Sego Lily

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A Desert Harvest
or Writer of the Purple Sage

Norman Anderson III

I have a distant but poignant memory in which I am standing in our yard in Holladay, it is spring and my mother is pointing to a small flower and telling me that it is the state flower, the Sego Lily. To me, this is one of those "the memory survives but parts of it don't," for as the area around us filled up with new homes and the open space disappeared, the sego lilies also went away. While some sego lilies are still growing in their original habitat (Canyonlands, Bonneville shoreline trail, Beaver Dam Mountains), most commonly the state flower and our society symbol, only survive inadvertently and are "spotted" on hikes or "bumped into" in less developed, more protected, remote places in Utah and other western states.

A similar tale accompanies the equally beautiful but even less abundant (threatened) Bearclaw poppy of southern Utah, a loss attributed to loss of habitat and development of subdivisions south of St. George, Utah. While early settlers devoured the bulbs of the sego lily for food, developers now devour the precious soil and habitat of the bear claw poppy. The similarities of history and loss are remarkably similar…..both species are beautiful, both treasured, both threatened and both "inadvertently" eliminated from their original communities.

In southwest Utah, loss of habitat is a problem that is likely to worsen in the years ahead for a variety of reasons that include; explosive growth, county policies that promote development at the expense of native species, grazing practices that destroy native plant communities, a lack of talented educators to promote utilization of waterwise and native plants in current landscape projects, new arid areas related to groundwater changes and the lack of community members that have gained meaningful exposure to the beauty, fragility and value of the many native species that surround them. It is noteworthy and related that few native species are available at local nurseries and only one local nursery (family owned and operated) offers a sizable selection of indigenous species that are better choices for the desert climate. For example, while many local ranchers routinely "chain" their land to get

Salvia dorrii of *The Riders of the Purple Sage* fame.

rid of the Utah Juniper, a tree that survives and brings beauty to any landscape, virtually none are available for purchase. As "the new West" meets "the old West," the changes in ecosystems are accompanied in a less visible way with changes in culture and values of those that are stewards of their communities.

In 1980, in Arizona, Phil Hebets originated a tree boxing methodology that enabled over a million native plants to be salvaged rather than bulldozed. In turn, municipalities in Arizona (principally Tucson) have passed ordinances requiring native plants to be saved and replanted in developments….these changes and the accommodation to native plants has completely changed the face of urban landscapes in southwest Arizona. Today, there are additional programs to "harvest" native species from development areas, warehouse them until a home is found and then "donate" them to municipal projects in need of desert landscaping.

My experience with "harvesting" or "relocating" native species began two years ago after an offhand conversation with a medical resident that had previously completed a master's thesis on *Salvia dorrii,* the purple sage, the sage that is most commonly associated with the western novel of southwest Utah,

Billowing, shrubby *Penstemon ambiguus.*

The Riders of the Purple Sage, but uncommonly seen or admired in the locale that made it well known. I had moved to southern Utah from northern Utah and was told to revegetate the part our yard that had been destroyed during the building process. I was also informed that I was only to use native species from a list that was provided by the Homeowner's Association. Few of the native species suggested by the HOA were available locally, but I remembered that *Salvia dorrii* was on the list of "approved" natives. While I searched locally without any real success (creosote, globe mallow, Parry's penstemon were available), purple sage remained in my memory due to it's association with literature and the rock bands of my youth. Numerous wanderings in the local desert produced no sign of the purple sage and I eventually ordered a small plant (5" pot) from an online supplier in Santa Fe…...a plant so small that it was only useful in showing me what type of leaf and color defined the *Salvia dorrii*…maybe the leaves were purple was an early, poorly researched idea.

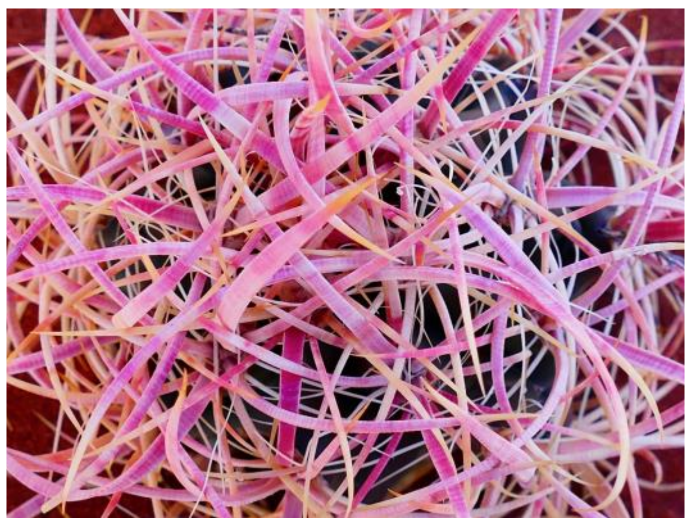
Claret Cup Cactus, *Echinocereus mojavensis*.

Hedgehog Cactus, *Echinocereus engelmanii*.

Months went by, fall, winter and early spring…... the small plant slowly began to grow (sage green leaves), we landscaped as best we could and took in the beauty of the desert, and marveled as the desert began to bloom.

Later that spring, the lot next to ours sold and later still, there were survey markers outlining the footprint of the house to be built. Curious of our new neighbor's plan, we walked over and studied the staked out area.

Old yucca flower stem .



A young Barrel Cactus, *Ferocactus cylindraceus*.

In the middle of the footprint was the most beautiful *Salvia dorrii* that I have yet ever seen… large, healthy plant with many light blue flowers of incredible delicacy and beauty. Washington County had been searched without success and there it was, the best example of the plant I was looking for… fifty yards away from my living room. To this day, I have not found a similar specimen but have seen much smaller examples in nearby protected areas (Snow Canyon, Beaver Dam Wilderness). After contacting the builder who was to bulldoze the area, I was given "unofficial" permission to move the plant to another place where it could continue to thrive. In the end, I split the plant into twenty substantial plants that were relocated to my yard where all of them have continued to grow and show off their beauty each spring. Since the nudge to "relocate" the purple sage, I have continued to find plants in newly created roadways, areas where homes or driveways are to be excavated and newly created erosion areas where proposed changes will result in destruction of habitat... there may be others similarly involved in a rescue effort for these plants but I consider myself a one man band, a distant relative of Hans Brinker putting a botanical thumb in the dam to slow a destruction of the desert that is clearly present with knowledge that the dam is leaking badly.

While friends of native species continue to look at the mounting loss of native species in southwest Utah, it is notable that the Bearclaw Poppy chapter of the Utah Native Plant Society faces its own threat of extinction. Despite a botanical need for intervention that may exceed other parts of the state in terms of loss of habitat, the small voices that call for prudence are drowned out by the legions of developers that see the desert as a profit center, nurseries that do what they can to produce gardens more related to Salt Lake than to the Mojave. It will take years of work for residents of southern Utah to see the many species of cactus a source of many months of flowering instead of a spiny plant that can hurt you. One look at the 10 foot flower that comes from the only native Utah agave, *Agave utahensis*, one glance at an area of bush penstemon should be all that it takes for locals to become "true believers" and "protectors"... but as the Bearclaw Poppy so clearly pointed out, there is a long standing desert "blindness" that interferes with clear vision.

Hopefully, as Phil Hebets did in Arizona, a rebirth of the local native plant society in southern Utah, the growing voice of Conserve Southwest Utah and help with friends of plants of the desert from the north, a process can take root in which the natural beauty of the desert landscape is better noticed, rejoiced, utilized and protected.

American Penstemon Society/UNPS Annual Meeting

June 2-5, 2017 Vernal, Utah

Speakers:

Sherel Goodrich "Uinta Basin Endemics"

Robert Johnson "Relating to Native Plants in Wildscapes and Landscapes: Rhymes and Reasons"

Field trips north, south and west of Vernal

Register now at: http://penstemons.org/index.php/annual-meetings

Penstemon goodrichii courtesy of Mikel Stevens. See more Penstemon images on the APS website http://penstemons.org/index.php/ on the Gallery tab.

Narrow Gypsophile Endemics of the Arapien Shale, Sevier County, Utah

Leanna Spjut Ballard, January 18, 2016

The Arapien Shale formation of Sanpete and Sevier Counties, Utah, is home to several rare endemic (meaning native or restricted to a certain country or area) plant species, including Lost Creek buckwheat (*Eriogonum mitophyllum*). *Eriogonum mitophyllum* is a very rare endemic species, known only from the area south of Salina to east of Aurora, Utah as shown in map 1 below. It occurs only in one four-by-1.5-mile swath. Due to the narrow range of *E. mitophyllum*, there is concern that there could be petitions to protect it under the endangered species act. Some *E. mitophyllum* plants are on federal land and are

Looking NNW from near Carter Peak over Arapien Shale containing populations of Lost Creek buckwheat and Arapien stickleaf. Photo by Leanna Ballard protected by the BLM as a sensitive species. Arapien stickleaf (*Mentzelia argillosa)* and Utah phacelia (*Phacelia utahensis)* are also known only from the Arapien Shale badlands, but have been found scattered across the entire area from Mayfield to Glenwood. These species are all considered sensitive by the Bureau of Land Management and are all restricted to gypsiferous soils.

Gypsophiles (plants that grow in gypsum - from the Greek word phileo meaning love) can be limited to a single island or small archipelagos of gypsum. Plants that are limited geographically and specialized for life only on a particular kind of substrate, such as the Lost Creek buckwheat and the Arapien stickleaf are called edaphic (soil) endemics. The Lost Creek buckwheat and Arapien stickleaf are local endemics that may be considered edaphic specialists; plants adapted to the soil conditions of this local environment (L. Hufford 2015).

