If you need more information, please write to reu.program@tropicalstudies.org

La Selva REU Mentors 2021

Laura Bizzarri

Project 1: Mechanisms of host choice in phoretic flower mites

Phoresy, defined as the use of another organism for dispersal, is widespread among mites. However, the underlying mechanisms for this unique lifestyle remain largely understudied. In particular, the mechanism by which a mite can recognize its preferred host, remains unclear. It is hypothesized that chemical cues from the host allow mites to recognize and ultimately choose one host over another. In flower mites that utilize either vertebrate or invertebrate animals to move among flowers, the standing hypothesis is that mites can recognize the scent of the flowers of their preferred host plant. This project will test this hypothesis using mites that rely on bat and moth pollinated plants as the study system. Specifically, the student will use an olfactometer setup to test: 1) The ability of mites to discern between air and flowers of their host; 2) Mites' preference among a variety of potential hosts in comparison to their known hosts.

Project 2: Direct effects of global warming on phoretic mites

Tropical ectotherms are predicted to be the most affected by global warming. One of the main mechanisms that might help ectotherms against global warming is the organism's physiological ability to withstand increasing temperatures. One way of predicting ectotherms' response to global warming is by estimating their critical thermal maximum (CT_{max}), the highest temperature an organism can withstand before ceasing life-supporting physiological functions. Variation in organisms' ability to carry out basic functions will likely affect the persistence of certain species as global temperatures rise. This variation might come in the form of adaptation to local microclimates. This project will determine the CT_{max} of phoretic mites from a lowland tropical rainforest site, specifically comparing mites from open habitats to mites that live in primary forest. The student will use small water baths and test tubes to simulate temperature increases and determine at which temperature mites from both habitats faint.

Tara Cornelisse

Project 1: Dung beetles in the canopy

Dung beetles provide important ecological services by recycling animal dung, including in the rainforest canopy, but their services in the treetops are less understood. This project will involve designing and implementing creative dung beetle traps, using bait, to capture dung beetle abundance and diversity in the canopy. Canopy dung beetle abundance and diversity can be compared along a gradient of disturbance, resource availability, and/or to ground-level dung abundance and diversity. The project will also involve identification of the beetles in the lab. This project will contribute to our understanding of the dung beetle community and the impact of deforestation or dung resource availability on the dung beetle community.

Project 2: Measuring herbivory along a gradient of disturbance

There have been many recent studies and reports on insect declines, but the level of decline is less understood in tropical systems as well as to what extent insect declines having on plants, including herbivory. This project will involve measuring percent herbivory on plants along a gradient of natural canopy cover and along a gradient of anthropogenic disturbance. The project can involve identifying the plants in each study plot, recording the types protection against herbivory as seen in the field, such as leaf thickness, hairs, etc., as well as chemical defenses learned through further research. In addition, the project will involve sampling phytophagous insects on measured plants, likely using a beat sheet and/or observations. The insects will then be identified in the lab. This project will contribute to our understanding of the impact of disturbance on phytophagous insect abundance, diversity, and herbivory and how that intersects with the defenses of plants present along the gradient.

Carissa Ganong

Project 1: Survey of stream decapod density and diversity

Decapods, particularly shrimp and crabs, are key components of many tropical stream ecosystems. This project will involve a survey of freshwater crab density in different La Selva streams, ranging in size from small streams to large rivers, and an analysis of whether crab density is related to shrimp density (including previously published determinations of shrimp populations in several La Selva streams), stream structure (channel size, substrate type), and/or chemical parameters such as pH and nutrient concentrations. This project will be field-based and will involve a significant amount of hiking.

Project 2: Quantification of aquatic insect emergence in La Selva streams

Many insect species with aquatic immature stages emerge from aquatic systems to live as terrestrial adults, and this emergence can constitute a key energy flux from aquatic to terrestrial systems. This study will quantify insect emergence rates across a range of aquatic systems via deployment of emergence traps, which capture the insects emerging from a certain area of stream substrate. We will explore possible relationships between emergence rates and abiotic parameters (for example, water chemistry and substrate type). This project will involve a significant amount of fieldwork and hiking, as well as identification of collected insects in the lab.

