



The Arizona  
Native Plant  
Society

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# The Plant Press

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*Echinocactus horizonthalonius* flower.

## In Search of *Amoreuxia* and *Echinocactus* in Sonora

by Thomas R. Van Devender<sup>1</sup> and Ana L. Reina-Guerrero  
Photos courtesy the authors

One of the tools that helps States and landowners plan and implement projects to conserve species is the Cooperative Endangered Species Conservation Fund (section 6 of the U.S. Endangered Species Act), which provides grants to States and Territories to participate in a wide array of voluntary conservation projects for candidate, proposed, and listed species on non-Federal lands. Section 6 surveys in Arizona and Sonora are very important in understanding the current statuses of Threatened and Endangered plants, and opportunities for general floristic inventories in the habitats where they occur.

We surveyed populations of Santa Rita mountain yellowshow (*Amoreuxia gonzalezii*) and Turk's head cactus (*Echinocactus horizonthalonius*) in Sonora, Mexico, under Section 6 funding.

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<sup>1</sup>Sky Island Alliance, PO Box 41165, Tucson, AZ 85717. [vandevender@skyislandalliance.org](mailto:vandevender@skyislandalliance.org)

# President's Note

by Douglas Ripley jdougripley@gmail.com

As 2013 comes to a close we can look with satisfaction upon the many accomplishments of the Arizona Native Plant Society. Each of our six chapters conducted monthly meetings with compelling speakers, numerous field trips, and individually sponsored activities including habitat restoration projects, invasive species detection and eradication programs, the establishment of a demonstration native plant garden, and several native plant identification training and collecting workshops through the Plant Atlas Program Arizona (PAPAZ). In February we co-sponsored with the Desert Botanical Garden the Arizona Botany 2013 Meeting which was a great success thanks to the efforts of the organizing committee (Wendy Hodgson, Kimberlie McCue, and Andrew Salywon). The Arizona Botany 2014 meeting (see box on right) will be co-sponsored by the AZNPS and the Arizona-Sonora Desert Museum on February 22, 2014, at the beautiful Arizona-Sonora Desert Museum in Tucson. I urge everyone to attend this informative meeting which will have as its theme, "Interdisciplinary Botany — How Related Scientific Fields Support Our Understanding of Native Plants." We have lined up a number of excellent speakers and will offer several field trips on the Sunday following the meeting.

This issue of *The Plant Press* features articles prepared by six of the presenters at the Arizona Botany 2013 Meeting, the theme of which focused on habitat and rare plant conservation. They provide a very interesting perspective on many aspect of rare plant biology, including breeding systems, distribution patterns, factors influencing dormancy, conservation strategies, and assessments of relative rareness. We hope you enjoy them.



*Ipomoea pedicellaris* courtesy Tom Van Devender

## 2014 BOTANY MEETING

*Interdisciplinary Botany: How Related Scientific Fields Support Our Understanding of Native Plants*

**Save the date: February 22-23, 2014**

**at the Arizona-Sonora Desert Museum, Tucson, AZ**

Charles Darwin, in *The Voyage of the Beagle*, wrote at length about geology, higher and lower animals, single-celled life, paleontology, plants, and anthropological observations as one great unified subject. The interrelationships between other scientific fields and botany have only expanded since Darwin's time. The theme for the 11th Annual 2014 Arizona Botany Meeting, jointly sponsored by the Arizona Native Plant Society and the Arizona-Sonora Desert Museum, is "Interdisciplinary Botany." Please plan to attend!

Presentations, poster sessions, luncheon, and an evening dinner and program will occur on Saturday, February 22, 2014. Field trips are scheduled for Sunday, February 23.

Check our website for more information and registration details, including a Call for Presentations/Posters:  
[www.aznativeplantsociety.org](http://www.aznativeplantsociety.org).

**DEADLINE TO SUBMIT ABSTRACTS IS DECEMBER 24, 2013.**



## Anna Van Devender

It is with profound gratitude that we acknowledge the invaluable help provided by Anna Van Devender as the Arizona Native Plant Society's administrative assistant during the past three years. Anna recently decided that she needed to devote more time to her growing family and will leave her position with AZNPS at the end of the year. During Anna's tenure, she managed the Society's business with efficiency, cheerfulness, and dedication that were beyond compare. Thank you Anna for your superb contributions to the AZNPS and all best wishes for the future.



from left *Amoreuxia gonzalezii* flower. *A. palmatifida* flower. *A. gonzalezii* leaf. *A. gonzalezii* fruit and seeds.

## In Search of *Amoreuxia* and *Echinocactus* in Sonora *continued*

### *Amoreuxia gonzalezii*

*Amoreuxia* is a genus of herbaceous perennial plants with fleshy roots and showy yellow-orange or pinkish flowers found from South America north to the United States. *A. palmatifida* is widespread from Colombia north through most of Mexico to Arizona. *A. wrightii* is found from the Caribbean islands and eastern Mexico north to Texas. *A. gonzalezii* is found in northwestern Mexico from Jalisco and Sinaloa north through Sonora to Arizona, and Baja California Sur (Baker 2012). *A. gonzalezii* can be differentiated from the common, widespread *A. palmatifida* by its lavender lower stamens (not dark maroon), spherical seeds (not kidney shaped), and the longer hairs on the ovary. In Sonora, *Amoreuxia* is called *saya* in the Mayo-Yaqui indigenous areas in southern Sonora and *témaqui* in the Ópata country in central Sonora. *A. gonzalezii* is only known in Arizona from small populations in the Baboquivari and Santa Rita Mountains in Pima and Santa Cruz counties (Baker 2012).

The protection status of *A. gonzalezii* is: GI category with NatureServe, CITES Appendix II, Bureau of Land Management Special Status Species, U.S. Forest Service Sensitive Species, and State of Arizona Highly Safeguarded Species. *A. gonzalezii* was a Category 2 candidate species, but in 2011 the FWS concluded that listing as endangered or threatened under the Endangered Species Act of 1973 was not warranted at that time (USFWS 2011). *A. gonzalezii* is not protected in Mexico under the NOM 059-SEMARNAT (2010) endangered species law.

Forrest Shreve and Ira L. Wiggins first found *A. gonzalezii* in Sonora in the Palm Canyon southeast of Magdalena de Kino in 1934, 12 years after it was described based on specimens from Cerro del Muerto near Croix in northern Sinaloa (Sprague 1922). Shreve and Wiggins were making collections for their 1951 *Vegetation and Flora of the Sonoran Desert* (republished in 1964).

In 2012 and 2013, we searched for *A. gonzalezii* on eight field trips to Sonora. Target areas were chosen from previous Sonoran localities, which are mostly available in the Southwest Environmental Information Network (SEINet) online database ([swbiodiversity.org/seinet](http://swbiodiversity.org/seinet)). We also recorded *Amoreuxia* on

various other projects in Sonora. A total of 3,431 plant observations made on 105 transects in potential *A. gonzalezii* areas were entered into the Madrean Archipelago Biodiversity Assessment database ([Madrean.org](http://Madrean.org)).

*Amoreuxia gonzalezii* populations in Sonora are at 160 to 1,087 m elevation in both intact and disturbed (grazed, roadsides) habitats. In August 1982, Frank W. Reichenbacher collected *A. gonzalezii* at Rancho Cola de Tizón near Benjamín Hill in central Sonora. Today the Sonoran desertscrub has been cleared and converted to a buffelgrass (*Pennisetum ciliare*) pasture, and *A. gonzalezii* was not relocated. The Magdalena Palm Canyon population and Mazocahui populations are transition between foothills thornscrub and Sonoran desertscrub and/or desert grassland. This species occurs in coastal thornscrub is near Yocogigua and foothills thornscrub at Arroyo los Garambullos, Curea, Nácori Grande, Ónavas, and Sierra Aconchi. It was found in tropical deciduous forest near San Bernardo by Howard S. Gentry in 1936 (Martin et al. 1998), along the Río Cuchujaqui near Álamos in 1992, and at Choquinahui north-northeast of Güirocoba in 1988 and 1994.

In summary, *A. gonzalezii* has been found in 13 areas in Sonora since 1934. We discovered it at nine localities in five areas, including new populations near Nácori Grande and in the Sierra Aconchi. In southern Sonora, *A. palmatifida* may be replacing it in disturbed tropical deciduous forest.

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above *Amoreuxia palmatifida* fruit and seed.

