



Sego Lily

Newsletter of the Utah Native Plant Society

Spring 2015
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Reveal's paintbrush (*Castilleja parvula* var. *revealii*) is a magenta to crimson-flowered perennial in the Scrophulariaceae (or Orobanchaceae, depending on one's taxonomic perspective) with bluish-purple stems 3-6 inches tall. This Utah endemic is restricted to orange or whitish limey-clays of the Claron Formation on the Markagunt and Paunsaugunt plateaus in the vicinity of Bryce Canyon and Cedar Breaks. Noel Holmgren described it as a new species in 1973 based on a specimen he collected with James Reveal on their epic 1965 botanical expedition across the Intermountain West. Reveal's paintbrush is closely related to the Tushar Plateau paintbrush (*C. parvula*), another Utah endemic, and the two have been made varieties by Duane Atwood. Jim Reveal is best known for his taxonomic work on the genus *Eriogonum* (for which he is remembered by the name *E. corymbosum* var. *revealianum*) and for research on botanical history and taxonomic nomenclature. Reveal died in January 2015 (see story on page 4). Photo by Douglas N. Reynolds from the Twisted Forest, north of Cedar Breaks National Monument.

Utah Native Plant Society



Utah Native Plant Society

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Sego Lily Editor: Walter Fertig (waltola64@gmail.com). The deadline for the Summer 2015 *Sego Lily* is 15 June 2015.

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Utah Native Plant Society Chapters

Unidentified Flowering Object

This month's UFO was photographed by Bill Gray in August 2014 on the White Pine Trail in Little Cottonwood Canyon. It occurs commonly in the mountains across Utah, but can be easily overlooked due to its small size. Any guesses?

The November Unidentified Flowering Object should have been a "UGO" or Unidentified Gall-Forming Object. The fuzzy, ball-like "fruits" were galls produced by the Sponge gall midge (*Rhopalomyia pomum*). Female midges lay eggs within the soft tissues of big sagebrush, causing the plant to form specialized tissues to sequester the developing insect larvae. Galls are commonly found on sagebrush, rabbitbrush, goldenrods, oaks, and many other native plants—with each type of gall produced by a specific insect.

Have a UFO to share? Send it in! - *W. Fertig*

Bulletin Board

UNPS now on Facebook: This winter, UNPS joined the 21st Century and established its own Facebook page (the Cache, Utah Valley, and Fremont chapters already were on Facebook). The Facebook page includes links to interesting botanical organizations and websites, news about upcoming events, photos of blooming plants, and other items that should be entertaining to native plant enthusiasts. Thanks to Wayne Padgett for advocating the page and for Tony Frates for creating it and generating some of the initial content. Our page can be accessed at www.facebook.com/unpsorg and already has 111 likes (and counting).

Salt Lake Chapter Meetings: 3 June 2015: Joel Tuhy will present his annual program on plants from the Moab area entitled "Wildflowers of the Twelve Moons". The meeting will be at 7PM at REI on 3300 South and 3300 East in Salt Lake City.

Calling Citizen Scientists: Wildflower Monitoring in the La Sal Mountains: The Wild Utah Project is inviting citizen scientists to help them gather field data on the distribution of rare plant species and impacts from recently introduced mountain goats (see the September 2013 *Sego Lily* for some background on the mountain goat issue). Participants will meet at the Moab BLM/Interagency office on July 15 and then carpool and camp for 3 nights at Geysers Pass for 3 full days of surveying and monitoring in the alpine areas of the La Sals, focusing on the Mt. Peale Research Natural Area. Wild Utah Project will be providing meals. For more information and to sign up (space is limited), contact Allison Jones, Wild Utah Project (Allison@wildutahproject.org, 801-328-3550).

New edition of A Utah Flora now available: The long-rumored 5th edition of A Utah Flora has recently been published and is available through the BYU bookstore. Stan Welsh has updated the previous edition, added some new species, and even included some color illustrations. Unfortunately, only a limited number were printed, and your umbel editor has not seen it yet to provide a more detailed review.

Have a botanical meeting or chapter event to publicize? Send announcements to the editor.



