6th Annual
St. Louis Ecology, Evolution, and Conservation (SLEEC) Retreat
Principia College

September 17, 2016
Schedule

0800 Bagels and coffee: signing in; setting up posters and talks

First morning session:
0900 Welcome and Introduction: Bob Marquis (UMSL and the Harris World Ecology Center)

0905 Greetings from Jonathan W. Palmer, President of Principia College

0910 Welcome and Logistics: Chrissy McAllister (Principia College)

0915 Laura Bhatti Catano (UMSL). Reefscapes of fear: The effect of predation risk and habitat structure of reef fish foraging behavior.

0930 Justin Zweck (SLU). Comparison of Generalized and Specialized Pollination Systems in Co-Occurring Legumes.

0945 Scott Eckert (Principia). Home range and habitat use of the threatened timber rattlesnake (Crotalus horridus) on the lands of Principia College.

1000 Suegene Noh (Wash U). Social amoebae express rapidly evolving genes in mixed company during multicellular development.

1015 Nicole Miller-Struttmann (MOBOT/Webster). Hacking acoustic signals to monitor an imperiled resource.

1030 Sara Wright (Wash U). Cyanogenesis and local adaptation in white clover.

1045 Coffee and posters

Second morning session:
1115 Edward Dell (NGRREC). Metabolic asymmetry drives the distribution of marine top predators.

1130 Joseph LaManna (Wash U). Negative density dependence, species relative abundance, and diversity-environment relationships across temperate and tropical forests.

1145 Danielle Lee (SIUE). Novelty Responses and Individuality of African giant pouched rats.

1200 Oyomoare Osazuwa-Peters (MOBOT). A guide to undiscovered species.

1215 Samoa Asigau (UMSL). The distribution of mosquitoes across an altitudinal gradient in the Galapagos Islands.

1230 Dapeng Zhang (SLU). Discovering codes and evolution of DNA modifications.

1245 Lunch break and posters

Afternoon session:
1415 Greg Bruland (Principia). Evolution of Undergraduate Research in the Biology & Natural Resources Department at Principia College.

1430 Zhen Peng (Wash U). Strong correlation between codon usage bias and gene functions across the entire genome of Drosophila melanogaster suggesting that synonymous mutations are not usually neutral.

1445 David Powell (STL Zoo). Animal Personality in Conservation Contexts: Theory, Applications, and Problems.

1500 William Shoenberger (SLU). Familiarity reduces aggression, and alters mating patterns, in *Leiobunum aldrichi.*

1515 Christine Edwards (MOBOT). Clarifying species boundaries in a taxonomically questionable endangered plant species: a population genomics approach.

1530 Simon Uribe-Convers (UMSL). Investigating the Accumulation of Evidence for Speciation.

1545 Coffee and posters

Keynote address:
1645 Ruth Shaw, University of Minnesota. Studying the adaptive process in wild plant populations: purple coneflower and partridgepea.

1745 Concluding remarks

1830 Happy Hour and Dinner: Audubon Center at Riverlands

ST. LOUIS SLEEC FALL 2016 RETREAT
ORAL PRESENTATIONS

Asigau, Samoa, University of Missouri St. Louis, Department of Biology, PhD Candidate Parker Lab. Dr. Patricia Parker, University of Missouri St. Louis, Department of Biology. **The distribution of mosquitoes across an altitudinal gradient in the Galapagos Islands.**

Through repeated sampling on three major islands of the Galapagos and across multiple years, we aimed to assess whether mosquitoes exhibited an altitudinal limit that could potentially create disease-free refugia for endemic avifauna populations, as in Hawaii. Using negative binomial models and zero inflated models, we found elevation, year of collection and human habitation status to be significant factors in influencing *Culex quinquefasciatus* distributions, the vector responsible for transmitting avian malaria in Hawaii. In contrast, year of mosquito trapping was the only significant factor for *Aedes taeniorhynchus*, suggesting a widespread distribution. Further investigation on the fine scale genetic structure of local populations of both species could provide important insights to gene flow, and indirectly to dispersal of wildlife disease pathogens. I am also trying to understand the host feeding ranges of mosquitoes and whether they exhibit a preference for certain host taxa. These aspects of mosquito ecology are important to managing diseases that threaten wildlife populations. Fortunately, Galapagos has yet to face any major extinctions of endemic avifauna from a disease outbreak as suffered in Hawaii. Therefore, an urgency remains to understand the role of mosquitoes in this parasite-host-vector relationship and disease dynamics in general.