# Ethnobotany of *Amoreuxia*

by Ana L. Reina-Guerrero and Thomas R. Van Devender<sup>1</sup>

The traditional uses for *Amoreuxia gonzalezii* (*saya mome*) and *A. palmatifida* (*saya*) by the Mayo Indians in southern Sonora were discussed in the 2002 book *Mayo Ethnobotany* by David A. Yetman and Van Devender. The plants were said to be locally common, but that in dry years may not leaf out. For example, we found *A. palmatifida* abundant and in glorious flower in the basalt lava plain south-southeast of Moctezuma in August 2011, but only occasional in other years. The Mayo informants thought that harvesting the tuber kills the main plant, but pieces of the tuber can resprout. They eat the tuber or *camote* raw or roasted, often with lime juice to add flavor. Green fruits are eaten raw. Mature seeds are ground into a meal that produces a coffee substitute of purportedly excellent flavor. The culture in the Masiaca-Yocogigua area has been rapidly shifting from Mayo Indian to *mestizo* dominance as older people die. Some traditional customs and knowledge are lost, but uses of plants often survive loss of indigenous languages. The use of *Amoreuxia* in these areas has probably declined in the past 20 years. We did find a *mestizo* craftsman (Armando Corral-Rochín, 70 years old in 2012) living in the Mayo community in Yocogigua, who used seeds of *A. gonzalezii* for eyes in coralbean/chilicote (*Erythrina flabelliformis*) woodcarvings of armadillos, frogs, and other small animals. His carvings are sold in handicraft stores in Álamos.

<sup>1</sup> Sky Island Alliance, PO Box 41165, Tucson, AZ 85717. vandevender@skyislandalliance.org



left *Amoreuxia* tuber. right *A. gonzalezii* young fruit and seed.

In central Sonora, *Amoreuxia* is called *témaqui*, an Ópata Indian name. Although the Ópatas merged into the *mestizo* culture long ago, names and traditional plant uses survive in the Moctezuma-Sahuaripa-Mazatán area. We found abundant *A. palmatifida* on Mesa los Témaquis near Sahuaripa. Wendy Hodgson's 2001 book *Food Plants of the Sonoran Desert* provides an excellent discussion of *Amoreuxia* use by various Sonoran tribes, including the Pima Bajo at Ónavas, Sonora. Reina-G's relatives recall eating *saya* in El Llano and Trincheras, Sonora in the Sonoran Desert. People in Ejido San Miguel near Benjamín Hill continue to harvest the tubers today.

In the Región del Evora in northern Sinaloa, *saya* is an important local resource. The root is considered a very nutritional food and is used medicinally for constipation, diabetes, diarrhea, an antidote for poisons, and an appetite stimulant. Together several rural families collect the roots when the plant is blooming from August to October, and cook and sell them door-to-door or in regional farm markets. Since the harvest of wild plants has increased, it has been suggested to cultivate the plants in family gardens as a rural microbusiness.



*A. gonzalezii* handicrafts in Yocogigua: left Frog carving. center Seeds for eyes. right Craftsman Armando Corral-Rochín.



*E. horizontalionius* left Mature plant. right Habitat near Nácori Grande.

## In Search of *Amoreuxia* and *Echinocactus* in Sonora continued from page 3

### *Echinocactus horizontalionius* var. *nicholii*

The Turk's Head Cactus (*Echinocactus horizontalionius*) is widespread in limestone areas in the Chihuahuan Desert from San Luis Potosí on the Mexican Plateau to western Texas and southeastern New Mexico (Correll and Johnston 1970). In his 1969 book *The Cacti of Arizona*, Lyman Benson described the Sonoran Desert populations in Arizona as *E. horizontalionius* var. *nicholii*. It also occurs in Sonora in the Sierra del Viejo 150 km south of the Arizona border (Yatskievych and Fischer 1983). It was later discovered in 1979, the variety was listed as an Endangered Species (USFWS 1979). It is not protected in Mexico because the NOM-059-ECOL-2010 legislation does not consider varieties.

In June 2011, we found *E. horizontalionius* in a planter in front of a hotel in Mazatán in central Sonora, prompting us to return in 2012 with funding from the Tucson Cactus and Succulent Society and FWS Section 6. At first we searched bedrock limestone areas from Hermosillo east to San Pedro de la Cueva, but no *E. horizontalionius*. Finally *vaqueros* Julio César Ahumada-C. and José Ángel León-P. led us to a population on *tierra calichosa* near Mazatán. Surprisingly the population was on gentle ridges covered by whitish gravel and not bedrock limestone. Only later were we able to chemically identify carbonate in the soil.

Potential *E. horizontalionius* habitat of white gravel ridges emerging from dense thornscrub is visible in Google Earth images. Additional populations were located near Nácori Grande about nine km northeast of Mazatán. In this area, limestone float rocks are locally common to abundant, and extremely variable as if they were derived from many different source bedrocks. In total, 83 living *E. horizontalionius* were

recorded in eight small areas in the Mazatán-Nácori Grande area in an estimated area of ca. 50 km<sup>2</sup>. Unlike the *E. horizontalionius* sites in the Sierra del Viejo and in Arizona, the vegetation at the Mazatán site is not Sonoran desertscrub but foothills thornscrub near the western edge of the New World tropics. Plant associates that do not occur in Arizona are *brasil* (*Haematoxylon brasiletto*), *cacachila* (*Karwinskia humboldtiana*), *mauto* (*Lysiloma divaricatum*), and *damiana* (*Turnera diffusa*). *Cacachila* does enter the United States on the east edge of the Chihuahuan Desert in Texas, where it may associate with *E. horizontalionius*.

*continued next page*



*Turnera diffusa* near Nácori Grande.

# Honoring Julia Fonseca

Julia Fonseca, a very active and long-time member of the Arizona Native Plant Society, was recently named Natural Resource Professional of the Year by the Arizona Game and Fish Commission.

Julia, who is the Senior Planning Manager for the Pima County Office of Sustainability and Conservation, was recognized for quietly advancing the conservation of wildlife and their habitats for nearly 30 years — since beginning her career in the mid-1980s as a hydrologist in the Pima County Flood Control District.

Some of Julia's more important accomplishments include:

- Securing the "Outstanding Arizona Waters" designation for segments of Cienega Creek and Davidson Canyon.

- The development and implementation of the Sonoran Desert Conservation Plan (SDCP), which aims to direct growth and development away from areas with the highest natural, historic, and cultural resources values.



- Developing the County's response to the proposed Rosemont mine.

*Congratulations Julia on this important recognition of your hard work over the years to help protect Arizona's priceless natural resources.*



## In Search of *Amoreuxia* and *Echinocactus* in Sonora *continued*

Marc Baker's multivariate analysis of spine measurements clearly shows that the Mazatán-Nácori Grande population is *E. h. var. nicholii*. (Baker 2007). This distribution is not an easy biogeographical pattern to interpret. *E. h. var. nicholii* in Arizona is a western disjunct of a Chihuahuan Desert species in the Arizona Upland subdivision of the Sonoran Desert. The population in the Sierra del Viejo is in the xeric Lower Colorado River Valley subdivision. The Mazatán-Nácori Grande population in foothills thornscrub documents a remarkable range extension of 260 km southeast from the Sierra del Viejo or 380 km south-southeast from the Waterman Mountains.



### Literature Cited

Baker, M. A. 2007. A multivariate study of morphological characters for *Echinocactus horizonthalonius* and *E. texensis* (Cactaceae). Report to U. S. Fish & Wildlife Service. [www.fws.gov/southwest/federal\\_assistance/PDFs/Nichol%27sTurk%27sheadactismorphologyAZE-6-9.pdf](http://www.fws.gov/southwest/federal_assistance/PDFs/Nichol%27sTurk%27sheadactismorphologyAZE-6-9.pdf)

Baker, M. A. 2012. Current knowledge and conservation of *Amoreuxia gonzalezii* (Cochlospermaceae), Santa Rita mountain yellowshow. Report to U.S. Fish and Wildlife Service, Tucson, AZ.

Benson, L. 1969. The cacti of Arizona. University of Arizona Press, Tucson.

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation. Renner, Texas.

Martin, P. S., D. A. Yetman, M. Fishbein, P. Jenkins, T. R. Van Devender, and R. K. Wilson (eds.). 1998. Gentry's Río Mayo Plants. The tropical deciduous forest and environs of Northwest Mexico. Univ. Arizona Press, Tucson.

NOM-059-SEMARNAT-2010. Norma Oficial Mexicana, Protección Ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo. Diario Oficial de la federación (D.O.F), Secretaría del Medio Ambiente y Recursos Naturales. 06 de marzo del 2002. México, D.F.

Shreve, F., and I. L. Wiggins. 1964. Vegetation and flora of the Sonoran Desert, Stanford Univ. Press, Stanford, CA.

Sprague, T. A. 1922. A revision of *Amoreuxia*. Royal Botanical Gardens, Kew. Bull. Misc. Info. Kew 1922:97-105.

U.S. Fish and Wildlife Service. 1979. Determination that *Echinocactus horizonthalonius* var. *nicholii* is an endangered species. Federal Register 44:61927-61929.

U.S. Fish and Wildlife Service. 2011. Endangered and threatened wildlife and plants; 12 Month finding on a petition to list *Amoreuxia gonzalezii*, *Astragalus hypoxylus*, and *Erigeron piscaticus* as endangered or threatened. Docket No. FWS-R2-ES-2011-0081; MO92210-0-0008.

Yatskievych, G., and P. C. Fischer. 1983. New plant records from the Sonoran Desert. Desert Plants 5:180-185.

