Poster Abstracts

Testing Color Change in Female Crab Spiders (*Misumenoides formosipes* and other Misuminae) and its Impact on Optimal Foraging

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Differential allocation of reproductive effort in male and female crab spiders is reflected in their extreme sexual size dimorphism as well as contrasts in their life histories. In *Misumenoides formosipes* the small, mobile adult males expend substantial energy finding and attempting to mate with females, whereas the large females are mostly sedentary and dedicated to foraging. We report on movement patterns, substrate choice, and life history traits that differ between the sexes. Another notable sex difference is the reversible color change capability found only in females. Changing between white and yellow allows a female to match the color of the inflorescence on which she is hunting and, hypothetically, appear cryptic to prey and/or predators. The rarity of this trait across animal species together with the apparent benefits suggests that significant costs are associated with color change. Neither costs nor benefits of color change in *M. formosipes* have been studied. Prey capture success of female *M. formosipes* will be tested in relation to color matching and mismatching through a series of trials in which females will be moved onto inflorescences of opposing and like colors. Digital photos will be used to quantify color values in the Lab color space component of Adobe Photoshop. We hypothesize that the tendency to tolerate the displacements will differ between white and yellow females due to different costs incurred, and that matched females will have greater prey capture success than unmatched females. Comparative observations with related species (*Misumena vatia*, *Mecaphesa* spp.) will be conducted whenever possible.

Spiders as potential biological control agents of stink bugs in cotton and soybeans

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Stink bugs (Hemiptera: Pentatomidae) have emerged as significant pests of cotton and soybeans in the southeastern United States with losses exceeding $70 million annually. Three of the most prominent pests are the southern green, *Nezara viridula*, green, *Chinavia hilaris* and brown stink bug, *Euschistus servus*. However, their predators are poorly understood, especially in respect to early season predation. As field observation of predation is difficult, molecular gut content analysis offers an alternative to traditional approaches. Consequently, species-specific 16S molecular markers were designed and used to discern the gut contents of active hunting spiders for stink bug consumption as well as some alternative prey sources, aphids and flies. Various spiders were collected throughout the summer in cotton and soybean in southeastern Georgia, and predation frequency was examined relative to prey availability. Predation rates were very low for all stink bug species. Our results showed that only *Oxyopes salticus* (Araneae: Oxyopidae) was feeding on stink bugs with various spider groups consuming both aphids and flies. These data suggest active hunting spiders are not playing a large role in the biological

control of stink bugs, but further collecting in the early season is needed to fully understand the interactions between stink bugs and spiders.

Reflections on the tapetum lucidum and eyeshine in lycosoid spiders

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In the lycosoid spiders, the secondary eyes possess a grate-shaped tapetum lucidum that reflects light, causing eyeshine when these spiders are viewed with coaxial illumination. This guanine-based reflective surface is thought to increase visual capabilities in dim light. We explored the eyeshine of the posterior medial eye in eight taxa of pisaurid and lycosid spiders. We found that there were significant family- and species-level differences in both the reflected spectra and the intensity of reflection. While the peaks of the reflected spectra were in the green range for all spiders, the mean peak was further toward the blue end of the spectrum for the lycosids than for the pisaurids. Variation among species (about 54% of the total variation) was dominated by *G. pulchra* (Lycosidae) and *D. vittatus* (Pisauridae), both of whose spectra peaked near yellow, vs. *V. avara* (Lycosidae) whose spectra peaked to the blue side of green. The lycosid spiders showed overall brighter eyeshine. However, when corrected for their larger eyes, the lycosid spiders' reflections were dimmer for their eye size than were those of the pisaurid spiders. These results demonstrate that the reflective qualities of the tapeta, and perhaps the absorptive qualities of other tissues and media that the light must traverse, vary widely among lycosoid spiders. This variation may signal both functional differences in visual capabilities and interesting developmental or selective histories within this clade.

Microhabitat and spatial complexity predict whip spider group size

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Although most amblypygid species are solitary and aggressive toward conspecifics, several *Heterophrynus batesii* can commonly be seen together on a single tree trunk. This study aimed to characterize the microhabitat preferences of *H. batesii* groups as a first step to understand these aggregations. I surveyed groups of amblypygids on the trail system of Tiputini Biodiversity Station bordering Yasuní National Park in Eastern Amazonian Ecuador in July and August 2010. Amblypygids were surveyed along with habitat and environmental data. Several measurements of trees associated with amblypygids were recorded, including those required to estimate surface area and calculate a Buttress Complexity Index. I compared these data to those of randomly selected trees to identify which microhabitat variables and spatial characteristics are selected by amblypygids. *Heterophrynus batesii* were found aggregated in groups of 2–8 animals. Groups used large, buttressing, complex trees with more leaf litter relative to those available.