Arapien Shale

The Arapien Shale was defined by Spieken (1946) as the "red to gray shale and fine grained sandstone" that had earlier been simply known as 'Jurassic Shale', as it was formed during the is Middle Jurassic (late Bathonian to early Callovian) in age, (lasting between 166.1 ± 4.0 Ma (million years ago) and 163.5 ± 4.0 Ma) and consists mostly of interbedded mudstone, silty sandstone, micritic limestone, anhydrite, gypsum, and halite. This highly

Map 1. The Arapien shale is also known as the White Hills, as evidenced in this Google Earth image. The Arapien Shale is exposed along the east side of the Sevier Valley from Richfield in the south to the Sanpete Valley near Manti in the north. The White Hills form a decorative white band that is 35 miles long; they rise sharply from the edge of the flat Sevier Valley. Their bony slopes are the only place where the Lost Creek buckwheat (*Eriogonum mitophyllum*) Arapien stickleaf (*Mentzelia argillosa*) are known to occur.

incompetent unit was severely deformed by Cretaceous to early Tertiary Sevier orogenic thrusting and folding, and later basin-and-range normal faulting. Minor diapirism (geological structure formed when a mass of material of high plasticity and low density, such as salt, gypsum, or magma, pushes upward into overlying strata and/or tectonic processes) and isostatic uplift also deformed the strata. These deformational events were important in repeating outcrops at the surface, thickening and concentrating gypsum and shale beds, and fracturing and aiding alteration of anhydrite to gypsum, thereby greatly increasing production and profitability

A narrow seam of gypsum runs through the steep gray shale and red clays of Arapien Shale east of Aurora. Photo by L. Ballard

potential for future gypsum mining interests (Willis, 2006). The type locality is Arapien Valley, which is parallel to the west-facing base of the Wasatch Plateau, about six miles southeast of Gunnison, Utah.

The formation contains the oldest geologic strata exposed in the area. It also crops out in Salina Canyon, and in Chicken Creek Canyon on the west side of the Gunnison Plateau where it forms one of the thickest units of the formation, being over 5000 to 7000 feet thick northeast of Salina (Spieken, 1946). The total thickness of the Arapien Shale is uncertain but may exceed 13,000 feet (Witkind, et al, 1987). Individual gypsum beds average 25 feet in thickness but can be as much as 100 feet thick. The Arapien Shale that crops out in the U.S. Gypsum Corporation quarries near Sigurd is comprised of contorted greyish shale. The non-resistant beds, which comprise most of the formation, are interbedded with more resistant beds 10-12 inches thick.

As described by Spiekin, The Arapien Shale consists of four units:

1. Gray limestone generally thin bedded;
2. Light gray siltstone and shale, very thin bedded, with occasional thin beds of finely rippled sandstone;
3. Gray shale, argillaceous and gypsiferous, with irregular red blotches, which locally become dominant;
4. Compact red salt-bearing shale.

The rare endemic gypsophiles species occur on #3 – gray shale with red clays interspersed with narrow gypsum seams.

Utility of Gypsum in the Arapien Shale

Early pioneers used gypsum for plaster and mortar, but the first commercial plaster operation started about 1885 near Nephi and about 1907 in the Sigurd area. The gypsum industry expanded significantly after sheetrock wallboard became a popular building material in the mid-1900s. Gypsum continues to be produced from quarries in the Arapien Shale near Sigurd, Nephi and Levan (Willis, 2006). The landform is comprised of nearly level plateaus or terraces. All sites where Lost Creek buckwheat and Arapien stickleaf occur are above floodplains and away from them. Alluvial and flooding processes do not strongly influence the vegetation, although overland flow or sheet/rill erosion from rain events are present on steep shale slopes, as seen in the photo below:

The deformed strata in the vicinity of the Sevier and Sanpete Valleys are attributed to compressional tectonics, such as the Sevier orogeny thrusts and Laramide folding; extensional tectonics, such as normal faulting of the Basin and Range; as well as diapirism (Willis, 1986; Witkind, et al, 1987). The Arapien Shale is also the surface expression of the Sevier Valley-Sanpete Valley anticline, where the Arapien Shale formation represents the axis of the structure that trends generally north on the east side of the Sevier Valley and into the southern end of the Sanpete Valley (BLM potential report, n.d.)

Gypsum is formed by the evaporation of seawater and precipitation of calcium sulfate, whereby it is one of the first in a sequence of evaporite minerals to form. Calcium sulfate is originally deposited as anhydrite, but hydration by infiltrating surface and groundwater transforms it into gypsum. In the semiarid climate of Utah, hydration seldom penetrates more than 30 feet below the surface, and in many places, gypsum is mixed with anhydrite in outcrops (Willis, 1986). Gypsum frequently occurs interbedded with limestone and calcareous shales. The thick deposits of complexly deformed calcareous mudstone, siltstone, and sandstone, along with thick beds of gypsum and salt were deposited in a Jurassic aged tidal flat basin environment in central Utah, which is now represented by the Arapien Shale.

Gypsum, or hydrated calcium sulfate ($CaSO4 \cdot 2H2O$; this is the major ingredient in plaster of Paris and wallboard), is a difficult substrate for plants to germinate and survive on because it typically forms a hard crust when dry, erodes quickly when wet, and is relatively low in available nutrients.

Gypsum can be advantageously mixed into the soil of one's garden, but in arid environments of the American West, where it occurs naturally and richly in some soils, it can limit the growth of plants. The intolerance that some plants have for gypsum rich soils, as well as the converse—the attraction to, even restriction to, gypsum-rich soils by so-called gypsophiles, is not well understood, although recent work (Muller 2015; Palacio et al. 2014) has revealed some biochemical mechanisms that may be involved. Limitations imposed by gypsum can be at least partly physical: gypsum-rich soils in arid environments tend to form surface crusts that can be difficult for the roots of newly germinated seeds to penetrate. High calcium concentrations in soil may also limit the ability of some plant to take-up nutrients like phosphorus and iron. Gypsophiles may have adaptations that enhance uptake of these two required nutrients from the soil despite the problems presented by its calcium-richness. For gypsophiles, there may be advantages to living on gypsum-rich soils. The relatively depauperate plant communities on gypsum rich soils can reduce resource competition for gypsophiles. Gypsum crusts can also provide strong thermal insulation, which enhances water retention.

However, such gypsum-rich soils communities are vulnerable to the effects of disturbance because unusual soils are spatially patchy and isolated, endemics are highly specialized, and the resources present in arid soil environments where such soils commonly exist are limited (Damschen et al. 2011). Soils rich in gypsum epitomize these biodiverse plant communities. Although gypsum deposits occur globally, gypsum soils are almost completely restricted to arid and semiarid regions, as evaporative demand creates capillary uplift of gypsum to surface soil layers, creating gypsum crusts; in more mesic or humid environments, water infiltration and percolation prevents gypsum crust development (Escudero et al. 2014, Parsons 1976).

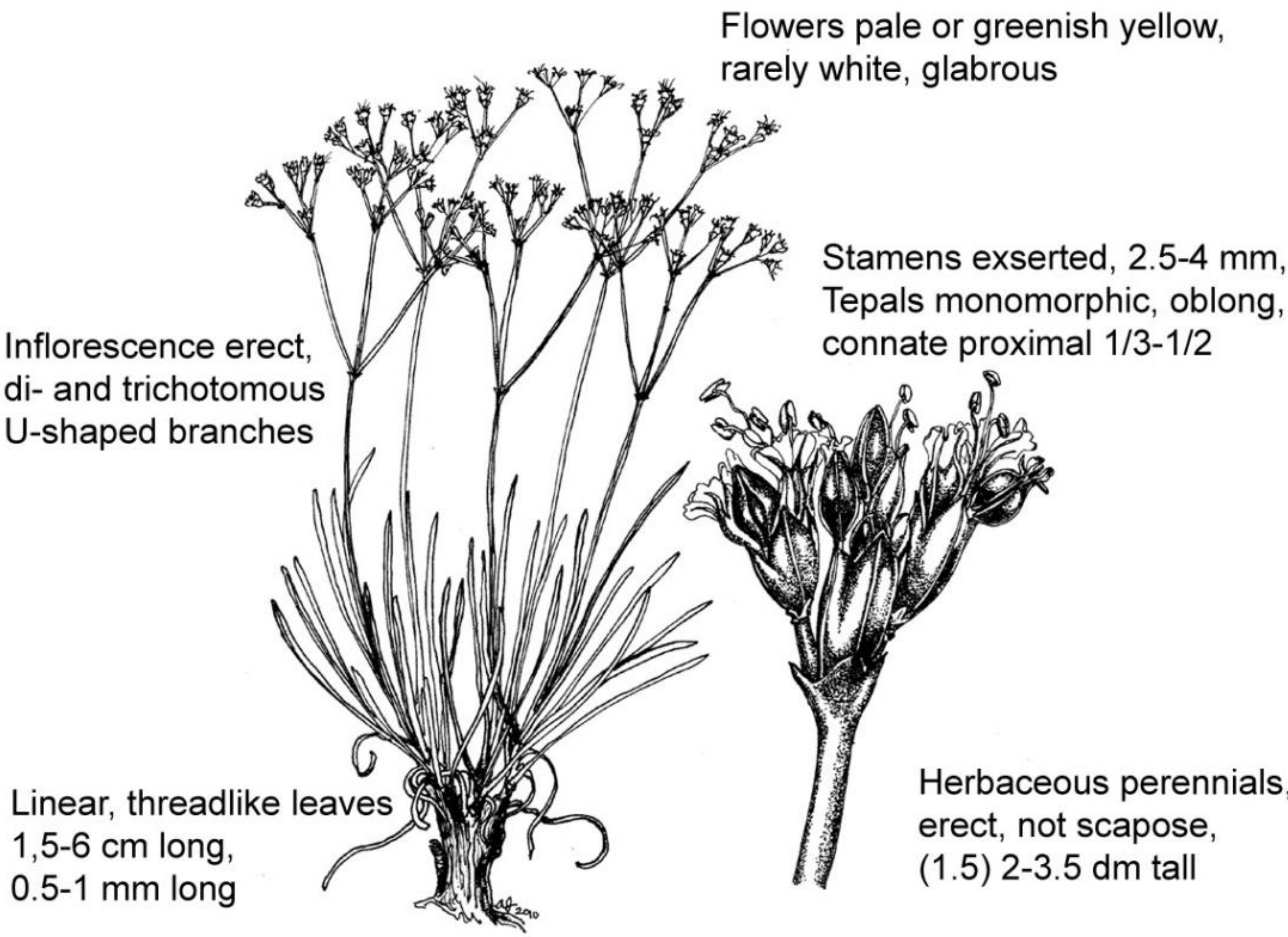
Eriogonum mitophyllum and *Mentzelia argillosa* as Narrow Edaphic Endemics

Members of Eriogonoideae are limited to North and South America, with nearly all of the species distributed throughout the arid portions of the western United States (Reveal 1978; Reveal 2005). *Eriogonum* accounts for approximately three quarters of the species richness in the subfamily, followed by *Chorizanthe* with 50 species. The remainder of the species in the subfamily are scattered throughout small segregate genera (Grady, 2012).

