Nevada Native Plant Society

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Society News

Northern Nevada Events

March 2 – Annie Overlin, UNR Research Scientist, will give a talk entitled "Revegetation of an agricultural wetland: utilizing seed bank and response to biomass management to inform restoration and management."

April 6 – Arnold "Jerry" Tiehm, Herbarium Curator at UNR's Museum of Natural History, will provide the program on 2016's botanical surprises from northwestern Nevada.

Join our speakers before the meetings for dinner at 5:30 at **Great Full Gardens**, 555 South Virginia Street.

Meetings are in room 300G of the Fleischman Agriculture Building on the UNR campus, north of 9th Street and Evans Avenue.

Enter the building under the breezeway on the west side near the street. There's an elevator at the east end of the building. Meet on the third floor and down the hall from the UNR herbarium.

Social time starts at 7:00 PM and the program starts at 7:30. The outside door will be automatically locked at 7:30.

Parking is enforced in the lot on the SE corner of Evans and Record Way. Parking passes and maps are available from the university – see **www.unr.edu/parking** for more information.

Southern Nevada Events

March 6 – Dr. Jim Boone, Ecologist and founder of BirdandHike.com will present "Gold Butte and the Biology of Elevation Gradients."

April 3 – Corrin Floyd, Restoration Specialist with Great Basin Institute and Southern Nevada Office of BLM will present her talk entitled "Multi-agency effort to restore burned areas of Mojave Desert Tortoise Habitat."

Southern Nevada Meetings are held in Henderson the first Monday of every month from 6:30-7:30 PM (unless otherwise noted when holidays fall on first Mondays) at the U.S. Geological Survey office at 160 North Stephanie Street.

Our program coordinator is Lesley DeFalco. If you would like email updates for Southern Nevada events, please email her at **defalco@usgs.gov** and ask to be added to the list.

Events subject to change.
Visit nvnps.org for updates.

