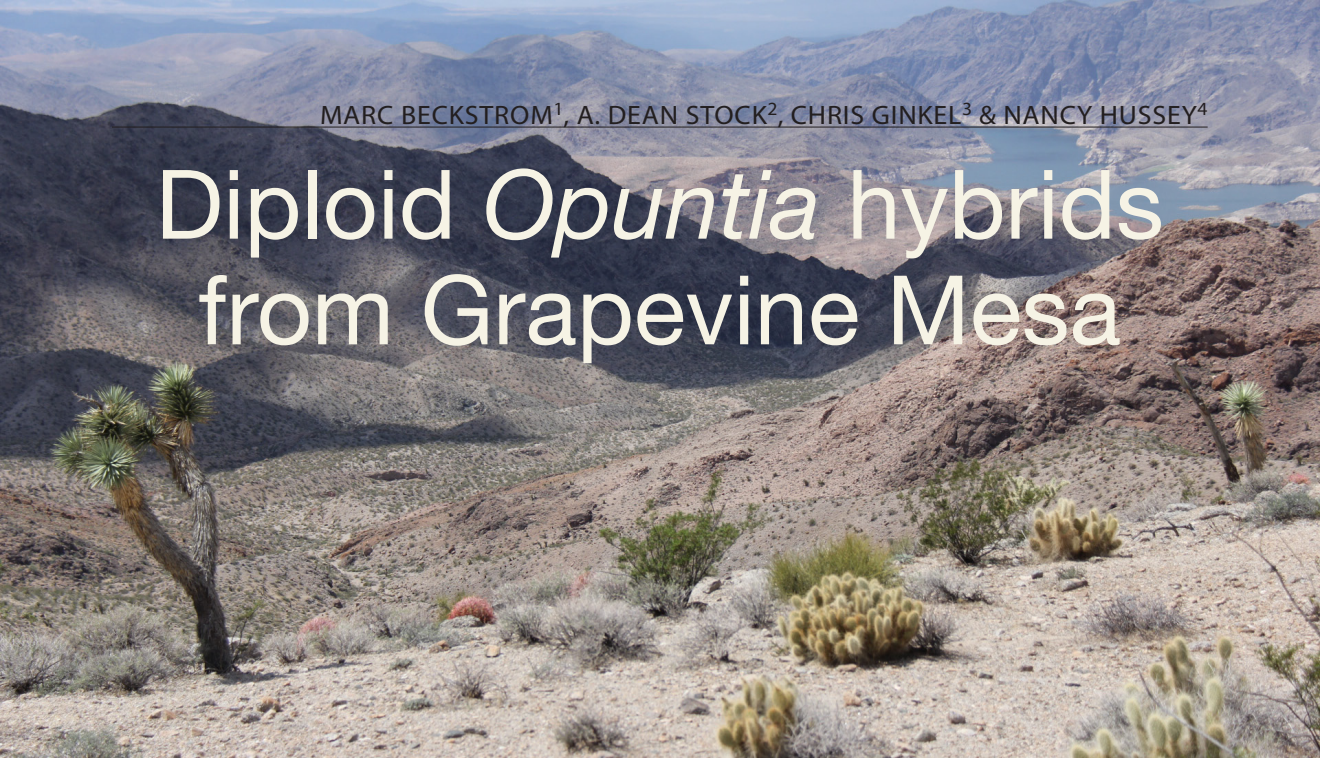
MARC BECKSTROM[1], A. DEAN STOCK[2], CHRIS GINKEL[3] & NANCY HUSSEY[4]

Diploid *Opuntia* hybrids from Grapevine Mesa



1. Grapevine Mesa looking west down at Lake Mead. Photo by Marc Beckstrom.

These unique hybrids are only found between Grapevine Mesa west to the White Hills and 12 miles south from the southern edge of Lake Mead. This is a rather small area, but extraordinarily rich in cactus diversity (Figs. 1 & 2) and among the commonly occurring cacti are: *Corynopuntia parishii* (Parish ex Britton & Rose) F.M. Knuth; *Cylindropuntia echinocarpa* (Engelm. & J.M. Bigelow) F.M. Knuth; *Cylindropuntia acanthocarpa* (Engelm. & J.M. Bigelow) F.M. Knuth; *Cylindropuntia multigeniculata* (Clokey) Backeb.; *Cylindropuntia ramosissima* (Engelm.) F.M. Knuth; *Echinocactus xeranthemoides* (J.M. Coult.) Engelm. ex Rydb.; *Echinocereus engelmannii* (Parry ex Engelm.) Lem.; *Echinomastus johnsonii* (Parry ex Engelm.) E.M. Baxter; *Ferocactus acanthodes* (Lem.) Britton & Rose; *Mammillaria tetrancistra* Engelm.; *Opuntia basilaris* Engelm. & J.M. Bigelow and *Opuntia diploursina* A.D. Stock, N. Hussey & M.D. Beckstrom.

