La Selva REU Mentors 2019

Marcelo Araya-Salas, Ph.D.
Cornell University/Universidad de Costa Rica
araya-salas@cornell.edu
Hummingbird vocalizations and behavior

Project 1: Costs and benefits of vocal coordination strategies in lekking hermit hummingbirds. We have documented coordinated singing in long-billed hermits. In this behavior, simultaneously singing males modify the timing of their songs to achieve synchronization. The type of coordination is dependent on the distance between individuals: non-overlapping singing is more common in close proximity while overlapping singing is mostly used when singing at farther distances. We hypothesize that, by overlapping their songs birds may amplify their combined signals and communicate across greater distances, but this benefit is diminished in close proximity, where the ability of bystanders (i.e. females) to locate singers decreases when songs are overlapped by nearby singers. A feasible project would involve measuring the response to overlapping songs emitted by speakers at both close and far distances, expecting that the ability of an individual to find a “singing intruder” (a speaker) will be affected by the distance between the speakers and the type of coordination. This project would require playback experiments and documentation of behavioral responses in lekking hermit hummingbirds.

Project 2: Amplitude modulation in songs and its role as an aggressive signal in a lekking species. This project would be related to the use of amplitude modulation in songs (i.e. singing louder) by lekking hermits during territorial intrusions. Hermit hummingbirds sing from fixed perches at intermediate heights, which allows positioning microphones right underneath singing males and at a consistent distance. This experimental design would allow to test the use of amplitude modulation in aggressive interactions (by simulating singing intruders) and to investigate the morphological correlates of song amplitude.

Christina Baer, Ph.D.
University of Connecticut
christina.baer@uconn.edu
Thermal tolerances and preferences of terrestrial invertebrates

Project 1: Can maximum heat tolerance reliably predict invertebrates’ temperature preferences?
Project 2: Is community structure determined by temperature in a heating experiment?
My research tackles a pressing question in ecology: how will tropical species and communities respond to climate change? One way to answer this is to conduct field heating experiments to predict how animals will be affected by a warmer future. Students working with me will perform a field warming experiment on invertebrates using newly developed field heaters. These heaters warm invertebrate communities found in the rolled leaves of heliconias and other banana relatives. Students will have the opportunity to work with everything from beetles and caterpillars to ants and katydids. By comparing the invertebrates found in heated

leaves to those found in unheated leaves, students will develop and test hypotheses relating invertebrates' maximum heat tolerance and temperature preferences to their potential climate change responses. These traits, especially temperature tolerance, are widely used to predict which species will be most vulnerable to climate change, but whether they can correctly identify the most vulnerable species has rarely been tested.

One student will test whether invertebrates' maximum heat tolerance can accurately predict their temperature preferences. The second student will test whether invertebrate communities found in ambient and heated leaves have different temperature preferences and tolerances. Each student will use different laboratory and statistical methods to tackle these questions but will work together to implement the field heating experiment. They will gain experience in experimental design, tropical field work, and mechanical skills. Students will have the opportunity to publish a research article based on these projects.

Nicholas Marzolf
North Carolina State University
nmarzol@ncsu.edu
Ecosystem processes in tropical streams; snail sensitivity to stream chemistry in tropical streams

Project 1: Comparing seasonal effects of experimental stream pH elevation on leaf litter decomposition. In this proposed project, the student will expand on previous studies that quantify the rate of leaf litter decomposition across the range of stream pH in streams at La Selva. Stream pH decreases naturally in response to precipitation events. However, low elevation streams exhibit greater buffering capacity due to inputs of carbonate rich groundwater and acidification events are lower in magnitude. During these acidification events, stream heterotrophs (microbes, macroinvertebrates) decomposition of allochthonous organic material in the stream is inhibited, suggesting acidification events alter ecosystem function within La Selva. This project would examine the response of stream pH to the addition of inorganic carbon, increasing the buffering capacity and preventing acidification events. If utilization of organic matter by heterotrophs is negatively affected during acidification, our hypothesis would conversely state heterotrophic decomposition would be unaffected or positively affected through stabilization of stream pH regime. We plan to answer these questions by conducting leaf litter decomposition experiments using available leaf litter from La Selva in 2 reaches in the Carapa stream: one reference reach with naturally variable stream pH and a second reach downstream of an injection of dissolved inorganic carbon, which will increase the buffering capacity and prevent pH reduction. This experiment will be part of a 2-part study outside the REU program, with one part during the dry season (January-April) and the REU component during the wet season (May-December). This study permits discussion of the effect of season on leaf litter decomposition and stream pH regime.