# Prolonged Vegetative Dormancy in Rare Plant Species of the Southwest

by Judy Springer<sup>1</sup>

Prolonged or long-term vegetative dormancy is a condition exhibited by an herbaceous perennial plant by which the adult plant remains underground for one or more growing seasons. Plants most likely to exhibit this phenomenon are geophytes (examples include lilies and onions) — plants with subterranean organs, such as rhizomes, corms, bulbs, tubers, and caudices.

Plants are hypothesized to have developed these underground structures as adaptations to unfavorable conditions such as drought, unusually cold temperatures, intense herbivory or fire, or possibly to serve as reserves for a source of available nutrients during periods of rapid growth. Arid and alpine areas in particular have high percentages of plants with well-developed subterranean storage organs.

The orchid family contains the most documented examples of species that exhibit prolonged dormancy worldwide (45 species). At least 27 families, 76 genera and 130 taxa (from milkweeds to cacti, perennial grasses to sundews, as well as members of the composite and pea families), are known to exhibit prolonged dormancy worldwide. *Scirpus* species have been observed to remain dormant for 20-25 years, orchids as long as 7-11 years, and many midwestern prairie species remained dormant for 5-7 years during the severe drought of the early 1940s. Knowing which species demonstrate this strategy is critical when designing monitoring or demographic studies in the arid and semi-arid Southwest, and is especially important in the design of rare plant studies.

Plants in a state of prolonged dormancy may continue to metabolize and even to maintain growth, but they do not produce aboveground vegetation, with a resulting temporary suspension of photosynthesis and sexual reproduction. Fluctuations in prolonged dormancy can be quite dramatic, with populations of some species numbering in the hundreds or thousands of plants aboveground in one year and few to none the following year.

Species likely exhibit local adaptations to dormancy, perhaps with those plants found in marginal or particularly harsh environments exhibiting higher rates than those in more suitable

habitat. There is a complicated connection between precipitation and dormancy, from which no clear pattern emerges among all species. Drought is the most studied factor leading to a prolonged subterranean state. However, in some studies, prolonged dormancy does not appear to be induced by dry conditions. Other hypothesized causes include pulses in underground herbivory, wet conditions in one or more previous years, inundation, or a fungal outbreak, rather than drought.

Refuge from the damaging effects of fire may be another benefit of exhibiting prolonged dormancy. Storage organs located in the mineral soil are better protected from fire than those located in the organic soil layers, and the more deeply they are buried, the higher the likelihood of survival. Populations may dwindle without regular burning to create and maintain open areas and light gaps. Growth in the period between fires is critical, for this is probably the period during which storage of carbohydrates occurs in the underground storage organs, rather than immediately following fire. Geophytes are suspected to be resilient to frequent fire regimes and are likely to be able to remain dormant for long periods in the absence of fire.

Prolonged dormancy has been observed in a number of plant species since the 1940s, primarily in the course of conducting demographic studies, but only in the past decade or so have experimental studies been implemented. Researchers studying plants that exhibit the strategy are presented with a significant challenge when conducting plant population studies. A major difficulty is that there is no easy way to

distinguish dead from dormant plants without conducting excavations. Species diversity may also be underestimated when species remain dormant belowground. Only long-term demographic studies or plant viability analyses can provide accurate estimates of mortality data in species that exhibit this phenomenon. Short-term studies, in which prolonged dormancy is not factored in, may underestimate plant densities and overestimate plant mortality. Detection of prolonged dormancy in a given species requires at least three years of consecutive monitoring.

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**Figure 1** *Astragalus rusbyi* (Rusby's milkvetch), an endemic Forest Service sensitive species with a small range near the San Francisco Peaks in northern Arizona near Flagstaff.

<sup>1</sup> Ecological Restoration Institute, Northern Arizona University, S. San Francisco St., Flagstaff, AZ 86011. judith.springer@nau.edu

# Who's Who at AZNPS

## BOARD OF DIRECTORS

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[cbloджетt2@cox.net](mailto:cbloджетt2@cox.net)

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**Mike Plagens**

Director at Large, Phoenix Chapter Co-President

[mjplagens@arizonensis.org](mailto:mjplagens@arizonensis.org)

**Doug Ripley**

President

[jdougripley@gmail.com](mailto:jdougripley@gmail.com)

**Andrew Salywom**

Director at Large

[asalywon@dbg.org](mailto:asalywon@dbg.org)

**Sue Smith**

Director, Prescott Chapter President

[suejs01@yahoo.com](mailto:suejs01@yahoo.com)

## AZNPS COLLABORATORS

**Sue Carnahan**

Happenings Editor

[carnahan.sue@gmail.com](mailto:carnahan.sue@gmail.com)

**Marilyn Hanson**

Web Editor

[mfhanson@comcast.net](mailto:mfhanson@comcast.net)

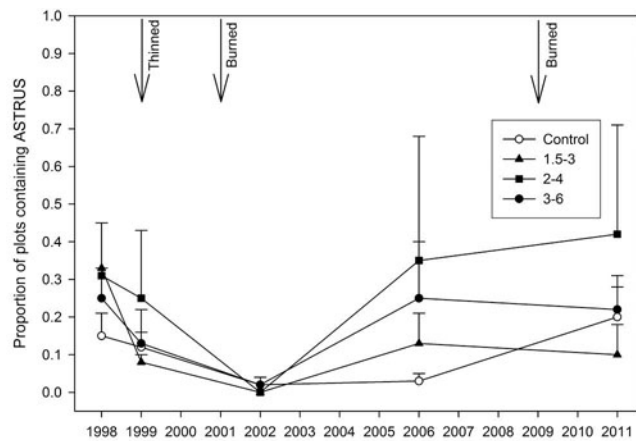
**Julie St. John**

The Plant Press Layout Editor [juliedesign@cox.net](mailto:juliedesign@cox.net)

**Anna Van Devender and Claire McLane**

Administrative Assistant

[aznpsinfo@yahoo.com](mailto:aznpsinfo@yahoo.com)



**Figure 2** Proportion of ecological restoration monitoring plots that contained individuals of *Astragalus rusbyi*. Note the reduced numbers of individuals detected in 2002, one of the driest years on record.

## Prolonged Vegetative Dormancy in Rare Plant Species of the Southwest *continued*

There are likely a large number of plant species, including rare species, in southwestern ecosystems that use the strategy of prolonged dormancy and that have not yet been documented. A long-term study conducted by the Ecological Restoration Institute at Northern Arizona University in Flagstaff to test varying levels of tree-thinning as part of ecological restoration treatments in ponderosa pine forests revealed that *Astragalus rusbyi* (Rusby's milkvetch) (Figure 1), a Forest Service sensitive species, likely employs this strategy. The summer of 2002 was one of the driest on record, and monitoring efforts detected very few individuals that year, regardless of thinning treatment (Figure 2). Although the study was designed to monitor the entire plant community, and individual plants have not been tracked through time, it is likely that the lack of individuals detected in 2002 was a result of prolonged dormancy, and not simply due to mortality. Prolonged dormancy has been detected in several *Astragalus* species in the western U.S.

Plant ecologists should be aware of this strategy when designing population and community studies, particularly short-term studies or when working with rare species. I am currently working on a manuscript (or alternatively a page on the ERI website or elsewhere) that documents the occurrence of this phenomenon worldwide. I am also interested in collaborating with other local researchers to promote awareness of this strategy and to document its occurrence among southwestern species. Please feel free to contact me at [judy.springer@nau.edu](mailto:judy.springer@nau.edu) if you would like to provide examples of species that you suspect exhibit prolonged dormancy or if you would like me to share information on the species that have been observed to use this strategy. Currently, we know of very few species in Arizona that remain dormant for multiple years, but I suspect there are many more to be discovered.







left *Graptopetalum bartramii*, Baboquivari Mountains. Photo by D.F. Austin. right *G. rusbyi*, Pinaleño Mountains, photo by Patrick Alexander, from SEINet.

## *Graptopetalum* (Crassulaceae) in Arizona

by Daniel F. Austin<sup>1</sup> and George M. Montgomery<sup>1</sup>

*Graptopetalum* was proposed in 1911 by Smithsonian botanist Joseph N. Rose (1862-1928). This Mexican species was followed by two more being found in Arizona in the early 1920s. Fifteen species are now recognized in *Graptopetalum* (Moran 2009), with still only two in Arizona.

*Graptopetalum rusbyi* (Greene) Rose (1924) was named for Henry H. Rusby (1855-1940). Edward L. Greene (1843-1915) said he found the species in the “San Francisco Mountains” in 1880, but it actually came from Metcalf (Greenlee County) on the San Francisco River. Either that specimen was lost or never collected (Moran 1984). Greene also cited a collection by Rusby from “Copper Mine Cañon, near Clifton, Arizona...” in 1881 (Rose 1924). The second Arizona species is *G. bartramii* Rose (1926), named for bryologist Edwin B. Bartram (1878-1964). Bartram found the species in Flux Canyon of the Patagonia Mountains, Santa Cruz County.

