Highlighting the 2023 Colorado Mountain Club Foundation Fellowship and Grant Recipients

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The mission of the Colorado Mountain Club Foundation is to raise, manage, and distribute funds to support the stewardship, conservation, education, and other programs of the Colorado Mountain Club and other similar organizations. Since 1982 The Colorado Mountain Club Foundation has awarded fellowships and grants for research consistent with the statement of purpose adopted by the founders of the Colorado Mountain Club in 1912:

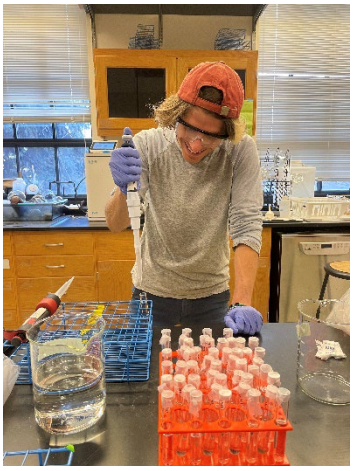
To unite the energy, interest and knowledge of the students, explorers, and lovers of the mountains of Colorado; to collect and disseminate information regarding the Rocky Mountains in behalf of science, literature, art and recreation; to stimulate public interest in the mountain area; to encourage the preservation of forests, flowers, fauna and natural scenery; and to render readily accessible the alpine attractions of this region.

Each year, the Foundation solicits applications from undergraduate and graduate students whose research is focused on the Rocky Mountain region. The Foundation awards grants ranging from approximately $500 to $2,000, in disciplines such as biology, chemistry, environmental studies, forestry, geography, geology, history, and law. The top three outstanding applicants are awarded a named fellowship: the ***Kurt Gerstle Fellowship***, in honor of the late Dr. Gerstle, professor of engineering at the University of Colorado, a long-time member of CMC, and the founder of the Foundation's Academic Fellowship program; the ***Neal B. Kindig Fellowship***, in honor of the late Dr. Kindig, a graduate of West Point and Stanford University and professor of electrical engineering at the University of Colorado, as well as an active member of The Colorado Mountain Club and The CMC Foundation; or the ***Al Ossinger Fellowship***, in honor of the late Dr. Ossinger, a graduate of Stanford University, a long-time member of CMC and the Foundation, and retired chair of the Academic Fellowship Committee.

In 2023, the CMCF Fellowship and Grant committee was able to support seven worthy students. Below are highlights from these recipients' 2023 research.

Annapurna Post-Leon, PhD Student at the University of Utah, was awarded the Gerstle Fellowship ($2,000) for the project, "Wildfire affects forest physiological responses to drought in montane southwestern Colorado." What happens to the surviving trees when a wildfire sweeps through a forest? That's the question I've been working to answer over the past few summers in the San Juan Mountains in southwestern Colorado, in and near the perimeters of the 2018 Burro and 416 fires and across an elevation gradient of four forest types (ponderosa pine, quaking aspen, and Engelmann spruce-subalpine fir). The Colorado Mountain Club Foundation's Kurt Gerstle Fellowship funded my general fieldwork costs for summer 2023 as well as analyses of leaf and wood carbon and nitrogen isotopes, which are currently in preparation. This funding has allowed me to combine multiple plant physiological techniques to understand how fire impacts tree water transport and drought resistance, leaf heat tolerance, and tree growth and carbon assimilation. My preliminary results suggest that impacts of fire on tree physiology vary by species. Burned ponderosa pine and subalpine fir trees are more drought-resistant than unburned trees, potentially due to structural changes in water-conducting xylem tissues after fire; burned Engelmann spruce experience less drought stress and grow a greater leaf area (relative to xylem area) compared with unburned trees, potentially due to reduced competition postfire; and burned ponderosa pine and quaking aspen leaves are less heat-resistant than leaves from unburned trees for unknown reasons. I am currently preparing tree core samples from summer 2023 for analysis of ring width, which quantifies annual growth; xylem vessel and tracheid size, an estimation of drought resistance in the

water-transporting tissues; and stable isotope analysis of carbon-13 fraction for growth rings immediately pre- and post-fire, which tells us drought stress during these growing seasons. Combined, these analyses will help improve our understanding of the impacts of fire on tree growth, drought stress, and drought resistance, and how long the legacy effects of the fire on trees persist.

