Sego Lily

Newsletter of the Utah Native Plant Society

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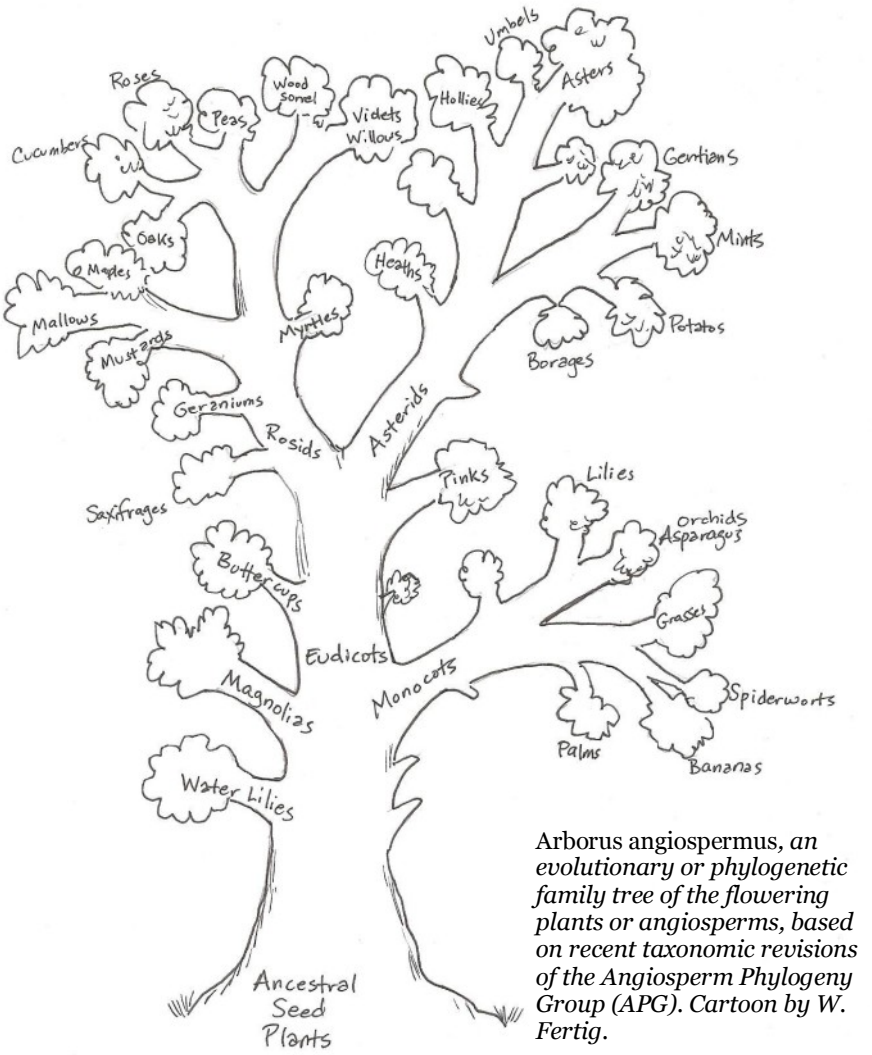
Farewell to the Aceraceae: Changes in the Angiosperm Family Tree



Arborus angiospermus*, an evolutionary or phylogenetic family tree of the flowering plants or angiosperms, based on recent taxonomic revisions of the Angiosperm Phylogeny Group (APG). Cartoon by W. Fertig.*

In this issue:

By Walter Fertig

The Maple family is dead.

For sure there are still plenty of species of maples (*Acer*) across North America and Asia, but the maple family (Aceraceae) is gone — cut down by a new generation of taxonomists wielding DNA datasets and modern phylogenetic theory. The maples and their close cousins the horse-chestnuts (Hippocastanaceae) are now part of an expanded Soapberry family (Sapindaceae).

The milkweed family (Asclepiadaceae) is also no more – absorbed by the Dogbanes (Apocynaceae). Gone too are the Goosefoots (Chenopodiaceae), Duckweeds (Lemnaceae), Pyrolas (Pyrolaceae), and Waterleafs (Hydrophyllaceae). Some familiar groups like the Lilies (Liliaceae) and Figworts (Scrophulariaceae) have received [continued on page 4]

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Sego Lily Editor: Walter Fertig (walt@kanab.net). The deadline for the November 2010 *Sego Lily* is 15 October 2010.

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Chapter News

Escalante: September 24-25—Escalante Canyons Art Festival, 10 AM to 5 PM. Please contact Harriet about helping with the Native Plant table.

Saturday, October 2—National Public Lands Day Re-vegetation Project at Calf Creek Campground and Escalante River Trailhead. 30 willing laborers are needed to plant native plants in designated spots. Please contact Jeanie Linn by 31 August (Jeanie_linn@blm.gov, 826-5624) if you can help.

Tuesday, October 12: "Dinosaur Salads: Flora of the Cretaceous age Kaiparowits Formation, Grand Staircase-Escalante National Monument" by Dr. Alan Titus, monument paleontologist at 7 PM at the Escalante Interagency Visitor Center auditorium.—*Harriet Priska*

Fremont (Richfield Area): The Fremont Chapter and Sevier County Master Gardeners are hosting a perennial plant exchange on September 18th at the Richfield City Park Pavilion on 300 North Main. UNPS member Barbara Jensen is the inspiration behind this event. Barbara, a real Green recycling pioneer, didn't want to throw away the extra plants in her garden.