Ecological and geographic patterns of narrow soil endemism in plants are striking, with azonal soils, such as calcareous, gypsum, and serpentine often hosting specialized suites of endemic species contributing a disproportionate number of edaphic specific endemics, such as are found in the genus *Eriogonum* (Polygonaceae). *Eriogonum*, commonly known as wild buckwheat, is well known in the western American flora as a remarkably speciose genus with many rare taxa. In fact, of the 250+ species currently included in *Eriogonum,* approximately one third are considered rare across their range (Reveal 1978, 2005). The United States Fish and Wildlife Service lists a total of thirteen taxa (species or varieties) in *Eriogonum* as either Endangered, Threatened, or as a Candidate for listing on the Endangered Species List (USFWS Species Reports). Many other species are listed by various state and federal agencies, acknowledging some level of rarity (Grady 2012).

Art Kruckeberg, a great student of soil specialization and plant distribution, suggested that edaphic endemics evolve from ancestors that are less specialized—they could become established and persist on restrictive as well as unrestrictive substrates (Kruckeberg, 2002,1986, 1985, 1984). There are different models for the evolution of edaphic endemics. Peter Raven applied the idea catastrophic selection in which small marginal populations become isolated, suffer a rapid decrease in number of reproductive individuals, and, subsequently, adapt rapidly under strong selection from an extreme environment as narrow edaphic endemics (Raven, 1964). In contrast, Don Levin's model of ecological speciation portrays edaphic shifts occurring more gradually, and possibly with interbreeding between the newly evolving edaphic specialist and its less specialized ancestral group. Levin's model calls primarily for shifts to "benign sinks"—environments that are not extreme and can permit the establishment of various species—that require little genetic change. Levin's model for the gradual evolution of edaphic tolerance and, perhaps, specialization, emphasizes that changes in few genes may be involved (Levin 2005; 2004).

These models emphasize new evolutionary change to account for edaphic endemics. Some have pointed out that we must also carefully distinguish species that are narrowly distributed because they are newly evolved (so-called neo-endemics) from those that once were more widespread but have become more narrowly distributed over time (so-called paleo-endemics). These paleo-endemics may have narrowed distributions because of climate change or increasing competition for resources. Paleo-endemics may not have evolutionary specializations for life on restrictive substrates but simply may be capable of tolerating the restrictive conditions, especially as a refuge from competition or intolerable environmental changes in their former ranges. With paleo-endemics, we should perhaps look for the absence of specializations and for the signs of escape (Hubbard, 2006).



ERIOGONUM MITOPHYLLUM

(from Utah Rare Plant Guide)

Eriogonum mitophyllum with linear leaves and reddish cast as it nears end of its growing season.
Photo by L. Ballard

Eriogonum mitophyllum

Eriogonum mitophyllum is a very restricted, narrow endemic as described by Reveal (2004), as it is known to occur only from a four-mile swath within the Arapien Shale badlands above Lost Creek northeast of Sigurd, Sevier County. It is allied to *E. ostlundii*, but differs in its linear leaf blades, narrow, strict inflorescences with di- and trichotomous, U-shaped branches, and longer, pale yellow flowers. The leaf blades are threadlike and the narrowest of any species in the genus (J. Reveal 2004). As of January 2015, *Eriogonum mitophyllum* Reveal (Lost Creek Buckwheat) is listed as an extremely high priority plant species in the Utah Rare Plant Guide. It is native to a location subject to mining and recreational activities that put the long-term survival of the species at risk.

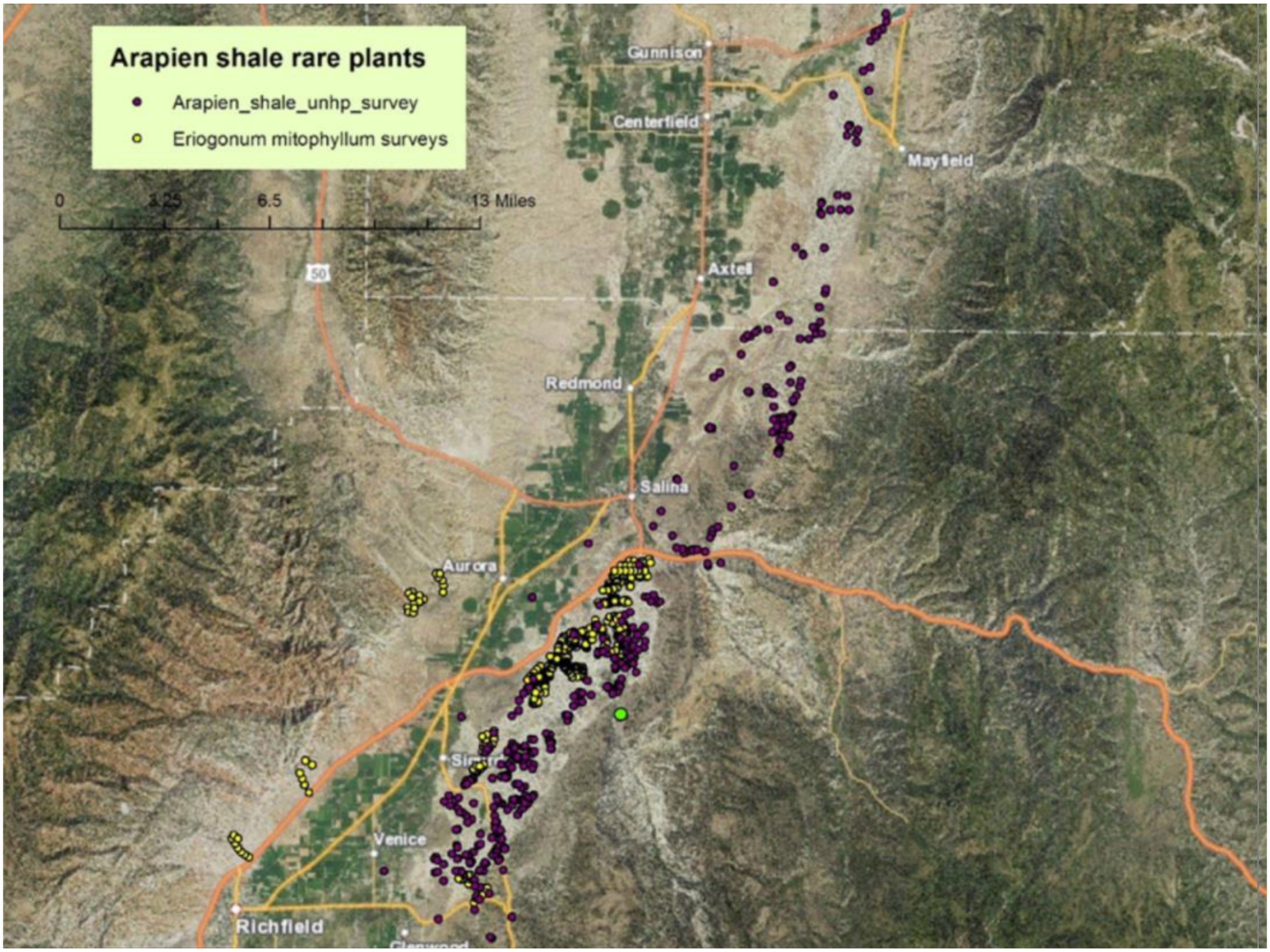
As the requirements for growth of *Eriogonum mitophyllum* are not currently known, Utah State University soil scientists collected seeds of this wild buckwheat in October 2016, and will attempt to grow seeds of and conduct soil tests from soil samples collected where Lost Creek buckwheat seeds were gathered. Seedlings from these growth experiments may aid in future restoration efforts to re-establish *Eriogonum mitophyllum* after mining disturbance. Soil samples will be characterized in detail in collaboration Dr. Paul Grossl, soil biogeochemist at Utah State University along with Jennifer MacAdam's soils lab at USU. They are planning to characterize the conditions that promote germination and establishment. The objective of this study is to define optimal conditions for propagation of this species from seed to support the long-term goal of active reintroduction.

Seed was collected from the native population in collaboration with Robert Fitts and Leanna Ballard, Utah Natural Heritage Program. Soil samples were taken from within the boundaries of the growth habitat and from outside the boundary of the habitat. This was done to identify soil characteristics of potential importance to species adaptation, including texture, pH and electric conductivity. Site descriptors that differ from Reveal (2004) will also be noted. A sufficient amount of soil meeting habitat characteristics to use in greenhouse germination and establishment studies, without disturbing the habitat, was collected on site. The Utah Native Plant Society is funding this work.

Besides the Lost Creek buckwheat, other Arapien Shale narrow endemics and rare plant species that occur on these shale badlands and that are tracked by the Utah Natural Heritage Program (UNHP) include: *Mentzelia argillosa, Phacelia utahensis, Ericameria nauseosa* var. *iridis*, which is a dwarf rubber rabbitbrush; Coulter bisquitroot (*Cymopterus coulteri*), Ward's penstemon (*Penstemon wardii*) and Rydberg's penstemon (*Penstemon rydbergii*).

The Arapien stickleaf or blazing star takes its common name from the substance of the White Hills; their powdery base of white, with its shades of gray, tan, green and pink, that is the Arapien Shale, rich with gypsum. Scattered on the surface of the hills are hunks of selenite, a crystalliferous form of gypsum, which looks like layer after layer of fused, slightly cloudy glass. The gypsum from these hills is mined and processed in a nearby facility, layered in bone white dust, near Sigurd.

Although the Arapien stickleaf (*Mentzelia argillosa*) is also very rare, no conservation status is currently assigned by management agencies. It was formerly on the BLM Sensitive Plant List, and was a category 2 candidate for listing under the Endangered Species



Map 2. Points of rare plant surveys in the Arapien Shale area conducted by Utah Natural Heritage Program, 2013. Note that the northern reaches of the Arapien Shale badlands have been surveyed for other rare plants but not Eriogonum mitophyllum.