While these two species are similar, there are several distinguishing traits, and they have largely disjunct ranges. *G. bartramii* is a fall-flowering species, typically blooming from August to December. The basal rosettes are 7-16 cm in diameter, solitary or multiple; the leaf blades are blue-green, and cuneate-oblongate or cuneate-ovate. Flowers are 5-parted and the corolla is 19-28 mm wide. The species is endemic to the Apachian District (McLaughlin 1995), thus being a Chihuahuan Desert species, and grows from 1,200 to 2,050 m elevation.

*Graptopetalum rusbyi* is a spring-flowering plant, with blossoms from March to June. The basal rosettes are 2-6(-10) cm in diameter and cespitose; leaf blades are green to reddish, and rhombic-obovate to oblanceolate. Flowers are 5-8 parted, with 6 or 7 petals being common; corollas are 14-21 mm wide. This species occurs in the Sonoran Desert in Arizona, growing from 600 to 1,650 m elevation.

The Arizona Rare Plant Committee (2001) included *G. bartramii* as a rare plant and subsequent events led the U.S. Fish and Wildlife Service to publish their first report on the species (USFWS 2012). The Arizona Game and Fish Department and the Arizona Department of Agriculture consider *G. bartramii* a species of special concern; the Bureau of Land Management and USFWS consider it a sensitive species. Because the *Graptopetalum* is known on the Buenos Aires National Wildlife Refuge segment in the Baboquivari Mountains, they and ranchers with the plants on their property are interested in the species and asked us about it.

After studying the plants in several sites and conferring with colleagues, we offer the following observations.

It is clear that *G. bartramii* is the rarer of the two *Graptopetalum* in Arizona. The species is known from only 10 mountain ranges; most occurrences are of single or a few plants. Although Moran (1984, 2009) reported *G. bartramii* from Chihuahua, we were unable to locate a specimen from there.

<sup>1</sup> Arizona-Sonora Desert Museum, 2021 N. Kinney Road, Tucson, AZ 85743

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left Flower of *G. bartramii*, showing the typical 5-parted corolla. Baboquivari Mountains. Photo courtesy Tom Vize. center Distribution of *G. bartramii*, based on records in SEINet with added information on other localities documented. right Distribution of *G. rusbyi*, based on records in SEINet with added information on other localities documented.

## *Graptopetalum* (Crassulaceae) in Arizona *continued*

There are several threats to *Graptopetalum* in Arizona (in no order).

- **Predation by the Xami Hairstreak butterfly** (*Callophrys xami*). This insect specializes on *Graptopetalum* but can survive on other Crassulaceae, e.g., *Dudleya*. This hairstreak is extremely rare in Arizona, but has been seen by several lepidopterists, including James Brock and Richard Bailowitz (personal communication, 2012). The butterfly is more common in Mexico where growers of Crassulaceae consider it a pest (D.D. Mullins, personal communication, 2012). The larvae eat the flesh from between cuticles and leave a hollowed, dead leaf. The full impact of this attack on the plants is not known. Plants may die after attack or fully recover when butterflies move on. Study is needed.
- **Predation by mammals is suspected.** Deer, javalinas, rabbits, and hares are suspected to browse *Graptopetalum* since they eat members of the Crassulaceae (Anderson et al. 1965, Dorsey 2009, Krausman et al. 1997).
- **Habitat loss (urbanization, mining, etc.).** An example is the place where Greene first recorded *G. rusbyi* is now the site of Morenci mine in Greenlee County. Another mine is proposed for the locality near the Flux Canyon site in the Patagonia Mountains.
- **Erosion (plants weakly rooted, easily dislodged).** See Shohet (1999) for discussion.
- **Collector pressure** (Salvage Restricted; collection only with permit, Arizona Native Plant Law (2008), [www.azda.gov/esd/NpRulesHome.aspx](http://www.azda.gov/esd/NpRulesHome.aspx)).
- **Global warming, prolonged drought.** Many of our plants are weakening and dying due to drought stress, even including some cacti. Yearly, many individuals of several tree species in the Baboquivari, Chiricahua, and other mountain ranges are succumbing.



### References Cited

- Anderson, A. E., W. A. Snyder and G.W. Brown. 1965. Stomach content analyses related to condition in Mule Deer, Guadalupe Mountains, New Mexico. *The Journal of Wildlife Management* 29(2):352-366.
- Arizona Rare Plant Committee. 2001. Arizona Rare Plant Field Guide. Arizona Game and Fish Commission, Tucson, AZ.
- Dorsey, A. 2009. The role of life-history traits, tradeoffs, and habitat in the rarity of Santa Monica Mountains *Dudleya* species. M.S. thesis, California State University, Northridge.
- Krausman, P. R., A. J. Kuenzi, R. C. Etchberger, K. R. Rautenstrauch, L. L. Ordway, and J. J. Hervert. 1997. Diets of Desert Mule Deer. *Journal of Range Management* 50(5):513-522.
- McLaughlin, S. P. 1995. An overview of the flora of the sky islands, Southeastern Arizona: Diversity, affinities, and insularity. Pp. 60-69 in Leonard F. DeBano, ed. *Biodiversity and the Management of the Madrean Archipelago: The Sky Islands of Southwestern United States and Northwestern Mexico*. USDA Forest Service, General Technical Report RM-GTR-264.
- Moran, R. 1984. *Graptopetalum rusbyi* (Greene) Rose and *G. occidentale* Rose (Crassulaceae). *Cactus & Succulent Journal* (U.S.) 56:169-176.
- Moran, R. 2009. Crassulaceae Pp. 227-228. In *Flora of North America*, Volume 8, Magnoliophyta: Paoniaceae to Ericaceae
- Rose, J. N. 1924. *Graptopetalum rusbyi*. *Addisonia* 9(2):31.
- Rose, J. N. 1926. *Graptopetalum bartramii*. *Addisonia* 11(1):1-2, pl. 353.
- Shohet, C. 1999. *Graptopetalum bartramii* Rose demographics and reproductive biology, including pollination and flowering phenology (Crassulaceae). M.S. thesis, Arizona State University, Tempe.
- USFWS. 2012. 90-Day Finding on a Petition to List *Graptopetalum bartramii* (Bartram Stonecrop) and *Pectis imberbis* (Beardless Chinch Weed) as Endangered or Threatened and Designate Critical Habitat. Federal Register

BOOK REVIEW *by Ries Lindley*

## **A Sonoran Desert Scrapbook: Some Desert Plants of Kino Bay and Vicinity** by William J. Little, 2011

151 pp. ISBN: 978-1-4575-0876-9. AZNPS member price \$32 + \$4 shipping. Dog Ear Publishing, [mbillit56@gmail.com](mailto:mbillit56@gmail.com)

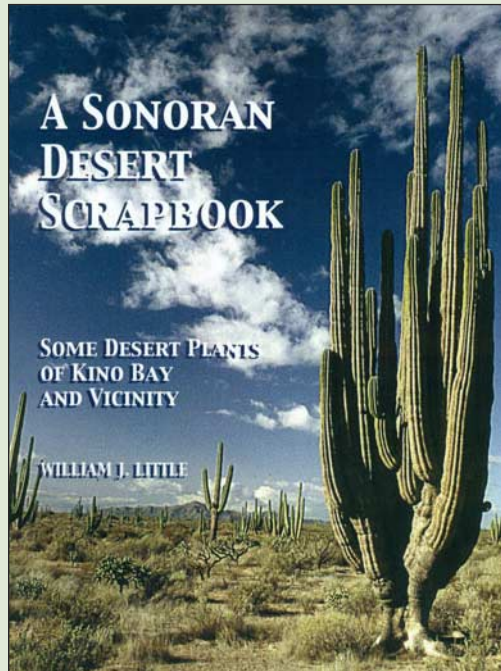
There are probably a lot of people interested in the combination of travelling and ecology study. My own bookshelf is still graced by *Roadside Geology of Arizona*. These sorts of books make you want to get in your car and just go see things. *A Sonoran Desert Scrapbook* is one of those. *Scrapbook* introduces us to the four great deserts of the Southwest and the seven divisions of the Sonoran Desert as classified by Forrest Shreve. Then we go for a tour of several areas through a Sonoran triangle of this wonderland.

The book's subject area is bounded by *Imuris* to the north, *Bahia de Kino* on the southwest gulf-coast apex, and *Tastiota* further south on the coast of mainland Mexico. This slice of Mexico takes in four of the seven parts of the Sonoran Desert. The area of Sonora included is roughly a thousand to 1,500 square kilometers, and by breaking that into five vegetative areas, A through E, the author has established some nicely achievable day tours.

