*Baileya multiradiata*, Desert Marigold

*Cora Estelle Mosher*

# Plant Press Arizona

## THE ARIZONA NATIVE PLANT SOCIETY

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## A Botany Extravaganza



### Plus



### With Regular Features



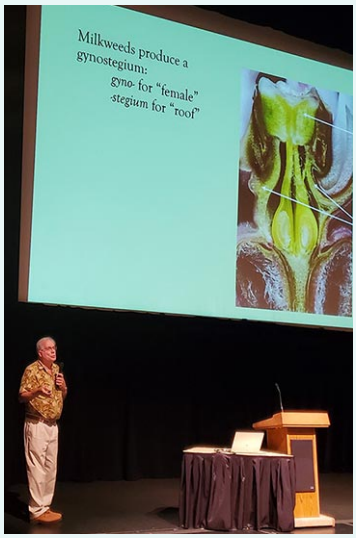


El Cañon de la Balandrona. Photo courtesy Sue Carnahan. See page 27 for "Richard Felger's Final Masterpieces — Two books that open the southern edge of the Sonoran Desert as never before."

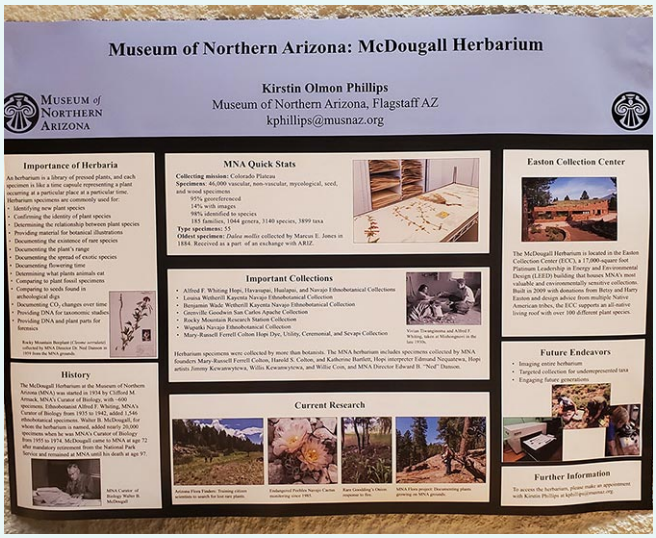
# Introduction

*by J. Douglas Ripley, President Arizona Native Plant Society*

This issue of *Plant Press Arizona* features several papers presented at the Society's August 2024 Conference held at the Pima Community College. Those describe interesting native plant survey work and conservation projects for several endangered species. One paper provides an update on new features coming soon to the invaluable SEINet network. Also included is a discussion of the background and accomplishments of the Society's Hakđtagwi:va Peach Springs Chapter, possibly the only Native American native plant society in the country. Finally, we present a paper on the coastal thornscrub flora and vegetation in the Municipality of Huatabampo, Sonora, Mexico.








From left: Presentations from Gene Thomas, John Scheuring, and Kirstin Olmon Phillips. Lower right: Jack Dash at the book sale. Inset: Our lovely venue at Pima Community College–West in Tucson. *Photos credit Doug Ripley.*

# President's Note

*by Douglas Ripley* jdougripley@gmail.com

As we approach the end of 2024, I wish to sincerely thank the wonderful support of the Arizona Native Plant Society Board of Directors, our members, Shelley Silva our *Happenings* newsletter editor, and our extremely conscientious and capable Administrator, Pat Sanchez for all they have done to help the Society accomplish its mission to promote knowledge, appreciation, conservation, and restoration of Arizona native plants and their habitats.


I think it's safe to say that in 2024 the Society made good progress in addressing each of the goals of our mission statement. Through our individual Chapter meetings, we have offered presentations on many aspects of the Arizona Flora. Also, our website and publications, such as this journal, our quarterly newsletter *Happenings*, and classes on botanical subjects, such as grass identification, encourage an appreciation for native Arizona plants. A number of highly effective conservation and restoration activities have been sponsored by both our State Conservation Committee as well as by several individual chapters. I'm confident that we will continue, and hopefully expand these activities in the New Year.

A major activity this year was our annual Botanical Conference, which was held at the Pima Community College in Tucson in August, the first in-person conference since 2019. Approximately 150 individuals attended the conference, which offered a wide range of presentations on Arizona native plant subjects, in both oral presentations and poster sessions. A new feature of this meeting was the offering of used botanical books for sale donated by the son of deceased member Doug Green from his father's extensive personal library. On the second day of the conference, we offered three different field trips. We have included in this issue of *Plant Press Arizona* some of the papers presented at this year's conference.

Thanks to the efforts of members Andrew Salywon and Wendy Hodgson, our 2025 conference will be held on March 1–2 at the world class Desert Botanical Garden in Phoenix. Field trips, including "behind the scenes" guided walks through some of the Garden's new facilities, will be offered on the first day. On the second day the formal program will be presented with a catered lunch. The organizing committee is just now being formed and will soon determine the theme for the meeting and issue a call for individuals to make presentations. Mark your calendars now for this major event!

With all best wishes for the holiday season, I again thank all members of the Arizona Native Plant Society for their support and participation in our Society.

Figure 1. Habitat of the Cliff Milkvetch. There are three plants on the ledge in the lower right. This is the layer supporting Cliff Milkvetch all around the North Kaibab Plateau escarpment. Figure 2. Cliff Milkvetch in flower, usually late April–May. Note the flowers barely extend above the foliage.

# Cliff Milkvetch: A Very Rare Plant on the North Kaibab Plateau

*by Frank Reichenbacher*[1] *All photos courtesy the author*

### Introduction

In September 2020, during the COVID-19 shutdown, I self-isolated with a week-long solo botanical reconnaissance of the Arizona Strip; 20,376 km$^2$ of the lonely northwest corner of Arizona between the Colorado River, Utah, and Nevada. Comprising only 6% of Arizona, the Arizona Strip supports 22% of species listed in the Arizona Rare Plant Committee's "Arizona Rare Plant Field Guide" and 36% of the U.S. Fish & Wildlife Service's Arizona endangered, threatened, and candidate species. It is a truly remarkable place.

One of the most interesting plants on the Arizona Strip is the Cliff Milkvetch (*Astragalus cremnophylax* var. *myriorrhaphis* Barneby, Figures 2–5), one of three diminutive varieties of the species, *Astragalus cremnophylax*. In addition to Cliff Milkvetch, the species includes Sentry Milkvetch (*Astragalus cremnophylax* var. *cremnophylax*), a Federally listed endangered species, and Hevron's Milkvetch (*Astragalus cremnophylax* var. *hevronii* Barneby), another rare taxon, but, like Cliff Milkvetch, it has no official conservation status other than consideration as a "Sensitive Species" by the U.S. Bureau of Land Management (BLM) and the U.S. Forest Service (USFS). All three varieties are found on limestone rock outcrops, ledges, and sparsely vegetated gravels around the margins of Marble Canyon and eastern Grand Canyon. Considerable attention has been given to Sentry Milkvetch, especially by the National Park Service (NPS) and it has, to some extent, paid off with the discovery of additional populations.

The Cliff Milkvetch was discovered by indomitable BLM botanist, Ralph Gierisch, in 1977, identifying it only as *A. cremnophylax*. Thinking that what he found might be a new variety or species, Gierisch returned to the site a year later with Gregory Brown and Bruce Parfitt and collected several specimens which soon made their way to Rupert Barneby at the New York Botanical Garden. Barneby published a description of a new variety, *myriorrhaphis*, in *Astragalus cremnophylax*. The site was a canyon just south of the Winter Road, a leg of the old Honeymoon Trail from the Mormon communities of Arizona to St. George. In the 1980s through the 2000s, botanists with the BLM Arizona Strip office, Kaibab National Forest, and the National Park Service, in several separate but overlapping efforts, did a great deal of work on the Cliff Milkvetch. They hiked across much of the North Kaibab, and then went west to the Hurricane Cliffs and even the Grand Wash Cliffs searching for the Cliff Milkvetch. Monitoring plots were set up and censused year after year, first by Gierisch and then by Lee Hughes. Later, Art and Barb Phillips, Loreena Allphin, and Nancy Brian participated in the monitoring. Over the years, several hundred Cliff Milkvetch plants were tagged, usually with aluminum tags attached to nails driven into the rock crevices where they grow.

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Figure 3. Three Cliff Milkvetch plants in typical habitat. The toothpick flags were used to aid in counting and were removed immediately. Figure 4. Cliff Milkvetch plant tagged in the 1990s(?). This is a not-quite-dead-yet plant with an unreadable tag.

# Cliff Milkvetch: A Very Rare Plant on the North Kaibab Plateau *continued*

I retrieved copies of some of the color print photographs Lee Hughers and others took on those monitoring efforts and was able to match two or three of them in 2024. Figure 6 shows 1977 and 2024 views of one of the sites. Although I was unable to use the previous monitoring data to analyze population trends between the 1980s–1990s and 2024, I saw what may be a change in the appearance of the Cliff Milkvetch plants from 1977 to 2024. The plants today seem less "tufty" and more irregular, and smaller, although there are more of them. The other vegetation on this rock outcrop seems to have increased. Something for future botanists to watch.

### Monitoring Update

In 2022, I received a U.S. Fish and Wildlife Service Endangered Species Research Grant through the Arizona Department of Agriculture to update the status of knowledge on Cliff Milkvetch, investigate the monitoring that has been done, and try to find new populations. Acting Arizona Strip BLM botanist, Jace Lambeth, kindly allowed me access to all their Cliff Milkvetch data. I also obtained some of the reports produced by Art and Barbara Phillips for the Kaibab National Forest, detailing their efforts to find more populations.

Records that allow relatively accurate mapping (1:24,000 scale topo maps) indicate that the BLM searched about 104 hectares along the west- and east-facing escarpments of the Buckskin Mountains. This does not include the many searches conducted by the BLM and Art and Barbara Philips. The true figure is likely to be closer to 500 hectares. In Art Phillips' 1992 report on Cliff Milkvetch for the Kaibab National Forest, he added up the actual areas, in square feet, occupied by 13 tiny populations, supporting 749 plants in a total area of 12,225 $ft^2$ (0.28 acres). We do not have such data from the populations in the canyons to the north on BLM lands, but if similar, the total area occupied by Cliff Milkvetch plants could be roughly 0.2–1.0 ha, with a total of 2,000–3,000 Cliff Milkvetch plants in 50–100 populations all concentrated in one 6 $km^2$ area on the northwest escarpment of the North Kaibab Plateau.

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Figure 5. Cliff Milkvetch plants with metal tags from the 1990s(?). One marks a still living plant with a still readable tag. The other two are now dead, and tags are unreadable.

# Cliff Milkvetch: A Very Rare Plant on the North Kaibab Plateau *continued*

In 25 days of field work, I was only able to find five of the old monitoring sites, and of the four I found, it was not possible to assess the status of the populations they were intended to represent.

### A New Monitoring Program

The old monitoring sites cannot be re-censused or re-started because of missing and ambiguous locality information and the lack of surviving tags (a total of 14 readable tags out of more than 200 actually placed). I decided to use a new approach to monitor the populations without tags that would take advantage of new technologies, including sub-meter GPS receivers, drones to provide centimeter-scale geo-referenced aerial imagery, and sophisticated computer mapping software. In addition, I realized it would be possible to take advantage of the unique Cliff Milkvetch habitat to create very long-term monitoring plots, using an absolute minimum of materials. I made the rock ledges where they live into monitoring "plots." This is a strategy partially employed by Nancy Brian and others in 1997.

I carried a battery-operated drill large enough to make a 2 cm wide, 10 cm deep hole in limestone bedrock plus a spare battery, 15 cm long 1.5 cm diameter carriage bolts, and additional assorted equipment up and down the canyons (Figure 7–8). I identified areas with significant populations on a well-defined ledge where a straight line across the ledge would be feasible and the two ends could be anchored in solid rock. Each bolt hole got a generous amount of Gorilla glue and then the bolt was dropped in. I had previously etched the plot ID number on the heads of the bolts. I had to give the glue a few days to dry then I returned and stretched my meter tape between the bolts and dropped a 24 in x 36 in cardboard with the center cutout over the bolt. GPS coordinates of each plot bolt were then obtained to about 60–80 cm accuracy. Then I sent up my drone to get a very high-resolution image of each plot using the cardboards as reference points. Back at the office, I downloaded and printed the drone images on 11 in x 17 in paper. The last step was to take those printed aerial images back to each site and map each individual Cliff Milkvetch. The resolution of the aerial imagery was about 1–2 cm so all but the tiniest Cliff Milkvetch can be seen and mapped with great precision. Then I imported the aerial images into a computer map (GIS) and digitized each individual plant on the computer. Each plant now has latitude and longitude coordinates within about 1–2 cm of each other and within about 1–1.5 m of real-world geographic coordinates. Table 1 lists the monitoring plots I set up in 2024 and their sizes, the number of plants in each of the plots and the areas of the Cliff Milkvetch

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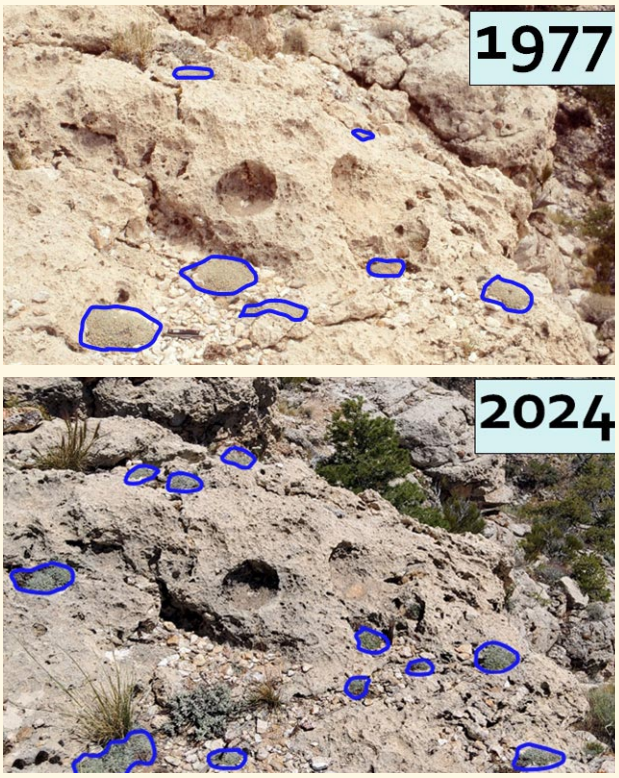


Figure 6a, 6b. Cliff Milkvetch matching photos from 1977 and 2024. Seven in 1977 and 11 in 2024. The large hollows near the center were left by cannonball concretions that had fallen out of the limestone matrix.


Figure 7 (above). Each of the eight plots (with one exception) was a line across a ledge anchored at a beginning with a 6 in carriage bolt glued into the rock and etched with the plot ID on the top. Figure 8 (below). An end bolt and 30 m tape.

Figure 9. Plot C06-1. The little red toothpick flags were used to keep track of the Cliff Milkvetch in a plot. Note the two atypical plants near the center that are growing on a cliff.

## Cliff Milkvetch: A Very Rare Plant on the North Kaibab Plateau *continued*

plants in each plot. Figure 9–10 are views of the process of setting up the plots and the Cliff Milkvetch plants I found. Figure 11 is a map of one of the plots, plot RC3-A, 38.76 $m^2$, supporting 44 Cliff Milkvetch plants.

This seems like a lot of work, but I was surprised at how relatively easy and straightforward it all was. Botanists of the future will simply bring a paper copy of the plot map, or, more likely, a computer map, and try to find each one. Plants

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Figure 10. Many of the Cliff Milkvetch plants seem to be reduced remnants of previously larger plants.

Table 1. Cliff Milkvetch monitoring plots, North Kaibab Plateau, Coconino Co., Arizona. Area $m^2$ is the sum of the outlines of individual plants in each site, Mean Area $m^2$ is the average size of the outline of a Cliff Milkvetch plant at each site.

| Plot | Site Area $m^2$ | No. plants | Area $m^2$ | Mean Area $m^2$ |
|---|---|---|---|---|
| C06-1 | 40.34 | 92 | 0.40 | 0.004 |
| RC3-A | 38.76 | 44 | 0.35 | 0.007 |
| RC3-B | 7.39 | 12 | 0.06 | 0.005 |
| RC3-C | 24.66 | 11 | 0.05 | 0.005 |
| RC3-D | 57.88 | 126 | 0.86 | 0.007 |
| WR1 | 169.03 | 61 | 0.19 | 0.003 |
| WR2 | 56.96 | 54 | 0.31 | 0.006 |
| Total | 58.22 | 400 | 2.23 | 0.006 |

Figure 11. Cliff Milkvetch monitoring plot RC3-A, Rock Canyon. Outline of the plot (red) and the individual plants (blue, a total of 44). The plot map was developed using drone imagery. Figure 12. Tiger Moth (cf. *Apantensis incorrupta*) larvae feasting on a delicious salad of Cliff Milkvetch.

# Cliff Milkvetch: A Very Rare Plant on the North Kaibab Plateau *continued*

that cannot be found will be assumed to have died (remains of dead Cliff Milkvetch plants persist for years), and new plants will be recruits. These are the basic elements of any population monitoring program. From time 0 –> *time* 0+*x*, did the population grow or shrink? Is there an identifiable trend? If so, is the trend significant?

### An Interesting Plant — But Why Ledges?

It really should be called the Ledge Milkvetch. Thankfully, for this ecologist, the plant does not grow on cliff faces except for a few individuals perched on the edge or just over the edge of a ledge. The ledges are Kaibab Formation limestone, the dominant geological formation of the Kaibab Plateau. The formation varies from less than 100 m to over 300 m thick and is exposed over 14,000 km$^2$ along both sides of the eastern Grand Canyon and Marble Canyon. In the area of Cliff Milkvetch, Kaibab Formation is the only rock formation. Early on, botanists saw that the plants are restricted to a certain layer of Kaibab Formation, about 20–30 m below the plateau cap layers and 50–150 m above the deeper canyon floors. The layer is a slightly lighter shade of gray, almost white, and must be a little more resistant to weathering because it forms a series of distinct, though much broken and interrupted ledges rimming the canyons.

Cliff Milkvetch lives on these ledges taking root in small pockets and crevices with a tiny bit of soil and gravel and usually with no other plants, of any species, nearby. It forms small cushion-like, disk-shaped tufts, about the size of a coffee saucer. Populations occupy a few square meters; a large population is 100–200 plants. There are miles of rock ledges on the west escarpment of the Buckskin Mountains, though only a tiny fraction support Cliff Milkvetch.

Why does it grow in such inhospitable environments? You never find it more than a yard from a bare rock surface, and then, only on a shallow veneer of limestone gravel with bedrock a couple of centimeters below the surface. It's almost like it's actively avoiding all the other plants, isn't it?

In fact, that is probably the case. They are avoiding competition with other species by inhabiting less-favored sites. Growing on those bare ledges, seedlings usually do not have any competitors at all. Adult plants are never overtopped and shaded out, they get exclusive use of pollinators in the immediate environment, and, perhaps, most importantly, they are less likely to be found and eaten by herbivores. The disadvantages may, however, be quite severe. Seed pods, which are rarely elevated more than a few millimeters above the foliage of the plant, open when mature and the pin-head-sized seeds just fall out. Very few will get more than a meter from the maternal parent (action of rain and snowmelt, and possibly insects) and so the population is very limited in its ability to explore new and better microsites. Once established, seedlings and adult plants are exposed to full, desiccating, unfiltered sunlight. The soil, which barely exists, is terrible (limestone is the main ingredient in cement). Most of the ledge is solid rock, and the only places a plant can take root at all are cracks and tiny pockets. They are exposed to trampling from deer and other animals, and, once herbivores discover the plants (Figure 12), there are no other plants nearby to attract them away from the Cliff Milkvetch. Exclusive use of pollinators sounds great, but only if the pollinators can find them, which, isolated as the Cliff Milkvetch are, may be infrequent at best. Populations are always small and therefore vulnerable to chance environmental fluctuation.

The Cliff Milkvetch-avoidance strategy has worked well enough and that is all that is necessary. However, it is not really a strategy. Rather it is best thought of as a consequence of evolutionary pathways that led to poor competitive ability. It is not where it "wants to be," it is simply where it "can be."

Figure 1. BLM staff planting Arizona eryngo at a wetland in Las Cienegas National Conservation Area in September 2023

# Conservation Work for Two Rare Wetland Endemic Plant Species at Las Cienegas National Conservation Area — Huachuca Water Umbel (*Lilaeopsis schaffneriana* var. *recurva*) and Arizona Eryngo (*Eryngium sparganophyllum*)

*by Theresa Condo*[1] *Photos courtesy the author unless otherwise noted.*

## Introduction

Huachuca water umbel (*Lilaeopsis schaffneriana* var. *recurva*) and Arizona eryngo (*Eryngium sparganophyllum*) are both rare wetland and riparian plant species in the *Apiaceae* family found in southern Arizona. Huachuca water umbel is inconspicuous with slender hollow leaves growing asexually singly or in clusters from horizontal rhizomes, forming "patches" or clumps. The umbel contains three to ten small white flowers and have been observed in bloom episodically from March through October, peaking in July. Huachuca water umbel is semi- to fully-aquatic, inhabiting wetlands, rivers, streams, and springs, generally in perennial, shallow water.

Arizona eryngo is a large perennial forb that inhabits ciénegas — marshland communities associated with perennial springs or headwater streams in the Sonoran and Chihuahuan Desert ecoregions. The plant resembles a monocot, with long lily-like parallel-veined leaves that emerge from a basal rosette and tall flowering stalks topped with dense clusters of white flowers. Individual plants can produce hundreds of seeds per season (Stromberg et al., 2020). Arizona eryngo can also reproduce asexually by forming clusters of clonal ramets.