Another event of independent evolution in color polymorphism on Theridiidae spiders in the Pacific Ocean?

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Convergent evolution is a recurrent phenomenon in the tree of life. It is usually explained by the adaptation of organisms to similar environmental conditions. Over the last few decades a series of examples of convergent evolution in color polymorphism have been described for the spider family Theridiidae. The best studied of these is the Hawaiian happy face spider, *Theridion grallator*, which presents more than 20 variants. This color polymorphism was well known to parallel the one on *Enoplognatha ovate* and *E. latimana.* More recently, a similar color polymorphism was described for *T. californicum*. There are also similar records for species present in Japan, Pohnpei and Fiji. In August 2011 after an expedition to Robinson Crusoe Island (Juan Fernández Archipelago, Chile), we found another species with a similar color polymorphism. Some morphs were identical to the Hawaiian species; meanwhile others were unique to Robinson Crusoe Island. The aim of this work is to locate the phylogenetic position of this species in order to verify whether its color polymorphism corresponds to an independent evolutionary event. Preliminary morphological analysis suggests that the collected species corresponds to *Selkirkiella alboguttata*. To add it and *T. californicum* to a previous phylogeny of the group, we amplified two mitochondrial (COI and 16S) and three nuclear genes (18S, 28S and H3). A Bayesian phylogeny of the concatenated genes showed that *S. alboguttata* is a sister species of *Enoplongnatha caricis, s*uggesting that this color polymorphism is likely an event of convergent evolution.

Cooperation and conflict during mating in an Opilionid

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Mating interactions can exhibit qualities of mate choice or sexual conflict. For choice-based mating, females assess male displays during which males attempt to solicit cooperation from the female to achieve successful copulation. For conflict-based mating, females may resist male attempts to force mating, consequently screening for only those

males capable of overcoming her resistance. We often consider choice and conflict as exclusive alternatives, but selection may favor the simultaneous occurrence of both. We test this in a common North American species of Opilionid, *Leiobunum vittatum* by characterizing several stages of mating and classifying the behavior as appearing more cooperative or conflict-based. We predicted that the more conflict-based behaviors would occur at earlier stages, and more cooperative/choice-based behaviors would occur at stages closer to copulation. Male-female interactions involved what appears to be an initial struggle during which males attempt to lock their pedipalps onto the base of the female's second pair of legs, and to wrap their third pair of legs onto distal portion of her second pair of legs. Males and females then exhibit what appear to be assessment behaviors involving movements of the chelicerae and pedipalps. Finally, the females appear to solicit the extension of the penis and to guide the penis towards her genitalia so that successful intromission occurs. This species show a shift from what appears to be conflict to cooperation as mating progresses: initial contact involves more conflict-based behaviors, whereas closer to intromission, more cooperative behaviors occur.

Population Genetics of *Phidippus audax* from Michigan to Texas: Are there distinct Northern & Southern forms?

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Phidippus audax is a common jumping spider found throughout North America from Canada to Mexico. Because it is so widely distributed, with a range encompassing distinct climates, and because regional color patterns have been reported, there may be genetically distinct northern and southern forms of *P. audax*. I collected samples from Michigan, Missouri, Oklahoma, and Texas, and sequenced approximately 1000 bp from the mitochondrial Cytochrome Oxidase I gene to determine whether these were consistent genetic differences between these populations. Preliminary results indicate that samples from Texas are genetically distinct from spiders collected at the other sites.

Influence of Acclimation on Prey Capture in Naïve Tarantula Spiderlings

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Several factors influence foraging success of newly emerged spiderlings, including experience, size, and environment. Spiderlings that forage successfully may experience increased growth rates, shorter intermolt periods, and larger size at sexual maturity. In this study, we compared prey capture success among three species of naïve tarantula

spiderlings (*Stromatopelma calceatum*, *Brachypelma angustum*, and *Pterinochilus murinus*). We examined the role of prey size and acclimation on prey capture times and growth rates. Spiderlings were separated into acclimated and non-acclimated groups. Acclimated groups were introduced to feeding arenas five days prior to feeding while non-acclimated groups were introduced just prior to feeding. Each group was divided into two sub-groups based on prey size (20%-25% or 40%-45% of total mass). We measured prey capture times over several feeding trials and used spiderling mass as a measure of growth. Surprisingly, acclimation did not significantly impact prey capture times. While prey capture times were typically longest for the first feeding trial, they did not necessarily continue to decrease with successive trials. Prey capture times also varied among species; some species showed large decreases in prey capture times after just one feeding, while capture times for other species did not decrease until later trials. Prey size did not significantly influence percent mass gain, and weight-gain varied substantially among different species. Our results suggest that experience influences prey capture times, but is very species dependent, and energetic demands associated with growth rates also vary substantially with species.