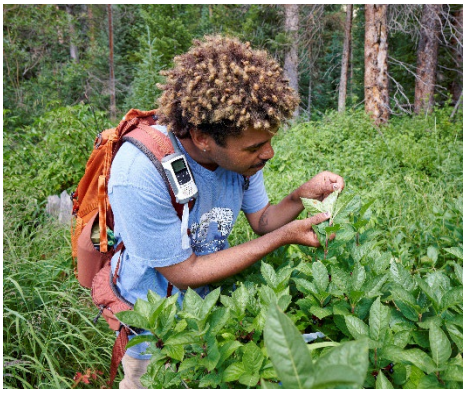


Zachary Schwartz, PhD student at the University of Colorado, Boulder was awarded the Kindig Fellowship ($2,000) for the project, "Examining the Effects of Rising Air Temperature on N Cycling and Trace Gas Emissions in the Alpine." This summer I investigated how early snow melt and a prolonged growing season, a component of rising air temperature, effects nitrogen cycling in an alpine environment. Rising air temperature can increase nitrogen cycling and induce earlier and longer growing seasons. An accelerated nitrogen cycle can help alleviate nitrogen limitation in plants, but also may cause plant species composition change. Moreover, excess nitrogen in the environment can have several negative effects, including soil acidification and nitrogen leaching. This can lead to a degraded alpine ecosystem. To understand how nitrogen cycling is changing in regards to rising air temperature, I collaborated on Niwot Long-Term Ecological Research Station's (NWT LTER) Black Sand Project. The Black Sand Project has been adding inert black sand to peak snowpack since 2018 to simulate and accelerate snow melt. The Colorado Mountain Club Foundation helped fund analysis for my initial results, which included finding elevated pools of ammonium and nitrate in the black sand plots. This may be due to the addition of black sand, but may also be a result of quantifying the heterogeneity of mountain ecosystems. Additionally, earlier snowmelt facilitated earlier microbial activity, sparking an increase in mineralization and nitrification rates during the start of the growing season. At some sites, mineralization and nitrification rates decreased drastically toward the end of the growing season, possibly due to moisture limitations.

Douglas Castro, PhD student at the University of Colorado, Boulder was awarded the Ossinger Fellowship ($2,000) for the project, "Microplastics in Mountain Ecosystems of the Colorado Front Range." With the aid of the CMCF Al Ossinger Fellowship, I developed an in-line filtration sampling apparatus. In addition, an MP collection net was created to compare with the filtration apparatus. Both sampling methods were deployed adjacent to each other to sample waters of Green Lake 4 (GL4) within the Niwot Long-Term Ecological Research Station (NWT LTER) to allow for sampling method comparison. In the laboratory, samples from the collection net were digested and run through stepwise filtration (e.g., 20 µm, 10 µm, 1.2 µm, and 0.6 µm) using polycarbonate filters. The in-line filtration sampling apparatus proved to be the most robust in sampling sensitive bodies of water which allowed samples to be taken from solifluction lobes and fast-flowing creeks within the NWT LTER. The filtration apparatus allowed for sampling of MPs through a 1 µm mesh. This is ideal for fully estimating the toxicological risk of MPs deposited in the NWT LTER. Screening of the 1 µm mesh via stereomicroscope shows that plastics are found mainly within GL4 and solifluction lobes. This is likely due to the long residence time of plastics within lakes and solifluction lobes compared to creeks. I will be analyzing samples of both methods to the United States Geological Survey Lab in Madison, Wisconsin to analyze for MP concentrations, morphologies, polymer type, and size. MP exposure assays on GL4 zooplankton will be conducted using the unique MP mixture captured by MP collection net and the in-line filtration apparatus. Doug talks about his research at:

https://www.youtube.com/watch?v=IQ_Tee6Nz1I&t=1s&ab_channel=IndianPeaksWildernessAlliance

Casey Carroll, PhD student at the University of Colorado, Boulder was awarded a $1,000 grant for the project, "Assessing the effects of increased nest temperature on cavity dwelling bee fitness and phenology across an elevation gradient." This summer, the support from the CMCF fund helped me to purchase materials to build over nine hundred individual cavity-dwelling bee nests. I placed 144 nests at each site across an elevation gradient spanning 1500m. I spent the beginning of the spring and early summer installing the nests and taking plant surveys. Over the course of the summer, I identified 74 distinct flowering species across the sites; 24,055 individual flowers were counted. The cavity-nesting bees began to move in during May, along with opportunistic wasps and spiders. After the nests were placed, pollinator surveys began. These surveys measured rates of plant-pollinator interactions. Many cavity-nesting bee species were observed visiting flowers, including leafcutter and mason bees. While I had several bees establish nests across the sites, the level of nest predation was high. By the end of the summer, only a few cavity-nesting bee nests were left intact. This year, I plan to learn from the results of last summer and cover nests once they have been established. This will reduce the amount of predation the bee nests may face. The project was originally designed to run for two years, so this summer the nest and plant surveys will continue. At the end of the second year, I hope that this project will shed more light on the effects of warming temperatures on the overwintering physiology of cavity-nesting bees.