Of the two *Opuntia* species present *O. basilaris* and *O. diploursina*, one is endemic, and there are also two different hybrids and a few rare backcross plants involving these two species. The *Opuntia* hybrids are found in two distinct diploid populations—northern and southern. The northern population is comprised entirely of (*O. diploursina* × *O. basilaris* "population 1"), and the southern population, of (*O. diploursina* × *O. basilaris* "population 2"). None of the hybrids, or the parent *O. basilaris* populations, have been described yet, although we are currently working on their descriptions. Of the two hybrids, the southern population has been known for some time, but with little information on its origin. At least one hypothesis has been suggested involving *O. aurea* E.M. Baxter as a parent, which is incorrect because the range of *O. aurea* is far to the north and does not cross over to the south side of the Grand Canyon. In addition, *O. aurea* is an allohexaploid and would not produce diploid hybrids with *O. basilaris* or *O. diploursina*.

[1]1538 Lomitas Ave., Livermore, CA 94550
[2]40 South, 7440 East, Kanab, UT 84741
[3]2446 East Cheryl Drive, Phoenix, AZ 85028
[4]29770 North Hardy Road, Meadview, AZ 86444

2. Cactus community on Grapevine Mesa.

3–5. Northern hybrid (*Opuntia diploursina* × *O. basilaris* "northern population"). Photos by Marc Beckstrom.

From about 2 miles north of Meadview there is roughly a 3 mile long area where the northern and southern populations of *Opuntia basilaris* and hybrids are separated from each other with no intergrading forms found. Only *O. diploursina* grows in this area uninterrupted from the south to the north of its range on Grapevine Mesa. We once thought that a small population of *O. erinacea* Engelm. & J.M. Bigelow occurred within the range of *O. diploursina* but this was based on a misinterpretation of locality data in our original description; *O. erinacea* occurs a few miles to the south of the range of *O. diploursina* just outside of Grapevine Mesa with no contact between the two species.

These two primary hybrids between *Opuntia basilaris* and *O. diploursina* are immediately distinguishable from each other by the shape of their cladodes, which is attributable to the two distinct *O. basilaris* populations parental to the hybrids. The cladodes of the northern hybrid population are mostly elliptic to spatulate and are green rarely bluish green in color (Figs. 3–5) whereas those of the southern hybrid population are mostly circular to broadly obovate and are green to blue green in color (Figs. 6–9). All other characteristics appear to be the same. All *O. basilaris* hybrids, and these primary hybrids, always have pink flowers like those of *O. basilaris*, but with a green stigma instead of the cream color of the latter. They also have straight, short reddish-brown spines that may or may not be easily observable on all cladodes. The spines are often more prominent on the edges of the cladode.

6. Southern hybrid (*Opuntia basilaris* × *O. diploursina*) in flower. Notice the green stigma characteristic of these hybrids. Photo by Dean Stock.

7. Southern hybrid (*Opuntia basilaris* × *O. diploursina*); close-up of the spines. Photo by Marc Beckstrom.

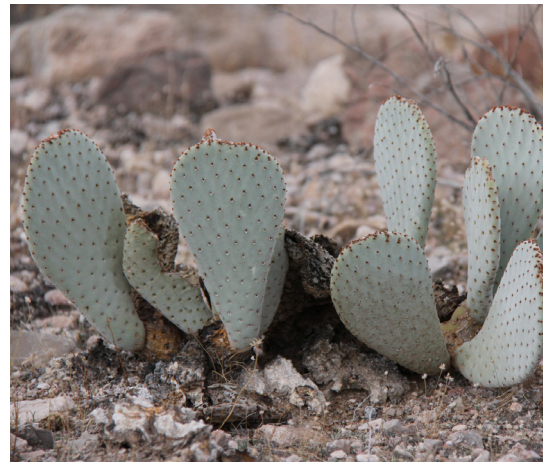
8 & 9. Hybrid, this is the southern population (*Opuntia diploursina* × *O. basilaris* "southern population").

10 & 11. *Opuntia diploursina*; an ancient diploid newly described in 2014. Note the long curly yellow spines. Photos by Marc Beckstrom.

12 & 13. *Opuntia diploursina*; an ancient diploid newly described in 2014. Note the flower color and the heavily spined fruit. Photos by Nancy Hussey.

The only exception to the green stigma in the *Opuntia basilaris* hybrids is *O. treleasei* which has a cream colored stigma, due to back-crossing to its parent *O. basilaris*.

