One year grant report: “The physiology of gypsophile lineages of the Chihuahuan Desert of New Mexico”

The primary purpose of this grant request was to aid in coverage of travel expenses from Cleveland, Ohio to New Mexico for four researchers, our equipment, and our plant collections. Most of the reward money was used to cover food and lodging during travel in New Mexico and the return trip to Cleveland (for a total of 5 nights). Because additional funding from a grant for travel provided to GYPENT collaborators, a global consortium of researchers studying gypsophily of which I am a member, remaining funds from the grant requested from NPSNM were also used to cover analytical lab analysis costs. Aid in analysis spending was extremely valuable for this project, because of the unexpected number of plants we were able to collect, and the resulting high cost of chemical analysis. These analyses are critical to the proposed study, which focuses on the internal tissue chemistry of gypsophilic plants in comparison to soil chemistry of gypsum. Success of the sampling trip throughout much of southern New Mexico and west Texas was greatly attributed to aid from NPSNM. We thank you for your patronage and look forward to sharing our results in the coming months.

Final budget:

Total awarded: $996

Lodging: $574.43

Food: $89.94

Analysis: $331.63

Total: $996

The physiology of the gypsophile lineages of the Chihuahuan Desert of New Mexico
Clare Muller

New Mexico is home to some of the largest deposits of surface gypsum in the United States. Gypsum soils are characterized by unique properties that pose physical and chemical challenges for plants. Despite these challenges, the Chihuahuan Desert is host to many native plant species that are only found on gypsum soils. Many of these species are rare, and some are only known from single locations, but little is known about their physiology. The atypical conditions associated with the physical crust of gypsum soil has led past ecological research to suggest that gypsophiles, plants that grow solely on gypsum, are restricted to gypsum because they are poor competitors. However, our more recent work indicates that gypsophiles are adapted to the chemical properties of gypsum. Additionally, our work suggests that lineages of gypsophiles have different methods of physiological adaptation, likely coinciding with subsequent colonization on gypsum by plant lineages over time. The goal of this project is to delineate the different adaptation mechanisms of gypsophile lineages in the northern Chihuahuan Desert. Moreover, we aim to clarify where some gypsophiles are storing high concentrations of the chemical components of gypsum ($CaSO_4 \cdot H_2O$) at the whole-plant level by collecting leaf, stem, and root tissues in New Mexican and Texan gypsum lands. Gaining a better understanding of the method by which these often rare endemics thrive on gypsum soil can aid in their protection and conservation. In addition, on a global scale, our results are paired with a similar study on gypsophiles from Spain in order to test our hypothesis that gypsophilic lineages share common mechanisms of physiological adaptation to gypsum.

In August of 2016, Clare Muller, a Master's student at John Carroll University in Ohio; Dr. Mike Moore, Associate Professor of Biology at Oberlin College in Ohio; Zoë Feder, an undergraduate student at Oberlin College; and Dr. Rebecca Drenovsky, Professor of Biology at JCU, travelled to gypsum deposits throughout southeastern New Mexico, including Roswell and Carlsbad areas and White Sands National Monument, to collect gypsophiles and related plant species along with their associated soils. This collection trip was extremely successful, and included sampling of 58 plant species across at least 15 soil types in both New Mexico and the Big Bend area of Texas. The large number of species is particularly important for this study, because representation from as many gypsophilic lineages as possible provides a clearer picture of common mechanisms of adaptation. Chemical analysis of over 600 leaf, stem, and root samples from collected plants is currently being conducted. Preliminary results indicate that sequestration of excess calcium and sulfur in root as well as leaf tissues protects some gypsophiles from toxic concentrations of these elements in gypsum. Furthermore, we expect that species relatedness plays a role in determining gypsophilic nutrient chemistry.

Funding generously provided by NPSNM in the year 2016 aided travel costs to and from New Mexico for the collection trip. Funding also supported the cost of lab chemical analyses. We could not have collected as many specimens or represented as many plant species and soil types without the aid of the NPSNM. We look forward to sharing the full results of this project with the botanic community of New Mexico.