2023 JTNP Graduate Student Research Grant Recipient Summaries:

Principal Investigators: Niveditha Ramadoss (PhD), Dr. Lluvia Flores-Renteria (advisor)
Institution: San Diego State University
Amount awarded (year): $4865 (2023)
Title: Does the Sexual System Affect the Adaptive Potential of Native Chollas?
Description: This research is focused on the genus *Cylindropuntia* (Chollas), which is in one of the most threatened plant families in the world, the Cactaceae. Niveditha Ramadoss will be exploring how breeding systems effect genetic diversity using four species of chollas in the park: *Cylindropuntia echinocarpa* (silver cholla), *C. bigelovii* (teddy-bear cholla), *C. ramosissima* (pencil cholla), and *C. chuckwallensis* (Chuckwalla cholla), a newly described endemic to California. *Cylindropuntia* offers an excellent opportunity to explore the effects of different breeding systems on genetic diversity because of the various sexual systems found within this genus, ranging from being hermaphroditic (each individual has flowers with male and female reproductive parts), dioecious (individual plants have only male or only female flowers), gynodioecious (individual plants are either hermaphrodite or have female flowers only), as well as asexual reproduction through cloning. Most species of chollas utilize clonal reproduction to some degree (stem pieces that fall off and then produce a new plant), but the teddy-bear cholla appears to be only reproducing in this way. This could eventually lead to population declines due to the negative effects of low genetic diversity. This is one of the questions that Niveditha hopes to address while conducting her study. Through genetic analysis, Niveditha will be able to determine whether the populations of these four cholla species in the park are harboring high levels of inbreeding. Through this study, conservation efforts to protect these iconic plants will be better informed by understanding how their breeding systems are impacting their genetic diversity.

Principal Investigators: Jaimie Kenney (PhD), Dr. Kerry Mauck (advisor)
Institution: University of California Riverside
Amount awarded (year): $5000 (2023)
Title: Tiny but deadly: is Joshua Tree National Park an overlooked haven for plant pathogenic microbes and their diminutive insect vectors?
Description: While most research on plant pathogens is conducted for the purpose of improving crops and protecting agricultural interests, this research is taking a step toward understanding how plant pathogens may impact native plant communities. Jaimie Kenny is looking to fill this knowledge gap by looking at vector-borne pathogens in native plants in the Colorado and Mojave Deserts of California. Specifically, Jaimie is looking at a bacterial plant pathogen (*Candididatus Liberibacter solanacearum* (*CLso*) known to affect members of the Solanaceae, such as potatoes and tomatoes; in Joshua Tree NP, Jaimie will be focused on native solanaceous plants such as groundcherry (*Physalis crassifolia*) and wolfberry (*Lycium andersonii, L. cooperi*). The vectors for the bacterium (*CLso*) are a group of insects called potato psyllids. Jaimie will be collecting samples of the insects and plants, from which she can identify the species of psyllids present through DNA sequencing, in addition she will be able to determine if the host plants are infected with the bacterial pathogen (*CLso*) and if so . Jaimie's research at JTNP is part of a bigger USDA-funded study throughout the state and Desert Southwest to

better understand the dynamics of insect-transmitted disease at the interface of natural ecosystems and the human controlled agricultural systems. This research will help guide conservation and restoration efforts in the future.

Principal Investigators: Benjy Luis Sedano-Herrera (PhD), Dr. Nicole Pietrasiak (advisor)
Institution: University of Nevada, Las Vegas
Amount awarded (year): $4545 (2023)
Title*:* Investigating the effect of nutrient stress to extracellular polymeric substances in biological soil crust cyanobacteria: A comparison of species from granitic and gypsum substrates
Description: Biological soil crusts play an essential role in desert ecosystems by reducing erosion, increasing water and nutrient availability in soils, and aiding the establishment of native vegetation. These biological soil crusts are often composed of organisms representing very different evolutionary lineages, including bacteria, cyanobacteria, algae, and fungi, all of which play different roles in these microscopic communities. This study is looking closely at the effects of nutrient stress on the cyanobacterial components of the crusts found in JTNP. More specifically, Benjy Luis Sedano-Herrera is measuring the effect of an essential nutrient (Phosphorous) on the ability of cyanobacteria to synthesize substances, such as lipids and nucleic acids, that are essential for proper growth of the crust. These critical substances are collectively referred to as extracellular polymeric substances (EPS) and the biological soil crust, as a community, relies heavily upon these EPN to protect it from harmful UV-radiation and desiccation stress. To be successful, many restoration efforts require soil inoculations with the various components of biological soil crust so the microbiotic community can recover first. The goal of Benjy's research is to establish a better understanding for how certain soils and certain nutrients influence recovery rates in restoration efforts. He will perform tests on cyanobacterial strains collected from JTNP (granitic soils) and from White Sands National Park (gypsum soils) to measure the effects of Phosphorous starvation, soil texture, and minerology on EPS production. Overall, Benjy's research will shed light on the important mechanisms that provide resilience to cyanobacteria from desiccation and nutrient starvation.