Adaptively flexible courtship and mating behaviors in a cellar spider

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Classic sex role stereotypes include sexually passive and choosy females that invest heavily in offspring, and promiscuous and indiscriminant males who contribute only inexpensive sperm to their progeny. These stereotypes underpin many explanations for a wide variety of sex differences in morphology and behavior. However, organisms often live in variable environments; thus, sex roles should be a product of adaptively flexible individuals responding to an array of ecological variables. We were interested in partially characterizing the sex roles of the cellar spider, Pholcus phalangioides, to reveal the degree to which these behaviors are fixed or respond to environmental variability. Specifically, we examined the effects of adult sex ratio, food quality and quantity on mating interactions between males and females. We discovered that adult sex ratio and food quantity influenced both male and female mating behaviors, which showed high degrees of plasticity. We also discovered sex differences in the amount of time necessary for individuals to re-mate, and this difference was modulated by diet. The findings of our research link individual behavior to the characterization of sex roles and reveals levels of adaptive complexity that deserve more attention.

Kinship and familiarity affect recognition and foraging in *Pardosa milvina*

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An evolutionary explanation for altruism is critical to understanding social behavior and kin selection is the mechanism most commonly invoked for both phenomena. If animals live at high densities and are food limited they may interact with relatives competitively. Recent theory and empirical studies suggest that this situation may result in a higher tolerance for exploitation in producer-scrounger foraging relationships. We tested this

hypothesis using the solitary wolf spider, *Pardosa milvina* (Araneae, Lycosidae) that exists in high densities in disturbed habitats of North America. Because *P. milvina* is chemically aware, we examined their activity on chemical cues and verified that they could discriminate between familiar animals and relatives. We then examined the foraging behavior of well-fed animals in the presence of chemical cues from hungry individuals. The cues presented included all combinations of siblings, non-kin, familiar and. unfamiliar spiders. Animals on cues from siblings took longer to capture prey and killed fewer prey. Familiarity with the animal producing the cues decreased the time to prey capture and increased the number of prey killed. Additionally, spiders consumed more of the prey they killed when on cues from a familiar conspecific. Thus, cannibalistic predator differentiated between relatives and familiar conspecifics and, while they actually left prey behind for hungry relatives, they were more voracious in the presence of familiar animals. Thus, well-fed foragers seemed to be more tolerant of exploitation by kin which may lead to foraging groups of relatives and help explain the early evolution of sociality in spiders.

Ladies' choice: Female wolf spiders prefer multimodal over unimodal male courtship

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Courting male wolf spiders use either multimodal (visual and seismic) signals or only seismic vibration, depending on the species. Previous studies of *Schizocosa ocreata* wolf spiders with live males as stimuli suggest individual signal modes are equally capable of eliciting female receptivity, but that multimodal cues enhance female response. In single presentation video playback studies, detection (latency to orient) and recognition (total receptivity displays) showed no significant differences with or without seismic cues. However, females may encounter more than one male at the same time. In paired choice video playback tests, orientation, approach and receptivity behaviors did not differ significantly when visual and seismic cues were presented alone. However, paired choice presentation of multimodal cues vs. unimodal visual or seismic cues showed significant differences in orientation, approach and receptivity behaviors. Females were more likely to be attracted to and respond with receptivity to multimodal cues than either mode alone. Results of multimodal video playback studies confirm earlier results with live males, and foster further manipulation of multimodal cues.

Exoskeletal Analysis of the Errant Scorpion *Centruroides vittatus*

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Behavior is limited by morphology. The errant scorpion *Centruroides vittatus* has shown behavior different than described in other scorpions. *Centruroides vittatus* climbs vegetation and rarely burrows while other scorpions studied rarely climb vegetation. The external morphology of the scorpion may be a factor that enables such behavior as climbing. Six scorpions were analyzed using a SEM at various magnifications ranging from 20000x to 100x to view the structure, texture, and shape of the scorpion

exoskeleton. The difference in texture of the cuticle and also differences in shape and arrangement of seta were observed, as well as the folding of the arthrodial membrane in parts of the exoskeleton that move. The micrographs reveal that the setae in the legs of the scorpion are serrated while those on the palp and carapace are smooth and those on the chelicera are long and thin. The claws showed wear and also a distinct texture and had no seta. The micrographs also indicate that the tarsal spurs may move and this could be a factor in climbing.

