femur to be grasped for manipulation. By convention in female spiders, the epigynum, a specialized structure that may or may not be sclerotized, was excised by perforating the abdominal integument around it using an insect pin and pulling it free with forceps. Soft tissues associated with the dorsal aspect of the epigynum were carefully scraped away with the insect pin. In cases when not all soft tissue could be removed, the epigynum was immersed in glycerol. This step rendered any remaining tissue transparent so that internal structures such as copulatory ducts and spermathecae could be fully visualized. Small dissected pedipalps and epigyna were stored in #1133A polyethylene microvials (BioQuip Products, Inc.) filled with isopropyl alcohol. The microvials were then sealed with a tiny cotton plug and placed in the shell vial containing the parent specimen. Pedipalps and epigyna too large to fit in microvials were placed directly in the shell vial alongside the parent specimen. For solifugids, in which the chelicerae of males bear important taxonomic characters, one chelicera was torn free with a pair of forceps.

In addition to the specimen(s), each shell vial also contains the following: an identification label, a sample label, a GPS label, a coordinate system label, and a catalogue number using the format YD-###. The identification label includes the scientific name of the species, its authority, and the number and sex of the individuals in the vial. The sample label displays the general locality, the array/habitat in which the specimen was collected, the GPS location of the central trap, the array's active date range for pitfall samples, or the sampling date for sweep netting and general collecting samples. All arachnids were deposited in the collections of West Texas A&M University's Department of Life, Earth and Environmental Sciences.

Abundance Measures

Arachnids identified to species were arbitrarily assigned to one of four abundance categories: ≤19 = rare, 20-50 = uncommon, 51-100 = common, and >100 = abundant. Arachnids identified to species were also assigned to one of four categories depending on how many pitfall arrays they were found in across the three years sampling was conducted: Ubiquitous – found in all eight arrays, frequent – found in five to seven arrays, infrequent – found in two to four arrays, scarce – found in only a single array.

Community Metrics

The Jaccard Similarity Index, originally used to measure the similarity of alpine flora quadrats (Jaccard 1912) can be applied more generally to any two communities of organisms. It is calculated by dividing the number of species shared by both communities by the sum of all species in both communities. The resultant value is then converted to a percentage. Larger values indicate increased overlap/similarity between the two communities in question.

Results

Members of five arachnid orders were captured at the site: Acari (mites), Araneae (spiders), Pseudoscorpiones (pseudoscorpions), Scorpiones (scorpions), and Solifugae (windscorpions). A total of 31 families, 68 genera, and 100 species of arachnids were identified (Appendix I). Relative abundances of the arachnids were also considered. The overwhelming majority of specimens were collected via pitfall trapping, and the relative abundances are presented in Table 2.

Table 3. Relative abundances of arachnids collected each sampling period via pitfall trapping at Yoakum Dunes WMA. Roman numerals indicate months. These values include all specimens referable to order, regardless of age and generic/species level identification.

	Sampling Date				
Order	IX/X2017	V/VI 2018	VI 2019	VII 2019	VIII/IX 2019
Acari	9 (4.24%)	33 (8.14%)	376 (63.83%)	738 (80.39%)	126 (39.49%)
Araneae	176 (83.01%)	339 (83.70%)	187 (31.74%)	156 (16.99%)	160 (50.15%)

Pseudoscorpiones	1 (0.47%)	6 (1.48%)	12 (2.03%)	2 (0.21%)	4 (1.25%)
Scorpiones	20 (9.43%)	8 (1.97%)	13 (2.30%)	19 (2.06%)	20 (6.26%)
Solifugae	6 (2.83%)	19 (4.69%)	1 (0.16%)	3 (0.32%)	9 (2.82%)
Total	212 (100%)	405 (100%)	589 (100%)	918 (100%)	319 (100%)

Acari

Four identifiable families were collected: Caeculidae, Erythraeidae, Erythracaridae and Trombidiidae. There was one unidentified species in the suborder Mesostigmata. At the generic level, *Abrolophus* sp., *Augustsonella* sp., *Lasioerythraeus* sp. and *Leptus* sp. were identified in the Erythraeidae, and *Dinothrombium* sp. in the Trombidiidae. One species each from the families Caeculidae and Erythracaridae were not identifiable. The four families represented 13% of all families, the eight genera represented 11.7% of all genera, and the eight species represented 8% of all species.

Two species of mites were found to be abundant in the samples: the unidentified mesostigmatid, with 1005 individuals captured (83.6% of total Acari) and an erythraeid, *Augustsonella* sp., with 168 individuals collected (14% of total Acari). The others were categorized as rare and had the following abundances: *Abrolophus sp*. (n = 5, 0.4% of total Acari), captured only at the A4 array; *Lasioerythraeus* sp. (n = 4, 0.3% of total Acari), captured at the A2, A3 and B1 arrays; *Leptus sp*. (n = 4, 0.3% of total Acari), captured at the A2 and B3 arrays; *Dinothrombium sp.* (n = 6, 0.5% of total Acari), collected at the B1 and B3 arrays; the unidentified species in the family Caeculidae (n = 4, 0.3% of total Acari), captured at the A3, A4 and B3 arrays; and the unidentified species of Erythracaridae (n = 6, 0.5% of total Acari), captured at the A3, A4, B3 and B4 arrays.

The unidentified mesostigmatid and *Augustsonella* were both ubiquitous, *Dinothrombium*, *Lasioerythraeus*, *Leptus*, the unidentified caeculid and erythracarid were all infrequent, and *Abrolophus* was scarce.

Table 4. Diversity and relative abundance of Acari at Yoakum Dunes WMA. A1-A4 = shinnery oak sites, B1-B4 = mesquite sites. PT = pitfall trapping, SN = sweep netting, GC = general collecting. Roman numerals indicate months.

Taxon	n	Site	Month	Year	Method
Caeculidae					
Undetermined genus/species	4 (0.32%)	A3, A4, B3	VI, VII, IX	2019	PT
Erythracaridae					
Undetermined genus/species	6 (0.48%)	A3, A4, B3, B4	V, VI, VII, IX	2017-2019	PT
Erythraeidae					
Abrolophus sp.	5 (0.40%)	A4	VII, IX	2019	PT
Augustonella sp.	168 (13.62%)	All	VII, VIII, IX	2017, 2019	PT
Lasioerythraeus sp.	4 (0.32%)	A2, A3, B1	V, VI, VIII, IX	2018, 2019	PT
Leptus sp.	4 (0.32%)	A2, B3	VII	2019	PT

Mesostigmata					
Undetermined genus/species	1036 (84.02%)	All	VI, VII, IX	2017, 2019	PT
Trombidiidae					
Dinothrombium sp.	6 (0.48%)	B1, B3	V, VI	2018	PT

Araneae

The order Araneae was represented by 20 families (65% of total arachnid families), 53 genera (78% of total arachnid genera), and 85 species (85% of total arachnid species). All specimens identified to species amounted to 712 individuals.

Table 5. Diversity and relative abundance of Araneae at Yoakum Dunes WMA. A1-A4 = shinnery oak sites, B1-B4 = mesquite sites. PT = pitfall trapping, SN = sweep netting, GC = general collecting. Roman numerals indicate months. Singletons are indicated with a [1] and unique species are indicated with a [2].

Taxon	n	Site	Month	Year	Method
Agelenidae					
Agelenopsis longistyla	7 (0.96%)	A1, A4, B3, B4	VII, VIII, IX	2017, 2019	PT
Agelenopsis naevia	1 (0.14%)	B3	VII	2019	PT
Agelenopsis spatula	3 (0.42%)	A2, A3	VII, IX	2019	PT, GC
Araneidae					
Acanthepeira stellata	4 (0.56%)	A2, A4, B2, B4	VI	2019	PT, GC
Argiope trifasciata	51 (7.16%)	All	VI, VII, IX, X	2017, 2019	SN, GC
Hypsosinga funebris	11 (1.54%)	B1-B4	VI, VII, IX	2017-2019	PT, SN
Metepeira labyrinthea	32 (4.49%)	A2-A4, B1-B4	VI, VII, IX, X	2017, 2019	GC
Neoscona crucifera	3 (0.42%)	A2	IX, X	2017, 2019	PT, SN, GC

Neoscona oaxacensis	12 (1.68%)	A1-A3, B2, B3	VI, VII, IX	2018, 2019	SN, GC
Corinnidae					
Castianeira alteranda[12]	1 (0.14%)	B1	VIII, IX	2019	PT
Castianeira occidens[2]	2 (0.28%)	A3	V, VI	2018	PT
Septentrinna bicalcarata[2]	2 (0.28%)	A4	IX	2017	PT
Dictynidae					
Dictyna volucripes	59 (8.28%)	All	VI, VII, IX	2018, 2019	SN, GC
Lathys delicatula	9 (1.26%)	A1, A2, A4, B1, B4	V, VI, IX	2017-2019	PT
Gnaphosidae					
Callilepis gertschi	16 (2.24%)	A1-A4, B1, B2	V, VI	2018, 2019	PT
Callilepis mumai	3 (0.42%)	B1, B2	VI	2018	PT
Cesonia sincera	18 (2.52%)	A2, B1-B4	V, VI, IX	2017-2019	PT
Drassodes auriculoides[12]	1 (0.14%)	A3	V, VI	2018	PT
Drassodes gosiutus[12]	1 (0.14%)	B	X	2017	GC
Drassyllus lepidus	13 (1.82%)	B1-B4	VI, VII	2018, 2019	PT
Drassyllus mormon	14 (1.96%)	A1-A4, B1, B2	V, VI	2018, 2019	PT
Drassyllus mumai	17 (2.38%)	B1, B3, B4	V, VI	2018	PT, GC
Drassyllus prosaphes	3 (0.42%)	A2, B1, B2	V, VI	2018, 2019	PT
Gnaphosa clara	4 (0.56%)	A3, B1	V, VI	2018, 2019	PT
Gnaphosa sericata	25 (3.51%)	A1-A4, B1, B3, B4	V-IX	2017-2019	PT
Herpyllus bubulcus[12]	1 (0.14%)	A4	VI	2018	PT
Micaria longipes	3 (0.42%)	B3, B4	IX	2017	PT
Micaria mormon[12]	1 (0.14%)	A3	V, VI	2018	PT
Micaria nanella[12]	1 (0.14%)	B4	IX	2017	PT
Micaria triangulosa	5 (0.70%)	B3, B4	V, VI, VIII, IX	2017-2019	PT
Nodocion utus[12]	1 (0.14%)	B4	VII	2019	PT
Sergiolus stella	3 (0.42%)	A1, A4	VI	2018, 2019	PT
Zelotes hentzi	2 (0.28%)	A1, A2	IX	2017	PT