Georgia Hernández-Corrales

Project 1: Plant strategies to cope with temperatures

Project 2: Implications of microhabitats in plants responses to temperature

Temperature shapes the natural distribution of plants and strongly affects plants' growth processes such as photosynthesis. Projected increases in global temperatures are expected to lead to a reduction in photosynthetic rates and an increase in plant mortality. However, tropical forests represent a mosaic of microhabitats characterized by differences in environmental conditions, including temperature. Because of the microhabitat differences, it is a priority to know how plants acclimate to these environmental conditions and how this will shape the way plants face global warming. To accurately predict changes in plant responses to temperature increases, there has to be a link among leaf shape,

morphology and thermal tolerance with microhabitat use. This research aims to (1) disentangle the mechanisms involved in plant responses to temperature, and (2) to understand the of role microhabitats in buffering or exacerbating the effects of global warming on a plant community. We will work with the Zingiberales order, a charismatic group that includes gingers, heliconias and bananas. In addition to their beauty, Zingiberales are a highly diverse group in the tropical wet forest and an easy group to identify. This makes Zingiberales an ideal study system to determine patterns of thermal tolerance strategies in the whole community. Potential students will utilize common methods in plant physiology, will learn how to use the latest equipment to measure photosynthesis in real time (Licor), and do laboratory work to analyze samples from the forest.

Rossana Maguiña Conde

Project 1: Bee deterrence floral mechanisms in a Neotropical plant system

Floral traits shape the interactions between plant and pollinators. Variation in floral traits can affect plant-pollinator interactions, for instance promoting pollinator shifts - which are changes between distinct pollination systems. A common pollinator shift is from bee to hummingbird pollinators. However, little is known about the processes underlying such transitions, including deterrence floral mechanisms for bee pollinators. This project will analyze the role of different floral traits to deter bee visitation using a Neotropical plant system. The student will conduct experiments artificially modifying floral traits (for instance, shortening the flower length, constraining the corolla opening, eliminating nectar guides) of the bee-pollinated species *Costusmalortieanus* and exposing the modified flowers to its bee pollinators. The bees' performance will be recorded using video cameras to analyze their flower handling behavior and the time they take to feed on the modified flowers.

Project 2: Intrinsic floral factors influencing heterospecific pollen receipt

Heterospecific pollen receipt (HP) is common in plant communities. HP affects plant fitness and is an underestimated cause of floral evolution. Knowing what factors influence HP is crucial for a better understanding of plant diversity origins. Previous studies mainly focused on analyzing extrinsic factors (spatial distribution, pollinator sharing and behavior, etc.) influencing HP, whereas studies on intrinsic floral factors are rare. Thus, this project will analyze intrinsic floral factors influencing HP. The student will collect stigmas from fallen/old flowers of focal plant families (Costaceae, Heliconiaceae) to count the number of heterospecific pollen deposited on them applying microscopy techniques. In addition, the student will record different floral traits (flower length, stigma/anthers position, stigma size, etc.) that can influence deposition and pickup of pollen by pollinators. Finally, the student will evaluate the effects of each factor on HP applying Generalized Linear Models.

Nick Marzolf and Ana Meza Salazar

Project 1: Aquatic insect responses to pH changes across a stream gradient.

We envision a project examining the response (e.g., growth rate) of aquatic insects under different levels of water pH. The project will have field and laboratory components.

We will be collecting individuals from well-buffered and poorly-buffered streams. Organisms will be taken to the laboratory, where they will be exposed to different pH treatments to assess their growth rates. We hope that this project can further inform biological responses to stream chemistry and the frequency of acidification experienced across the stream gradient at La Selva and corroborate previous work from the STREAMS project.

Project 2: Greenhouse gases in streams

A second project will measure CO_2 fluxes in various reaches in the stream network at La Selva, consisting of primarily field work. We will use sensors to simultaneously measure stream gases, O_2 and CO_2, to measure in stream respiration, evasion to the atmosphere, and export of carbon across various stream reaches. We aim to explore variation in C fluxes across a solute gradient, particularly focused on inputs from CO_2 from groundwater and CO_2 evasion to the atmosphere. Work will involve multiple day deployments of sensors and computation of CO_2 fluxes and statistical comparisons.