In Quotes: "He moons about in the garden, and I have seen him standing doing nothing before a flower for ten minutes at a time. If he only had something to do, I really believe he would be better." - Charles Darwin's gardener referring to his boss's interest in botany and work ethic (V.B. Smocovitis, "Darwin's Botany in *On the Origin of Species*", Ruse and Richards, eds., *The Cambridge Companion to Darwin's "Origin"*, Cambridge Univ. Press, 2008.)

In Memoriam: James Laurintz Reveal (1941-2015)

The botanical community lost a major contributor in January with the sudden passing of Dr. James Reveal. Best known in the west for his monographic work on the complex genus *Eriogonum*, Reveal was also an expert on botanical nomenclature, an historian of botany, and a significant contributor to improving our understanding of evolutionary relationships among vascular plant families and orders. He was also a lifelong advocate of plant conservation and a co-author (with Stan Welsh) of the first comprehensive overview of threatened and endangered plants of Utah in 1975.

Jim Reveal was born on March 29, 1941 in Reno, Nevada to Jack and Arlene Reveal. Jack had been a classmate of Arthur Holmgren at Utah State Agricultural College (better known today as Utah State University) and later worked as a forester. The Reveal family relocated to the foothills of the Sierra Nevada in California, where young Jim became proficient with horses and helped guide pack trips into the high country.

Following in his father's footsteps, Jim Reveal enrolled at Utah State University in 1959 to major in forestry. Two years later he switched to botany after taking Arthur Holmgren's taxonomy course. Reveal also came under the influence of Arthur Cronquist, another alumnus of Utah State, who was starting the ambitious Intermountain Flora project through the New York Botanical Garden. In 1964 Reveal and Aggie classmate Noel Holmgren were hired by Cronquist to travel around Utah, Nevada, and other western states to collect material for the flora project. The young men were provided a pickup truck from the Intermountain Herbarium, collecting gear, and paid the princely sum of \$7 per day.

Reveal stayed at Utah State to complete his Masters degree and then enrolled at Brigham Young University to work on *Eriogonum* for his doctoral thesis in 1967. With 255 species, *Eriogonum* is one of the largest genera in North America, but many taxa were still unrecognized when Reveal began his revision. Reveal's dissertation consisted of 546 double-spaced pages (condensed down from an original 1800 page manuscript). Following graduation in 1969, Reveal was hired by the University of Maryland, where he remained until retiring in 1999.



Above: James L. Reveal, leading a class for the *Eriogonum* Society. Photo courtesy of the *Eriogonum* Society.

Reveal moved to Colorado in 1999, perhaps to be closer to his beloved wild buckwheats (ironically, there are just two *Eriogonum* species in eastern North America, neither of which occurs in Maryland). In his latter years, Reveal completed a revised monograph of *Eriogonum* for the *Flora of North America* (2005) and wrote the Polygonaceae treatment for the *Intermountain Flora* (2012). Of the 195 species and varieties of *Eriogonum* covered in the *Intermountain Flora*, Reveal named 56 and published new combinations for 22 others.

But Reveal's academic interests were not limited to wild buckwheats. In all, he published over 500 articles and books on botanical topics, including taxonomic treatments of *Potentilla*, *Agave*, Brassicaceae, and various genera of Liliaceae and Polygonaceae. Many of his publications dealt with the arcane rules of botanical publication, for which he earned the nickname "the Great Validator". Reveal also wrote about botanical history, including studies of the botany of Lewis and Clark, 19th century painter Mark Catesby, and a biography of John Torrey. Reveal's 1992 book *Gentle Conquest: The Botanical Discovery of North America* won the outstanding academic book award from the Association of College and Research Libraries. Reveal even tried his hand in historical fiction, co-authoring a novel with a childhood friend loosely based on their experiences growing up in the Sierra Nevada.



Above: Cushion wild buckwheat (*Eriogonum ovalifolium* var. *purpureum*), one of the more widespread buckwheat species in western North America. Photo by Al Schneider from the SW Colorado Wildflowers website (www.swcoloradowildflowers.com)

Reveal returned to academia in 2007, accepting an adjunct position at Cornell University. He was also an honorary curator at the New York Botanical Garden. In 2009, Reveal was named the first honorary member of the newly founded Eriogonum Society and was active in promoting the culture and appreciation of wild buckweats through the society's annual fieldtrips and website (www.eriogonum.org).