To start off the event, Ross Murdock, greenhouse manager at Southern Utah University, will give a presentation on growing perennials. The lecture and plant exchange are free to the public but donations will gladly be accepted for the Richfield County Library.

The lecture starts at 9 AM with the plant exchange from 10 AM until noon. All gardeners are encouraged to contribute extra plants from their gardens and take home new ones. The goal of the event is to promote water wise gardening, recycling plants, and learning something new. For more information, call Barbara (435-896-8798), Ron Parsons (435-527-4751) or Lisa White (Lisa_Ogden@nps.gov).— *Janett Warner*

Manzanita (Kane County): Our annual fall native plant sale will take place on Saturday, 11 September 2010, from 9-11 AM at the Kanab Farmer's Market. Janett Warner of Wildland Nursery in Joseph, UT will be on hand with a selection of native shrubs, small trees, wildflowers, and grasses adapted for southern Utah gardening. - *W. Fertig*

Salt Lake: Our potluck in City Creek Canyon was held August 14th. After paying homage to the rare Utah angelica (*Angelica wheeleri*) - one topped out at 8 feet tall - we hiked the trail from the end of the road. Lynn Bohs introduced us to some neat tricks for identifying plants that were not in flower. Then we enjoyed an excellent picnic supper. Next day we had 10 people hike up to the newly discovered population of Woodnymph (*Moneses uniflora*) at Brighton. The very late Spring and slow Summer has meant that flowers in general are staying arounf longer; about 80 species were in bloom and the Woodnymphs were are their best. This will surely become an annual pilgrimage, like our early Spring trip to see Anderson's buttercup (*Ranunculus andersonii*).—*Bill Gray*

Southwestern/Bearclaw Poppy: Our September meeting will be held on Wednesday, Sept. 8th at 7 PM at the Springdale Canyon Community Center. Donna Peppin, botanist intern for Zion National Park is working towards getting the Zion working herbarium up and available for the public. Her talk is entitled "Seeding Natives after Wildfire and Development of Zion National Park's Working Herbarium". Please note that the chapter is moving its monthly meetings to the second Wednesday of the month.—*Barbara Farnsworth*

Utah Valley: Anyone wishing to pick up a few native plants can come to the Wasatch Heritage Garden (1040 N 900 E in Provo) at 10 AM on Saturday, September 11. Bitsy Schultz will be on hand to dig up several chokecherry and hackberry seedlings that have grown out of their intended spots at the garden. There are a few other plants that could be transplanted and seeds to collect.— *Celeste Kennard*

*Right: Maguire's primrose (*Primula maguirei*) is known only from the dolomitic limestone cliffs of Logan Canyon in northeastern Utah and has been listed as Endangered under the Endangered Species Act since 1985. Photo by Hillary White.*

Bulletin Board

Annual UNPS Member's Meeting: The Society's annual fall members meeting is scheduled for Saturday, October 23 on the campus of Utah Valley University in Orem, UT. Dr. Jason Alexander, curator of the UVU Herbarium, will speak about current floristic projects for students and volunteers being sponsored by the university. The meeting will begin at 4PM in Room PS110 of the Pope Science Building (located next to the Student Center). As in years past, the meeting will include a New World potluck dinner featuring cuisine of North and South America. After dinner, Jason's lecture will be in one of the nearby lecture halls in the Pope Science Building. The UVU herbarium is also located two doors down.

Utah Valley University is located just off I-15 at the University Parkway exit. Parking lot "L" is located closest to the science building and has free parking on the weekend. If this lot should be full for some unforeseen reason, additional parking is available nearby in Lot N near the entrance to the new library or in lots T or U by the Events Center. There is a lot of construction taking place on campus this fall, so some of the enclosed walkways between buildings will not be open. Consult the printable campus map at the UVU website (http://herbarium.uvu.edu/location.shtml) for more detailed directions.

Utah Valley Herbarium Events: The Utah Valley University Herbarium is hosting a series of events for member of the Utah Native Plant Society. Herbarium volunteer mounting days are continuing the first Saturday of every month this fall. Three are currently scheduled on the 4th of September, the 2nd of October, and the 6th of November, from noon until 4 PM in the Herbarium (PS108). Due to the holidays, there will be no volunteer days in December or January. Parking is free on Saturdays in Lot N near the library. For further information on either of these events, please email or call Jason Alexander at alexanj@uvu.edu or 801-863-6806.

UNPS Fall Student Scholarship Winners: Andrew Rayburn, a graduate student from Utah State University, was awarded the Fall 2009 research scholarship by the Utah Native Plant Society's scholarship/grants committee. Andrew and colleagues Jacob Davidson and Hillary White are studying the endangered Maguire's primrose (*Primula maguirei*) and its relationship to soil chemistry and microhabitat variability within its limited range in Logan Canyon. In particular, these young researchers are looking at possible facilitation of primrose seedling establishment by moss patches growing in cracks and ledges of its limestone cliff habitat. The results of this study will help land managers better understand the habitat needs of Maguire's primrose and contribute to the ecological literature on relationships between mosses and seedlings. UNPS is pleased to contribute $1000 in our scholarship/grant fund to help Andrew and colleagues recover travel costs and fees for soil analysis associated with their project. Andrew and colleagues will provide a summary of their findings in a future issue of the *Sego Lily*. - *W. Fertig*

Farewell to the Aceraceae: Changes in the Angiosperm Family Tree

[continued from page 1] extreme makeovers and while still alive, are barely recognizable. Meanwhile, several formerly obscure families, like the Lopseeds (Phrymaceae), Broomrapes (Orobanchaceae), and Plantains (Plantaginaceae) have attained prominence thanks to an influx of new species transferred from elsewhere.

