LA SELVA REU MENTORS 2018

* Andrew Bruce

1. Scouting in Leaf-cutting ants: Tracking and understanding the scouts of leaf-cutting ants

Leaf-cutting ants are charismatic animals of tremendous ecological impact that build large, highly visible trails through the jungle so that they can transport leaf-fragments home to their nests. Their sophisticated trail network has been extensively studied, but the process by which they scout the forest around them has not. Individual leaf-cutting ant scouts can be readily observed travelling from the plant at which they have removed a leaf-fragment back to the nest, yet no scientific field data exists on this process. To remedy this, research on both scouting ability and scouting effort is in order. To examine scouting ability, I propose that we seek out these scouts, follow them back to their nests and record the extent of their scouting range. Other metrics, such as walking speed and plant species sampled will also be useful in fully characterising the scouting abilities of leaf-cutting ants. The second stage of the project would be to choose a small number of focal colonies and survey them on a regular basis so as to determine their scouting effort. This would involve walking transects that cut across a colonies foraging range and searching for individual leaf-cutting ants, both unladen and laden, not attached to trails. Once a detailed picture of scouting expeditions has been completed, then it should be possible to extrapolate from the data the maximum scouting range of a colony, compare it to its foraging range, and integrate this knowledge into understanding the ecological impact of leaf-cutting ants.

2. The establishment of foraging in leaf-cutting ants: The dynamics of leaf-cutting ant trails as foraging begins

Leaf-cutting ant trails are a fascinating synthesis of behavioural systems that transmit information about the plant to be foraged on while stimulating and facilitating the flow of laden ants across difficult terrain. However, most work investigating leaf-cutting ant trails focuses on foraging trails that have already reached a state of equilibrium where foraging is stable. By contrast, the commencement of foraging on leaf-cutting ant trails is characterised by a sudden flood of outbound workers that leads to a rapid increase in foraging intensity. Most parts of this process are completely unexamined. For example, are the lead ants in the process a specialised behavioural sub-caste? Do ants walk faster during commencement than during equilibrium? Are there characteristic behaviours that help to establish the trail such as specialized pheromone deposition behaviors? These questions can be answered by simple methods such as mark and recapture, the timing of ant movement, and by developing ethograms describing behaviour and interactions. Answering these questions and more by using these simple but robust techniques will allow the student to develop competence in fundamental research and an appreciation of the link between micro-behavioural interactions and large scale ecological effects.

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* Michael Cove

Potential students will utilize traditional methods as well as current noninvasive survey techniques and statistical modeling procedures to study animal population and community responses to global changes. One subject that I am interested in is further examining the **behavioral ecology of collared peccaries (*Pecari tejacu*) and other common mammals in response to release from predation and human habituation**. Students will use sounds recordings of variable predator calls to quantify prey species responses to predators and other auditory stimuli along a gradeitn of human habituation. We could also use camera traps to collect data on mammal behavioral ecology. Student might further identify individual mammals based on their patterns from camera trap data to examine co-occurrence and abundance of species such as paca (*Cuniculus paca*) and ocelot (*Leopardus pardalis*) by utilizing these data in spatial capture-recapture and occupancy models. Pacas and other medium-sized mammals have decreased in abundance in recent years and we will try to determine if this decline is a consequence of strong interactions with other taxa. We might also examine the **distribution of seedlings around parent trees to determine if seed dispersal is affected by paca decline or peccary abundance**. If students are interested, we could also utilize more traditional approaches such as attaching small radio transmitters to herpetofauna or small mammals to explore habitat use at a small scale.

* Danielle Palow

1. **Legume seedling establishment near parent trees**

The REU student would work with me to develop a project that examines seedling establishment, juvenile tree health status and age class structure near a focal tree. The project would involve learning to: identify plant species (including identification of juveniles), characterize seedling light environment, and use GPS and GIS. This project would require work in the field off trail.

2. **Factors affecting seed germination in legumes**

The REU student would work with me to develop a project that examines germination success. The project would involve learning to identify plant species (including identification of juveniles), characterize seedling light environment, employ multiple methods to induce germination and use GPS and GIS. This project would require a combination of work in the field, shade house and laboratory.

LA SELVA REU MENTORS 2018

* Alonso Ramírez

Dr. Alonso Ramírez, University of Puerto Rico, works on the ecology of aquatic insects and stream ecosystems as part of the STREAMS project, a long-term project at La Selva Biological Station. STREAMS is assessing the ecological consequences of groundwater/surface water interactions for lowland stream ecosystems. Students could develop an independent research project around the following areas: (1) **Aquatic insect life history** – we know very little about the life history of aquatic insects in tropical streams. Students could develop a project assessing which environmental factors are important controlling aquatic insect populations. Several insect groups are good candidates for this type of research: mayflies, dragonflies and damselflies, among other. (2) **The role of aquatic insects in ecosystem processes** – Aquatic insects are important consumers in stream ecosystems, playing a key role consuming basal resources such as detritus and algae, and making that energy available to higher trophic levels. Students could investigate how important are insects in processes like detritus decomposition and primary production. Student projects will be developed with the context of the STREAMS project, adding valuable information to large-scale questions and complement ongoing research or uncover new lines of research for future study.