Bhatti Catano, Laura, **University of Missouri St. Louis, Department of Biology. Reefscapes of fear: The effect of predation risk and habitat structure of reef fish foraging behavior.**

Predators exert strong effects on ecological communities by intimidating their prey. Risk effects are often not uniform across landscapes or among species and can vary widely across gradients of habitat complexity and with different prey escape tactics. These context dependencies may be important for coral reef ecosystems that vary widely in habitat complexity and have species-rich predator and prey communities. With field experiments using predator decoys of the black grouper, I investigated how reef complexity interacts with predation risk to affect the foraging behavior and herbivory rates of herbivorous fishes across four reefs in the Florida Keys. Predation risk suppressed herbivory more strongly in areas of high complexity and skewed the distribution of fishes towards smaller individuals. As predator populations decline due to overfishing and structural complexity declines with coral loss, the key process of grazing, which is integral to the persistence and recovery of reefs, may be altered.

Bruland, Greg, Principia College, Department of Biology and Environmental Studies, greg.bruland@principia.edu. Chrissy McAllister, Scott Eckert, John Lovseth **. Recent Evolution of Undergraduate Research in the Biology & Natural Resources Department at Principia College.**

There is growing interest in creating meaningful research experiences for undergraduates. The Biology Department at Principia College has revised their program to better prepare students to conduct research and to create more opportunities for research. Revisions to the program included adding a biometry course and shifting the mandatory senior capstone to a voluntary senior thesis. While the number of theses has decreased, the quality has increased. Some students have presented their research at conferences and published in scientific journals. Per the recommendation of an external review and strategic funding, an on-campus Summer Research Program was initiated. The program provides room and board in addition to a stipend. Eight students participated in 2015 and 2016. The students were involved in researching the morphological variation in important grasses, movement patterns of timber rattlesnakes, and dendrochronology of local tree species. The talk will conclude with lessons learned and recommendations for promoting undergraduate research.

Dell, Edward, National Great Rivers Research and Education Center, tonyidell@gmail.com. **Metabolic asymmetry drives the distribution of marine top predators.**

Mammals and birds have independently invaded the sea over a dozen times during the Cenozoic, and currently represent ecologically significant marine top predators. This radiation has occurred primarily in cold, thermally stressful waters, counter to general biogeographic patterns of animal diversity and diversification. Using empirical data and mechanistic theory that links organismal physiology (metabolism) to ecosystem consumption rates, we show that in cold waters energetic constraints lead to metabolic and foraging asymmetries that favor endotherms over ectotherms. For example, after controlling for resource availability and other factors, thermal drivers of consumption lead to a 1–2 orders of magnitude increase in abundance and prey capture rates of marine mammals from the equator to the poles. These processes correspond to an increase in abundance and morphological/phylogenetic diversity of endotherms in cold waters, as their ectothermic prey (predators) become easier to capture (escape), thus accounting for the striking distributional pattern observed in marine endotherms.

Eckert, Scott, Principia College, Biology and Natural Resources Department, scott.eckert@principia.edu. Andrew Jesper, Samson Myers, Taylor Bookout and Ian Armesy. **Home range and habitat use of the threatened timber rattlesnake (Crotalus horridus) on the lands of Principia College.**

As a species particularly well-adapted to forested environments, the timber rattlesnake (Crotalus horridus) is threatened through much of it range by destruction of these habitats. Within Illinois, the loss of contiguous forests is particularly distinct, as there is currently less than 1% pre-settlement forest lands remaining. Principia college was established on 2,600 acres of mix-use woodland in the early 1930's and has seen an increase of forested habitat by more than 30% since its founding. Today the College manages 2,000 acres of forest, 235 acres of old farm fields, 60 acres of prairie and provides a highly desirable and diverse habitat for C. horridus. We initiated the following radio tracking study to understand habitat use by the species on the Principia lands; the location of active hibernacula; and to eventually evaluate population status.

