

# The American Arachnological Society

24th Annual Meeting

July 2000

Lexington Kentucky

## Presentation Abstracts

Abstracts are listed in alphabetical order by first author. The \* indicates presenter if there is more than one author.

### **Towards a phylogeny of cobweb spiders and the re-limitation of the genus *Anelosimus* (Araneae, Theridiidae)**

Ingi Agnarsson - The George Washington University

Theridiidae is one of the largest spider families comprising over 2000 described species in 72 genera and exhibiting extreme diversity in morphology, ecology and behavior. Theridiids are unique in including many cooperative or quasi-social species, a behavior otherwise very rare in arachnids. Despite their relatively high profile, systematic work on the family has so far been limited to the inclusion of a few of its members in family level phylogenetic analyses. Furthermore, many if not most, theridiid genera are currently para- or polyphyletic, being poorly defined and recognized by symplesiomorphies. I present the first cladistic analysis of the family, representing twenty valid theridiid genera using a total of 220 morphological and behavioral characters. The results not only clarify trans-generic relationships within the family, but also allow objective delimitations of many genera and cast light on the evolution of the many interesting theridiid features. The genus *Anelosimus* provides an excellent example, at present containing numerous superficially similar species, united by symplesiomorphic character states, and including both solitary and social spiders. The results of this study clearly indicate that *Anelosimus* as currently defined is highly polyphyletic in need of relimitation. More surprisingly, perhaps, the results suggest the diphyletic origin of sociality within *Anelosimus*, contrary to a commonly held assumption. At a closer look many independent lines of evidence are congruent with this scenario and I believe this result demonstrates the power of the systematic approach in the study of evolution.

### **Courtship and male-male competition in the wolf spider *Pardosamilvina* (Araneae: Lycosidae)**

Cora Allard\* and Marianne Robertson - Millikin University

We studied mating behavior and male-male competition in the wolf spider *Pardosa milvina*. We observed 20 mating pairs of *P. milvina* and described 12 behaviors and 25 significant behavioral transitions in courtship and copulation. We also conducted 21 trials to examine male male competition for mates. The larger male mated in 13

trials, and the smaller male mated in eight trials. Sexual cannibalism occurred in two trials, both males mated in one trial, and male-male cannibalism occurred in one trial. There was no significant difference in: length of time from introduction to copulation between male-female versus male-male-female trials, length of time from introduction to copulation in large males versus small males in male-male-female trials, length of copulation between male-female versus male-male-female trials, and length of copulation in large males and small males in male-male-female trials. Additionally, there was no significant difference in the number of palpal insertions between large males versus small males in male-male-female trials; however, there were significantly more palpal insertions in male-female trials than in male-male-female trials.

### **The costs of reproduction in the wolf spider *Pardosa dorsuncata*: A test of the survival hypothesis**

Chris Amaya\* and Daniel Formanowicz - University of Texas at Arlington

Previous studies have shown that wolf spiders may incur a cost of reproduction in the form of reduced sprint speed while carrying an egg sac or offspring. Spiders carrying an egg sac or offspring run slower than unburdened individuals. It is believed that this reduced sprint speed may lead to increased rates of predation on individuals carrying an egg sac or offspring. In this study, we examined the potential for increased predation by introducing a female *Pardosadorsuncata* carrying an egg sac and an unburdened female *P. dorsuncata* into an arena with a predator (the wolf spider, *Rabidosa rabida*). We found that females carrying an egg sac were significantly slower than unburdened females and were significantly more susceptible to predation. The results from this study confirm that the reduced sprint speeds exhibited by females carrying egg sacs are translated into decreased survival during predatory encounters.

### **Factors influencing community structure in spiders**

Monica Beals - University of Tennessee, Knoxville

Two different but potentially complementary approaches are often used in the study of community structure: some studies examine species' associations with specific habitat features (e.g., structural, floristic, or microclimatic features) while others focus on patterns of species co-occurrence. I investigated the structure of spider communities in three adjacent habitats (an old field, a tussock-grass field, and a deciduous woodland) in East Tennessee over a two-year period using habitat associations as well as patterns of species co-occurrence to generate estimates of spatial overlap. Patterns of spider species co-occurrence were analyzed using a community matrix to describe species' roles in the community along a continuum from generalist to specialist. The co-occurrence patterns are generally concordant with those found in a 1976 census of spiders in the same habitats, suggesting that community patterns of co-occurrence in this system are persistent through time. Associations with habitat features were analyzed using ordination techniques, and by correlating spider species with measures of habitat structure and microclimate, and with plant species grouped on the basis of physiognomic characteristics. Multiple linear regressions and logistic regressions were also used to elucidate relationships between spiders and habitat. Preliminary results from these analyses have indicated lesser degrees of association with floristic and physiognomic features than with structural features and other spider species. Plant species diversity was a consistent predictor of spider abundance and species and guild diversity.

### **Venom differences among Hawaiian *Tetragnatha* as a function of feeding behavior and sex**

Greta Binford - University of Arizona

On the Hawaiian archipelago, *Tetragnatha*, a cosmopolitan orb-weaving genus, has undergone a radiation in which

a monophyletic lineage, the "spiny leg clade", has abandoned web building and become obligately wandering foragers. In this study I compared venom composition and feeding ecology between orb-weaving and wandering Hawaiian *Tetragnatha*. I also compared the degree of sexual dimorphism between those clades. SDS gel electrophoresis patterns indicate that relative to orb-weavers, wandering species have a reduced concentration of low molecular weight (< 14 kDa) components. Field data indicate that both orb-weaving and wandering *Tetragnatha* capture flying prey (adult lepidopterans, dipterans), but wandering spiders also capture non-flying prey (larvae, spiders). There are no distinct differences between these two clades in prey capture and immobilization sequences, or in the sequential effects of the venom after bites. Prey bitten by wanderers tend to take longer to be permanently immobilized than prey bitten by orb-weavers. There was no indication that web-loss in this group was associated with an increase in venom potency. There is striking sexual dimorphism in venom composition in which male *Tetragnatha* have many high molecular weight proteins in their venoms that are absent, or present in low concentration, in females. This dimorphism is present in orb-weaving as well as wandering species. There were no detected differences in the taxonomic composition of prey consumed, or in prey immobilization behavior that might easily explain this dimorphism in venoms.

### **Deep molecular divergence in the absence of morphological and ecological change in the Californian coastal dune endemic trapdoor spider *Atostichus simus***

Jason Bond - The Field Museum of Natural History

*Aptostichus simus* a trapdoor spider endemic to the coastal dunes of central and southern California and, on morphological grounds, is recognized as a single species. Mitochondrial DNA 16S rRNA sequences demonstrate that populations from San Diego County, Los Angeles County, Santa Rosa Island, and Monterey County are extremely divergent (6- 12%), with estimated separation times ranging from 2 to 6 million years before present. A statistical cluster analysis of morphological features demonstrates that this genetic divergence is not reflected in anatomical features that might signify ecological differentiation among these lineages. The species status of these divergent populations of *A. simus* depends upon the species concept utilized. If a time - limited genealogical perspective is employed *A. simus* would be separated into two genetically distinct species. This study suggests that species concepts based on morphological distinctiveness, in spider groups with limited dispersal capabilities, probably underestimate true evolutionary diversity.

### **Estimating the diversity of spider species in Ohio: a statistical approach**

Richard Bradley - Ohio State University, Marion

Data from 16 thoroughly-sampled localities in Ohio were used to construct a dataset of relative abundance for spiders across the state. An additional four sites with only presence/absence records were included to supplement these data. A total of 421 species are represented on these 20 species lists. The computer package developed by Robert Colwell (EstimateS) was employed to calculate eight species-richness estimators from the dataset. All eight methods are known to underestimate species richness if the data are sparse. Methods which required relative-abundance data (limited to the first 16 lists), and most sensitive to small samples sizes, yielded the lowest overall richness estimates (418-499). The least-biased estimators gave the highest estimates (515- 578). I conclude that between 550-600 species probably occur within Ohio. To obtain a true picture of spider diversity the number and distribution of well-sampled localities will need to be expanded. Special efforts will be needed to obtain sufficient data for certain under sampled families (e.g. Gnaphosidae).

### **Reproductive investment patterns in four species of scorpion (Buthidae, Diplocentridae, Vaejovidae) from Arizona and New Mexico**

Chris Brown - SUNY College at Fredonia

Scorpions are a common, and potentially ecologically important, component of the fauna in many areas of the southwestern United States. Unfortunately, little is known of the life history for many scorpion species in this region. In an ongoing attempt to rectify this, I discuss reproductive investment in four species from southeastern Arizona and southwestern New Mexico: *Centruroides exilicauda*, *Diplocentrus peloncillensis*, *Vaejovis spinigerus*, and *Uroctonus apacheanus*. Female mass was generally uncorrelated with litter size or offspring mass; the only exception was for *C. exilicauda* in 1996, when larger females produced smaller offspring. For all species, females increased total litter mass by producing more, but not larger, offspring. For *V. spinigerus* only, larger litters (in terms of number of offspring or total mass) contained offspring more uniform in size. There was little evidence for an offspring size-number trade-off, which appears to be the rule in scorpions. In comparisons with other species, both *C. exilicauda* and *D. peloncillensis* produced larger offspring and smaller litters, and had lower total and relative investment, than did congeners from west Texas (*C. vittatus* and *Diplocentrus* sp., respectively). Average litter sizes were smaller than previously reported for *C. exilicauda*, but larger than previously recorded for *V. spinigerus* (with a maximum litter size of 76, the largest reported for any vaejovid). Duration of the first instar was similar to that previously reported for *C. exilicauda*, but slightly longer for *V. spinigerus*.

### **The spider fauna of downed woody material in a deciduous forest in central Alberta, Canada**

Chris Buddie - University of Alberta

Downed woody material (DWM) is an essential element of forest ecosystems. Although many arthropods (e.g., saproxylic beetles) are dependent on dead wood, it is unknown to what extent generalist predators, such as spiders, utilize fallen logs. Pitfall traps placed directly on the surface of fallen logs and placed on the forest floor collected over 10,000 spiders representing 100 species. Although fewer spiders were collected on fallen logs, spider diversity was higher on DWM than on the forest floor. The majority of species collected on the forest floor were also collected on DWM suggesting the spider fauna of fallen logs is a sub-set of the forest floor fauna. Additionally, 11 species were collected more frequently on DWM and the proportion of immature spiders was significantly higher on DWM than on the forest floor. In a second experiment, spiders collected on natural logs were compared to collections on telephone poles that were brought into the forest in order to assess whether spiders were dependent on the habitat or structure provided by DWM. Web-building spiders were seldom collected on telephone poles; these spiders depend on the complex habitat provided by natural logs. In contrast, hunting spiders did not distinguish between telephone poles and logs.

### **Substrate preference in adult females of *Parawixia bistriata*, a colonial orb-weaver Florencia**

Fernandez Campon\* and Susan Riechert - University of Tennessee

Adult females of *Parawixia bistriata* basically present two distinct morphs characterized by brown and yellow opisthosomes. When dispersing from the colony becoming solitary, females can be either found on leaves or on trunks of and branches of trees. In the field, the yellow morph was only found on leaves, specifically below or inside groups of leaves glued with silk. The brown morph, however, did not show a significant substrate association. We tested for individual preference for the different substrates in a mark and reciprocal release experiment on trunk versus leaf substrates and recorded the substrate they were found on days 3 and 5 following the release. All but one yellow spider was found on leaves on the last day of the experiment. Four of the 7 brown morphs released on leaves were found on leaves, and the remaining 3 were found on branches (with no leaves). Half of the brown spiders released on trunks (3/6) were found on either a branch with no leaves or trunk and the other half were found on leaves. These results indicate that females of the yellow morph present a marked preference for leaves as a substrate whereas individuals of the brown morph do not seem to prefer a particular substrate.