Plants chosen for each vegetative area include the iconic, the ordinary, the standouts, and even some exotic species like castor bean. A minimum of a full 8.5 by 11 inch page is devoted to each species, with a generous portion of photos both descriptive and beautiful. Both scientific and common names are listed for each plant. Descriptions are suited for both a general audience as well as those with a botanical bent, striking a nice balance between user-friendly and botanically accurate. Here is an example concerning the red mangrove from page 44:

*Leaves are thick, leathery, ovate or broadly elliptic, and 3 to 6 inches long. They occur in groups at the ends of branches. The flowers are small, whitish to yellowish-green, axillary with the leaves, and appear March through November.*

The plant descriptions include where each species can be found and, for some of those plants with confusing



cousins, include a wonderful feature with the heading “How To Tell Them Apart.” These descriptions are, to the extent possible, written for use throughout the year. The author uses vegetative key features, which don't depend entirely on the reader's good luck in finding flowers or fruit.

Discussion about the plants includes a good deal about plant uses, perhaps as food or medicine; oddities, like crestate forms of cacti, origins of common names, and other interesting facts that keep the writing more alive than a simple plant description.

In addition to a table of contents, there is a complete list of all the included plants by area, a glossary (thank you very much), and a chart of the plants showing relative abundance. This latter will be appreciated by all the birders/botanists who wonder at the sense in anything published without abundance charts.

My own wish list for improvements to the *Scrapbook* would include a glossy paper that would make the photographs show in all their full resolution and splendor. Some photographs are not captioned, but just about all of those that are not are actually illustrating a point made in the text. It would be helpful if all the photos had captions, for people thumbing through the book.

*A Sonoran Desert Scrapbook* is fun to read, fun to thumb through, and, yes, it does bring on the yearning to travel. The book is also informative, not in the dusty, dry sense of one of those old floras with arcane vocabulary, but in the more present-and-awake sense you get when you learn something interesting you didn't even know you wanted to know. If you want a tour without the travel, this book works; if you want to travel, take it with you.



## **Nanisé', A Navajo Herbal: One Hundred Plants from the Navajo Reservation** by Vernon O. Mayes and Barbara Bayless Lacy, with illustrations by Jack Ahasteen and Jason Chee

153 pp. Tsale, Navajo Nation: Navajo Community College Press, 1989. Reprinted in 2012 by Five Star Publications, Chandler, Arizona.

The relational uses between *Nanisé'* (wild plants) and the Diné (Navajo) people are significant. The people I come from, the Diné, sometimes referred to as The Navajo Nation, have long inhabited and continue to live in our homelands, Diné Bikéyah. The homelands are located between our beloved four Sacred Mountains: *Sis Naajini*, *Tsoodzil*, *Dook'óoslítid*, and *Dibé Ntsaa*.

*Nanisé': A Navajo Herbal* was originally published by Navajo Community College, now known as Diné College. It is a book that has much relevance to me and the research I am doing as an undergraduate student at Arizona State University. The original book was commissioned by the Navajo Health Authority and covers 100 "wild plants" used by the Diné throughout our history and present-day lives. The reprinting will make valuable information available to new readers.

The preface and introduction are brief, while the remainder covers in detail 100 plants found on the Navajo Reservation. For each plant, the common name is followed by the family name and other common names. Next comes the scientific name with an explanation of its Greek or Latin roots. The Navajo name(s) is finally mentioned with a short English interpretation. Considerable information on the plant is then provided in the next two sections: "Description & Distribution" followed by "Navajo Uses." Navajo Uses in some cases is further categorized into "Medicinal, Household, Ceremonial, and Other." The Appendix provides many recipes and the Annotated Bibliography summarizes relevant ethnobotanical publications.

The book provides not only scientific information, but also cultural information, which is especially useful for Diné readers who are interested in learning more about how their ancestors and grandparents used plants. The inclusion of line drawings and color plates (in the middle of the book) offers a good visual reference for readers who

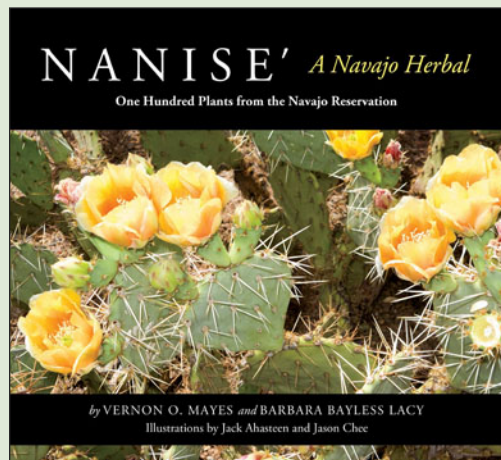
are trying to identify plants. The section in the introduction that briefly describes how stories, games, prayers, and songs were established the way plants were to be related to and used, are strong supportive statements for any Diné person to read.

I have some suggestions for improvement. First, the cover photo could have an image of someone, preferably a Diné person, working with a plant such as *Gad bika'ígíí* (Juniper) which seems from my own knowledge and from the book to be a more culturally significant plant to the Diné

and is more abundant in Diné Bikéyah compared to that of the prickly pear flower shown. Second, the authors reference our Diné lands including only the boundaries of the present-day Navajo Reservation. This is smaller in comparison to what we Diné consider to still be our homelands. Diné Bikéyah, encompasses the habitats of our four sacred mountains and our sacred rivers.

I would like to see more attention given to Diné terminology. It would be beneficial if the Diné names were broken down in their meanings, as seen on the *Navajo Word Of The Day Website* ([www.NavajoWOTD.com](http://www.NavajoWOTD.com)). For example the word *Yádilhił* is interpreted to mean, in the first part, "yá," as in *yáát'ééh*, which means "up" or "sky." The rest of the word, "dilhił," is understood to mean "dark black (in some cases, red)." A Diné Name index would also be worth adding to the Common Name and Scientific Name indexes.

Ultimately, *Nanisé'* is a good book for anyone wanting to learn more about wild plants found in Diné Bikéyah and how the Diné have interacted with them. Even though the book could provide a more thorough Diné perspective, it is still beneficial for any Diné person who is interested not only in the scientific information of plants found around us but also in their traditional knowledge and uses.



# Hybridization of the San Francisco Peaks Rare Endemic, *Packera franciscana*, with a Lower Elevation Congener: Evidence from Morphometric and Molecular Data

by Elizabeth P. Johnson<sup>1\*</sup> and Tina J. Ayers<sup>1</sup>

## Introduction

The San Francisco Peaks groundsel, *Packera franciscana* (Greene) W.A. Weber & A. Löve, is a rare plant endemic to the alpine tundra of the San Francisco Peaks in Coconino County, Arizona. In 1983, the U.S. Fish and Wildlife Service listed the plant as threatened and in 1987 developed a recovery plan urging better management of the ecosystem as well as further monitoring of the taxon (USFWS 1987).

In the late 1990s a population of *P. franciscana* with unusual leaf morphology was found in the Inner Basin near Snowslide Spring. The leaves were narrower and less lobed than the typical *P. franciscana* (Figure 1). This unusual morphology may be a result of hybridization with another species of *Packera* or the result of natural variation within the species. If the result of hybridization, the likely candidate is a slightly lower elevation species, *P.*

*wernerifolia* (A. Gray) W.A. Weber & A. Löve, which co-occurs in the San Francisco Peaks. *P. wernerifolia* is widespread and occurs near or above timberline from the Rocky Mountains west to the Sierra Nevada. Although no populations were found at Snowslide Spring, *P. wernerifolia* occurs in the spruce-fir forests up to timberline in the San Francisco Peaks. This species is morphologically variable throughout its range, but all populations within Arizona have leaves that are nearly linear with revolute margins (Figure 1) (Trock 2006). The phenology of the two species in the San Francisco Peaks is also different. *P. wernerifolia* generally flowers from the middle of June to the middle of August whereas *P. franciscana* flowers from the middle of August to October.

Hybridization can have a myriad of consequences on the species involved. Although interspecific gene interactions are often deleterious or neutral, some are favorable and can

lead to adaptive evolution in the hybrid (Rieseberg et al. 1996; Arnold 1997). In addition, hybridization can lead to the extinction of a parental species if the hybrids are fertile and fitness is not decreased. In this case, genetic assimilation is possible due to total introgression between the hybrid and the parental species (Rhymer & Simberloff 1996; Wolf et al. 2001). It has become commonplace for studies of hybridization to include both morphological and molecular analyses. This combination of techniques serves to elucidate the extent of hybridization and introgression that may be occurring in a population (Guo et al. 2006; Field et al. 2009; Lindhardt et al. 2009). The purpose of this project was to gather evidence from morphological and molecular data as independent assessments to test the hypothesis: *P. franciscana* and *P. wernerifolia* are hybridizing in the Inner Basin of the San Francisco Peaks.

## Results

**Morphometrics**—We used two multivariate techniques to examine morphological differences among 86 individuals representing the two parental species and the putative hybrid. First, we used principal components analysis (PCA) to visually explore patterns in the data. Second, we used analysis of variance (ANOVA) to statistically test for differences in the morphology. These analyses of the morphometric data were performed using JMP Pro 10.0.0 (SAS Institute Inc., Cary, NC).