Project 2: Gastropod distribution and response to stream pH across Neotropical groundwater gradient. In this project, the student would conduct experiments on physiological responses of aquatic macroinvertebrates to episodic acidification frequent in low-solute streams. Previous studies have shown strong macroinvertebrate behavioral response to acidification, but little is known about physiological responses, particularly in sessile macroinvertebrates. Gastropods are a useful model organism to study the effect of acidification on physiology. Gastropods require a range of pH for shell strength and to prevent dissolution of the calcium carbonate matrix and require calcium from the environment to build and maintain shells. This project will take 2 parts: 1) surveys across several streams at La Selva to determine snail presence, abundance, and assemblage; and 2) growth and reciprocal transplant growth studies. Snail surveys will follow developed techniques in previously studied streams to map and identify the gastropod assemblage at La Selva. Growth studies will take place in low elevation and high elevation streams, spanning the groundwater gradient at La Selva. Dominant species of snails will be confined in mesh bags in the stream, and measured before, during, and after deployment in the stream for up to 6 weeks. Pre-growth experiment physiological metrics (dry mass, ash-free dry mass, shell mass) will be taken and used to compare snail allocation of resources and physiological tolerance to the range of stream conditions. We predict snail growth metrics and shell strength will be greatest in low elevation streams where pH is more alkaline and calcium more available, whereas pH in high elevation streams is more acidic and calcium more limiting.

Colin Morrison
University of Texas at Austin
crmorrison@utexas.edu
***Passiflora* plant-insect interactions**

Project 1: Variable susceptibility to predation on different* Passiflora *species. Predation from natural enemies contributes to the evolution of dietary specialization on specific plant species. It remains unclear if specialist herbivorous insects eating different plants vary in their susceptibility to predators across the suite of plants they can eat. Does the plant that an insect eats predict whether they survive attack by predators? The student that accepts this project will investigate this question by raising *Passiflora* specialist caterpillars and beetles on different *Passiflora* species and then present those insects to predatory ants. Survival against ant colonies will be observed in experimental arenas that we will establish at the beginning of the field season. The student will use R to analyze variation in survival between *Passiflora* species.

Project 2: Influence of herbivory on* Passiflora *leaf chemistry. Leaf chemistry varies considerably between species, individuals, even between day and night. Evidence exists demonstrating that leaf herbivory also affects this variation by inducing the release of chemicals that deter herbivory. We know that many *Passiflora* species possess substantial chemical variation between individual plants. However, we do not know whether herbivory affects this variation. Do specialist insects cause *Passiflora* leaf chemistry to change? The student that accepts this project will explore this question by measuring leaf hydrogen cyanide concentrations (HCN) of leaves not experiencing herbivory and leaves being eaten by caterpillars or beetles. The student will use R to explore whether *Passiflora* HCN concentrations change when leaves undergo herbivory.

Jessica Murray
Utah State University
murray.jessica@aggiemail.usu.edu
Canopy soil carbon cycling

Project 1: The temperature sensitivity of canopy soil decomposition. Canopy soils form from decaying tree and epiphyte material on rainforest tree branches and play an important role in forest nutrient cycling and rainfall interception. Because canopy soils consist entirely of organic matter, warmer temperatures under climate change may pose a direct threat to these soils by accelerating decomposition. However, the true sensitivity of canopy soil decomposition to temperature, or Q_{10}, is unknown. Assessing the Q_{10} of canopy soil would allow us to infer the vulnerability of canopy soils to climate change. I propose that we determine the Q_{10} of canopy soils and compare them to terrestrial soils. We will incubate canopy soils and terrestrial soils under different temperatures in the laboratory and measure decomposition by quantifying CO_2 flux with a portable chamber. For each sample, CO_2 fluxes at different temperatures will be used to calculate Q_{10}.

Project 2: Nutrients limiting decomposition of canopy soil. Climate change may affect canopy soils indirectly by shifting epiphyte community composition and altering N and P content of their litter inputs. Canopy soil microbes may be nutrient limited, such that increases in epiphyte nutrient input would enhance microbial decomposition of canopy soil. We will test which nutrients (N vs. P) limit canopy soil decomposition by adding these nutrients to canopy soil samples in the laboratory, then measuring CO_2 fluxes with a portable chamber.