## **Towards a synthesis of spider phylogeny**

Jonathan Coddington - Smithsonian Institution

Matrix representation with parsimony is a "supertree" technique used here to synthesize quantitative cladistic studies at the generic level or above for spiders published to date into a single, synergistic phylogeny spanning the entire Order. The resulting "supermatrix" includes 513 spider taxa representing 103 of the 108 named families and 15.6% of the 3,300 named genera. The matrix included 579 phylogenetic statements about these taxa, of which two were ad hoc constraints on ambiguity arising from guesses about missing entries in the matrix. Conflict or ambiguity among source trees occurred within Theraphosidae, Theraphosoidina, Filistatidae, Eresoidea, amaurobioids, lycosoids, Anyphaenidae, araneoid families, and Linyphiidae. Parsimony analysis yielded a small number of most resolved most parsimonious trees of length 602 ( $ci = 0.96$ ) that represented all combinations of four areas of ambiguity, with 2, 3, 8, and 9 resolutions, respectively, all minor and local rearrangements of taxa. The four polytomies were each resolved in favor of the source tree based on the most taxa and characters. The main result is, for the first time, an objectively derived cladogram of nearly all spider families and many subsidiary lineages. Five families (Cybaeidae, Cycloctenidae, Hahniidae, Halidae, and Homalonychidae) were omitted due to their absence in any higher-level phylogenetic study. The placement of Palpimanoidea is resolved among entelegynes, but problems persist among amaurobioids and lycosoids.

## **Spider diversity in remnant and restored tall grass prairies of western Illinois**

Kenneth Cramer - Monmouth College

I sampled two tall grass prairies in western Illinois for spiders with pitfall traps and sweep net during a 6-week period in the summer of 1999. The two prairies are small, 1-2 acre abandoned pioneer cemeteries dedicated as nature preserves. Brownlee prairie is divided into a virgin plot and an adjacent 1-acre restored prairie. Spring Grove is entirely virgin prairie and half of it is burned each spring. Using the EcoSim program of Gotelli and Graves (1996) to conduct rarefaction analysis of both richness and evenness (Hurlbert's PIE, probability of an interspecific encounter), I compared the two prairies, the restored and virgin areas of Brownlee, and the burned and unburned areas of Spring Grove. Spring Grove, although lower in plant diversity, was slightly richer in spiders (40 species) than Brownlee prairie, and its spider population was more evenly distributed ( $PIE = 0.48$ ). The two sites were remarkably dissimilar, sharing only 43% of the species encountered. Contrary to expectations, the restored area of Brownlee was richer than the virgin plot, although it contained far lower numbers of spiders. Further, the virgin area had a much lower evenness ( $PIE = 0.59$ ) than the restored area ( $PIE = 0.97$ ). The burned and unburned areas of Spring Grove were similar in species richness, but the burned area showed greater evenness and lower numbers of spiders.

## **Colorado Spider Survey**

Paula E. Cushing<sup>1</sup> and Matthew Siderhurst<sup>2</sup> - 1. Denver Museum of Nature and Science 2. Colorado State University

The Colorado Spider Survey (CSS) began in May 1999. The purpose of this biotic survey is to gather baseline information about the biodiversity of spiders in the Rocky Mountain/ Great Plains region of Colorado. The information gathered in this survey will be used to document species distributions in ecosystems throughout the state, altitudinal variations in distributions, and species composition in urban areas. The information will also be used to document the extent to which habitat degradation has affected these top invertebrate predators over time. The survey is being carried out by trained citizen scientists. These arachnophiles have received information about

the survey and instructions on how to participate through 3-4 hour training workshops or 7-8 hour spider biology classes. Approximately 350 people have attended these workshops or classes. In each of these training events, CSS participants are provided with CSS Handbooks that describe the project, explain spider collecting methodology, provide a simplified dichotomous key to spider families, and contain collecting permits for all the natural areas covered in the survey. Thus far, over 7,000 specimens have been sent in by nearly 100 CSS participants including six teachers who have each gotten their students involved in the project.

### **Surface ultrastructure of *Aphonopelma seemanni* cuspules (Araneae, Theraphosidae)**

Bruce Cutler\* and Ferdouz Vuilliomenet - University of Kansas, Lawrence

Cuspules are tooth-like structures on the endites and often the maxillae of mygalomorph spiders. They have been used as characters in systematic studies. However, cuspule morphology and function have been little investigated.

A class exercise in scanning electron microscopy utilizing the exuviae of a subadult *A. seemanni* (F. O. P. - Cambridge) (Fig. 1) provided the basis for this study. The endite has approximately 120 similar cuspules about 50  $\mu$ m long, and about 40  $\mu$ m in diameter (Fig. 2). Bases of cuspules exhibit sharp ridges parallel to the longitudinal axis with a spacing of about 2  $\mu$ m. The distal third of the cuspules have concentric sharp ridges with a spacing of 1 - 2  $\mu$ m (Fig. 3). The apex consists of a broken concentric ridge with a complex of small ridges and a small 0.25  $\mu$ m pore. It is possible that cuspules perform other than a simple mechanical function. The pore may represent the opening of a sensory pit or a secretory gland. Further microscopy investigations are underway to elucidate the structure and possible function of the cuspules in several mygalomorph families.

### **Ecology of *Lathys* spp. and other ground-dwelling Dictynidae from the southeastern U.S. coastal plain.**

Michael Draney - University of Wisconsin-Green Bay

Dictynids are a more prominent component of the ground-layer spider fauna in the southeast than has generally been recognized. In a year-long study of eight South Carolina coastal plain habitats involving ten continuously-operating pitfalls and sixty 0.04 m<sup>2</sup> litter samples per habitat, Dictynidae was the most abundant family in litter samples (30.7% of 1,178 spiders), but only the fifth most abundant family in pitfall samples (5.1% of 14,934 spiders). Of adult dictynids, 96% were either *Lathys albida* or *Lathys maculina*, making up 8.5% and 19.2%, respectively, of spiders in litter samples, as opposed to only 0.74% and 0.76% of pitfall-trapped spiders. However, both sampling methods show similar patterns of species distribution among habitats. Habitat distributions are given for three other dictynids, *Lathys sylvania*, *Cicurina arcuata*, and *Dictyna formidolosa*, which were all much more numerous in pitfalls than litter samples, indicating either that mobility, not high density, results in high pitfall representation, or that they occur mainly in microhabitats (tree trunks, coarse woody debris) not sampled by the litter protocol. Males of *L. sylvania* were previously unknown, and several were collected during this study. Phenological data suggest that all species are probably annual. Peak pitfall male abundance indicates winter mating of *C. arcuata*, *L. albida* and *L. sylvania*, and spring mating of *L. maculina* and *D. formidolosa*. The *Lathys* species were reared using methods successfully developed for ground-dwelling linyphiids. Less than one third of 54 field-collected females oviposited, less than 20% of egg sacs developed, and no offspring survived to adulthood.

### **Observations of mating and plugging for species of the genus *Eperigone***

Eric Edwards -United States Postal Service

Five pairs of *E. Tridentata* were observed mating after being placed in 50mm Fisher petri dishes. Plugging at the end of mating was also observed. The spiders lived in their dishes for some time, being fed *Drosophila* and watered

at regular intervals. Females were able to construct egg sacs in several instances. Specimens for this study were found in a boggy area covered with maple leaves near a kettle pond in Falmouth, MA (Barnstable county), through the months of December, 1999 and January, 2000. A single mating was observed for *E. maculata* (from oak leaf litter), with plugging in March. Some behavior was noted for *E. contorta* (from seaside marsh), in March. The egg sacs produced by *E. tridentata* and *E. contorta* are similar in appearance to gnaphosid egg sacs. Five pairs of *E. tridentata* were observed mating after being placed in 50 mm Fisher petri.

### **Some variations in erigonine mating behavior**

Robert Edwards - Retired

Following the unexpected successful breeding of *Eperigone* species, several other genera were bred in captivity, using the technique described by Eric Edwards earlier. Genera observed included *Ceraticelus*, *Grammonota*, *Erigone*, *Satlatlas*, *Colonus* and *Floricomus*. Observations included courtship, if any, and the manipulation of the palps. Depending on the genus, courtship varied from periods of days to instant action. The small size of some of the species made it difficult to determine if the palps were inserted in the comparable receptacle (orthogonal). In general, it appears that the right palp was inserted in the right receptacle and left in the left receptacle. Insertions varied from rapidly alternating palps (*Erigone*) to single insertions sometimes lasting for an hour or more. One genus (*Satlatlas*) repeated copulations on following days. *Erigone* and *Ceraticelus* mated in webbing at the top of the petri dish, venters up. The others mated venter to venter in minimal or no webbing. *Grammonota* held the female by wrapping its first legs around the cephalothorax at the level of the sulcus. *Satlatlas* held the female by wrapping its first legs across the top of the female's legs. All matings resulted in egg sacs with one exception (*Floricomus*).

### **Estimating clade richness**

Andrew Farke\* and Johathan Coddington - National Museum of Natural History

The estimation of the number of "classes" in a "population" is a fundamental statistical problem with several biological applications. One is estimating population size from mark-recapture data. In this case, individual organisms are identified, and the statistics depend on whether and how often known individuals are recaptured. Another application is estimating species richness from community samples, in which the important datum is the number of times particular species are "recaptured." Here we suggest a new application: the estimation of the number of species in a monophyletic lineage or clade. As in local species richness, the method depends on the number of times species are observed, but a clade rather than a community is the sampling universe, and the data are museum specimens and/or localities. Here we report the results of applying these methods to selected spider and non-spider clades, including Hawaiian Linyphiidae and South American erigonine linyphiids. The method offers a new technique to assess quantitatively the maturity (or immaturity) of taxonomic knowledge for specific lineages.

### **Nuclear and mitochondrial markers reveal the existence of two parapatric scorpion species in the Alps (Scorpiones: Euscorpiidae)**

Benjamin Gantenbein<sup>1</sup>, Victor Fet<sup>2</sup> and Mark Barker<sup>2</sup> - University of Berne, Marshall University,

A molecular (mtDNA and allozyme) data set reveals a clear divergent phylogeny within the Alpine scorpion species *Euscorpius* (*Alpiscorpius*) *germanus* (C. L. Koch, 1837). Two distinct (ca. 7% DNA sequence divergence), monophyletic clades exist which are geographically separated by the Adige (Etsch) River in northern Italy. At the

allozyme level, these population groups are fixed for alternative alleles at eight out of 18 gene loci and correspond roughly to the morphological subspecies *E. g. germanus* and *E. g. alpha*. No evidence of introgressive hybridization between the two groups is shown by the allozyme data. The branching points of the two population groups are found at unusually high distances compared with the outgroup taxa. *E. g. alpha* is therefore elevated to species level: *Euscorpius alpha* Caporiacco, 1950, stat. nov. Phylogenetic and biogeographic implications are discussed.