Ummat Somjee and Pablo Allen

Project 1: A mark-recapture study of territorial male insects in a wild population

Measuring selection in wild populations has yielded significant contributions to evolutionary biology. However, most species are difficult to find and follow in nature. In this study I will mentor students during a mark-recapture study in a tractable wild insect population. Our major objective is to measure selection and social structure in a wild population. *Leptoscelis quadrisignata* are territorial insects that often return to their territories on *Heliconia* inflorescences. Insects (~60) will be individually marked and measured and released. Mating and guarding are very visible on territories, and we will keep track of this behavior for 21 days. I will guide the student in performing selection and social network analysis.

Project 2: The metabolic cost of sexually selected weapons

Horns in antelopes, tusks in elephants and antlers in deer are all examples of sexually selected weapons used in competition for mating opportunities. These structures are often composed of metabolically active tissues such as muscles and nerves, as well as metabolically inactive tissues such as cuticle or bone. Most studies focus on the metabolically inactive tissue, yet the active tissues may be important in shaping the cost of these traits. The insect, *Leptoscelis quadrisignata* has large hind legs which males use in competition for mating opportunities. These structures are composed of both muscle and cuticle, but we don't know the energetic cost of these structures, or how these tissues scale with increasing body mass. I will bring equipment to measure metabolic rates (CO_2 production rate) of individual insects with different relative trait sizes. Students will collect a small sample (~30) of these abundant insects and measure the scaling of muscles, trachea and cuticle to understand the energetic cost of these weapons.

Las Cruces REU Mentors 2021

Justin Montemarano

Project 1) Constructing a particulate carbon budget for a neotropical stream.

Allochthonous organic matter is an important source of energy and nutrients in forested streams, and understanding the deposition, retention, transport and decomposition of these sources of organic matter is crucial to monitoring stream health and change. While characterization of organic matter processing in temperate forested streams has been well described, analogous studies are lacking for neotropical streams. I would like to construct a budget of particulate organic matter within the Las Cruces stream network by conducting surveys of litter deposition rates, measuring standing stock, and using a series of litter releases to characterize litter retention and transport. Additionally, I am interested in developing related projects, such as surveying macroinvertebrate community structure associated with leaf litter packs in streams and monitoring decomposition rates.

Project 2) Controllers of freshwater crab behavior and implications for decomposition dynamics.

We have found two species freshwater crab (Pseudothelphusidae) associated with stream systems at Las Cruces. Previous projects show that (1) the distribution of the crabs within and outside of streams is highly variable, and (2) that the crabs contribute to the decomposition of leaf matter through shredding. I would like to explore factors controlling crab behavior, densities, and leaf processing rates. For example, crab species and parasite load (trematode metacercariae were discovered in both crab species) may impact activity.

Rachel Olzer

Project 1) Insect Diversity and Behavior in a New Light.

Light is arguably the most important abiotic factor for living organisms. Organisms evolved under specific lighting conditions and their behavior, physiology, and ecology are inexorably linked to light. Understanding light effects on biology could not be more important as present anthropogenic effects are greatly changing the light environments in which animals exist. The two biggest anthropogenic contributors to changing light environments are: (1) anthropogenic lighting at night (i.e., light pollution); and (2) deforestation and the built environment. We will survey insect diversity and behavior along a canopy cover gradient using the four regions within the Las Cruces Biological Station: primary forest, secondary forest, selectively logged primary forest, and abandon pasture.

Project 2) Selective Regimes and Animal Signaling in a New Light.

Many animals balance the trade-offs between various selective pressures. How animals balance the costs and benefits of signaling is important for understanding signal evolution. Most animals must signal to attract mates, while also avoiding predation. Additionally, many animal signals, particularly visual signals, are difficult and energetically expensive to produce. Furthermore, visual signals require certain light environments to best broadcast to potential mates and to predators and parasites. Understanding light effects on biology could not be more important as present anthropogenic effects are greatly changing the light environments in which animals exist. We will survey butterfly diversity and signals along a

canopy cover gradient using the four regions within the Las Cruces Biological Station: primary forest, secondary forest, selectively logged primary forest, and abandon pasture.