Both species are federally listed on as Endangered under the Endangered Species Act; Huachuca water umbel was listed in 1997 and Arizona eryngo in 2022. They are both obligate wetland plant species and rely on the presence of perennially moist to wet soil to survive. While strikingly different in appearance, a shared threat to both species is the loss and

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Figure 2. Arizona eryngo transplants about to be planted at LCNCA.

Figure 3. Arizona eryngo being carried out to a planting location.

# Conservation Work for Two Rare Wetland Endemic Plant Species at Las Cienegas National Conservation Area *continued*

degradation of riparian and ciénega habitat. These unique habitat types are found within the Las Cienegas National Conservation Area (LCNCA) in southern Arizona, managed by the Bureau of Land Management (BLM), creating conservation opportunities for both species.

### Huachuca Water Umbel Surveys in Cienega Creek and its Tributaries

Perennial reaches of Cienega Creek in LCNCA support 1 of 17 known extant Huachuca water umbel occurrences in Southern Arizona. There are also possibly 21 locations in Sonora, Mexico, supporting Huachuca water umbel, though most of these occurrences have not been revisited in recent years (USFWS 2017). The population in Cienega Creek represents about 12% of the species' total range (USFWS 2017), making inventory, monitoring, and management at LCNCA an important part of their conservation.

In late May 2023, BLM staff and an intern completed Huachuca umbel surveys on Cienega Creek, and two tributaries Mattie Creek and Empire Gulch within LCNCA. Location data, patch length, patch width, density; and other variables regarding invasive species presence, canopy cover, disturbances, and habitat were collected at each Huachuca water umbel "patch." Usually, distinct patches were easily discernible in the field, however, some patches were long (over 10 meters), varied in density, and were difficult to separate. Therefore, a gap in a Huachuca water umbel patch larger than 2 meters was marked as a separate patch.

From the 2023 surveys, a total of 150 Huachuca water umbel patches were located and measured throughout LCNCA. Of those, 125 were in the 9 miles surveyed on Cienega Creek, 24 were in the one mile surveyed in Empire Gulch, and one was in Mattie Creek. Patch area (length x width) ranged widely with the smallest patch being 0.06 $m^2$ to the largest patch being 212.5 $m^2$. Mean patch area was 14.74 $m^2$ and median patch area was 2.1 $m^2$. The top five longest patches, all over 30 meters, were in the lower perennial reaches of Cienega Creek, and the longest patch was 80 meters. The longer patches, growing along the creek banks, often varied in cover, width, and density.

Other plant species found growing in and amongst Huachuca water umbel included, rabbit's-foot grass (*Polypogon monspeliensis*), horsetail (*Equisetum laevigatum*), cut leaf water parsnip (*Burula erecta*), pennywort (*Hydrocotyle ranunculoides*), watercress (*Nasturtium officinale*), bulrush (*Schoenoplectus americanus*), and spikerushes (*Elrocharis* sp.). Most Huachuca water umbel patches were partially covered with overstory trees and shrubs, such as cottonwood (*Populus fremontii*), ash (*Fraxinus velutina*), willow (*Salix goodingii*), and seep willow (*Baccharis salicifolia*). One hundred patches (67%) were partially covered with overstory vegetation, 14 patches (9%) were completely covered, and 25 patches (17%) were open with no overstory cover.

For phenology, 14 patches (9%) were flowering and most, 136 patches (91%), were vegetative. The 14 patches with flowers were observed throughout the survey area (not concentrated in one

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Figure 4. Arizona eryngo, planted in 2021 and flowering in summer 2024 at LCNCA. Figure 5. Huachuca water umbel flowers. Figure 6. Butterflies on Arizona eryngo transplant at LCNCA. *Photo courtesy Aaron Peretz.*

# Conservation Work for Two Rare Wetland Endemic Plant Species at Las Cienegas National Conservation Area *continued*

area). Flowering did not appear to be related to any of the other variables collected, though no correlation analysis was done. Since surveys were done in May, it is likely that more patches would have had flowers if the surveys were conducted later in the summer.

The last comprehensive Huachuca water umbel survey done at LCNCA prior to 2023 was in 2011 by now retired BLM Fisheries Biologist, Jeffery Simms. Overall, patch locations have remained similar between 2011 and 2023. The highest density of Huachuca water umbel patches occurs in the lower section of Cienega Creek between Pump Canyon and Fresno Canyon (75 patches in 2023 and 69 patches in 2011). In the upper section of the creek (headwaters reach), the highest density of patches occurs upstream of the Gardner Canyon confluence (19 patches in 2023 and 19 patches in 2011). Sections that had significantly more patches in 2023 were Empire Gulch (24 patches in 2023 and one in 2011) and downstream of the 49 Wash confluence (13 patches in 2023 and zero in 2011).

The results from this survey and comparison to the 2011 surveys may indicate that Huachuca water umbel is stable at LCNCA. There were record floods in Cienega Creek in 2021, which apparently did not substantially impact Huachuca water umbel presence and distribution in Cienega Creek and its tributaries based on the 2023 survey results. Riparian restoration activities planned and being implemented at LCNCA by BLM and partners include installation of erosion control structures, beaver dam analogs (BDAs), reintroduction of beaver, and invasive species treatments. These actions benefit Huachuca water umbel and its habitat by reducing sediment load from the uplands into the creek, aggrading incised channels, increasing wetland habitat, and reducing non-native species competition.

### Huachuca water umbel planting at LCNCA

In 2013 and 2014, BLM planted Huachuca water umbel at 3 locations within LCNCA. Two locations were natural wetlands that were excavated to maintain perennial water supplied by near surface ground water and one location was a wildlife pond maintained with pumped water from a well. Plant materials were sourced directly from Cienega Creek and translocated into the three locations.

In 2022 and 2023, BLM planted Huachuca water umbel at three additional locations within LCNCA. The plants were grown by Pima County Native Plant Nursery from plant material collected at Cienega Creek. Establishment and success of all Huachuca water umbel plantings have been variable across sites. Half of the sites have dried due to drought, issues with pond infrastructure at the wildlife ponds, or from competition of other native vegetation. Of the six locations, Huachuca water umbel is currently present at three.

### Arizona eryngo plantings at LCNCA

There are four naturally occurring extant populations of Arizona eryngo: two in Arizona and two each in the states of Sonora and Chihuahua, Mexico. The largest population is at La Cebadilla wetland, which is in a neighborhood near Tucson, AZ. The second largest population is at Lewis Springs wetlands on the San Pedro Riparian National Conservation Area (SPRNCA) near Sierra Vista, AZ, managed by the BLM. While BLM continues to

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Figure 7. Huachuca water umbel in Cienega Creek from 2023 surveys.

Figure 8. BLM staff and intern about to carry Arizona eryngo to a wetland planting site in LCNCA.

# Conservation Work for Two Rare Wetland Endemic Plant Species at Las Cienegas National Conservation Area *continued*

monitor the Lewis Springs population using demography plots set up in 2020 (Li et al., 2023), BLM and the U.S. Fish and Wildlife Service (FWS) have looked to expand conservation efforts of Arizona eryngo outside of its natural habitat. Suitable habitat within LCNCA presented a unique opportunity to increase the number of populations through outplantings.

Beginning in 2020, the Pima County Native Plant Nursery began growing Arizona eryngo in pots using seed from the La Cebadilla population. This seed source was used for transplants going to LCNCA to keep genetic material within the Santa Cruz Watershed. In October 2020, we planted 100 plants across eight locations – six natural wetland and riparian habitats and two wildlife ponds within LCNCA. These initial plantings were done at a variety of sites to test which areas might be the most successful in supporting Arizona eryngo. Unfortunately, this effort was not very successful and many of the plants did not survive. This was likely attributed to hot and dry conditions during the summer and fall of 2020. In 2021, BLM planted 52 plants across four locations, all at naturally occurring wetlands. In 2023, BLM planted 181 plants, the biggest effort yet, across three locations. And in 2024, we planted 116 plants across three locations. This amounts to 449 Arizona eryngo transplants planted at Las Cienegas from 2020.

Based on counts from this summer, 281 of the 449 transplanted plants have survived at eight sites, ranging from 2 to 142 plants per site. Factors that are likely influencing planting success are substrate, animals digging up or eating the plants, competing vegetation, and water fluctuations after planting. The most successful sites have consistent soil moisture or are at least moist enough after planting and at critical times of the year to allow the transplanted Arizona eryngo plant to establish and grow.

Overall success is yet to be determined. The introduced plants produce clonal ramen and usually flower within the first year or two after planting. However, there has been no seedling recruitment observed at the planting sites, which is vital to maintain a sustaining population.

### Future Actions

Future activities that would aid in the conservation of Huachuca water umbel and Arizona eryngo include monitoring, plantings, studies, and restoration. BLM will continue to inventory and monitor both naturally occurring and planted populations of both Huachuca water umbel and Arizona eryngo to track conditions and trends of populations on BLM-managed lands. Planting efforts will continue as well as seeking funding opportunities and partners interested in studying planting success, seedling establishment, and genetics. Ongoing and planned invasive species treatments and other restoration projects, such as erosion control on Las Cienegas, will benefit wetland and riparian habitat conditions. In addition, continuing to work and coordinate with partners, including the U.S. Fish and Wildlife Service, Pima County, and the Desert Botanical Gardens, will be critical as we continue this work.

### Citations


Li, Y.M., J.R. Simms, T.C. Condo, D. Wolkis, R. Wang, A. Hatch, E. Makings, S. Blackwell, and M. Mayer,. 2023. Population dynamics and life history of the endangered cienega endemic *Eryngium sparganophyllum* in Arizona. *Journal of Arid Environments* 214, 104984

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U.S. Fish and Wildlife Service. 2017. Recovery plan for *Lilaeopsis schaffneriana* ssp. *recurva* (Huachuca water umbel). U.S. Fish and Wildlife Service, Arizona Ecological Services Field Office, Tucson, Arizona. 108 pp.

# Bridging Botanical Traditions with Tribal Knowledge: A Reflection on the Hakđagwi:va Peach Springs Chapter of the Arizona Native Plant Society

*by Carrie Cannon*[1]

On June 17, 1744, the commission from Maryland and Virginia negotiated a treaty with the tribal peoples of the Six Nations at Lancaster, Pennsylvania. The tribal members were invited to send boys to William and Mary College. The next day they declined the offer as follows:

> "We know that you highly esteem the kind of learning taught in those Colleges, and that the maintenance of our young men, while with you, would be very expensive to you. We are convinced that you mean to do us good by your proposal; and we thank you heartily. But you, who are wise must know that different Nations have different conceptions of things and you will therefore not take it amiss, if our ideas of this kind of education happen not to be the same as yours. We have some experience of it. Several of our young people were formerly brought up at the Colleges of the Northern Provinces: they were instructed in all your sciences; but, when they came back to us, they were bad runners, ignorant of every means of living in the woods…neither fit for hunters, warriors, nor counselors, they were totally good for nothing. We are however not the less oblig'd by your kind offer, tho' we decline accepting it; and, to show our grateful sense of it, if the gentlemen of Virginia will send us a dozen of their sons, we will take care of their education, instruct them in all we know, and make Men of them." (Touch the Earth p.57)

The age-old adage "history is written by the victors" poignantly captures the general phenomenon that the dominant historical narrative is most often shaped by the perspective of those who "won" a conflict, often leading to a biased interpretation that favors the "winners" thereby downplaying the experiences of those who were subject to colonization. The above quote however is a rare glimpse of the "other" perspective that is so rarely shared beyond minority communities. Fellow members of the Native Plant Society, I am delighted to share a reflection on the presentation I delivered at the 2024 Annual Arizona Native Plant Society Conference on the exciting developments emerging from the Hakđgwi:va Peach Springs Chapter of the Arizona Native Plant Society. The involvement in our chapter in the state is not only an achievement for the Hualapai Tribe, but a powerful reminder of how Indigenous knowledge enhances the broader field of botany.

The Peach Springs Chapter is an innovative chapter—remarkably, the first Native Plant Society chapter on an Indian Reservation in the state of Arizona (Figure 1), and quite possibly, the first of its kind in the entire country! The Hualapai community's engagement has been vibrant, bringing together tribal knowledge, local expertise, and a shared love for native plants in new ways. Through monthly presentations, plant family explorations, and collaborations with botanists, we are reweaving narratives that honor both Western scientific methods and Traditional Ecological Knowledge and Indigenous science.

### Reclaiming and Expanding Botanical Narratives

Historically, Indigenous voices have been omitted from the mainstream botanical narrative. Many dominant stories in

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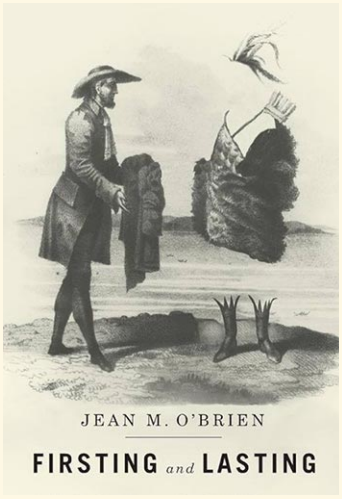
Figure 1. Jesse Yazzie and Alicia Cesspooch passing plant specimens. *Photo credit Carrie Cannon.*

[1]Ethnobotanist for the Hualapai Tribe. **calisay17@hotmail.com**




Clockwise from top left: Figure 2. "Firsting and Lasting" book by Jean M. O'Brien. Figure 3. Hualapai Tribal member and ethnobotany instructor the late Malinda Powskey. *Photo credit Carrie Cannon.* Figure 4. Hualapai Tribal member and ethnobotany instructor Lucille Watahomigie. *Photo credit Hualapai Department of Cultural Resources.* Figure 5. Muscogee Creek Tribal member Jane Breckinridge, Director of Euchee Butterfly Farm. *Photo credit Euchee Butterfly Farm.* Figure 6. Ka-voka Jackson, Hualapai Tribal member, Ecologist and Director of the Hualapai Department of Cultural Resources and member of the Peach Springs Chapter. *Photo credit Carrie Cannon.* Figure 7. Navajo Tribal member and Botanist Arnold Clifford. *Photo credit Carrie Cannon.*

# Bridging Botanical Traditions with Tribal Knowledge

*continued*

botany celebrate the "discoveries" of Western botanists while ignoring the millennia of knowledge held by Indigenous peoples. This exclusion, in the overall historical narrative of our nation, has been termed "firsting and lasting" by historian Jean M. O'Brien. Her book demonstrates the dominant narrative that throughout history European settlers have been framed as the first to establish civilization, relegating Native peoples to a forgotten past. However, the rich history of plant use and stewardship in Indigenous communities has been essential for the ecological balance we continue to rely upon today.

The Peach Springs Chapter is actively working to change these outdated paradigms. We are not only members but also presenters and knowledge bearers. Hualapai botanists such as the late Malinda Powskey—whose passion for plants inspired so many—have shared their insights and broadened our understanding of native species. Her work, along with that of other Native botanists and plant enthusiasts like Arnold Clifford (Navajo), Lucille Watahomigie (Hualapai), Jane Breckenridge (Euchee/Creek), and Ka-voka Jackson (Hualapai) serve as an excellent example of how tribal perspectives can revitalize botanical science.

### Fostering Connection Through Presentations and Partnerships

Our chapter meetings have become a space for dynamic cross-cultural exchanges. Presentations cover a diverse range of topics, including Grand Canyon plant communities, pollinator-plant relationships, and the U.S. Fish and Wildlife Service's efforts to protect rare plants. Some highlights include explorations of the intricate interactions between yuccas and their pollinators and sessions on desert habitat monitoring techniques led by the Bureau of Land Management.

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# Bridging Botanical Traditions with Tribal Knowledge *continued*

These gatherings not only celebrate native flora but also emphasize the intersection between plants, people, and place. For example, our collaborative work in knowledge exchange with the Grand Canyon National Park explores how Indigenous stories and modern botany together can deepen our understanding of the park's unique ecosystems.


### Celebrating Community and Sharing Knowledge

In addition to intellectual exchange, our meetings reflect the community spirit that defines us. We enjoy shared meals, gift raffles, and exchanges of member-produced and acquired items such as T-shirts, field guides, hand lenses, prickly pear cactus jelly, and gifting of native potted plants. These gatherings are not just about plants—they are also about fostering relationships within the community and across cultures.

We have also highlighted the contributions of Native women botanists through special presentations. These women are not just stewards of traditional plant knowledge—they are active participants in the evolving field of ethnobotany. Their stories inspire young people to pursue plant science and help reclaim a space for Indigenous voices within botanical research.

### Shifting the Paradigm: A Future Rooted in Inclusion

The book *Brave the Wild River* by Melissa L. Sevigny was addressed in the presentation at the annual conference in a compare-and-contrast format alongside the book *The Forgotten Botanist* by Wynne Brown. In *Brave the Wild River* we are reminded of what the colonial legacy in plant science has historically been, drawing a spotlight on how Indigenous knowledge was often disregarded in favor of "discoveries" by Western explorers: "Plant collectors in the United States, meanwhile, turned around this superior attitude toward Indigenous peoples in every country, including their own, dismissing local knowledge of plants in an eagerness to "discover" species. The field of botany suffered because of racism and colonialism." (page 13)

The author did an outstanding job explaining the context of how Indigenous knowledge had historically been marginalized. Today, we at the Peach Springs Chapter of the AZ Native Plant Society aim to reverse this trend, recognizing that both oral traditions and scientific research are essential parts of a shared botanical heritage.

As we reflect on these collaborative efforts, one question continues to resonate: What is the dominant narrative in botany, and how can we shift it? By weaving together Indigenous histories and scientific perspectives, we can create a richer, more inclusive narrative. This requires actively addressing the legacy of exclusion in plant science and valuing the insights of Native communities. One of the ways we are working toward this goal is by promoting interdisciplinary exchanges. We must continue to ask: whose knowledge is being privileged? Whose stories are missing from the conversation? Most importantly, how can we ensure these perspectives are included moving forward?

In the spirit of these questions, we honor both the past and the future of botany. The book *The Forgotten Botanist* highlighted a narrative of historical sexism in botanical realms as the subject of the biography, Sarah Plummer Lemmon did not get the same recognition for her botanical achievements as her counterpart and husband John Gill Lemmon who was also a botanist. The book pieced together the narrative of Sara

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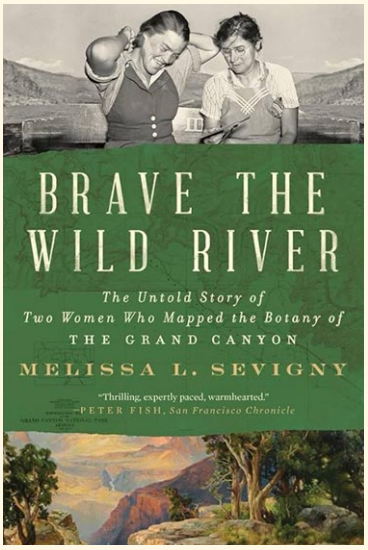


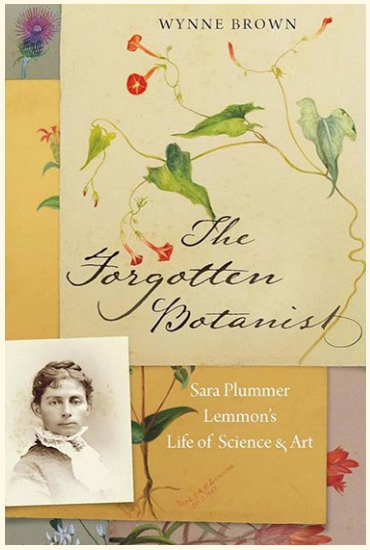


Figure 8 (inset). Peach Springs Chapter member Marcie Craynon showcasing member t-shirts. *Photo credit Carrie Cannon.* Figure 9. *Brave the Wild River* by Melissa Sevigny. Figure 10. *The Forgotten Botanist* by Wynne Brown.

Figure 11. Sand Canyon Pueblo, Colorado. Figure 12. Chaco Canyon Pueblo, New Mexico.

## Bridging Botanical Traditions with Tribal Knowledge *continued*

Lemmon Plummer's career through a meticulous series of letters written throughout her life. While the book expounded on the historical injustices of sexism in the field of botany, this same narrative unfortunately also perpetuated a contemporary Eurocentric narrative that served to inadvertently erase Indigenous people's contributions.

While there is appreciation for the author's comprehensive spotlight on Lemmon, statements such as "Eventually the Lemmons would discover three percent of Arizona's plants and dozens of those would carry the Lemmon's name…" ignores the reality that Arizona was inhabited by tens of thousands of tribal peoples who undoubtably had names, uses, and botanical classifications for such species. Plainly put, statements of "new discoveries" should be qualified by the words "Western Science" because this knowledge has already been held and fine-tuned by empirical observations gathered by Indigenous people for millennia.

Sophisticated Indigenous classification systems were and continue to be a cornerstone for understanding and organizing the natural world. Indigenous peoples class plants and animals into groupings and categories based on progressively more detailed features of distinction; distinguishing between key features such as size, shape, color, scent, relation to other plants, and specific use. Brent Berlin's landmark work *Ethnobiological Classification Principles of Categorization of Plants and Animals in Traditional Societies* provides supplemental reading on this topic highlighting numerous examples of complex Indigenous classification systems.

Other statements in *The Forgotten Botanist* were shared in the context of a contemporary Eurocentric vision of history: "Before he (John Muir) gained fame as a naturalist, writer, and conservationist, he was a botanist and glacier geologist and was the ***first*** to propose that glaciers were living beings that advanced then retreated, while, very slowly, carving out gigantic valleys" (page 119). Yet, Indigenous Alaska Native narratives are replete with observations about glaciers advancing, retreating, and surging. "Glacial understandings are expressed through an ancient art of storytelling that articulates an intimate, *animate*, and ethical relationship with glaciers. Tlingit and Tagish narratives describe glaciers as *sentient beings*; glaciers that listen, glaciers that can smell, glaciers with attitude. The coastal and inland Tlingit and Tagish have lived for thousands of years with profound understandings of the agency of glaciers." (McEwan, C. 2021. Decolonizing the Anthropocene).