Zelotes lasalanus	51 (7.16%)	All	V-X	2017-2019	PT
Hahniidae					
Cicurina cf. varians[12]	1 (0.14%)	B	X	2017	GC
Linyphiidae					
Agyneta fratrella[12]	1 (0.14%)	B3	VI	2019	PT
Masoncus conspectus[12]	1 (0.14%)	A4	IX	2017	PT
Liocranidae					
Neoanagraphis chamberlini	20 (2.80%)	A1-A4, B1, B3	V, VI, IX	2017-2019	PT
Lycosidae					
Allocosa morelosiana[12]	1 (0.14%)	A1	VI	2019	PT
Geolycosa missouriensis	8 (1.12%)	A1, A3, A4, B2	VI, VII, IX	2018, 2019	PT, GC
Hesperocosa unica	25 (3.51%)	A3, B1-B4	V, VI	2018, 2019	PT, GC
Hogna antelucana	21 (2.94%)	A1-A4, B1, B3, B4	V-IX	2018, 2019	PT
Hogna baltimoriana	1 (0.14%)	BH	X	2017	GC
Hogna carolinensis	2 (0.28%)	B4	VI	2019	
Hogna coloradensis	7 (0.96%)	A1, A2	VI, VII, IX	2017, 2019	PT
Pardosa delicatula[12]	1 (0.14%)	B4	IX	2017	PT
Pardosa sp. [12]	1 (0.14%)	B1	VI	2019	PT
Schizocosa bilineata[12]	1 (0.14%)	B4	VI	2019	PT
Schizocosa mccooki	16 (2.24%)	A2, A4, B1-B4	VI-IX	2019	PT
Varacosa shenandoa	1 (0.14%)	A3	IX	2017	PT
Mimetidae					
Mimetus Hesperus	3 (0.42%)	A2, B1, B4	VI, IX	2019	SN, GC
Oxyopidae					
Oxyopes apollo	32 (4.49%)	B1-B4	VI-IX	2018, 2019	PT, SN
Oxyopes salticus	6 (0.84%)	A1-A3, B2, B3	VI, VII	2019	PT, SN, GC
Oxyopes tridens[12]	1 (0.14%)	B4	VI	2019	PT
Philodromidae					
Thanatus formicinus	1 (0.14%)	B4	VI	2019	PT
Tibellus oblongus	7 (0.96%)	A1, A2, B2, B3, B4	V, VI, VII	2018, 2019	PT, SN
Pholcidae					

Physocyclus enaulus	1 (0.14%)	BH	X	2017	GC
Psilochorus imitatus	54 (7.58%)	All	V-IX	2017-2019	PT, GC
Phrurolithidae					
Phrurotimpus certus	10 (1.40%)	A1-A3, B1, B3, B4	V, VI, VIII, IX	2017-2019	PT
Piabuna pallida	7 (0.96%)	A1, A3, B1, B3, B4	VI, IX	2017-2019	PT
Scotinella/Phruronellus sp.	13 (1.82%)	B1-B4	V, VI, VII	2017-2019	PT
Salticidae					
Habronattus cf. calcaratus[12]	1 (0.14%)	B4	VIII	2019	PT
Habronattus cognatus	4 (0.56%)	A1, A3, A4, B1	V, VI, IX	2017-2019	PT, SN
Phidippus apacheanus	4 (0.56%)	A2-A4, B1	IX	2017, 2019	SN, GC
Phidippus octopunctatus[12]	1 (0.14%)	A1	IX	2019	GC
Phidippus texanus	6 (0.84%)	A1, A2, A4, B1	VII, IX	2019	PT, SN, GC
Phlegra hentzi	4 (0.56%)	A1, A2	V, VI, VII, IX	2017-2019	PT
Tutelina elegans	7 (0.96%)	A1-A4	VI, VII, IX	2017, 2019	SN, GC
Tetragnathidae					
Tetragnatha sp. [12]	1 (0.14%)	B4	IX	2017	SN
Theraphosidae					
Aphonopelma hentzi	6 (0.84%)	B1, B3	VIII, IX	2017, 2019	PT, GC
Theridiidae					
Euryopis lineatipes	2 (0.28%)	A4	VI	2018	PT
Euryopis mulaiki	5 (0.70%)	A1, B2, B3	VII-IX	2019	PT
Euryopis texana	10 (1.40%)	A1-A4	V, VI, IX, X	2017-2019	PT, GC
Latrodectus hesperus	8 (1.12%)	A2-A4, B3	VI, VII, IX	2019	PT, SN, GC
Latrodectus mactans	1 (0.14%)	B3	VII	2019	PT
Thomisidae					
Mecaphesa celer	17 (2.38%)	B1-B4	VI, VII	2019	SN, GC
Xysticus auctificus[2]	1 (0.14%)	B3	VI	2019	PT
Xysticus coloradensis	2 (0.28%)	B3	VII	2019	PT

Xysticus concursus	3 (0.42%)	B1, B2	VII	2019	PT
Xysticus pellax	2 (0.28%)	B1, B3	IX	2017	PT
Xysticus texanus	6 (0.84%)	A2, B4	VII	2019	PT

Based on the previously defined abundance categories, 86 spider species were rare, eight were uncommon, four were common, and one was abundant. Likewise, two species were ubiquitous, 12 were frequent, 17 were infrequent, and 23 were scarce.

Oxyopes apollo Brady 1964, *Scotinella/Phruronellus* sp., *Hypsosinga funebris* (Keyserling, 1892) and *Drassyllus lepidus* (Banks, 1899) were caught at all mesquite arrays, but none of the shinnery oak arrays. Conversely, *Tutelina elegans* (Hentz, 1846) was caught at all shinnery oak arrays, but no mesquite arrays.

The sole abundant species was *Dictyna volucripes* Keyserling, 1881. Fifty-nine adults, three subadults and 20 juveniles were collected, plus 37 spiderlings gathered along with three of the adult females. Seventy-four individuals were taken by general collecting from the tips of mesquite branches. Forty-four individuals were taken by general collecting in shinnery oak, including one female with 24 spiderlings, at site A2. This species was found in all sites except A1, and in 5 or 6 sites per year. The only year in which it was not found was 2017; in this case, sampling was done in September, and it is possible that the species was not active at that time.

The common species were: *Psilochorus imitatus* (Gertsch and Mulaik, 1940), 54 individuals, *Argiope trifasciata* (Forsskål, 1775), 51 individuals, *Zelotes lasalanus*

(Chamberlin, 1928), 51 individuals, and *Metepeira labyrinthea* (Hentz, 1847), 32 individuals.

Most *P. imitatus*, 50 individuals, were collected via pitfall traps, with 28 caught in mesquite habitat and 22 in shinnery oak habitat. General collecting yielded the remaining four, two at the B3 array, one at the A3 array, and one at the A4 array.

Of the 51 individuals of *A. trifasciata* collected, 44 originated via sweep netting. Thirty-eight were captured in mesquite habitat and six in shinnery oak habitat. General collecting accounted for the seven leftover individuals, five from shinnery oak habitat and two from mesquite habitat.

All individuals of *Z. lasalanus* were caught in pitfall traps at all eight sampling sites.

Twenty-eight of the 32 individuals of *M. labyrinthea* were similarly plucked from mesquite branches during general collecting sessions. The rest were gathered at shinnery oak sites during such sessions.

The following 19 species were represented across all sampling periods by isolated individuals, referred to commonly as singletons, indicated in Table 4 by “[1]”: *Agyneta fratrella, Allocosa morelosiana* (Gertsch and Davis, 1940), *Castianeira alteranda* Gertsch, 1942, *Cicurina cf. varians* Gertsch and Mulaik, 1940, *Drassodes gosiutus* Chamberlin, 1919, *Drassodes auriculoides* Barrows, 1919, *Habronattus cf. calcaratus*

(Banks, 1904), *Herpyllus bubulcus* Chamberlin, 1922, *Masoncus conspectus* (Gertsch and Davis, 1936), *Micaria mormon* Gertsch, 1935, *Micaria nanella* Gertsch, 1935, *Nodocion utus* (Chamberlin, 1936), *Oxyopes tridens* Brady, 1964, *Pardosa delicatula* Gertsch and Wallace, 1935, *Pardosa* sp., *Phidippus octopunctatus* (Peckham and Peckham, 1883), *Schizocosa bilineata* (Emerton, 1885), *Tetragnatha* sp. and *Xysticus auctificus* Keyserling, 1880.

The following 22 species were encountered only once across all sampling periods, hereby referred to as unique species, indicated in Table 5 by “[2]”: *Agyneta fratrella, Allocosa morelosiana, Castianeira alteranda, Castianeira occidens, Cicurina cf. varians, Drassodes gosiutus, Drassodes auriculoides, Habronattus cf. calcaratus, Herpyllus bubulcus, Masoncus conspectus, Micaria mormon, Micaria. nanella, Nodocion utus, Oxyopes tridens, Pardosa delicatula, Pardosa* sp., *Phidippus octopunctatus, Septentrinna bicalcarata* (Simon, 1896), *Schizocosa bilineata, Tetragnatha* sp., *Xysticus auctificus,* and *Xysticus coloradensis* Bryant, 1930.

These categories are not mutually exclusive; 19 species were included in both categories. The species *Castianeira occidens, Septentrinna bicalcarata*, and *Xysticus auctificus* were categorized as uniques, but not singletons.

Of the 84 species caught by pitfall traps, 19 were captured in shinnery oak habitat, 31 were captured in mesquite habitat, and 34 were captured in both shinnery oak and mesquite habitats.