So what is going on?

These changes are the result of studies by the Angiosperm Phylogeny Group (APG), an international consortium of research institutes and professional taxonomists. The APG has been at work for nearly two decades applying modern research methods and theory to several centuries-old riddles. What is the most primitive group of angiosperms? How natural are existing orders and families? What does the family tree (phylogeny) of flowering plants look like? Through sharing datasets and findings, the APG is attempting to forge an elusive consensus among taxonomists. The work of APG, (originally published in 1999, updated in 2003, and most recently revised in 2009) has corroborated many hypotheses of species relationships among the angiosperms but has also challenged long-held assumptions, much to the consternation of some botanists.

Taxonomy has two main purposes: to provide standardized names for distinct species and subspecies/varieties and to organize these taxa into a logical sequence. The rules for naming species were largely developed by Carolus Linnaeus in the mid 1700s and since formalized and periodically updated in the International Code of Botanical Nomenclature. Hundreds of classification systems have been proposed over the last three millennia, beginning with the simple growth form approach (tree, shrub, perennial herb …) of Theophrastus in ancient Greece. Linnaeus's own "sexual system", based primarily on the number and degree of fusion of stamens per flower, was an early attempt to apply repeatable criteria to the problem of organizing the chaotic jumble of plant species.

Above: Bigtooth Maple (Acer grandidentatum) from Bells Canyon Trail, just east of Lower Bells Canyon Reservoir, Salt Lake County, UT. The Maple family (Aceraceae) is now part of an expanded Soapberry family (Sapindaceae) according to the Angiosperm Phylogeny Group. Photo by Steve Hegji.

Since Linnaeus's time, plant taxonomists have been striving to create ever more natural combinations of species by including information from many sources, such as floral and fruit morphology, embryology, wood anatomy, leaf architecture, cytology, genetics, and the fossil record. Starting in the 1860s with the acceptance of Darwin's theory of evolution, the primary emphasis of taxonomy has shifted from creating mere order to identifying the underlying genealogical relationships among species and families.

Over the last 40 years the dominant angiosperm classification system has been that of the late Arthur Cronquist of the New York Botanical Garden*. Cronquist split the flowering plants into six subclasses of dicots and five subclasses of monocots, with each subunit representing a major evolutionary line. Of these, the Magnolia group (Magnoliidae) is thought to be the most primitive and closest to the putative ancestral flowering plant. Typical Magnoliids, such as the magnolias (Magnoliaceae), buttercups (Ranunculaceae), and water-lilies (Nymphaeaceae) have numerous, separate sepals and petals, numerous stamens, many unfused pistils, and pollen opening by a single germination pore. Other dicot lines include the mostly wind-pollinated and petal-less Hamameliidae (oaks, elms, birches, and sycamores), chemically-unique Caryophyllidae (carnations, buckwheats, and cacti), the large and somewhat amorphous Rosidae (roses, peas, maples, euphorbs, and parsleys) and Dilleniidae (mustards, heaths, violets, and willows), and the Asteridae (asters, mints, phloxes, gentians) considered to be the most advanced group because of the pronounced reduction and fusion of floral parts.

The monocots are believed to derive from the magnoliids through the primitive Alismatidae (mostly aquatic species with numerous stamens and separate pistils such as the arrowheads and pondweeds). Additional monocot lines include

*Russian botanist Armen Takhtajan and American Robert Thorne independently derived comparable, though somewhat more complex, systems at about the same time as Cronquist, but their works have not been as widely used in North America.

the Arecidae (palms and arums), Commelinidae (bromeliads, sedges, and grasses), Zingiberidae (bananas and gingers), and Liliidae (lilies, iris, and orchids). Like the Asteridae, the Liliidae are considered the most evolutionarily advanced group within their class.

The systems advocated by Cronquist, Taktahjan, and Thorne were derived from their authors' encyclopedic knowledge of flowering plant diversity and the taxonomic literature. By contrast, the Angiosperm Phylogeny Group's taxonomy is derived from pooling datasets and experiences of numerous individual researchers, augmented by breakthroughs in analyzing DNA that were unavailable even two decades ago. In addition, the APG has applied formal cladistic methodology to the problem of family relationships.

The basic premise of cladistics is that species and families can be organized based on deviations from an original set of shared characteristics. These changes can be depicted visually as branches of a tree (each branch is a "clade") and the distance between branches is analogous to the degree of similarity between taxonomic groups. To be legitimate under the rules of cladistics, families and higher taxonomixc groups must include all species above a given fork in the tree (the decision of what fork to choose is left to the taxonomist). Families that are nested within forks comprising another, related family cannot stand alone, regardless of how distinct they might appear otherwise. Thus, the maple and horsechestnut branches nest within that of the soapberries and must be included within an expanded family concept of Sapindaceae. Likewise, the milkweed clade falls within the dogbanes, duckweeds within the arums, and so forth (see chart at right).

