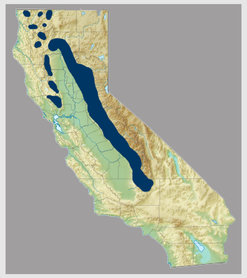
Patterns of polyploid formation in manzanitas

S.M. Serkanic and V.T. Parker
Department of Biology, San Francisco State University

Taxa under investigation

Arctostaphylos viscida Parry (whiteleaf manzanita)

-xeric sites at lower elevations (100-6,500ft.)
-white-glaucous leaves
-sticky and glandular inflorescence
-lacks burl
-diploid (2n=2x=26)

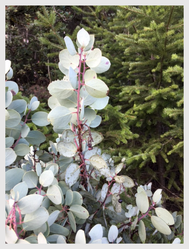


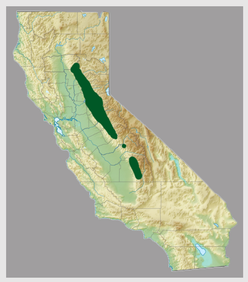
Arctostaphylos patula Greene (greenleaf manzanita)

-higher elevation (2500-11,000ft.) conifer forests across western United States
-bright green leaves
-burl present in most populations
-diploid (2n=2x=26)

Arctostaphylos mewukka Merriam (Indian manzanita)

-occurs in the sierra where *A. patula* and *A. viscida* populations overlap
-gray-glaucous leaves
-two subspecies: *A. mewukka* Merriam ssp. *mewukka* (burled);
and *A. mewukka* Merriam ssp. *truei* (W. Knight) P.V. Wells (lacks burl)
-transgressive phenotypes (dark colored fruit and large, gray-glaucous leaves)
-tetraploid (2n=4x=52)





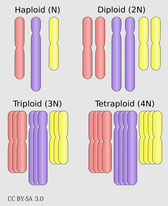
Background

-Genome duplication through polyploidization is a profound mechanism for reproductive isolation and hybrid speciation in sympatry (1,7).

-The formation of polyploid species through genome duplication is widely recognized and is considered to have occurred numerous times throughout the evolutionary history of flowering plants (6).

-*Arctostaphylos,* commonly referred to as manzanita, contains 105 minimum rank taxa and is primarily distributed throughout California, with 104 taxa occurring within the region's boundary (2).

-37/105 minimum rank taxa are documented tetraploids, indicating a strong relationship between genome duplication and species richness in the group.



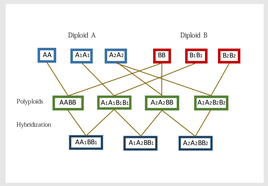
*37 minimum rank taxa are documented tetraploids in the genus *Arctostaphylos*. Polyploid individuals are largely isolated from progenitors with unduplicated genomes.

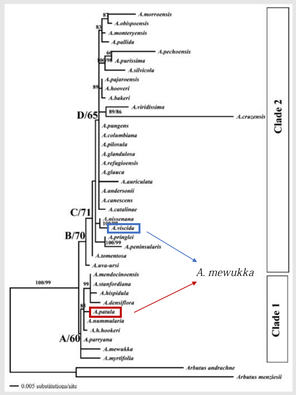
-The Sierra Nevada is home to two widely distributed diploid manzanita species: *A. patula* and *A. viscida.*

-Schierenbeck et al. (1992) demonstrated that *A. mewukka* is the resulting allopolyploid from hybridization between *A. patula* and *A. viscida.*

-Two subspecies of *A. mewukka* are recognized. One subspecies possesses a burl and the other does not. This salient distinction is an indication that both subspecies may have arisen from separate and independent hybridization events, as recurrent formation of polyploid taxa through repeated hybridization events is the commonly observed trend in plant evolution (4,5).

*Polyploid species arise from multiple and repeated hybridization events, resulting in separate and compatible individuals with distinct genotypes.





*Boykin et al. (2005) demonstrated a two-clade topology in the phylogeny of the genus *Arctostaphylos* (ML tree based on nuclear ribosomal DNA).

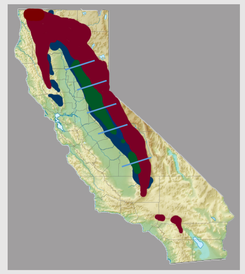
*Schierenbeck et al. (1992) demonstrated *A. mewukka* as the resulting allopolyploid from hybridization between the two common diploid sierran manzanitas.

*Progenitors of *A. mewukka* are in opposite clades, providing an opportunity to detect hybridization signatures throughout the hybrid species' range.

Methods and Analysis

Field

-collect samples of each species from five transects throughout the distribution of *A. mewukka*



*Five transects throughout the distribution of *A. mewukka*

* Two samples of each progenitor, and five samples of *A. mewukka* collected from each transect

(5 transects)(2 *A. viscida* + 2 *A. patula* + 5 *A. mewukka*) = 45 samples

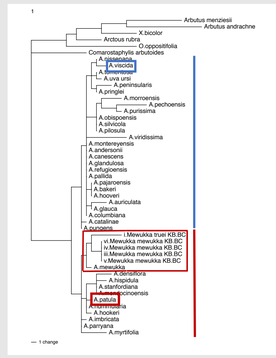
*investigate disjunct population south of the Kaweah River watershed

Lab

-amplify and sequence two regions of maternally inherited cpDNA for each of the 45 samples
-construct separate and concatenated 3-taxon/45-OTU phylogenies for each cpDNA haplotype

-amplify and sequence biparentally inherited nrDNA for the 25 *A. mewukka* samples
-reconstruct Boykin et al. (2005) phylogeny with nrDNA data from this study

Results from pilot study



*NJ tree, based on nrDNA, showing the placement of *A. mewukka* sequences acquired from five (I-V) herbarium specimens, each representing separate populations throughout the species' range.

*Results suggest biased gene conversion of homeologous nrDNA repeats toward sequences similar to *A. patula.*

*Further investigation, with maternally inherited cpDNA, may reveal signs of reciprocal parentage among progenitors, providing insight into hybridization patterns and distinct origins of certain populations.

Literature cited

1- Grant V. 1981. Plant speciation. New York, USA: Columbia University Press. **2**- Kauffmann, M. E., Parker, T., Vasey, M., & Bisbee, J. (2015). *Field guide to manzanitas: California, North America, and Mexico.* Kneeland, CA: Backcountry Press. **3**- Schierenbeck, K. A., Stebbins, G. L., & Patterson, R. W. (1992). Morphological and cytological evidence for polyphyletic allopolyploidy in Arctostaphylos mewukka (Ericaceae). *Plant Systematics and Evolution, 179*(3 – 4), 187 – 205. **4**- Soltis DE, Soltis PS. 1999. Polyploidy: Recurrent formation and genome evolution. Trends in Ecology and Evolution 14: 348 – 352. **5**- Soltis, D. E., Soltis, P. S., Pires, J. C., Kovarik, A., Tate, J. A., & Mavrodiev, E. V. (2004). Recent and recurrent polyploidy in Tragopogon (Asteraceae): cytogenetic, genomic and genetic comparisons. *Biological Journal of the Linnean Society, 82*, 411 – 423. **6**- Soltis, D. E., Albert, V. A., Leebens- Mack, J., Bell, C. D., Paterson, A. H., Zheng, C., ... Soltis, P. S. (2009). Polyploidy and angiosperm diversification. *American Journal of Botany, 96*(1), 336 – 348. **7**- Stebbins GL. 1950. Variation and evolution in plants. New York, USA: Columbia University Press.

SAN FRANCISCO STATE UNIVERSITY 1899

DEPARTMENT OF BIOLOGY