Juveniles of an unidentified species of tetragnathid, *Tetragnatha* sp., were found only in sweep net samples. Juveniles of a philodromid crab spider, *Ebo* sp., distinct at the generic level due to the significantly elongated second pair of legs, were found in the B4 pitfall sample from July 2019, a sweep sample at the A2 site on 22 June 2019, and a sweep sample at the B1 site on 9 June 2018. Juveniles of a thomisid crab spider, *Ozyptila* sp., were found in the A2 and B3 pitfall samples from September 2017, again in the B3 sample from June 2019, the A3 pitfall sample from July 2019, and a sweep net sample at the B4 site in September 2019.

Due to the taxonomic confusion and delimitation issues involving species of *Scotinella* and *Phruronellus*, individuals belonging to these genera are presently unplaceable to species, and hence are referred to as *Scotinella/Phruronellus* sp.

Figure 13. Characteristic funnel web constructed by *Agelenopsis* sp. in shinnery oak habitat. These webs are typically erected in locations that provide space for a sheltered retreat such as here, where it extends into the leaf litter. The spider lies concealed in the retreat until a prey item blunders onto the web. Sensing the vibrations, the spider rushes out and attacks the prey.

Figure 14. Habitus of adult male Texas brown tarantula (*Aphonopelma hentzi*). This species is the sole member of its genus in the Texas Panhandle. Males wander in search of females during the mating season and can be seen crossing roadways in September and October.

Figure 15. Habitus of adult *Phidippus texanus*. The abdominal coloration in this species can vary from solid red orange to black and white or to a blend of red-orange, black and white as in this individual.

Pseudoscorpiones

Represented by 24 individuals of two species from two families: *Levichelifer fulvopalpus* (Hoff, 1946), Cheliferidae, and *Parachernes nubilis* Hoff, 1956, Chernetidae. *L. fulvopalpus* (n = 19, 79.16% of total Pseudoscorpiones) was captured at the A1, A2, A3, B1, B2 and B3 arrays. *P. nubilus* (n = 5, 20.83% of total) was captured at the B2, B3 and B4 arrays. The two families represented 6.45% of all families, the two genera represented 2.94% of all genera, and the eight species represented 8% of all species. *L. fulvopalpus* was rare and frequent, whereas *P. nubilus* was rare and infrequent.

Table 6. Diversity and relative abundance of Pseudoscorpiones at Yoakum Dunes WMA. A1-A4 = shinnery oak sites, B1-B4 = mesquite sites. PT = pitfall trapping, SN = sweep netting, GC = general collecting. Roman numerals indicate months.

Taxon	n	Sites	Month	Year	Method
Cheliferidae					
Levichelifer fulvopalpus	19 (79.16%)	A1-A4, B1, B2, B3	VI, VII, IX	2017-2019	PT
Chernetidae					
Parachernes nubilis	5 (20.83%)	B2, B3, B4	VI	2019	PT

Figure 16. Habitus of adult male *Levichelifer fulvopalpus* (photo by Garrett Hughes, used with permission).

Figure 17. Habitus of adult male *Parachernes nubilis* (photo by Garrett Hughes, used with permission).

Scorpiones

Represented by 80 individuals of four species from two families, one belonging to the family Buthidae, *Centruroides vitattus* (Say, 1821), and the remaining three belonging to the family Vaejovidae: *Chihuahuanus russelli* (Williams, 1971), *Paruroctonus pecos* Sissom and Francke, 1981 and *P. utahensis* (Williams, 1968). The two families represented 6.45% of all families, the four genera represented 5.88% of all genera, and the eight species represented 8% of all species. *Centruroides vittatus* (n = 24, 30% of total Scorpiones), was captured at the A2, A3, A4, B3 and B4 arrays. *Centruroides russelli* (n = 23, 28.75% of total Scorpiones) was captured at all four mesquite arrays and the A2 array. *P. utahensis* (n = 19, 23.75% of total Scorpiones) was captured at the A1, A2, A4, B3 and B4 arrays. *P. pecos* (n = 14, 17.5% of total Scorpiones) was captured at the B3 and B4 arrays. Abundance-wise, *C. vittatus* and *C. russelli* were uncommon, while *P. pecos* and *P. utahensis* were rare. Based on number of array captures, *C. vittatus* and *P. utahensis* were frequent, while *C. russelli* and *P. pecos* were infrequent.

Table 7. Diversity and relative abundance of Scorpiones at Yoakum Dunes WMA. A1-A4 = shinnery oak sites, B1-B4 = mesquite sites. PT = pitfall trapping, SN = sweep netting, GC = general collecting. Roman numerals indicate months.

Taxon	n	Sites	Month	Year	Method
Buthidae					
Centruroides vittatus	24 (30%)	A2, A3, A4, B3, B4	V-IX	2017-2019	PT
Vaejovidae					
Chihuahuanus russelli	23 (28.75%)	A2, B1-B4	VI-IX	2017, 2019	PT
Paruroctonus pecos	14 (17.5%)	B3, B4	VI-IX	2017-2019	PT
Paruroctonus utahensis	19 (23.75%)	A1, A2, A4, B3, B4	V, VI, VII, IX	2017-2019	PT

Figure 18. Habitus of adult female *Centruroides vittatus* (photo by David Sissom, used with permission). The black triangular marking at the front of the carapace is diagnostic for the species. Metasomal segment proportions can be used to distinguish sexes: they are robust in females and long and slender in males.

Figure 19. Habitus of *Chihuahuanus russelli* (photo by David Sissom, used with permission).

Figure 20. Habitus of *Paruroctonus utahensis* (photo by David Sissom, used with permission). This species is a sand dune specialist that resides in burrows excavated in sandy soils.

Figure 21. Habitus of *Paruroctonus pecos* (photo by David Sissom, used with permission). This species, like its relative *P. utahensis*, lives in burrows it excavates in sandy soils.

Solifugae

Members of the order Solifugae were nearly nonexistent, being represented by two species from the same family, Eremobatidae: *Eremobates pallipes* (Say, 1823) and *Hemerotrecha branchi* Muma, 1951. The single family represented 3.2% of all families, the single genus represented 1.47% of all genera, and the two species represented 2% of all species. A single individual of *E. pallipes* was found in the A1 pitfall sample from July 2019, and a single individual of *H. branchi* was found in the A2 pitfall sample from May/June 2018. Consequently, they were both categorized as rare and scarce.

Table 8. Diversity of Solifugae at Yoakum Dunes WMA. A1-A4 = shinnery oak sites, B1-B4 = mesquite sites. PT = pitfall trapping, SN = sweep netting, GC = general collecting. Roman numerals indicate months.

Taxon	n	Site	Month	Year	Method
Eremobatidae					
Eremobates pallipes	1 (50%)	A1	VII	2019	PT
Hemerotrecha branchi	1 (50%)	A2	V/VI	2018	PT

Figure 22. Habitus of adult female *Eremobates pallipes*.

Community Similarity

Thirty-eight species were shared between mesquite grassland and shinnery oak scrub out of 91 species total. This results in a Jaccard similarity Index of 41.7%.

Quantitative Comparisons

In sampling period one, 10 species were collected in shinnery oak habitat, 12 species were collected in mesquite habitat, and 22 species were collected in both habitats. In sampling period two, eight species were collected in shinnery oak habitat, 10 species were collected in mesquite habitat, and 26 species were collected in both habitats. In sampling period three, seven species were collected in shinnery oak habitat, 11 species were collected in mesquite habitat, and 30 species were collected in both habitats. In sampling period four, four were collected in shinnery oak habitat, nine were collected in mesquite habitat, and 29 were collected in both habitats. In sampling period five, four were collected in shinnery oak habitat, eight were collected in mesquite habitat, and 30 were collected in both habitats.

Of the 100 arachnid species documented, 22 species (22%) were collected solely in shinnery oak habitat, 33 (33%) species were collected solely in mesquite habitat, and 44 species (44%) were collected in both shinnery oak and mesquite habitats. Two species were encountered only at the bunk house and collected by hand, *Hogna baltimoriana* (Keyserling, 1877) (Lycosidae) and *Physocyclus enaulus* Crosby, 1926 (Pholcidae).

In total, 70 species were collected via pitfall trapping (70%); one species was collected via sweep netting (1%); six species were collected via general collecting (6%); seven species were sampled via pitfall trapping and sweeping (7%); six species were sampled via sweeping and general collecting (6%); seven species were sampled via pitfall trapping and general collecting (7%); four species were sampled via all three methods (4%).

Six species were collected in all five sampling periods, whereas 29 species were collected in only a single sampling period.

Sampling period-wise, 46 species were collected in the 1st, 45 in the 2nd, 51 in the 3rd, and 46 in the 4th, and 43 in the 5th.

Discussion

The knowledge of arachnid community is fragmentary, and likely the result of disjunct sampling efforts across time and space. This poor state of knowledge is attributed to few detailed studies of Arachnida done in the Southern High Plains.

Previous surveys in the Southern High Plains of Texas include: (1) a study by Knutson, et al. (2010) on spiders associated with saltcedar (*Tamarix* spp.) in Howard Co., Texas; and (2) an unpublished study of the macroinvertebrate fauna of the Pantex Plant in Carson Co., Texas (Sissom, 2003). Some results from the 2003 study pertaining to the arachnids of playa lakes at Pantex were subsequently published (Cokendolpher, et al. 2008). A recent catalogue (Dean 2016) listed 177 species of spiders from the 34 counties of the Southern High Plains of Texas. The average number of counties in which species were reported was 2.1; 104 of the 177 species were known from only a single county, and only 12 species were known from more than five counties. *Mecaphesa celer* (Hentz, 1847), a thomisid crab spider, is known from 14 counties or 41% of all SHP counties. Records are based on sporadic visits by researchers over time. Many of the specimens thus collected end up in museum or university collections, and the records may appear in revisionary studies of species and genera.