Other situations are more complex, such as the old Scrophulariaceae where genera once included in the Figwort family were scattered among numerous branches and intertwined with Orobanchaceae, Phrymaceae, and Plantaginaceae. Either all of these families had to be merged into one very amorphous family, or they had to be reconstituted into more evolutionarily coherent subgroups. Unfortunately, due to the naming rules set down under the International Code, the family names Orobanchaceae, Phrymaceae, and Plantaginaceae had to be retained, even though they are named for relatively unfamiliar genera.

Another family that has been split up considerably is the Liliaceae. For years, specialists have recognized that the group was unnatural and served as a catch-all for a diverse assemblage of monocots with six tepals and six stamens. Based on recent genetic and morphological studies, several lily genera have been relocated to other monocot families and orders. The false asphodels (*Tofieldia*) turn out to be more closely related to the arrowheads and are now placed in their own family (Tofieldiaceae). Likewise, camas (*Camassia*) is better placed with the yuccas and agaves (Agavaceae). Other lily genera have been split into two main clades based on seed and nectary features. One, the asparagus line, includes the onions (*Allium*), funnel-lilies (*Androstephium*), and false Solomon's seal (*Maianthemum*), which turn out to be more related to the irises, orchids, and agaves than the true lilies. While

Family Changes Based on Recent Taxonomic Research by the Angiosperm Phylogeny Group

Old Family	New Family
Aceraceae (maples)	Sapindaceae (soapberries)
Asclepiadaceae (milkweeds)	Apocynaceae (dogbanes)
Buddlejaceae (butterfly-bushes)	Scrophulariaceae (figworts)
Callitrichaceae (water-starworts)	Plantaginaceae (plantains)
Chenopodiaceae (goosefoots)	Amaranthaceae (amaranths) & Sarcobataceae (greasewood)
Cuscutaceae (dodders)	Convolvulaceae (morning-glories)
Fumariaceae (fumitories)	Papaveraceae (poppies)
Hippuridaceae (mares'-tails)	Plantaginaceae (plantains)
Hippocastanaceae (horse-chestnuts)	Sapindaceae (soapberries)
Hydrophyllaceae (waterleafs)	Boraginaceae (borages)
Lemnaceae (duckweeds)	Araceae (arums)
Liliaceae (lilies, in part: still includes *Erythronium, Fritillaria, Lilium, Lloydia*)	Alliaceae (onions) Amaryllidaceae (daffodils) Asparagaceae (asparagus) Colchicaceae (crocus) Melanthiaceae (bunchflowers) Ruscaceae (butcher's brooms) Themidaceae (funnel-lilies)
Monotropaceae (pinesaps)	Ericaceae (heaths)
Najadaceae (naiads)	Hydrocharitaceae (frogbits)
Pyrolaceae (pyrolas)	Ericaceae (heaths)
Scrophulariaceae (figworts, in part, still includes *Scrophularia Verbascum, Buddleja*)	Orobanchaceae (broomrapes: includes *Castilleja, Cordylanthus, Orthocarpus, & Pedicularis*) Phrymaceae (lopseeds: includes *Mimulus & Mimetanthe*) Plantaginaceae (plantains: includes *Collinsia, Penstemon, & Veronica*)
Tiliaceae (basswoods)	Malvaceae (mallows)
Viscaceae (mistletoes)	Santalaceae (sandalwoods)
Zannichelliaceae (horned pondweed)	Potamogetonaceae (pondweeds)

Other changes:
Celtis goes from Ulmaceae (Celtidaceae) to Cannabaceae (hemps)
Nolina goes from Agavaceae to Ruscaceae (butcher's brooms)
Sambucus & *Viburnum* go from Caprifoliaceae to Adoxaceae (moschatels)

the lily family remains, it is much reduced and retains mostly the true lilies (*Lilium*), tulips (*Tulipa*), checker-lilies (*Fritillaria*), and trout lilies (*Erythronium*). There is still disagreement as to whether the sego lilies and mariposas (*Calochortus*) belong here or in their own family, Calochortaceae. Other former lily family members have been segregated, including the catbriers (Smilacaceae), Trilliums (Trilliaceae), and death-camas (Melanthiaceae).

Some of the changes proposed by the APG remain controversial. The borages (Boraginaceae) traditionally have been allied with the mints (Lamiaceae) on the basis of similar fruit structures: four 1-seeded nutlets. DNA evidence suggests these two groups are only distantly related within the Asterid clade and that the borages should contain the waterleafs (Hydrophyllaceae), despite the latter group (*Phacelia, Hydrophyllum* and relatives) having capsule fruits with numerous seeds.

Besides re-arranging plant families, the APG has altered Cronquist's long-standing family tree. The most primitive flowering plants are now thought to be a group of herbs and shrubs that includes the water-lilies and several small orders found-mostly in the south Pacific and Australia. From this basal group, the angiosperms split into the magnoliid line (analogous to Cronquist's concept with a few of the most primitive forms and the buttercups removed), the monocots, and the "true dicots" or eudicots. Among the eudicots, the buttercups diverged early, as did the Caryophyllidae. Two main branches later arose: the Rosids (which include most of Cronquist's Rosidae, Hamamelidae, and Dilleniidae) and the Asterids (expanded from the original Asteridae to include the umbels (Apiaceae), hollies (Aquifoliales), dogwoods (Cornales), and heaths (Ericales).