Effects of Temperature and Glyphosate Exposure on Foraging in the Wolf Spider, *Pardosa milvina* (Araneae, Lycosidae)

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Anthropogenic chemicals can have both unique and interactive effects on non-target organisms when experienced in combination with other stressors. While previous work has shown that a glyphosate-based herbicide alone affects activity and chemically-mediated behavior of the wolf spider, *Pardosa milvina*, limited research has been done regarding its effects when coupled with simultaneous abiotic stressors. Since glyphosate can be applied at multiple times during a growing season, it is possible that it may interact with changing temperatures and have graded effects on animals. Here we tested the hypothesis that glyphosate and temperature will have separate and interactive effects that impact foraging of *P. milvina*. For twenty-four hours, female *P. milvina* and pinhead crickets (*Acheta domesticus*) were housed in an arena with a treated substrate containing either glyphosate or water, at temperatures of 15, 25, and 35°C. The number of crickets alive, killed, and consumed was counted after each trial. Body measurements of each spider were also taken before and after trials as an additional measure of prey consumption. Results indicate that warming temperatures significantly increased both prey eaten and the change in abdomen width of *Pardosa*. In addition, the presence of glyphosate significantly increased superfluous prey killing. Thus, glyphosate and temperature independently affected foraging but we did not see evidence of additional interactive effects.

Biomimetic Analysis on the Spider Silk Apparatus for Designing the Electrospinning Nozzle

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The biomimetic approach using various visualizing techniques on the cuticular spinning nozzles of the major ampullate silk glands in the golden-web spider *Nephila calvata* has been attempted to improve the design of nanofiber-spinning nozzle for electrospinning apparatus. The major ampullate spigot has the most effective nozzle system to produce nanofibers for dragline silk with high strength and elasticity. The excretory duct which transports the liquid silk feedstock from ampulla to spigot is divided into 3 limbs by loops back on itself to form an S-shape morphology. Final diameter of the nanofibers at nozzle was dramatically reduced by gradual narrowing of duct cuticle less than 10 times

comparing to its original size of funnel region. Moreover, the funnel has a characteristic cuticular organization with porous microstructure which seems to be related to water removal from feedstock of silk precursors. High magnification electron micrographs also reveal the presence of the spiral grooves on the surface of the cuticular intima near the valve which presumed to reduce friction during rapid flow of liquid silk.

Fine Structure of the Spinning Nozzle of the Dragline Silk in the Spider *Nephila clavata*

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The dragline silk with high elasticity and strength is produced finally from the nozzle of the spigot on the anterior spinneret as the feedstock passes through the funnel of the duct. The duct of the major ampullate gland in *Nephila clavata* has the function to polymerize the dragline silk with the mechanisms of water absorption, ion exchange and physical pressure. By the fine structural image analysis using high quality field emission electron microscope, the presence of cuticular cavities which distributed along the third limb of the duct was first noticed. Histologic examination reveals that the epithelial flask-shaped cells are distributed to the exocuticle layer through these cavities. In addition, we could find helical grooves which reduce frictions and facilitate the spiral movement of the feedstocks during the passage of cuticular surface of the duct. It assumed that these cuticular cavities and helical grooves also contribute to the major production procedure from liquid feedstocks to insoluble dragline silk.

Estimating physical performance: A study of body condition in the Wolf Spider, *Schizocosa ocreata*

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In natural conditions, spiders are usually food limited and must compensate for this in order to survive and reproduce. Because these organisms have a hydrostatic skeleton, intake of both water and food may drastically alter their ability to function and survive. When spiders are met with such environmental stressors, they must adjust their physical responses to stimuli or avoid further expenditure to conserve energy. In this study, we tested the effect of water and food limitations on the performance of the wolf spider *Schizocosa ocreata*. Two separate feeding regimens (food limited and food abundant) were maintained for approximately 5 weeks. After which, body measurements were taken and spiders were run until exhaustion. A second trial round was implement after removing water from half of each feeding treatment for an additional 5 days. All spiders were then measured again as in the previous. Results indicated that both food and water availability impact spider survival, body condition and physical response to stimuli (performance). However, those given limited food and water were similar in performance attributes: peak speed and expenditure duration. This study consequently reveals that spiders can alter physiological processes under suboptimal conditions and may additionally provide insight into how these organisms adjust to such stressors in particular environments. Additionally, the use of Body Condition Indices as predictors of performance will be discussed.