Edwards, Christine, Conservation Geneticist, CCSD, Science & Conservation, Missouri Botanical Garden. Joel Swift, Alex Linan, Missouri Botanical Garden, CCSD, Science & Conservation. **Clarifying species boundaries in a taxonomically questionable endangered plant species: a population genomics approach.**

Understanding the distinctiveness of taxonomically questionable, threatened or endangered species is important to ensure that conservation efforts are devoted to truly unique taxa. One such species, *Lilaeopsis schaffneriana subsp. recurva*, is a federally endangered plant occupying freshwater streams in Arizona and northern Mexico. Both the morphology and the geographic range of this subspecies overlap with those of *L. schaffneriana subsp. schaffneriana*, a more widespread subspecies found in Mexico and Ecuador, suggesting that they may not be distinct. The goal of this study was to assess whether the two subspecies of *L. schaffneriana* are genetically differentiated and whether *subsp. recurva* is unique and deserves protection. We used a 2B-rad approach to generate SNP data from populations of both subspecies and a closely related congener and analyzed patterns of genetic structure. Results show that populations of the two subspecies in Arizona and Mexico are not genetically distinct, whereas populations in Ecuador are highly divergent. These results indicate that several taxonomic changes are necessary, which will have important implications for conservation efforts for this species.

LaManna, Joseph, **Washington University in St. Louis, Department of Biology & Tyson Research Center, St. Louis, Missouri, USA, jlamanna@wustl.edu.** Maranda L. Walton, Washington University in St. Louis, Department of Biology & Tyson Research Center, St. Louis, Missouri, USA, maranda.walton717@gmail.com. Benjamin L. Turner, Smithsonian Tropical Research Institute, Balboa, Ancon, Panama, turnerbl@si.edu. Dilys M. Vela Díaz, Washington University in St. Louis, Department of Biology & Tyson Research Center, St. Louis, Missouri, USA, veladd@wustl.edu. Jonathan A. Myers, Washington University in St. Louis, Department of

Biology & Tyson Research Center, St. Louis, Missouri, USA, jamyers@wustl.edu. Smithsonian Center for Tropical Forest Science – Forest Global Earth Observatory (CTFS-ForestGEO) Network (42 principal investigators and researchers from 21 forest-dynamics plots in 9 countries). **Negative density dependence, species relative abundance, and diversity-environment relationships across temperate and tropical forests.**

Conspecific negative density dependence is thought to maintain diversity by limiting abundances of common species. Yet the extent to which this mechanism explains patterns of species diversity across environmental or latitudinal gradients is largely unknown. We examined density-dependent recruitment of woody-plant seedlings and saplings and changes in species diversity within a temperate stem-mapped forest and across 21 temperate and tropical stem-mapped forest plots worldwide. Within the temperate forest, the strength of negative density dependence increased with resource availability and appeared to reduce diversity when stronger for rare than common species, but increase diversity when stronger for common species. The strength of negative density dependence also increased with mean annual temperature and was associated with increasing species richness across latitudes. Our results suggest that the strength of negative density dependence is mediated by the environment at both local and global scales and contributes to the latitudinal gradient in species diversity.

Lee, Danielle, **Southern Illinois University Edwardsville, Department of Biological Sciences,** danilee@siue.edu. **Novelty Responses and Individuality of African giant pouched rats.**

Alternative tactics can arise in which behavior of some individuals systematically differ from others. By investigating the degree of variation that exists in natural populations, we gain insight into how evolution has shaped the 'personality' of individuals and established evolutionary stable alternatives, usually along a continuum. In the first known study to investigate the behavioral scope of *Cricetomys ansorgei*, we examined the spontaneous responses of two study populations of wild-caught African giant pouched rats. One population was examined soon after capture in Tanzania (and released back into the wild at the end of the study) and the other population was transferred to the United States to establish a colony and was examined several months after living in captivity. Presenting a series of novel stimuli tests (light-dark box and novel food items), we measured the proactive-reactive responses of subjects in each study group. In both wild and captive study populations, about a quarter- third subjects demonstrated flexible responses to novelty; however these responses were not necessarily correlated across tests. Proactive-reactive responses to novelty may be relevant to understanding the mechanisms responsible for individual variation in exploration as well as adjusting to captivity.