Of course no classification is ever complete or universally accepted. Numerous refinements were made in the third edition of the APG system published in 2009 and more changes will likely arise and be posted on the APG website in the future (www.mobot.org/mobot/research/apweb/). Taxonomists are still free to use systems of their choosing in technical manuals, floras, and species checklists. Users of these products will still need to be fluent in multiple family synonyms and concepts.

We live in an era of unstable taxonomy, and this is not likely to change any time soon. Efforts to create more natural taxonomic systems, like that proposed by APG, are worthwhile, even though they may be upsetting when they impact our favorite families or world view. Taxonomy is, after all, a legitimate science and not merely pasting and rearranging stamps in a binder. Some of the changes proposed by APG will prove to be wrong in light of new discoveries and changes in theory (cladistics is not without its logical shortcomings, particularly the problems of hybridization and reticulate evolution). The goal of the perfect, natural classification will remain elusive, just as it has since Linnaeus's time nearly 250 years ago.

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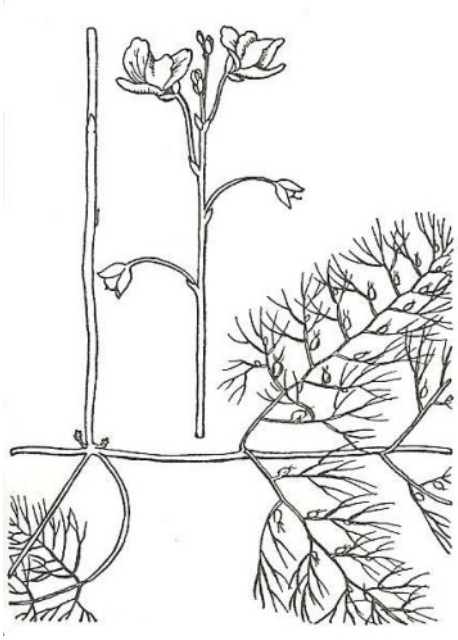
Bladderworts: Terrors of the Wetlands

By Stuart Markow
Adapted from *Castilleja*, the newsletter of the Wyoming Native Plant Society

The idea of plants killing and eating animals has intrigued man for centuries. This fascination with carnivorous plants may result from: 1) the thought that there just might be plants that actually eat people as portrayed in such movie classics as *Little Shop of Horrors* and *The Lost World*, and 2) an apparent situation of serious role reversal; people are used to thinking of animals eating plants rather than vice-versa. In fact, while the ability of certain plants to capture insects and other small invertebrates has been accepted for a long time, the thought that these plants might digest and absorb critters was roundly rejected by biologists for many years. The concept was energetically denounced with the same scientific reasoning that historically has been used to deny reality on a number of fronts: it just didn't seem right!



Left: Common bladderwort, Utricularia vulgaris *or* U. macrorhiza *has yellow, snapdragon-like flowers and leaves with bladders borne amid the rounded leaflet segments. Illustration from Britton and Brown (1913).*

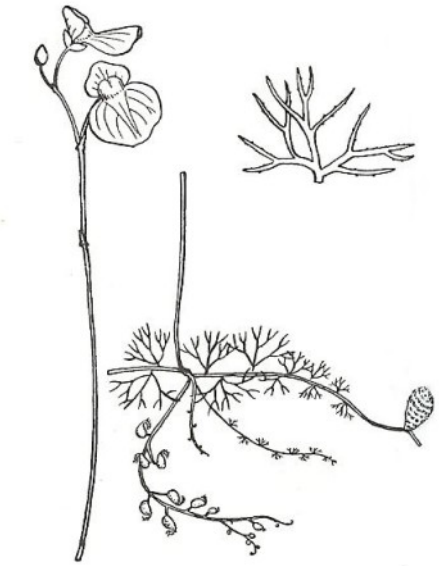
Thus, those who did suggest that plants might be snacking on insects were ridiculed or ignored. It wasn't until the late 1800s that, with a series of elegant experiments using sundews and Venus flytraps, Charles Darwin provided such conclusive evidence for insectivory that the

skeptics received little further attention. Subsequent investigation by Darwin and others served to elucidate the various mechanisms of carnivory in plants.

Today it is well documented that plants can and do prey on not only insects, but a wide variety of invertebrates and even vertebrate species as diverse as frogs, fish, birds, and mice. The number of plants able to perform this feat is not well established, with reported figures ranging from 400 to 600 species. Part of this discrepancy is due to the taxonomic concepts subscribed to by various authors, but perhaps more importantly there is not complete agreement as to what constitutes a carnivorous plant. In almost all cases, the anatomical equipment and processes used are simply modifications of structures and processes found throughout the plant kingdom. None of the individual features—traps, lures, directional guides, secretory glands, absorbing glands—are unique to carnivorous plants.

In North America, there are five main groups of carnivorous plants. The sundews (*Drosera*) have sticky leaves that catch small bugs like flypaper. Venus flytrap (*Dionaea*) has an ingenious hinged leaf and trigger. Pitcher plants (*Sarracenia* and *Darlingtonia*) have leaves shaped like a vase that drown their prey in liquid pools. Butterworts (*Pinguicula*) have sticky, butter-yellow, basal leaves that trap insects. Bladderworts (*Utricularia*) catch tiny underwater creatures through the power of suction. Of these, only the bladderworts occur naturally in Utah. None appear to be man-eaters.