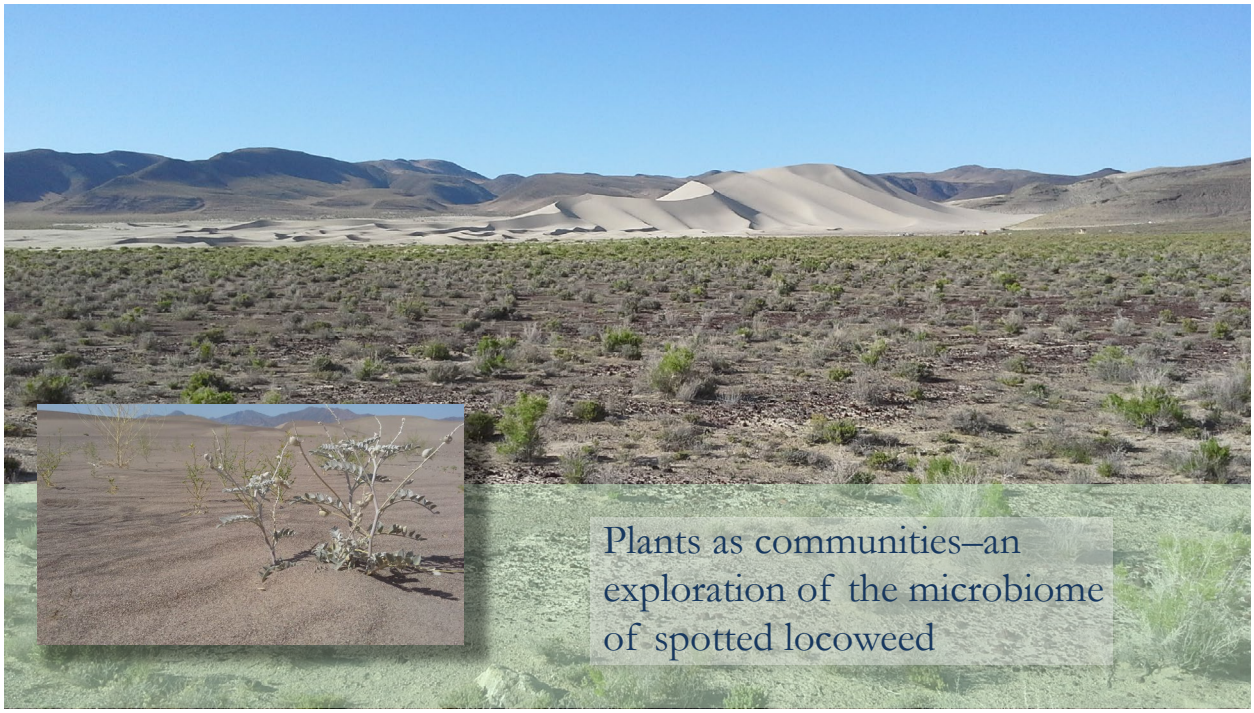

Fig. 1 Sand Mountain near Fallon, NV. Spotted locoweed (*Astragalus lentiginosus*) can be found near the old Pony Express station here. (Inset) Big Dune, NV. *A. lentiginosus* var. *variabilis*. Spotted locoweed is a tremendously widespread Nevada native occurring on roadsides, sand dunes, and subalpine meadows. *J.G. Harrison*

Story by Josh Harrison

We tend to think of plants as individuals – a single, striking bristlecone pine for instance. However, an individual plant is really a complex community of interacting organisms that are too small for us to sense without a microscope. Indeed, myriad bacteria and fungi have been found living within the tissues of all plants examined so far. My research focuses on understanding the reciprocal interactions between plants and these microbial denizens–botany writ small!

I am particularly interested in foliar fungal endophytes. These are fungi that live *inside* the leaves of healthy plants (Rodriguez et al. 2009). Relatively little is known regarding endophyte natural history, but there are a few amazing examples of the influence they can have on their hosts. For instance, the widespread grass *Dichanthelium lanuginosum* hosts a fungal endophyte that conveys a measure of heat tolerance to the grass. This in turn allows the grass to grow near geothermal hot springs in Yellowstone National Park. Amazingly, the fungal endophyte must itself be colonized by a virus in order to provide the heat protection which allow the grass to grow in such hot soil (Márquez et al. 2007). This is a great example of how a fungal endophyte can profoundly influence the ecology of its host. However, the ecological roles of most fungal endophytes are unknown and, consequently, this is a burgeoning field of study. In order to gain insight into who these fungi are, where they live, and what they are doing, I have embarked on a research program using the widespread Nevada native plant, spotted locoweed (*Fig. 1*; *Astragalus lentiginosus*; *Fabaceae*).