Laurent Duverglas, PhD student at the University of South Carolina, was awarded a $1,000 grant for the project, "Has regulatory enemy release resulted in the persistence of an introduced butterfly population?" The population dynamics of prey are driven in part by their natural enemies. Population survival may be altered as enemy abundance and enemy diversity change across space. Oviposition site selection (OSS), in other words where a female lays her eggs, is the result of choosing leaves that increase offspring survival. The abiotic factors that influence oviposition are well understood, but few studies cite the importance of biotic factors. Examining density-independent mortality factors (e.g., incidental predation) may add context to how biotic factors influence OSS. I collected data associated with the developmental rate of egg clusters as previous research identified a relationship between development and predation. I also set up an enemy exclusion experiment that excluded enemies based on their size. I found that each treatment group in the enemy exclusion experiment had different ranges of survivorship values. Second, I found a strong effect of density-independent predation but also a weaker, yet still strong, effect of density-dependent predation on the survival probability. I also found a relationship between the number of eggs in a cluster and predation on survival. I also collected data on pupal and larval parasitism though the sample size is smaller than expected. However, as this project will be continued in the next two summers, I anticipate I will have a great dataset to examine the effects of habitat, microhabitat, density-independent mortality, and density-dependent mortality on two vital rates important to population growth. The money obtained from the Colorado Mountain Club Foundation allowed me to partially cover the cost of doing research at the Rocky Mountain Biological Laboratory. In other words, the funding I received allowed me to increase my length of stay and thus give me more time to collect the data I required. Further, I was able to purchase the equipment I needed.

Melissa Ocampo, MS student at Murray State University in Kentucky, was awarded a $1,000 grant for the project, "Does Climate Change Promote Cannibalism?" Polyphenisms occur when different environmental conditions produce multiple discrete morphologies in different individuals of the same species. Arizona tiger salamanders (*Ambystoma mavortium nebulosum*) experience several different polyphenisms, one of which being a cannibalistic polyphenism in which cannibal morphs possess teeth and larger, U-shaped heads than typical morphs. No previous studies have examined the impact of climate change on the development of cannibal morphs. This summer, I investigated the impacts of climate change on the frequency of Arizona tiger salamander cannibal morphs. I conducted field sampling throughout the Gunnison basin of Colorado to determine the current proportions of cannibal morphs in natural populations. I haven't yet analyzed these data, but I will compare it with data collected throughout 1994-1996 to determine how the proportion of cannibal morphs has changed over time. Additionally, I conducted an experiment in which I utilized two temperature and three density treatments to investigate whether increased temperatures and density levels influence the production of cannibal morphs. I found no difference in the development of the cannibal morphology between treatments, but increased temperatures and density levels both resulted in significantly more cannibalistic behavior. The CMCF grant helped me cover a portion of my station and housing fees at the Rocky Mountain Biological Laboratory (RMBL) this summer, which enabled me to stay at and conduct my research at RMBL.

Megan Zerger, MS student at Murray State University in Kentucky, was awarded a $1,000 grant for the project, "Assessing the interaction of stress physiology and Bd infection in Arizona tiger salamanders (*Ambystoma mavortium nebulosum*)." Amphibian biodiversity has greatly diminished in recent years due to pathogenic fungi *Batrachochytrium dendrobatidis* (*Bd*), the cause of the deadly disease chytridiomycosis (chytrid). The pathogenesis of chytrid is still unclear, as certain species and individuals within a species are differentially affected. Prolonged corticosterone activity hinders immune response, and may influence susceptibility and mortality of *Bd*. Thus, the objective of my Master's thesis study is to assess the relationship of corticosterone variation and *Bd* spore load in Arizona tiger salamanders (*Ambystoma mavortium nebulosum*) of Gunnison County, Colorado. In 2022 and 2023, I used a dermal swabbing method to collect baseline (resting) corticosterone and *Bd* samples from paedomorph (aquatic) and metamorph (terrestrial) Arizona tiger salamanders. I am currently processing these samples in the lab at Murray State University, and preliminary corticosterone results suggest that some methods of physical agitation are more efficient in eliciting a stress response in this species. I will have more results once I finish processing my samples within the upcoming months. This study will provide a greater understanding of the pathogenesis of *Bd* and the interacting effects of glucocorticoid production and polyphenic life history on disease resistance. These results will develop the use of corticosterone as a predictor of *Bd* and *Batrachochytrium salamandrivorans* (*Bsal*) susceptibility and severity.