The bladderworts feature the most sophisticated trapping devices to be found among the carnivorous plants. These consist of tiny, very numerous bladders with one-way entrances adapted to catching miniscule swimming creatures in standing water or wet soil. The bladder-like trap is provided with a baited trap door complete with a tripping device. Once a small animal brushes against the door, the trap is sprung and the door flies open releasing a partial vacuum which sucks the victim inside. The door then shuts, imprisoning the prey within.



Above: Flatleaf bladderwort, Utricularia intermedia *is distinctive in having bladders borne on separate leaf segments. It is rare in Utah, being known from only three locations in Cache, Rich, and Wayne counties. Illustration from Britton and Brown (1913).*

Utricularia (Lentibulariaceae family) is a large genus of nearly 300 species distributed worldwide. Most are aquatic, some are moist-terrestrial, a few are even epiphytic. All three Utah species are strictly aquatic, lurking in shallow wetlands and lunching on insects, water fleas, rotifers, copepods, and other minute critters.

The traps are scattered about the plants in great numbers, sometimes on the stems, sometimes on the leaves, sometimes on both. They are generally oval-shaped, with antennae-like appendages that appear to funnel prey to the trap entrance. A hinged door in front of the bladder is attached to the top of the opening and swings inward. At the base are pointed bristles which act as trigger hairs. The trap is set by removal of most of the water through glands located both inside and outside of the bladder. This removal generates a partial vacuum and, as a result, the door is held in place by a very finely balanced tension involving hydrostatic pressure countered by the door's weak grip on the edges of the bladder walls. The slightest touch of the trigger hairs is enough to break this tension.

The exact mechanism by which the touch stimulus opens the door has not yet been determined. Some researchers claim that the trigger hairs act as a lever, lifting the door's lower edge and breaking the tenuous connection between the door and the bladder walls. Others argue that the mechanical stimulus is transduced to an electrical signal which reduces the rigidity of the door, causing it to buckle under the inwardly directed hydrostatic pressure. In either case, when the door loses its precarious grip it swings open and the prey is swept into the bladder with the inrush of water. Once the vacuum is released the door swings back to its normal, closed position and the victim is trapped. Glands within the bladder secrete digestive enzymes and acids, and the same glands absorb the nutrients.

The activation of a trap results in some of the fastest movement ever recorded in plants. Older literature reports that the sequence of events from tripping to re-closing the bladder occurs in about 1/50th of a second. However, recent investigations suggest that the trapping process occurs at a much faster rate, perhaps as quickly as 1/500th of a second. Unfortunately, the small size of the traps makes the adventure difficult to observe and, while this operation provides as dramatic a display as plants have to offer, few people have actually seen bladderworts in action.

Because of their unique capabilities, carnivorous plants are often collected and cultivated as novelties. Without special, individualized care by knowledgeable horticulturists, they usually die within a few months. With the exception of the Common bladderwort (*Utricularia vulgaris*), all of Utah's carnivorous plants are fairly rare within the state, so removing them from their preferred sites cannot be justified. Besides, it may turn out that some of these are man eaters after all. It is best to leave them be.

On the False Report of an Edward Palmer Collection as a New Record for the Genus Oligomeris *(Resedaceae) for Utah*

By Jason Andrew Alexander
Utah Valley University Herbarium

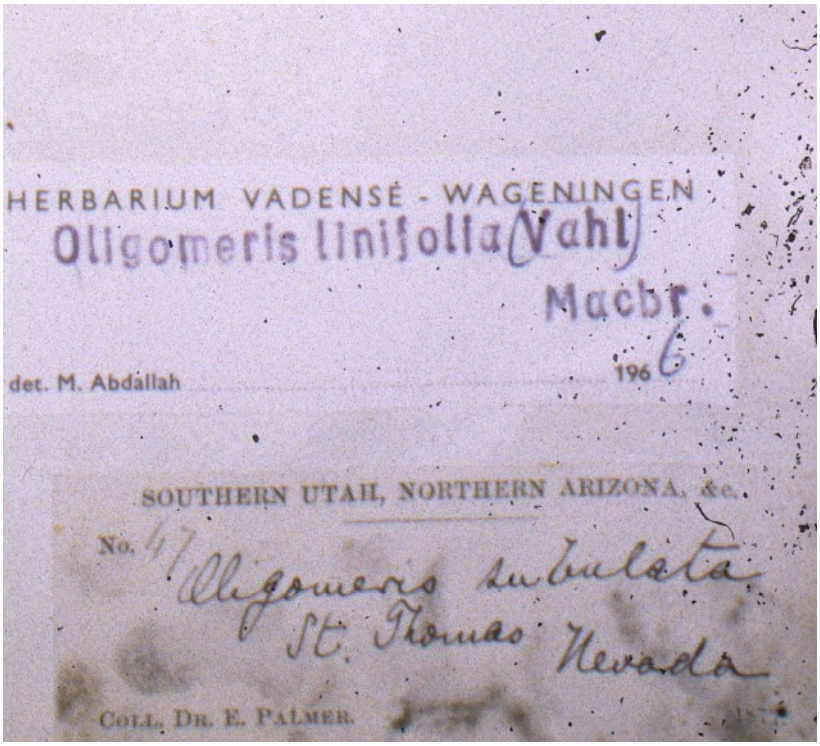
In the July issue of the *Sego Lily*, a new taxon, *Oligomeris linifolia* (Vahl) J.F. Macbride (Resedaceae) was reported for Utah based on *Edward Palmer 47,* an 1877 collection deposited in the U.S. National Herbarium (US) at the Smithsonian Institution. This report originated from the newly published Volume 7 of the *Flora of North America* (FNA). Attributing this species and collection to Utah, however, is problematic. As has been the case for most of the past century, Edward Palmer's collections have more frequently been mis-cited by 20th century taxonomists than any other 19th century Utah collector.