### **Spider assemblages of natural and restored wetlands in central Alberta, Canada**

Alice Graham\* and John Spence - University of Alberta

There is a pressing need to restore and maintain wetland environments that are physically and biologically equivalent to natural habitats. To achieve this, it is necessary to compile lists of all species characteristic of wetlands and to understand the biology of these species. Spiders are abundant predators in many terrestrial and wetland ecosystems, and appear to be sensitive indicators of disturbance. Spider communities of natural and restored wetlands in the prairie pothole region of central Alberta were described and compared to better understand a poorly known component of wetlands, and add to knowledge of Alberta's invertebrate biodiversity. The efficacy of current wetland restoration practices for reconstructing these communities was also assessed by examining mechanisms of dispersal and comparing spider diversity at restored marshes of varying ages. Ground-dwelling and semi-aquatic spiders associated with wetland shores were sampled at six natural and nine restored marshes using pitfall traps dug into the ground surface and floating on the water surface. Preliminary results indicate that several species of *Pardosa* (Araneae, Lycosidae) were common at marshes in late spring. Significant differences in total abundance, species richness, and abundance of *Pardosafuscula* were found at natural and restored marshes. Nearly twice as many individuals, and more species were collected at natural marshes than restored marshes. However, no differences in spider abundance between the restored marshes of various ages were detected.

### **Modular habitat refugia enhance generalist predators and lower plant damage in soybeans**

Juraj Halaj<sup>1</sup>, Alan Cady\*<sup>2</sup>, and George Uetz<sup>3</sup> - 1.University of Kentucky, 2. Miami University and 3.University of Cincinnati

Generalist predatory arthropods in agricultural systems are poorly studied, and may be positioned to contribute to biological control schemes. The Chinese have placed straw structures in rice paddies for thousands of years as refugia for spiders to conserve these predators during flooding cycles. However, this technique has not been systematically investigated on larger scales in western-style agriculture. After conventional tillage of a field, we found a significant decrease in the abundance of spiders (76%) and their egg sacs (75%). This led us to hypothesize that placing discrete habitat refugia in tilled fields would conserve generalist predatory arthropod assemblages following this major disturbance. Refugia fabricated from chicken wire frames (0.4m<sup>2</sup>) loosely filled with bedding straw were positioned in a freshly-tilled soybean field. Over the growing season, we observed that these straw refugia held 5-36 times the spider density (- 60% more spider species) compared with the open field, and the number of spider egg sacs increased 18-87 times. Other generalist predatory arthropods densities (harvestmen, carabid and staphylinid beetles) also were higher in the refugia. Perhaps increased habitat cover and prey sources suitable for various predator life stages contributed to these dramatic increases. Soybean seedlings growing within 1 m of refugia suffered 33% less insect damage than plants at control locations, but this did not produce a statistically significant increase of soybean yield. These discrete habitat refugia may be useful as a habitat manipulation to conserve and promote generalist predatory arthropods in agroecosystems, augmenting biological control efforts.

### **Detection of prey populations by a spider that aggressively mimics pheromone blends**

Kenneth Haynes\*, Kenneth Yeargan and Cesar Gemeno - University of Kentucky

Adult female bolas spiders have a unique hunting tactic that combines aggressive chemical mimicry of the sex pheromone blends of their prey moths with a specialized weapon (the bolas) and behaviors to capture attracted male moths. At night female bolas spiders sometimes assume a unique posture in which their forelegs are extended, but they have not made a bolas that would be required to capture an attracted moth. Using a volatile collection technique and gas chromatography with electroantennographic detection, we determined that adult female *Mastophora hutchinsoni* spiders in this posture release the pheromone components of the bristly cutworm moth *Lacinipolia renigera*. Wing vibrations from hand-held moths or playback of recordings of moth wing vibrations will stimulate the spider to produce a bolas. The response to these wing vibrations including the construction of a bolas takes several minutes, therefore the spider is unlikely to capture the moth that stimulates the reaction. However, detection of wing vibrations provides information that prey are available, and therefore construction of the bolas will be less likely to be a waste of resources. This ability to sample for prey presence allows this predator to adapt its hunting activity to the temporal and spatial availability of its prey, and thereby may reduce the risks associated with extreme prey specialization.

### **An electrophysiological study of olfaction in the whip spider *Phrynus parvulus* (Arachnida, Amblypygi)**

Eileen Hebets - University of Arizona

Arachnids in general are not thought to have a well-developed olfactory sense, but in whip spiders (Amblypygi), the first pair of legs is modified from walking appendages into sensory structures. These antenniform first legs are extremely elongate and are covered with hairs that, from their structures, appear to be mechanosensory and chemosensory. Some of the hairs are multiparous, resembling the olfactory sensilla of insects. The olfactory response of the whip spider *Phrynus parvulus* from Costa Rica was examined using a technique analogous to that used for insect electroantennograms. Responses to 42 chemicals representing different chain lengths of alkanes, carboxylic acids, alcohols, aldehydes, ketones, esters, monoterpenes, and phenolics were examined. Fifty four percent of the chemicals tested elicited responses. Concentration-response curves were generated for guaiacol and hexanol, methyl salicylate, benzaldehyde, octanoic acid, and linalool. Guaiacol, bezaldehyde, and hexanol elicited the greatest responses and no differences were detected between the sexes. Compounds with chain lengths of 6 carbon atoms generated strong responses and most monocarboxylic acids and ring compounds elicited responses. Some compounds produced increases in potential believed to arise from a hyperpolarizing effect on the neurons. The broad spectrum of chemicals to which these animals respond is similar to results of other studies examining the general olfactory sense of insects.

### **Movement patterns and natural history of the whip spider *Phrynusparvulus* from Costa Rica**

Eileen Hebets - University of Arizona

An individual mark-recapture study was conducted on the whip spider *Phrynus parvulus* in an attempt to gain insight into the movement patterns and basic natural history of this species. Two 50m by 25m plots were set up at La Selva Biological Station in Costa Rica and all trees with a diameter at breast height (DBH) of 15 or greater were surveyed for whip spiders every 4 nights for two and a half months. *Phrynus parvulus* is a generalist predator and was seen feeding on a variety of prey types including several different orthopteran species, spiders, opilionids, roaches, millipedes, and moths. A total of 86 individuals were marked (26 females and 60 males) with an averaged 59% recapture rate. Recapture rates differed by sex with 73% of the marked females found more than once while only 43% of the males were found more than once. Movement patterns also seemed to differ between the sexes: 74% of the females could be found on the same tree on multiple nights while only 46% of the males were found in

the same place on multiple nights. Females had a significantly higher residency index than males ( $P < 0.0009$ ). All individuals tended to be found on trees with more buttressing as well as on trees with a larger DBH. *Phrynus parvulus* individuals seem to have home ranges and the movement patterns of each sex is dependent upon the distribution of the opposite sex.

### **Molecular insights into *Hypochilus* diversification**

Marshal Hedin\* and Dustin Wood - San Diego State University

Members of the spider genus *Hypochilus* (Hypochilidae), with interesting morphological characteristics, unique web design, and relictual distributional patterns, have long fascinated arachnologists. The research presented here continues this tradition of fascination. Using a combined molecular phylogenetic and population genetic approach, we reexamine problems of phylogenetic relationship, historical biogeography, and morphological stasis in *Hypochilus*. Analyses of both nuclear and mitochondrial DNA sequence data suggest the following general results. First, with respect to patterns of phylogenetic relationship, molecular data are generally congruent with previously published morphological data (Catley 1994). Second, levels of interspecific molecular divergence differ across regional montane faunas (i.e., Californian, Rocky Mountain, and Appalachian faunas), suggesting that speciation in each region has occurred over different time intervals, all probably well before the Pleistocene. Finally, observed levels of intraspecific mtDNA sequence divergence are extraordinarily high, a pattern that appears to hold for all *Hypochilus* species. A more detailed, but still preliminary, examination of this pattern in the Appalachian species *H. gertschi* suggests that high intraspecific divergence reflects a fragmented population structure. The implication is that *Hypochilus* species are maintaining "morphological cohesion" despite a lack of genetic connectedness.

### **A web-based key to spider families**

Jerry Hinn\*, Gina Sagel, and George Uetz - University of Cincinnati

Learning to identify spiders is a daunting task for the beginning arachnologist, and the two most commonly-used keys - Kaston 3rd edition "How to Know the Spiders" and Roth 3rd edition "Keys to North American Spiders" - present a number of challenges. Most critical for the novice are the diversity of traits used as dividing factors (many of which are rarely seen in common species), and the labor-intensive nature of following all the steps in a dichotomous key. With computers becoming a useful tool for so many parts of research, adapting taxonomic keys for their use is a fitting application, and as a student project for Arachnology class, we set out to create a computer-based key to spider families. We chose an HTML format, allowing the key to appear as a web page. Families represented in both keys were scored into a trait matrix, thus combining traits utilized by either one of the keys to give a more robust survey of definitive morphologic characteristics of the families. At the same time, we sought to add grouped illustrative materials and information to facilitate overall recognition. When conflicts arose, information from Roth's key was used based on its more recent revision history. The matrix of spider families was then sorted using Microsoft Access (2000 edition) into subgroups that possess unique character states, then developed a question format with choices indicated as "radio buttons". We present this key as a "project in development", and invite feedback from arachnologists.

### **Habitat associations of generalist predators in a mosaic agricultural landscape.**

Maggie Hodge\* and Dana Sherman - The College of Wooster

This study examined the habitat associations of 3 taxa of generalist predators (wolf spiders, carabid beetles and opiliones) in a mosaic landscape surrounding twelve one-acre soybean fields, half of which were conventional

tillage and half of which were conservation tillage. Three replicate drift-fences with pitfall traps were constructed in each habitat type (old field, deciduous forest, hedgerow and grassy field margin), including the soybean fields. Traps were opened for 48 hat 2-3 week intervals from July 2- September 10 1998. Wolf spiders were significantly more abundant in the grassy margin adjacent to the soybean fields and in the conventional till soybean fields. There were no significant differences in carabid abundance among habitats with the exception of the last sample date, which found significantly more carabids in the conventional tillage soybean fields. Opiliones were consistently more abundant in the forest and hedgerow habitats. Implications for predator interaction and biological control are discussed.

### **The Spider Fauna of DMZ of Chulwon areas in Kangwon-do, Korea**

Kim Joo-Pil - Dongguk University, The Arachnological Institute of Korea

The spider fauna of DMZ (Demilitarized Zone) of Chulwon in Kangwon-do, Korea was investigated. As a result, the authors present a list of 54 species of 54 genera in 14 families (2 unidentified species newly known to Korea; *Evarch* sp(C)., *Helicius* sp.(A)) and revise *Asianellus festivus* of the unrecorded genus to be transferred from the genus *Phlegra* from Korea.

### **Got Sperm? Acquisition of sperm by female fishing spiders (*Dolomedes triton*) increases cannibalism of males**

Nancy Kreiter\*, Kim Getz and Julee Johns - College of Notre Dame of Maryland

Intraspecific cannibalism by adult females on adult males (sexual cannibalism) has been reported in several species of spiders. Evolutionary benefits provided to males and females by this behavior have been widely discussed. Cannibalism of a potential mate prior to copulation may cost females by limiting fertilization opportunities, and previously mated females probably incur less cost when cannibalizing males than do virgin females. We tested the hypothesis that *Dolomedes triton* females differentially cannibalize males according to the female's mating status. We introduced female fishing spiders as penultimate juveniles (n=16), adult virgins (n=32), and mated adults (n=23) at randomly assigned pre- and post-molt ages to males in the laboratory. Ages of the females ranged from 1 to 25 days prior to the adult molt for the penultimate juveniles and from 1 to 35 days post-molt for the virgin and mated adult females. Trials were scored in terms of male survival and successful copulation. Prior female mating significantly reduced male survival.