Johana Goyes

The Emerald Glass Frog, *Espadarana prosoblepon* (Family: Centrolenidae), found from eastern Honduras to northern Colombia, is a common inhabitant of Las Cruces Biological Station. Little is known about the natural history, reproductive behavior and ecology of this species in particular, if egg attendance behavior provides any benefits to the offspring. Using a combination of female-removal experiments and prey-choice tests with natural predators of the egg clutches, these student projects will test if the egg attendance behavior of *E. prosoblepon* females increases hatching success.

Project 1) Benefits of egg attendance in the Emerald glass frog.

Early studies of the natural history of this species report little or no parental care. Jacobson (1985, *Herpetologica* 41:396–404) observed females near the eggs for a few minutes after oviposition but later deserted the clutch. Previous studies on this species at Las Cruces Biological Station revealed that the females stay between 45–85 minutes with the clutch before deserting it. Females who stayed with the clutches longer do not have higher hatching success, but no studies have evaluated if female presence provides a direct benefit to the clutch. To test this, the student will use enclosures in the field to carry out parent-removal experiments. After fertilization and oviposition occurs, females assigned to the removal treatment will be displaced from the clutch. Hatching success and sources of mortality will be compared between the two treatments to determine if egg attendance provides any benefit to the offspring.

Project 2. Predation experiments with clutches of the Emerald glass frog.

Previous studies on the reproductive behavior of this species indicate that predation is one of the main sources of egg mortality in *E. prosoblepon*. To determine if egg attendance behavior provides any benefit to the offspring in the form of anti-predatory deterrents, the student will carry out prey-choice tests using natural predators of *E. prosoblepon* eggs. If egg attendance provides any benefit, removal clutches (female was removed after oviposition) will suffer higher predation than control clutches. This study will provide evidence of the benefits (or lack of) of egg attendance behavior in this species, and ultimately will provide critical information to study the evolution of parental care behaviors in the glass frog family.

Patricia Esquete

My research interests are related with the ecology and biology of aquatic invertebrates. Apart from the projects suggested below, I am opened to discuss other ideas with students that show interest in any aspect of tropical stream invertebrates.

Project 1) Microhabitat preferences of benthic invertebrates in tropical streams.

Benthic environments in tropical streams host a variety of organisms of different life strategies, ranging from soft bodied, infaunal plathelmints to insects with aquatic larvae or macrocrustaceans. The REU student will develop a project that examines the factors

affecting the aquatic invertebrates' preferences for certain microhabitats, their abundances or species composition across a tropical stream. For this purpose, they will use different field capture techniques, animal manipulation methods and habitat characterization, as well as laboratory methods including the use of microscopes and identification tools. If more than one student is interested, two projects could be carried out on this subject.

Project 2) Predation-prey relationships of semi-aquatic spiders.
Semi-aquatic spiders are fascinating animals that live in rocks and crevices in the vicinity of water bodies, preying on insects, frogs, tadpoles, and other organisms including small fish. Two species of the non-web genus Trechalea are abundant in the rainforest's streams of Costa Rica, where they play an important ecological role by controlling other species' populations. However, little is known about their behaviour and the factors affecting their hunting/resting activities. This study aims to investigate their predation strategy and activity rhythms; The REU student can expect searching rivers for big spiders during different times of the day, observing activity patterns, and mapping their movements. If more than one student is interested, two projects could be carried out on this subject.

Sara Shuger Fox
Project 1) San Vito Public Health Investigating Dietary Factors Contributing to Longevity.
The objectives for this site study are to explore the feasibility of my current research agenda on the investigation of the correlation between dietary intake and longevity in the designated Blue Zones of Costa Rica, specifically targeting an additional recently discovered population in San Vito. Specific objectives are: Conduct an in-country population comparison of individuals over the age of 80 in a Blue Zone region where research has yet to be conducted (Nicoya vs. small island in SanVito), to further explore Blue Zone research methods in conjunction with the current International Blue Zones Initiative, and to develop preventative medicine protocol for local practitioners based on data obtained.