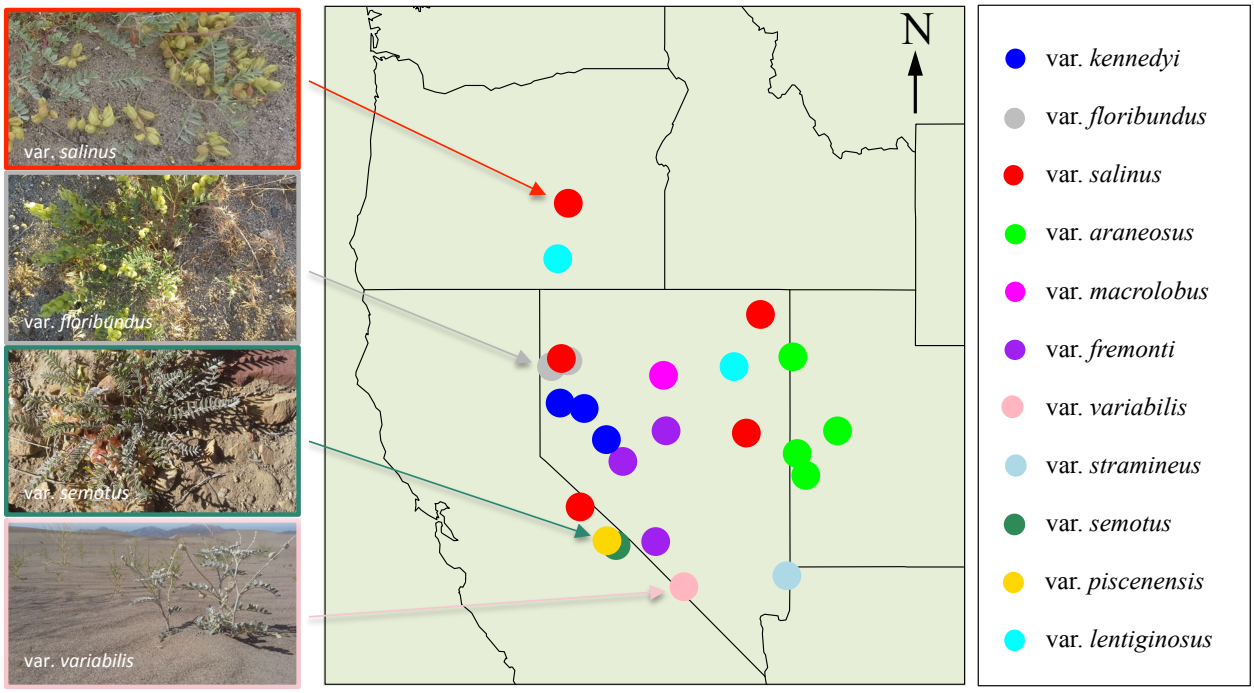

Fig. 2 Study locations. At each location ~15-20 individual plants were sampled. The colors correspond with varieties. Inset are pictures illustrating just a portion of the morphological variety encompassed by the spotted locoweed taxon. *J.G. Harrison*

I find spotted locoweed one of the most fascinating plants in- Nevada for two reasons. First, there are more varieties of spotted locoweed than any other plant species in the North America flora. Indeed, Welsh (2007) suggested that spotted locoweed be parsed into 42 varieties! These varieties encompass a great deal of morphological variation (Fig. 2), but tend to intergrade which makes identification quite challenging. This makes spotted locoweed a microcosm of the diversity within the *Astragalus* genus–the most species rich genus of flowering plants. The other fascinating thing about spotted locoweed is that it hosts a fungus, *Alternaria fulva* (previously *Undifilum fulvum*), which makes a potent compound called swainsonine. Swainsonine inhibits the breakdown of carbohydrates and can harm livestock. Upon ingestion of locoweed, livestock go “loco” and exhibit all manner of terrible symptoms and can even die if enough locoweed has been ingested. Locoweed poisoning can be caused by several other *Astragalus* and *Oxytropis* species, each of which has an Alternaria fungus that makes swainsonine (Cook et al. 2016). This is a tremendous problem in the West, as locoweed poisoning of livestock is estimated to cause ~$100 million in damages annually (Cook et al. 2009). Interestingly, the fungus that causes all these problems is heritable – it grows into the seeds of locoweeds, and is thus passed down from one generation to the next.

As part of my dissertation work at the University of Nevada, Reno I set out to understand more about this fascinating interaction. Accordingly, I collected tissues from a number of spotted locoweed populations from throughout the West (*Fig. 2*). I extracted DNA from these leaves–this included both plant DNA, and the DNA from all the fungi

Fig. 3 *Astragalus lentiginosus semotus* in flower and fruit. *J. Morefield*

living within those leaves. With funding from the Nevada Native Plant Society Margaret Williams Research Grant, I then sequenced this DNA to describe genetic variation in spotted locoweed, and to rapidly characterize the fungi living within each focal plant. Briefly, this process involves sequencing many bits of DNA that are diagnostic of fungi, and looking for differences in those fungal DNA sequences. The number of different sequences provides an idea regarding the number of different types of fungi within the sample. Sequence-based approaches to characterizing the microbiome like this have revolutionized biology because many microbes are difficult to grow in the lab and are challenging to identify by morphology alone.