Miller-Struttmann, Nicole, Webster University, Biological Sciences Department. David Heise[2], Johannes Schul[3], Jennifer C. Geib[4], and Candace Galen[3]; [2] Department of Life and Physical Sciences, Lincoln University; [3] Division of Biological Sciences, University of Missouri; [4] Department of Biology, Appalachian State University.
Hacking acoustic signals to monitor an imperiled resource

Declines in bee populations threaten wild and agricultural plant yields. Diverse mechanisms, including flower declines, pesticides and climate change, have been implicated. Mitigating these declines requires extensive monitoring, but traditional survey techniques are labor and time intensive. Bees create vibrations (buzzes) when they forage, fly and communicate. Bee buzz structure may correlate with traits that determine foraging effectiveness and could be used to survey bee populations and pollination services. In this study, we evaluate the reliability of acoustic survey techniques for monitoring bumble bees and their pollination services to alpine clovers (*Trifolium dasyphyllum* and *T. parryi*). We conducted flight cage experiments and a literature review to determine the relationship between flight buzz frequency and traits influencing pollination success (i.e., body size, tongue length, species identity). We then compared acoustic and traditional visual surveys to test the efficacy of using buzz density to estimate pollinator abundance and pollination services. We show that acoustic signals can be leveraged to monitor pollinator activity and pollination services in a bumble bee pollinated system. Tongue length and body size were negatively correlated with buzz frequency, indicating that buzz diversity reflects bumble bee functional diversity. Acoustic surveys reliably predict bumble bee density and seed set of both *Trifolium* species. In order to respond to rapid, geographically variable declines in pollinators, conservation

biologists and farmers need a fast, mobile monitoring system that can assess pollination services in real time. We posit that acoustic monitoring addresses these goals while circumventing the downfalls of traditional survey techniques.

Noh, Suegene, Washington University in St. Louis, Department of Biology. Katherine Geist, Joan Strassmann, David Queller, Department of Biology, Washington University in St. Louis. **Social amoebae express rapidly evolving genes in mixed company during multicellular development.**

If conflict is important in nature when different parties join social interactions, the genes involved should show this. Arms races can result in rapid evolution or frequency-dependent stalemates. We studied conflict during the transition from unicellular to multicellular states in the social amoeba Dictyostelium discoideum. These amoebae develop fruiting bodies in which about 20% of cells die and become stalk. When two clones come together, they compete to contribute to spores, not stalk. To identify conflict genes, we compared expression profiles of single genotypes to mixed genotypes (chimeric). Genes that are over-expressed in chimera are those involved in forming the multicellular fruiting body. Under-expressed genes are cell cycle genes. Both expression differences increase the odds of becoming spores in chimeras. Furthermore, these genes evolve under positive selection. These results show that chimeras and social conflict are important in nature, supporting laboratory studies that support the same.

Osazuwa-Peters, Oyomoare, Post-Doctoral Fellow, Science & Conservation, Missouri Botanical Garden. Elizabeth Tokarz[2], Doug Stevens[1] and Iván Jiménez[1], [1]Missouri Botanical Garden, Research and Conservation, [2]Yale University, Department of Ecology and Evolutionary Biology. **A guide to undiscovered species.**

Far more species exist than are known to science. But where do undiscovered species occur? As a step towards addressing this question, here, we developed a model that relates sampling effort to the probability that a given species remains undiscovered within a geographic region. We then applied this model to the plants of Nicaragua, a Neotropical country with a relatively well-documented flora. We found that the probability that a given species remained undiscovered was often close to 1, when geographic range was small. This was commonly the case for species with geographic ranges that were small enough to be considered "critically endangered" according to guidelines by the International Union for Conservation of Nature. This finding reveals the great depth of our ignorance about the geographic distribution of plants (i.e., the "Wallacean shortfall"), even for a country with a relatively well-known flora. It also questions recent attempts to estimate the conservation status of Neotropical plants.