Communication and Courtship Behavior in the Ischnocolid tarantula *Heterothele villosella*

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One of the earliest divergences on the evolutionary tree of (Arachnid) spiders represents the mygalomorphs, this group includes the tarantulas and funnel web spiders. Consequently, mygalomorph communication and courtship has been generally characterized as quite simple, where a male invests minimally in courtship when in the presence of a female and mates with her while she remains relatively inactive or unselective. This courtship sequence leaves little variation for sexual selection to act on, virtually eliminating mate choice pressure. We aim to examine the actuality of these claims by analyzing mating interactions in the Ishnocolid tarantula *Heterothele villosella*. This species lives in relatively high population densities and displays a quasi-social or communal lifestyle. From these observations, we have been able to establish that, contrary to anecdotal accounts, male tarantulas display a complex range of behaviors that are influenced by female behavior. These interactions are highly dynamic since females prove not to be passive players but control whether or not a male continues courtship, successfully copulates or is rejected. Without female cooperation, males will not be able to attain a copulatory position or may be rejected and cannibalized. We argue that this female interaction is evidence of sexual selection pressure acting on males and has the ability to shape how courtship proceeds (courtship duration, male vigor, etc). This study shows that while phylogenetically "primitive", not all tarantulas are behaviorally simple.

Male courtship behavior by temperature for the wolf spider *Schizocosa ocreata*

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The courtship behavior of wandering spiders, such as jumping spiders (Salticidae) and wolf spiders (Lycosidae), commonly includes active visual and seismic signals. The vigor (rate and duration of bouts) with which these signals are produced may directly influence mating success in many species. As spiders are ectotherms, the temperature of the environment can have a significant effect on metabolism and behavioral performance (vigor). In order to better understand temperature effects on vigor, courtship behaviors were observed for male wolf spiders (*Schizocosa ocreata*) exposed to conspecific female silk and chemical cues. Rate and duration of specific courtship behaviors were analyzed within a range of 0 to 40 ˚C. Analysis indicates that spiders behaved as expected based on previous data collected for another wolf spider, *Schizocosa bilineata* (Roberts *et al*., in prep), that is, rate of behavioral bouts increased with increasing temperature and total duration of courtship behaviors increased. If increased courtship vigor increases the probability of reproduction, these results suggest that males of this species should behave in a manner that maximizes their body temperature relative to

competitors. Future work on these species will evaluate the significance of these body temperature controlled behaviors.

Foraging strategy of *Argiope trifasciata* from a biomechanical perspective

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Secondary consumers face selective pressure from trade-offs involved with adaptive foraging. The daily web-constructing behaviors of orb-weaving spiders (Araneoidea) make them interesting models to study when considering these trade-offs. In response to hunger levels and prey availability the diurnal orb-weaver, *Argiope trifasciata* has the ability to alter web area. We predicted a change in behavior as the success rate of prey encounter diminishes. Because silk composition is partially dependent on diet, we also predicted a measurable change in silk performance. To test our predictions, we starved individuals collected from Bath Nature Preserve for 8-day periods in laboratory settings. Two treatments were set up, one that was fed a day prior to the start of the 8-day period and another that was left unfed. This was to control for variation from differences in foraging success prior to the experiment. Response to prey capture failure was quantified by taking measurements of mechanical performance of capture and ampullate silk, several web parameters and aggregate glue investment. Using repeated measures ANOVAs, we found that capture silk stickiness decreased over time when mechanically tested. This was accompanied by increases in silk strength, total capture area and capture silk volume. Unfortunately, due to small sample sizes, we were only able to find marginally significant p-values. Results of this experiment, however, imply that there are several trade-offs made to counter the material performance of aggregate glue within capture silk, which is likely due to a dietary constraint.