With these data in hand, my co-authors and I asked three questions:

1. What can we learn about the population genetics of spotted locoweed?
2. How do the genetic relationships among spotted locoweed populations manifest in differences in the microbiome?
3. What habitat factors are associated with fungal diversity in our region?

First, we found very strong population genetic structure among spotted locoweed populations (*Fig. 4*). Most of the varieties were genetically distinct, and even some populations within a variety were distinct from one another (e.g. var. *salinus*). For the most part, proximal locoweed populations were more genetically similar to one another,

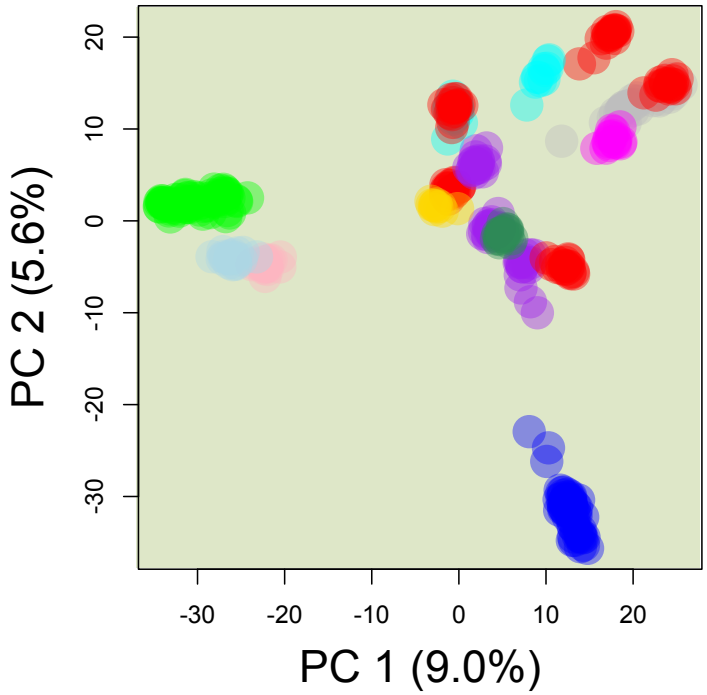

Fig. 4 Genetic variation among spotted locoweed varieties. See **Fig. 2** for a legend mapping color to variety. This figure shows an analysis (principle components analysis) that facilitates visualization of genetic variation by plotting in two dimensions. Each focal plant is a single point. Points that are closer together on the plot are more similar genetically. This plot shows that different varieties of spotted locoweed are genetically distinct because plants from the same variety tend to clump together. Axis labels reference the percentage of genetic variation described by the axis; we used information from over 13,000 loci for this analysis. *J.G. Harrison*