For more on the life of Jim Reveal, see the moving tribute by Noel Holmgren in the March 2015 issue of the Eriogonum Society Newsletter (available online on the Eriogonum Society webpage noted above). On a personal note, I never had the opportunity to meet Reveal in person, though we did correspond a few times regarding some interesting *Eriogonum* collections from Utah and Wyoming. I was always impressed by the speed in which Reveal replied to my inquiries, and the great interest he took in encouraging other botanists, in spite of his own heavy workload. Jim Reveal was a great role model for botanists and scholars. - *Walter Fertig*

Lois Arnow (1921-2014)

Utah lost another prominent botanist with the passing of Lois Arnow in December. Arnow was born in Lorain, Ohio, in 1921 to Lewis and Glen Gooddell. She served as a nurse for the US Public Health Service in Egypt and Greece during World War II. After the war, Lois attended Columbia University under the GI Bill, where she received a Bachelors degree in Nursing in 1949. More importantly, she met her future husband, Ted Arnow at Columbia, where he was receiving a Master's degree in Geology. Ted was also a war veteran, having served with distinction in the Navy and receiving the Bronze Star.

After the war, the Arnows eventually settled in Utah, where Ted worked for 40 years for the US Geological Survey. Lois became interested in botany at the University of Utah, and completed her Masters degree there in 1971. For many years, Lois was the curator of the Garrett Herbarium at the U. In 1977 Arnow and colleagues Beverly Albee and Ann Wyckoff published a local flora for students in plant taxonomy. Their *Flora of the Central Wasatch Front, Utah* has been used by three generations of botanists in the greater Salt Lake area. With her generous help the treatment was recently reissued as a digital "cyberflora" with 2500 color photographs by Bill Gray of the Utah Native Plant Society. A fully updated revision had been in process, but was left incomplete.

Lois Arnow developed a strong interest in the taxonomy of grasses, including some of the more vexing nomenclatural questions in *Poa* and *Koeleria*. She wrote the original Gramineae treatment for the Utah Flora, published in 1987 in the *Great Basin Naturalist Memoirs*. The key and descriptions continue to be used in later versions of *A Utah Flora* by Stan Welsh. Two grass species (both from Utah) are named in her honor: *Poa arnowiae* by Rob Soreng and *Stipa arnowiae* (*Achnatherum arnowiae*) by Welsh and Atwood. The latter is a species derived from hybridization of Indian ricegrass and needle-and-thread grass and was first recognized as possibly being distinct by Arnow. Noel and Pat Holmgren also recently named a new species or *Eremogone* (*E. loisiae*) after their friend.

Lois Arnow died peacefully at her home on December 14, 2014. Perhaps not being able to bear the absence of his partner of 65 years, Ted Arnow passed away just four days later. - *Walter Fertig*

USDA Agricultural Research Service Hears from Western Native Plant Societies

By Peter Lesica

The U.S. Department of Agriculture (USDA) has a history of importing exotic plants for use in lawns, pastures, roadsides, rangeland and other applications. They are usually bred or selected for traits that make them highly productive. This selection and the fact that they are imported without their natural pests make them highly competitive in their new environment. Several of these intentional introductions (e.g., tamarisk, Lehmann lovegrass) have invaded native plant communities resulting in losses of native plant diversity as well as millions of dollars in attempts to control them. In the summer of 2013 a coalition of five western native plant societies (AZ, MT, NV, OR, UT) wrote a letter to the USDA Agricultural Research Service (ARS) protesting the practice of importing exotic plants for rangeland “improvement” (see *Kelsey* Vol. 27, No.1). Since then a lot has happened.

In the spring of 2014 ARS organized a conference call between several of their scientists and administrators and representatives of the five native plant societies to discuss the issue raised by our letter. ARS made the point that these plants are introduced to address serious rangeland health problems. The most recent example is the introduction of forage kochia (*Kochia prostrata*, *Bassia prostrata*) to vegetate burned-over sagebrush steppe invaded by cheatgrass (*Bromus tectorum*). Native plant societies countered by pointing out that there is evidence that forage kochia is invading native rangeland and is considered a threat to the federally-listed slickspot peppergrass (*Lepidium papiliferum*). In the final analysis, importing exotic plants seems to be a case of trying to solve an immediate problem at the expense of potential adverse impacts further down the road.