Incidence of cannibalism of males was low in trials involving both juveniles (13%) and virgin females (13%). However, 43% of trials with mated females resulted in cannibalism of the male. Copulation was observed in 50% of the trials with virgin females, but only 1 of the previously mated females (4%) copulated a second time. These results indicate that adult female *D. triton* do not cannibalize males indiscriminately. Previous sperm acquisition appears to be particularly important in whether female fishing spiders cannibalize male suitors.

### **The influence of the spider assemblage on Collembola densities and rate of litter disappearance in the forest-floor food web**

Kendra Lawrence\* and David Wise - University of Kentucky

Spiders are major predators in forest-floor leaf litter, yet little is known about their impact on prey populations and on forest-floor processes such as litter decomposition. We conducted short and long-term experiments to investigate the potential cascading effects of spider predation on litter decomposition via effects on Collembola. Twenty-eight 1-m<sup>2</sup> plots were randomly assigned in August 1998 to one of four treatments: 0 - open, no

manipulations; F - fenced, no litter sifted, no spiders removed; FS - fenced, litter sifted, no spiders removed; and FSR - fenced, litter sifted, spiders removed. In early August, we sifted the FS and FSR plots, removing spiders from FSR plots. In September, we placed one litterbag filled with straw into each plot. Litterbags were collected 6 weeks later and fauna were extracted from the bags. After the completion of the short-term experiment, we placed four litterbags filled with recently fallen leaves and four trot lines, consisting of three leaves of a known weight tied together, into each plot. Manipulation of spider densities resumed May 1999 and continued monthly until August 1999. The manipulations significantly reduced spider densities in both experiments. Reduced spider densities led to increased Collembola densities and rate of straw litter disappearance in the short-term experiment, but long-term spider reductions had no statistically significant effect on fungal biomass or rate of litter disappearance, despite increases in Collembola. However, a trend toward lowered rates of litter disappearance in FSR plots suggests that spiders may have had a net positive effect on litter disappearance in the long-term experiment.

### **Female *Misumena vatia* allocate greater initial resources to female offspring than to male offspring**

Edgar Leighton\* and Douglass Morse - Brown University

Fisher's theory of sex allocation predicts that females should invest equal resources in both sexes. However, exceptions to Fisher's theory may occur when one sex has a greater potential fitness than the other, or when competition for mates is higher in one sex. We predicted that female *Misumena vatia* would allocate greater initial resources to females than to males. *M. vatia* has a slightly female-biased primary sex ratio, but the operational sex ratio may become strongly female-biased. The highly skewed operational sex ratio provides each male with the opportunity to mate with several females. Although each male has the potential to mate several times, the variation in mating success for males may be great. The potential high variation in male mating success and the near certainty that females will be fertilized suggests that females should invest more in female eggs. In the summer of 1999 we collected and weighed 240 *M. vatia* spiderlings from 12 broods as they emerged from their egg sac. Spiderlings were reared in the laboratory until their sex could be determined. At least 30% of all spiderlings were male and four egg sacs were male-biased. We found that females invest greater initial resources in females than in males. Males weighed less than females and weighed significantly less than all females and undetermined individuals.

### **Habitat distribution and life history strategies of *Pirata* wolf spider species in the Great Smokey Mountains National Park**

Michael Lowder\* and Frederick Coyle - Western Carolina University

*Pirata* (Lycosidae) is the most species-rich, and possibly the most abundant, wolf spider genus in the Great Smoky Mountains National Park (GSMNP). This study describes the habitat distribution patterns of *Pirata* species among multiple sites, representing all major biotic communities in the GSMNP. A total of seven *Pirata* species were collected from nine mid elevation focal sites (*P. alachuus* Gertsch & Wallace, *P. hiteorum* Wallace & Exline, *P. insularis* Emerton, *P. montanus* Emerton, *P. sedentarius* Montgomery, *P. suwaneus* Gertsch, and *P. sylvanus* Chamberlin & Ivie); none were found in the six high elevation sites (1550-1830 m). Five species are uncommon. The two most abundant species are strictly segregated by habitat; *P. montanus* is abundant in four mesic forest habitats and is the only *Pirata* species in the GSMNP associated with forests, while *P. insularis* is abundant in two montane wetland sites and common at a native grassland site. Size frequency distribution histograms of seasonal samples of juvenile and adult *P. montanus* show that this species has a two-year life cycle. Seasonal size distribution histograms of juvenile and adult *P. insularis* reveal a "polymorphic phenology" in which both rapidly developing (annual life cycle) and slowly developing (biennial life cycle) individuals are present within the same population. This study describes a key difference in the life history strategies of the two most abundant *Pirata* species in the GSMNP.

**Analyses of Floridian historical biogeography and late cenozoic paleogeography using wolf spiders (*Lycosidae:geolycosa*) as a model taxon**

Sam Marshall\*<sup>1</sup>, Kory Thornburg<sup>2</sup>, and Randy Hoeh <sup>2,1</sup> - 1. Hiram College 2.Kent State University

Currently, 15 species of *Geolycosa* have been described based on a limited number of morphological characteristics. The species limits and evolutionary relationships for *Geolycosa* are poorly understood. The state of Florida has nine *Geolycosa*., seven living in endangered habitats. The goals of this project are to (1) estimate the evolutionary relationships among Floridian *Geolycosa* populations and species using comparisons of cytochrome c oxidase subunit I (Cool) DNA sequences and (2) use these relationships to infer the historical pattern of Floridian scrub habitat evolution. *Geolycosa* individuals from a total of 33 Florida scrub sites were collected and identified based on morphological characteristics. DNAs from 74 individuals representing the species *G. escambiensis*, *G. micanopy*, *G. patellonigra*, *G. x. xera*, *G.x. archboldi*, *G. hubbelli*, *G. ornatipes*, *G. wrighti*, *G. nussyruებსუსმ*, *G. rafaellana*, *G. turricola*, and *G. pikei* were extracted and a portion (ca. 710 base pairs) of the COI gene amplified using the polymerase chain reaction. To date, the COI fragments from 38 individuals representing 11 species of *Geolycosa* have been cycle sequenced. Preliminary phylogenetic analyses of the COI sequences, using parsimony, suggest that (1) Floridian *Geolycosa* are not a monophyletic assemblage, (2) *G. xera*, *G. escambiensis*, *G. hubbelli*, *G. patellonigra*, and *G. micanopy* are not valid species in a phylogenetic sense, and (3) *Geolycosa* external morphology may be highly mutable yielding convergence and possible habitat-dependent adaptations.

**A comparative study of the defense behaviors of theraphosid spiders (Araneae: Theraphosidae)**

Sam Marshall and Richard Blatchford\* - Hiram College

We compared the response of 5 different tarantula genera to two levels of intensity of aversive stimulus: puffs of air and prodding. We chose the genera *Aphonopelma*, *Cyriopagopus*, *Hysteroocrates*, *Phlogius*, and *Pterinochilus* to represent divergent clades in the family Theraphosidae. We found that the overall structure of the defensive behavior was similar between the different taxa, consisting of fleeing, rearing, and striking with the anterior appendages. However, the latency to express a response and the intensity of the response differed. *Aphonopelma* had the longest latency to respond and the shortest duration, *Hysteroocrates* had the shortest latency and longest duration. We hypothesize that the relatively low level of responsiveness of *Aphonopelma* may be linked to its possession of urticating hairs as a defensive strategy.

**The influence of group size on growth rates in the theraphosid spider *Hysteroocrates gigas* (Araneae, Theraphosidae).**

Sam Marshall, Melissa Varrecchia and Vanessa Gorley\* - Hiram College

We reared spiderlings of the theraphosid spider *H. gigas* in groups of 1, 2, and 4 to examine the influence of social interactions on growth rates. We selected this taxon because observations made on captive populations indicate that *Hysteroocrates* spp. tarantulas have an unusually high level of mutual tolerance and captive juveniles have been observed to feed cooperatively on large prey until several months old. We used spiderlings from two different captive-produced clutches. Spiderlings were fed once a week on pre-killed crickets of a large enough size to ensure a superabundance of prey for all members of the group. We examined growth rates for 10 weeks (through two successive molts) and found no clear effect of group size on growth rates. There was, however, a tendency for a greater asymmetry in growth rates for the dyads than in the tetrads. Cannibalism was only observed in one instance. Observations of the feeding behavior were made to examine feeding behavior and agonistic interactions.

## **Nutrition and cannibalism in the wolf spider *Pardosa prativaga***

David Mayntz\* and Soeren Toft - University of Aarhus

Experiments were performed to investigate the relationship between the nutritional history of wolf spiders and their propensity to cannibalize. First, an experiment was conducted to assess the quality of conspecifics as food for developing spiders. Spiders fed a monotypic diet of conspecific hatchlings had a slower initial growth rate and a lower survivorship compared to spiders fed monotypic diets of fruit flies (*Drosophila melanogaster*). We then tested the effects of nutrient deficiency and starvation on the spiders' tendency to cannibalize and the corresponding food utilization efficiency of the cannibalism. We created spiders with different nutrient balance by feeding them *Drosophila melanogaster* that were raised in cultures that differed in their nutrient composition. The spiders were further separated according to starvation level. Results showed that starvation increased the spiders' propensity to cannibalize. However, nutrient deficiency decreased cannibalistic consumption. Fruit flies were, across treatments, consumed in higher quantities than conspecifics. The spiders' utilized conspecific prey better than fruit flies and their previous nutrient balance did not affect the food utilization efficiency of cannibalism. Thus, the spiders had higher consumption of the less utilizable fruit flies, and although nutrient deficient spiders in particular would have gained from increasing cannibalism, nutrient deficiency reduced their cannibalistic behavior.

## **Inferring trophic positions of spiders and carabid beetles in a detritus enriched food web: evidence from stable isotope analysis**

Denise McNabb\*, Juraj Halaj and David Wise - University of Kentucky

Differences between species in the ratios of stable isotopes of carbon and nitrogen ( $^{13}\text{C}$  and  $^{15}\text{N}$ ) can be used to infer the resource base and the trophic position of the species in a food web. Our objective was to determine the feasibility of using stable isotope analysis to infer the trophic position of spiders and carabid beetles in detrital and grazing food webs of squash gardens. Stable isotope ratios were determined for two categories of primary consumers, detritivores (Collembola) and herbivores; and major arthropod predators, including Linyphiidae; the lycosids *Pardosa milvina* and *Hogna helluo*; and several species of carabid beetles. Spiders and Collembola had similar  $^{13}\text{C}$  values, suggesting these detritivores are a significant source of energy to spiders in this system. The  $^{15}\text{N}$  values of linyphiids and lycosids were not significantly different, indicating that these spiders are feeding on the same trophic level; and the degree of difference in  $^{15}\text{N}$  between spiders and Collembola indicates that spiders are 1.6 trophic levels above Collembola. The trophic position of spiders may be elevated by cannibalism and intraguild predation, or by additional feeding on non-detrital sources of energy. The carabid *Scarites* had isotopic values similar to those of spiders, supporting the conclusion in the literature that they are primarily predaceous. The  $^{15}\text{N}$  value of *Harpalus* was significantly lower than the spiders, suggesting a lower trophic level and predominantly omnivorous feeding habit for this carabid species. Our results showed the suitability of stable isotope techniques in investigating the structure of vegetable-crop food webs.