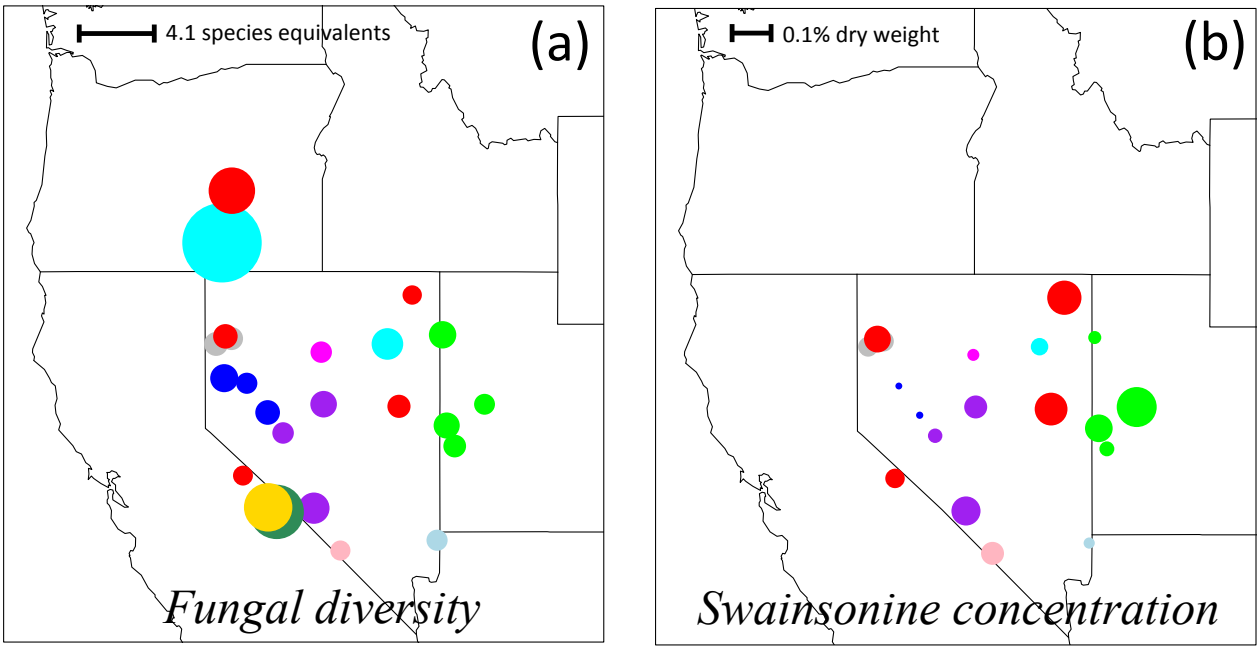

Fig. 5 Panel (**a**) shows the variation in fungal diversity we observed across the Great Basin. Points are scaled proportionally to diversity, so bigger points mean there was a more diverse fungal community in spotted locoweed at that location. Here, we are referring to average diversity in a sample, which was made up of just a few leaflets. Panel (**b**) shows the amount of swainsonine we found in dried tissues of spotted locoweed. Notice that we found no swainsonine in the Columbia Plateau and along the Eastern Sierra, and we also found more fungal diversity at those locations. This highlights the negative correlation we found between swainsonine and fungal richness and diversity. *J.G. Harrison*

Fig. 6 *Astragalus lentiginosus fremontii.* *J. Morefield*

regardless of their varietal classification. However, this was not always the case, which suggests a complicated recent evolutionary history for this interesting plant.

Our data also showed that there was quite a bit of variation in the fungal communities of spotted locoweed across the Great Basin (*Fig. 5*). For instance, there was much greater fungal diversity in populations of spotted locoweed in the Columbia Plateau, and along the Eastern Sierra. Why might this be? I compared a number of variables with fungal diversity, including mean annual temperature and precipitation, soil type, and locoweed genotype, size, and phenology. It turns out that that there are typically fewer fungi in plants growing in warmer temperatures, and in plant populations that are more inbred. Overwhelmingly however, the most important predictor of fungal diversity was the abundance of the heritable fungus, *Alternaria fulva*. Plants that had more *A. fulva* living within their tissues tended to have much a much less diverse cadre of endophytic fungi. When we looked deeper we found that this association was even stronger for swainsonine, the bioactive compound that *A. fulva* synthesizes that can harm livestock. Plants with higher concentrations of swainsonine in their tissues had greatly reduced endophyte communities. For instance, in *Fig. 5* the locoweed populations in the Columbia plateau have no swainsonine and high fungal diversity. Interestingly, one of

the common fungi we found on spotted locoweed was the powdery mildew *Leveillula taurica*. This is a common pathogen of many plants. When locoweed plants were colonized by the heritable fungus *A. fulva* they had much less of this pathogen. This suggests that *A. fulva* benefits the host plant as a mutualist. These results are quite exciting because they highlight how a heritable fungus influences the ecology of its host plant.

I hope this brief story highlights how a microbial perspective can deepen the wonder we feel when observing our native plants. This spring when you are out viewing wildflowers consider that each individual plant is host to hundreds of bacteria and fungi. While these microbes may be unapparent to our eyes they are nonetheless fundamentally important and their study represents a new way for us to explore the natural world.

Acknowledgements

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