Act of 1973, as amended (see Vol. 58 Federal Register No. 188 - Franklin, 2005).

This species is a central Utah endemic that occurs in the Sevier River Valley, Sanpete and Sevier counties. It is known on steep, eroding, semi-barren slopes of the Arapien Shale Formation along the east side of the valley from Ninemile Reservoir, north of Mayfield, south to the vicinity of Rainbow Hills near Glenwood. It grows in piñon-juniper and mixed desert shrub communities with alder-leaf mountain mahogany, (*Cercocarpus montanus*), shadscale and *Ephedra* (Fitts, pers. comm. 2005a, Welsh et al.

2003). It occasionally grows in close association on barren gray shale puffy soils with *Eriogonum mitophyllum* being the only other vegetation species present (L. Ballard, pers. observation. 2016).

Edaphic specialization in *Mentzelia* section *Bartonia* (family Loasaceae) may be best explained by the model called 'refuge endemism.' This model proposes that a plant species that is poor competitor for resources may be limited to growing in marginal environments, such as restrictive substrates, if it can tolerate the substrate restriction but most other local species cannot. The data that are available indicate that mentzelias are poor resource competitors but they appear to be widely tolerant of restrictive substrates. The mentzelias also have relatively good dispersal ability. Chance dispersal of seeds to an "island" of restrictive substrate could result in the establishment of a new population of *Mentzelia* that would be reproductively isolated from its parent population. This reproductive isolation over time could facilitate adaptation to local ecological

Mentzelia argillosa occurs on barren soils where no other vegetation species exist on grey-tannish shale soils. It also co-occurs with Lost Creek buckwheat in several locations.
Photo by L. Ballard

Lost Creek buckwheat and Arapien stickleaf grow side by side on barren grey shale mounds.
Photo by L. Ballard

conditions and speciation—the divergence of the new population from its parent population (Hufford, 2005).

Arapien Shale Vegetation Communities

The areas of Arapien Shale where these rare endemic species occur includes a variety of vegetative community habitats; most of them with sparse, depauperate vegetation cover due to the harsh red clay, grey shale and gypsum bearing soils that dominate the formation outcrops. The average precipitation is low - 9.77 inches per year, with average maximum temperature of 63.9 degrees and average minimum temperature of 33.6 degrees (Western Regional Climate Center, 2016).

Barren grey shale mounds and steep slopes with puffy soils, within the relatively narrow elevational band that Lost Creek buckwheat occurs at between 5,250 to 5,575 feet elevation are the most common locations where the gypsophilic Lost Creek buckwheat and Arapien stickleaf co-occur. This habitat is often devoid of any other vegetation species.

At the lowest elevations of the White Hills, low-lying somewhat concave flats contain substrates that are shallow, typically saline or alkaline, with fine-textured soils developed from shale or alluvium. The infiltration rate is very low in the Arapien shale. These low-lying areas with alkaline, shallow soils support dwarf-shrublands composed of relatively pure scattered stands of shadscale (*Atriplex confertifolia*) and other *Atriplex spp*. such as *A. corrugata or A. gardneri*. Other less dominant or codominant dwarf-shrubs include *Artemisia nova, Ephedra viridis,* or *Tetradymia spinosa. Artemisia tridentata* variety *wyomingensis* occurs on adjacent higher, convex hills where soils are deeper and better developed. Sagebrush uplands adjoin the low-lying *Atriplex* communities and dominate the mid-elevational zones.

Ericameria nausosus var. iridis near Carter Peak at 5900 feet elevation. Photo by L. Ballard

A close association exists on the Arapien Shale between black sagebrush and the Lost Creek buckwheat; but the buckwheat does not occur in stands of Wyoming sage.

On relatively flat lowlands, large tracts of Wyoming sage or *Artemisia tridentata* ssp*. Wyomingensis,* black sage (*Artemisia nova)*/ Green or viscid rabbitbrush (*Chrysothamnus viscidiflorus)* and rubber rabbitbrush/ Indian ricegrass (*Ericameria nauseosus/Achnaetherum hymenoides)* communities exist where soil disturbance has not been extensive. Indian ricegrass is the dominant graminoid (grass) species in all areas but other native wheatgrasses including bluebunch wheatgrass (*Pseudoroegneria spicata* variety *spicata)*, Salina wildrye (*Leymus salinus ssp. salinus*) and Western wheatgrass (*Pascopyrum smithii*) occur less frequently.

Both the harshness of the Arapien shale soils to most vegetative species and the low precipitation of the area have contributed to the lack of species diversity. Although low levels of diversity, frequency and cover of forbaceous species occur on the areas where gypsum is actively mined, several wild buckwheat *Eriogonum* species dominate the upland, herbaceous forb component, which consists for the most part of wide, rolling to very steep barren slopes and some valley sage uplands. Basin yellow cryptantha (*Cryptantha confertifolia)* and beardtongue (*Penstemon)* species are also common forbs found through much of the area. Gypsum seam rock outcrops extrude through the finely-textured shale and red clay, in shallow soils at many locations throughout. Shallow soils and sparse vegetative cover characterize most of the Arapien Shale area, except in drainages and valley bottoms where more precipitation accumulates.

A mountain shrub community with dominant shrubs mountain mahogany/Stansbury cliffrose (Cercocarpus montanus)/Purshia stansburyana occurs forms an elevational band higher than the sagebrush zone but lower than the pinyon-juniper woodland. It forms a minor component of the overall vegetation cover of the Arapien Shale. On mid-to-upper elevation north facing slopes in the Eagle Rock and Carter Peak areas, these mountain brush communities occur in patchy, scattered populations.

Pinyon-juniper (*Pinus edulis/Juniperus osteosperma*) woodlands are found on mesa tops and slopes at higher elevations above those of lower elevations that support populations of Lost Creek buckwheat (*Eriogonum mitophyllum*) and Arapien stickleaf (*Mentzelia argillosa*). The only BLM sensitive species located in this higher elevation plant community is rubber rabbitbrush variety iridis (*Ericameria nauseosa* variety *iridis*). Substrates are shallow, rocky, and commonly comprised of steep shale soils. The vegetation is dominated by dwarfed (usually less than 3 m tall) pinyon pine and/or Utah juniper. Other shrubs which are interspersed as the elevation and slope steepness lessen, include Wyoming big sage, black sage, and/or green rabbitbrush. Ground cover is often sparse but is moderately dense in small ephemeral drainages near Carter Peak. Drought-tolerant grass species including western wheatgrass and bluebunch wheatgrass are present.

Current Narrow Edaphic Endemism and Gypsophile Research

Why are there so many edaphic endemic species in certain plant lineages? Various models have been proposed for the ecology and evolution of edaphic endemism. Gankin and Major (1964) outline the "refuge model" (also referred to as the "generalist model"), in which a stress- tolerant generalist species or population is able to proliferate by growing on marginal soils in the absence of competition from other stress-intolerant species. Alternatively, some plant species may be better adapted to unusual chemical and physical properties associated with a certain soil types, i.e. the "specialist model" proposed by Meyer (1986). This model states that "specialist" plant species are physiologically better adapted to special azonal soils, than they are to more typical zonal soils. If a plant lineage is composed of edaphic generalists, than we would expect to see little pattern of edaphic similarity when compared to the evolutionary history. Soil characteristics, when mapped on a phylogeny of a group, would show strong, clade-specific affinities if the "specialist model" applies (Grady, 2012); an intriguing line of inquiry in future studies of *Eriogonum*.

The ability of plants to survive in substrates with limiting conditions for plant life has intrigued biologists since early times (Mason, 1946). Gypsum soils are amongst the most widespread special substrates, extending over 100 million hectares (Verheye, et al. 1997), but yet they have received comparatively less attention than other substrates such as serpentines, saline or calcicolous soils (Palacio et al. 2014). Gypsum soils develop from gypsic rocks in arid and semi-arid areas where low precipitation prevents gypsum from being leached. Together with the arid conditions, gypsum soils have particularly stressful physical and chemical properties for plant life including the presence of hard soil crusts, high mechanical instability, low soil porosity, extreme nutritional deficits, high concentration of sulphates and moderate salinity (Guerro et al. 1999; Meyer et al. 1986, 1989, 1992). As a consequence, they are among the most restrictive soils for plants (Parsons, 1976). Nevertheless, the adverse conditions of gypsum soils contrast with the rich and specialized flora they shelter, comprising diverse arrays of narrow endemic and rare plants in arid and semiarid regions, many of which are threatened or endangered and constitute a global conservation biodiversity concern (Palacio et al. 2014).

The patchy distributions of unusual soils, in combination with the highly specialized endemics that inhabit these regions, make them biodiversity hotspots (Escudero et al. 2014). Edaphic endemics contribute to a large portion of the world's biodiversity despite their limited distribution (Damschen et al. 2011). Utah has a high percentage of narrow edaphic endemics which are currently being tracked by the Utah Natural Heritage Program.

Understanding the specific drivers of gypsum endemism is an area of current focused research, particularly in Europe. Current work by Palacio and others (2007, 2014) suggests that gypsophiles are adapted to the unique chemistry of gypsum soils, as indicated by the unique leaf nutrient signatures in gypsophiles versus gypsovags. Depending on their specificity to gypsum soils, plants can be classified as gypsophiles, i.e. plants growing exclusively on gypsum substrates, or gypsovags, i.e. plants growing both in and out of gypsum (Duvigneaud et al. 1968). In general, regionally dominant gypsophiles have higher concentrations of inorganic compounds than gypsovags, and in some cases accumulate calcium oxalate crystals. The unique leaf nutrient signatures of gypsophiles are strong evidence of physiological specialization in the sampled gypsum flora of the Central Iberian Peninsula of Spain.

Other recent studies (Muller, 2015) in the Chihuahan Desert concur with the Palacio et al. (2014) findings. Plants growing on gypsum showed a distinct leaf chemical signature, driven primarily by calcium and sulfur. Gypsophilic plants had much higher Ca and S than plants growing off gypsum, including close relatives.