There is one parent plant that is shared by both hybrids; it is the diploid, dry fruited, prickly pear, *Opuntia diploursina* (Figs. 10–13), newly described this year (2014) by us (*Cact. & Succ. Journal (Los*

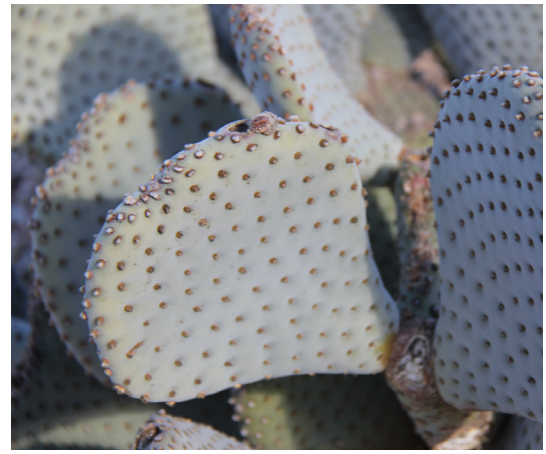


14 & 15. *Opuntia basilaris* "northern population" only grows at the northern end of Grapevine Mesa continuing north and northwest to the Colorado River and Lake Mead. We are also hoping to find it following Wheelers Ridge just north of the river. Photos by Marc Beckstrom.

Angeles) 86(2): 79-83). *O. diploursina* is an ancient diploid species with just a small remnant population; it also may be the "missing link"—the ancestor to tetraploid *O. erinacea*. Its range starts roughly 5 miles south of Lake Mead City, then north about 2 miles past the road to South Cove and west to the eastern edge of the White Hills. It also occurs north of Lake Mead in the Gold Butte and Grand Wash areas. Each of the two hybrids has as its second parent a different population/variety of *O. basilaris*, neither of which has been described yet.

The first *Opuntia basilaris* population (Figs. 14 & 15) is from the northern end of Grapevine Mesa, from about two miles south of South Cove Road then north to Lake Mead including Wheeler Ridge and east to Pearce Ferry. The second population (Figs. 16 & 17) ranges from about 2 miles north of Meadview and west to Greggs Hideout Road, then south past the end of Grape Vine Mesa into the Cerbat Mountains, located north of Kingman. The western and eastern edges of its range have not yet been fully determined.

There are other similar hybrids, but with only a few rare plants found here and there, and they vary slightly depending on what varieties of *Opuntia basilaris* and *O. erinacea* are found growing together. An example is found on Mormon Mesa, Clark County, Nevada, discovered by David Silverman (*O. erinacea* × *O. basilaris*), (Figs. 18 & 19). Blake Wellard discovered a small populations of similar hybrids in the SW corner of Washington Co., Utah. Wherever there are sympatric populations of *O. basilaris* and *O. erinacea*, there is a possibility of finding interspecific hybrids, but they are few and hard to find because the resulting



16 & 17. *Opuntia basilaris* "southern population" only grows at the southern end of Grapevine Mesa continuing southward past the Mesa. Photos by Marc Beckstrom.

18 & 19. *Opuntia basilaris* hybrid, *(O. basilaris* × *O. erinacea)* found at Mormon Mesa, Clark Co., Nevada. Note the spines; they are very similar to *O. treleasei*. Photos by Marc Beckstrom.

20 & 21. Only one of this rare back-cross hybrid has been found among the northern hybrid population. Photos by Marc Beckstrom.

22 & 23. Only one of this rare back-cross hybrid has been found among the southern hybrid population. Photos by Nancy Hussey.

triploid hybrids are relatively infertile and reproduce mainly by vegetative means.

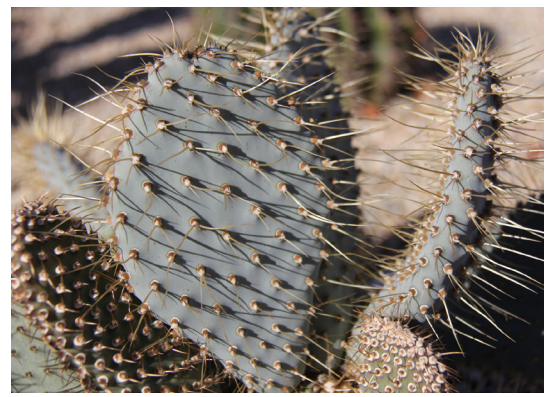
Rare plants were observed (one each among both northern and southern hybrid populations) that are back-crossed to *O*puntia *diploursina* and are characterized by having much longer spines as seen in the plant from the northern hybrid population (Figs. 20 & 21). The back-cross plant that was found among the southern hybrids is more like *O. diploursina* in spine characteristics and form (Figs. 22 & 23). It is possible that we did not detect all back-cross plants but they appear to be rare, indicating a certain level of a breeding barrier between the two species and their resulting hybrids even though they are all diploids. How flowering time affects interbreeding between these populations has not yet been established.