## **Progress in erigonine systematics**

Jeremy Miller

George Washington University and Smithsonian Institution

I report on my ongoing investigations into erigonine systematics. I have added new characters and taxa to the cladistic analysis of Hormiga (in press). I also discuss the notion of progress in systematics and how it might be assessed. The central test of a homology statement is congruence with other characters. If our observations of

similarity in organisms are indeed the residue of evolution, we expect the addition of new observations to lead to the discovery of independent synapomorphies in a nested hierarchical arrangement. We also expect that homoplasy will be generally non-hierarchical and incongruent. I present a method for assessing the hierarchical quality of data. The method produces curves that can be graphed and compared between data sets. The curves are produced by rarefying data and then counting the average number of nodes in common with a reference tree. This is accomplished using NONA in conjunction with a novel computer program. In an idealized situation, extremely well supported phylogenetic data would be able to lose some portion of its data before losing nodes in the tree, producing an asymptotic curve. Using real data sets, the method can be used to assess which phylogenetic questions are most in need of additional work or what data partitions are contributing the most hierarchical signal to a total evidence analysis. I present examples from my own research on erigonine spiders and the arachnological literature to demonstrate this method. The pitfalls of this and similar statistical methods used in phylogenetic contexts are discussed.

### **The role of experience in the patch choice of newly emerged spiderlings**

Douglass Morse - Brown University

Crab spiders (*Misumena vatia*:Thomisidae) emerging from their egg sacs have only enough resources to survive for a few days and hence are under strong pressure to capture prey. I tested the hypothesis that these spiderlings enhance their selection of hunting sites by incorporating experience into their decision-making. In northeastern USA, spiderlings typically hunt on flowering goldenrods, which attract many small dipteran prey. The spiderlings recruit to goldenrod flowers and remain on them more often than on either yellow or green buds. Experiments incorporating experience, age, energetic condition, and supplemental feeding did not affect choice at this early stage. Shifting the substrate on a subsequent run produced minor changes; those shifted from flowers to buds left the buds more often than did controls on buds, and those shifted from buds to flowers remained on flowers more often than did controls on flowers. However, substrate selection by recently emerged young appears to be largely innate. I compare these results with those from later instars, where experience may play a larger role.

### **Intra-cohort cannibalism is linked to territoriality in the Mediterranean tarantula (*Lycosatarentula*)**

Jordi Moya-Laraiio\* and David Wise - University of Kentucky

Intra-cohort cannibalism may be linked to defense in territorial species. Adult females of the Mediterranean tarantula (*Lycosa tarentula*), a burrowing wolf spider, are cannibalistic. Their dispersion pattern and other indirect evidence suggest that this spider is territorial. We tested the hypothesis of territoriality directly in two complementary field experiments. In a long-term experiment in a natural, open population we placed an intruder in an artificial burrow within the hypothesized territory of a resident. Additional treatments controlled for possible effects of the manipulation on the introduced spider. The results indicate that the resident hunts in an area around her burrow and excludes conspecifics from the area, sometimes by cannibalizing them. We induced encounters between females in a short-term field experiment. Resident spiders tended to overcome intruders. Fights were more likely to escalate when spiders were of similar size, and cannibalism occurred only after escalation. These results are contrary to what would be expected if cannibalism solely were a means of predation. It is clear that in addition to providing energy to the successful cannibal, cannibalism in the Mediterranean tarantula is a component of territorial defense.

### **Relationship between sprint speed and flight distance in a wolf spider.**

Matthew Nelson\* and Dan Formanowicz University of Texas at Arlington

The relationship between running speed and flight distance is an important one in terms of escape from predators, especially in species that may have multiple defensive strategies. In the wolf spider, *Lycosa carolinensis*, the most obvious antipredator mechanism is flight. We examined the relationship between sprint speed and flight distance in wolf spiders by measuring sprint speed on a running track and, in a separate set of experiments with the same individual spiders, measured the distance at which they fled from an advancing model predator. Sprint speed was not significantly correlated with mass, size, or sex of the spiders. Sprint speed was significantly, positively correlated with flight distance. This correlation may be the result of a trade-off between two competing modes of antipredator mechanisms: escape and crypsis. In individuals with higher sprint speeds, escape may be the more advantageous option. Slower individuals may have a greater chance of surviving an encounter with a predator simply by remaining still and relying on crypsis.

### **Video playback studies of female mate preference and male visual signals in wolf spiders.**

Stephanie Norton\* and George Uetz  
University of Cincinnati

Wolf spiders (Lycosidae) and jumping spiders (Salticidae) have been demonstrated to respond to video images of conspecifics and prey insects as if they were real. We used video playback experiments to examine female mate preference for aspects of visual signaling by males of the brush-legged wolf spider, *Schizocosa ocreata*. Male *S. ocreata* have decorative tufts on their forelegs, and use conspicuous visual leg-waving displays in courtship, which females may use as an indicator of male quality in choosing mates. In order to control for the influence of potentially covarying indicator traits, we studied the responses of female wolf spiders to video images of the same courting male with selected signal traits altered by computer digitization. Females were shown videos of courting males two ways: either a single (no choice) presentation, or a pair viewed simultaneously in a video choice chamber. The "virtual" males were identical in behavior and size, but varied in either (a) tuft size, or (b) vigor of visual signaling. Results confirm that females recognize male conspecifics on video and behave toward them in a manner similar to live males. Female *S. ocreata* showed significant differences in receptivity in response to video images with altered tuft size and increased/decreased rates of display (with other variables held constant) in both single presentation and choice experiments. Video choice tests suggest a preference for larger tufts and more vigorous courtship display. These results suggest that multiple signal traits, independently or together, may influence female mate choice in *S. ocreata*.

### **Estimating the stickiness of the adhesive capture threads in orb-webs**

Brent Opell - Virginia Tech

Sticky capture threads improve an orb-web's ability to retain the insects that strike it, allowing a spider more time to subdue them before they can escape the web. Most orb-weavers produce adhesive capture threads that feature small droplets of aqueous material. Inside each droplet glycoprotein granules coalesce to impart thread stickiness. Phylogenetic (transformational and independent contrast) analyses of threads produced by the adults of five species and ontogenetic studies of the threads of two of these species show that the volume of material in a thread's droplets is directly related to its stickiness. Models based on these analyses predict thread stickiness to within an average of 11% of the measured values using measurements of droplet diameter and distribution that are easily made with a compound microscope. This approach will facilitate the inclusion of thread stickiness in studies that examine the properties and performance of spider orb-webs.

### **Changes in the mechanical properties of capture threads and the evolution of modern orb-weaving spiders**

Brent Opell\*<sup>1</sup> and Jason Bond<sup>2</sup> - 1. Virginia Tech 2. Field Museum of Natural History

The capture threads of spider orb-webs not only retain prey but also contribute to a web's ability to absorb the forces generated when prey strike the web. Primitive orb-webs produced by the Deinopoidea clade are horizontally oriented and contain dry cribellar capture thread, whereas modern orb-webs constructed by the Araneoidea clade are vertically oriented and contain viscous adhesive threads. A comparison of the capture threads produced by three deinopoid species and six araneoid species shows that the evolution of modern orb-weaving spiders was associated with changes in the mechanical properties of their capture threads. The breaking energies of these two thread types are not distinct, but the manner in which they resist breaking differs. Adhesive threads have smaller tensile strengths and Young's moduli than do cribellar threads, rendering them weaker, but better equipped to dissipate force by stretching. This mode of absorbing force is advantageous for vertical orb-webs which typically intercept faster flying prey than do horizontal orb-webs. It permits a capture thread to absorb force as it is transferred to the web's non-sticky supporting threads and enhances a web's ability to flex and dissipate some force through air resistance.

**Fitness costs and benefits of chemically-mediated antipredator behavior in the wolf spider *Pardosa milvina* (Araneae: Lycosidae)**

Matthew Persons\*, Sean Walker<sup>2</sup> and Ann Rypstra<sup>2</sup> - 1. Susquehanna University 2. Miami University

Animals may exhibit a variety of defensive behaviors in the presence of predator chemical cues. Such behavior offers immediate fitness benefits but may also incur substantial foraging and reproductive costs. We measured shifts in space use (vertical climbing) by the wolf spider *Pardosa milvina* induced by chemical cues (silk and feces) from a co-occurring predatory wolf spider *Hogna helluo*. We then measured foraging and reproductive costs as well as survival benefits of this behavior. For two weeks, we maintained mated adult female *Pardosa* in plastic containers with one of three treated peat moss substrates: (N = 25/treatment): 1) container previously occupied by a conspecific for three days, 2) container previously occupied by an adult *Hogna* for three days, and 3) peat moss devoid of either cue (control). We measured prey capture efficiency, body condition, egg sac production, egg sac weight, and egg number for individuals in each treatment. We also counted the number of *Pardosa* that survived and exhibited climbing behavior in the presence of a live *Hogna* with and without silk and feces cues. *Pardosa* climbed container walls significantly more often in the presence of *Hogna* silk and feces relative to other treatments. *Pardosa* exposed to *Hogna* cues coupled with live *Hogna* survived significantly longer than spiders that had no predator cues available. *Pardosa* placed in containers with *Hognacues*, but no *Hogna* lost weight more quickly, ate fewer prey, were in poorer body condition, produced lighter egg sacs, and fewer eggs than spiders in control or conspecific treatments.

**Life history characteristics of *Agelenopsis aperta* (Entelegynae, Agelenidae)**

Marius Pfeiffer - University of Texas at Arlington

Variation in life history characteristics of *Agelenopsis aperta* were examined. Females from two geographically distinct populations in Texas were collected in Sept. and the majority were found to be gravid. Female weight at capture, date of egg deposition and clutch number were recorded. Dispersing (third instar) young were counted, weighed and reared to maturity. Number of molts to maturity and weights of mature offspring were recorded. Female mass was positively correlated with total # of offspring as well as clutch mass. Additional relationships between female mass and clutch characteristics were explored. Observations regarding feeding, egg-sack and web construction, rearing and lifespan we also recorded.

### **Mother-offspring interactions and social behavior in Amblypygids**

Linda Rayor\* and Benjamin Larsen - Cornell University

Social behavior and extended maternal interaction with offspring is extremely rare among arachnids. Here we report for the first time extensive affiliative behaviors among mother and offspring tailless whipscorpions (Arachnida: Order Amblypygi: *Phrynus marginemaculata*). The first pair of legs of these fast, non-visual, tactile predators are modified into antenniform whips three times their body length. Mothers give birth to ~18 offspring, which cling to her abdomen through the first instar. From the 2nd through the 4th instar in captivity, young remain in groups of 4-10 individuals around the mother or in close contact with one another. Mothers and offspring mutually stroke each others whips and pedipalps in greeting. Young orient to the adult female and initiate pedipalp to pedipalp contact. Non-kin young are immediately accepted into the social group. Prey is not shared, nor is prey stolen by larger individuals. Affiliation between the mothers and offspring lasts for over nine months. Adults are found in loose colonies. These affiliative behaviors are indicative of complex sociality typical of only the most social spider species, and extend social behavior into a new Order.