* Andrea Romero

Predation and scavenging responses to a recovering forest

Little is known about predation and scavenging rates of small mammals (mice, rats, shrews, and small opossums) in tropical forests. Small mammals are important components of tropical forest food webs, as their presence and abundance can affect the plant communities. In addition, small mammals can be important prey items for a variety of animals such as ocelots, jaguarundis, tayras, owls, snakes, etc. Additionally, environmental factors can affect interactions within food webs. For example, we know that primary (old growth) and secondary (regenerating after being cleared) forests can be different in regards to both biotic and abiotic factors, which can ultimately affect the predator/scavenging communities and rates. It would be reasonable to hypothesize that predation and/or scavenging activity may differ too. Other factors that may affect these rates include properties of the prey/scavenging item, and distances to environmental structures, like rivers/streams, trails, etc. Students interested in working with these types of questions will be able to develop projects that will include fieldwork with predation and/or scavenging models, camera traps, and GIS (computer mapping program). In addition to using models to determine rates of removal, camera traps will provide interesting feedback as to which animals are involved in predation and/or scavenging. Students participating in these projects will gain experience in identifying and learning about the mammal communities in La Selva.

LA SELVA REU MENTORS 2018

* Paolo Segre

1. Leaf-cutter ant walking kinematics

Leaf-cutter ants (genus *Atta*) harvest and transport leaf segments that weigh several times their body mass. Larger ants move faster but all ants slow down as the load they carry increases. However, little is known about the kinematic parameters that are altered as ants increase in size and as the load they carry increases. This project would combine commonly used measurements of velocity (by timing distances traveled) with high speed video of leg kinematics (using action cameras at 120-240fps) to determine stride frequency and amplitude of unladen, laden, and under experimentally manipulated conditions (increasing and decreasing loads). This project is particularly interesting because it has been recently determined that ants use their steps as odometers to determine distances between their colonies and foraging sites.

2. Biomechanical determinants of hummingbird territoriality

Hummingbirds use their agility to defend territories from inter and intraspecific competitors. An individual's ability to maneuver is related to its ability to generate bursts of aerodynamic lift. Aerodynamic burst performance can be measured using trials where the bird is fitted with a harness and a chain of beads: the weight lifted off the ground is equivalent to the maximum aerodynamic lift the bird can generate. Species that have higher lifting ability are more territorial than species with lower lifting ability. However, the relationship between individual lifting performance and territorial dominance has never been demonstrated. This project would require capturing hummingbirds, performing loadlifting trials, marking the birds for observation, and conducting dominance trials using feeders with different nectar concentrations.

* Angela Smilanich

1. Immune response in generalist vs. specialist caterpillars.

There is accumulating evidence from studies beyond our own that there may be a general trend for specialist herbivores to have compromised or lower immunity compared to generalist herbivores. This may be related to how much phytochemistry the herbivores are sequestering, where increased sequestration (normally found in specialist herbivores) leads to lower immunity. In this project, the student would collect a spectrum of specialist to generalist caterpillars, measure their immune response, then quantify the amount of secondary compounds sequestered. Because compromised immunity can also affect parasitoid success, the student can also rear caterpillars for parasitism rates, or design a field project to test for parasitoid preference of caterpillars where immunity or sequestration is manipulated.

2. Are caterpillar defenses redundant?

In this project, the student will address whether caterpillars that use one type of defense against natural enemies (i.e. spines) would necessarily invest heavily in another defense (i.e. immunity). This question gets at the concept of trade-offs, which allows ecologists to understand why

certain species have traits that others do not, or are present in only some environments. We have a rich database cataloguing caterpillar defenses (physical, behavioral, morphological) that the student can go through to design specific hypotheses that will answer questions about redundancy and trade-offs.

* Amanda Wendt

Tropical forests are dynamic places shaped by disturbance that varies in type, frequency, intensity, duration, and spatial scale. For instance, animals may cause frequent low-intensity disturbance at a small scale through foraging while humans may cause infrequent high-intensity disturbance at a large scale when forests are fragments by logging. Non-native or invasive species can also cause a form of disturbance to forest ecosystems, altering interactions and forest composition over time. Seed dispersal and seedling recruitment drives forest recovery and regeneration following disturbance. Dr. Amanda Wendt, of OTS at La Selva Biological Station, works broadly on forest restoration and regeneration, disturbance, and plant-animal interactions.

REU students working with Amanda could explore a project related to one of the following themes:

1. Does the presence of non-native vegetation influence animal forest use? In the La Selva forest reserve, invasive or non-native plant species, for instance coffee or breadfruit, dominate specific parts of the forest. Since the understory species composition of these areas is less diverse than other areas of the forest, how does this affect how animals use these areas? Students could study birds, peccaries, or other animals to compare how they forage or utilize these areas as compared to other more diverse areas of La Selva.

2. Does forest type affect the frequency and size of tree fall gaps? Global change can affect the forest at La Selva through many diffuse environmental stressors which may affect be affecting the disturbance regime of La Selva, for instance in the frequency of tree fall gaps. We have little recent information about the frequency or size of tree fall gaps at La Selva as compared to previous studies. In addition, forest characteristics in some areas of La Selva may also have changed since these previous studies. How many tree fall gaps are there in different forest types? How is the subsequent regeneration of seedlings of focal species different among tree fall gaps in different forest types? Students could ask myriad questions about how these important features of the forest influence species composition, forest structure, or even animal behavior.

Key words: Disturbance, forest regeneration, seedlings, invasive species, animal behavior, forest structure