Acari

There has been virtually no inventory work done on the Acari in the Southern High Plains. Mites were reported by Sissom (2003) and Cokendolpher, et al. (2008) from the Pantex Plant in Carson Co., TX. Except for one tick species, identifications were carried out only to the family level; a total of six families were identified at that location. At Yoakum Dunes WMA, three families were documented (Erythraeidae, Caeculidae and Trombidiidae), and these three were reported at Pantex (Cokendolpher et al. 2008). However, it is unclear if the Pantex and Yoakum Dunes WMA specimens belong to the same genera and species.

Araneae

To place the diversity of Yoakum Dunes WMA and the broader Southern High Plains into perspective, comparisons were made to the taxa reported in Dean's (2016) catalogue of Texas spiders. The catalogue lists 53 families, 311 genera and 1084 species for the state. At Yoakum Dunes WMA, the 20 spider families comprised 37% of all families documented in Texas, the 53 genera comprised 17% of all genera documented, and the 85 species comprised 8% of all species documented.

Yoakum Dunes WMA is found in the Southern High Plains ecoregion, which partly or wholly encompasses 34 counties based on the map by Gould et al., 1960. A given county was considered as belonging to the Texas SHP if 50% or more of its land area lay within the ecoregion. In these 34 counties, 29 families, 100 genera, and 177 species of spiders were documented by Dean (2016). Seventeen of the 20 families found at Yoakum Dunes were previously known for the ecoregion; thus, three new families are reported for the Southern High Plains. As for genera, the 53 found at Yoakum Dunes WMA represented 60% of previously reported genera, and 14 genera at Yoakum Dunes WMA are new for the region. At the species level, 37 of the Yoakum Dunes WMA species were listed in Dean's catalogue, meaning that 48 new species were recorded for the Southern High Plains region in Texas.

The following species were found at Yoakum Dunes WMA, but were previously unreported from the Southern High Plains (Cokendolpher et al. 2008, Knutson et al. 2010, Dean 2016): *Agelenopsis naevia* (Walckenaer, 1841), *Agyneta fratrella, Callilepis gertschi* Platnick, 1975, *Callilepis mumai* Platnick, 1975, *Castianeira alteranda, Castianeira occidens* Reiskind, 1969, *Dictyna personata* Gertsch and Mulaik, 1936, *Dictyna volucripes, Drassyllus mormon, Drassyllus mumai, Drassyllus prosaphes* Chamberlin, 1936, *Euryopis lineatipes* O. Pickard-Cambridge, 1893, *Euryopis mulaiki* Levi, 1954, *Geolycosa missouriensis* (Banks, 1895), *Gnaphosa clara* (Keyserling, 1887), *Habronattus cf. calcaratus, Hogna baltimoriana* (Keyserling, 1877), *Hogna coloradensis* (Banks, 1894), *Lathys delicatula* (Gertsch and Mulaik, 1936), *Masoncus conspectus, Micaria longipes* Emerton, 1890, *Micaria mormon, Micaria nanella, Micaria triangulosa* Gertsch, 1935, *Neoanagraphis chamberlini* Gertsch and Mulaik, 1936, *Oxyopes apollo, Oxyopes tridens, Pardosa delicatula, Phidippus octopunctatus, Phrurotimpus certus* Gertsch, 1941, *Physocyclus enaulus, Piabuna pallida, Schizocosa bilineata,* *Scotinella/Phruronellus sp., Septentrinna bicalcarata*, *Sergiolus stella* Chamberlin, 1922, *Tibellus oblongus* (Walckenaer, 1802), *Tutelina elegans, Varacosa shenandoa* (Chamberlin and Ivie, 1942), and *Zelotes hentzi* Barrows, 1945.

All identified species of arachnids represent new records for Cochran County because there have been no previous reports of Arachnida from this county. In addition to adding 3 families, 14 genera, and 48 species to the Southern High Plains list, *Agyneta fratrella*, *Allocosa morelosiana* and *Piabuna pallida* represent new state records.

The type locality for *Piabuna. pallida* was stated as the "mountains near Romeroville, New Mexico" in San Miguel County (Chamberlin and Ivie 1935). The known range of *P. pallida* is thus expanded eastward.

The type locality of *Agyneta fratrella* is Utah's Uintah Mountains (Chamberlin 1919). The northwestern limit of its distribution lies in eastern Washington, from there extending southeast across the Midwest to encompass parts of Idaho, Wyoming, Utah, and Colorado before terminating in northeastern New Mexico. The NM record is from Cimarron Canyon State Park in Colfax County (Duperre, 2013), approximately 412 km NW of Yoakum Dunes. Hence, its distribution has been elongated southeast across the NM/Texas border.

Allocosa morelosiana (Araneae, Lycosidae) was first collected in Texas during a survey at the Pantex Plant in Carson County in 2000, but reported as *Allocosa* sp. (Sissom, 2003; Cokendolpher, et al. 2008). These records and the current ones from

Yoakum Dunes WMA represent the first reports of the species in Texas. Its distribution stretches from the state of Morelos in south-central Mexico to Santa Cruz County in SW Arizona and Lincoln County in central New Mexico (Dondale and Redner 1983). The known range of *A. morelosiana* has been expanded eastward to a great degree.

Gnaphosid Dominance

The most diverse family at the site, the Gnaphosidae, is deserving of special attention. At Yoakum Dunes WMA, 20 species were documented, including the common species *Z. lasalanus.* The second most diverse family at Yoakum Dunes WMA was the Lycosidae, with 12 species represented, though none were common.

In a previous study that examined shortgrass steppe spider communities in Colorado's Weld County utilizing pitfall trapping, albeit on a larger scale, 15 species of gnaphosid were documented, making them the most speciose family present (Weeks and Holtzer 2000). The species *G. sericata* was the most abundant with 193 collected. This species was much less abundant at Yoakum Dunes WMA, with 25 collected. Conversely, while only 65 *Z. lasalanus* were collected at the Weld County site, it was the most abundant species at Yoakum Dunes WMA with 51 collected.

Two prior studies at the Pantex Plant (Sissom 2003, unpub., Cokendolpher et al. 2008) yielded nine species of Lycosidae and 18 species of Gnaphosidae between them. Diversity-wise, the ground spiders were more speciose than the wolf spiders, as they were at Yoakum Dunes WMA.

The family Lycosidae dominated pitfall samples from three Illinois black soil tall grass prairie sites (Zeiders, Dietrich and Voegtlin, 1999). At the Loda site in Iroquois County, lycosids comprised 66% of all spiders collected, whereas gnaphosids made up 2%. The same trend was observed at the Paxton site in Ford County, 44% versus 2%, and the Rantoul site in Champaign County, 30% versus <1%. The species *Pardosa saxatilis* was most abundant at the Loda and Paxton sites, a species not found at Yoakum Dunes WMA. The species *Schizocosa bilineata* came in behind *P. saxatilis* in terms of abundance at the Paxton site, a single individual of which was collected at Yoakum Dunes WMA.

The family Lycosidae was again the most diverse as revealed by pitfall sampling conducted at five sites along a prairie-savanna-woodland gradient in DuPage County, Illinois (Wolff, 1990). Sampling at the two grassland sites resulted in a combined fifteen documented species of lycosids, outnumbering the four species of gnaphosids documented.

A similar result was found with pitfall sampling at a grassland site in El Paso County, Colorado (McIver, 1984) near Colorado Springs. At this location, a small study site was sampled by 25 pitfall traps from March through November in three years: 1972, 1974, and 1975. The families Lycosidae, Salticidae, and Theridiidae were the most diverse, if by a small margin, with five species documented for each; four species of Gnaphosidae were found. The most abundant lycosid species was *Schizocosa mccooki*, which was the second most abundant species at Yoakum Dunes. *Zelotes subterraneus* was the most abundant gnaphosid species, followed by *Drassodes saccatus*, neither of which occur at Yoakum Dunes. *Gnaphosa sericata* was 3rd most abundant, being the most abundant at Yoakum Dunes WMA. The gnaphosid *Herpyllus bubulcus* was the rarest species at both sites.

Consequently, prevalence of one family or another fluctuates from one prairie/grassland community to the next. The Yoakum Dunes WMA and Pantex sites in the Southern High Plains were dominated by Gnaphosidae; a nearby site in southeastern Colorado was relatively balanced in the diversity gnaphosids or lycosids, although much less diverse.

At the Pantex Plant site, 43 species were shared between playa edges and grasslands out of 85 species total. This results in a Jaccard Similarity Index of 50.5%.

The following 19 species were recorded at Yoakum Dunes WMA and the Pantex site: *Acanthepeira stellata* (Walckenaer, 1805), *Argiope trifasciata, Hypsosinga funebris, Neoscona oaxacensis* (Keyserling, 1864), *Drassodes auriculoides, Drassodes gosiutus, Drassyllus lepidus, Nodocion utus, Zelotes lasalanus, Scotinella sp., Hogna antelucana* (Montgomery, 1904), *Hogna carolinensis, Schizocosa mccooki* (Montgomery, 1904), *Oxyopes salticus* Hentz, 1845, *Thanatus formicinus* (Clerck, 1757), *Habronattus cognatus* (Peckham and Peckham, 1901), *Phidippus apacheanus* Chamberlin and Gertsch, 1929, *Phidippus texanus* Banks, 1906, and *Aphonopelma hentzi* (Girard, 1852).

Pseudoscorpiones

The type locality for *L. fulvopalpus* is Reynosa, Tamaulipas, Mexico (Hoff, 1946a), which is a short distance from McAllen, TX. In a subsequent 1950 publication, Hoff listed records from additional sites across Texas, the furthest from the type locality being the Canadian River, 30.5 km north of Amarillo. Records from two New Mexico counties were also provided: shin-oak litter at an elevation of approx. 1067 m in Eddy County (eastern NM), and a woodrat (*Neotoma* sp.) nest at an elevation of approx. 1829m in Grant County (western NM). This study site sits comfortably within the known range of this species. In agreement with the observations in Hoff's publication, it was collected in shinnery-oak habitat at Yoakum Dunes WMA, but also collected in mesquite habitat.