Improved rangeland and pasture plants for the western U.S. are developed by the Forage and Range Research Laboratory in Logan, Utah (FRRL). Following the phone conference, the five native plant societies were invited to send a represent-

ative to the 2014 meeting of the FRRL Focus Group Executive Committee meeting held in central Washington in mid-October. I attended this meeting and raised the issue of forage kochia being a potential threat to native plant communities. I also suggested that importing exotic species should be discontinued because these plants are always going to be a risky proposition. They do not have their natural enemies and diseases, and there is often a lag time between when exotic plants are introduced and when they become invasive, so results from a short “test period” are not reliable in the long term. I felt that the ARS and BLM people present took these considerations seriously, but a rancher from Dillon, Montana and a seed grower from Logan, UT remained unconvinced. Jack Staub, the FRRL director, stated that they evaluate imported plants for 7-15 years to determine whether they will escape; however, details of how this research is conducted were not provided. The BLM restorationist present at the meeting stated that agency is no longer seeding forage kochia into rangeland but using it only to create fire-resistant buffer strips.

In follow-up correspondence ARS scientists indicated that they are working on methods for treating forage kochia with herbicide when it invades native grasslands and sagebrush steppe. They have also started to develop protocols to grow and establish stands of American kochia (*Kochia americana*, *Bassia americana*) that could eventually take the place of the exotic forage kochia. FRRL also plans to hire a plant ecologist to monitor if and when forage kochia escapes into native plant communities. Most hopefully, the director of FRRL informed us that in 2009 they decided to discontinue their collecting trips to Asia, suggesting that there will be no more exotic plants in the near future. The five native plant societies are hopeful that their involvement will raise awareness of the problems with importing exotic plants for restoration.



By Jove, it's a Buttercup

By Walter Fertig

How in heaven did a pretty yellow wildflower with stems no more than 4 inches tall get the name of Jupiter buttercup? The species epithet "*jovis*" and the common name both come from Jove or Jupiter – the largest planet in the solar system and the all-powerful god of sky and thunder in Roman mythology. Wyoming botanist Aven Nelson came up with the name in 1900 to commemorate "The Thunderer", a peak in the Absaroka mountains of northeastern Yellowstone National Park where the type collection was made, and not to be facetious about the little buttercup's unimposing stature.

The Jupiter buttercup is one of nearly 80 species of *Ranunculus* found in North America. Like most buttercups, it has flowers with five bright yellow petals and a ball-like head of numerous 1-seeded fruits. Leaves of Jupiter buttercup are deeply three-lobed and resemble the foot of a bird (another common name for *Ranunculus* is crowfoot). The uppermost leaves sometimes form a whorl surrounding the relatively large flowers. But the Jupiter buttercup's most distinctive feature cannot be seen above-ground – it is the cluster of fleshy, thick roots that resemble miniature baseball bats.

Why the thick roots? Perhaps they store a sufficient amount of food to let Jupiter buttercup produce its showy flowers almost as soon as the ground thaws in early spring. Some years, this species has been observed in flower as early as February, though more often blossoms appear from March to June, depending on the elevation where the plants occur. Jupiter buttercup grows mostly in high mountain meadows, maple thickets, or sagebrush communities and flowers are frequently seen in moist areas below melting snowbanks.

As buttercups go, *Ranunculus jovis* is one of the less frequently seen species. Its native range extends from southwestern Montana to eastern Idaho, northern Utah, and northern Colorado. Additional reports from Nevada are apparently based on mis-



Above: Jove's buttercup from Yellowstone NP by Jennifer Whipple.
Bottom: Jove's buttercup in flower in Albion Basin, Utah by Bill Gray.

identifications of the somewhat similar Sagebrush buttercup (*R. glaberrimus*), a related species with taller stems, less deeply divided leaves, and fibrous roots. The apparent scarcity of Jupiter buttercup may also be related to its early flowering period and low stature (fruiting plants can be hard to see once the petals fall off). So head out to the mountains early, because, by jove, this is one pretty buttercup you don't want to miss.