The "firsting and lasting" paradigm was consistent throughout the book's entire narrative: "…and later he was the ***first*** to climb Colorado's 14,278 foot Grays Peak — which he measured, as well as naming for his friend and colleague Asa Gray." (page 58) In this instance the book presumes Indigenous people who lived on the continent for tens of thousands of years never climbed a mountain. A mountain they surely had a name for in their own languages and lived at the foot of for a lifetime, thereby exemplifying yet another way in which Indigenous narratives, presence, and achievements gets washed out of existence.

Another statement in *The Forgotten Botanist* continues on the same trajectory; "He developed America's ***first*** *gated and planned community*." (page 18) Yet numerous examples in this country demonstrate that tribal people had both gated and planned communities. "Sand Canyon was surrounded by a *defensive wall*." (Ancient and Modern Pueblo Structure). The largest pre-European contact civilization in North America,

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Figure 13. Members and guest presenter of the Hakđtagwi:va Peach Springs Chapter of the Arizona Native Plant Society. *Photo credit Adrian Cordovi.*

## Bridging Botanical Traditions with Tribal Knowledge *continued*

the mound builders of Cahokia, was also surrounded by a *defensive wall.* Regarding land-use planning: "Within Chaco Canyon…the structures had ceremonial, religious, and public uses, and they were connected via an elaborate road system that provides evidence of *advanced urban planning.*" (Chaco Canyon, the Ancient Ruins of New Mexico). We can recognize Chaco Canyon is just one among multitudes of examples in our own backyard of advanced urban planning that was a regular feature of the layout of Indigenous communities here in the Southwest.

The critical analysis of *The Forgotten Botanist* during the annual conference falls into the paradigm addressed earlier, as the "firsting and lasting" phenomenon where Europeans are always portrayed as the first to accomplish something, while Indigenous people are always the last….the last something…. to vanish from the annals of history. A critical analysis of this book is not a criticism of the author, it is an opportunity to move beyond the modern cancel culture that pervades our society, and to have open, honest, and sometimes challenging conversations on broadening perspectives and shifting the narrative towards inclusion of wider perspectives. It is an invitation to explore together what inadvertent biases may exist within botanical realms and the larger historical narrative of mainstream culture. It can serve as a crucial reminder to us of the need for Indigenous perspectives that can broaden our historical and botanical narrative. By creating spaces for Indigenous perspectives, we broaden the scope of plant science and ensure it remains relevant to all communities.

### Moving Forward Together

As members of the Peach Springs Chapter and the larger Arizona Native Plant Society, we are at the forefront of redefining how plant science is practiced and understood. The lessons we learn from native species are intertwined with lessons about respect, reciprocity, and community. When we care for the land and the plants that sustain us, we honor both ancient traditions and modern ecological principles, some of which are one and the same. Together we can continue to foster this spirit of collaboration and inclusion. Whether through guest presentations, community dinners, or the simple joy of walking among native plants, we celebrate both: Western scientific principles hand in hand with Indigenous empirical knowledge and the stories that connect us. This is how we shift the paradigm—by embracing a botanical narrative that values the wisdom of both Indigenous science and Western scientific traditions.

Thank you for being part of this journey. I look forward to seeing you at our next gathering, where we will continue to learn from one another and deepen our shared connection to the land.

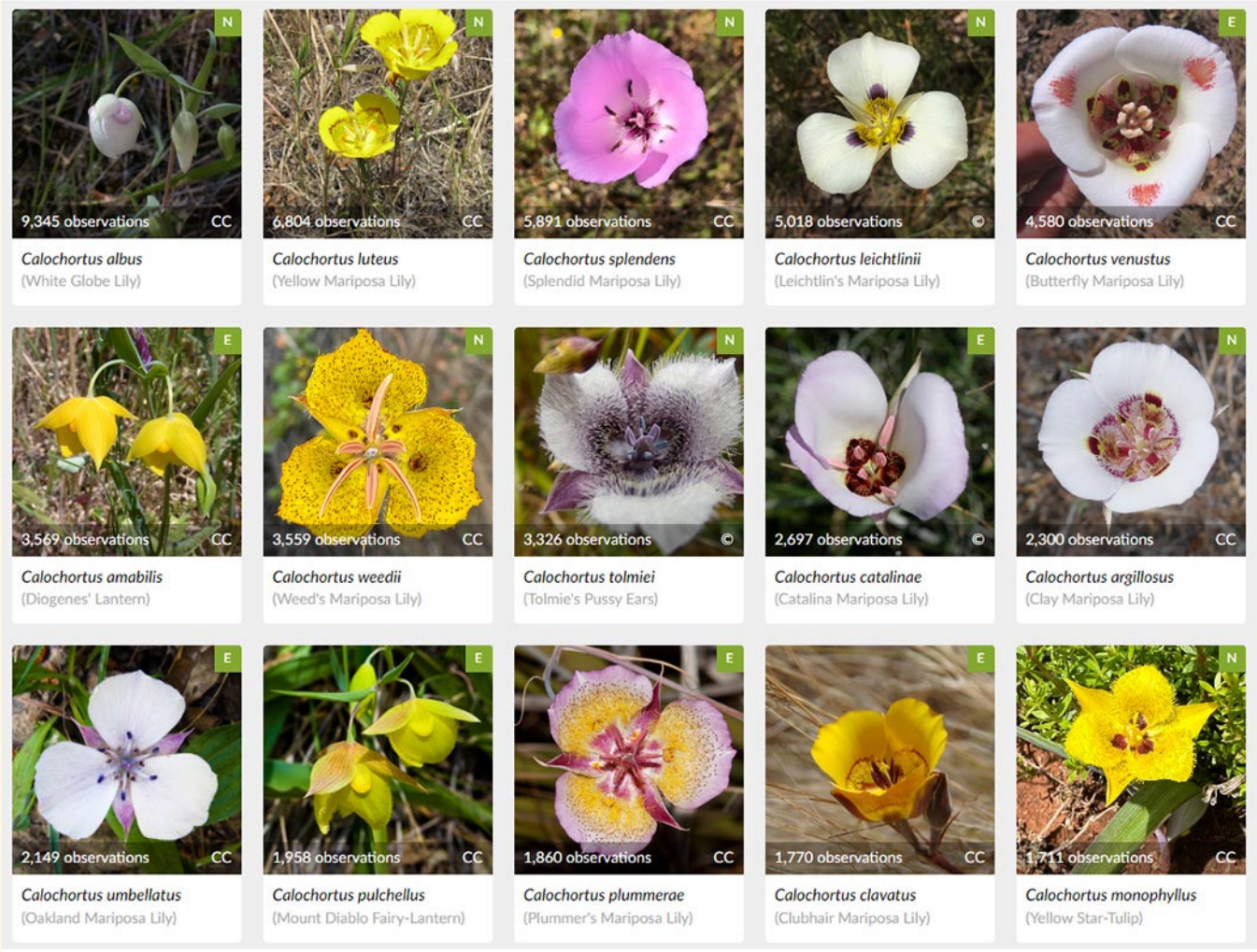


Figure 1. Image gallery displaying fifteen *Calochortus* species. *Images obtained via iNaturalist.*

# *Calochortus* Biogeography and Phenology in Arizona

*by Alexandra Permar[1] and Conor Flynn[1]*

### *Calochortus* Diversity and Growth

In Arizona, the *Calochortus* genus is suitable for a case study of biogeography and phenology because the species grow in relatively distinct geographic locations and elevation zones. Throughout the state, there are six species which range in color from white to pink, yellow, and orange. The flowers typically have diagnostic markings located on the inner surface of their petals. Because *Calochortus* flowers are very showy, iNaturalist app users have documented more than 2,400 research-grade observations of Arizona species.

Each year in the spring, *Calochortus* plants emerge from underground bulbs. They grow, flower, and die back relatively quickly. Casual plant observers are unlikely to notice the plants growing with just their stems visible aboveground before they flower. In iNaturalist, there are only a few photos of the growing stems and senescent fruits. This means that almost all the plant observations documented in iNaturalist are of plants with flowers. As a result, iNaturalist users like us who want to study the genus using the app's data require relatively little work to annotate images about phenology states such as flowering or not flowering.

[1]Alexandra Permar and Conor Flynn are an ecology team and long-time plant nerds who live in Arizona. Alexandra and Conor offer consulting services and information products via their business, Kakapo Konsulting. Feel free to contact them with questions or requests via **kakapokonsulting.com.**

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# *Calochortus* Biogeography and Phenology in Arizona *continued*

### Purpose of Our Case Study

We seek to understand *Calochortus* biogeography and phenology. To approach this goal, we conducted a case study of the *Calochortus* species in Arizona with publicly available data. We obtained data on the genus via citizen-science plant observations documented throughout the state. These observational data include place-based presence data with flowering condition documented for individual plants. We supplemented the plant observational data with publicly available geographic elevation information.

In ecology, plants tend to reveal patterns with their growth habits. For example, early in a growing season, plants growing at low elevations and with adequate natural resources tend to flower earlier than comparable plants growing at higher elevations. Environmental variables such as elevation; habitat vegetation type; seasonal temperature variation; soil type and condition; atmospheric weather patterns; and precipitation events; influence and inform a plant's phenology. Phenology entails the science of tracking and understanding nature's annual life cycles and growth patterns with indicators such as tissue growth, flowering, and leaf senescence.

### Our Research Methods

In our analytical case study, we

- acquired research-grade *Calochortus* observational data
- supplemented observational data with elevation information
- reviewed and cleaned our database to prepare it for analysis
- analyzed our database
- generated data visualizations
- developed key findings about the data
- processed and prepared our research for distribution

#### *Acquire Observational Data*

Using the iNaturalist citizen-science biodiversity app, we downloaded all available research-grade observations of *Calochortus* in Arizona. The iNaturalist research-grade observations are useful for ecological research. Across the world, ecologists use such observations to document new species and understand global changes and discoveries in biodiversity. For an observation to be classified as *research grade*, two separate app users must verify its scientific (taxonomic) identity in the iNaturalist computer application.

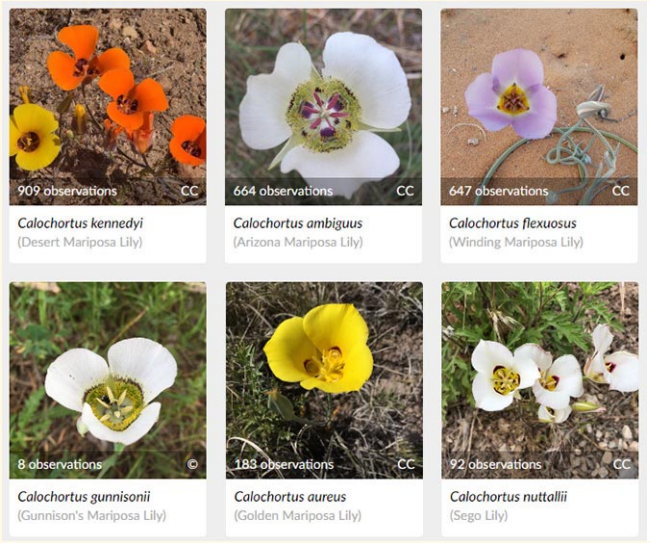


Figure 2. Image gallery displaying the six *Calochortus* species in Arizona. *Images obtained via iNaturalist.*

Via the iNaturalist app, we downloaded a total of 2,350 *Calochortus* research-grade observations.

#### *Enhance Observational Data with Elevation Information*

When a user uploads a biodiversity observation into the iNaturalist computer application, the app does not record elevational data associated with the observation's geographic location. For our case study, we found it necessary to enhance the observational data with elevation information. To do so, we intersected our database of acquired *Calochortus* observations (mapped as points with latitude and longitude) with a digital elevation model (DEM) using computerized geographic information systems (GIS).

To enhance our database with elevation information which we linked to each iNaturalist observation,

- We loaded the original *Calochortus* iNaturalist observations into ArcGIS Pro and displayed them via their geographic XY coordinates.
- We linked each plant observation to its corresponding geographic elevation data using the **Ground Surface Elevation (30 m)** digital terrain model which is available via the United States Geological Survey (USGS) and Esri. To do this, we used a geoprocessing tool called "Extract Multi Values to Points" (which requires an Esri user Spatial Analyst license).
- We incorporated the observational elevation data into our working database.

#### *Clean the Data*

We reviewed, cleaned, and processed the *Calochortus* data in Microsoft Excel and **Tableau Public.** As part of our database

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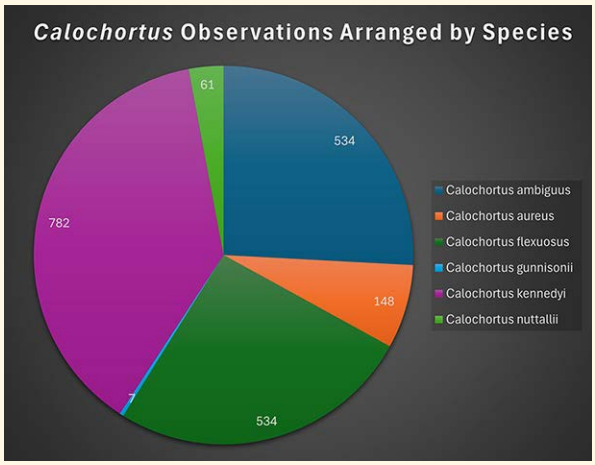


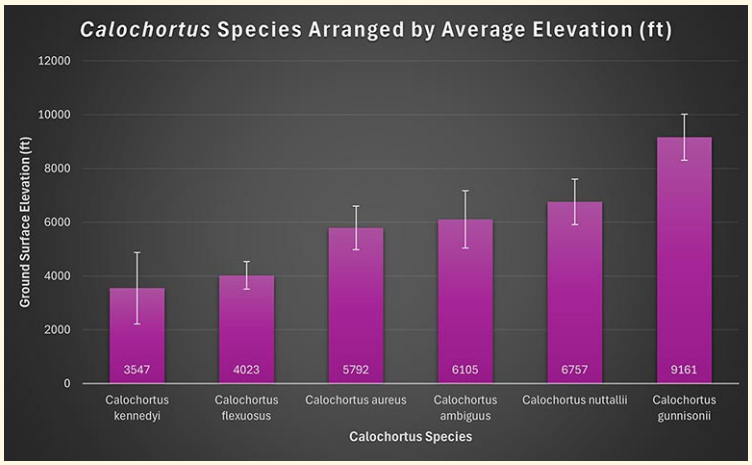


Figure 3. In our database, *Calochortus kennedyi* has the most observations (782); *C. ambiguus* and *C. flexuosus* both have the second-highest observation counts (534); *C. aureus* ranks third with 148 observations; *C. nuttallii* ranks fourth with 61 observations; *C. gunnisonii* has the least number of observations (7). Figure 4. The average elevation of the six *Calochortus* species in Arizona (feet). Error bars represent +/– one standard deviation.

## *Calochortus* Biogeography and Phenology in Arizona *continued*

acquisition, review, cleaning, and processing, we conducted the following steps:

- We reviewed our database of 2,350 *Calochortus* research-grade observations.
- Where applicable, we consolidated subspecies into species. (In their original form, the *Calochortus* taxa were classified into species and subspecies.)
- We removed records with geopositional accuracy greater than (>) 1,000 meters (m).
- We removed 61 records with *obscured* geoprivacy. (In iNaturalist, obscured geoprivacy impacts an observation's geopositional accuracy +/– 500 square kilometers [$km^2$].)
- We removed eight observations from the database that were not flowering.

After cleaning, our database contains 2,066 records (research-grade observations). This means about 88% of the original iNaturalist data satisfies inclusion criteria for our case study.

### Our Results

In our study of *Calochortus* data for Arizona, we analyzed observations with respect to 1) biogeography and elevation, and 2) flowering phenology.

#### *Biogeography and Elevation*

When ranked by average elevation, our database reveals:

- *Calochortus kennedyi* typically grows at the lowest elevations for all species studied.
- *Calochortus flexuosus* typically occurs at elevations like *C. kennedyi*, but—on average—a bit higher.
- *Calochortus aureus*, *C. ambiguus*, and *C. nuttalli* tend to grow at middle elevations relative to all species analyzed.
- *Calochortus gunnisonnii* typically grows at the highest elevations for all species studied.

Review Figure 4 for details. In the iNaturalist app, you can easily **visualize the biogeography of *Calochortus* species** in Arizona.

In Figure 5, you can see the following distributions for each *Calochortus* species studied:

- *Calochortus kennedyi* (**blue**) is visible growing at lower elevations along the foothills of Arizona mountains. In the app view (linked above), you can see the species' range extends westward beyond the distribution of any other Arizona species.
- *Calochortus flexuosus* (**green**) is visible growing in central and northwest Arizona. Its range extends through the lower-elevation valleys of the Verde, Salt, and Gila rivers.
- *Calochortus gunnisonnii* (**purple**) is more widespread in Colorado and northward; its range barely extends into the high country of Arizona.
- *Calochortus ambiguus* (**red-orange**) is mainly visible growing throughout the mountains and high country of central Arizona.
- *Calochortus aureus* (**pink**) occupies the Navajo Nation region in northeastern Arizona and southeastern Utah.

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# *Calochortus* Biogeography and Phenology in Arizona

*continued*

❊ *Calochortus nuttallii* (**brown**) is more common in states north of Arizona, such as Utah and Colorado. Most of the Arizona observations of this species are documented in the vicinity of the Grand Canyon and northward.

When we map a species' latitude and elevation, we can better understand and illustrate the biogeographic relationships that characterize species and their growth habits.

In Figure 6, we show observations by ground-surface elevation (on the X axis) and latitude (on the Y axis). In this graph, you can see the following patterns:

❊ *Calochortus kennedyi* (**green**) is the most southerly of our *Calochortus* species in Arizona. It also occurs at the lowest elevations.

❊ *Calochortus flexuosus* (**red**) grows at middle latitudes and farther north. It also grows at relatively low elevations.

❊ *Calochortus gunnisonnii* (**light blue**) is a clear outlier among the Arizona species; it occurs only at high elevations in our study area.

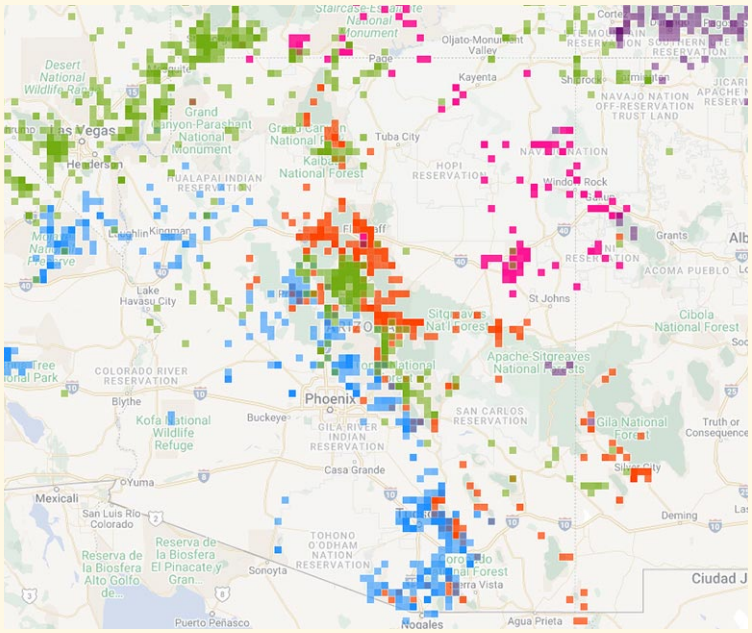


Figure 5. A clipped image of user observations mapped in iNaturalist showing part of the biogeographic distributions of *Calochortus* species analyzed in our study.

❊ *Calochortus ambiguus* (**blue**) tends to occupy habitats located at middle and high elevations. The data for this species convey it grows across a spectrum of latitudes.

❊ *Calochortus aureus* (**orange**) and *Calochortus nuttallii* (**gold yellow**) reveal quite a bit of overlap in their biogeographic habits with respect to latitude and elevation. They both

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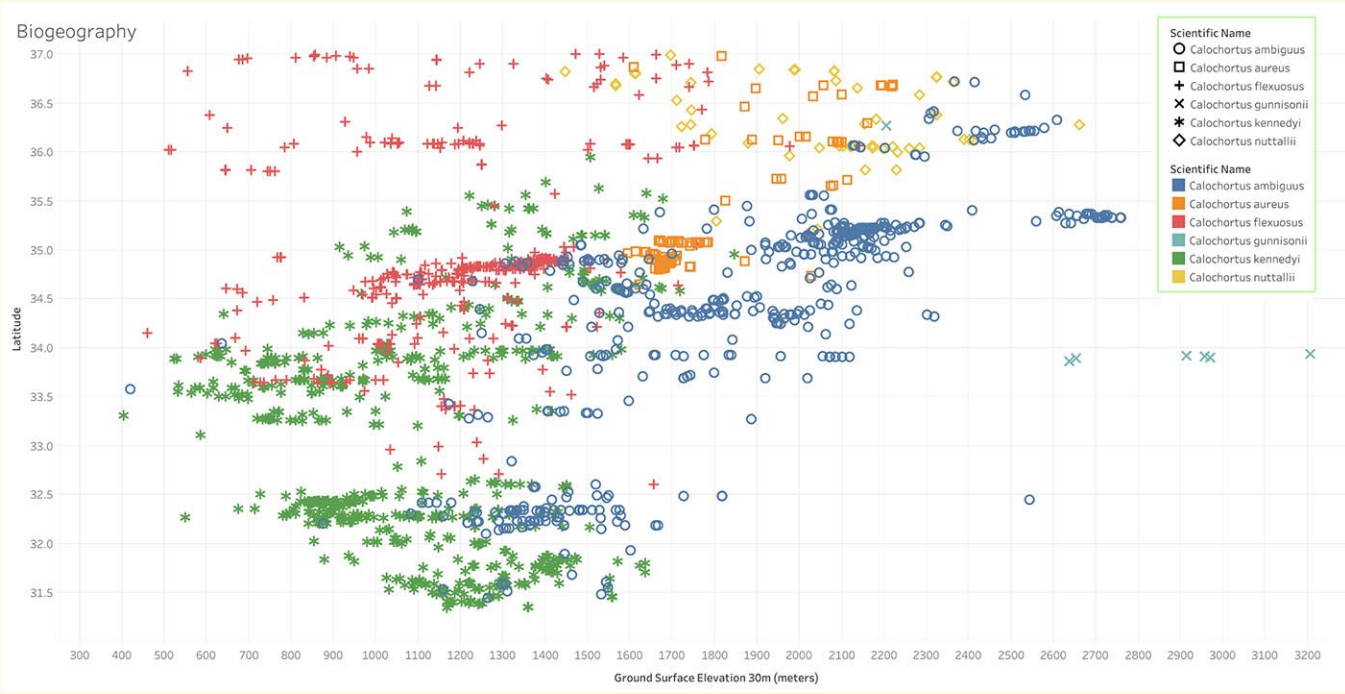


Figure 6. Graph of *Calochortus* observations included in our study mapped by ground-surface elevation (X axis) and latitude (Y axis).