The female holotype of *P. nubilis* originated from Bernalillo County in central New Mexico, collected on sandy soil near Albuquerque at 1524 m in elevation. Other noteworthy collection sites are Chaves County, mesquite litter at approx. 1219 m in elevation; Roosevelt County, shinnery oak litter at approx. 1310 m in elevation; Socorro County, live-oak litter at ~2011 m in elevation (Hoff, 1956). Its collection in three of the four mesquite habitats sampled at Yoakum Dunes reflects the observations in Hoff's 1956 paper.

Scorpiones

Six species are present in the Southern High Plains of Texas (Shelly and Sissom, 1995; McWest et al. 2015), four of which were encountered in Cochran County.

Centruroides vittatus is a habitat generalist and readily occupies sandy habitat sporting sand sagebrush and shinnery oak (Shelley and Sissom, 1995). Records exist for Bailey Co. (north of Cochran), Hockley (east of Cochran) and Yoakum (south of Cochran; McWest et al. 2015). Being the most widespread and abundant species in the Southern High Plains (McWest et al. 2015), finding it in Cochran County was expected.

Paruroctonus utahensis prefers sandy areas such as shifting dunes, be they sparsely or well vegetated. Habitats populated by shinnery oak in the southwestern Texas Panhandle are a reservoir for the species (McWest at al. 2015). Near Cochran County, it has been found only in Bailey and Lamb counties (McWest et al. 2015). As Cochran County lies near Bailey and Lamb Counties, its presence at Yoakum Dunes was expected.

Paruroctonus pecos is found, as its name suggests, along the Pecos River near Roswell and Carlsbad, New Mexico and west Texas, north to the Canadian River drainage (Stockwell 1986; McWest et al. 2015). It is also known in the Pecos River drainage as far southeast as Iraan (Pecos County), Texas (Stockwell 1986). It tends to occupy somewhat more consolidated sandy habitats compared to *P. utahensis*. Sporadic records from mesquite/shinnery oak habitat blends in the Southern High Plains (Bailey, Lamb and Hockley counties) exist (McWest, et al. 2015). As Yoakum Dunes features the same types of habitats, its presence mirrors the records found in the above-referenced publication.

Chihuahuanus russelli occupies a diverse spectrum of habitats, ranging from mesquite-populated grasslands to talus slopes. It can be found on a similarly diverse spectrum of substrates, from sandy soil to the rocky slopes of canyon walls (McWest et al., 2015). Its presence at Yoakum Dunes reflects its nature as a habitat generalist.

Two of the six species documented as part of the NW Texas scorpion fauna by the 2015 McWest et al. study, *Chihuahuanus coahuilae* and *Maaykuyak waueri*, were not collected in this study. *C. coahuilae* is both a widespread and common species over much of its range, which includes parts of the Texas Panhandle and adjoining New Mexico (Sissom, unpub. data; used with permission). It has been observed readily sharing habitat space with *Centruroides vittatus and Chihuahuanus russelli* in Palo Duro Canyon State Park. It was also seen in proximity to both *P. utahensis* and *P. pecos* near Glenrio, and to *C. vittatus* at Lake Meredith and McBride Canyon (McWest et al., 2015). The abundance of *C. coahuilae* is much greater than that of its counterpart *C. russelli* (D. Sissom, pers. comm.). Records of this species from Yoakum County were listed by McWest, et al. 2015, but were apparently overlooked when plotting localities on the species distribution map. Sparse sampling restricted to a few locations in this area may be partially responsible for its absence in the samples.

As shown in the 2015 McWest et al. study, *Maaykuyak waueri* has a pronounced affinity for rocky slopes. Its collection records conform quite nicely to the northern, eastern, and southern contours of the Llano Estacado caprock. Yoakum Dunes WMA lack of vertical relief associated with such rocky, rugged terrain provides a likely explanation for the absence of this species.

The reliance on pitfall traps to sample scorpions acted as a limiting factor. Had time been invested in nocturnal blacklight searches that took advantage of their ability to fluoresce, more would have undoubtedly been captured, leading to a better assessment of their relative abundances on a per-species, as well as total, basis.

Solifugae

The status of *E. pallipes* as a dominant species in arid ecosystems is well-earned, being noted in prior studies conducted in parched regions of the USA (Muma 1974, Brookhart and Brantley 2000).

A second species in the *pallipes* group, *Eremobates simoni*, was strangely not found. Its distribution includes the states of California, Arizona, New Mexico, and Texas (Muma, 1970). The male holotype was sourced from Gillespie County, Texas (Muma, 1970), and the female allotype from Wichita County, Texas (Brookhart and Brookhart, 2006). Based on the distribution map of *pallipes* group species in Brookhart and Muma 1981, the northern edge of its range extends a fair distance into the Texas Panhandle, while the southern edge terminates in Midland and Ector counties. The western edge protrudes slightly into eastern New Mexico. The distribution map in Brookhart & Muma 1981 states it replaces *E. pallipes* south of Randall and Castro Counties. However, this study modifies the distribution of *E. pallipes* to encompass Cochran County. Their ranges therefore appear to overlap.

Opiliones

The WTAMU catalogue lists four species of Opiliones (harvestmen) found in the Texas Panhandle. Three belong to the family Sclerosomatidae, *Eumesosoma roeweri* (Goodnight and Goodnight, 1943), *Leiobunum townsendi* Weed, 1893 and *Trachyrhinus rectipalpus* Cokendolpher, 1981. The fourth belongs to the family Cosmetidae, *Vonones sayi* (Simon, 1879). None of these species from this prominent order were captured in Cochran County.

Figure 23. Habitus of *Eumesosoma roeweri*. Members of this genus differ from the other genera in the Sclerosomatidae by being comparatively short-legged. Image obtained from Wikimedia Commons.

Figure 24. Habitus of *Leiobunum townsendi*. An example of a species with noticeably elongated legs. Image obtained from Wikimedia Commons.

Figure 25. Habitus of *Trachyrhinus rectipalpus*. Image obtained from Wikimedia Commons.

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Figure 26. Habitus of *Vonones sayi*. Image obtained from Wikimedia Commons.

Community Similarity

Mesquite and shinnery oak habitats exhibited a Jaccard Similarity Index of 41.7%, a moderate amount of overlap. The Jaccard Similarity Index calculated from data in Cokendolpher et al. 2008 for grassland and playa edge habitats at the Pantex Plant was 50.5%. This is a surprising result, as the mesquite and shinnery oak habitats at Yoakum Dunes are quite different in terms of plant communities and overall structure. Despite this, their Jaccard Similarity Index is almost equal to that of grassland and playa edge habitats at the Pantex Plant, which are in contrast quite similar. The Jaccard Similarity Indices calculated from data in Bultman et al. 1982 for old field vs. oak forest, old field vs. beech-maple forest, and oak forest vs. beech-maple forest were 7.89%, 3.33% and 34.78% respectively. Again, the two types of forest habitat demonstrated moderate overlap approaching that of mesquite and shinnery oak habitats. The result from Yoakum Dunes opposes those derived from the mentioned arachnid diversity studies.

Quantitative Comparisons

Mites and spiders far overshadowed the three remaining arachnid orders in terms of abundance. Mite numbers exhibited a steep increase in number during the months of June and July. Much of the available literature on mite abundance is concerned with soil mite taxa such as the Oribatida, or beetle mites. How populations of the mite taxa at Yoakum Dunes measure up against those at other sites, and if there are any trends in temporal variation of abundance, is not clear.

Spider numbers remained relatively stable from one sampling period to the next. For species distributed across a collection of sites, a uniform relationship has been repeatedly observed in the litertature: a few species are abundant, a moderate number are less abundant but still common, and many are rare (Turnbull 1973). The spider fauna at Yoakum Dunes were no exception, as one species was abundant, eight were uncommon, and 86 were rare.

Little is known about the typical abundances and densities of specific pseudoscorpion species, including the two found in this study. In general, pseudoscorpion densities can sometimes be very high, but populations are greatly fragmented spatially (Buddle 2005).

Scorpions are typical inhabitants of arid and semiarid areas throughout the western half of the United States. Anywhere from three to 11 species often live sympatrically in communities, leading to elevated diversity within those communities. By the same token, scorpion densities can exceed 3,200 per hectare (Polis 1990; Polis 1993). As scorpions fluoresce when exposed to UV light, this method can be used to reliably locate them after dark. Had nocturnal UV light searches been incorporated into this study, it is likely that many more scorpions would have been collected. Spotting fluorescing scorpions in open mesquite habitat would have been simple, but the same could not be said for shinnery oak habitat given the vegetation density. Regardless, had this method been utilized, scorpion abundance on per-species and total basis would have been more accurately assessed.

Eremobates pallipes was one of twelve species encountered in a study targeting the solpugids of Sevilleta Wildlife Refuge in New Mexico. It turned out to be the most abundant species and was collected in higher numbers at grassland sites (Brookhart & Brantley 2000). Out of the 38 solpugids collected at Yoakum Dunes WMA, two were male, the rest being either juveniles or adult females. While taxonomic keys for males and females are available, only males can be readily identified. If the abundance of *E. pallipes* at Yoakum Dunes mirrors its abundance at Sevilleta NWR, it is possible that most individuals, if not all, are those of *E. pallipes*.

Arachnid Functional Groups

The term functional group first arose in a treatise on the interactions between organisms in stream ecosystems (Cummins, 1974). The functional group concept delineates assemblages of species in an ecosystem that demonstrate comparable resource use and act in a related capacity (Simberloff & Dayan 1991; Blondel 2003; Root 1967). How functional groups are delineated is based on certain traits possessed by all members in a species assemblage, be they behavioral, biochemical, ecological, morphological, or physiological in nature. This delineation is done in an *ad hoc* manner using the above-described traits (Davic, 2003). For this study, all non-acarine arachnid species were lumped into nine functional groups based on hunting strategy, referencing those described in Bradley 2012. To simply the lumping process, a subset of those groups provided by Bradley, relevant to taxa encountered at the study site, was selected. The groups are as follows: (1) orb-web builders, species utilizing vertical circular webs to ensnare prey; (2) sheetweb builders, species utilizing various types of horizontal web to ensnare prey; (3) space-filling web builders, species utilizing irregular 3D webs to trap wandering prey; (4) funnel-web builders, species utilizing flared webs with tubular retreats that rush out to grab prey landing on the web; (5) ground hunters, cursorial species that actively chase down prey on the land surface; (6) ambush hunters, species employing sit-and-wait tactics on vegetation that strike at unsuspecting prey; (7) foliage hunters, those that stalk prey on and among vegetation and pounce upon approaching sufficiently close; (8) burrowers, those that excavate tunnels in the soil and grab passing prey; and (9) under-debris hunters, species that rest concealed beneath natural objects such as stones and logs but leave their shelters in order to find prey.