Some data suggest that widespread gypsophiles are capable of sequestering excess Ca as calcium oxalate crystals, which can be stored or excreted through their leaves (Palacio et al. 2014). Other work suggests gypsophiles can secrete crystal forms of gypsum through their leaves (He et al. 2015). Although the mechanisms used to prevent elemental toxicity are not yet currently known, current work in research laboratories using Fourier transform infrared spectroscopy (FTIR) are underway to determine which forms of calcium and sulfate are stored (Muller 2015).

Despite the recent efforts devoted to understand plant life on gypsum, the mechanisms displayed by plants to become competitive on gypsum soils are still not fully understood. Early investigations showed that the chemical composition of gypsophiles and gypsovags differs, with the former showing higher concentration of certain nutrients (N, P, Ca, S) and total ashes than the latter (Duvigneaud, 1968; Duigneaud, 1966; Boukhris et al. 1970).

Palacio (2014) reported the first empirical confirmation that some of the crystals observed in gypsophiles from non-saline soils are made of mineral gypsum (i.e. $CaSO_4N2H_2O$). Wide gypsophiles are commonly considered as ''accumulators'' of compounds such as S, Ca or Mg, being highly permeable to them and hence able to tolerate high concentrations (toxic for most plant species) in their leaves (Duvigneaud, 1968; Duigneaud, 1966, Boukhris et al. 1970). Soil gypsum contents above 20–30% are generally considered to be toxic for most plant species, but gypsum contents often surpass 50% in the soils where these plant species were collected from the two more massive and distinctive gypsum outcrops of the Iberian Peninsula: Central Spain (Middle Tajo Basin, near Madrid) and NE Spain (Middle Ebro Basin, near Zaragoza).

In the Palacio et al. study (2014), results indicated widespread presence of gypsum and calcium oxalate crystals in most of the specialist plants examined, by utilizing Fourier Transform Infrared (FTIR) Spectroscopy. While gypsovags seem to be stress tolerant plants that tightly regulate the uptake of S and Ca by their roots, narrow gypsum endemisms share the ability to accumulate excess Ca as oxalate with gypsophiles, possibly indicating their incipient specialization to live on gypsum. Further studies should focus on evaluating the generality of these conclusions and their extrapolation to gypsum plants from other regions of the world, perhaps to those plant residents of the Arapien Shale in Sevier County, Utah?

These results have important implications for the understanding of plant adaptation to gypsum substrates as they suggest that narrow gypsum endemisms are not just stress-tolerant plants that find refuge from competition on gypsum without particular specialization to this special substrate. The narrow gypsum endemisms studied in Spain might have recently evolved from stress-tolerant gypsovag species or ecotypes, and could be in the process of specializing to gypsum soils, developing adaptive mechanisms, such as the accumulation of oxalate, to survive on gypsum.

An intriguing area for future studies of *Eriogonum mitophyllum* may be to test for the signatures of oxalate crystals and other adaptations to the harsh gypsiferous soils of the Arapien Shale certainly seems warranted in view of these recent findings.

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Two of the references in Leanna Ballard's article are for editions of *A Utah Flora* authored by Dr. Stan Welsh et al. Here is Stan with Bill King, at the UNPS Rare Plant Meeting on March 7th of this year, with his lifetime achievement plaque presented by UNPS for his lifelong dedication to the study of the flora of Utah and for the co-founding of the Utah Native Plant Society.

Dr. Welsh gave a 10 minute extemporaneous talk about rare plants in Utah which you can read on page 30.

Something Looks Different About this Juniper: Morphological Variations of *Juniperus osteosperma*

By Jonathan Barth, The Amateur Naturalist

Last summer while on a bioblitz as a photographer, and nominally a plant expert, I came across some coniferous shrubs and trees. They looked like Utah junipers with small scale like leaves, tight against each deep green twig. However, on some other twigs and branches, the leaves were pointy and stuck out from the twigs. Instead of being deep green, they were glaucous, having a grey-blue haze.

Fortunately there were real plant experts on the bioblitz with me. I showed some photos of the pointy prickly leaves of the conifer that I now know is *Juniperus osteosperma* to someone in the group. (I forget to whom I can give credit.) He immediately said that it is the juvenile foliage of the Utah juniper.

Juniperus osteosperma seedlings each with 4 cotyledons. Photo by Al Schneider www.swcoloradowildflowers.com

J. osteosperma twig with prickly juvenile foliage.

Usually when plants are described in less academic sources, you might find only one description for leaves on a species like *J. osteosperma*, "leaves are scale like." A more academic description might also mention that, "foliage consists of first-year, awl-shaped needles."

Reading the first description may lead an amateur like me to think all leaves on a Utah juniper are the same. The second description may go over my head as I try to comprehend a long paragraph full of technical language.

Then there's the question of what is meant by first year. Is it the first year of the plant's life? Or, first year of each branch? As precise as technical language is, sometimes it isn't precise enough.

A single plant species, like the Utah juniper, may look different depending on a variety of factors. It may have more morphological variations than are listed in even the most thorough academic description. There may even be differences that have not been described, or even documented. There may be variations depending on a plant's:

Maturity: Is it a sprout, juvenile, or mature?
Sun Exposure and Duration: Is it on a northern or southern slope, in shade or full sun?
Soil Moisture: Is it growing in wet or dry conditions, or is the moisture inconsistent from season to season.

Air flow: Is it growing on an exposed windy ridge, or is it protected in a canyon?
Animal influence: If there are many grazers - domestic or wild – they may shape a plant, shrub or tree and make it look completely different than one growing in the absence of herbivory.
The Sex of the Plant: Males and female forms may/or may not be different from one another for dioecious plants. Monoecious plants, with both sexes on the same plants, may have those differences on the sample plant.

All photos by the author (except the one for which permission to use was granted by Al Schneider).

Mature twigs with scale like leaves. The brown tips look like dried out leaves, but are the male cones.

A scenic looking Utah juniper on a cliff side at Johnson Lakes Canyon, Ut.

Mature twigs and a female cone.

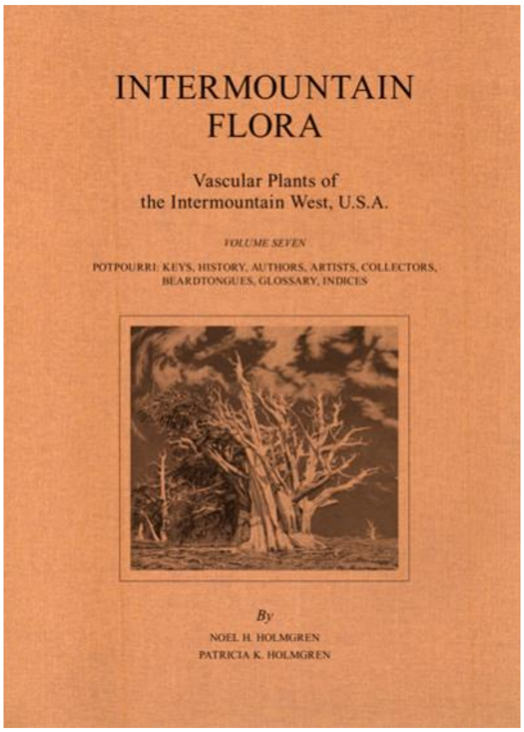
Below, a mature Utah Juniper, wild yet appearing manicured.

A specimen about 2 meters tall, with “juvenile foliage.” I doubt if this small tree is only a year old.

Botanist's Bookshelf: DVD Extras for Lovers of the Intermountain Flora

Review by Walter Fertig

Holmgren, Noel H. and Patricia K. Holmgren. 2017. Volume Seven. Potpourri: Keys, History, Authors, Artists, Collectors, Beardtongues, Glossary, Indices. Intermountain Flora. Vascular Plants of the Intermountain West, U.S.A. New York Botanical Garden. 303 pp.



In 1972 the Godfather was the top movie in the United States, Mark Spitz won seven gold medals at the Olympics, Atari introduced the video game PONG, a Ford Pinto cost $2078, the Apollo 17 astronauts were the last to walk on the moon, a third-rate burglary was thwarted at the Watergate Hotel in Washington, and Richard Nixon was re-elected President by a landslide. 1972 was also the year that Volume 1 of the *Intermountain Flora* was published by the New York Botanical Garden. The flora covered the basin and range country between the major mountain axes of the Sierra Nevada and central Rockies from southeastern Oregon and southern Idaho through Nevada and Utah to northern Arizona (with slivers of California and Wyoming thrown in for good measure). It was modeled after the 5-volume *Vascular Plants of the Pacific Northwest* and included keys, full species descriptions, and line drawings of every known plant species of the region. Volume 1 focused on ferns, fern-allies, and gymnosperms, but also included information on the geology, vegetation, plant geography, and history of botanical collecting in the intermountain west.

Like sequels to a successful movie, new volumes of the Intermountain Flora appeared every three to eight years, finally culminating with the eighth volume (technically Volume 2A) in 2012. Those eight tomes covered 3847 species in 898 genera and 146 plant families. At 731 pages, the last volume was by far the largest, covering the "basal" dicot subclasses in Cronquist's influential (though now somewhat dated) classification scheme. Some additional summary features had been planned for the final volume, but the heft of the book prevented their inclusion. Left on the cutting room floor were the cumulative index and glossary and a key to all of the plant families of the intermountain region.

But like a successful movie franchise, a ninth installment of the Intermountain Flora saga has now been published. The volume (technically number seven in keeping with previous naming conventions) is appropriately entitled "Potpourri: Keys, History, Authors, Artists, Collectors, Beardtongues, Glossary, Indices." For fans of the Intermountain Flora, Volume 7 is like a whole DVD of extras from your favorite movie or television series (though, sadly, there is no blooper reel). The book is loaded with valuable supplemental material and many guilty pleasures for the botanically-minded.

Of course there is a family key, glossary, and index, as originally promised. The family key is outstanding and uses tangible field characters, rather than arcane or microscopic anatomical details, to differentiate genera and families, and thus can actually be used to identify unknown specimens. Workable family keys are among the hardest to write, and Noel Holmgren deserves a lot of credit for the extra effort he put into making the key user-friendly. The glossary is nearly 30 pages long and covers most of the specialized botanical terms necessary for describing plants.