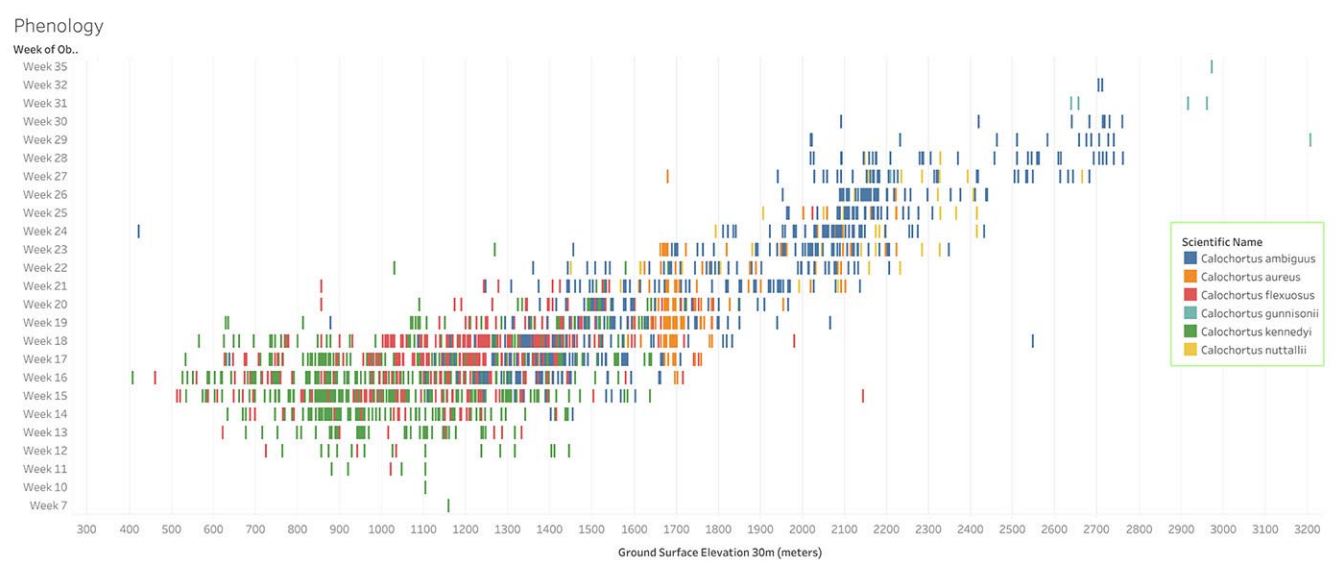


Figure 7. Graph of *Calochortus* observations included in our study mapped by ground-surface elevation (X axis) and flowering week (Y axis).

# *Calochortus* Biogeography and Phenology in Arizona *continued*

tend to grow at relatively high latitudes and middle elevations.

This biogeographic comparison helps us differentiate species that may appear similar when analyzed in other ways.

### *Flowering Phenology*

When we graph flowering phenology represented by ground-surface elevation (on the X axis) and annual calendar week (on the Y axis), we see the following trends:

For *Calochortus* species in Arizona, the average dates of flowering begin at lower elevations around weeks 12 and 13 (the last weeks of March) and continue onto higher elevations with most late-season flowering occurring around weeks 29 and 30 (second half of July). Exceptions to these trends are visible in our data. For example, an observation of *C. kennedyi* shows this species is documented to flower in calendar week 7 (mid-February) while an observation of *C. gunnisonii* shows this species is documented to flower during calendar week 35 (late August).

Which species are flowering at any given time changes as the growing season progresses:

- *Calochortus kennedyi* (**green**) and *C. flexuosus* (**red**) tend to flower early in the growing season and at lower elevations. The *C. flexuosus* tends to grow and flower at relatively higher elevations than *C. kennedyi* (see also Figure 4).
- *Calochortus gunnisonnii* (**light blue**, barely visible in the far upper right of Figure 7) is typically the last *Calochortus* species to flower in Arizona. In our data, the first observation of it flowering occurs at week 27 (early July) while the last observation occurs in week 35 (late August). It grows at high elevations.
- *Calochortus ambiguus* (**blue**) is not among the first species to flower in a given calendar year. It tends to start flowering around calendar week 16 (mid-April). However, it appears to have the longest flowering season; its last week of flowering occurs in week 32 (early August) at higher elevations.

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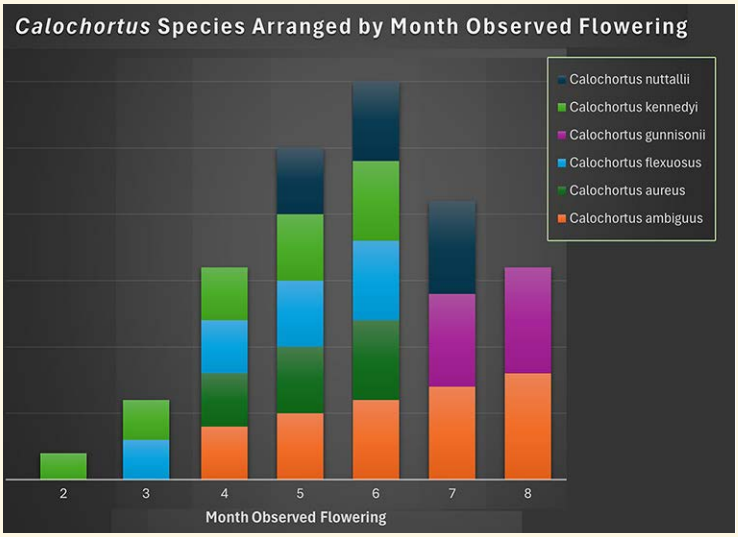



Figure 8. *Calochortus* species in Arizona arranged by month observed flowering.

# *Calochortus* Biogeography and Phenology in Arizona *continued*

- *Calochortus aureus* (**orange**) starts flowering around week 16 and typically grows until week 25 or so. It typically grows at middle elevations.
- *Calochortus nuttallii* (**gold yellow**) typically starts flowering around week 20 (mid-May) and continues flowering until around week 28 (early/mid-July). It grows at mid-high elevations.

## Discussion

To supplement our analysis of biogeographical and phenological relationships across the six *Calochortus* species in Arizona, we assessed within-species relationships among latitude, elevation, and flowering date.

### Focus on *C. ambiguus*

Among all the species we analyzed for this study, the data we graphed for *C. ambiguus* reveals the strongest relationship between latitude, elevation, and flowering date.

In Figure 9, you can see *C. ambiguus* tends to bloom at lower elevations and latitudes early in the growing season. As the growing season advances, the species tends to flower at progressively higher elevations and latitudes.

### Focus on *C. kennedyi*

An example of *C. kennedyi* data shown in our scatterplot (below) displays weak relationships between all three variables assessed (latitude, elevation, and flowering date).

As you can see in Figure 10, *C. kennedyi* grows across a range of latitudes and elevations throughout the growing season.

*Calochortus kennedyi*, *C. aureus*, and *C. flexuosus* do not reveal strong correlations between latitude, elevation, and flowering phenology as clearly patterned as *C. ambiguus* (Figure 9).

Our database does not contain enough Arizona observations of *C. gunnisonnii* to reveal clear relationships between the three variables (latitude, elevation, and flowering date).

### Assess R-Squared Values

To further assess within-species variation between latitudinal trends, elevation, and flowering phenology, we generated some additional graphs. When we separately graph flowering week versus latitude or elevation, we see some weak patterns in the data (Figure 11).

In Figure 11, we added trendlines to the data and calculated R-squared values to assess the strength of the relationships between either flowering week and ground-surface elevation

*continued page 24*

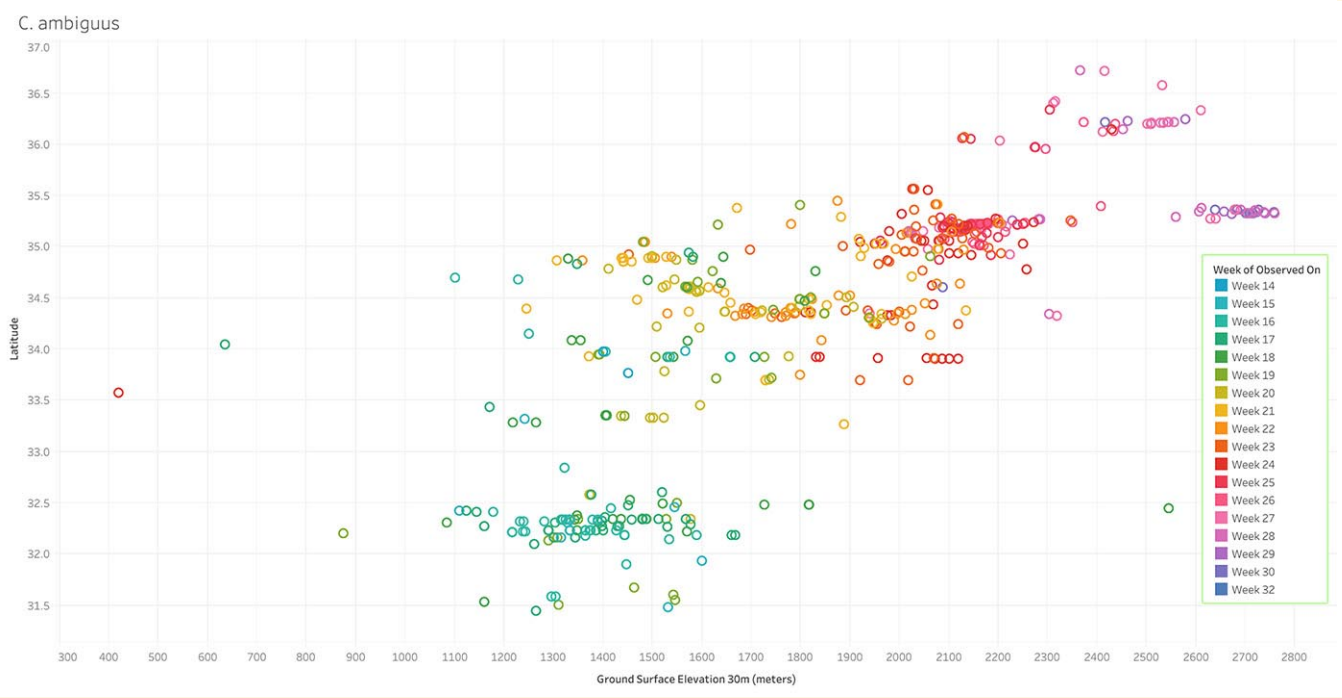



Figure 9. Graph of *Calochortus ambiguus* observations included in our study mapped by ground-surface elevation (X axis), latitude (Y axis), and flowering week (colorized).

# *Calochortus* Biogeography and Phenology in Arizona *continued*

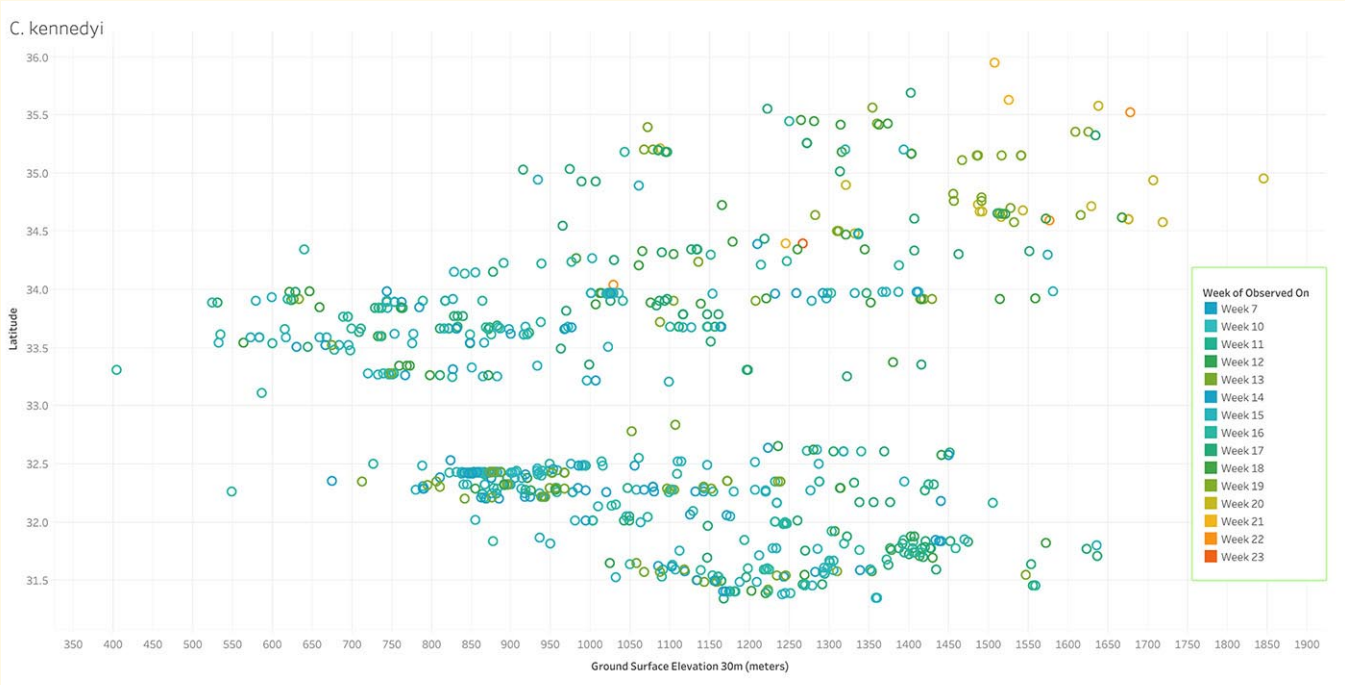



Figure 10. Graph of *Calochortus kennedyi* observations included in our study mapped by ground-surface elevation (X axis), latitude (Y axis), and flowering week (colorized).


Figure 11. Graph of *Calochortus kennedyi* observations included in our study mapped by flowering week (X axis) and either ground-surface elevation (Y axis, bottom) or latitude (Y axis, top).

or latitude. The R-squared values (measured from 0 to 1) indicate how much variation in a dependent variable (plotted on the Y axis) can be explained by an independent variable (plotted on the X axis). For the graph in Figure 11, the R-squared values are 0.23 (top) and 0.12 (bottom); these indicate weak relationships between the dependent and independent variables shown.

In Figure 11, it is further interesting to note the data show *C. kennedyi* flowering starts at middle elevations around calendar week 11. As the growing season advances, flowers appear at lower and higher elevations, across a range of latitudes around week 16. Eventually, flowering occurs only at higher elevations and latitudes around week 20. Our graphs for *C. aureus* and *C. flexuosus* show somewhat similar patterns (data not shown).

There are many possible ecological and data-collection reasons for data with weak R-squared values:

**Micro-site Variation.** A plant's micro-site habitat may impact its growth patterns and flowering phenology more than latitude or ground-surface elevation. For example, environmental variables such as south-facing aspect; whether a site is forested; whether there is sun or shade lingering over a plant's growth site most of the day; and whether there are small-scale variables affecting a plant's access to soil moisture or precipitation can inform when and where a *Calochortus* plant grows and flowers.

**Genetic Variation.** If the data for a single species reveal it grows in two distinct populations, there may be biogeographic evidence to justify the taxonomic division of that species into subspecies. In our data, all populations studied show continuous variation across latitude and elevation (see Figure 6).

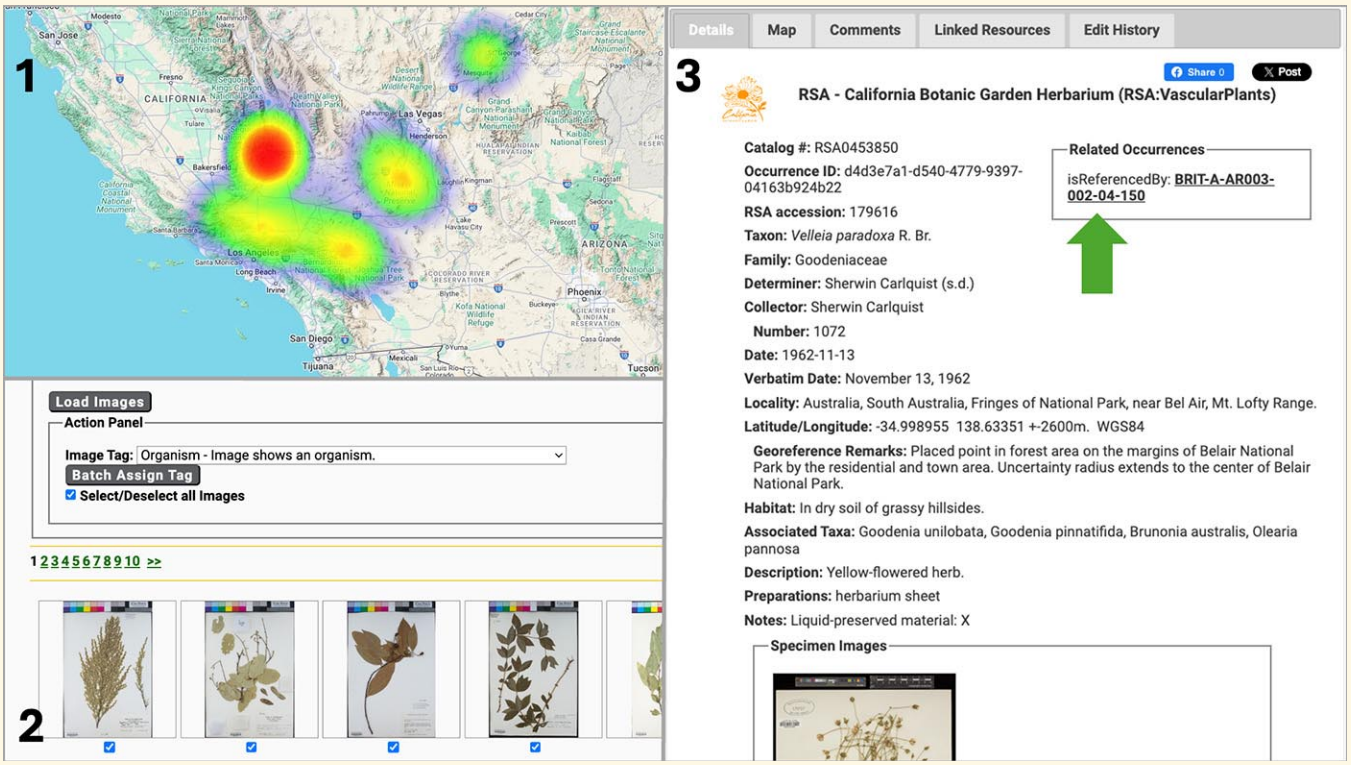
**Unknown Flowering Period.** Our database records only indicate when an observation (plant) is *in* flower, not when that observation *started* flowering (formed/opened its first flower) or *ended* flowering (formed/opened its last flower) during the growing season. The iNaturalist data do not reveal the *total period of flowering* for each observation in our database. We may be able to better derive correlations across distinct species if we have complete data on flowering phenology; however, our data is not complete and we only have point-observations which we can plot in geographic space and time.

For example, if species **A** flowers April 1–30 and species **B** flowers April 28–May 28, a visitor who documents species **A** and **B** flowering on April 28 will document both species as flowering at the same time. However, species **A** and **B** do have *distinct* flowering windows which happen to overlap temporally but which only reflect as single time points in the data.

To view the graphs we made using Tableau Public, visit ***Calochortus* Bio-Geo-Phenology**.

## Conclusion

This case study shows how easy it is to use publicly available data to analyze plants which interest you. In this study, we analyzed the biogeography and flowering phenology of *Calochortus* species in Arizona. We gained insight into the growth habits and life cycles of these species. We look forward to asking and answering more questions about Arizona's remarkable biodiversity.




Implementation of Symbiota 3.1 in SEINet will activate new features in this Symbiota portal. Examples of new tools coming soon to this portal include: 1) the ability to create heat maps within the Map Search interface; 2) a user interface for batch image tagging images; and 3) an interface for collection administrators to batch upload links to associated occurrences and other external resources.

# SEINet: What can it do for you, and what's coming soon?

*by Lindsay Walker*[1]

### What is SEINet?

SEINet is a public, online portal for searching and managing herbarium specimen data—information about where and when plants have been collected and where those scientific specimens are now housed. This portal is the largest and most active online database that uses the "Symbiota" software, which also underlies, e.g., the Lichen Portal (lichenportal.org) and the Bryophyte Portal (bryophyteportal.org). SEINet began in the 2000s as a cooperative effort between several Arizona-based herbaria and has since expanded from a handful of collections to include 23.8 million records from 450 datasets. Much of this growth was directly influenced by the US National Science Foundation's Advancing the Digitization of Biological Collections program (2011–2021), which enabled the digitization of millions of biological specimens across the United States, many of which are now digitally accessible through SEINet and other Symbiota portals.