Across the nine groups, more species occurred in both habitats, 38, versus mesquite grassland or shinnery oak scrub individually, 33 and 20, respectively.

The ground hunter group, containing 56 species, was markedly more speciose than the remaining groups. Twenty of these (35.7%) were gnaphosids, the archetypes of the group, and 10 (17.8%) were lycosids. Members of this group comprised the bulk of species found in the individual habitats: 22 of 33 species (66%) in mesquite, 13 of 20 (65%) species in shinnery oak, and 22 of 38 (57.8%) species common to both.

Foliage hunters were the next most speciose group, containing 15 species. Eight (53.3%) were found in both habitats, compared to five (33%) in mesquite grassland and two (13.3%) in shinnery oak.

Nineteen species were distributed among the four web-building functional groups. Seven (36.84%) belonged to both the orb-web and space-filling web groups, three (15.78%) belonged to the funnel-web group, and two (10.52%) belonged to the sheet-web group. Five species (26.3%) were found in mesquite as well as shinnery oak, while nine species (47.3) were found in both. Within the orb-web building group, four species (57.1%) were common to both habitats, two (28.5%) were found in mesquite, and 1 (14.2%) was found in shinnery oak. Within the space-filling web group, the habitat associations were quite similar: four species (57.1%) were common to both habitats, 2 (28.5%) were found in shinnery oak, and one (14.2%) was found in mesquite. One species of linyphiid sheet-web builder, *Agyneta fratrella*, was found only in mesquite, whereas the other species in the same family, *Masoncus conspectus*, was found only in shinnery oak.

Twenty-one species were assigned to two separate groups. Three species each (14.28%) in the families Oxyopidae, Philodromidae, and Thomisidae were placed in the foliage hunter and ground hunter groups. Two vaejovid scorpion species, *Paruroctonus utahensis* and *Paruroctonus pecos*, were placed in the burrower and ground hunter groups as they readily excavate burrows in sandy soil. The third vaejovid, *Chihuahuanus russelli*, and the sole buthid, *Centruroides vittatus*, were placed in the ground hunter and under-debris hunter groups. The lycosid *Hogna antelucana* was placed in the burrower and ground hunter groups, as it is a facultative burrower that hunts from within its retreat at times and engages in active pursuit at others. The theraphosid *Aphonopelma hentzi* was also placed in the burrower and ground hunter groups, as males and females tend to remain sequestered in burrows, with males initiating wandering during the mating season.

Table 9. Distribution of arachnid species among web-building functional groups. A single asterisk indicates presence solely in mesquite, a double asterisk indicates presence solely in shinnery oak, and a triple asterisk indicates presence in both. Select taxa whose hunting methods warranted inclusion in two separate groups were indicated with a dagger symbol (†**).**

Orb-web builders
Araneidae
*Acanthepeira stellata****
*Argiope trifasciata****
*Hypsosinga funebris**
*Metepeira labyrinthea****
*Neoscona crucifera***
*Neoscona oaxacensis****
Tetragnathidae
Tetragnatha sp.*

Funnel-web builders
Agelenidae
*Agelenopsis longistyla****
*Agelenopsis naevia**
*Agelenopsis spatula***

Space-filling web builders
Dictynidae
*Dictyna volucripes****
Pholcidae
*Psilochorus imitatus****
Theridiidae
*Euryopis lineatipes***
*Euryopis mulaiki****
*Euryopis texana***
*Latrodectus hesperus****
*Latrodectus mactans**

Sheet-web builders
Linyphiidae
*Agyneta fratrella**
*Masoncus conspectus***

Table 10. Distribution of arachnid species among non-web-building functional groups. A single asterisk indicates presence solely in mesquite, a double asterisk indicates presence solely in shinnery oak, and a triple asterisk indicates presence in both. Select taxa whose hunting methods warranted inclusion in two separate groups were indicated with a dagger symbol (†).

Ambush hunters
Thomisidae
*Mecaphesa celer**
Ozyptila sp.*** †
*Xysticus auctificus**
*Xysticus coloradensis**†
*Xysticus concursus**†
*Xysticus pellax**†
*Xysticus texanus****†

Under-debris hunters
Buthidae
*Centruroides vittatus****†
Phrurolithidae
*Phrurotimpus certus****†
*Piabuna pallida****†
Scotinella/Phruronellus sp.* †

Foliage hunters
Mimetidae
*Mimetus hesperus****
Oxyopidae
*Oxyopes apollo**†
*Oxyopes salticus****†
*Oxyopes tridens**†
Philodromidae
Ebo sp.*** †
Philodromus sp.*** †
*Thanatus formicinus**†
*Tibellus oblongus****
Salticidae
*Habronattus cf. calcaratus**
*Habronattus cognatus****
*Phidippus apacheanus****
*Phidippus octopunctatus**

Vaejovidae	*Phidippus texanus****
*Chihuahuanus russelli****†	*Phlegra hentzi***
	*Tutelina elegans***

Burrowers
Lycosidae
*Geolycosa missouriensis****
*Hogna antelucana****†
Theraphosidae
*Aphonopelma hentzi**†
Vaejovidae
*Paruroctonus pecos**†
*Paruroctonus utahensis****†

Table 11. Distribution of arachnid species in the cursorial functional group. A single asterisk indicates presence solely in mesquite, a double asterisk indicates presence solely in shinnery oak, and a triple asterisk indicates presence in both. Select taxa whose hunting methods warranted inclusion in two separate groups were indicated with a dagger symbol (†**).**

Ground hunters	
	Hahniidae
Buthidae	*Cicurina cf. varians**
*Centruroides vittatus****†	Liocranidae

Cheiracanthiidae

*Cheiracanthium sp.***

Cheliferidae

*Levichelifer fulvopalpus****

Chernetidae

*Parachernes nubilis**

Corinnidae

*Castianeira alteranda**

*Castianeira occidens***

*Septentrinna bicalcarata***

Dictynidae

*Dictyna personata**

*Lathys delicatula****

Eremobatidae

*Eremobates pallipes***

*Hemerotrecha branchi***

Gnaphosidae

*Callilepis gertschi****

*Callilepis mumai**

*Cesonia sincera****

*Drassodes auriculoides***

*Drassodes gosiutus**

*Drassyllus lepidus**

*Neoanagraphis chamberlini****

Lycosidae

*Allocosa morelosiana***

*Hesperocosa unica****

*Hogna antelucana****†

*Hogna carolinensis**

*Hogna coloradensis***

*Pardosa delicatula**

Pardosa sp.*

*Schizocosa bilineata**

*Schizocosa mccooki****

*Varacosa shenandoa***

Oxyopidae

*Oxyopes apollo**†

*Oxyopes salticus****†

*Oxyopes tridens**†

Philodromidae

Ebo sp.*** †

Philodromus sp.*** †

*Thanatus formicinus**†

*Tibellus oblongus****

Phrurolithidae

*Phrurotimpus certus****†

*Drassyllus mormon****

*Drassyllus mumai**

*Drassyllus prosaphes****

*Gnaphosa clara****

*Gnaphosa sericata****

*Herpyllus bubulcus***

*Micaria longipes**

*Micaria mormon***

*Micaria nanella**

*Micaria triangulosa**

*Nodocion utus**

*Sergiolus stella***

*Zelotes hentzi***

*Piabuna pallida****†

Scotinella/Phruronellus sp.* †

Theraphosidae

*Aphonopelma hentzi**†

Vaejovidae

*Chihuahuanus russelli****†

*Paruroctonus pecos**†

*Paruroctonus utahensis****†

Future Research

Being a preliminary investigation of the undocumented arachnid fauna of Yoakum Dunes WMA, this study was bound by the limiting factors of time, required effort, and expense. More consistent sampling for a longer duration at other locations within the Cochran County portion of the site, as well as the Terry and Yoakum County portions, may yield additional species. The identities of arachnids encountered in this study could be corroborated or, if any misidentifications were made, corrected. A more robust investigation building off this study could further improve the distributional knowledge of arachnid fauna in Texas and the Southern High Plains.

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Appendices:

Appendix 1. The Arachnida of Yoakum Dunes WMA. Each species-level taxon found at particular sites and collected by the three sampling methods is indicated by "•". Months (Roman numerals) and years in which the species were collected are also specified. Singletons are indicated with a [1] and unique species with a [2].