The PCA ordination (Figure 2) depicts *P. franciscana* and *P. wernerifolia* as two distinct groups with the putative hybrids intermediate. This pattern was corroborated by the ANOVAs performed on the principal components for each taxon.

Results of the ANOVAs showed the pair-wise combinations of each parental species and putative hybrid to be significantly different in leaf



**Figure 1** Leaf morphology of parental species and putative hybrids. A. *Packera franciscana* (Agassiz); B. Putative hybrid population at Snowslide Spring; C-E. *P. wernerifolia*, C. Kendrick Peak, D. Inner Basin, E. Abineau Trail. Categorical character states for morphometric data set: 0-entire revolute margins; 0.25-teeth at tip; 0.5-shallow teeth to middle; 0.75-shallow teeth to base of blade; 1-deeply lobed.

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<sup>1</sup> P.O. Box 5640, Department of Biological Sciences, Northern Arizona University, Flagstaff, AZ, 86011. \*epj@nau.edu

# Hybridization of a Rare San Francisco Peaks Endemic *continued*

length to width ratio, basal leaf width and length, as well as peduncle length ( $P < 0.0001$ ). Floral traits also showed significance when analyzed by group, but only *P. franciscana* and the putative hybrid were significantly different ( $P = 0.0281$ ).

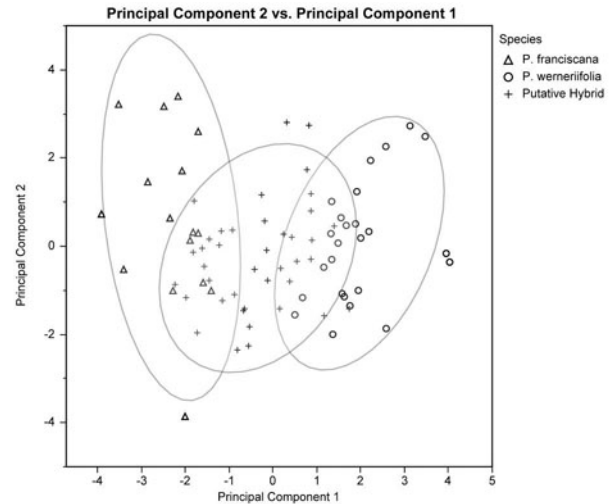
**Genetics**—Genetic analysis using amplified fragment length polymorphisms (AFLP) of 86 individuals from five collection sites resulted in 321 polymorphic, reliable loci from four primer combinations. Analysis of the data showed two distinct genetic groups ( $K = 2$ ). Figure 3 is a graphical representation of the proportion of alleles from each of the parental species present in each individual. The putative hybrid population from Snowslide Spring shows varying levels of admixture from the two parental species, with generally more alleles coming from *P. franciscana*. Almost all individuals of *P. werneriiifolia* from the Inner Basin showed some admixture with *P. franciscana*.

## Discussion

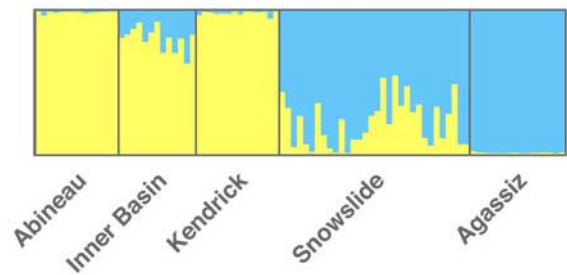
Results of this study suggest there is hybridization happening between *P. franciscana* and *P. werneriiifolia* in the Inner Basin of the San Francisco Peaks. The PCA and the ANOVAs provide morphological evidence. As a suite of traits, the leaf length to width ratio, basal leaf length and width, and peduncle length, might serve as a tool to separate the hybrids from the parental species. The molecular evidence for hybridization can clearly be seen in the hybrid index, which is represented visually in Figure 3. Admixture of the two parental species is not equal in the Snowslide Spring hybrid population suggesting that the individuals sampled there are not F1 hybrids. Instead, they represent hybrids that have backcrossed with *P. franciscana* because *P. franciscana* alleles are more highly represented. This is corroborated by the leaf morphology. Individuals representing the hybrid population in Figure 1, have more lobed leaves, and are therefore more similar morphologically to *P. franciscana*.

The molecular evidence also suggests that hybridization may be more widespread than was hypothesized at the beginning of this study, as seen in the admixture occurring in the Inner Basin population of *P. werneriiifolia*. Mapping of high elevation *P. werneriiifolia* populations and surveys for additional hybrid populations should be a priority.

A more thorough population genetic analysis of *Packera franciscana* is necessary to assess the extent of the hybrid zone on the San Francisco Peaks. Additional investigations could include whether phenology or elevational distribution of one or both species is changing due to climatic shifts, if hybrids reproduce sexually, and whether there are other hybrid populations of *P. franciscana* and *P. werneriiifolia* in the San Francisco Peaks.



**Figure 2** Ordination of the Principal Components Analysis (PCA) including first and second principal components on the x and y axes respectively. Individuals of *Packera franciscana* (blue), *P. werneriiifolia* (green), and the putative hybrids (red) are overlaid on the graph. Each genetic group is symbolized by a different shaped marker and overlaid with an ellipse encompassing 90% of the groups' data points.



**Figure 3** Distruct Graph. Visual representation of the entire hybrid index sorted according to collection site showing admixture of parental species in each of the 86 individuals in the study. *Packera franciscana* (Agassiz), *Packera werneriiifolia* (Abineau, Inner Basin, Kendrick), putative hybrids (Snowslide). *P. franciscana* = blue; *P. werneriiifolia* = yellow

## Acknowledgements

We thank M. Zinkgraff for his help with all software programs relating to genetic analysis. Thanks also to T. Clark, R. Crawford, A. Hazelton, K. Olmon, and D. Smith for their help. This study was funded by a grant from the U.S. Fish and Wildlife Service.

Complete paper submitted for publication to *The Southwestern Naturalist*.

## Literature Cited

Arnold, M. L. 1997. Natural hybridization and evolution. Oxford University Press, Oxford.



above *Nemastylis tenuis* in blue and rarer white form in the Huachuca Mountains, Cochise County, Arizona. Courtesy the author.

## SPOTLIGHT ON A NATIVE PLANT

### Pringle's Pleatleaf (*Nemastylis tenuis* var. *pringlei*)

by Bob Herrmann, Cochise Chapter, Arizona Native Plant Society

This uncommon wildflower with six pale blue petals (and occasionally a pure white form) is a beauty to feast your eyes upon. The plant is known in Arizona only from several populations in the Huachuca Mountains of Cochise County where it grows at approximately 6,000 feet elevation. Its range extends to West Texas, through Mexico, to Central America. The 1-1/2 to 2 inch diameter flowers bloom in July through August after a summer monsoon. A slender 6 to 12 inch tall plant with 3 or 4 grass-like leaves, it blends in well with the surrounding grasses. Not knowing which monsoon will trigger this plant to bloom, coupled with its short flowering period, makes finding this wildflower a challenge. It is a member of the Iris Family with a conspicuous bulb.

The genus *Nemastylis* is represented in North and Central America by five species and was described by the famous British botanist Thomas Nuttall in 1835 who lived and

worked in America from 1808 until 1841. The genus name is derived from the Greek “nema” (meaning thread) and “stylos” (meaning pillar or rod), referring to the thread-like arm on the style. Sereno Watson, an assistant to Asa Grey at Harvard University, named the plant in honor of Cyrus Guernsey Pringle (1838-1911), an indefatigable American botanist who spent a career of 35 years describing and cataloguing the plants of North America, especially Mexico.

I photographed this plant while it was being pollinated by several varieties of solitary bees. In the past few years I photographed the blue-flowered form of the plant but was surprised to encounter the rare white form on July 16, 2012. Finding this uncommon and beautiful plant in bloom would be a memorable experience for anyone interested in native Arizona irises.



## Hybridization of a Rare Endemic *continued*

Field, D. L., D. J. Ayre, R. J. Whelan, & A. G. Young. 2009.

Molecular and morphological evidence of natural interspecific hybridization between the uncommon *Eucalyptus aggregata* and the widespread *E. rubida* and *E. viminalis*. *Conservation Genetics*, 10(4):881-896.

Guo, Y. P., C. Vogl, M. Van Loo, & F. Ehrendorfer. 2006. Hybrid origin and differentiation of two tetraploid *Achillea* species in East Asia: Molecular, morphological and ecogeographical evidence. *Molecular Ecology*, 15(1):133-144.

Lindhardt, M. S., M. Philipp, L. R. Nielsen, & A. Tye. 2009. Molecular, morphological, and experimental evidence for hybridization between threatened species of the Galapagos endemic genus *Scalesia* (Asteraceae). *International Journal of Plant Sciences*, 170(8):1019-1030.