Project 2) Rural Uvita- Type 2 Diabetes Prevention and Public Health Outreach.
Evaluating and Preventing Type 2 Diabetes in Rural Costa Rica: The objectives for this site study are to explore the rural populations of Costa Rica, specifically identifying prevalence of Type 2 Diabetes and developing preventative measures to articulate public health literature. This specific site is of great interest due to the fact that I have now led an undergraduate research program in Uvita for the past 3 summers. Specific objectives are to allow students to develop cross-cultural competency in Costa Rica by fostering experiential learning goals, investigate the differences in a universal vs. public healthcare system, and establish literature for preventative public health promotion outreach in Central American communities, specifically on Type 2 Diabetes.

Hernani Oliveira
Project 1) Habitat use by phyllostomid bats (Chiroptera: Phyllostomidae) across the landscape.

Phyllostomidae is one of the most diverse bat families worldwide, which presents a range of morphological adaptations for different feeding habits, such as frugivory, nectarivory, insectivory, and sanguivory. These morphological adaptations might have also enabled them to use and explore their environment in different ways, creating microhabitat specializations. However, the relationship between habitat use and morphological specialization has not been very well explored for phyllostomid bats. In this project, we will compare the habitat use of phyllostomid bats from different feeding guilds at sites with different habitat characteristics (gaps, clutter, and open) to check the importance of their morphology on the way that they use their environment.

Project 2) Frugivory rates of phyllostomid bats (Chiroptera: Phyllostomidae) across the landscape.
With more than 1,400 bat species spread across 21 families worldwide, only two families have evolved to include fruits on their diet. Phyllostomidae is a diverse family of Neotropical bats that have evolved frugivory as one of their main feeding habits. Some bat genera within this family are known to specialize in specific plant genera. However, these relationships have been mostly studied from the bats point of view by looking at their diets through their feces. Very few studies have analyzed this aspect of their ecology from the plants point of view. In this project, we will use camera traps to analyze frugivory rates of different plant species by phyllostomid bats.

Lindsey Swierk and Bree Putman (co-mentors)
Project 1) Water anole home range and microhabitat use.
Understanding how individuals distribute themselves in space is a fundamental problem in ecology. This project will explore the social structure of water anole populations and their relationship to the microhabitat. The student conducting this research will study water anole home range sizes and shapes to address natural history questions regarding sex- and age-related habitat use, territoriality, and density.

Project 2) Communication in courtship and aggressive encounters.
How animals use signals to communicate is an essential component of behavioral ecology. This project will test how water anoles use behavioral and morphological cues during inter- and intra-sexual encounters. Several morphological cues are of interest, namely dewlaps ("chin-flaps" of skin) in males and rapid body coloration changes. These traits have never been quantified in relation to contest outcome in water anoles. Hypotheses generated may focus on the relationship of a) male body/dewlap characteristics with female mate choice, b) effect of color change on aggressive encounters, or c) male courtship in relation to female reproductive value.

Terry Torres
Project 1) Diversity of microfungi in primary tropical forests.
Fungi in the genus *Fusarium* are widely distributed around the world. However, most of our research efforts study these fungi for their importance in agriculture by causing plant diseases and economic losses in various crops. Our knowledge of their diversity in uncultivated areas is currently limited and there is potential for discovery of new species in

primary tropical forests, which are species-rich and understudied. The REU student will develop a project that describes the occurrence and diversity of fungi from the genus *Fusarium* in a primary tropical forest. The student will learn sampling techniques for plant tissues and soils, collection and recording of field data, and will develop basic microbiology laboratory skills like isolation, culturing and use of a microscope. Additionally, the student will gain experience in data analysis and develop scientific oral and writing communication skills that are generally applicable to different professions and fields of study.

Project 2) Variation in plant and soil fungal diversity under different reforestation strategies.

Soil and plant fungi are key players in tropical rainforests. These fungal communities can be affected by the use of land and habitat loss. We have little information about the diversity of fungi in the genus *Fusarium* associated with different reforestation approaches after agricultural use. The REU student leading this project will compare the *Fusarium* communities found in secondary forests under different reforestation strategies. The student will learn sampling techniques for plant tissues and soils, collection and recording of field data, and will develop basic microbiology laboratory skills like isolation, culturing and use of a microscope. Additionally, the student will gain experience in data analysis and develop scientific oral and writing communication skills that are generally applicable to different professions and fields of study.