Chapter 3 is where the fun begins. Noel Holmgren recounts the origins of the Intermountain Flora project with a fond biography of Bassett Maguire, the intellectual father or grandfather of all of the original authors from 1972. Maguire was just the third faculty member in the Department of Botany at Utah State

Agricultural College (now Utah State University) in Logan, when he was hired in 1931. His avid collecting helped grow the USU herbarium into one of the largest in the region, and his abilities as an educator attracted many top-notch students, including Arthur Cronquist and Arthur Holmgren. Maguire was also keenly aware of the need for a modern flora of Utah and surrounding states and the fieldwork required to make it happen. In 1943, Maguire was hired as the curator of the New York Botanical Garden, leaving Utah State's herbarium in the capable hands of his protégé, Arthur Holmgren. Maguire's research interests shifted towards tropical botany, and his collecting in the West diminished considerably. But his most important contribution was formalizing an agreement between the Garden and Utah State University to produce the Intermountain Flora. Other commitments ultimately forced Maguire to hand over leadership of the project to his former student, Arthur Cronquist, who had followed Maguire to New York.

Additional biographies follow for each of the primary authors who contributed to the flora over the years. Each is filled with interesting and amusing anecdotes based on Noel Holmgren's memories and experiences. Thus we learn about Arthur Holmgren's ability to simultaneously draw and label plant diagrams on a chalkboard with his right and left hands. Or how Arthur Cronquist would acquire empty cardboard boxes for storing dried plant specimens in the field by helping stock shelves at rural grocery stores. Or share in the excitement of Rupert Barneby jumping up and down and making sounds "like that of some stricken bat or a poetess at a cocktail party" after discovering a new species of *Astragalus* while Noel and Pat were parking their camper for the night. Or discover Jim Reveal's alter ego as a novelist, basing a cowboy character on his own adventures as a teen horse packer in the Sierra Nevada. Or Pat Holmgren's formative botanical experiences on her parent's Christmas tree farm in Indiana. All of these stories help to personalize these famous botanists, who otherwise might be remembered only by their papers and specimens. Noel and Pat also provide biographies for Jeanne R. Janish and Bobbi Angell, two of the foremost artists who contributed the botanically accurate and beautiful illustrations that make the Intermountain Flora stand out among other regional floras.

One of my favorite "extras" is the section on plant collectors of the Intermountain West assembled by Pat Holmgren. Over 40 pages are devoted to images of 353 plant collectors active in western North America. These range from Thomas Nuttall and Nathaniel Wyeth in the 1830s to several dozen contemporary collectors. There is a lot of pleasure in matching names to faces and seeing how our colleagues looked when they had more hair or wore groovier clothes. It is also interesting to contrast the formal, sepia-toned portraits of early botanists with the more relaxed attire and demeanor of modern workers, while knowing the common thread that binds us all together. Space permitted only one formal biography in this section, but few are more deserving of the attention than Arnold "Jerry" Tiehm, one of the foremost plant collectors of Nevada in the modern era and a real "botanist's botanist." As with the other characters described in the preceding chapters, Tiehm has his own interesting background, having worked for many years as a bellman and limo driver in casinos in Reno to support his passion for plant exploration.

The final notable "extra" in the potpourri is an update on the genus *Penstemon*. Noel Holmgren is one of the foremost experts on this important western genus, and much additional information has come to light since his original treatment appeared in Volume 4 in 1984. Eighteen new species or varieties have been documented in the flora region in the last 30 years, including ten new to science. Holmgren has re-written the artificial key to *Penstemon* taxa and the more formal technical keys to different sections of the genus, as well as provided new and updated species descriptions for the 23 taxa impacted by changes in taxonomic rank or circumscription. As always, each species is accompanied by a detailed line drawing, a full description, and a paragraph or two describing the collector who documented the species. These anecdotes, along with the images of modern collectors juxtaposed with field workers from the 19th and early 20th centuries, provides a nice bookend to the chapter on "Botanical Explorations in the Intermountain Region," which appeared in Volume 1 back in 1972.

True to its title, Volume 7 is a medley of botanical odds and ends that help bring the Intermountain Flora series to a joyous conclusion. Future historians will find it especially useful as a trove of original information on some of the leading botanists of the 20th Century. Armchair explorers and nature lovers will appreciate the stories and photos of seemingly sane individuals who spend their free time traipsing about desert mountains and remote canyons, looking for new species or range extensions, or just satisfying an itch to see what plants lie beyond the bend.

Milkvetch (*Astragalus*) of Northern Utah

by Wayne Padgett

The name *Astragalus*, or milkvetch as they are "commonly" known, bring fear to many people in the botany world – it certainly does to me! Not because it has inherent negative aspects, although some species are toxic to livestock. Rather, it is because of all the genera in the world, this genus in the Pea Family has the most species (over 3,000). According to Wikipedia, the nearest competitor for most species is the genus *Bulbophyllum* in the Orchid Family, which has just over 2,000 species; only one of which occurs in the continental United States in southern Florida. Utah alone has over 100 species of *Astragalus*. All I have to do is open *A Utah Flora* to the Key I, Key to Selected Species and Groups (on page 408 in the 4th Edition) and I start to shake. For years, the fear of this genus made me resist even *trying* to identify these pretty little (sometimes not so little) plants to the species level.

But it was because of this fear that I decided to face it head on. I started by going through the Plants Database online and finding only those *Astragalus* species that occur within the counties of Utah and Idaho that include the Wasatch Mountains and the Bear River Range. That narrowed the list from 122 to 24. Ahhh... that felt better. I then created a spreadsheet with all those species, and their varieties in a list on the left and all the characteristics used to describe those species on the top. I filled out the spreadsheet and developed my own version of a key with photos to help me (and maybe others) identify the species I was going to encounter as a part of my personally inflicted challenge to photograph every vascular plant species in the Wasatch Mountains and Bear River Range. I started taking photos of every *Astragalus* species I could find on those landscapes. And, because I had started to find and learn about these fun plants, I volunteered last year to lead a field trip for UNPS. And, several UNPS friends to see a few species that occur in the Bear River Range near Monte Cristo and in the foothills of Rich County north of Randolph (Figure 1).

On top of the Monte Cristo pass from Weber County to Rich County we saw the white-flowered *Astragalus tenellus* (pulse milkvetch) with its narrow leaflets and flattened seed pods (Figures 2a & 2b). From there we traveled to the foothills below the pass where we found the little, simple-leafed *Astragalus spatulatus*, (draba milkvetch, Figures 3a & 3b) and the equally small trifoliate *A. gilviflorus* (plains milkvetch, Figures 4a & 4b). Both plants are small with small flowers, but their leaves are the perfect way to distinguish one from another.

We also saw *Astragalus purshii* var. *glareosus* (Pursh's milkvetch, Figure 5). While it is very similar in characteristics to the widespread *A. utahensis* (Utah milkvetch) and it is often difficult to distinguish between the two species, we knew we could do it! We're tough plant geeks, don't ya know! *Astragalus purshii* pods are "shaggy villous" and *A. utahensis* pods are "***long*** shaggy-villous". *A. purshii* flowers are between 19-26 mm long, while *A. utahensis* flowers are between 23-31 mm long. *A. purshii* pods are between 13-26 mm long and 5-11 mm wide, while *A. utahensis* pods are between 17-30 mm long and 5.5-7.5 mm wide. While the flowers of the plants we saw were 24mm (totally within the overlap of the two species), our pods (once the hairs were removed) were about 14 mm long; clearly under the size of *A. utahensis*. Thumbs up!

Figure 1. UNPS Astragalus fans on the foothills near the Rich County landfill checking out the plants!

From there we traveled to the road going up to the landfill northwest of Randolph where we saw *Astragalus jejunus* var. *jenunus* (starvling milkvetch) with its beautiful maroon-mottled pods and tiny flowers, 5-6.5 mm long (Figure 6). This variety occurs in northeastern Nevada, then isn't found again until you reach the area where northern Utah, southeastern Idaho, southwestern Wyoming, and northwestern Colorado come together. Nowhere is this plant

Figure 2a. *Astragalus tenellus* with its tiny flowers (6-9 mm long) and its narrow leaflets.

Figure 3a. *Astragalus spatulatus* plant with its tiny flowers (5.7-9.5 mm long), pods, and linear leaves.

Figure 4a. The 17-28 mm long flowers of *Astragalus gilviflorus* are carefully hidden close to the ground beneath the leaves.

Figure 2b. The flattened pods of *Astragalus tenellus*.

Figure 3b. Image clearly shows the linear (non-divided) leaves of *A. spatulatus* as well as its small pods (4 -13 mm long).

Figure 4b. The trifoliate leaf of *A. gilviflorus* clearly separates this from most other species of *Astragalus*, and from all those found in the Bear River Range and its foothills.

Figure 5a. *Astragalus purshii* var. *glareosus* flowers (19-26 mm long).

Figure 6a. *Astragalus jejunus* var. *jejunus* are beautiful, tiny plants with small flowers (5-6.5 mm long) and colorfully mottled pods.

Figure 8a. The typically white flowers of *Astragalus eurekensis* (22-28 mm long) with their purple keel distinguish this from many species in this part of the state.

Figure 5b. While the pod appears to be nearly 18mm in length, they are measured without the hairs; ours were 14mm long.

Figure 6b. Small mottled pods (10-17 mm long) of *A. jejunus* var. *jejunus*

Figure 8b. The beautiful pods of *A. eurekensis* (15-40 mm long) with their sparse hairs (photo taken in early June 2016)

abundant, but we were lucky enough to find it in flower and with seed pods that clearly stand out. It was a fantastic day in the field for a newly-developing *Astragalus* nerd, like me!

Which brings us to this year's field trip (and future field trips)!

Because we had just a fun group and great response to last year's *Astragalus* field trip, and because I needed an excuse to get out to see something in flower, we decided another trip (this time to the foothills of the southern Stansbury Mountains) in April was in order, so we could see some early flowering *Astragalus* (is the plural of *Astragalus*, *Astragali*?). Off we went, south of Tooele (and Stockton) to Utah Highway 199! Another great group of folks and another fun day in the field!