For many early expeditions it can be a challenge relocating the populations from which specimens were obtained. However, due to an unusually persistent series of publication and typographical errors which originated in the 1870's with Asa Gray at the herbarium of Harvard University (GH), Edward Palmer's specimens have been the most problematic. Palmer's collections were distributed by eastern taxonomists such as George Vasey (his 1869-1870 collections), Asa Gray (his 1874 and 1877 collections) or Sereno Watson (his 1875 and 1879 collections). Palmer sent most of his original and duplicate sets to these botanists, who later sold & distributed them after identification (McVaugh 1956). The specimens of 1877 were one of the only collections that Palmer himself distributed, with some assistance from Charles Christopher Parry, a prolific collector of Rocky Mountain plants who spent much of his later years in Iowa.

Some problems with the 1877 collection are related to the manner in which Palmer and Parry assembled the specimens for distribution. First, Palmer distributed his 1877 collections (and many of his later collections through the 1890's), with a handwritten serial number only, on a preprinted label entitled "southern Utah, northern Arizona, & c." (see image of the label from *Palmer 47,* below). Between September and December 1877, they assembled and numbered the collections into at least 18 sets to be sold to other botanists and herbaria. Palmer and Parry rapidly distributed these sets to raise funds for a combined trip to Mexico scheduled for departure in January of 1878 (McVaugh 1956: 72-74). Second, neither Palmer nor Parry wrote tentative identifications on the specimen labels. Instead the specimens were sorted taxonomically, assigned a handwritten serial number, resorted into sets, and distributed without determinations. By late 1877, Gray was sent a complete set of specimens for determination.

Most of the evidence, however, supports the hypothesis that Gray was the primary contributor to the overall confusion surrounding Palmer's 1877 collection, which was first proposed by McVaugh & Kearney (1943) in a treatment of problematic type specimens for the *Arizona Flora*. Problems with specimens or Gray's publications can be attributed to his handling of the specimens at GH. It appears that Gray split mixed or misidentified specimens and reassembled those elements onto separate sheets. As a result, many GH specimens are missing the original label assigned by Palmer. Of all the other original sets examined by me in the last decade, only specimens at GH and US were found to be regularly missing Palmer's pre-printed label. Most specimens at US were assigned a "replacement" Department of Agriculture label by George Vasey and sometimes Palmer's original is missing. Additionally, Gray transcribed Palmer's original list upon receipt and amended some of Palmer's identifications with his own determinations into his manuscript of collections (Gray, no date), now deposited in the Harvard Botany Libraries. It can be inferred that

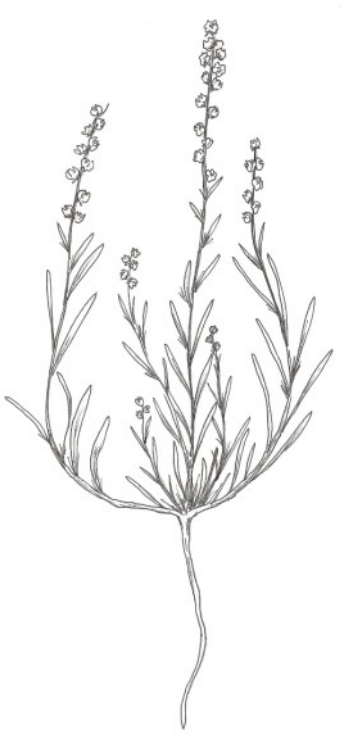
Below: Palmer's 1877 *collection of* Oligomeris linifolia *is from Nevada, not Utah.*



sometime in December of 1877 Gray finished his determinations and began writing his type descriptions of new taxa, some of which were published in Gray (1878). Afterwards, some form of a list was sent to each of the botanists and herbaria to which a set was sent, containing the serial number, the determinations, and Gray's abbreviations of Palmer's collection localities. In fact, the identifications on labels of the specimens of the 18 distributed sets all are written in the unique handwriting common to the collections of those botanists or herbaria to which the set was sent, and not in Gray's, Parry's or Palmer's hand. All have determinations identical to those found in Gray's later manuscript and a small number of specimens in these sets even have Gray's localities.

Though Gray can be attributed as the primary source of error regarding Palmer's 1877 specimens, the majority of western taxonomists have all unintentionally contributed to this accumulation of error over the past 150 years. In addition, many taxa cited for Utah (those that have not been recollected since his 1877 expedition, for the most part) in many floristic treatments are actually records from Arizona or Nevada. Since "southern Utah" is the first state mentioned on Palmer's pre-printed label, many botanists have historically assumed that Utah is the likely collection locality for a majority of his 1877 collection. This error has been perpetrated, unknowingly, by botanists who are unaware that specific collection localities for specimens prior to the 1880's were frequently only recorded in unpublished manuscripts or published in catalogues, and not regularly written on the specimen label (and frequently differed from any generic title preprinted on the label itself).

