CAREER: Feedbacks from drought on the phytochemical landscape
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The western United States is suffering from its worst drought in centuries. To predict how drought will impact the environment, the effects of drought must be studied in the context of full ecological systems. These systems include variation across space in resources and in food webs. Plants produce mixtures of nutrients and toxins, and this chemistry varies genetically and with changes in the environment. Because plants use resources to form the base of food webs on land, plant chemistry can link variation in resources with variation in food webs. An understanding of how plant chemistry responds to extreme drought could thus shed light on the larger system. This research will improve understanding of (a) how plant chemistry changes in response to drought at the scales of individual plants and of plant communities, and (b) the relationship of these changes to changes in plant-animal interactions and decomposition. The project is based in the Great Basin Desert on the border between Nevada and California, where extreme drought is now commonplace. The researchers will test the hypothesis that extreme drought reduces environmental variation, with consequences for system function. The project will also provide training to student and community scientists in Nevada to increase access to science education.

Drought imposes acute stress on plant metabolism, which may reduce the strength of feedbacks between trophic interactions and soil carbon dynamics, simplifying ecological communities. To test this hypothesis, the researchers will conduct drought experiments on focal plant individuals and on plant communities. Using outdoor gardens of western milkweed, the researchers will assess how the amount and variability of water impacts plant-herbivore-predator interactions, as well as how plant tissues from different watering treatments influence decomposition and soil respiration. Using drought shelters and rainfall additions in plant communities in sagebrush ecosystems, the researchers will assess how drought affects plant chemistry at the plot scale, including changes in the chemistry of individuals and changes due to differential survival and recruitment in the community. These measurements will then be related to changes in arthropod communities and in soil carbon dynamics in a spatially explicit design. The researchers will measure plant chemistry using untargeted metabolomics approaches that consider the composition and diversity of compounds as well as their concentrations. The complexity of plant-animal interactions will be also manipulated in the milkweed gardens using factorial combinations of herbivores and their predators to test the importance of such trophic feedbacks. The work will provide insight into the dynamics of future ecosystems in the American West and the extent to which we can predict those dynamics through an understanding of plant chemistry.