### **An airborne spider pheromone associated with male attraction and release of courtship**

Susan Reichert\*<sup>1</sup>, Mirjam Papke<sup>2</sup> and Stefan Schulz<sup>2</sup> - 1. University of Tennessee 2. Technical University Braunschweig

Whereas communication between individual spiders generally involves agonistic signaling in the form of vibratory and visual displays which serve to maintain a widely dispersed population, pheromones have been implicated in bringing the sexes together during reproduction. Here two potential sex pheromones collected from virgin, sexually mature females of the desert spider, *Agelenopsis aperta*, are identified and the synthetic pheromones used to test conclusions reached from previous behavioral trials that indicate that chemical cues emitted by this female class attract courting males. We also investigate the role of chemical communication in prescribing the complex male courtship sequence. In separate trials, one of the synthesized pheromones, 8-methyl-2-nonanone, was found to both attract males to the source of the cue and to elicit courtship behavior from them at very low dosages. Pheromonal cues release most elements and stages of the male courtship sequence in *A. aperta*.

### **The spider fauna of sugar cane in the Sao Paulo state, Brazil**

Isabela Rinaldi\* and Beatriz Mendes - State University of Sao Paulo

The spider fauna (Araneae) from sugar cane crop was monthly surveyed, collected by hand, and beaten in an extensive crop area of Botucatu, State of Sao Paulo, Brazil. Composition and richness (families and species), microhabitat preferences, diversity and evenness indexes of their fauna were analyzed. A total number of 1,295 spiders belonging to 83 species and 20 families were collected. The most diverse families were Theridiidae, Salticidae, and Araneidae, and the most abundant families were Theridiidae, Salticidae, Anyphaenidae and Titanoecidae. Seven species represented 58.6% of the total fauna, whereas *Cryso pulcherrima* weaver, alone, made up to 28.2%. About 56.6% of the spiders occupied the stratum 20 cm from the soil. Spiders were always present throughout the development of the crop. Along with the suppression of the previous burning of the sugar cane crop, the importance of knowing these natural enemies increases.

### **Illegitimate receivers: Evaluating the predation risk of male ornamentation**

J. Andrew Roberts\* and George Uetz - University of Cincinnati

Visual displays and elaborate decorations in males are crucial for mate attraction in many taxa. While previous research has established that predators (illegitimate receivers) exploit courtship signals, few studies have quantified increases in predation selection pressure associated with increased ornamentation. Males of the wolf spider *Schizocosa ocreata* have leg-waving courtship displays and sexually selected ornaments (tufts) on the forelegs, providing a model for evaluating predation risk associated with secondary sexual characteristics. To test the hypothesis that visually hunting predators are more likely to attack males with exaggerated secondary sexual characteristics, we studied the responses of American toads (*Bufo americanus*) to video playback of male *S. ocreata* courtship. This predator co-occurs with *S. ocreata* throughout much of its range, readily accepts wolf spiders as prey, and responds to prey images on video as if real. We compared responses of toads to standardized videos of male *S. ocreata* courtship that vary only in the degree of elaboration of foreleg tuft area. Toads show decreased latency of attack response to video of courting male spiders with artificially enhanced tuft area when compared to standard male video or video with tuft area reduced, suggesting that predators may be more likely to respond to, and thus selectively predate upon, spiders with larger tufts. While earlier studies have demonstrated a female preference for increased tuft size in male *S. ocreata* (see Norton!Uetz poster), this research suggests that illegitimate receivers of sexual signals may curb the exaggeration of this sexually selected trait.

### **Mating behavior of the funnel web spider, *Agelenopsis pennsylvanica* (Araneae: Agelenidae): Does copulatory behavior by successive males differ?**

Marianne Robertson\*1, and Jason Minton2 - 1. Millikin University 2. Brookfield Zoo

We studied the courtship and mating behavior of funnel web spiders, *Agelenopsis pennsylvanica* (Araneae: Agelenidae). We allowed females to mate with two males. The second male was not introduced until after the first male had completed copulation and was removed from the arena. We recorded both the time that elapsed from male introduction to the beginning of copulation and the copulation duration for first and second males. We also noted the total number of palpal insertions by first and second males. There were no significant differences in the time until copulation or total number of palpal insertions in first males versus second males. However, first males copulated for significantly longer than second males. Durations of double mating trials ranged from 5.07 hours to 16.56 hours.

### **Competition as a result of anti-predator behavior in two species of wolf spider (Araneae; Lycosidae)**

Ann Rypstra\*1, Sean Walker1 and Matt Persons2 - Miami University 2. Susquehanna University

The spider species, *Hogna helluo* and *Pardosa milvina* coexist in disturbed habitats and agroecosystems throughout North America. Although at adulthood, *Hogna* is much larger than *Pardosa*, they overlap in size through much of their life cycle. Both species detect chemical cues deposited by the other spiders as they move through the environment (silk draglines and feces) and change their behavior in response to those cues. *Pardosa* move less, feed less and are more likely to move up the side of their rearing container in the presence of *Hogna* cues. Reduced locomotion and feeding in *Pardosa* decreases detection by potentially predatory *Hogna* and the change in space use suggests an attempt to escape. Immature *Hogna* in the same size class as *Pardosa* move more, feed less and are less likely to burrow into the soil in the presence of *Pardosa* cues. Reduced feeding, increase locomotion and a lower tendency to burrow suggests that *Hogna* are more transient in the presence of *Pardosa*. These behaviors protect them from mutual predation and, in field experiments where they are housed together, survival is quite high. Surviving spiders experience reduced access to resources and shifts in space use where they coexist which can be construed as evidence of interference competition. In essence, anti-predator behavior that enhances the survival of these species forces them into a competitive coexistence across the landscape.

### **Colony relatedness in a facultative group living spider**

Regina Sagel\*, George Uetz and Ron DeBry - University of Cincinnati

Group living in spiders is extremely rare, but is observed in the orb weaver, *Metepeira spinipes*. This facultative group living spider forms colonies in periods of high resource availability, but the mechanisms underlying group formation are not known. It is postulated that group formation can be attributed to risk sensitivity, kin selection, or some combination of the two. During the 1998 El Nino year, *M spinipes* were observed to be living in groups in California. By using the techniques of RAPDs and microsatellites, the genetic relatedness of spiders within groups can be compared to the genetic relatedness between groups to examine the hypothesis that group living in *M spinipes* is attributable, at least in part, to kin selection.

### **Biogeography and Range Expansion of *Anelosimus studiosus* in North America**

Jamel Sandidge - University of Kansas

The non-territorial periodic social spider, *Anelosimus studiosus*, in southeastern Kansas has led to the opportunity to study a possible case of range expansion and establishment. *Anelosimus studiosus*'s range was previously known to occur in eastern portions of North America and areas of eastern and southern Mexico, south to Argentina. Since then it has been discovered in portions of Texas, Oklahoma, Missouri, and Kansas. Utilizing manual cycle sequencing, I analyzed two mitochondrial genes, NADH Dehydrogenase Subunit I and Cytochrome Oxidase Subunit III, to determine and document the presence of genetic variation among populations in North America. Levels of genetic variability were obtained through estimates of true base pair substitutions and amino acid sequence similarity for each mitochondrial subunit. This information was then used to map the geographic distribution of mitochondrial haplotypes. Preliminary data, collected from individuals throughout Florida, Tennessee, Oklahoma and southeastern Kansas, have shown geographical distribution of genetic variation. Though direct mechanisms of movement are unknown for recently discovered populations, nest site location on popular recreational lake edges and adjacent areas, and absence of webs in intervening areas, suggest human transportation. Within local populations, individuals of both long-lived and newly established colonies disperse to neighboring sites. Limited migration and higher extinction and predation rates have been hypothesized to lead to fixation of distinct alleles within populations. The use of genetic data in dispersal and establishment studies may help answer questions concerning whether recent discoveries of *Anelosimus studiosus* are the result of range extensions, or merely previously unnoticed populations.

### **Ground spider community reactions to prescribed dormant season fire in the third year of an ongoing study**

Chad Schone - Ohio State University

In the central hardwood regions, oak-dominated ecosystems have shown a shift towards mesic and/or fire-sensitive species. Prescribed fire is known to enhance oak regeneration; however, little else is known about how this manipulation affects other ecosystem components, including ground dwelling spider communities. In 1994, a multidisciplinary project was initiated to study the use of prescribed fire as a restoration tool in southern Ohio mixed oak ecosystems. Here, I report on the response of ground dwelling spider communities after 3 years of early spring (dormant season) fires. Using pitfall traps, species' frequencies were recorded in 1,728 2m<sup>2</sup> quadrats in 4 study areas (75 ha), each with a control (no fire), infrequent (1 fire in 4 years), and frequent (annual fires) burn unit. In 1997, 92 species were identified. Although the surface fires have altered the understory environment by greatly decreasing the leaf litter, fire has not affected the frequency of most spider species. No significant differences have been discovered in number of species, species compositions, nor number of individuals between treatments or between sites. Most studies of this nature have examined prairie or agrarian ecosystems, and very few studies have examined the community response of ground spiders to surface fires in forests. These studies are generally similar

to ours indicating that prescribed fires have a neutral effect on species diversity. These findings indicate that dormant season prescribed fire may be used as a tool to promote oak regeneration while maintaining the diversity of the ground dwelling spider communities.

### **Thermal ecology of male tarantulas (*Aphonopelma anax*) during the mating season**

Cara Shillington - Oklahoma State University

Male tarantulas of North America represent an interesting case for studying thermoregulation because of their complete change in life history once they reach sexual maturity. As juveniles and subadults males are fossorial, sit-and-wait predators. However, once they reach sexual maturity, males abandon their burrows and engage in intense mate-searching for well dispersed females (which are fossorial throughout their life cycle). They compete (scramble competition) for opportunities to mate and their mating success depends largely on rapid walking. Because they are ectotherms, activities such as locomotion are correlated with body temperature and may directly influence mating opportunities. To determine the exact times when male tarantulas were active, individuals were radiotagged at a field site in southern Texas so they could be relocated and observed throughout the day and night. Activity patterns indicate that male tarantulas are primarily thermoconformers and usually restrict active locomotory periods to times when ambient and ground temperatures are within their preferred range of body temperatures (22.3 - 31.4 degrees Celsius). As a result of exceedingly hot daytime temperatures at the study site (sometimes exceeding 70 degrees Celsius), males retreat below ground into abandoned burrows or holes during daylight hours and emerge around sunset. Times of retreat and emergence are temperature dependent although light intensity and humidity may also be important factors.

### **Boreal spiders as indicators of multi-scale forest structure and disturbance**

David Shorthouse\* and John Spence - University of Alberta

The maintenance of biodiversity is paraded as the key to sustainable forest management. However, we are largely ignorant of the biodiversity we seek to maintain. In addition, we know very little about the link between biodiversity and forest structure, the tangible key to managing forests. Through the Ecological Management by Emulating Natural Disturbance (EMEND) experiment situated in the boreal mixed wood forest of northwestern Alberta, Canada, industry and research partners are evaluating critical aspects of the natural disturbance paradigm. The central hypothesis of this experiment is that the amount and distribution of residual material left after harvest can emulate the residual left after fire. I am contributing to the EMEND effort by assessing the biodiversity of spiders in experimentally harvested and burned sites. Pre-treatment (1998) and post-treatment results (1999) are presented at three structural levels: stand, treatment, and within treatment. A gradient in spider assemblage structure mirrors that of harvest intensity. These results will contribute to a basic understanding of boreal forest spider biology and diversity, to an assessment of the natural disturbance model, and hopefully to the aging socio-political discussion about forest sustainability.