	Sites												
	Shinnery oak				Mesquite				Methods				
Taxon	**A 1**	**A 2**	**A 3**	**A 4**	**B 1**	**B 2**	**B 3**	**B 4**	**Pitfall**	**Swe**	**General**	**Months**	**Years**

										e p			
Acari													
Caeculidae													
Undetermined genus/species			•	•			•		•			VI, VII, IX	2019
Erythracaridae													
Undetermined genus/species			•	•			•	•	•			V, VI, VII, IX	2017, 2018
Erythraeidae													
Abrolophus sp.				•					•			VII, IX	2019
Augustsonella sp.	•	•	•	•	•	•	•	•	•			VII, VIII, IX	2017, 2018, 2019
Lasioerythraeus sp.		•	•		•				•			V, VI, VIII, IX	2018, 2019
Leptus sp.		•					•		•			VII	2019
Mesostigmata													
Undetermined genus/species	•	•	•	•	•	•	•	•	•			VI, VII, IX	2017, 2019
Trombidiidae													
Dinothrombium sp.					•		•		•			V, VI	2018
Araneae													
Agelenidae													
Agelenopsis longistyla	•			•			•	•	•			VII, VIII, IX	2017, 2019
Agelenopsis naevia							•		•			VII	2019
Agelenopsis spatula		•	•						•			VII, IX	2019
Araneidae													
Acanthepeira stellata		•		•		•			•		•	VI, VII	2018, 2019
Argiope trifasciata	•	•	•	•	•	•	•	•		•	•	VI, VII, IX, X	2017, 2019
Hypsosinga funebris					•	•	•	•	•	•		VI, VII, VIII, IX	2017, 2018, 2019

Metepeira labyrinthea	•	•		•	•	•	•	•			•	VI, VII, IX, X	2017, 2019
Neoscona crucifera									•	•	•	IX, X	2017, 2019
Neoscona oaxacensis	•	•	•			•	•			•	•	VI, VII, IX	2018, 2019
Cheiracanthiidae													
Cheiracanthium sp.	•			•					•	•		V, VI, IX	2017, 2018
Corinnidae													
Castianeira alteranda[12]					•				•			VIII, IX	2019
Castianeira occidens[2]			•						•			V, VI	2018
Castianeira sp.						•	•		•			VI, VIII, IX	2018, 2019
Septentrinna bicalcarata				•					•			IX	2017
Dictynidae													
Dictyna personata						•	•		•			VI, VII	2018, 2019
Dictyna volucripes		•	•	•	•	•	•	•		•	•	VI, VII, IX	2018, 2019
Lathys delicatula	•	•		•	•			•	•			V, VI, IX	2017, 2018, 2019
Gnaphosidae													
Callilepis gertschi	•	•	•	•	•	•			•			V, VI	2018, 2019
Callilepis mumai					•	•			•			VI	2018
Cesonia sincera		•			•	•	•	•	•			V, VI, IX	2017, 2018, 2019
Drassodes auriculoides[12]			•						•			V, VI	2018
Drassodes gosiutus[12]											•	X	2017
Drassyllus lepidus					•	•	•	•	•			VI, VII	2018, 2019

Drassyllus mormon	•	•	•	•	•	•			•			V, VI	2018, 2019
Drassyllus mumai					•		•	•	•		•	V, VI	2018
Drassyllus prosaphes		•			•	•			•			V, VI	2018, 2019
Gnaphosa clara			•		•				•			V, VI	2018, 2019
Gnaphosa sericata	•	•	•	•	•		•	•	•			V, VI, VII, VIII, IX	2017, 2018, 2019
Herpyllus bubulcus[12]				•					•			VI	2018
Micaria longipes							•	•	•			IX	2017
Micaria mormon[12]			•						•			V, VI	2018
Micaria nanella[12]								•	•			IX	2017
Micaria triangulosa							•	•	•			V, VI, VIII, IX	2017, 2018, 2019
Nodocion utus[12]								•	•			VII	2019
Sergiolus stella	•			•					•			VI	2018, 2019
Zelotes hentzi	•	•							•			IX	2017
Zelotes lasalanus	•	•	•	•	•	•	•	•	•			V, VI, VII, VIII, IX	2018, 2019
Mimetidae													
Mimetus hesperus		•			•			•		•	•	VI, IX	2019
Oxyopidae													
Oxyopes apollo					•	•	•	•	•	•		VI, VII, VIII, IX	2018, 2019
Oxyopes salticus	•	•	•			•	•		•	•	•	VI, VII	2019
Oxyopes tridens[12]								•	•			VI	2019
Philodromidae													
Ebo sp.		•			•			•	•	•		VI, VII	2018, 2019
Thanatus formicinus								•	•			VI	2019

Tibellus oblongus	•	•			•		•	•	•	•		V, VI, VII	2018, 2019
Pholcidae													
Physocyclus enaulus[3]											•	X	2017
Psilochorus imitatus	•	•	•	•	•	•	•	•	•		•	V, VI, VII, VIII, IX	2017, 2018, 2019
Phrurolithidae													
Phrurotimpus certus	•	•	•		•		•	•	•			V, VI, VIII, IX	2017, 2018, 2019
Piabuna pallida	•		•		•		•	•	•			VI, IX	2017, 2018, 2019
Scotinella/Phruronellus sp.					•	•	•	•	•			V, VI, VII, IX	2017, 2018, 2019
Salticidae													
Habronattus cf. calcaratus[12]								•	•			VIII, IX	2019
Habronattus cognatus	•		•	•					•	•		V, VI, IX	2017, 2018, 2019
Phidippus apacheanus		•	•	•	•					•	•	IX	2017, 2019
Phidippus octopunctatus[12]	•										•	IX	2019
Phidippus texanus	•	•		•	•				•	•	•	VI, VII, IX	2019
Phlegra hentzi	•	•							•			V, VI, VII, IX	2017, 2018, 2019
Tutelina elegans	•	•	•	•						•	•	VI, VII, IX	2017, 2019
Tetragnathidae													
Tetragnatha sp.[12]								•		•		IX	2017
Theraphosidae													

Aphonopelma hentzi					•		•		•		•	VIII, IX	2017, 2019
Theridiidae													
Euryopis lineatipes				•					•			VI	2018
Euryopis mulaiki	•	•					•		•			VII, VIII, IX	2019
Euryopis texana	•		•	•					•		•	V, VI, IX, X	2017, 2018, 2019
Latrodectus hesperus				•			•		•	•	•	VII, IX	2019
Latrodectus mactans							•		•			VII	2019
Thomisidae													
Mecaphesa celer					•	•	•	•				VI, VII	2019
Ozyptila sp.		•	•				•	•	•	•		VI, VII, IX	2017, 2019
Xysticus auctificus[12]							•		•			VI	2019
Xysticus coloradensis[2]							•		•			VII	2019
Xysticus concursus					•	•			•			VII	2019
Xysticus pellax					•		•		•			IX	2017
Xysticus texanus	•	•		•					•			VII	2019
Pseudoscorpiones													
Cheliferidae													
Levichelifer fulvopalpus	•	•	•	•	•	•	•		•			VI, VII, IX	2017, 2018, 2019
Chernetidae													
Parachernes nubilis						•	•	•	•			VI	2019
Scorpiones													
Buthidae													
Centruroides vittatus		•	•	•			•	•	•			V, VI, VII, VIII, IX	2017, 2018, 2019
Vaejovidae													

Chihuahuanus russelli		•			•	•	•	•	•			VII, VIII, IX	2017, 2019
Paruroctonus pecos							•	•	•			VI, VII, VIII, IX	2017, 2019
Paruroctonus utahensis	•	•		•			•	•	•			V, VI, VII, IX	2017, 2018, 2019
Solifugae													
Eremobatidae													
Eremobates pallipes[12]	•								•			VII	2019
Hemerotrecha branchi[12]		•							•			VI	2018

Appendix II. Abundances of arachnid species gathered by pitfall sampling.

Taxon	IX 2017	V/VI 2018	VI 2018	VI 2019	VII 2019	VIII/IX 2019	IX 2019
Acari	**5**	**8**	**6**	**421**	**666**	**7**	**92**
Caeculidae				**1**	**2**		**1**
Undetermined genus/species				**1**	**2**		**1**
Erythracaridae	**1**	**1**			**4**		
Undetermined genus/species	**1**	**1**			**4**		
Erythraeidae	**3**	**1**		**71**	**5**	**7**	**91**
Abrolophus sp.					**1**		**1**
Augustsonella sp.	**3**			**69**		**6**	**90**
Lasioerythraeus sp.		**1**		**2**		**1**	
Leptus sp.					**4**		
Mesostigmata	**1**	**3**	**3**	**349**	**655**		
Undetermined genus/species	**1**			**349**	**655**		
Trombidiidae		**3**	**3**				
Dinothrombium sp.		**3**	**3**				
Araneae	**64**	**94**	**73**	**97**	**70**	**31**	**22**
Agelenidae	**1**			**3**	**2**	**1**	**3**
Agelenopsis longistyla	**1**			**3**		**1**	**2**
Agelenopsis naevia					**1**		
Agelenopsis spatula					**1**		**1**
Araneidae			**2**	**1**		**2**	**1**
Acanthepeira stellata			**2**				
Hypsosinga funebris				**1**		**2**	
Neoscona crucifera							**1**
Cheiracanthiidae		**1**					
Cheiracanthium sp.		**1**					
Corinnidae	**2**	**2**				**1**	
Castianeira alteranda						**1**	
Castianeira occidens		**1**					
Castianeira sp.		**1**					
Septentrinna bicalcarata	**2**						
Dictynidae	**5**		**3**	**4**	**1**		
Dictyna personata			**2**	**1**	**1**		

Dictyna volucripes							
Lathys delicatula	**5**		**1**	**3**			
Gnaphosidae	**11**	**42**	**40**	**44**	**26**	**6**	**2**
Callilepis gertschi		**10**	**3**	**3**			
Callilepis mumai			**3**				
Cesonia sincera	**2**	**7**	**6**	**2**			**1**
Drassodes auriculoides		**1**					
Drassyllus lepidus			**4**	**4**	**5**		
Drassyllus mormon		**3**	**2**	**9**			
Drassyllus mumai		**1**	**5**				
Drassyllus prosaphes		**1**	**1**	**1**			
Gnaphosa clara		**2**	**1**	**1**			
Gnaphosa sericata	**1**	**4**	**1**	**5**	**11**	**3**	
Herpyllus bubulcus			**1**				
Micaria longipes	**3**						
Micaria mormon		**1**					
Micaria nanella	**1**						
Micaria triangulosa	**2**	**2**				**1**	
Nodocion utus					**1**		
Sergiolus stella			**1**	**2**			
Zelotes hentzi	**2**						
Zelotes lasalanus		**10**	**12**	**17**	**9**	**2**	**1**
Linyphiidae	**1**			**1**			
Agyneta fratrella				**1**			
Masoncus conspectus	**1**						
Liocranidae	**11**	**6**	**1**				**2**
Neoanagraphis chamberlini	**11**	**6**	**1**				**2**
Lycosidae	**5**	**21**	**3**	**25**	**10**	**3**	**1**
Allocosa morelosiana				**1**			
Geolycosa missouriensis					**4**		**1**
Hesperocosa unica	**1**	**9**	**7**	**5**			
Hogna antelucana		**12**	**6**	**1**	**1**	**1**	
Hogna carolinensis				**2**			
Hogna coloradensis	**2**			**3**	**2**		
Pardosa sp.				**1**			