[1](ORCID: 0000-0002-2162-6593). iDigBio Symbiota Support Hub, University of Kansas Biodiversity Institute

### What can SEINet do for you?

SEINet contains a suite of tools for managing, aggregating, and discovering herbarium specimens and botanical observations. It is free for public use, and anyone can create a user account to begin accessing the portal's various data management features.

**Curators and collection managers**, for instance, can use SEINet to catalog, maintain, and share data associated with vouchered specimens. Over 300 herbaria currently use SEINet as their primary specimen management database because it includes tools for direct data entry and bulk data ingestion, adding images, georeferencing, data cleaning, linking to external resources (like genetic data), and even locating botanical duplicates housed in other collections. Importantly, specimen records managed in SEINet are readily interoperable with many other biodiversity data resources, as the data fields closely follow international data standards.

**Collectors, researchers, and natural resource managers** can explore SEINet's checklist and dataset tools. Checklists are

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# SEINet: What can it do for you, and what's coming soon? *continued*

used to create taxon-based inventories that can be publicly, privately, and/or collaboratively managed. These lists can be associated with images and/or vouchered specimen records cataloged within the portal, as well as one of several taxonomic thesauri. Similarly, datasets enable portal users to maintain dynamic lists of cataloged specimen records, for instance, in association with publications. Both checklists and datasets can be created quickly and easily generated with the portal's interface.

Of additional use to **field botanists** are SEINet's observation management tools, which are especially helpful for cataloging specimens that have yet to be accessioned. Specifically, if a collector catalogs their specimens using SEINet's observational profile, once their vouchers are sent to a permanent repository, their corresponding records in SEINet can be easily transferred to the recipient institution.

### What is Symbiota 3.1?

In September 2024, the Symbiota software development team at University of Kansas (KU) and Arizona State University released the latest version of the Symbiota code, "Symbiota 3.1". The Symbiota Support Hub (SSH) is now working to update all Symbiota portals maintained by KU to this new version of the code. Once Symbiota 3.1 is implemented in SEINet, the portal will function essentially the same way as before, but with a more modern, streamlined appearance. New features that will be available a part of this update include:

- An **updated search form** to complement the classic search form, as well as a **quick search** box available on each collection's unique profile
- Additional Darwin Core-compliant fields on the Occurrence Editor form: *End Date*, *Continent*, *Water Body*, *Island Group*, *Island*, and *Vitality*
- An **"Extended Data Import" tool** to facilitate the association of specimen records in SEINet with other resources, such as external data portals and websites
- An improved user interface for the **Linked Resources** tab within the Occurrence Editor
- An interface to **batch tag images,** allowing collection administrators to apply descriptive metadata to multiple specimen occurrences at once
- **Improved mapping features** based off the open-source platform, Leaflet
- New **accessibility features** to assist visually impaired portal users

### How do I learn to use SEINet's new features?

Instructions for all new features coming to SEINet are outlined in Symbiota Docs (link below), the central resource for Symbiota user documentation maintained by the SSH. A compilation of relevant tutorials is also available on the SSH's blog for ease of reference: **symbiota.org/symbiota-3-1**. The SSH will notify the SEINet user community of these changes in advance of their implementation. Questions about Symbiota 3.1 and how to join SEINet should be directed to the SSH's Help Desk: **help@symbiota.org**.


### Acknowledgements

The Symbiota Support Hub is funded by US National Science Foundation Award #2027654. We extend sincere gratitude to the US Department of Agriculture, the National Ecological Observation Network, the California Botanic Garden, the Botanical Research Institute of Texas, George Mason University, the Big-Bee TCN, and the Eastern Seaboard TCN for their financial support of the new features coming soon to SEINet.


### Related Resources

SEINet Data Portal: **https://swbiodiversity.org/seinet**

SEINet Background: **https://symbiota.org/seinet**

Symbiota Portal Directory: **https://symbiota.org/symbiota-portals**

Symbiota User Resources: **https://symbiota.org/help-resources**

Symbiota 3.1 Summary: **https://symbiota.org/symbiota-3-1**

BOOK REVIEW

Richard Felger in Cañón Las Pirinolas, Sierra el Aguaje. *Photo credit Jesús Sánchez-Escalante.*

# Richard Felger's Final Masterpieces — Two books that open the southern edge of the Sonoran Desert as never before

*by Benjamin T. Wilder[1], Next Generation Sonoran Desert Researchers*

***Plants and Animals in the Yoeme World: Ethnoecology of the Yaquis in Sonora and Arizona*** by Richard Stephen Felger and Felipe Silvestre Molina. Desert Institute Press, 2024

***The Desert Edge: Flora of the Guaymas–Yaqui Region of Sonora, Mexico***
by Richard Stephen Felger, Susan Davis Carnahan, and José Jesús Sánchez-Escalante. BRIT Press, 2023

Nineteen fifty-three was the first time Richard Felger (1934–2020) crossed into Sonora, Mexico and ventured to where the desert grades into the tropics. That experience in Nacapule Canyon, just outside San Carlos and Guaymas where the Sonoran Desert hits its southern limits on the Mexican mainland, was the beginning of a life-long pursuit. Now, some 70 plus years later, and after his passing, we have been given two magnificent works that capture the full diversity of what is known of the plant life (*The Desert Edge*, 2023, BRIT Press) and the biocultural knowledge of the plants and animals of the Yoeme People (*Plants and Animals in the Yoeme World*, 2024, Desert Institute Press) of the southern edge of the Sonoran Desert.

In the interim, Richard went on to become a botanical expert of the Sonoran Desert and arid lands of the world. His more than 100 publications, including 13 books, are nothing short of floristic bibles of the desert. With decoded identification keys that are each customized and tailored to the flora of that region, they are definitive and easily accessible works. They include *People of the Desert and Sea* (Felger & Moser 1985), *Flora of the Gran Desierto and Río Colorado of Northwestern Mexico* (Felger 2000), *Trees of*

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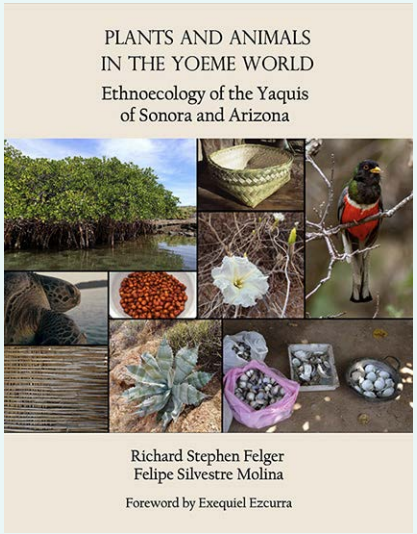
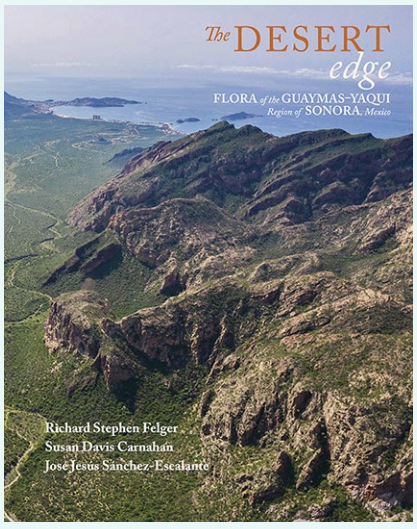
[1]Dr. Benjamin T. Wilder is a desert ecologist, botanist, and biographer who began working with Richard Felger in the early 2000s and served as editor on these two books.

# Richard Felger's Final Masterpieces *continued*

*Sonora* (Felger et al. 2001), *Plant Life of a Desert Archipelago* (Felger & Wilder 2012), and now these two works.

Though they each have their own origin stories, Richard always saw these two most recent books as sister publications, both decades in the making. From that first trip in the early 1950s, Richard began making herbarium collections from the Sierra el Aguaje, the expansive and largely unknown massif that rises just to the north and east of San Carlos. The range's deep canyons, several only accessible from a boat ride up or down the coast of the Gulf of California, quickly revealed themselves to be home to tropical species, found here at the northern limits of their ranges. Those collections built on themselves, soon numbering in the thousands, augmented by thorough research in the herbarium and the literature. The first product of this decades-long effort was his 1999 publication of the flora of Nacapule Canyon (Felger 1999).




In parallel, his interest in the peoples of the desert and their knowledge deepened. As his work with the Comcaac (Seri People) was reaching a milestone in the publication of the *Seri Ethnobotany* (Felger & Moser 1985), his interest in the knowledge of the Yoeme grew. He soon connected with Felipe Molina, who was raised by his extended family and community members in different Yoeme communities of Arizona and Sonora, and soon became a well-recognized expert of *Yoeme Bwiara* (the sacred, traditional land of the Yoemem centered along the lower Río Yaqui, or *Hiak Vatwe*, in Sonora, Mexico). Richard and Felipe began extensive field trips in the late 1980s, with the creation of a thorough treatment of Yoeme biological knowledge in mind. They then received tribal authorization and grant support in the 1990s to further their efforts. The work largely paused as the first two decades of the twenty-first century saw them pursue other projects, though in Richard's final years, the completion of his work with Felipe became almost a singular focus. He knew how much vital knowledge they had assembled, and how much would be lost without its publication.

Similarly, he was driven to continue what he started in the Sierra el Aguaje. He partnered with Jesús Sánchez Escalante, Sonoran botanist and curator of the herbarium of the University of Sonora (now curator emeritus). Jesús added hundreds of collections and dozens of new additions to the flora. Richard also connected with botanist Sue Carnahan, whose interest in the region, determination, and editorial expertise rapidly pushed the project toward completion. Sue also contributed hundreds of beautiful photos of the flora, which bring to life the 800+ plants that are found there. As a prelude, this team of three published a revised and updated Flora of Nacapule Canyon (Felger et al. 2017). That proved to be the tip of the iceberg, with the two volume, 1,100+ page *Desert Edge* masterpiece in the works.

As you begin to dig into *The Desert Edge*, the magnitude of the work is quickly apparent. A quick flip through, or scroll of the freely available digital version, is filled with stunning landscape images, macro photos of nearly all 837 plant taxa found in the flora area, and images and stories of the people that helped document these plants. You will also see dozens of taxonomic keys, "the poetry of botany" as Richard would say, at the outset of each family, generic, and species descriptions. As you push deeper, you begin to soak in the endless details that are brought together on these pages. Information of this place on the Mexican mainland is melded with botanical knowledge that unites the global context of a plant family with hyper-local treatment of a species in this Sierra complex and its adjacent areas. As you read, facets of this tropically infused flora seep in. In many ways, you can choose your own adventure. No need to lug the two-volume set into the field (though it is well worth the investment). Download the single-file pdf and quickly navigate to the

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Alacran Rada. *Photo credit Sue Carnahan.*

## Richard Felger's Final Masterpieces *continued*

family or genus of interest, made effortless by the search and find function on whatever digital device you may be using. If truly stumped, start at the key to families, which is not as daunting as you may think, due to reduced jargon and years of refinement of the multi-stepped couplets. The quality and quantity of photos is so good that even the page-flipping, key-adverse will readily find an answer to their botanical questions.

Equally monumental, *Plants and Animals in the Yoeme World* is anchored in a person's responsibility to pass on knowledge to future generations. It is based in Yoeme cosmovision which encompasses multiple spiritual worlds or realms — *Aniam* — that are connected, flexible, and overlapping. Each of the more than 415 species of plants and over 600 forms of animal life described via individual species descriptions in this work can best be understood by starting with Part 1, especially the section "Way of Life" (page 10). This short and synthetic overview grounds the reader in the depths of the relationships and interconnections between humans, other life forms, the land, and different dimensions of existence. In this light, each species description, Yoeme species name, song, or other cultural connection is not a factoid, but a piece of a larger whole. That larger whole is shared with us here, as Richard and Felipe intended, to perpetuate ways of knowing and interacting with the world that manifest the intrinsic life forces all around us.

Perhaps more than anything else, these sister works document the biological and cultural wealth of an area too often overlooked. Prior to their publication, floristic and biocultural information was fragmented and incomplete. In fact, these works fill a long-standing gap of botanical information, not just in the Sonoran Desert, but for all of Mexico. Perhaps in part due to a lack of information, the Sierra el Aguaje remains outside of any formal protected status at the state or federal level. Meanwhile, urban encroachment edges ever closer, especially to Nacapule Canyon. At the same time, centuries of appropriation, disenfranchisement, and oppression of the Yoemem, their water, and their lands continue. These two books stand as a testament, and hopefully a pillar and calling, for the

*continued next page*

Exploring Los Anegados. *Photo credit Jesús Sánchez-Escalante.*

# Richard Felger's Final Masterpieces *continued*

preservation of the diversity and worldviews of the sacred lands pulsed by rivers and bordered by tropical canyons.


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Felger, R.S., M.B. Johnson, and M.F. Wilson. 2001. *Trees of Sonora, Mexico.* Oxford University Press, New York.

Felger, R.S. and B.T. Wilder in collaboration with H. Romero-Morales. 2012. *Plant Life of a Desert Archipelago: Flora of the Sonoran Islands in the Gulf of California.* University of Arizona Press, Tucson.

Felger, R.S., S.D. Carnahan, and J.J. Sánchez-Escalante. 2017. *Oasis at the Desert Edge: Flora of Cañón del Nacapule, Sonora, Mexico.* Proceedings of the Desert Laboratory Contribution 1, University of Arizona: 1–220.


Visit Richard Felger's website, **www.desertfoodplants.org**

You can download or order these two books here:

***The Desert Edge: Flora of the Guaymas–Yaqui Region of Sonora, Mexico*** by Richard Stephen Felger, Susan Davis Carnahan, José Jesús Sánchez-Escalante (BRIT Press, 2023)

Available for purchase:
**https://shopbritpress.org/products/desert-edge-flora-of-guayamas-yaqui-region-of-sonora-mexico-vol-i**

and for free download:
**https://www.desertfoodplants.org/_files/ugd/d133c2_7bdc031c4f9c4dbf9907de20f1944079.pdf**

***Plants and Animals in the Yoeme World: Ethnoecology of the Yaquis in Sonora and Arizona*** by Richard Stephen Felger and Felipe Silvestre Molina (Desert Institute Press, 2024)

Available for purchase: **https://www.amazon.com/Plants-Animals-Yoeme-World-Ethnoecology/dp/B0CXG9BMSK/ref=sr_1_1?crid=22F2TA6U5H822&dib=eyJ2IjoiMSJ9.UD6FnM0QsQudXE9laxVze_hFBHJSScAKGcwgInraMqU.UcCpSy2I8FsB7sCAFfuJSdzSNRMEhCWclD2kEAXeSD8&dib_tag=se&keywords=plants+and+animals+in+the+yoeme+world&qid=1724086413&sprefix=plants+and+animals+in+the+yoeme+world%2Caps%2C190&sr=8-1**

and for free download:
**https://www.desertfoodplants.org/_files/ugd/d133c2_d32a7ef228754ac1962c91222bb6e143.pdf**

Figure 1. Tropical deciduous forest near Álamos in late summer 1991. *Photo credit M.A. Dimmitt.*

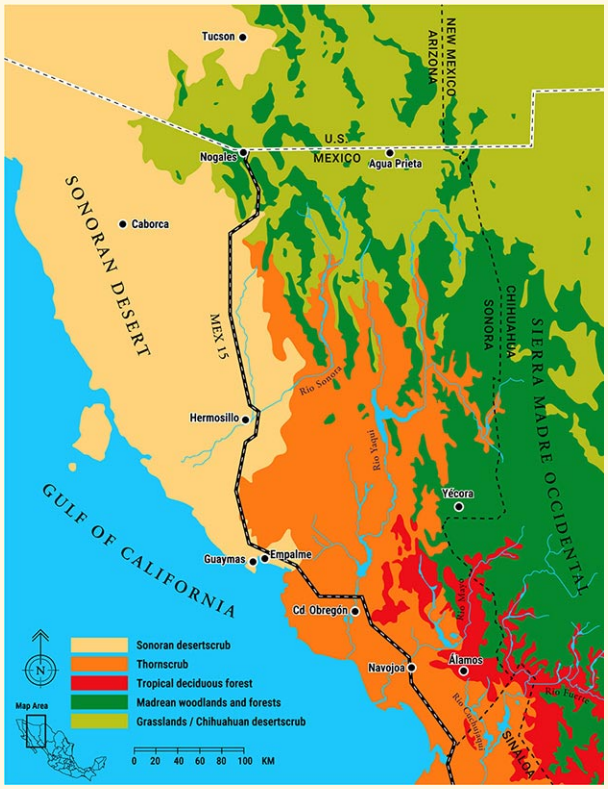


Figure 2. Map of the vegetation of Sonora. Modified from Brown & Lowe (1982).

# Coastal Thornscrub Flora and Vegetation in the Municipality of Huatabampo, Sonora, Mexico

*by Thomas R. Van Devender[1], Samuel L. Friedman[2], Andrew C. Sanders[3], and Ana Lilia Reina-Guerrero[1]*

**Abstract**

The Municipality of Huatabampo is located along the coast of the Gulf of California in southern Sonora, Mexico. The vegetation is coastal thornscrub, the more xeric version of tropical deciduous forest. In 1890, Edward Palmer collected plants at Agiabampo in the municipality. In the late 1980s and 1990s, Paul S. Martin and his associates extensively surveyed the Municipality as part of the 1998 *Gentry's Rio Mayo Plants* book project. In the 1990s, Samuel L. Friedman studied the flora and vegetation of coastal thornscrub for his 1996 master's degree at Arizona State University. David Yetman, Van Devender, Reina-G., and Rigoberto López-E. collected plants in the area as part of the 2002 *Mayo Ethnobotany* book project. The flora of the Municipality of Huatabampo currently has 529 species plus two additional varieties in 93 families and 320 genera. The most species-rich families are Poaceae (52), Fabaceae (50), Asteraceae (42), Euphorbiaceae (35), Convolvulaceae (28), Solanaceae (26), Malvaceae (25). and Cactaceae (21). There are 39 non-native species (7.2%) but none are invasive. Many species are new Sonoran state records, regional endemics, and northern range extensions of tropical species. *El Pitahayal* near Las Bocas is a unique coastal thornscrub dominated by dense tree-like organ pipe cacti (*Stenocereus thurberi*). In 2000, David Yetman and Vicente Tajia created the Coteco Biological Reserves in the Masiaca Indigenous Community to protect 563 acres of this world class succulent habitat. Since 2018, the Tucson Cactus and Succulent Society has supported Coteco.

**Resumen**

El Municipio de Huatabampo está ubicado a lo largo de la costa del Golfo de California en el sur de Sonora, México. La vegetación es matorral espinoso costero, la versión más xérica de la selva baja caducifolia. Edward Palmer colectó ejemplares de herbario en Agiabampo en el municipio en 1890. A finales de las décadas de 1980 y 1990, Paul S. Martin y sus colaboradores hicieron estudios botánicos extensos en el Municipio como parte del proyecto del libro *Gentry's Rio*

*continued next page*

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Figure 3. Álamos, Sonora. A. La Parroquia de la Purísima Concepción church. B. Gazebo in plaza. *Photos credit Van Devender.*

# Coastal Thornscrub Flora and Vegetation, Huatabampo *continued*

*Mayo Plants* (Martin et al. 1998). En la década de 1990, Samuel L. Friedman estudió la flora y vegetación del matorral espinoso costero para su maestría en la universidad Arizona State University (Friedman 1996). David Yetman, Van Devender, Reina-G. y Rigoberto López-E. colectaron ejemplares botánicos en el área como parte del proyecto del libro *Mayo Ethnobotany* (Yetman & Van Devender 2002). La flora del Municipio de Huatabampo cuenta actualmente con 529 especies más dos variedades adicionales en 93 familias y 320 géneros. Las familias más diversas son Poaceae (52), Fabaceae (50), Asteraceae (42), Euphorbiaceae (35), Convolvulaceae (28), Solanaceae (26), Malvaceae (25) y Cactaceae (21). La flora incluye 39 especies no nativas (7.2%) pero ninguna es invasora. Algunas especies son registros nuevos para Sonora, otras endémicas regionales, o extensiones del rango hacia el norte de especies tropicales. *El Pitahayal* cerca de Las Bocas es un matorral espinoso costero único dominado por montes densos de pitahayas (*Stenocereus thurberi* ) arborescentes. En 2000, David Yetman y Vicente Tajia crearon las Reservas Biológicas Coteco en la Comunidad Indígena de Masiaca para proteger 563 acres de este hábitat de suculentas único en el mundo. Desde 2018, la asociación Tucson Cactus and Succulent Society ha patrocinado la vigencia de Coteco.