For either project, students will help analyze results and author a manuscript summarizing the findings of our work. These experiments will contribute to a larger project investigating the vulnerability of canopy soils to climate change.

Kelsey Reider, Ph.D.
Florida International University
kreid006@fiu.edu
Distribution and biodiversity of peccary wallows

My research is focused on understanding patterns of reptile and amphibian diversity and abundance and ecosystem-level effects of large mammals. I will assist REU mentees to develop research questions related to the ecosystem engineering effects of collared peccaries (*Pecari tajacu*) in lowland tropical forests. As seed dispersers, peccaries have an important role in shaping the structure and diversity of tropical forests. Peccaries also play an important but less understood role in engineering crucial habitat for other organisms.

Project 1: Spatial analysis of peccary wallows. The REU researcher will conduct systematic surveys of small aquatic habitats, also called wallows, created by collared peccaries throughout La Selva. They will use GIS to investigate spatial patterns of wallow density and distribution (e.g., forest type, proximity to trails).

Project 2: Peccary wallows as novel habitat. The REU researcher will conduct a survey of biodiversity of organisms (e.g., amphibians, reptiles, and aquatic invertebrates) using peccary wallows and evaluate ecological hypotheses related to community assembly.

These are labor-intensive projects that require extensive field work. To get the most out of working with me, applicants should be physically and mentally prepared to work long hours in the forest, frequently alone and under difficult conditions.

Ulli Seibt, Ph.D.
University of California, Los Angeles
useibt@ucla.edu
Soil respiration in response to rain; soil fluxes in wind-created forest gaps

Students will work on measuring soil carbon and water fluxes with a new type of soil flux chamber based on low-cost sensors. The new chambers make it possible to obtain field data across multiple places at a fraction of the cost of a conventional soil flux system.

The chambers consist of a rigid enclosure with flexible skirt to provide a seal with the soil surface. Sensors for CO_2 concentration, temperature and humidity of the air inside the chamber provide data that is used to calculate soil carbon and water fluxes. Four chambers will be installed and operated, together with a conventional (LI-COR) soil flux chamber. Since this research involves some technical components, the two students will work together on operating the chambers and analyzing the data. The students can then define their independent projects by their respective research questions. For guidance, I will provide several options at the start: Do soil fluxes vary along the soil micro-topography? How fast do fluxes change when it rains? Are soil fluxes systematically different in forest gaps (left by the recent storm disturbance)? Ideally the students will also come up with their own questions. The students will then collect preliminary data for about a week to explore these options, and decide on their projects based on what they find. Since data on soil fluxes in tropical rainforests is very limited, any of these projects will provide new insights that will be highly valuable for the flux research community.

Wu Sun, Ph.D.
University of California, Los Angeles
wu.sun@ucla.edu
Leaf photosynthetic characteristics

The La Selva station is a hotspot of ecosystem productivity and diversity. The variety of species and leaf traits and the complexity of canopy environment create an ideal natural laboratory to study the photosynthesis of tropical plant species. The proposed projects will focus on the variability of leaf photosynthetic characteristics among different species and canopy environments. Students will use a Portable Chlorophyll Fluorometer (Walz PAM-2500) to collect leaf active fluorescence data on different species and use statistical methods to analyze the controlling factors of leaf photosynthetic parameters.

Project 1: Variability of leaf photosynthetic characteristics among species. The La Selva forest hosts a diversity of plant species and they differ in their photosynthetic capacity. Understanding of interspecies difference of photosynthetic parameters is important to the interpretation of ecosystem scale changes in photosynthetic CO_2 uptake. In this project, the student will collect active fluorescence data from a variety of species, derive the photosynthetic parameters from statistical analysis, and explore factors that determine the interspecies differences.

Project 2: Light adaptation of leaf photosynthetic characteristics. The complex light conditions in a canopy can lead to contrasting acclimations of leaf photosynthesis even for the same species. Understanding of such acclimation would provide knowledge on the distribution of photosynthesis within a canopy. The student will collect leaf active fluorescence data from sunlit and shaded leaves from the same species (e.g., *Pentaclethra* spp.) for a cohort of dominant species in the forest. The student will analyze the data to see how light adaptation of photosynthesis differ between overstory and understory (perennially shaded) species.