Rieseberg, L. H., B. Sinervo, C. R. Linder, M. C. Ungerer, & D. M. Arias. 1996. Role of gene interactions in hybrid speciation: Evidence from ancient and experimental hybrids. *Science*. 272:741-744.

Rhymer, J. M., and D. Simberloff. 1996. Extinction by hybridization and introgression. *Annual Review of Ecology and Systematics*. 27:83-109.

Trock, D. 2006. *Packera*: Flora North America. 20:570-602.

U.S. Fish and Wildlife Service. 1987. San Francisco Groundsel Recovery Plan. United States Fish and Wildlife Service, Albuquerque, New Mexico.

Wolf, D. E., N. Takebayashi, & L. H. Rieseberg. 2001. Predicting the risk of extinction through hybridization. *Conservation Biology*. 15(4):1039-1053.

# New ideas about rarity of *Carex* species of Arizona

by Glenn Rink<sup>1</sup> and Max Licher<sup>1</sup>

Sedges; under-appreciated; relatively unknown. The latest treatment of sedges in Arizona (currently in review) includes 12 species not previously found in treatments for sedges of Arizona, three of these were found in just the last year.

Let's start out by busting a few sedge myths. Sedges are wetland plants, right? Well, many are, but over a third (25) of Arizona species grow in dry places, and one species grows only in very hot, dry places. Another thing; our understanding of the ranges of the 66 species now known in the State has changed dramatically over the last three years. We now know that half of the species in Arizona have very limited distributions within Arizona.

Using the latest annotations of specimens and SEINET range maps, as well as improved knowledge of each species' habitat requirements, we are now in a position to judge just how common and uncommon many *Carex* species are within Arizona. That information may help decide if some of these species need special land management designation to ensure their continued existence.

We rated each *Carex* species (32 in all) which might qualify for agency status using both the At-Risk System (ARS) (Spence 2012) and the modified Fertig approach described in Laurenzi and Spence (2013). (For these scorings, contact [faroutbotany@gmail.com](mailto:faroutbotany@gmail.com).) The modified Fertig approach is simpler than the ARS, but does not predictably deal with aspects of plants where knowledge is lacking. For all of these sedge species, there are life history uncertainties and for most we don't have full knowledge of other attributes which are used in this ranking. For instance, for most of these species, we do not have any information on their intrinsic rarity, threats, or trends. Intrinsic rarity is difficult to assess. But we could learn more about trends with additional survey work.

Using both the ARS and the modified Fertig system, we scored each of 31 species both for their overall ranges as well as their ranges within Arizona, then combined those scores. In the ARS system, *C. specuicola* had the highest combined score, perhaps confirming its status as our only Federally Listed Threatened *Carex* species. It was followed closely by three alpine species found only on the top of the San Francisco Peaks in Arizona, *C. albonigra*, *C. deflexa*, and *C. elynoides*, all of which are more common further north in the Rocky Mountains.

Using the modified Fertig system, we scored for *Carex* species overall ranges as well as their ranges within and then combined these scores. We ended up with nine species with combined scores of 8 or 9. These are *C. albonigra*, *C. aquatilis*, *C. canescens*, *C. conoidea*, *C. endlichii*, *C. serratodens*, *C. specuicola*, *C. spissa* var. *ultra*, and *C. stevenii*. According to our

notions of rarity, given existing conditions and that we may not be able to do much about climate change, these are the species that may deserve greater attention. The rest of this discussion will focus on these nine species, as well as *C. "arizonica"* and *C. curatorum*. *C. "arizonica"* is a recently discovered, but not yet described, species that seems to be endemic to Arizona. *C. curatorum* has been considered for conservation status in the past.

While six of these species are known to be widespread or common in other states, five are not. *C. "arizonica"* is endemic to Arizona; *C. curatorum* is primarily known from the Grand Canyon; *C. endlichii* is primarily known from the Chiricahua Mountains in southern Arizona; *C. specuicola* is primarily known from the northeastern Navajo Nation; and *C. spissa* var. *ultra* is primarily known from southeastern and central Arizona, southwest New Mexico, and northern Mexico.

Two of these five species presently have status with federal government agencies. *C. specuicola*, Navajo sedge, is designated a U.S. Fish and Wildlife Service Listed Threatened species. *C. spissa* var. *ultra* is designated a U.S. Forest Service "Sensitive" species. Agency listings are slow to change. It may take years or decades to add a species to an agency list, and it may take just as long or longer to remove one. Yet our knowledge of *Carex* in Arizona has improved at a much faster rate. Agencies charged with managing rare plant species will be slow to catch up.

*C. "arizonica"* is primarily known from the central part of the state. Since this new species was not recognized before now, it has no agency status. We don't recommend special status for *C. "arizonica."* It is fairly widespread in riparian habitats, areas unlikely to face development in the near future. The one thing that would change our recommendation is if we started making more use of water resources from streams and springs on the Mogollon Rim.

*C. curatorum* is restricted to seeps, springs, and small streams in the drainage from the Grand Canyon to canyons of the Colorado River in northern Utah. In the Grand Canyon, it ranges from Toroweap to springs in the vicinity of Vasey's Paradise in Marble Canyon. It is very common in the eastern half of the Grand Canyon. We don't see impending threats to these habitats and don't see a need for conservation status for this species.

Based on our present understanding of the overall ranges of sedge species in the state, *C. endlichii* is the narrowest endemic. It is known from a handful of sites in northern Mexico, a single plant at Rose Canyon Lake in the Santa Catalina Mountains, and primarily from the Chiricahua Mountains in southeast Arizona. Much of the Chiricahuas burned in 2011. We would be interested to know if *C. endlichii* is doing better or worse since that fire. Any species that is primarily known from only one mountain range should be on the radar of government

<sup>1</sup> University of Northern Arizona Herbarium, S. San Francisco Street, Flagstaff, AZ 86011. [faroutbotany@gmail.com](mailto:faroutbotany@gmail.com); [mlicher@wildapache.net](mailto:mlicher@wildapache.net)



## Two New Native Plant Books of Interest

***Flora of the Four Corners Region. Vascular Plants of the San Juan River Drainage, Arizona, Colorado, New Mexico, and Utah*** by Kenneth D. Heil, Steve L. O’Kane, Jr., Linda Mary Reeves, and Arnold Clifford.

Missouri Botanical Garden Press. 1,098 pages with numerous illustrations and color photographs. \$72.00. [www.mbgpress.info](http://www.mbgpress.info)

This massive contribution to the floristic knowledge of western North America describes the 2,303 species, subspecies, and varieties of vascular plants currently known to grow spontaneously in the drainage basin of the San Juan River, a major tributary of the Colorado River.

***Going Native—Small Steps to a Healthy Garden*** by Tammie Painter. Portland, Oregon

Available in hard copy and as an e-book (Amazon, Barnes and Noble, iTunes). Contact: Tammie Painter, 503-475-8931, [painterwrite@yahoo.com](mailto:painterwrite@yahoo.com)

This book encourages the use of native plants to build an organic garden that protects native wildlife, conserves resources and keeps chemicals out of the ecosystem. In *Going Native*, Painter shows how small changes in the plants we choose can create a healthier garden. *Going Native* guides the reader through the benefits of going native, provides tips on how to plan a native garden, and helps gardeners get their native garden off to the best start possible. In addition, *Going Native* teaches the basics of eco-friendly gardening such as controlling invasive plants, going chemical free, dealing with pests, rethinking the lawn, attracting wildlife, and more.

## New ideas about rarity of *Carex* species of Arizona *continued*

agencies as a species of concern, especially when large wildfires are becoming more the norm.

*C. specuicola* was listed as threatened in 1985, when it was known from only one or two hanging gardens. Since then, the known range of the species has grown by 50 miles to the south, 100 miles to the east and 75 miles to the north through the documentation of over 60 localities. While we still do not have a complete understanding of the full range, necessary habitat characteristics, population trends, or any aspects related to dispersal of the species, we feel that it is present over such a large area, that no one threat is likely to cause a significant decline in its range.

*C. spissa* var. *ultra* has a bimodal distribution in Arizona. It is common where perennial water debouches from southeastern mountain ranges, known from along the border with Mexico, north to Aravaipa Creek at the northern edge of the Galiuro Mountains. It is also known from the Verde Valley from along Oak Creek to as far south as Fossil Creek. *C. spissa* var. *ultra* is a wetland sedge that grows in desert areas where water is scarce. So, while its range is fairly broad, it may be threatened by water development interests.

What about the six species that are known to be widespread outside, but are restricted in their ranges within the state?

We have only 3-4 collections of *C. albonigra*, all from the San Francisco Peaks, where Max Licher recently re-located it after three seasons of searching. This taxon is rare in Arizona. Surveys to find more populations on the San Francisco Peaks would add to our understanding of its status here.

*C. aquatilis* is only known from Bear Lake on the Kaibab Plateau and a small region in the White Mountains; previously thought to be more widespread in Arizona, due to misidentifications of *C. emoryi*, *C. senta*, and *C. nebrascensis*. This taxon is uncommon in Arizona, but not what we would call rare. Some habitat is protected in the Phelps Botanical Area in the Apache-Sitgreaves National Forest, but perhaps other areas should be identified for protection.