Ten Things You Might Not Know About Ferns, But Wish You Did

By Walter Fertig

Ferns are easily recognized by their intricately divided, or lacey foliage that makes an appealing accent in floral arrangements or shady gardens. But how much do you really know about ferns? The following annotated list of factoids will make you an expert on pteridology (the study of ferns) at your next dinner party, or whenever you might be tipping one back at a Fern Bar.

1. *Ferns are basically just a collection of leaves.* They do produce stems, but these are typically oriented horizontally, rather than vertically, and are often below ground or just at the soil surface. Technically, the stem of a fern is a rhizome, and it is usually covered by scales, hairs, or old leaf bases. Roots are present on the lower side of the rhizome, but they tend to be small and wiry. In the tropics, some ferns have thick, upright stems and resemble palm trees, but they never produce true wood or bark. Ferns also do not produce flowers or fruits.

2. *Ferns reproduce by spores rather than seeds.* Ferns are distant cousins of the flowering plants (angiosperms) and conifers (gymnosperms) and share some features, such as large, multi-veined leaves and complex internal plumbing of xylem and phloem. They differ, however in the way they reproduce. Flowering plants and conifers produce seeds, which contain a diploid embryo enveloped in nutritive tissue and protected by a hard seed coat. Seeds germinate into miniature versions of their parent plant. By contrast, ferns and other primitive vascular plants (including the club-mosses, spikemosses, quillworts, and horsetails) reproduce by spores. Although they may look superficially like seeds, spores are significantly smaller and do not contain much food or an embryo. Upon germination, the spore gives rise to nearly microscopic filament of cells or a tiny heart-shaped blob called a gametophyte that bears little resemblance to its parent plant.

3. *Ferns alternate between haploid gametophyte and diploid sporophyte generations.* Like the spore it germinated from, the gametophyte phase is haploid, or contains just half of the full chromosome complement of a mature fern plant. The gametophyte gets its name because it produces two types of gametes or sex cells. Numerous flagellated



Above: *Southern maidenhair fern*, *Adiantum capillus-veneris*, Zion National Park. Photo by W. Fertig.

sperm are produced in a specialized structure called an antheridium found below the surface of the gametophyte, while an egg is formed in a flask-shaped structure called an archegonium. Sperm swim in a film of water from the antheridium of one gametophyte to the archegonium of another, where one will fuse with the egg cell to form a diploid zygote (restoring the original chromosome number). The zygote is initially nourished by the gametophyte but eventually outgrows its parent and develops into a mature sporophyte—the phase of the life cycle that we recognize as a typical fern. Sporophytes produce spores, to begin the life cycle anew. The complex life cycle of the fern is called an “alternation of generations” because the gametophyte phase alternates with the sporophyte phase.

4. *Ferns can only grow in habitats where the gametophyte phase can survive.* We tend to think of ferns as delicate plants that can only grow in wet, shady sites. Like some stereotypes, this is partially based on fact. The requirement of a thin layer of water for sperm to swim from one gametophyte to another for reproduction severely limits the diversity of sites where gametophytes can occur.

Since the sporophyte generation matures out of the fertilized embryo in the archegonium, fern plants can only be found in the same sites as the gametophyte phase. Water is not a limiting factor in many tropical habitats or cool, shaded canyons, where many ferns grow. Some ferns are able to grow in hot, sunny, desert environments, but typically only from cracks in bedrock. The cracks provide a shady site where spores can germinate and enough moisture gets trapped in the cracks to allow for fertilization.

5. *Those little brown spots on the underside of fern leaves are not bug eggs or a disease but actually their reproductive parts.* Technically, the dots are called sori (singular = sorus) and consist of clusters of spore-bearing sporangia. Without the sporangia, the sporophyte would not be able to produce the spores that give rise to the gametophyte generation. Thus, there is no need to help a fern by scraping the sori off, or dipping them in insecticide. In many ferns, each sorus is partially covered by a membranous flap of tissue called an indusium, or protected by the inrolled margins of the leaflet. The shape and position of indusia is a useful characteristic for identifying fern species to genus.