***Terra incognita*: New species and major range expansions of Opiliones in the United States**

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The invertebrate fauna of the eastern United States is one of the most intensively studied in the world and thus the discovery of a radiation of large-bodied terrestrial arthropods would be surprising. Yet, recent work on the taxonomy of harvestmen has revealed nearly 20 new species, including a heretofore unknown radiation in the genus *Hadrobunus*. In the last three years, *Hadrobunus* in the eastern U.S. has expanded from two poorly delimited species to at least 15 distinct species, with only one resulting from a transfer of a previously known *Leiobunum* species. New undescribed species of *Leiobunum* are known from Arizona and Nebraska, and two more – *L. euserratipalpe* Ingianni et al. and *L. hoffmani* Ingianni et al. – have recently been described. A new species of the peculiar triaenonychid Fumontana (Laniatores) has been discovered in the vicinity of Gainesville, Florida. Major range expansions have also been found, including the discovery of a specimen of the rare *Acropsopilio boopis* from the mountains

of western North Carolina. This is a southern range extension of over 450 miles and is the first specimen recovered outside the post-glacial north. These findings are derived from limited, untargeted and spotty sampling and suggest that much remains to be learned about the harvestman fauna of the United States, especially in the under-studied South.

Lack of trait-mediated effects of predators on detritivore activity

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Generalist arthropod predators have been shown to impact the grazing component of terrestrial food webs, and a growing collection of studies make progress towards characterizing the role of spiders and beetles in detrital food webs. Historically, researchers have manipulated the predator community (e.g., removed spiders) and measured changes in detritivore abundance or ecosystem function (e.g., nutrient cycling), but detailed behavioral observations are lacking. Here, we examined the response of *Sinella curviseta* (Entomobryomorpha: Entomobryidae) to chemotactile cues (silk, feces, excreta) from four potential predators: wolf spiders (Araneae: Lycosidae) *Pardosa milvina, Hogna helluo, Rabidosa rabida*, and a beetle (Coleoptera: Carabidae), *Scarites quadriceps*. We anticipated reduced activity in response to cues from *Pardosa*, though none of the larger predators were expected to elicit a response. The activity of individual *Sinella* was quantified using motion capture software in a split arena containing cues from a single predator paired with unmanipulated substrate. *Sinella* activity did not differ between the untreated arena side and the portion containing predator cues. The lack of response to cues from *Hogna, Rabidosa*, and *Scarites* may be adaptive, as these predators are unlikely to consume *Sinella*. Cues from *Pardosa* did not cause an activity change, which may indicate that *Sinella* does not avoid areas where predators are present. Instead, *Sinella* may rely on predator avoidance tactics (i.e., jumping) upon contact with a predator. Although it appears that trait-mediated interactions between *Sinella* and *Pardosa* are unimportant, the effects of cues from *Pardosa* may manifest in aspects of *Sinella* behavior other than movement.

***Trachyzelotes lyonneti* (Auduoin) (Araneae: Gnaphosidae) in south Texas**

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Twenty-two specimens of the introduced spider *Trachyzelotes lyonneti* (Auduoin) were collected from March to June over a 4 year period (2008-2012). All of the specimens (7♂ & 15 ♀) were collected in Webb County, Texas and all but 3 of the specimens were collected in pit-fall traps in propylene glycol. Generic and specific characters of males and females were prepared and examined with a scanning electron microscope at magnifications ranging from 35- 5,000 X. The dorsal view of the cleared epigynum was photographed under a dissecting microscope.

Evolution of spider silk genes in cob-web weaving spiders

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Orb-web weaving spiders and their relatives (Orbiculariae) make task-specific silks that originate from specialized abdominal glands. Silk fibers are composed of one or more unique structural proteins called spidroins (spider fibrous proteins), which are members of a gene family. Different spidroins are expressed in different gland types. For example, *MaSp1* and *MaSp2* form dragline silk and originate in the major ampullate glands. We are describing each member of the spidroin gene family from three closely related species of cob-web weavers, the western black widow, *Latrodectus hesperus*, brown widow, *L. geometricus*, and the false black widow, *Steatoda grossa* (Theridiidae). Our goals are to determine relationships among spidroin members and evaluate rates and patterns of evolution in this gene family. These species are an ideal model for evolution of silks because they possess dragline silks that vary from the weakest known (false black widow) to the strongest known (black widow) despite their close relationship. We constructed libraries of genes expressed in silk glands of the brown and false black widows and identified genes encoding most types of spidroins, include ones incorporated into dragline silk (*MaSp1* and *MaSp2*), minor ampullate silk (*MiSp*), prey-wrapping silk (*AcSp*), egg case silk (*TuSp*), and attachment cement (*PySp*). *AcSp* and *TuSp* group together in spidroin gene trees suggesting that one is an ancient copy of the other. These spidroins are also the most conserved among cob-web weaving species. We will discuss potential sources of selection on spidroins that form functionally distinct fibers.