So, what did we find? Well, while I did not get a shot of it, we had three species of Astragalus in bloom right next to each other: *Astragalus eurekensis* (Eureka milkvetch), a Utah endemic pretty much limited to western Utah (Figures 8a & 8b); *Astragalus beckwithii* var. *beckwithii* (Beckwith's milkvetch), a cream-to yellow-colored variety of this species (Figures 9a & 9b); and the more common *Astragalus utahensis* (Figures 10a & 10b), with its low growing, fuzzy leaves, and its big flowers. A successful day indeed! I'm including in the figures below, images that I took last year of the pods of these plants to assure you that we are not just guessing which species we saw. The

Figure 9a. Cream- to yellow-colored flowers of *Astragalus beckwithii* var. *beckwithii* (14.5-21 mm long). *A. beckwithii* var. *purpureus*, which can also be found in Tooele and a few other counties in Utah, has pink-purple or bicolored flowers. We did not see that species.

Figure 9b. Pods of *A. beckwithii* are obliquely ellipsoid and ours were beautifully mottled. This image was taken in June 2016 – reason enough for folks to go back out to see this beauty in seed.

Figure 10a. *Astragalus utahensis* with its large (23-31 mm long) flowers and densely villous-tomentose leaves. Plants can get much larger than this one, up to 5 dm wide, and *that's* a BIG plant!

Figure 10b. Last year's *A. utahensis* pods over 20mm long, which are within the ***size*** range of *A. purshii* var. *glareosus* described above, but outside known ***distribution*** of the latter species!

pods of *A. beckwithii*, inflated and mottled, are the perfect means to distinguish it from the closely allied *A. oophorus* (egg milkvetch), with its flattened and mottled pods. And the pods of *A. eurekensis* are beautifully colored with short hairs that are scattered across their surface.

We also had the opportunity to view a very recent (within the past few weeks) bullhog treatment of several hundred acres of Utah juniper. I was able to discuss the probable reasons why this was being done (I say "*probable*", because I've talked to nobody involved with the project; I simply know that while working for the U.S. Forest Service and the Bureau of Land Management, these were the reasons we initiated such projects). My thoughts are that it was to restore the sagebrush grasslands that had been significantly invaded by juniper since settlement in the mid -late 1800s because of excessive grazing, which reduced the fuels that typically carried fire. In addition, our ability to extinguish fires has been greatly improved.

Figure 11. What is very most likely to be *Astragalus molissimus* (wooly milkvetch) growing in very sandy soil on the western side of the southern Stansbury Mountain foothills. Follow up trip is in order this year to collect pods and verify the identification of this plant.

But, if that weren't enough, our illustrious Bill Gray had some general information about the location of another species, *Astragalus newberryi* (Newberry's milkvetch). So, we went off in search of this new plant. But, instead of finding *A. newberryi*, we found what we are all nearly sure was *Astragalus molissimus* (wooly milkvetch, Figure 11). I say, "nearly sure," because we have yet to see the pods, which will give us certainty of our new discovery. This is not a rare plant by any means, but an unexpected find nonetheless! So back to the southern Stansbury Mountain foothills I will go to find and photograph what I expect will be, at least according to *A Utah Flora*, pods that are "11-23 mm long, 6-11 mm thick, curved, densely villous-tomentose, [and] bilocular." I'd say it was a great day! At least is was for me!

2017 Field Trips

This, of course, brings us to our other field trips planned for the 2017 flowering season. First of all, we are hoping to have some more-or-less spontaneous after-work (early evening) field trips to various locations along the Wasatch Front. We will send notices out as far in advance as possible so you can get them on your calendar. These are going to focus on the relative novices in our organization and we'll talk about some fun and interesting plants, while maybe giving a tip or two about how to best photograph those things. We had planned on a June field trip, but that has been postponed from late June to the first weekend in July because of the high snowpack in the Uinta Mountains. This will be an overnight trip (June 30-July 1) and we will likely camp at the East Park Reservoir Campground north of Vernal, where Marv Poulson will help us easily find four orchids: Calypso orchid (*Calypso bulbosa*), Brownie's lady's slipper orchid (*Cypripedium fasciculatum*), Yellow coralroot orchid (*Corallorhiza trifida*), and Spring Coralroot (*Corallorhiza wisteriana*) in one place. Then a couple weeks later (July 16) we will visit Bill Stockdale's property in Lambs Canyon, where we will have an opportunity to go onto his private land and see a variety of ecosystems including aspen and other subalpine communities and the plants that decorate those landscapes. This trip will be led by Kipp Lee and, because it is behind locked gates, we will be gracious enough to be on time and courteous to Bill and other folks living in the area. Guaranteed to be another fun field trip!

It's going to be a good flowering year, a fun year, and most of all... a great time to get out and breathe some fresh air (we hope) and hang out with some of our favorite plant nerds in the great state of ~~confusion~~... I mean, Utah!

Sticky Plants

by Peter Lesica, Clark Fork Chapter , Montana Native Plant Society

(First published in Kelseya, newsletter of the Montana Native Plant Society Vol. 30 No. 1. Reprinted with permission of the author)

There are a lot of sticky plants out there, and often when you inspect one there will be little insects trapped in the goo. Insect-trapping plants occur in at least 110 genera in 49 different families. It is estimated that 20 to 30% of all vascular plants have glandular hairs. It's often assumed that these sticky hairs are produced in order to slow down or stop herbivory by plant-eating insects. In the case of carnivorous plants such as sundews (*Drosera* spp.), insects that are trapped by the glandular hairs are digested with the aid of enzymes secreted by the plant's leaves. Such "truly carnivorous" species usually occur in nutrient-poor habitats, such as bogs, or are epiphytic on tropical trees. However, about 20 years ago, George Spommer showed that some of our native grassland species with glandular stems or leaves, such as sticky geranium *(Geranium viscosissimum)* and alumroot *(Heuchera cylindrica)*, also are able to digest dead insects caught in their hairs (See Kelseya Vol. 8, No. 4). This was found also to be the case with a thistle *(Cirsium)* and a beardtongue *(Penstemon)* in Illinois. However, Spommer did not demonstrate that these "protocarnivorous" species actually incorporate the ingested insects into their tissue or that this ability confers any advantage to these sticky plants. Recently the story has become more complex.

Some plant ecologists, particularly Gustavo Romero from Brazil and Billy Krimmel at the University of California-Davis, have suggested a more complicated way in which glandular trichomes can be advantageous. First of all, while some plants can absorb nutrients from dead insects on their leaves and stems, many other sticky species have no enzymes capable of digesting insects; they are clearly not protocarnivorous.

So, is there a reason to produce sticky hairs other than just trapping bugs that are trying to eat you? Romero, Kimmel and others think there is. Ian Pearse and colleagues at UC-Davis studied a glandular species of columbine *(Aquilegia)* and found that the sticky hairs gave off a scent that attracted all sorts of small insects that would otherwise not have any reason to visit the plant. These "tourists" become entrapped in the glandular trichomes. Predatory insects come to feed on the hapless tourists and at the same time reduce the number of herbivorous insects that, unlike the tourists, are there to damage the plant. Pearse and Krimmel found the same pattern for a species of tarweed *(Madia)*. It seems that these plants are using their glandular trichomes to provide a meal for predatory insects that help protect them from their enemies.

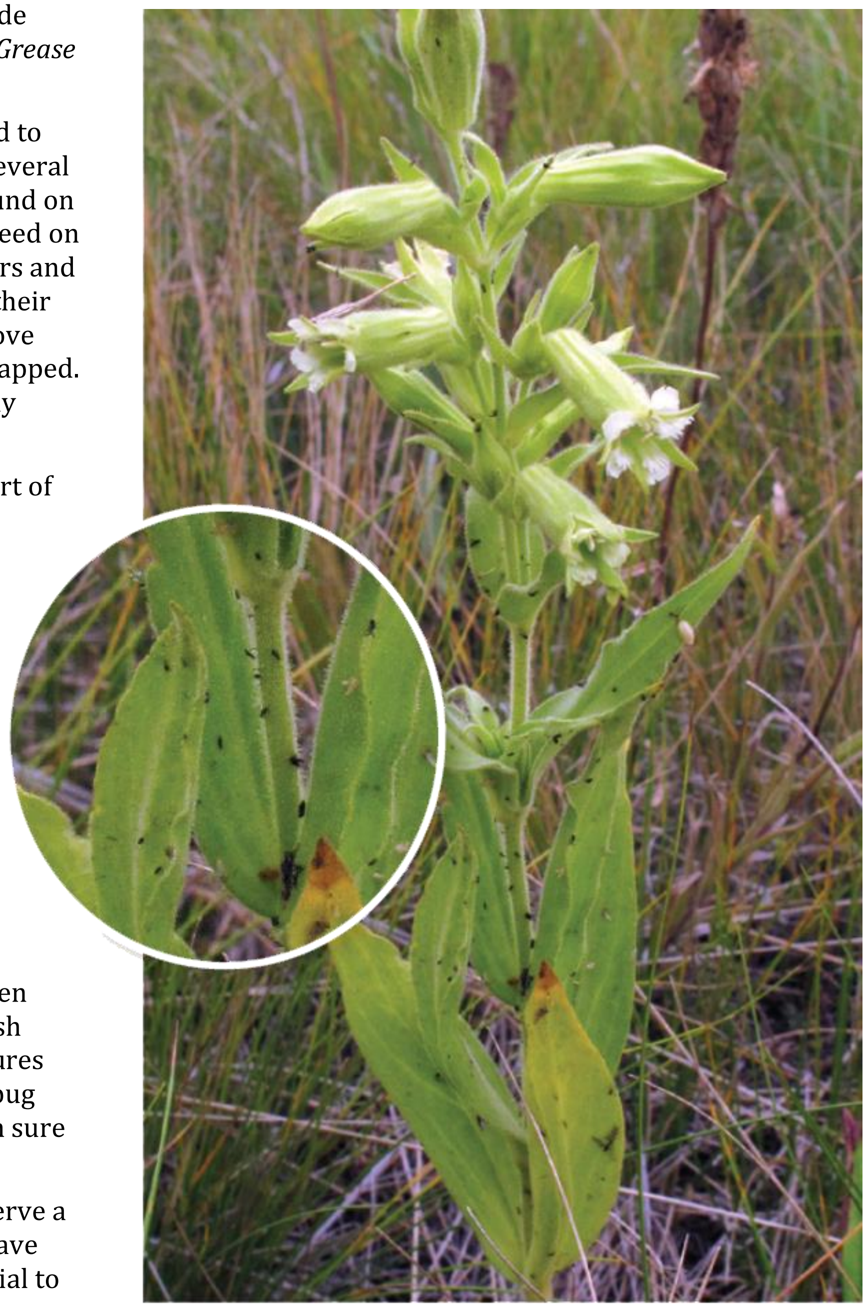
Sticky geranium *(Geranium viscosissimum)*. *Photo by Peter Lesica.*

This bizarre pattern is not just a fortuitous relationship. It turns out that many species of predatory true bugs (Family Miridae) are always found on glandular plants. Furthermore, these predatory plant bugs have special adaptations for their sticky lives. Some of these bugs have long legs that allow them to keep their bodies above the goo. Others have special glands that excrete grease on their bodies, allowing them to glide through the sticky hairs with impunity — *"Grease is the word…."*

True bugs are not the only insects restricted to sticky plants. Gustavo Romero found that several South American lynx spiders are always found on plants with glandular hairs. These spiders feed on insects trapped by the plant's glandular hairs and deter herbivorous insects from feeding on their host plant. Their long legs allow them to move among the glandular hairs without being trapped. Who needs a web if you have ready-made fly paper?