6. *Ferns invented the catapult.* The sporangia of most ferns are borne on a short stalk and have a prominent ridge of partially thickened cells called an annulus. Under magnification, the annulus looks like the segmented body of a worm or arthropod. The annulus functions much like a medieval catapult in the forcible ejection of spores. As the sporangium matures it begins to lose moisture, causing the outer cells walls to be sucked inward and the thickened annulus to contract. Eventually, the sporangium is torn at a weak point and the thick annulus becomes pulled backward like the cup of a catapult. As water is continually lost, the annulus comes under tremendous tension (about 300 atmospheres of pressure). When the tension is finally broken, the annulus snaps back to its original shape and in the process flings the spores out into the air, where they may be caught in the wind and moved a far distance from the parent plant. On dry, windy days you can watch the sporangia of a fern begin to recoil, though the actual release of the spores is too fast for the human eye to detect. (There are several videos on youtube where you can see this in slow motion.)

7. *Fern spores are capable of extremely long-range dispersal.* Spores usually land relatively close to their parent plant—which makes some sense since they require similar environmental conditions in order to germinate. In rare cases, however, spores can travel 500 miles or more if they are lofted



Above: *Black spleenwort (Asplenium-adiantum-nigrum) occurs widely in Europe, Asia, and Africa and in a few isolated sites in western North America, including a few shady canyons and grottos in Zion National Park. Its spores are thought to have reached North America naturally via strong, high atmosphere winds. Illustration by Kaye Thorne.*

into the upper atmosphere by strong winds. Recent experiments have shown that fern spores remained viable after being adhered to the wings of commercial aircraft and exposed to high UV radiation and other extreme conditions above 30,000 feet. Ferns are often common on remote islands, suggesting that they are not limited by dispersal barriers. The black spleenwort (*Asplenium adiantum-nigrum*) occurs primarily in Eurasia and Africa, but widely disjunct populations are also found in shady canyons in northern Mexico, Arizona, Colorado, and Utah's Zion National Park. Although sometimes considered a separate species, the North American populations are indistinguishable from those of the Old World. This species is not grown commercially and so the most likely explanation for its unusual geographic distribution pattern is the long-distance dispersal of spores from Asia to North America in the distant past. Bracken fern (*Pteridium aquilinum*) is found on nearly every continent and has one of the largest global distributions of any plant (or animal!). Its ability to spread readily is attributed to strong atmospheric winds blowing its tiny spores.

8. Among vascular plants, ferns are the second only to the flowering plants in total number of species. Taxonomists recognize at least 12,000 species of ferns worldwide. While this number pales compared to the estimated 300,000-320,000 angiosperms, it is much higher than the 650 or so known gymnosperms. Ferns also greatly outnumber other “fern ally” groups, such as lycophytes (clubmosses). Fern species richness is greatest in the tropical regions of the world. Only 50 species of ferns are known from Utah. Another 13-15 spore-bearing fern allies (*Equisetum*, *Selaginella*, and *Isoetes*) occur in the state. All told, the seedless vascular plants make up less than 2% of the native and naturalized flora of Utah. Perhaps the best place in Utah to see ferns is Zion National Park, which has nearly half of all the fern taxa from the Beehive state.

9. Recent molecular studies suggest that horsetails and whisk-ferns are actually ferns rather than separate groups of seedless vascular plants. Morphologically, horsetails (*Equisetum*) and whisk-ferns (*Psilotum*) bear little resemblance to true ferns. Modern horsetails have minute, scale-like leaves and fluted green stems capped by a cone-like collection of sporangia. Whisk-ferns (a common greenhouse weed) are even stranger in appearance—resembling branched twigs and are both leafless and rootless. Whisk-ferns are often thought to resemble the earliest known vascular plants (called rhyniophytes) that first colonized dry land in the late Silurian nearly 430 million years ago. Molecular studies now place *Equisetum* squarely within the true ferns alongside the tropical Marattiales. *Psilotum* also appears to share genetic traits with the grapeferns and moonworts (Ophioglossales). Its primitive characters are thought to be a modern adaptation to being epiphytic. The placement of the horsetails within the ferns remains controversial, however, as it is not well supported by the fossil record (ancient, tree-like horsetails were common in the Coal Swamps of the Carboniferous Era, 325-345 million years ago).