### Introduction

Although the Tropic of Cancer (23.45°N) just north of Mazatlán, Sinaloa, is often said to be the northern limits of the New World tropics, the northernmost tropical deciduous forest (Figures 1 & 2) is in Sierra San Javier in south-central Sonora (28.6°N; 800 km north-northeast of Mazatlán, 300 km south of the Arizona border). Thornscrub is an important,

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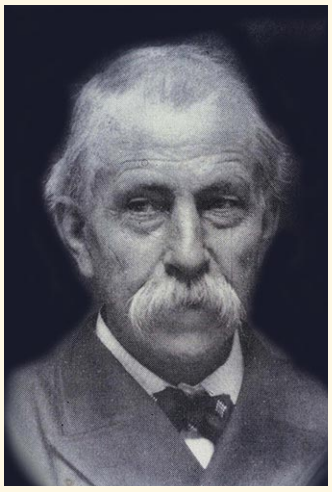
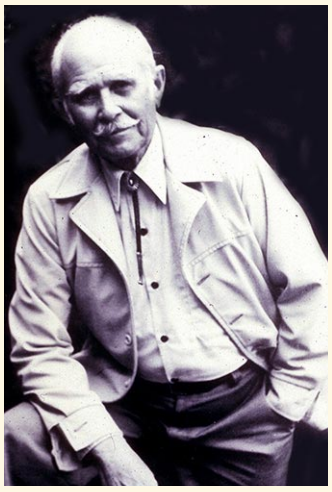

Figure 4. A. Edward Palmer. B. Howard S. Gentry. C. Paul S. Martin. *Photo credit K. Moore.* D. Andrew C. Sanders pressing plants in Álamos in 1994. *Photo credit Ceal Smith.*

# Coastal Thornscrub Flora and Vegetation, Huatabampo

*continued*

widespread, transitional tropical vegetation type in Sonora (Van Devender et al. 2013, Van Devender & Reina-G. 2021). In southern Sonora, it is transitional between tropical deciduous forest and Sonoran desertscrub, and in central Sonora, between oak woodland and Sonoran desertscrub. Foothills thornscrub extends northward in river valleys to ca. 30.4°N (104 km south of the Arizona border; Van Devender et al. 2013), where it merges into desert grassland as winter temperatures decline. Coastal thornscrub extends on the coastal plain of the Gulf of California in southern Sonora north to merge with Sonoran desertscrub in the Plains of Sonora Subdivision of the Sonoran Desert near Guaymas (27.930°N, Van Devender & Reina-G. 2021, Van Devender et al. 2024). Here, we discuss the flora and vegetation of coastal thornscrub in the Municipality of Huatabampo, Sonora.


Figure 5. Map of the Municipio of Huatabampo area.

## Botanical History

The first botanical studies in northwestern Mexico were in tropical southern Sonora. Álamos was founded by Jesuit missionaries in 1630 and, after fabulously rich silver deposits were discovered in 1863 at nearby Aduana, thrived as a mining and religious center (Figure 3). The 21 missions founded by Padre Eusebio Francisco Kino in northern Sonora and southern Arizona in the mid-1600s were funded by the Diocese of Álamos.

Spanish physician Martín Sessé y Lacasta and Mexican botanist José Mariano Mociño led the Royal Botanical Expedition to New Spain in 1787–1803 which resulted in about 7,500 new species of plants (McVaugh 2000). They collected many plants in the Álamos area in 1790.

In 1890, Edward Palmer (Figure 4A) collected in Agiabampo (Figure 5 inset), which was then the seaport for Álamos, connecting it to the rest of the world. Rose (1895) described nine of Palmer's 55 collections as new species, including *Acalypha papillosa, Jatropha purpurea,* and *Justicia mexicana* (now *Justicia candicans*). Howard S. Gentry collected plants in the Río Mayo region in southern Sonora from 1933 to 1940 (Figure 3B, Martin et al.1998). His monumental book *Rio Mayo Plants* was the first comprehensive flora of tropical deciduous forest in Mexico (Gentry 1942). Although most of the Municipality of Huatabampo is not in the Río Mayo drainage, Palmer's collections from Agiabampo and Gentry's from the Las Bocas area were included in the flora.

## Study Area

The Municipality of Huatabampo is on the coastal plain of the Gulf of California from the Sinaloa border (26.318°N) north to Huatabampo (26.852°N). The eastern boundary of the municipality is Mexican Federal Highway 15 (MEX 15, 109.009 to 109.365°W; Figure 5). This is not an ecological boundary as coastal thornscrub extends eastward to merge into the botanically rich tropical deciduous forest in the Sierra de Álamos (Van Devender et al. 2000). Elevations in the Municipality mostly range from sea level to 50 m but reach 236 m on Cerro Tasirogojo near Francisco Sarabia. The coastal plain between the Sierra de Álamos and the Gulf of California is drained by Arroyo Masiaca and many smaller arroyos. The mouth of the Río Mayo is west of Moroncarit in the northernmost Municipality of Huatabampo. The Bahías de Agiabampo (Figure 8A) and Yavaros are large bays on the southern and northern ends of the municipality. Plants were collected at Agiabampo, Arroyo Jeberojaqui, Arroyo Masiaca, Bachoco, Bachomojaqui, Bacorehuis, Bahía Santa Bárbara, Barochipa, Camahuiroa, Cerro Tasirogojo, Chichibojoro, Ejido 10 de Abril, Estero El Tecucure, Francisco I. Madero, Francisco Sarabia, Huatabampito, Huatabampo, Las Aguilas, Las Bocas, Loma Chomojabires, Mate Mula, Melchor

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# Coastal Thornscrub Flora and Vegetation, Huatabampo

*continued*

Figure 6. Pitahayal on Las Bocas road. *Photo credit Van Devender.*

Ocampo, Moroncarit, Navopatia, Nescotahueca, Punta Lobera, Sirebampo, Tierra y Libertad, Tojahui, and Yavaros.

### Methods

Howard Gentry's plant specimens collected in the Río Mayo Region in 1933–1940 (Martin et al. 1998) are in the University of Arizona Herbarium (ARIZ, Gentry 1942). In 1958, Richard S. Felger visited Agiabampo, Huatabampo, and Yavaros, where he collected *Encelia halimifolia, Euphorbia californica, E. lomelii, Jatropha cinerea,* and *Maytenus phyllanthoides.* Andrew C. Sanders' (Figure 4D) many specimens collected in the Municipality in 1983–1984, 1988–1989, and 1992–1994, were deposited in the University of California at Riverside Herbarium (UCR) and ARIZ. In the late 1980s and 1990s, the flora of coastal southern Sonora was surveyed extensively by Paul S. Martin (Figure 4C) and his many students and colleagues as part of the *Gentry's Río Mayo Plants* book project (Martin et al. 1998); all of the specimens were deposited in ARIZ. Samuel L. Friedman's numerous specimens collected for his master's degree were deposited in the Arizona State University Herbarium (ASU, Friedman 1996). Additional specimens collected by Van Devender, David A. Yetman, Reina-G., and Rigoberto A. López-E. as part of the *Mayo Ethnobotany* book project (Yetman et al. 2000, Yetman & Van Devender 2002) were deposited into ARIZ and the Herbario de la Universidad de Sonora (USON). Specimens collected in the Yavaros area by J. Jesús Sánchez-E. in 2010 are in USON. Municipality of Huatabampo specimens were also deposited in 12 other herbaria in the United States and Mexico. Collection dates in the Municipality were December 25, 1983; December 15, 1988; September 4, 1989; February 1, October 7–8, 1992; March 13, 15, 21–22, November 23–24, 1993; April 4, 8–9, 15, September 10, 22, 1994; April 13, September 27, 1995; October 23–24, 1998; February 23, December 1, 2007; September 2010; August 2020; December 15, 2023; March 21–22, 2024.

Additional botanist who collected in the Municipality of Huatabampo include Karen Adams, John L. Anderson, Marc A. Baker, G. Balmer, C. David Bertelsen, D. Charlton, Oscar F. Clarke, Mark A. Dimmitt, R. L. Dressler, Julie Emmett, Mark Fishbein, J. D. Freech, Philip D. Jenkins, Kristen J. Johnson, L. Lubinsky, Adrian Mayor, Stephanie A. Meyer, Shelley McMahon, G. Guadalupe Morales-F., Edgar Felipe Morán-P., Mary K. O'Rourke, Donald J. Pinkava, Barbara Pitzer, David Sánchez, David Silverman, Barbara Skye, Victor W. Steinmann, John F. Wiens, Rebecca K. Wilson, and Jack R. Zittere.

Early plant collections in southern Sonora were made before the advent of GPS and Google Earth, which provide coordinates for accurate localities. In the last 40 years, most herbaria including ARIZ, ASU, UCR, and USON have digitized and integrated their records into the SEINet-SYMBIOTA public online herbarium network, greatly helping botanical studies using geographic distributions. The preliminary flora for the Municipality (Checklist) was compiled from 1,239 records and observations in the Madrean Discovery Expeditions (**madreandiscovery.org**, a SEINet portal) and linked databases.

### Results

The flora of the Municipality of Huatabampo currently has 529 species plus two additional varieties and one hybrid in 93 families and 320 genera (Checklist). The most species-rich

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Figure 7. A. *Pholisma culiacanum*. *Photo credit Philip D. Rosen.* B. Slipper flowers (*Euphorbia lomelii*). *Photo credit Van Devender.*

## Coastal Thornscrub Flora and Vegetation, Huatabampo *continued*

families are Poaceae (52), Fabaceae (50), Asteraceae (42), Euphorbiaceae (35), Convolvulaceae (28), Solanaceae (26), Malvaceae (25), Cactaceae (21), Amaranthaceae (20), Cyperaceae (18), Apocynaceae (15), Acanthaceae (13), and Nyctaginaceae (11). The most species-rich genera are *Cyperus, Euphorbia,* and *Ipomoea* (14); *Cuscuta* and *Physalis* (7); *Lycium* (6); *Pectis* and *Solanum* (6); *Acalypha, Bouteloua, Cenchrus, Croton,* and *Metastelma* (5); and *Abutilon, Acacia, Boerhavia, Cylindropuntia, Heliotropium, Jatropha, Justicia,* and *Panicum* (4).

*Dicoria argentea* is endemic to coastal thornscrub in Sonora while *Agave aktites, Aldama congesta, Asclepias subaphylla,* and *Jatropha purpurea* are near endemics with records in northern Sinaloa. Other new Sonoran records are near endemic coastal thornscrub species whose ranges extend into adjacent tropical deciduous forest to the east or Plains of Sonora desertscrub to the north are *Aloysia sonorensis, Neltuma articulata* (= *Prosopis articulata*), and *Pholisma culiacanum* (Figure 7A).

*Pholisma* is a genus of three species of root parasites in the Lennoacease. *P. culiacanum* is a tropical deciduous forest (Figure 7A) and thornscrub relative of *P. sonorae*, the sand food of the Tohono O'odham people on sand dunes in Arizona, California, and Sonora.

***Non-native species.*** There are 39 non-native species (7.2% of the flora) in the Municipality of Huatabampo. Some of them are serious invasive species in other parts of Sonora (Van Devender et al. 2020), but not in the study area. In the 1930s, Howard Gentry only collected seven of these species in the Río Mayo region, including rubber vine (*Cryptostegia grandiflora*), stink grass (*Eragrostis cilianensis*), tree tobacco (*Nicotiana glauca*), and Johnsongrass (*Sorghum halepense*; Gentry 1942). He did not find the other non-native species (82.1%), including the grasses, giant reed (*Arundo donax*), common wild oat (*Avena fatua*), buffelgrass (*Cenchrus ciliaris*), swollen fingergrass (*Chloris barbata*), Bermuda grass (*Cynodon dactylon*), crowfoot grass (*Dactyloctenium aegyptium*), Kleberg's bluestem (*Dichanthium annulatum*), Asian crabgrass (*Digitaria bicornis*), jungle rice (*Echinochloa colona*), blue panic (*Panicum antidotale*), and littleseed canary grass (*Phalaris minor*); the legumes, river tamarind or *guaje* (*Leucaena leucocephala*), burr medic (*Medicago polymorpha*), and sweet clover (*Melilotus indicus*); the mustards, black and field mustards (*Brassica nigra, B. rapa*), shepherd's purse (*Capsella bursa-pastoris*), lesser swine-cress (*Lepidium didymum*), and London rocket (*Sisymbrium irio*); the cleome, Asian spiderflower (*Corynandra viscosa*); the tamarisks, athel tree (*Tamarix aphylla*) and saltcedar (*T. chinensis*); the spurge, castor bean (*Ricinus communis*); the mallow, cheeseweed (*Malva parviflora*); the composite, common sowthistle (*Sonchus oleraceus*); and the nutsedge (*Cyperus rotundus*).

Some of the Huatabampo non-native species are cultivars that escaped or were discarded, including *aloe vera* or *sábila* (*Aloe barbadensis*), dill (*Anethum graveolens*), watermelon or *sandía* (*Citrullus lanatus*), muskmelon (*Cucumis melo*), pink morning glory (*Ipomoea carnea*), sesame (*Sesamum orientale*), and tomato (*Solanum lycopersicum*). Most (87.2%) of the non-natives are herbs and grasses. The only Huatabampo woody non-natives are athel tree, castor bean, pink morning glory, river tamarind, rubber vine, and saltcedar. All of the Huatabampo non-natives were present in the Rio Mayo region, including the coastal plain, by the mid-1990s (Martin et al 1998). It is remarkable that so many non-native species

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Figure 8. A. Mangroves at Bahía Agiabampo. *Photo credit Van Devender.* B. White mangrove (*Rhizophora mangle*) at Bahía Concepción, Baja California Sur. *Photo credit Susan D. Carnahan.*

## Coastal Thornscrub Flora and Vegetation, Huatabampo *continued*

apparently arrived after 1940. The absence of Natal grass or *zacate rosado* (*Melinis repens*) is notable.

### Vegetation

Gentry used the terms *short tree forest* and *thorn forest* for the tropical vegetation in the Río Mayo region, following Forrest Shreve's (1937) description of the lowland vegetation of Sinaloa. Today, we call these vegetation types *tropical deciduous forest* and *thornscrub* (Van Devender & Reina-G. 2021). Shreve's Foothills Subdivision of the Sonoran Desert (Shreve 1964) was redefined as *thornscrub* (Felger & Lowe 1976, Turner & Brown 1994), a tropical vegetation type. Brown (1994) called it *Sinaloan thornscrub* but this term was abandoned because it is a typical Sonoran vegetation type that barely extends into northernmost Sinaloa. Friedman (1996) and Martin et al. (1998) recognized *coastal thornscrub* on the coastal plain of the Gulf of California and *foothills thornscrub* on rocky slopes inland. These vegetation types have been recognized in subsequent publications, including Búrquez et al. (1999), Martínez-Y. et al. (2000), Martínez-Y. et al. (2010), Van Devender et al. (2010), Van Devender et al. (2013), Van Devender & Reina-G. (2021), and Van Devender et al. (2024). The vegetation of the Municipality is mostly coastal thornscrub.

Along the coast of the Gulf of California in the Municipality of Huatabampo, dunescrub occurs behind the beaches and halophytic plants such as *Allenrolfea occidentalis, Arthrocnemum subterminale, Batis maritima,* and *Salicornia bigelovii, Sarcocornia pacifica, Sesuvium portulacastrum, S. verrucosum, Suaeda esteroa,* and *S. nigra* are present in saline flats and estuaries.

*Manglares* are mangrove communities in coastal estuaries along the coast of the Gulf of California in Sinaloa and Sonora, including Agiabampo (Figure 8A) and Yavaros in the Municipality of Huatabampo. Black, red, and white mangroves (*Avicennia germinans, Rhizophora mangle* (Figure 8B), and *Laguncularia racemosa,* respectively) as well as button mangrove (*Conocarpus erecta*), *jamiolaama* (*Stegnosperma halimifolium*), and *mangle dulce* (*Maytenus phyllanthoides*) are present. In Sonora, black and white mangroves occur as far north in Sonora as Punto Sargento (29.0°N), and north of Bahía de Kino (28.8°N): in Baja California Sur, red and white mangroves are at La Paz (24.2°N).

***Pitayhayal.*** The *pitahayal* is a large area of diverse succulent coastal thornscrub that is especially well-developed near Las Bocas and Camahuiroa. It is dominated by very tall organ pipe cactus or *pitahaya* (*Stenocereus thurberi*; Bustamante & Búrquez 2008, Figure 9). This columnar cactus is a shrub that branches from the ground in drier areas in Sonora, Baja California, and Arizona but is a tree in the *pitahayal* (Figure 6) and tropical deciduous forest in southern Sonora (Yetman & Van Devender 2001, Yetman 2006). Other cacti in the *pitahayal* include *Cylindropuntia fulgida, C. leptocaulis, C.*

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Figure 9. Organ pipe cactus (*Stenocereus thurberi*) near Sirebampo. *Photo credit Reina-G.*

Figure 10 (above). Twisted barrel cactus (*Ferocactus herrerae*) at Baguo. A. Exceptionally spiraled plant. B. Top of stem. *Photos credit Reina-G. and Van Devender.*

Figure 11. *Lophocereus schottii* var. *tenuis*. A. Large, dense plant near Sirebampo. *Photo courtesy Reina-G.* B. Top of stem near San Marcial. *Photo credit Van Devender.*

Figure 12. *Jejeri* (*Pereskiopsis porteri*) on Mesa Masiaca. A. Leaves. B. Spiny stem. *Photo credits Van Devender.*

## Coastal Thornscrub Flora and Vegetation, Huatabampo *continued*

*thurberi, Echinocereus leucanthus, Ferocactus herrerae* (Figure 10), *Lophocereus schottii* var. *tenuis* (Figure 11), *Mammillaria bocensis, M. grahamii, M. mazatlanensis, Opuntia bravoana, O. decumbems, Peniocereus marianus, P. striatus, Pereskiopsis porteri* (Figure 12), *Selenicereus vagans,* and *Stenocereus alamosensis* (Figure 13). Other succulents present include *Agave aktites, A. angustifolia, Euphorbia cymosa, E. lomelii* (Figure 7b), *Ibervillea sonorae* (Figure 14), *Jatropha cardiophylla, J. cinerea, J. cordata,* and *J. purpurea.*

The twisted barrel cactus or *biznaga* (*Ferocactus herrerae*) is a striking species with deep sulci between often spiraled ribs in tropical deciduous forest in Sinaloa and coastal thornscrub in Sonora (Figure 10). *Senita* (*Lophocereus schottii*) is endemic to the Sonoran Desert Region in Sonora, adjacent Arizona in Organ Pipe Cactus National Monument, and throughout the Baja California Peninsula. *Lophocereus schottii* var. *tenuis* with slender stems with more ribs is found in coastal thornscrub in southern Sonora (Figure 11). Leafy cacti in the genus

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Figure 13. Octopus cactus (*Stenocereus alamosensis*) near Benjamín Hill. *Photos credit Van Devender.* A. Plant. B. Flower. C. Fruit.

# Coastal Thornscrub Flora and Vegetation, Huatabampo *continued*

*Pereskiopsis* are mostly found in tropical Central America and Mexico, with one species in Bolivia. *Jejeri* (*Pereskiopsis porteri*) is found in tropical deciduous forest and coastal thornscrub in Sinaloa, Sonora, and the Cape Region in Baja California Sur. Octopus cactus or *sina* (*Stenocereus alamosensis*) is a red-flowered "galloping" cactus found in tropical deciduous forest and coastal and foothills thornscrub from southern Sinaloa into Sonora. The northernmost stands are in Plains of Sonora desertscrub near Benjamín Hill (30.2°N; Figure 13). Hybrids between organ pipe and *sina* (*S. alamosensis* X *S. thurberi*) are known in tropical deciduous forest near Masiaca east of MEX 15 in the Municipality of Navojoa (26.7°N; Yetman & Van Devender 2002).

Slipper flower or *candelilla* (Figure 7B) is found in coastal thornscrub from northern Sinaloa into southern Sonora and from the tropical Cape Region in Baja California Sur north to the Vizcaíno Sonoran desertscrub in central Baja California. With its elegant red or orange flowers and red fruits, it is a commonly cultivated succulent. *Güerequi* (*Ibervillea sonorae,* Figure 14A, B, & C) occurs in coastal thornscrub in northern Sinaloa and Sonora as far north as Carbó in central Sonora in Sonoran desertscrub as well as in Baja California Sur. Its tuberous rootstocks are widely used medicinally for rheumatism, diabetes, and cancer (Yetman & Van Devender 2002) and it is overharvested in the *pitahayal.*

Notable woody shrubs in the *pitahayal* include boatthorn acacia or *güinolo* (*Acacia cochliacantha*), *Atamisquea emarginata, Bonellia macrocarpa, Celtis pallida, Condalia globosa, Cordia parvifolia, Forchhammeria watsonii, Fouquieria macdougalii* (Figure 14D), *Guaiacum coulteri* (Figure 15), *Havardia sonorae, Jatropha cordata, Neltuma odorata* (= *Prosopis glandulosa* var. *torreyana*), *Parkinsonia praecox, Phaulothamnus spinescens,* and *Sarcomphalus* (= *Ziziphus*) *amole.*

The following includes other notable trees and shrubs found in coastal thornscrub. Lollipop tree or *jito* (*Forchhammeria watsonii*) is a distinctly shaped tree in coastal thornscrub and southern Plains of Sonora desertscrub in Sonora and Central Gulf Coast desertscrub in Baja California Sur. *Guayacán* (*Guaiacum coulteri*) is a common shrub or small tree with intense blue-purple flowers in late spring (Figure 15). It is in the same genus as the threatened *lignum vitae* (*G. sanctum*), a tropical tree which has dense, highly prized wood. *Ébano* (*Libidibia sclerocarpa*) is a tropical tree on the western coast of Mexico as far north as the Culiacán, Sinaloa area, with a disjunct stand in the Huatabampo study area in Sonora. Reaching 15 m in height, it is one of the tallest trees in coastal

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Clockwise from top left:

Figure 14. *Güerequi* (*Ibervillea sonorae*). A. Tuberous plant. B. Young fruit. C. Mature fruit and leaves. D. Tree ocotillo (*Fouquieria macdougalii*) near Benjamín Hill. *Photos credit Reina-G. and Van Devender.*

Figure 15. *Guayacán* (*Guaiacum coulteri*). A. Flowering tree at Hermosillo. Jesús Sánchez-E. near plant. *Photo credit G. Guadalupe Morales-F.* B. Flowers at Mátape. *Photo credit Van Devender.*

## Coastal Thornscrub Flora and Vegetation, Huatabampo *continued*

thornscrub (Martin et al. 1998) and has one of the densest woods in the world. Cudjoewood (*Bonellia macrocarpa*) is a tropical shrub from Panama north to western Mexico. In Sinaloa and Sonora, *san juanico* (*B. m.* subsp. *pungens*) is in tropical deciduous forest, coastal and foothills thornscrub, and Plains of Sonora desertscrub. The needle-sharp spines on the leaf tips and small orange flowers are distinctive.