### **Palpatores is monophyletic: molecular systematics of higher relationships in harvestmen (Opiliones)**

Jeffrey Shultz\*<sup>1</sup> and Jerome Regier<sup>2</sup> - 1. University of Maryland, 2. University of Maryland Biotechnology Institute

Recent phylogenetic studies of Opiliones have convincingly demonstrated that Cyphophthalmi and Phalangida (= Palpatores + Laniatores) are sister groups, but higher relationships within Phalangida remain ambiguous. Current debate focuses on whether Palpatores (= Caddoidea + Phalangioidea + Ischyropsalidoidea + Troguloidea) is

monophyletic or paraphyletic, with an Ischyropsalidoidea + Troguloidea clade being more closely related to Laniatores. The latter hypothesis was weakly favored in a recent combined study of 18S and 28S ribosomal DNA and morphology. Here higher relationships within Phalangida are examined using two nuclear genes (elongation factor-1 alpha and RNA polymerase II) from 27 opilion species representing seven superfamilies. Cyphophthalmi was used as the outgroup. Nucleotide and inferred amino acid sequences were analyzed using maximum-parsimony and maximum-likelihood methods. All analyses recovered Palpatores as the monophyletic sister group to Laniatores with moderate to strong empirical support. Most palpatorean superfamilies were also recovered, but relationships among them were ambiguous or weakly supported. Re-examination of evidence from 18S + 28S rDNA showed that these data do not significantly favor paraphyly of Palpatores over monophyly. Additionally, the morphological evidence originally interpreted to favor a paraphyletic Palpatores is weakened when several characters are coded more accurately. Combined analysis of all nuclear protein-encoding genes, ribosomal genes and morphology supports a monophyletic Palpatores.

### **Phylogeny of the North American *Schizocosa*: a morphological study**

Gail Stratton - University of Mississippi

Although several of the genera in the North American Lycosinae (Family Lycosidae) have been revised, there has yet to be a phylogenetic study of the subfamily. One step in clarifying relationships in the Lycosinae is this phylogenetic study of the North American genus *Schizocosa* Chamberlin using a morphological data matrix. Thirty taxa are included in this analysis, including three outgroups (*Gladicosa pulchra*, *Hogna georgicola* and *Rabidosa rabida*), one undescribed species, three geographically distinct populations of *S. ocreata* and two distinct populations of *S. crassipes*. Fifty characters were found to be informative and include 20 somatic characters, 13 male palpal characters, 11 female epigynal characters and 6 male secondary sexual characters. The genus is of interest because there are several species that display prominent secondary sexual characteristics; several species have been used as models for sexual selection, fluctuating asymmetry and speciation. Heuristic searches were performed using Paup (Ver. 4.0b4a), using the Stepwise-addition option & 1000 reps of random addition sequences. All characters were unordered. The following data sets were run: (1) all characters included, equal weight; (2) palpal and epigynal characters weighted as "2"; somatic and secondary sexual characters weighted as "1"; (3) characters reweighted by the CI (consistency index), RC (rescaled consistency index) and RI (retention index). There was support for three clades on the preferred trees: [*aulonia*, *cespitem*, *salsa*, *mimula* and *chiricahua*], [*avida*, *communis*, *retrorsa*, *mccooki*, *maxima* and *minnesotensis*] and [*humilis*, *bilineata*, *crassipalpata*, *saltatrix*, *duplex*, *crassipes*, *ocrea*, *rovneri*, *stridulans*, *uetzi* and *jlorigana*]. Characters of interest are mapped onto the phylogeny.

### **Walking in the dark: can sand scorpions orient to objects in complete darkness?**

Vail Stephens and Douglas Gaffin\* - University of Oklahoma

Sand scorpions orient to and from their home burrows and around objects at night. These animals have sense organs with the potential to detect several types of environmental stimuli. These organs include: lateral and medial eyes (light information); basitarsal compound slit sensilla (BCSS), tarsal mechanosensory hairs, and trichobothria (mechanical information); tarsal organs (temperature and humidity information); pectines and tarsal taste hairs (chemical information). Here we focus on scorpion orientation relative to two forms of mechanical energy: 1) seismic waves initiated by the scorpion's own footsteps reverberating off nearby objects (putatively sensed by BCSS) and 2) near-range changes in air movement around objects (putatively sensed by trichobothria). Desert grassland scorpions, *Paruroctonus utahensis*, were dropped individually in the center of a circular arena with one quadrant removed. Scorpion movements were plotted relative to the open portion of the arena and to magnetic north. All trials were monitored under infrared illumination (940 nm) to reduce potential visual cues, and several measures were taken to remove possible chemical cues. Trials were conducted under two sets of conditions: 1)

arena in contact with the sand and 2) arena suspended immediately above the sand. For both conditions, movements in relation to magnetic north were random. Movements in relation to the open quadrant were statistically non-random for both conditions. These findings indicate that sand scorpions can detect objects in the absence of known visual and chemical cues. We are now developing assays to determine the relative contributions of seismic and near-range air movements to scorpion orientation.

### **Predator avoidance on the water surface? Kinematics and efficacy of vertical jumping by *Dolomedes***

Robert Suter\* and Jessica Gruenwald Vassar College

Vertical jumps of fishing spiders (*Dolomedes* sp.) from the water surface have been presumed to be evasive behaviors directed against predatory fish. We used high-speed videography to analyze the jumps of fishing spiders and then constructed a numerical model to assess the effectiveness of these jumps in evading predatory strikes by trout. Jump height (mean=3.7 cm) and duration (mean= 0.17 sec) were similar across spider masses (0.05- 0.66 g) but latency to jump increased significantly with mass. To accomplish jumps of similar height, more massive spiders had to generate more force during the propulsive phase of the jump than did smaller spiders; and the contribution of fluid drag to the total force used in jumping was substantially greater for large spiders than for smaller ones. Our model juxtaposing the jumps of spiders and the attacks of trout revealed that jump heights and durations were inadequate; only the most lethargic strikes by trout could be successfully evaded by jumping vertically from the water surface.

### **Spider sincerity: the mechanisms of honest communication**

Phillip Taylor - University of Cincinnati

Spider interactions are usually mediated by assessment via communication systems that are thought to help rivals and potential mates discriminate each other's quality. In jumping spiders (Salticidae), visual displays play a key role both in contests and in courtship. If salticid displays are designed to reveal signaller quality, then we need to consider the kinds of mechanisms that prevent 'cheating' by poor quality signallers. Current theory indicates three likely mechanisms: 'handicap', 'index' and 'amplifier'. The handicap mechanism is by far the most widely accepted. These signals are expensive to produce and so only high quality signallers can afford the cost of an extravagant signal. For example, only healthy male salticids may be able to afford the energetic cost of dancing for prospective mates. Indices and amplifiers are not widely known and depend on design rather than costs for honesty. Indices bear a direct association with the signaled quality and so poor quality signallers unavoidably bear less elaborate signals. Whereas handicaps and indices are both 'quality indicators', amplifiers are not. Instead, amplifiers only aid assessment by increasing the ease with which receivers can assess pre-existing cues and signals that are associated with quality. A more intense amplifier does not make the bearer seem of superior quality but does make true quality easier to discriminate. I present results of experiments involving *Plexippus paykulli* to illustrate how each of the three mechanisms of honest signaling may contribute to our understanding of communication in salticids and in other spiders.

### **Plant nectar increases survival, activity, and predation in a running spider**

Robin Taylor - Ohio State University

Nocturnal running spiderlings *Chiracanthium inclusum* (Hentz) (Araneae: Miturgidae) crowded together, on a diet

of plant nectar and water, lived significantly longer than controls with access to water only. They were also more active at night. Nectar feeding, therefore, may be related to the "running" lifestyle of these spiders. Nectar-fed *C. inclusum* also consumed twice as many prey as did controls, a product of living longer and perhaps increased activity. The question remains, however: do these spiders have a preference for prey or nectar? The answer would be useful for pest management in California vineyards and Texas cotton crops, where *C. inclusum* is one of the most abundant spiders.

### **Effects of sublethal doses of pesticides on spider behavior**

Bill Tietjen - Bellarmine University

Research in our laboratory has concentrated on four aspects of this problem: (1) develop methods for delivering sublethal doses of malathion to spiders under laboratory conditions, (2) develop assays to record changes in the behavior of spider species from different guilds (orb weavers, irregular web weavers, non-web-weaving spiders), (3) record changes in the behavior of spiders and determine if they recover from sublethal effects, and (4) compile a "directory" of behaviors, spider species, and methods related to the effects of malathion on behavior that can be used in the more extensive survey presented here. Techniques were developed to dose spiders at sublethal concentrations and to measure changes in several behaviors. Data related to courtship behavior, prey capture, diurnal activity, and measures of web structure were taken in detail for several species. We have cataloged behavioral responses of 11 spider species from five families, and five insect species (three orders). Equipment was designed and built to accomplish these tasks and novel methods were perfected to collect and analyze the data which included image analysis, video digitization, and laser-based vibration measurement. These methods are applicable to a variety of spider and insect species and can be easily adapted to other studies in animal behavior, pest control, and general entomology.

### **El Nino influence on group formation in facultative colonial web-building spiders**

George Uetz and J. Andrew Roberts - University of Cincinnati

The discovery of aggregations of the colonial web-building spider *Metepeira spinipes* on the Monterey peninsula in California, linked to the 1998 El Nino phenomenon, has presented a unique opportunity to examine the mechanism(s) responsible for group-living in spiders. In previous years, populations of *M spinipes* in these areas were predominately solitary, but following the El Nino event, large colonies have been observed. On several trips to the central California coast (Fall 1998, Summer and Fall 1999), we collected data on colonies of *M spinipes* from populations at Half Moon Bay (San Mateo Co.), Asilomar State Beach and San Jose Creek State Beach (Monterey Co.). Our field studies confirm earlier observations that increases in prey insect abundance during El Nino years result in higher density of spider populations, creating conditions favorable to aggregation and social behavior. Our data indicate that spiders aggregate in greater numbers in localized sites with higher prey availability. Observations of prey availability and individual prey capture rates support the predictions of risk-sensitivity theory: i.e., spiders living in groups have reduced variance in prey. Grouping may increase fitness, as spiders living in groups have more egg sacs/female than solitaries, and variance in egg sac number decreases with colony size. Specimens collected from field populations are being used to examine the genetic structure of populations: i.e., genetic similarity among colonies and genetic relatedness among individuals within colonies (see poster by G. Sagel et al.).

### **0, what a tangled web we weave: the anatomy of the *Arachnius gluteus* hoax**

Richard Vetter - University of California

In September 1999, a hoax involving an alleged deadly spider started circulating the internet. According to the alarming message, the South American blush spider, *Arachnius gluteus*, was found under a toilet seat in a restaurant at Blare Airport in Chicago as was ascertained by the deaths of 4 women who had used the facilities. Further searching of airplane toilets uncovered more deadly spiders which now could be anywhere in the country. As with most hoaxes, it was then suggested that the email recipient warn all friends and loved ones. Many did. Because of the Univ. Calif. Riverside website on spiders, several emails a day tumbled in, requesting verification of the story. Rather than answer each email, it was more efficient to erect a website debunking the hoax. For the first 2 weeks of operation, the debunking website added 1,000 hits every 2 to 3 hours during the workday. Just as the hoax was being circulated around the country, the debunking started to defuse the hoax as skeptical recipients sought out *Arachnius* websites and counter-emailed. Additionally, the perpetrator contacted me and I was able to question him regarding the rationale for initiating the hoax. This internet spider hoax showed the general public's fears of spiders, the unknown and the unfamiliar, their willingness to believe much of what they read on the internet and the willingness to pass along information without checking its veracity. Although the internet can be misused, it also is a powerful tool for the dissemination of correct information.