Another unusual back-cross population (Figs. 24 & 25) co-exists among the northern hybrid population that is densely covered by white spines and has a shape like that of the northern hybrid population. It develops long curling major spines at maturity like those of *Opuntia diploursina*. The minor spines

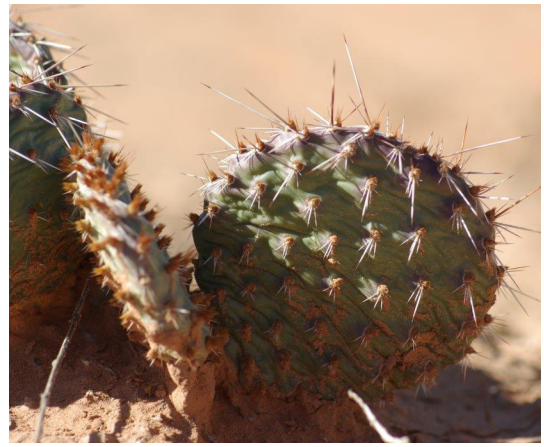
22 & 23. Only one of this rare back-cross hybrid has been found among the southern hybrid population. Photos by Nancy Hussey.

of this form are more rigid and thicker than those of *O. diploursina* and tend to become longer and less appressed to the pad surface much like those of *O. erinacea*. These diploid hybrids are only found along South Cove Road and seem to be fairly common, but fewer in number than *O. diploursina*, *O. basilaris*, or their primary hybrids. The back-crossing of hybrids to *O. diploursina* and subsequent conversion to tetraploidy, may be how *O. erinacea* evolved. It is likely that *O. diploursina* once had a much wider range in the Mohave Desert region.

A related *Opuntia* which has confused taxonomists for many years is *O. basilaris* var. *treleasei*, also likely of hybrid origin (*O. basilaris* × *O. erinacea*), and should be treated as *O.* × *treleasei*, or, preferably, at the species level, as *O. treleasei* (J.M. Colter) J.M. Colter ex Toumey (Figs. 26 & 27). When *O. treleasei* is compared to the (*O. basilaris* × *O. erinacea*) hybrid from Mormon Mesa, one can clearly see where the spines of *O. treleasei* came from, and even with the *O. basilaris* hybrids from Grapevine Mesa one can also see the similarity in spines, and general morphology, although different because of the involvement of *O. diploursina* in place of *O. erinacea*. From comparisons with other *O. basilaris* hybrids, including those with *O. basilaris* var. *heilii* S.L. Welch & Neese and *O. nicholii* L.D. Benson, (Figs. 28–30) discovered by Dorde Wright Woodruff, we believe that the data convincingly demonstrate that *O. basilaris* var. *treleasei* should not be regarded as a "*basilaris* variety", but as a very old hybrid between *O. basilaris* and *O. erinacea*. The latter species is now extinct in the area and this distinct hybrid derived population is no longer being created by hybridization. It is now a stable, self-propagating population, comprised of both diploids and triploids, and should be given full species ranking as *O. treleasei*. The triploids remaining in the population may be reproducing by apomixis (replacement of the normal sexual reproduction by asexual seed reproduction, without fertilization), which might account



26 & 27. *Opuntia treleasei* is likely the result of hybridization between *Opuntia basilaris* and *Opuntia erinacea*. This species is quite rare and only found in isolated populations around Bakersfield. Photos by Marc Beckstrom.



28-30. An unusual *Opuntia basilaris* hybrid (*O. basilaris* var. *heilii* × *O. erinacea* var. *hystricina*) has only been found around Hanksville, Utah. Photos by Dean Stock.

for their continued existence in spite of the current absence of a tetraploid *O. erinacea* population to produce them.

ACKNOWLEDGEMENTS

We thank David Silverman for sharing material from the hybrids involving *Opuntia erinacea* and *O. basilaris* he discovered at Mormon Mesa, Nevada. We also thank Dorde Wright Woodruff for contributing material from the hybrids involving *O. erinacea var. hystricina* and *O. basilaris var. heilii* that she discovered near Hanksville, Utah.

We also thank Dr. Stephen Beckstrom-Sternberg (Northern Arizona University) for suggestions on an early draft of the manuscript.

LITERATURE CITED

(IPNI), International Plant Names Index. 2009. Published on the Internet. 2010. Mar 12 [1].

(FNA), Flora of North America. 2003. Vol. 4. Oxford University Press, New York.

Stock AD, Hussey N & Beckstrom MD 2014. A new species of ***Opuntia*** (Cactaceae) from Mohave Co., Arizona. *Cact. Succ. J. (Los Angeles)* 86(2): 79-83.