10. Aquatic ferns were once dominant in the Arctic Ocean and may have triggered global cooling that preceded the Ice Age. While most ferns live on land, several species have become adapted to living in fresh water. One such group is the genus *Azolla*, also known as the Mosquito fern. Today, mosquito ferns are widespread in



Above: Northern holly fern (*Polystichum lonchitis*) is widespread across western and northeastern North America, including rocky canyons and alpine areas in the Wasatch Range. Holly ferns can be recognized by their leathery green leaves with saw-toothed leaflet margins and their sori covered by a silvery, kidney-shaped indusium. Illustration by W. Fertig.

warm areas and are important for fertilizing rice fields (the free-floating ferns have a pouch-like structure among their leaflets that supports Nitrogen-fixing blue-green algae). About 10 years ago, researchers were shocked to discover thick beds of fossilized *Azolla* and its spores in sediment cores taken from the floor of the Arctic Ocean. The fossils were dated to 50 million years ago when the Arctic was ice-free and the entire planet was significantly hotter than today. Some geologists now suspect that the straits connecting the Arctic Ocean to other oceans were closed off at this time, allowing freshwater running off the surrounding continents to cover the surface. The freshwater and warm climate were hospitable for *Azolla*, and in fact the Arctic Ocean may have literally been a carpet of these plants. As *Azolla* plants died, they would sink and carry their reserves of carbon produced from photosynthesis to the oxygen-depleted ocean floor, allowing thick beds to accumulate. This natural sequestration of carbon may have helped reduce the level of CO₂ in the atmosphere and initiated a period of cooling. By 47 million years ago, the Arctic Ocean had become frozen, as it has remained mostly to this day. Could tiny *Azolla* help bind Carbon dioxide today and reduce the impacts of climate change?

Grow This:

Cacti

By Robert Dorn (Adapted from *Castilleja*, publication of the Wyoming Native Plant Society, Dec. 2014)
Photos by Al Schneider from Southwest Colorado Wildflowers website
(www.swcoloradowildflowers.com)

Cacti generally require a dry, sandy or gravelly location in full sun. They should not be given any supplemental water except during extreme drought when extra water will not harm them. The mature plants have no leaves. The stems are globose, cylindrical, or flat pads that are usually spiny.



Coryphantha vivipara (*Escobaria vivipara*, Red ballcactus, above) has a globose to cylindrical stem to 4 inches high and 3 inches across. Sometimes they form a crowded cluster of several stems. The flowers are bright pink or pinkish-red, up to 2 inches across, clustered at the top of the stem, and appearing from May to July. The plants occur naturally in open, sandy or gravelly areas of the plains and basins over much of the western United States. They can be grown from seed lightly covered to allow light exposure.



Opuntia polyacantha (Plains pricklypear, below left) has flattened pads to about 7 inches tall with many spines. The flowers are yellow or sometimes deep pink or red and up to 4 inches across appearing from May to July. The fruits are spiny and rather unattractive. The plants occur naturally in dry, open areas of the plains, basins, and valleys across the west on a variety of soils, especially where gravelly. They can be grown from seed after 60 days of cold stratification. Press the seed lightly into a mix of three parts sand and one part loam. Also the pads can be broken off, allowed to callus at the break, and then inserted into the soil mix. Water regularly until roots develop, usually in about four weeks. They also transplant easily.



Pediocactus simpsonii (Simpson's ballcactus, above) has a globe-shaped stem to 4 inches tall and 6 inches across. The stems are sometimes in clusters. The flowers are yellowish-green or pink to light purple, up to 1 inch across, clustered at the top of the stem, and appearing from May to July. The plants occur naturally in rocky or gravelly places in the plains, basins, and mountains. They can be grown from seed and are available in the nursery trade.

Nearly all cacti transplant easily but should not be dug up from their native habitat except when about to be destroyed by construction activities.

Utah Native Plant Society



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