Perhaps the most interesting case of this sort of indirect mutualism is that of the flycatcher bush *(Roridula gorgonia)*. Darwin thought the plant was carnivorous because it has very sticky glandular hairs; however, it was later found that the plant does not exude any digestive enzymes and is therefore unable to digest entrapped insects. More recently, entomologists found that a type of assassin bug *(Pameridea noridulae)* is common on flycatcher bush and is not found anywhere else. This bug waits until the flycatcher bush traps an insect and then consumes it. Shortly after its meal, the assassin bug excretes a liquid rich in nitrogen that is easily absorbed by the flycatcher bush stems and leaves. The flycatcher bush captures insects for the assassin bug to eat, and the bug returns the favor by fertilizing the bush. I'm sure that Darwin would have loved this story.

It's pretty clear that glandular hairs must serve a function if a quarter of all vascular plants have them. Sticky hairs might be directly beneficial to plants by immobilizing or deterring herbivorous insects. Or they might be indirectly advantageous by encouraging the presence of predatory insects that prey on the herbivores. Sticky plants might be directly carnivorous by ingesting the trapped insects, or indirectly carnivorous by having a mutualist digest the prey for them. Just think of all the fun you can have speculating which strategy it is the next time you see a plant with little bugs caught in its glandular hairs.



Aptly named Spalding's catchfly (*Silene spaldingii*). *Photo by Peter Lesica*

Further reading

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UNPS
Salt Lake Chapter Report

by Catherine King, President of UNPS Salt Lake Chapter

As we head into summer, it is time to wrap up the Utah Native Plant Society Salt Lake Chapter meetings at the REI community room with a perennial favorite.

Joel Tuhy from **The Nature Conservancy**, will give a presentation on **"Rare or Interesting Plants of the Moab Area."**
This meeting will be on **Wednesday, June 7th at 7:00 at REI, 3300 East 3300 South, Salt Lake City**.

Chapter program director, Bill Gray, has done a marvelous job organizing our programs for many years. Here is a review of the outstanding programs we have enjoyed this past year:

- **September 2016 UFO Night (Unidentified Flowering Objects)**
- **October 2016 Dr. Ty Harrison "Utah's Monarch Butterflies and their Plants**
- **November 2016 Dr. Loran Anderson "Seed Dispersal Strategies"**
- **December 2016 Wayne Padgett "Climate Change and the Future Biodiversity in the Intermountain West: An Uncertain Future."**
- **January 2017 This was to be the "Potpourri" night, but was cancelled due to bad weather.**
- **February 2017 Dr. Karen Mock "Aspen: New Perspectives from Genetic Research."**
- **March 2017 Faye Rutishauser "Waste Crashers: A Guide to Creating a Water-Wise Garden from A to Fabulous."**
- **April 2017 Wayne Martinson "Envisioning a Sustainable Population Living in Harmony with Utah's Natural Environment."**
- **May 2017 David Sellars double lecture "Chaos in the Rock Rock: Putting Theory Into Practice" and "Photographing Alpine Plants: A Landscape Point Of View." This was a joint UNPS and Wasatch Rock Garden Society meeting.**

We are fortunate to have an active and involved group of UNPS members that regularly attend the Salt Lake Chapter meetings. There are many stimulating conversations and discussions revolving around the presentations at these meetings. All members of the public are invited to attend.

Salt lake Chapter extends thanks and appreciation to REI for the use of the Community Room, it is a wonderful public service they provide us.

The leadership team of the Salt Lake Chapter is always open to ideas and suggestions for programs and field trips. Please feel free to contact us.

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Annual Utah Rare Plant Meeting

March 7, 2017
Sponsored by UNPS, NHMU and RBG

There were sixteen, 20-minute presentations given, as well as three posters presented this year at the Annual Rare Plant Meeting. The topics ranged from rare plant survey work to statistical analysis of rare plant data. Of special interest was a presentation by Aaron Sims, the rare plant botanist from the California Native Plant Society, who explained the rare plant designation procedures in California.

The highlight of the day was the UNPS lifetime achievement presentation to Dr. Stanley Welsh for his lifelong dedication to the study of the flora of Utah and for the co-founding of the Utah Native Plant Society.

Dr. Welsh then gave a 10 minute extemporaneous talk about rare plants in Utah (see next article).

Attendance at the meeting this year was record breaking, with over 105 registrants, which has been showing growth steadily for the last several years. Representatives were present from many government agencies, universities, contractors, researchers, and interested individuals.

The meeting was co-sponsored by the Utah Native Plant Society, the Garrett Herbarium and the Natural History Museum of Utah and Red Butte Garden. Many thanks to the NHMU for hosting the meeting, as well as the excellent catering provided by Paul Mulder from The Cafe at the Museum. Also, much appreciation to the organizing committee and volunteers.

Save the Date
for the Utah Rare Plant Meeting next year:

Tuesday, March 6, 2018. See you then!

“Rare plants”

by Stan Welsh, 7 March 2017

Plants and the Endangered Species Act of 1973, as amended!
Some thoughts!
Plants became an afterthought to the Act designed as it was for animals. Possibly, even probably, the two were ultimately confused as being the same. They differ in remarkable ways, as illustrated that one of a breeding pair of animals may hasten onto a highway and be crushed by a passing Semi, or onto a railroad track and be similarly crushed by a speeding locomotive.
Plants, on the other hand individually constitute a breeding pair, and they do not flee onto either a highway or a railroad, or fly into a power line and neither are they distracted by solar panels or wind farms, but they might be displaced by such.
Whether such a perfect, i.e., hermaphroditic plant, is subject to threat to its existence does not depend on the same threats as do animals; they are sedentary, and the threats might be likened to idling bulldozers. Remove the habitat and the plant goes along with it, and while true for animals as well, the animals are locomotive and can escape, at least initially. The same is not true for plants. Knowing of the location of the plant, not the artificial numerology developed within agencies with the implied application to threat, will allow the idling bulldozer to be directed away from it. In other words, identify the threat, and divert it elsewhere.
More succinctly, the plants have rather finite limits to their populations, limits that were ecologically, not human, imposed, and understanding where they occur and the ecology of their environment, along with protecting their specific environments will suffice to allow for their continued existence.
But, the ESA of 1973, as amended, has been interpreted ad infinitum far beyond original intent, which was and is laudable, to facets of existence not known to have any real impact on the plants per se. Examples include air pollution, wherein the culprit is carbon dioxide, without which photosynthesis would not be possible, and which doubtlessly is utilizing that same "poison" in its physiological processes. And, global warming (which is a fact) is now recognized as a culprit also, despite the fact that such warming has been underway for at least the previous 15,000 years, allowing the development of civilization as we understand it.

We also understand that the habitats available for endemic species in the Colorado Plateau are the result of erosion by the Colorado River and its dendritic tributaries, indicated as five to six million years. That erosion resulted in exposure of the substrates now occupied by the endemic species, and those entities speciated on the peculiar exposed substrates.
No one knows how many species of plants have been driven to extinction during the time of expansion of human evolution. Never-the-less, reasonable attempts at preventing loss of our heritage of endemic and other rare species should be undertaken. Divert the idling bulldozer wherever or whenever possible represents reason, while always knowing that the concept of carrying capacity and Malthus concept of over population represents reality, i.e., the greater the human population the greater will be the number of idling bulldozers.
Salvation of vast areas of public lands by fiat might not in fact be their salvation after all; consider an attempt to visit our present national parks for examples. Unintended consequences are always possible, or even probable.

A short and undoubtedly incomplete list of rare indigenous plant species in Utah.

A much longer list is to be found in Plant Endemism and Geoendemic Areas of Utah (Welsh & Atwood, 2009, 2012, 2017):

Agave utahensis
Alloysia wrightii
Amaranthus fimbriatus
Antirrhinum kingii

Aralia racemosa ssp. bicrenata
Aster exilis
Astragalus lentiginosus var. stramineus
Astragalus striatiflorus
Azolla mexicana
Baccharis sergilloides
Carex alma
Cladium californicum
Cyperus strigosus
Dudleya pulverulenta
Enceliopsis argophylla
Echinocereus engelmannii var. variegatus
Eremalche rotundifolia
Eriogonum heermannii var. subspinosum
? ? var. sulcatum
? wrightii
Eschscholzia mexicana
Fagonia laevis
Galium stellatum
Gaillardia mexicana
Geraea canescens
Gilia filiformis
Hulsea heterochroma
Imperata brevifolia
Juncus macrophyllus
Lepidium huberi
Lotus tomentellus
Lupinus higginsii
Menodora spinescens
Mohavea brevifolia
Mortonia scabra
Oenothera primiveris
Parthenium incanum
Pediomelum retrorsum
Penstemon petiolatus
Petalonyx parryi
Petunia parvifolia
Peucephyllum schottii
Phacelia caerulea
Psorothamnus polydenius
Ptelea trifoliata var. lutescens
Robinia neomexicana
Rubus neomexicanus
Sisyrinchium douglasii
Stylocline intertexta
Yucca schidigera

And, many other plants whose distribution laps within the state, or from Utah into surrounding states, yet are not included in lists of "rare" plants.

Utah Native Plant Society

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