Immature *Hogna helluo* (Araneae, Lycosidae) display anti-predator behavior in response to chemical cues from conspecific adults

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A spider's capability to utilize available information from its habitat in reducing predation risk is advantageous to its survival at all points in its career. Two experiments were designed to investigate whether immature *Hogna helluo* (Araneae: Lycosidae) shows a behavioral response to chemical cues (silk draglines, feces and other excreta) left behind by adult *Hogna* in the environment. The first experiment examined the activity of immature *Hogna* when encountering chemical cues from an adult. Juvenile *Hogna* were released in a small neutral space between one side with adult cues and the other side with nothing and then monitored for 15 min. we found statistically significant decreases is the juvenile's total travel distance, time spent moving, and time spent ambulatory while on chemical cues from their adult counterparts. In the second experiment juvenile *Hogna* were given the choice of moving to different regions of a rectangular arena containing adult cues or nothing. The spider was released in the neutral zone and its location in the box was noted at the end of twenty-four hours. Juvenile preferred to reside in the cue free territory when given the choice. Thus, immature *Hogna* exhibited the ability to recognize and utilize information in chemical cues left by conspecific adults. There is a premise for further research into the ontogeny shift in the ecology of juvenile *Hogna*, and

especially its intriguing mid-career relationship to its intraguild competitor, *Pardosa milvina*.

The effects of the glyphosate-based herbicide on the foraging patterns of predatory wolf spiders

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Many studies have shown that non-target taxa in glyphosate-sprayed environments are not directly affected by this herbicide. Indirect effects, however, have been shown to exist. For example, in the wolf spider *Pardosa milvina* (Araneae, Lycosidae) glyphosate alters both mate-finding and locomotor behavior. In this study, we examined the effects of glyphosate on the foraging behavior of two wolf spider species common to agricultural fields in Ohio, *Hogna helluo* (Araneae: Lycosidae) and *Pardosa milvina*. Experiments were conducted by allowing the spider predator to lay down chemotactile cues in an arena prior to trials. Either a commercial formulation of a glyphosate-based herbicide or distilled water was then applied to patches of the arena before a prey species, either *P. milvina* or *Acheta domesticus* (Orthoptera: Gryllidae), was presented. Trials were then repeated with *P. milvina* as predator and A. domesticus as prey. All predator-prey interactions were recorded and scored. *Hogna helluo* oriented toward and captured both prey species more quickly when glyphosate was present. Herbicide had no effect on the orientation or capture time for *P. milvina*, but it increased the number of attacks required to capture *A. domesticus*. Our results show that glyphosate is having indirect effects on the foraging behavior of these wolf spiders, and that the effects are species dependent.

Effects of intraguild cues of ground-dwelling and foliage-dwelling spiders on lady beetle oviposition and aphid suppression

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The presence of multiple predators in a system causes competition for resources, which can impact the life-history traits of competitors. Little is known about the interactions of spider cues and lady beetles, which are both known biological control agents of pests. In this project, the influence of chemical cues of the ground-dwelling spiders (*Pardosa milvina*) and foliage-dwelling spiders (*Frontinella communis*) on oviposition of lady beetles (*Hippodamia convergens*) and aphid abundance was examined. Trials were performed in a greenhouse setting designed to simulate a winter wheat microhabitat with mild infestation of aphids (*Rhopalosiphum padi*). Spiders were placed in the microcosms two days prior to lady beetle introduction to lay silk and cues. Some

treatments had the spiders removed to test the effect of only indirect cues on beetles and in other treatments, predators were left in the microcosm along with the lady beetles to assess the effect of predator presence along with the cues. In the presence of predator cues, lady beetles exhibited higher oviposition frequency. There is an indication that direct and indirect cues are important in influencing oviposition behavior. When spiders or spider cues are present, lady beetles oviposit at a greater rate. When only cues and predators are present, lady beetles forage less. These data suggest that predator cues elevate lady beetle oviposition and lower foraging, which provides evidence that beetles detect and respond to multiple predators in the system.

Tracking predation shifts in forest spiders over the cold season

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Forest-dwelling spiders are thought to feed opportunistically during times of low prey availability. This is complicated, however, by the fact that prey populations show considerable spatio-temporal variation, and many of these prey items are of poor nutritional quality. The primary objective of this research was to identify seasonal spider predation patterns in response to fluctuations in prey availability, focusing on shifts in foraging dynamics during the autumn, winter, and early spring where there is the greatest paucity of information. Within an eastern deciduous forest ecosystem, prey availability was monitored and, in parallel, spiders were collected for molecular gut-content analysis in order to delineate predation strength throughout the season. Prey availability and predation were correlated to ultimately identify reliance and food preference patterns of these predators. Tomoceridae (Collembola), an important prey item for eastern forest spiders, remained active but decreased throughout the winter. In contrast, dipterans fluctuated in activity and increased significantly during February thus providing a critical pulse resource for these predators as alternative food items decreased in abundance. The dominant spiders of the forest, from the genus *Schizocosa*, were collected throughout the cold season for molecular gut-content analysis. These predation results and their correlation with available prey will be discussed. Tracking seasonal feeding dynamics between spiders and their prey provides valuable insights into their functional role in forest floor food webs.