Peng, Zhen, Washington University in St. Louis, Department of Biology, peng.z@wustl.edu. Strong correlation between codon usage bias and gene functions across the entire genome of Drosophila melanogaster suggesting that synonymous mutations are not usually neutral.

Synonymous mutations are usually assumed evolutionarily neutral. However, codon usage bias, the phenomenon that some codons are used more often than their synonymous codons, may undermine this assumption. Recent studies have shown that introducing synonymous mutations to specific genes can modify their functions. In addition, our analysis on the protein coding genes across the entire genome of Drosophila melanogaster revealed that 1. the correlation between gene functions and codon usage exists in most genes and is not a special case; 2. specific set of nonsynonymous codons contribute more to codon usage bias; 3. codon usage patterns of genes correlate to their organ-specificity, sexual dimorphism, molecular functions, and genomic locations; and 4. recently diverged paralogs can have fairly different codon usage biases. These findings suggest that "synonymous mutations as evolutionarily neutral" is a risky assumption. Evolutionary neutrality does not depend on how mutations happen, but how they influence gene functions.

Powell, David, Director of Research, St. Louis Zoo. Animal Personality in Conservation Contexts: Theory, Applications, and Problems.

In the last 20 years there has been an increased interest in studying consistent behavioral differences among individual animals – personalities or behavioral types – and the ramifications of those. A variety of approaches for characterizing behavioral types have been developed and the scope of species studied has rapidly increased. This talk will focus on how animal personality data have been used in conservation contexts – from ex-situ to in-situ and how thinking about behavioral type more explicitly might benefit various conservation initiatives. I will also highlight some of the conceptual challenges we face in the study of animal personality.

Shaw, Ruth, University of Minnesota, Department of Ecology, Evolution, and Behavior. Studying the adaptive process in wild plant populations: purple coneflower and partridgepea.

The process of adaptation is a keystone of evolutionary thought. Numerous demonstrations of past adaptation, as well as failure to adapt, have yielded a wealth of evolutionary insight. Yet we still have little basis for predicting whether and how rapidly populations will adapt as they are confronted with the drastic changes in environment currently ongoing. I will outline how these questions can be directly addressed by implementing well established concepts that have been largely overlooked by empirical evolutionists. I will illustrate the approach with examples from our recent studies. Contrary to a widely espoused view, we have found substantial additive genetic variance for fitness, which implies considerable capacity for ongoing adaptation. Further empirical work of this kind would broaden understanding of the process of ongoing adaptation and strengthen prediction of it.

Shoenberger, William, PhD Student (Fowler-Finn Lab), Saint Louis University. Shoenberger* W, Jocson D, Mhaskar P, Beckett C, Scott E, and Fowler-Finn KD. **Familiarity reduces aggression, and alters mating patterns, in *Leiobunum aldrichi.***

Animals often adjust behavior during interactions with conspecifics. For example, within a mating context, males may alter how they compete for mates depending on their familiarity. We tested if mating dynamics of males change depending on prior experience with one another. We did this by using the harvestmen species *Leiobunum aldrichi* (Opiliones: Sclerosomatidae). We quantified mating dynamics (aggressiveness, successful mating, copulation duration) in male-male-female mating trials where competing males were either familiar or unfamiliar. We manipulated familiarity by pairing males overnight in cages in which they were separated by netting. The following day we ran male-male-female mating trials in which we paired males with either a familiar male (from the same cage) or an unfamiliar male (male from a different cage). We found male-male aggression in familiar trials was considerably lower than in unfamiliar trials and males were less likely to mate. These results demonstrate familiarity from previous social interactions may play an important role in mating dynamics.