### **A comparative analysis of sexual dimorphism and body size in wolf spiders (Araneae: Lycosidae)**

Sean Walker\* and Ann Rypstra - Miami University

Foraging mode (e.g. sit-and-wait versus active foragers) has been correlated with a number life-history and ecological characteristics. Most comparative studies of spiders focus on differences between a number of species across different families and generally, after accounting for phylogeny, show no correlation between life-history characteristics and foraging mode. In such a large group of species, it seems likely that important patterns may be obscured because of different rates of evolution or different allometric relationships among characteristics between different clades. We tested the hypothesis that degree of sexual size dimorphism and body size were correlated with foraging mode in a single family of spiders, Lycosidae. Lycosids, or wolf spiders, vary widely in size and also exhibit variation in foraging mode. We collected data on body size (carapace width, abdomen and total length) and foraging mode from taxonomic keys and literature on 138 species of wolf spider. After accounting for phylogeny, there was no association between sexual size dimorphism and foraging mode; however, both sexes were larger in species that were sit and wait foragers. Also, there was a greater degree of sexual dimorphism in abdomen length than in carapace width. Coupled with the positive correlation between body size and clutch size, these data suggest fecundity selection is important in the evolution of sexual dimorphism and body size in wolf spiders.

### **The influence of predation risk on mate choice and courtship behavior in the wolf spider, *Pardosa milvina***

Sean Walker\*<sup>1</sup>, Matt Persons<sup>2</sup> and Ann Rypstra<sup>1</sup> - 1. Miami University, 2. Susquehanna University

In empirical and theoretical studies, predation risk has been shown to reduce the intensity of sexual selection by female mate choice and may also reduce the intensity male courtship behavior. *Pardosa milvina* and *Hogna helluo* represent an ideal species pair to examine the effects of predation risk on male courtship behavior and female mate choice since both male and female *Pardosa* respond with similar antipredator behavior to chemical cues from *Hogna*, a common *Pardosa* predator. We predicted that male courtship behavior will be reduced under predation risk. Similarly, female preferences for conspicuous male courtship behavior as well as morphological features (body size and fluctuating asymmetry) will be reduced under predation risk. We tested these hypotheses by monitoring the courtship behavior and mate selection of *Pardosa* on chemical cues from *Hogna* (predation risk) and on blank filter

paper (no predation risk). When not under predation risk, females prefer males that performed body shakes and leg raises at a high rate whereas under predation risk we found no significant preference for these behaviors. Also, males that mated when not under predation risk performed the most intense courtship behaviors. However, females, regardless of predation risk, preferred males that had low levels of fluctuating asymmetry. Therefore it appears that females are not changing their mating preference in response to predation risk but males are changing their courtship behavior.

### **The effect of background color and starvation on the prey capture ability of three jumping spider species.**

Elizabeth Wells - University of Massachusetts

The ability to capture flour beetle larvae on a black or white background was measured in the jumping spiders, *Paraphidippus aurantia*, *Phidippus asotus*, and field caught and lab reared *Phidippus audax*. Beige colored larvae were presented to a spider on either a white or a black background and spiders were given 15 minutes in which to capture the larvae. Spiders were tested after one, two, and three weeks of starvation. Prey capture rate was not affected by prey background color. Prey on white and black backgrounds were captured at an equal rate by spiders. Prey capture rates at one, two, and three weeks of starvation were not significantly different and the occurrence of prey capture events was not significantly different from a random distribution. The number of prey captures by field caught *P. aurantia*, *P. asotus*, and *P. audax* were not significantly different after one week of starvation, but *P. asotus* had significantly less prey captures than *P. audax* at two weeks of starvation and *P. aurantia* had significantly more prey captures than *P. audax* at three weeks of starvation. Prey capture rates by field caught *P. audax* and lab reared *P. audax* were not significantly different.

### **A structured inventory of the spiders in a southern Appalachian bog**

Emily Whiteley - Western Carolina University

A modified Coddington protocol was used to sample the spider assemblages in five vegetation zones within a southern Appalachian bog in Jackson County, North Carolina. Four sets of standardized samples were collected ten weeks apart, from May to December 1999. A total of 108 species in 75 genera and 17 families were found in 113 samples. The observed species accumulation curve failed to reach an asymptote, and the shape of this curve and the richness estimates (ACE, ICE, Chao1, Chao2, first order jackknife, second order jackknife, bootstrap, and Michaelis-Menten means) suggest that there may be 120-180 spider species in this bog. Comparisons of the spider sample sets from the three principal vegetation zones indicate that as the structural complexity of the vegetation increases, the spider species richness and diversity (Shannon's and Simpson's diversity indices) increase.

Complementarity and Bray-Curtis similarity values for each pairing of the spider sample sets from the five vegetation zones indicate that the vegetation zones with greater structural differences support spider assemblages that are taxonomically more distinct. Ground dwelling spiders appeared more abundant and species rich than aerial guilds. Three of the most abundant species were lycosids (*Schizocosa humilis* (Banks), *Pirata insularis* Emerton, and *Trabeops aurantiaca* (Emerton)) which coexisted in three of the zones and were significantly different in adult body size. Four previously undescribed species were collected, belonging to the erigonine linyphiid genera *Annapolis*, *Anthrobia*, and *Walckenaeria*, and the salticid genus *Zygoballus*, and reinforce the view that this bog is a significant storehouse of biodiversity.

### **Defensive behavior of *P. vadosa*: responses to different types of predators**

Valerie Wielard - The University of Texas at Arlington

The anti-predator behavior of *Pardosa vadosa* Barnes 1959 was examined in the laboratory. Responses to three predator models (bird, scorpion, and lizard) and one sympatric live predator, *Hogna punctulata* Hentz 1844, were recorded. Three classes of *P. vadosa* were used: males, females, and females carrying egg sacs. Responses were typically freezing (stopping all motion for at least one minute) or a combination of freezing and running. Possible differences among the three classes' responses to a single predator and differences among all *Pardosa*'s responses to different predators (i.e. bird vs. scorpion models) were examined.

### **Sex-based differences in anti-predator behavior in the spotted cucumber beetle (Coleoptera: Chrysomelidae)**

Jennifer Williams\*<sup>1</sup>, Willam Snyder and David Wise<sup>1</sup> - University of Kentucky, <sup>2</sup>University of Wisconsin-Madison

Adult females of many arthropods require high food intake for making eggs, whereas males feed less and spend more time searching for mates. If males and females differentially prioritize activities, they may experience a different ratio of costs to benefits of antipredator behaviors. We investigated sexual differences in the behavioral responses of spotted cucumber beetles, *Diabrotica undecimpunctata howardi* (Barber), to the wolf spider *Rabidosa rabida* Walckenaer in laboratory arenas in which the beetle could detect the spider, but the spider was prevented from preying upon the beetle. In structurally simple arenas with a single plant, female beetles spent less time on the plant, and fed less when on the plant, in the presence of a spider. In contrast, male beetles did not alter their behavior in response to the spider. A second experiment utilized larger arenas, in which the beetle could choose between a side containing a plant with a spider at its base, and the other side with no spider. Female cucumber beetles spent less time on the side with the spider, whereas males did not consistently avoid the spider. The reduction in feeding by females was sometimes sufficient to lead to decreased plant damage. The weaker antipredator response of males leads to a greater predation risk, as revealed by a third experiment in which predation was allowed. In this experiment males were 16 times more likely than females to be killed by wolf spiders, demonstrating that the lower responsiveness of male beetles to predators increases the risk of being preyed upon.

### **Predation by cursorial spiders limits densities of tomocerid Collembola: evidence from a long-term field experiment**

David Wise\* and Benrong Chen - University of Kentucky

It has been hypothesized that predation by spiders limits densities of Collembola and other detritivores and fungivores in the food web of deciduous leaf litter, but few experiments have tested this hypothesis directly. We reduced densities of spiders in replicated fenced plots for 1.3 years in order to determine if Collembola {springtail} populations would exhibit a release from spider predation. In June, thirty 4-m<sup>2</sup> fenced plots (15 spider-removal, 15 control plots) and 15 open reference areas were established in a deciduous forest in central Kentucky, USA. Spiders were removed from the removal treatment by periodic live pitfall trapping and searching the litter surface. Densities of web spinners were not affected, but the total density of cursorial spiders was rapidly reduced by c. 50% in the spider-removal treatment and was maintained at levels lower than control plots until September of the following year. Lycosids and gnaphosids displayed the highest activity/abundance, accounting for > 50% of the cursorial spiders trapped. The density reduction was greatest for *Schizocosa* and other wolf spiders (>90%). Total Collembola numbers did not differ between spider-removal and control plots. However, Collembola in the family Tomoceridae exhibited a significant release from spider predation. Densities of tomocerids, which are the largest and most active springtails in the leaf-litter community we studied, and which accounted for c. 1/3 of the Collembola biomass on the research site, became 2x higher in the spider-removal treatment than either the fenced control or open reference plots after a year of reducing densities of cursorial spiders.

**A screening of two scorpion populations, *Centruroides vittatus* (Say), for random amplified polymorphic DNA markers**

Tsunemi Yamashita\* and Daniel Hodgson - Arkansas Tech University

We extracted total DNA from several individuals to screen for RAPD markers. The scorpions were removed from populations 87 km apart in Arkansas. Individuals were collected from the Ouachita mountains (Logan County) and the Ozark mountains (Pope County). We tested 18 RAPD primers for suitability in a population analysis. Nine of the 18 primers appeared to show distinct, variable bands suitable for use in a larger genetic analysis of *C. vittatus* populations. Our results indicate RAPD's are useful to investigate subdivision in scorpion populations.

**How do bolas spiders cope with seasonal and within-night periodicity of prey availability?**

Kenneth Yeorgan\*, Cesar Gemenio and Kenneth Haynes - Department of Entomology, University of Kentucky

During late summer and autumn, females of the bolas spider *Mastophora hutchinsoni* produce allomones that mimic the sex pheromones of five moth species and capture attracted male moths. Two of the moth species (the bristly cutworm and the smoky tetanolita) account for more than 90% of the spider's captured prey. The smoky tetanolita is active throughout the spider's moth-hunting season (mid-July to early November in Kentucky), and its sexual activity occurs late at night, typically after 11 p.m. The bristly cutworm is available to the spider only from late August until early October, and its sexual activity occurs early each night (before 10 p.m.). We wanted to know if the spider's allomone emissions varied seasonally and within nights in accordance with prey availability. Seasonal and diel changes in allomone emission may improve hunting efficiency because the bristly cutworm's pheromone interferes with attraction of smoky tetanolita males to smoky tetanolita pheromone. We used field-cage experiments with seasonally manipulated, photoregime-manipulated, and normal moths, collections of allomones emitted from hunting spiders, and electroantennogram analyses to address this question. Bolas spiders were able to capture the bristly cutworm outside its normal seasonal and nightly periods of activity; bolas spiders captured the smoky tetanolita outside its normal nightly period of activity. Analyses of early-night and late-night volatile allomone collections from hunting spiders, however, indicated that the bolas spider decreases its rate of emission of the bristly cutworm allomone late at night, which may reduce interference with attractiveness of the smoky tetanolita allomone to smoky tetanolita males.