Most of the 11 species of *Fouquieria* in the family Fouquieriaceae are small trees. The *ocotillo* (*Fouquieria splendens*) with multiple long stems from the base and boojum tree or *cirio* (*F. columnaris*) with a single swollen trunk and small side branches are the exceptions. *Ocotillo* is one of the most widely distributed desert plants in North America in the Chihuahuan, Mohave, and Sonoran Deserts. Tree ocotillo or *ocotillo macho* (*F. macdougalii*) is a common succulent tree in tropical deciduous forest in Sinaloa and coastal and foothills thornscrub and Plains of Sonora desertscrub in Sonora (Figure 14D). *Palo Adán* (*F. diguetii*) is a shrubby ocotillo common from the Vizcaíno subdivision south to the tropical Cape Region in Baja California with mainland populations in Plains of Sonora desertscrub in the Guaymas area and in coastal thornscrub near Las Bocas in southern Sonora.

### Discussion

The strongest floristic affinities of the Huatabampo flora are with the New World tropics. Species that are new records for Sonora and northern range extensions of tropical species include *Bastardia viscosa, Citharexylum scabrum, Clinopodium brownei, Doyerea emetocathartica, Fimbristylis pallidula, Kosteletzkya depressa, Libidibia sclerocarpa, Marsilea deflexa, Mimosa pigra* var. *asperata, Neptunia plena, Pithecellobium unguis-cati, Lycium carolinianum, Okenia hypogaea,* and *Varronia globosa. Nesaea longipes* in the Municipality is the first record from Sonora, the second for Mexico, and a range extension of a Texas species. *Tumamoca macdougalii* is a Sonoran Desert species that was federally listed in the United States in 1986 and then delisted in 1993. The southern limit of its range is in the coastal thornscrub area.

Palmer's 1890 specimen from Agiabampo was the holotype of *Jatropha purpurea. Euphorbia gentryi* was described from Mesa Masiaca just east of the Huatabampo study area in the Municipality of Navojoa (Steinmann & Daniel 1995). Both species are endemic to coastal thornscrub in southern Sonora and adjacent Sinaloa.

***Conservation.*** The *pitahayal* is a succulent-dominated unique vegetation type unmatched in northern Mexico or the southwestern United States. Large areas of the Municipality of

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Figure 16. Coteco Biological Reserves near Las Bocas. A. David A. Yetman in 2000. *Photo credit Van Devender.* B. Caretaker Pilar Sesma and Van Devender. *Photo credit Reina-G.*

## Coastal Thornscrub Flora and Vegetation, Huatabampo *continued*

Huatabampo — where water is available from the Sinaloa border north to Francisco Sarabia and near Huatabampo in the north — have been cleared for agriculture. Less than half of the *pitahayal* remains intact. In 2000, David Yetman (Figure 16A) and Vicente Tajia created the Coteco Biological Reserves on Masaica Indigenous Community land near Las Bocas. Areas of about 500 and 63 acres were fenced to prevent cattle grazing and wood harvesting (Yetman 2006; Figure 16B). Since 2018, the Tucson Cactus and Succulent Society has supported Coteco. Working with Nature and Culture International, there is a current initiative to create a Reserva Estatal El Pitayal (a Sonoran state reserve) to protect a remnant area of *pitahayal* on Bahía Agiabampo in southernmost Sonora near La Estación de Campo Navopatia, a non-profit organization incorporated in 2002 (Arellano 2023).


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# CHECKLIST: Municipality of Huatabampo, Sonora, Mexico *page 1 of 6*

An asterisk (*) denotes non-native status.

## Pteridophytes

### MARSILEACEAE

*Marsilea deflexa* A. Braun

*Marsilea vestita* Hook. & Grev.

### OPHIOGLOSSACEAE

*Ophioglossum nudicaule* L. f.

### PTERIDACEAE

*Cheilanthes lozanoi* (Maxon) R.M. Tryon & A.F. Tryon

## Eudicots

### ACANTHACEAE

*Avicennia germinans* (L.) L.

*Carlowrightia arizonica* A. Gray

*Carlowrightia pectinata* Brandegee

*Dicliptera resupinata* (Vahl) Juss.

*Elytraria imbricata* (Vahl) Pers.

*Henrya insularis* Nees ex Benth.

*Justicia californica* (Benth.) D. Gibson

*Justicia candicans* (Nees) L. Benson

*Justicia longii* Hilsenb.

*Justicia masiaca* T.F. Daniel

*Ruellia ciliatiflora* Hook.

*Tetramerium nervosum* Nees

*Tetramerium yaquianum* T.F. Daniel

### ACHATOCARPACEAE

*Phaulothamnus spinescens* A. Gray

### AIZOACEAE

*Sesuvium portulacastrum* L.

*Sesuvium verrucosum* Raf.

*Trianthema portulacastrum* L.

### AMARANTHACEAE

*Allenrolfea occidentalis* (S. Watson) Kuntze

*Alternanthera stellata* Uline & Bray

*Amaranthus fimbriatus* (Torr.) Benth. ex S. Watson

*Amaranthus palmeri* S. Watson

*Amaranthus venulosus* S. Watson

*Arthrocnemum subterminale* (Parish) Standl.

*Atriplex barclayana* D. Dietr.

*Atriplex linearis* S. Watson

**Chenopodiastrum murale* (L.) S. Fuentes, Uotila & Borsch

*Chenopodium ficifolium* Sm.

*Chenopodium palmeri* Standl.

*Chenopodium pratericola* Rydb.

*Dysphania graveolens* (Willd.) Mosyakin & Clemants

*Gomphrena globosa* L.

*Gomphrena sonorae* Torr.

*Salicornia bigelovii* Torr.

*Sarcocornia pacifica* (Standl.) A.J. Scott

*Suaeda esteroa* W.R. Ferren & S.A. Whitmore

*Suaeda nigra* J.F. Macbride

*Tidestromia lanuginosa* (Nutt.) Standl.

### APIACEAE

**Anethum graveolens* L.

*Eryngium nasturtiifolium* Juss. ex F. Delaroche

### APOCYNACEAE

*Asclepias subaphylla* Woodson

*Asclepias subulata* Decne.

**Cryptostegia grandiflora* R. Br.

*Dictyanthus altatensis* (Brandegee) W.D. Stevens

*Funastrum clausum* Schltr.

*Funastrum heterophyllum* (Engelm. ex Torr.) Standl.

*Funastrum pannosum* Schltr.

*Metastelma arizonicum* A. Gray

*Metastelma californicum* Benth.

*Metastelma cuneatum* Brandegee

*Metastelma schaffneri* A. Gray

*Metastelma schlechtendalii* Decne. var. *arenicola* Liede & Meve

*Polystemma canisferum* McDonnell & Fishbein

*Ruehssia edulis* (S. Watson) L.O. Alvarado

*Vallesia glabra* Link

### ARISTOLOCHIACEAE

*Aristolochia watsonii* Wooton & Standl.

### ASTERACEAE

*Aldama congesta* (Rose ex Ralph Hoffm.) E.E. Schill. & Panero

*Ambrosia ambrosioides* (Cav.) W.W. Payne

*Ambrosia confertiflora* DC.

*Ambrosia cordifolia* (A. Gray) W.W. Payne

*Baccharis salicifolia* (Ruiz & Pav.) Pers.

*Baccharis sarothroides* A. Gray

*Bebbia juncea* (Benth.) Greene

*Blumea viscosa* (Miller) Badillo

*Brickellia coulteri* A. Gray

*Chloracantha spinosa* (Benth.) G.L. Nesom

*Chromolaena sagittata* (A. Gray) R.M. King & H. Rob.

*Dicoria argentea* Strother

*Eclipta prostrata* (L.) L.

*Egletes viscosa* (L.) Less.

*Encelia farinosa* A. Gray ex Torr.

*Encelia halimifolia* Cav.

*Flaveria trinervia* (Spreng.) C. Mohr

*Gamochaeta stagnalis* (I.M. Johnst.) Anderb.

*Helenium laciniatum* A. Gray

*Hymenoclea monogyra* Torr. & A. Gray ex A. Gray

*Lagascea decipiens* Hemsl.

*Lasianthaea fruticosa* (L.) K.M. Becker

*Melampodium appendiculatum* B.L. Robins.

*Melampodium cupulatum* A. Gray

*Melampodium divaricatum* (Rich.) DC.

*Palafoxia arida* B.L Turner & Morris

*Palafoxia linearis* (Cav.) Lag. var. *linearis*

*Pectis coulteri* Harvey & A. Gray

*Pectis cylindrica* (Fern.) Rydb.

*Pectis papposa* Harv. & A. Gray var. *papposa*

*Pectis prostrata* Cav.

*Pectis purpurea* Brandegee var. *sonorae* Keil

*Pectis stenophylla* A. Gray

*Perityle californica* Benth.

*Perityle microglossa* Benth.

*Pluchea carolinensis* G. Don

*Pluchea symphytifolia* (Miller) W.T. Gillis

*Porophyllum gracile* Benth.

**Sonchus oleraceus* L.

*Trixis californica* Kellogg var. *californica*

*Verbesina encelioides* (Cav.) Benth. & Hook. f. ex A. Gray var. *encelioides*

# CHECKLIST: Municipality of Huatabampo, Sonora, Mexico 

*Viguiera dentata* (Cav.) Spreng.

*Xylothamia diffusa (*Benth.) G.L. Nesom

**BATACEAE**

*Batis maritima* L.

**BIGNONIACEAE**

*Handroanthus impetiginosus* (Mart. ex DC.) Mattos

*Macfadyena unguis-cati* (L.) A.H. Gentry

**BIXACEAE**

*Cochlospermum palmatifidum* (DC.) Byng & Christenh.

**BORAGINACEAE**

*Johnstonella grayi* (Vasey & Rose) Hasenstab & M.G. Simpson var. *cryptochaeta* (J.F. Macbr.) Hasenstab & M.G. Simpson

**BRASSICACEAE**

**Brassica nigra* (L.) W.D.J. Koch

**Brassica rapa* L.

**Capsella bursa-pastoris* (L.) Medik.

*Descurainia pinnata* (Walter) Britton

*Dryopetalon runcinatum* A. Gray

**Lepidium didymum* L.

*Lepidium lasiocarpum* Nutt.

*Rorippa teres* (Michx.) Stuckey

**Sisymbrium irio* L.

**BURSERACEAE**

*Bursera fagaroides* (Kunth) Engl. var. *elongata* McVaugh & Rzed.

*Bursera laxiflora* S. Watson

*Bursera microphylla* A. Gray

**CACTACEAE**

*Cylindropuntia fulgida* (Engelm.) Knuth

*Cylindropuntia leptocaulis* (DC.) F.M. Knuth

*Cylindropuntia leptocaulis* (DC.) F.M. Knuth x *C. thurberi* (Engelm.) F.M. Knuth

*Cylindropuntia thurberi* (Engelm.) F.M. Knuth var. *thurberi*

*Echinocereus leucanthus* N.P. Taylor

*Ferocactus herrerae* Ortega

*Lophocereus schottii* (Engelm.) Britton & Rose var. *tenuis* G.E. Linds.

*Mammillaria bocensis* R.T. Craig

*Mammillaria grahamii* Engelm.

*Mammillaria mazatlanensis* K. Schum.

*Opuntia bravoana* E.M. Baxter

*Opuntia decumbens* Salm-Dyck

*Opuntia maxonii* J.G. Ortega

*Opuntia* aff. *wilcoxii* Britton & Rose

*Pachycereus pecten-aboriginum* Britton & Rose

*Peniocereus marianus* (Gentry) Sánchez-Mej.

*Peniocereus striatus* (Brandegee) Buxbaum

*Pereskiopsis porteri* Britton & Rose

*Selenicereus vagans* Britton & Rose

*Stenocereus alamosensis* (J.M. Coult.) A.C. Gibson & K.E. Horak

*Stenocereus thurberi* (Engelm.) Buxbaum

**CANNABACEAE**

*Celtis pallida* Torr.

**CAPPARACEAE**

*Atamisquea emarginata* Miers ex Hooker & Arnott

*Capparis flexuosa* (L.) L.

**CARYOPHYLLACEAE**

*Drymaria glandulosa* Bartl.

**CELASTRACEAE**

*Maytenus phyllanthoides* Benth.

**CLEOMACEAE**

*Cleome tenuis* S. Watson

**Corynandra viscosa* (L.) Cochrane & Iltis

**COMBRETACEAE**

*Conocarpus erecta* L.

*Laguncularia racemosa* S. Watson

**CONVOLVULACEAE**

*Cressa truxillensis* Kunth

*Cuscuta americana* L.

*Cuscuta boldinghii* Urban

*Cuscuta desmouliniana* Yunck.

*Cuscuta erosa* Yunck.

*Cuscuta indecora* Choisy

*Cuscuta legitima* Costea & Stefanovic

*Cuscuta tuberculata* Brandegee

*Evolvulus alsinoides* L. var. *angustifolia* Torr.

*Ipomoea arborescens* (Humb. & Bonpl.) G. Don var. *glabrata* (A. Gray) Gentry

*Ipomoea barbatisepala* A. Gray

*Ipomoea bracteata* Cav.

**Ipomoea carnea* Jacq.

*Ipomoea costellata* Torr

*Ipomoea cristulata* Hallier f.

*Ipomoea imperati* (Vahl) Giseb.

*Ipomoea jalapa* Schiede & Deppe ex G. Don

*Ipomoea pedicellaris* Benth.

*Ipomoea pes-caprae* Roth

*Ipomoea plummerae* A. Gray

*Ipomoea scopulorum* Brandegee

*Ipomoea ternifolia* Torr. var. *leptotoma* (Torr.) J.A. McDonald

*Ipomoea triloba* L.

*Jacquemontia agrestis* (Mart. ex Choisy) Meisn.

*Jacquemontia polyantha* Hallier f.

*Jacquemontia pringlei* A. Gray

*Merremia palmeri* Hallier f.

*Operculina pinnatifida* (Kunth) O'Donell

**CORDIACEAE**

*Cordia parvifolia* G. Don

*Varronia curassavica* Jacq.

*Varronia globosa* Jacq.

**CUCURBITACEAE**

*Apodanthera palmeri* S. Watson

**Citrullus lanatus* (Thunb.) Matsum. & Nakai

**Cucumis melo* L.

*Cucurbita argyrosperma* K. Koch subsp. *sororia* (L.H. Bailey) Merrick & D.M. Bates

*Doyerea emetocathartica* Grosourdy

*Echinopepon cirrhopedunculatus* Rose

*Echinopepon wrightii* (A. Gray) S. Watson

*Ibervillea sonorae* Greene

*Tumamoca macdougalii* Rose

**EBENACEAE**

*Diospyros sonorae* Standl.

**ELATINACEAE**

*Bergia texana* (Hook.) Seub.

**EUPHORBIACEAE**

*Acalypha aliena* Brandegee

*Acalypha californica* Benth.

# CHECKLIST: Municipality of Huatabampo, Sonora, Mexico *page 3 of 6*

*Acalypha ostryifolia* Riddell ex J. M. Coult.
*Acalypha papillosa* Rose
*Acalypha subviscida* S. Watson
*Adelia brandegeei* V.W. Steinm.
*Argythamnia serrata* (Torr.) Müll.-Arg
*Bernardia viridis* Millsp.
*Croton californicus* Müll.-Arg
*Croton ciliatoglandulifer* Ortega
*Croton flavescens* Greenm.
*Croton sonorae* Torr.
*Croton subjucundus* Croizat
*Euphorbia abramsiana* L.C. Wheeler
*Euphorbia albomarginata* Torr. & A. Gray
*Euphorbia californica* Boiss.
*Euphorbia capitellata* Engelm.
*Euphorbia cymosa* Poir.
*Euphorbia florida* Engelm.
*Euphorbia hyssopifolia* L.
*Euphorbia incerta* Brandegee
*Euphorbia lomelii* V.W. Steinm.
*Euphorbia pediculifera* Engelm.
*Euphorbia petrina* S. Watson
*Euphorbia polycarpa* Benth.
*Euphorbia tomentulosa* S. Watson
*Euphorbia trachysperma* Engelm.
*Jatropha cardiophylla* (Torr.) Müll.-Arg
*Jatropha cinerea* (Ortega) Müll.-Arg
*Jatropha cordata* Müll.-Arg.
*Jatropha purpurea* Rose
*Manihot davisiae* Croizat
**Ricinus communis* L.
*Tragia glanduligera* Pax & K. Hoffm.
*Tragia mcvaughii* Urtecho

## FABACEAE

*Acacia cochliacantha* Humb. & Bonpl. ex Willd.
*Acacia constricta* Benth.
*Acacia farnesiana* (L.) Willd.
*Acacia russelliana* (Britton & Rose) Lundell
*Albizia sinaloensis* Britton & Rose
*Caesalpinia platyloba* S. Watson
*Caesalpinia pulcherrima* (L.) Sw.
*Calliandra eriophylla* Benth.
*Chloroleucon mangense* (Jacq.) Britton & Rose var. *leucospermum* (Brandgee) Barneby & Grimes
*Coursetia caribaea* (Jacq.) Lavin var. *caribaea*
*Coursetia glandulosa* A. Gray
*Dalea mollis* Benth.
*Desmanthus covillei* (Britton & Rose) Wiggins ex B.L. Turner
*Desmodium procumbens* (P. Mill.) A.S. Hitchc.
*Erythrina flabelliformis* Kearney
*Erythrostemon palmeri* (S. Watson) Gagnon & G.P. Lewis
*Eysenhardtia orthocarpa* (A. Gray) S. Watson
*Gretheria sonorae* (S. Watson) Duno & Torke
*Haematoxylum brasiletto* Karst.
*Havardia mexicana* (Rose) Britton & Rose
**Leucaena leucocephala* (Lam.) de Wit
*Libidibia sclerocarpa* (Standl.) Britton & Rose
*Lonchocarpus hermannii* M. Sousa
*Lonchocarpus mexicanus* Pittier
*Lysiloma divaricatum* (Jacq.) J.F. Macbr.
*Macroptilium atropurpureum* (Moc. & Sessé ex DC.) Urban
*Marina palmeri* (Rose) Barneby
*Marina peninsularis* (Rose) Barneby
*Mariosousa russelliana* (Britton & Rose) Seigler & Ebinger
**Medicago polymorpha* L.
**Melilotus indicus* (L.) All.
*Mimosa distachya* Vent.
*Mimosa pigra* L. var. *asperata* (L.) Zarucchi, Vincent & Gandhi
*Neltuma articulata* (S. Watson) Britton & Rose
*Neltuma odorata* (Torr. & Frém.) C.E. Hughes & G.E. Hughes
*Neptunia plena* (L.) Benth.
*Olneya tesota* A. Gray
*Parkinsonia aculeata* L.
*Parkinsonia florida* (Benth. ex A. Gray) S. Watson
*Parkinsonia praecox* (Ruiz & Pav.) J.A. Hawkins
*Piscidia mollis* Rose
*Pithecellobium dulce* (Roxb.) Benth.
*Pithecellobium unguis-cati* (L.) Benth.
*Rhynchosia minima* (L.) DC.
*Rhynchosia precatoria* DC.
*Senna atomaria* (L.) H.S. Irwin & Barneby
*Senna covesii* (A. Gray) H.S. Irwin & Barneby
*Senna pallida* (Vahl) H.S. Irwin & Barneby
*Sesbania herbacea* (P. Mill.) McVaugh
*Sphinctospermum constrictum* (S. Watson) Rose

## FOUQUIERIACEAE

*Fouquieria diguetii* (Tiegh.) I.M. Johnst.
*Fouquieria macdougalii* Nash

## GENTIANACEAE

*Eustoma exaltatum* (L.) Salisb. ex G. Don

## HELIOTROPIACEAE

*Euploca fruticosa* (L.) J.I.M. Melo & Semir
*Heliotropium angiospermum* Murray
*Heliotropium curassavicum* L.
*Heliotropium hartwegianum* (Steud.) Halse & Feuillet
*Heliotropium macrostachyum* Hemsl.

## KOEBERLINIACEAE

*Koeberlinia spinosa* Zucc.

## KRAMERIACEAE

*Krameria erecta* Willd. ex J.A. Schultes
*Krameria sonorae* Britton

## LAMIACEAE

*Clinopodium brownei* (Sw.) Kuntze
*Hyptis albida* Kunth
*Salvia misella* Kunth
*Salvia riparia* Kunth
*Teucrium cubense* Jacq.
*Teucrium glandulosum* Kellogg
*Vitex mollis* Kunth

## LENNOACEAE

*Pholisma culiacanum* (Dressler & Kuijt) Yatsk.

# CHECKLIST: Municipality of Huatabampo, Sonora, Mexico *page 4 of 6*

**LOASACEAE**

*Mentzelia aspera* L.

**LORANTHACEAE**

*Psittacanthus sonorae* (S. Watson) Kuijt

*Struthanthus palmeri* Kuijt

**LYTHRACEAE**

*Ammannia robusta* Heer & Regel

*Nesaea longipes* A. Gray

**MALPIGHIACEAE**

*Callaeum macropterum* (Moc. & Sesse ex DC.) D.M. Johnson

*Cottsia californica* (Benth) W.R. Anderson & C. Davis

*Galphimia angustifolia* Benth.

*Malpighia emarginata* ex DC.

**MALVACEAE**

*Abutilon abutiloides* (Jacq.) Garcke ex Britton & Wilson

*Abutilon californicum* Benth.

*Abutilon incanum* (Link) Sweet

*Abutilon palmeri* A. Gray

*Anoda pentaschista* A. Gray

*Ayenia filiformis* S. Watson

*Ayenia jaliscana* S. Watson

*Bastardia viscosa* (L.) Kunth

*Bastardiastrum cinctum* (Brandegee) D.M. Bates

*Byttneria aculeata* (Jacq.) Jacq.

*Ceiba aesculifolia* (Kunth) Britten & Baker f.