Female receptivity towards sequentially courting males of varying quality in *Schizocosa ocreata*

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In the wolf spider, *Schizocosa ocreata* (Hentz), males possess dark pigmentation and tufts on their forelegs that are a conspicuous secondary sexual characteristic. Previous studies have shown that, when given a choice, females demonstrated increased receptivity towards males with large tufts over males with small tufts. In trials with two

males, females frequently mated with the males that courted first. However, it has yet to be investigated whether female receptivity changes when males of varying quality are encountered sequentially. This is a particularly interesting question in the context of eavesdropping behaviors, as male "interlopers" could use courtship signals to locate and intercept potential mates. We used video playback to introduce females to a courting male, followed by a second courting male interloper thirty seconds later. The second (interloper) male had tufts of greater, lesser, or equal size relative to the first male. When the first male had average-sized tufts, there was no effect on female receptivity towards the second male. However, when the first male had reduced tufts and the second male had enlarged tufts, females' latency to approach the interloper male video was significantly shorter. Additionally, the females were more likely to be receptive and showed more receptivity displays towards the second male. These results suggest that eavesdropping behavior could be beneficial for a male, depending on the relative quality of the first and the second male encountered.

The effects of autotomy and nutrition on the weight-specific resting metabolic rates and development of orange baboon tarantula (*Pterinochilus murinus*) spiderlings

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Autotomy, or voluntary limb-loss, is a technique employed by spiders to escape predation or discard damaged legs. With successive molts, the limb is regrown and the fitness costs of autotomy often seem to be minimal. We performed a preliminary investigation of the effects of autotomy on the weight-specific resting metabolic rates (WSRMRs) of orange baboon tarantula (*Pterinochilus murinus*) spiderlings. We hypothesized that regenerative growth, which eventually produces limbs indistinguishable in size from those produced by developmental growth, results in greater metabolic demands. We also investigated the interactive effects of nutrition and autotomy on regenerative growth and metabolic rates, and hypothesized that nutritional limitations reduce WSRMRs and the effects of autotomy. Second instar spiderlings were divided into four autotomy-nutrition treatments. Autotomy was induced by holding the second and third legs of one side with forceps until they were dropped. Spiderlings were fed with feeder crickets bi-weekly following either a low nutrition (2.5-7.5% body weight) or high nutrition (20-25% body weight) diet. Metabolic rates were measured bi-weekly using flow-through respirometry. Leg removal had a stronger influence on WSRMR than nutrition initially, but nutrition seemed to play the greater role after about six weeks. Differences in WSRMRs lacked statistical significance; however, though inconclusive, the data suggest that further research is needed. Most interestingly, 100% mortality without molting occurred in the un-autotomatized low nutrition treatment, while in the autotomatized low nutrition treatment only 40% died without molting and 40% successfully molted. These differences may be explained by cellular repair pathways.

Blind Dating: The role of different eye rows in female mate recognition by the wolf spider *Schizocosa ocreata* (Hentz)

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Female *Schizocosa ocreata* wolf spiders utilize visual cues from males (tufts on forelegs and visual signals) in mating decisions. As wolf spiders have eight eyes in two sets of different sizes and orientations, we tested the hypothesis that the anterior (small) and posterior (large) eyes play different roles in detection and decision-making processes involved in mate choice. We occluded different eyes of individual females using an opaque, non-toxic paint, and presented them with video playback of a courting male. When the posterior eyes were occluded, there was a significantly longer latency (seconds) to orient, as well as to respond to males with receptivity when compared to unmanipulated controls. This suggests the posterior eyes are involved in mate detection and recognition. There was no statistically significant difference in mean latency to orient between unmanipulated controls and females with anterior eyes occluded, and no differences in female receptivity displays were seen among all treatments. The data suggest that the two sets of eyes may have different roles in detection and identification of courting males (with posterior eyes playing a more important role), although both eye sets may be equivalent in mate assessment by females once mate recognition has occurred.