*C. canescens* is only known from the area around Mt. Baldy in the White Mountains. While its geographic range is very limited in Arizona, the existing populations are large enough that we would call it uncommon, but not rare.

*C. conoidea* is only known from one record in the White Mountains, collected in 1969. The Flora of North America (Ball and Reznicek, 2002) described this as a waif, not considering it present in Arizona. We returned to the original collection site with the collector, and were unable to relocate it. That site was heavily grazed, with no inflorescences present. We believe that it may still be there, just not visible. If present, this taxon is rare in Arizona. If that pasture was released from grazing, then re-surveyed, we might learn if it persists in the State.

*C. serratodens* is widespread in western California and southwestern Oregon. It is disjunct in Arizona, growing at only a few springs and streams on the east slope of Four Peaks in the Mazatzal Mountains, making it rare in Arizona. Surveys in the vicinity of known populations might help us understand its range in the state, as well as help us understand its unusual disjunct status.

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# Applied Conservation Botany: *Examples from Wyoming and the Colorado Plateau* by Walter Fertig<sup>1</sup>

Vascular plants are rarely the focus of conservation attention. This is unfortunate because 20 to 33 percent of all plant species are considered vulnerable to extinction. Because of their high species richness and the availability of robust datasets for mapping or modeling their distribution, plants are also an underutilized proxy for total species diversity in conservation planning. Two such applications of conservation botany are prioritizing species based on patterns of rarity and Gap Analysis.

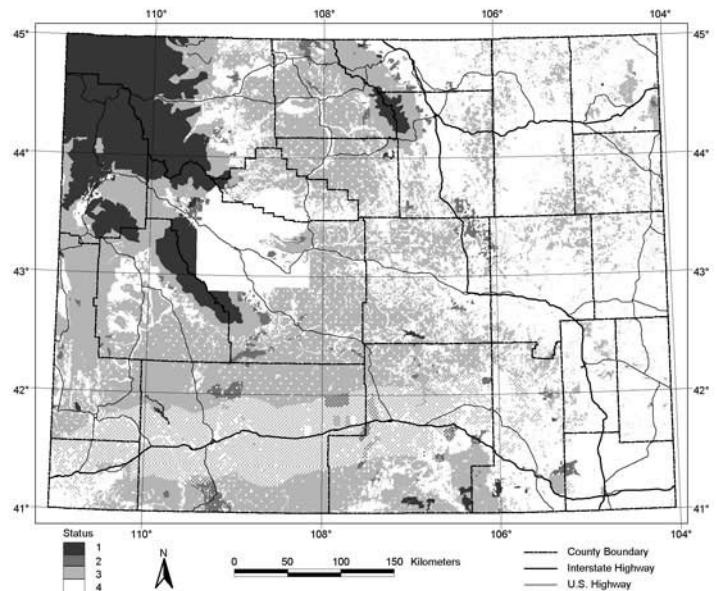
I modified Deborah Rabinowitz's binary ranking system (Rabinowitz 1981) to assess the conservation status of native plant species in Wyoming and Utah. My ranking system scores species according to their geographic range, number of populations, abundance, habitat specificity, intrinsic rarity, magnitude and imminence of threats, and population trends (Fertig 2011). This system is described in detail and applied to G1 and G2 plant species of Arizona by Laurenzi and Spence (2013).

Results from Wyoming and Utah indicate that about two percent of the flora is in immediate danger of extirpation, although another 20 percent is potentially vulnerable without some management attention. Habitat specificity contributed the most to predicting species rarity. This criterion was one of three emphasized by Rabinowitz (1981) but is not currently used in other ranking systems, such as those of NatureServe, the International Union for Conservation of Nature (IUCN) Red Lists, or the U.S. Fish and Wildlife Service. Rare species occur across a wide variety of habitats and over most geographic areas of Wyoming and Utah, although the highest priority taxa tend to occur in arid sites or on unusual (and localized) geologic outcrops.

Gap Analysis is a tool for identifying species, habitats, or geographic areas that are missing or poorly represented within the existing network of protected lands.

Usually Gap studies are done by modeling the potential distribution of species or vegetation types and then intersecting these coverages with land protection maps in GIS. Since modeled distribution maps are not available for most plant species, I substituted location data from herbarium databases and checklists for protected areas and then developed a master table indicating the number and percentage of occurrences for each species

<sup>1</sup> Moenave Botanical Consulting, Kanab, UT. Current address: Arizona State University Herbarium, School of Life Sciences, Arizona State University, P. O. Box 874501, Tempe, AZ 85287-4501. wfertig@asu.edu



Wyoming Gap land status map.

found in protected or unprotected areas for the entire flora of Wyoming and the Colorado Plateau portion of Utah. In Wyoming, approximately 80 percent of the state flora is found in at least one protected area. Of the unprotected or poorly-protected species (those found in five or fewer protected sites), the vast majority were rare taxa, or species restricted to desert basins and grasslands. Rare species were also twice as likely to be unprotected in the Colorado Plateau of Utah, though montane species were less well-protected than in Wyoming due to different land ownership and settlement patterns. Nearly 70 percent of the unprotected species in the Colorado Plateau are concentrated in just 12 major “hotspots” that are themselves

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above Three species used for conservation ranking. From left, *Streptanthus cordatus*, *Ligusticum porteri*, and *Anemopsis californica*.

## New ideas about rarity of *Carex* species of Arizona *continued from page 17*

*C. stevenii* is widespread in the Rocky Mountain states, but is only known from one location in Arizona, a high mountain meadow on White Mountain Apache tribal lands. This taxon is rare in Arizona. Surveys to find more populations in the White Mountains would add to our understanding of its status in Arizona.

In conclusion, we do have sedge species in Arizona that we believe should have priority for more study as to their rarity or likelihood to persist. We know that *C. specuicola*, USFWS Listed Threatened, and *C. spissa* var. *ultra*, USFS sensitive, are both much more common and widespread than *C. endlichii*. Our prediction: the former two will remain with their present status for decades to come, while *C. endlichii* and others with limited ranges in Arizona will remain unlisted, with no funding or incentives to learn more about them.



### Literature Cited

- Ball, Peter W. and Reznicek, A.A. 2002. *Carex*, in: Flora of North America, Vol. 23, Oxford University Press, Oxford.
- Laurenzi, A. and J. R. Spence. 2013. Conservation priority setting for Arizona G1 and G2 plant species: a regional assessment. The Plant Press, Arizona Native Plant Society, Vol. 36, No. 1.
- Spence, J. R. 2012. A new look at ranking plant rarity for conservation purposes, with an emphasis on the flora of the American Southwest. Calochortiana, Research Journal of the Utah Native Plant Society, No. 1.

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## Applied Conservation Botany

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unprotected at present. Biodiversity accounting methods, such as prioritizing species and identifying those that are unprotected, can help conservationists make better use of their limited financial resources and the short window in which to stave off extinction.



### Literature Cited:

- Fertig, W. 2011. Strategies for plant conservation in Wyoming: Distributional modeling, Gap Analysis, and identifying species at risk. Dissertation, University of Wyoming, Laramie, WY. 451 pp.
- Laurenzi, A. and J.R. Spence. 2013. Conservation priority setting for Arizona G1 and G2 plant species: A regional assessment. The Plant Press, Arizona Native Plant Society, 36(1):11-17.
- Rabinowitz, D. 1981. Seven forms of rarity. In: Synge, H. (ed.) The biological aspects of rare plant conservation. John Wiley & Sons, Ltd. 205-217.



## Remembering Doug Green

*by Douglas Ripley*

It is with sadness that we note the sudden passing of Charles Douglas (Doug) Green at age 78 in Scottsdale, Arizona, on September 11, 2013. As a long-time member of the Arizona Native Plant Society, Doug truly loved Arizona's native plants and contributed his many talents to the Arizona Native Plant Society by serving for many years as the president of the Phoenix Chapter, as a member of the Board of Directors, and through his active participation in numerous Society activities.

Doug is survived by his wife of 48 years, Joanne Green and by his three sons, Mason Green, Scott Green (wife April), and Chris Green, daughter Robin Yeargain (husband Carl), and six grandchildren. An Army veteran, Doug served in the 101st Airborne Division before joining 3M Corporation as a Regional Sales Manager for 41 years. Once retired, he pursued his passion in botany, birding, and spending time with his family. In addition to the AZNPS, Doug was an active member of the Audubon Society and the Central Arizona Cactus and Succulent Society.

We shall miss Doug's wonderful optimism, cheerful willingness to contribute to the accomplishment of AZNPS' goals, and his friendship. We offer our sincere condolences to his family.



# THE ARIZONA NATIVE PLANT SOCIETY

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For more information, please write to AZNPS (see return address above), visit [www.aznativeplantsociety.org](http://www.aznativeplantsociety.org), or contact one of the people below:

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