*Corchorus hirtus* L.

*Corchorus siliquosus* L.

*Guazuma ulmifolia* Lam.

*Herissantia crispa* (L.) Briz.

*Hibiscus biseptus* S. Watson

*Kosteletzkya depressa* (L.) O.J. Blanch., Fryxell & D.M. Bates

**Malva parviflora* L.

*Malvastrum bicuspidatum* (S. Watson) Rose

*Malvastrum coromandelianum* (L.) Garcke

*Melochia pyramidata* L.

*Melochia speciosa* S. Watson

*Melochia tomentosa* L.

*Sida abutilifolia* Mill.

*Sphaeralcea coulteri* (S. Watson) A. Gray

**MARTYNIACEAE**

*Proboscidea althaeifolia* (Benth.) Decne.

*Proboscidea parviflora* (Wooton) Wooton & Standl.

**MENISPERMACEAE**

*Nephroia diversifolia* (DC.) L. Lian & Wei Wang

**MOLLUGINACEAE**

*Glinus radiatus* (Ruiz & Pav.) Rohrb.

*Mollugo verticillata* L.

**MORACEAE**

*Ficus cotinifolia* Kunth

*Ficus petiolaris* Kunth

**NAMACEAE**

*Nama coulteri* A. Gray

*Nama hispidum* A. Gray var. *sonorae* L.C. Hitchc.

**NYCTAGINACEAE**

*Abronia maritima* Nutt. ex S. Watson

*Allionia incarnata* L.

*Boerhavia erecta* L.

*Boerhavia spicata* Choisy

*Boerhavia triquetra* S. Watson var. *intermedia* (M.E. Jones) Spellenb.

*Boerhavia xantii* S. Watson

*Commicarpus scandens* (L.) Standl.

*Okenia hypogaea* Schltdl. & Cham.

*Pisonia capitata* (S. Watson) Standl.

*Salpianthus arenarius* Bonpl.

*Salpianthus macrodontus* Standl.

**NYMPHAEACEAE**

*Nymphaea elegans* Hook.

**ONAGRACEAE**

*Ludwigia octovalvis* (Jacq.) Raven

*Oenothera drummondii* Hook. subsp. *thalassaphila* (Brandegee) W. Dietr. & W.L. Wagner

*Oenothera kunthiana* (Spach) Munz

**OPILIACEAE**

*Agonandra racemosa* Standl.

**PAPAVERACEAE**

*Argemone ochroleuca* Sweet

**PASSIFLORACEAE**

*Passiflora arida* (Mast. & Rose) Killip

*Passiflora foetida* L. var. *gossypiifolia* (Desv. ex Ham.) Mast.

**PEDALIACEAE**

**Sesamum orientale* Sieber ex Presl

**PETIVERIACEAE**

*Rivina humilis* L.

**PHYLLANTHACEAE**

*Phyllanthus evanescens* Brandegee

**PLANTAGINACEAE**

*Callitriche terrestris* Raf.

*Mecardonia procumbens* (Mill.) Small

*Nuttallanthus texanus* (Scheele) D.A. Sutton

*Sairocarpus costatus* (Wiggins) D.A. Sutton

*Stemodia durantifolia* (L.) Sw. var. *durantifolia*

**PLUMBAGINACEAE**

*Plumbago zeylanica* L.

**POLEMONIACEAE**

*Dayia sonorae* (Rose) J.M. Porter

**POLYGONACEAE**

*Antigonon leptopus* Hook. & Arn.

*Rumex inconspicuus* Rech. f.

*Rumex maritimus* L.

**PORTULACACEAE**

*Portulaca oleracea* L.

*Portulaca suffrutescens* Engelm.

*Portulaca umbraticola* Kunth

**PRIMULACEAE**

*Bonellia macrocarpa* B. Ståhl & Källersjö subsp. *pungens* (A. Gray) B. Ståhl & Källersjö

**RESEDACEAE**

*Forchhammeria watsonii* Rose

*Oligomeris linifolia* (Vahl) J.F. Macbr.

**RHAMNACEAE**

*Colubrina triflora* Brongn.

*Colubrina viridis* (M.E. Jones) M.C. Johnst.

*Condalia globosa* I.M. Johnst.

*Condaliopsis divaricata* (A. Nelson) G.L. Nesom

*Gouania rosei* Wiggins

# CHECKLIST: Municipality of Huatabampo, Sonora, Mexico *page 5 of 6*

*Karwinskia humboldtiana* Zucc.

*Sarcomphalus amole* (Sessé & Moc.) Hauenschild

### RHIZOPHORACEAE

*Rhizophora mangle* Roxb.

### RUBIACEAE

*Chiococca alba* (L.) Hitchc.

*Hintonia latiflora* Bullock

*Mitracarpus hirtus* (L.) DC.

*Randia echinocarpa* Sessé & Moc. ex DC.

*Randia obcordata* S. Watson

*Randia thurberi* S. Watson

*Spermacoce tenuior* L.

### RUTACEAE

*Amyris balsamifera* L.

*Esenbeckia hartmanii* B.L. Robins. & Fernald

*Zanthoxylum fagara* Sargent

### SALICACEAE

*Populus mexicana* Sarg. subsp. *dimorpha* (Brandegee) Eckenw.

### SANTALACEAE

*Phoradendron brachystachyum* (DC.) Oliv.

*Phoradendron californicum* Nutt.

### SAPINDACEAE

*Cardiospermum corindum* L.

*Sapindus saponaria* L.

*Serjania palmeri* S. Watson

### SAPOTACEAE

*Sideroxylon occidentale* (Hemsl.) T.D. Penn.

### SCHOEPFIACEAE

*Schoepfia shreveana* Wiggins

### SCROPHULARIACEAE

*Buddleja sessiliflora* Kunth

### SOLANACEAE

*Calibrachoa parviflora* (Juss.) D'Arcy

*Capsicum annuum* L. var. *glabriusculum* (Dunal) Heiser & Pickersgill

*Datura discolor* Bernh.

*Datura innoxia* Mill.

*Datura lanosa* Barclay ex Bye

*Lycium andersonii* A. Gray

*Lycium berlandieri* Dunal

*Lycium brevipes* Benth.

*Lycium californicum* Nutt. ex A. Gray

*Lycium carolinianum* Walter

*Lycium fremontii* A. Gray

**Nicotiana glauca* Graham

*Nicotiana obtusifolia* M. Martens & Galeotti

*Physalis acutifolia* (Miers) Sandw.

*Physalis crassifolia* Benth.

*Physalis latiphysa* Waterfall

*Physalis minuta* Griggs

*Physalis philadelphica* Lam.

*Physalis pubescens* L.

*Physalis subulata* Rydb.

*Solanum americanum* Mill.

*Solanum elaeagnifolium* Cav.

*Solanum ferrugineum* Jacq.

*Solanum grayi* Rose

*Solanum houstonii* Martyn

**Solanum lycopersicum* L.

### STEGNOSPERMATACEAE

*Stegnosperma halimifolium* Bentham

### TALINACEAE

*Talinum paniculatum* (Jacq.) Gaertn.

### TAMARICACEAE

**Tamarix aphylla* (L.) Karst

**Tamarix chinensis* Lour.

### URTICACEAE

*Parietaria hespera* B.D. Hinton var. *hespera*

### VERBENACEAE

*Aloysia gratissima* (Gillies & Hook.) Tronc.

*Aloysia sonorensis* Moldenke

*Bouchea dissecta* S. Watson

*Citharexylum scabrum* Sessé & Moc. ex D. Don

*Lantana camara* L.

*Lippia graveolens* Kunth

*Lippia palmeri* S. Watson

*Phyla nodiflora* (L.) Greene

*Verbena halei* Small

*Verbena menthifolia* Benth.

### VIOLACEAE

*Hybanthus attenuatus* (Humb. & Bonpl. ex Willd.) Schulze-Menz

*Hybanthus fruticulosus* I.M. Johnst.

### VITACEAE

*Cissus mexicana* Moc. & Sessé ex DC.

*Cissus trifoliata* (L.) L.

### ZYGOPHYLLACEAE

*Guaiacum coulteri* A. Gray

*Kallstroemia californica* (S. Watson) Vail

*Kallstroemia grandiflora* Torr. ex A. Gray

*Kallstroemia parviflora* Norton

## Monocots

### ALISMATACEAE

*Echinodorus berteroi* (Spreng.) Fassett

*Sagittaria longiloba* Engelm. ex J.G. Sm.

### AMARYLLIDACEAE

*Hymenocallis sonorensis* Standl.

### ASPARAGACEAE

*Agave aktites* Gentry

*Agave angustifolia* Haw.

### ASPHODELACEAE

**Aloe barbadensis* P. Mill.

### BROMELIACEAE

*Tillandsia exserta* Fernald

*Tillandsia recurvata* (L.) L.

### COMMELINACEAE

*Commelina erecta* L.

### CYPERACEAE

*Bolboschoenus maritimus* (L.) Palla var. *paludosus* (A. Nelson) Á. Löve & D. Löve

*Cyperus compressus* L.

*Cyperus dentoniae* G.C. Tucker

*Cyperus entrerianus* Boeckeler

*Cyperus esculentus* L.

*Cyperus flavicomus* Michx.

*Cyperus hermaphroditus* (Jacq,) Standl.

*Cyperus odoratus* L.

*Cyperus oxylepis* Nees ex Steud.

*Cyperus perennis* (M.E. Jones) O'Neill

**Cyperus rotundus* L.

*Cyperus semiochraceus* Boeck.

*Cyperus squarrosus* L.

*Cyperus surinamensis* Rottb.

# CHECKLIST: Municipality of Huatabampo, Sonora, Mexico *page 6 of 6*

*Cyperus trachynotus* Torr.

*Fimbristylis annua* (All.) Roemer & J.A. Schultes

*Fimbristylis dichotoma* Vahl

*Fimbristylis pallidula* Kral

**POACEAE**

*Anthephora hermaphrodita* (L.) Kuntze

*Aristida adscensionis* L.

*Aristida californica* Thurb. ex S. Watson var. *californica*

*Aristida ternipes* Cav. var. *ternipes*

**Arundo donax* L.

**Avena fatua* L.

*Bouteloua aristidoides* (Kunth) Griseb.

*Bouteloua barbata* Lag. var. *barbata*

*Bouteloua barbata* Lag. var. *rothrockii* (Vasey) Gould

*Bouteloua barbata* Lag. var. *sonorae* (Griffiths) Gould

*Bouteloua diversispicula* Columbus

**Cenchrus ciliaris* L.

*Cenchrus echinatus* L.

*Cenchrus incertus* M.A. Curtis

*Cenchrus palmeri* Vasey

*Cenchrus spinifex* Cav.

**Chloris barbata* Sw.

*Chloris virgata* Sw.

**Cynodon dactylon* (L.) Pers.

**Dactyloctenium aegyptium* (L.) Willd.

**Dichanthium annulatum* (Forssk.) Stapf

**Digitaria bicornis* (Lam.) Roem. & Schult.

*Dinebra panicea (*Retz.) P.M. Peterson & N. Snow subsp. *brachiata* (Steud.) P.M. Peterson & N. Snow

*Dinebra panicoides* (J. Presl) P.M. Peterson & N. Snow

*Dinebra viscida* (Scribn.) P.M. Peterson & N. Snow

*Distichlis littoralis* (Engelm.) H.L. Bell & Columbus

*Distichlis spicata* (L.) Greene

**Echinochloa colona* (L.) Link

**Eragrostis cilianensis* (All.) Vignolo ex Janch.

*Eragrostis pectinacea* (Michx.) Nees ex Steud.

*Eriochloa aristata* Vasey

*Jouvea pilosa* Scribn.

*Luziola gracillima* Prodoehl

*Panicum alatum* Zuloaga & Morrone var. *minus* (Andersson) Zuloaga & Morrone

**Panicum antidotale* Retz.

*Panicum hirticaule* J. Presl var. *hirticaule*

*Panicum stramineum* A.S. Hitchc. & Chase

*Pappophorum philippianum* Parodi

*Paspalum squamulatum* E. Fourn.

**Phalaris minor* Retz.

*Setaria arizonica* Rominger

*Setaria liebmannii* E. Fourn.

*Setaria Setaria macrostachya* Kunth

**Sorghum halepense* (L.) Pers.

*Sporobolus cryptandrus* (Torr.) A. Gray

*Sporobolus pyramidatus* (Lam.) A.S. Hitchc.

*Sporobolus virginicus* Kunth

*Steinchisma hians* (Elliott) Nash

*Tridentopsis eragrostoides* (Vasey & Scribn.) P.M. Peterson

*Urochloa arizonica* (Scribn. & Merr.) Morrone & Zuloaga

*Urochloa fusca* (Sw.) B.F. Hansen & Wunderlin

**Urochloa reptans* Stapf

**PONTEDERIACEAE**

*Heteranthera limosa* (Sw.) Willd.

## Correction/Addition to Gymnosperm Article in *Plant Press Arizona* Vol. 47(1), Spring 2024

Two AZNPS members, Max Licher and Tom Van Devender, have pointed out that some of the information presented in the previous *Plant Press Arizona* issue article on Arizona gymnosperms should be expanded based on the lack of agreement among botanists on the taxonomic relationships of some of the species presented. Specifically, Max has made the following observations:

**1. Single-needled Plants from NW through Central AZ**. These trees should be called *Pinus edulis* var. *fallax*, *not Pinus monophylla*, based on a number of needle morphological characters, seasonal variation in number of needles per bundle, and habitat/climate adaptations. Tom Van Devender, however, disagrees with that conclusion and cited several studies that indicate that *Pinus monophylla* is indeed the correct name for the Arizona pinyon.

2. **The Bristlecone Pine in AZ.** The San Francisco Peaks trees are allied with the Rocky Mountain trees, not the Great Basin trees. Most taxonomic sources that he has seen treat this group as separate species, with *Pinus balfouriana* (Foxtail pine) along the Pacific coast, *Pinus longaeva* (Great Basin Bristlecone pine) in eastern CA, Nevada, and Utah, and *Pinus aristata* (Colorado Bristlecone pine), in Colorado, NM, and the San Francisco Peaks in AZ.

**3. The Subalpine Firs.** These trees pose a more complicated taxonomic question, with less agreement found in the literature. The *Flora of North America* (1993) treated Rocky Mountain plants, including Arizona species, as *Abies bifolia*, with *Abies lasiocarpa* relegated to the Pacific Coast. Ackerfield (2015) did the same in her recent *Flora of Colorado*. In this case, the Arizona Corkbark fir would best be treated as a variety of *A. bifolia*, rather than *A. lasiocarpa*, but Max does not believe that that combination has been published anywhere.

# Iris Rodden, *In Remembrance*

It is with much sadness we share the loss of a very special person in the native plant community. Iris Rodden passed away on May 30, 2024, after a prolonged struggle with metastatic cancer. She leaves behind her husband, Jim Verrier, her mother, Hilde Rodden, and her four beloved cats. Iris was a highly talented wildlife biologist, a skilled botanist, and a longtime member of the Arizona Native Plant Society.

From a very early age, Iris formed strong connections with both animals and plants. As a young girl growing up in rural New England, she searched for wild orchids and would pick wild wintergreen (*Gaultheria procumbens*). She loved animals and insects from a young age and was the 5-year-old that was trying to save any drowning insect in her path.

Iris earned her Bachelor's degree in Renewable Natural Resources from the University of Arizona and received her Master's degree in Ecology and Evolutionary Biology from Tulane University in 2005. She graduated *Magna cum laude* with both of her degrees. At the time of her passing, she was halfway through a PhD program at the University of Arizona, where she was pursuing work in Remote Sensing and Advanced G.I.S. Despite dealing with the limitations of a debilitating terminal illness, she still aspired to contribute to society through Remote Sensing work with an emphasis in climate change mitigation.

She worked professionally as a wildlife biologist for over two decades and served as the Conservation Biologist for Pima County Natural Resources, Parks and Recreation from 2007–2020. Iris worked with numerous endangered species including Chiricahua leopard frog, southwestern willow flycatcher, western yellow-billed cuckoo, lesser long-nosed bat, ferruginous pygmy-owl and Pima pineapple cactus (*Coryphantha robustispina* var. *robustispina*). She had over 18 years of experience netting bat species, and worked on the acoustic monitoring of bat species for nine years while with Pima County. During her time at Pima County, Iris also helped develop monitoring protocols and procedures for range management on multiple County ranches, including writing coordinated management plants.

Iris co-authorized a rare-plant study of *Buddleja sessiliflora* that resulted in the immediate designation of very rare/critically imperiled for this species, which comprises less than 30 known individuals in Arizona. One of her passions was working on a flora of the Hayhook Ranch in the Coyote Mountains, Pima County; Phil Jenkins and Patty Guertin also worked on this study, both of whom are deceased. Iris also collaborated with Jim Verrier and Sue Carnahan on the flora of the Santa Rita Mountains, for which five years of field work was completed in 2022 and will hopefully be published in 2025.

Iris was a gentle and kind soul. She was passionate about animals, plants, and loyalty to friends. She will be sorely missed by friends, science, and most of all, her husband Jim and her mother Hilde.

Figure 1 (inset). *Photo credit John Scheuring*. Figures 2 and 3 (above). *Photos credit the author.*

SPOTLIGHT ON A NATIVE PLANT *by Jack Dash*[1]

# Saguaro (*Carnegiea gigantea*)

We typically use our "Spotlight on a Native Plant" section to highlight some of our favorite beautiful Arizona plants. However, in this issue, we are highlighting the unusual, bizarre, and grotesque forms sometimes assumed by the most stately of Arizona species, the saguaro (*Carnegiea gigantea*). Saguaros are an iconic species of our state and of the Sonoran Desert as a whole. In many ways, they are the quintessential cactus, probably the first species that comes to mind when most people from other parts of the country or the world think about our region. Reaching heights of 30 to 40 feet with life spans approaching 175 years, saguaros perfectly demonstrate the "keystone species" concept. Their thick trunks provide homes for Gila woodpeckers and gilded flickers alongside other birds such as purple martins. The crooks of their arms are nesting sites for great horned owls and red-tailed hawks. The flowers of saguaros provide sustenance for white-winged doves and lesser long-nosed bats. The fruit is a favored food for creatures ranging from ants to javelina to humans. But some saguaros don't quite fit the mold. Throughout the Tucson basin, populations of saguaros can be found with a high preponderance of cresting, deformity, or an above-average amount of branching. Scientists and saguaro-huggers have speculated and debated the cause of these aberrant individuals and populations, but answers remain elusive. What is clear is that certain areas host higher numbers of these unusual individuals. One example is the population along Avra Valley Road near the ASARCO mine northwest of Tucson where an iconic saguaro with multitudinous arms exists in a grouping of other individuals with what seems to be excessive branching (Figure 1). The fact that these plants occur in a group would suggest that there is either an environmental cause or that cross-pollination among more aggressively branching plants is leading to a genetically distinctive group of plants where high levels of branching have become the norm.

[1]Vice President, Tucson Chapter, Arizona Native Plant Society.
**nativeplantstucson@gmail.com**

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## SPOTLIGHT ON **Saguaro**
*continued*

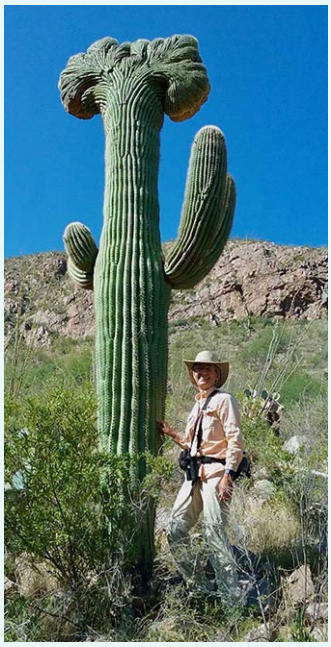


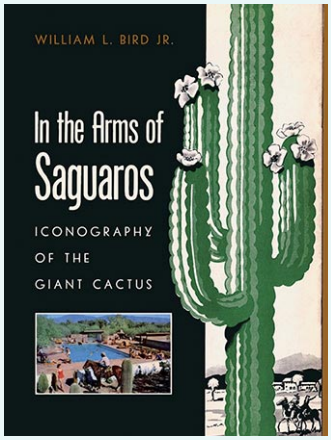
Figure 4. Sue Carnahan with crested saguaro. *Photo credit John Wiens.*

Another locality where odd saguaros can be found is Sentinel Peak (A Mountain) near downtown Tucson (Figures 2 and 3). Many of the saguaros on the upper south-facing slopes of this hill are severely disfigured, sporting bunches of stubby, malformed branches. The dominant theory regarding these oddballs appears to be the influence of the various chemicals (particularly magnesium) that are found in the fireworks launched from Sentinel Peak every 4th of July. These saguaros also probably suffer from the not-infrequent fires that result from these fireworks, along with the malign influence of dense populations of buffelgrass. The soil toxicity theory is interesting because plants with similar deformations have also been observed near mines where soil toxicity is highly likely.

Then of course, you have the famous crested saguaros (Figure 4). The fan-shaped growths at the top of these plants have been the subject of much debate. Some people ascribe these growths to abiotic factors like lightning strikes or freeze damage, while others point to biotic influences such as insects, fungi, bacteria, or genetic mutation. Whatever the precise cause, crested saguaros are truly charismatic and impressive, sparking delight and speculation wherever they are found.

Whatever the precise causes of these deformities and unusual growth patterns in saguaros, they add to the charm and interest of what is already a compelling species. Just as we like to celebrate the showiest specimens in Arizona's flora, let's also celebrate the oddballs!

Although he never expressed a particular interest in the Saguaro cactus, the species was named for the famous Scottish American industrialist and philanthropist Andrew Carnegie by botanical collaborators N.L. Britton and J.N. Rose.




A most interesting book by William Bird entitled *In the Arms of Saguaros* provides detailed descriptions and illustrations of the Saguaro cactus and outlines the history of our fascination with the species.

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