Principal Investigators: Allyssa Richards (PhD), Dr. Exequiel Ezcurra (advisor)
Institution: University of California Riverside
Amount awarded (year): $3509 (2023)
Title: Investigating the potential mutualism between "cheating" ants and extrafloral nectary-bearing *Ferocactus cylindraceus*
Description: Most people know that nectar plays an important role in pollination, as this sugary substance is what the plant can "pay" insects with in exchange for inadvertently moving pollen among flowers. However, there are also nectar glands that are found on other parts of the plants (not in flowers); these are called extrafloral nectaries (EFN). It turns out that these EFN also play an important role for plants by providing a reward to insects that protect the plant from herbivory. Over 2,000 plant species have evolved EFN, and it has long been observed that ants often play an important ecological role in protecting plants from herbivore damage. *Ferocactus cylindraceus*, the barrel cactus, is an example of one of the many plant species that exhibit this mutualistic relationship with ants. Allyssa Richards plans to investigate the ants

found in and around the barrel cactus, with the goal of understanding the timing of EFN development, which ant species are present, and how these ants might be benefitting the cactus. In particular, Allyssa is interested in documenting the presence of ant species that are in fact not providing a protective service, but still utilizing the nectar; these ants are labeled as being "cheaters" because it is thought that the plant is not receiving any benefit from their presence. Allyssa aims to answer this question: Are the cacti receiving any benefit from the cheaters? She will be testing the hypothesis that cheater ants living at the base of a barrel cactus do in fact provide the plant with additional nutrients and therefore a fitness advantage. If this is the case, these "cheater" ant-plant relationships would qualify as a mutualistic relationship and would no longer be considered cheating. Understanding the plant-insect relationships that govern the success of our native flora is paramount to being able to protect and conserve the desert as a functional ecological system.

Principal Investigators: Nathaniel Green (PhD), Elizabeth Murray (advisor)
Institution: Washington State University
Amount awarded (year): $3333 (2022) + $1855 (2023)
Title: The Systematics of North American Pollen Wasps (*Pseudomasaris*, Vespidae)
Description: This study is largely a taxonomic endeavor diving into the evolutionary history of the pollen wasps. Taxonomy is an important part of understanding biological diversity, as this is the process by which scientists can put a name on individual taxa or species. Without this naming system, we lose the ability to discuss the basic component of biological diversity and therefore cannot manage for this highly valued metric. Conservation of biological diversity requires that we know something about how many taxa exist, but more so what kind of organism they are, how they are related to one another, where they occur, and their ecological role. All of this begins with taxonomic studies. Pollen wasps are unique among wasps in that they are vegetarians (most wasps are flesh eaters), in other words they harvest pollen and nectar, which makes them important pollinators. Furthermore, they are known to be specialists on species of *Phacelia, Eriodictyon*, and *Penstemon*, for which JOTR has many species. Currently there are no known records of any pollen wasps occurring in the park, though they undoubtedly occur here. This work will add significantly to our understanding of invertebrate diversity and pollinator services in the park. Nathan also plans to survey pollinators found on our two rare *Penstemon* species (*P. clevelandii var. mohavensis* and *P. thurberi*). This research will help to fill a major void in taxonomic collections, allowing for a better understanding of the geographic distribution, plant associations, and seasonality of the pollen wasps found in this region. In addition, Nathan plans to use DNA from his specimens to run phylogenetic analyses. This will provide a better understanding of the evolutionary history of the entire family of Vespidae (includes almost all wasps, ~5000 species). Taxonomic studies such as this are often responsible for newly discovered taxa. It wouldn't be surprising if this study discovered a new species or even a new genus.