Pardosa delicatula	**1**						
Schizocosa bilineata				**1**			
Schizocosa mccooki				**11**	**3**	**2**	
Varacosa shenandoa	**1**						
Oxyopidae			**12**	**3**	**5**	**7**	
Oxyopes apollo			**12**	**1**	**5**	**7**	
Oxyopes salticus				**1**			
Oxyopes tridens				**1**			
Philodromidae		**1**		**2**	**1**		
Ebo sp.					**1**		
Thanatus formicinus				**1**			
Tibellus oblongus		**1**		**1**			
Pholcidae	**12**	**11**	**9**	**3**	**2**	**4**	**9**
Psilochorus imitatus	**12**	**11**	**9**	**3**	**2**	**4**	**9**
Phrurolithidae	**7**	**3**	**7**	**6**	**2**	**1**	**4**
Phrurotimpus certus	**2**	**1**	**1**	**4**		**1**	**1**
Piabuna pallida	**3**		**1**				**3**
Scotinella/Phruronellus sp.	**2**	**2**	**5**	**2**	**2**		
Salticidae	**2**	**2**	**1**	**1**	**2**	**1**	
Habronattus cf. calcaratus						**1**	
Habronattus cognatus	**1**	**1**					
Phidippus texanus					**2**		
Phlegra hentzi	**1**	**1**	**1**	**1**			
Theraphosidae						**4**	
Aphonopelma hentzi						**4**	
Theridiidae	**2**	**5**	**2**	**2**	**9**	**1**	
Euryopis lineatipes			**2**				
Euryopis mulaiki					**4**	**1**	
Euryopis texana	**2**	**5**		**2**			
Latrodectus hesperus					**4**		
Latrodectus mactans					**1**		
Thomisidae	**5**			**2**	**12**		
Ozyptila sp.	**3**			**1**	**1**		
Xysticus auctificus				**1**			
Xysticus coloradensis					**2**		

Xysticus concursus					**3**		
Xysticus pellax	**2**						
Xysticus texanus					**6**		
Pseudoscorpiones	**1**		**5**	**12**	**2**		**4**
Cheliferidae	**1**		**5**	**7**	**2**		**4**
Levichelifer fulvopalpus	**1**		**5**	**7**	**2**		**4**
Chernetidae							
Parachernes nubilis				**5**			
Scorpiones	**19**	**7**	**1**	**13**	**19**	**16**	**5**
Buthidae	**4**	**6**	**1**	**4**	**6**	**2**	**1**
Centruroides vittatus	**4**	**6**	**1**	**4**	**6**	**2**	**1**
Vaejovidae	**15**	**1**		**9**	**13**	**14**	**4**
Chihuahuanus russelli	**3**			**5**	**8**	**6**	**1**
Paruroctonus pecos	**4**			**1**	**1**	**8**	
Paruroctonus utahensis	**8**	**1**		**3**	**4**		**3**
Solifugae		**1**			**1**		
Eremobatidae		**1**			**1**		
Eremobates pallipes					**1**		
Hemerotrecha branchi		**1**					

Appendix III. Abundances of arachnid species gathered by sweep netting.

Taxon	**IX 2017**	**V/VI 2018**	**VI 2018**	**VI 2019**	**VII 2019**	**VIII/IX 2019**	**IX 2019**
Araneae	**5**		**10**	**56**	**30**		**11**
Araneidae	**2**		**3**	**29**	**15**		**4**
Argiope trifasciata				**26**	**14**		**4**
Hypsosinga funebris	**1**		**2**	**3**	**1**		
Neoscona crucifera	**1**						
Neoscona oaxacensis			**1**				
Dictynidae				**3**			
Dictyna volucripes				**3**			
Mimetidae				**1**			**1**
Mimetus hesperus				**1**			**1**
Oxyopidae				**7**	**3**		**1**
Oxyopes apollo				**5**	**1**		**1**
Oxyopes salticus				**2**	**2**		
Philodromidae			**1**	**3**	**3**		
Ebo sp.			**1**	**1**			
Tibellus oblongus				**2**	**3**		
Salticidae	**2**		**1**	**3**	**2**		**2**
Habronattus cognatus			**1**				**1**
Phidippus apacheanus	**1**						
Phidippus texanus							**1**
Tutelina elegans	**1**			**3**	**2**		
Tetragnathidae	**1**						
Tetragnatha sp.	**1**						
Theridiidae				**1**			**2**
Latrodectus hesperus				**1**			**2**
Thomisidae				**9**	**7**		**1**
Mecaphesa celer				**9**	**7**		
Ozyptila sp.							**1**

Appendix IV. Abundances of arachnid species gathered by general collecting.

Taxon	**IX 2017**	**V/VI 2018**	**VI 2018**	**VI 2019**	**VII 2019**	**VIII/IX 2019**	**IX 2019**
Araneae	**8**		**58**	**52**	**59**	**1**	**26**
Agelenidae				**1**			
Agelenopsis spatula				**1**			
Araneidae	**2**			**29**	**9**	**1**	**16**
Acanthepeira stellata				**3**	**1**	**1**	**2**
Argiope trifasciata				**3**	**1**		**2**
Metepeira labyrinthea	**1**			**16**	**6**		**9**
Neoscona crucifera	**1**						
Neoscona oaxacensis				**7**	**1**		**3**
Dictynidae			**48**	**18**	**49**		**1**
Dictyna volucripes			**48**	**18**	**49**		**1**
Gnaphosidae	**1**		**1**				
Drassodes gosiutus	**1**						
Drassyllus mumai			**1**				
Hahniidae	**1**						
Cicurina cf. varians	**1**						
Lycosidae	**1**		**5**				
Geolycosa missouriensis			**2**				
Hesperocosa unica			**3**				
Hogna baltimoriana[3]	**1**						
Mimetidae							**1**
Mimetus hesperus							**1**
Oxyopidae					**1**		
Oxyopes salticus					**1**		
Pholcidae	**1**		**4**				
*Physocyclus enaulus**	**1**						
Psilochorus imitatus			**4**				
Salticidae	**1**			**1**			**7**
Phidippus apacheanus	**1**						**3**
Phidippus octopunctatus							**1**

Phidippus texanus				**1**			**2**
Tutelina elegans							**1**
Theraphosidae	**1**						**1**
*Aphonopelma hentzi***	**1**						**1**
Theridiidae	**1**			**1**			
*Euryopis texana**	**1**						
Latrodectus hesperus				**1**			
Thomisidae				**1**			
Mecaphesa celer				**1**			

Appendix V. Family-level species richness of arachnids based on pitfall trap samples.

Taxon	**IX 2017**	**V/VI 2018**	**VI 2018**	**VI 2019**	**VII 2019**	**VIII/IX 2019**	**IX 2019**
Acari	3	3	1	2	6	2	3
Caeculidae				1	1		1
Erythracaridae	1	1			1		
Erythraeidae	1	1			3	2	2
Mesostigmata	1			1	1		
Trombidiidae		1	1				
Araneae	23	22	21	33	24	15	10
Agelenidae	1				3	1	2
Araneidae			1	2		1	1
Cheiracanthiidae		1					
Corinnidae	1	1				1	
Dictynidae	1	1		1			
Gnaphosidae	5	11	12	9	4	3	2
Linyphiidae	1			1			
Liocranidae	1	1	1				1
Lycosidae	4	2	2	8	4	2	1
Oxyopidae			1	3	1	1	
Philodromidae		1		2	1	1	
Pholcidae	1	1	1	1	1	1	1
Phrurolithidae	3		2	2	1	1	2
Salticidae	2	2		1	2	1	
Theraphosidae						1	
Theridiidae	1	1	1	1	3	1	
Thomisidae	2			2	4		
Pseudoscorpiones	1		1	2	1		1
Cheliferidae	1		1	1	1		1
Chernetidae				1			
Scorpiones	4	2	1	4	4	3	2
Buthidae	1	1	1	1	1	1	1
Vaejovidae	3	1		3	3	2	1
Solifugae		1			1		
Eremobatidae		1			1		

Appendix VI. GPS locations of pitfall array center traps.

September 2017 and May – June 2018

Array	Latitude	Longitude	Elevation
A1	33°24.106' N	-102°42.851' W	1124m / 3687ft
A2	33°24.299' N	-102°40.935' W	1119m / 3671ft
A3	33°23.988' N	-102°42.828' W	1123m / 3684ft
A4	33°24.089' N	-102°42.912' W	1125m / 3690ft
B1	33°24.175' N	-102°42.031' W	1114m / 3654ft
B2	33°24.258' N	-102°42.143' W	1114m / 3654ft
B3	33°24.428' N	-102°40.143' W	1109m / 3638ft
B4	33°24.348' N	-102°40.480' W	1110m / 3641ft

June and July 2019

Array	Latitude	Longitude	Elevation
A1	33°24.358' N	-102°42.426' W	1117m / 3664ft
A2	33°24.299' N	-102°40.935' W	1119m / 3671ft
A3	33°23.988' N	-102°42.828' W	1123m / 3684ft
A4	33°24.108' N	-102°42.852' W	1124m / 3687ft
B1	33°24.175' N	-102°42.031' W	1114m / 3654ft
B2	33°24.258' N	-102°42.143' W	1114m / 3654ft
B3	33°24.428' N	-102°40.143' W	1109m / 3638ft
B4	33°24.348' N	-102°40.480' W	1110m / 3641ft

August – September 2019

Array	Latitude	Longitude	Elevation
A1	33°24.358' N	-102°42.426' W	1117m / 3664ft
A2	33°24.299' N	-102°40.935' W	1119m / 3671ft
A3	33°23.988' N	-102°42.828' W	1123m / 3684ft
A4	33°24.095' N	102°42.915' W	1125m / 3690ft
B1	33°24.175' N	-102°42.031' W	1114m / 3654ft
B2	33°24.258' N	-102°42.143' W	1114m / 3654ft
B3	33°24.428' N	-102°40.143' W	1109m / 3638ft
B4	33°24.348' N	-102°40.480' W	1110m / 3641ft