Uribe-Convers, Simon, University of Missouri St. Louis, Department of Biology, Postdoctoral Fellow Muchhala Lab, uribe.convers@gmail.com. Investigating the Accumulation of Evidence for Speciation. Although it is widely accepted that speciation is a gradual and constant process with no clear boundaries for the identification of species, to our knowledge, this is the first study to empirically evaluate the accumulation of species properties across time scales or from a comparative phylogenetic perspective. The research objective of this study is to evaluate the order and magnitude of change in species properties over time in two plant Andean genera—*Neobartsia* and *Burmeistera*—comprised of closely related species that show varying degrees of morphological, ecological, and geographical differentiation.

Wright, Sara, **Washington University in St. Louis, Department of Biology, email: sarajeanes@wustl.edu.** Daniel Cui Zhou[1], Linda Small[1], Amy Kuhle[2], and Kenneth Olsen[1]; [1]Washington University, Saint Louis, MO; [2]Quincy University. **Cyanogenesis and local adaptation in white clover.**

White clover (*Trifolium repens*) is a widespread legume that was introduced to North America within the last 500 years. Across its range, it has repeatedly evolved clines in cyanogenesis, the ability to produce hydrogen cyanide upon tissue damage. Higher proportions of cyanogenic plants occur in warmer and more arid climates. To further assess local climatic adaptation in North American white clover, we performed a common garden pilot experiment at Washington University's Tyson Research Center with individuals collected from 15 widespread populations. Plants were assessed for herbivory, growth and survival, and reproductive fitness traits throughout the 2015 season. Multiple fitness traits showed evidence of local adaptation, such that plants from populations nearer to St. Louis performed better than those collected farther away. Future work includes QTL mapping of fitness traits in reciprocal common gardens to identify SNPs associated with local adaptation and assess the relative contribution of cyanogenesis for local adaptation.

Zhang, Dapeng, Assistant Professor Biology, Saint Louis University. Zheng* D, LM Iyer and L Aravind. **Discovering codes and evolution of DNA modifications.**

DNA modifications, such as cytosine methylation in animal, thymine hydroxylation and further glycosylation in kinetoplastids, have served as epigenetic marks that direct DNA repair, chromatin organization, gene silencing, and repression of selfish DNA elements in eukaryotes. However, many of the enzymes that catalyze specific DNA modifications remain to be discovered, and a global picture about their origin is still missing. By using domain-centric phylogenetic anlaysis and comprative genomics, we were able to establish that major eukaryotic DNA-modifying enzymes were originated from bacteriophage DNA modification systems. By studying bacteriophage genomic data, we have reconstructed several key pathways which catalyze yet unknown modification of DNAs. We identified the long-mysterious glycosyltransferase in the pathway generating base-J in kinetoplastids. We also discovered a lineage-specific expansion of TET/JBP genes involved in oxidization of 5-methylcytosine in all major clades of basidiomycete fungi, and established that the expansion was mediated by a transposon-coupled mechanism.

Zweck, Justin, PhD Candidate (Bernhardt Lab), Saint Louis University. Zweck* J, Muñiz P, Arduser M, Bernhardt P. **Comparison of Generalized and Specialized Pollination Systems in Co-Occurring Legumes.**

The floral morphology of many Amorpheae legumes differs dramatically from the papilionoid legume floral form typical of the Faboideae subfamily. While papilionoid species enclose their sexual organs within the petals, the sexual organs of many Amorphaeae species are exposed, potentially permitting pollination by a greater range of taxa. We tested this hypothesis by comparing pollination and reproduction in 4 Amorpheae species versus 4, co-occurring, papilionoid legumes species at the Shaw Nature Reserve, MO in summer 2015. Results indicate that Amorpheae species featured a more generalized pollination system than the papilionoid species, higher insect visitation rates, and significantly higher reproductive rates than papilionoid species in each comparison. Amorpheae species were more likely to feature heterospecific pollen deposition and active pollen collection than papilionoid species, however, suggesting the possibility of a tradeoff in the shift to generalization.