McVaugh (1956: vi-vii) states that in the 19th century, "the prevailing attitude toward documentation of specimens... was a careless one by today's standards... some [specimens were] sent out with generalized geographical information covering a whole year's work ... some have been misdated by as much as a year, and assigned to nonexistent localities." The botanists to whom Palmer sent his specimens for determination and distribution, "wrote his labels and transcribed his data in addition to their own..., and perhaps they should not be censured too harshly for hasty and superficial attention to the tedious details" (McVaugh, 1956: vii-viii).



Above: Flax-leaf whitepuff, a.k.a. Oligomeris linifolia *is an annual or short-lived perennial forb with slender, succulent leaves, tiny, white, 2-petaled flowers, and flattened-globular fruits. The species was originally described from the Canary Islands and ranges across the deserts of northern Africa and the Middle East. Populations also occur from SE California and southern Nevada to western Texas and northern Mexico. Thomas Nuttall collected* O. linifolia *in southern California as early as 1836. Some biogeographers have questioned whether the North American populations are native. A recent genetic study by Santiago Martin-Bravo and colleagues comparing New and Old World populations found significant differentiation, suggesting that the species arrived in North America by long-distance migration in the Quaternary, well before the modern era of human-facilitated dispersal. Illustration by W. Fertig.*

In regard to the citation of *Oligomeris linifolia* as a taxon new to Utah, it appears that this is simply another case in which the authors for the Resedaceae treatment for FNA failed to consult Asa Gray's manuscript and (as is too commonly done) assumed this specimen was collected in southern Utah. In the image on the previous page, the collection number 47, in the upper left hand corner, is the only part of the label that was originally written by Palmer & Parry. The identification and the collection locality are written in the hand of the worker who, in the late 1870's, was curating the Columbia University Herbarium (now part of the New York Botanical Garden Herbarium, NY). There are at least 7 duplicates of *Palmer 47* in eastern herbaria, including the two cited in the North American Flora, and this one from NY is the only one I have seen with Gray's manuscript collection locality. The correct citation for this specimen is as follows:

Oligomeris linifolia (Vahl) J.F. Macbride**;** U.S.A. NEVADA. Clark Co.: between St. Thomas and the Muddy River Valley [GH Manuscript locality: "Muddy"], 17-20 April 1877, *Dr. Edward Palmer 47* (GH, NY!, 4 sheets, US, WIS).

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Native Plant Profiles: Four-wing Saltbush

By Walter Fertig

Four-wing saltbush (*Atriplex canescens*) is a fairly non-descript shrubby member of the goosefoot family (Chenopodiaceae — now Amaranthaceae) that ranges across much of the southern Great Plains, Great Basin, and desert Southwest at elevations up to 8000 feet. It is characterized by grayish, linear to spoon-shaped leaf blades, yellowish twigs, and small yellowish or brown wind-pollinated flowers clustered in slender inflorescences and lacking showy petals. Mature fruits can be eye-catching because of their relatively large size (1/2 to 1 inches long and broad) and four membranous, slightly toothed wings (thus, the name "four-wing"). Four-wing saltbush is often abundant, especially in sandy or saline areas, and easy to ignore.

But when it comes to reproduction, Four-wing saltbush is anything but ordinary. More than 90% of the saltbush plants in any population are dioecious, meaning that individual shrubs are either completely staminate ("male") or pistillate ("female"). Staminate plants only produce flowers that have anthers and shed pollen, and usually occur in harsher microsites in the environment. By contrast, pistillate plants only produce seed and are not capable of self-fertilization. About 10% of plants in a population are monoecious and have separate male and female flowers on the same individual.

What makes Four-wing saltbush unusual is that the sex of any given plant is not genetically fixed (as in most animals), but can change based on environmental cues. Researchers have discovered that over a seven year period nearly 40% of the saltbush plants in a population switched sexes, with as many as 20% doing so each year. Pistillate plants were more likely to change sides than staminate ones, especially in years following an unusually cold winter, drought, or after an atypically heavy fruiting season.

Above: Pistillate ("female") specimen of Four-wing saltbush laden with young, green, four-winged fruiting bracts in late summer. Each set of bracts encloses a one-seeded dry fruit. Four-wing plants are unisexual (either staminate or pistillate) but can switch sexes from year to year depending on environmental conditions. Photo by W. Fertig.

Male plants that became females enjoyed a reproductive advantage over other pistillate plants by being able to flower earlier in a good season. The result of all this switching is that sex ratios in saltbush populations can become skewed and sexes partially segregated along gradients of environmental quality, with females predominating in richer sites and able to become larger and produce more fruits.

Whether Native Americans paid attention to the sexual intrigue of Four-wing saltbush is unknown, but tribes did make extensive use of saltbush. Before the advent of steel axes made it easier to harvest trees, many Indians used brittle saltbush stems as fuel. Smoke from burning leaves was thought to revive those feeling weak or faint. Yellow dyes were made by boiling the leaves with raw alum. Saltbush seeds are edible (with a naturally mild, salty taste) and were parched by the Navajo to make flour.

Four-wing is regarded as one of the most important browse species in the western United States. In part this is due to the plant's ability to thrive in semi-arid saline and sandy basin habitats that cover much of the intermountain west, where Four-wing saltbush is often one of the dominant shrub species. More importantly, the foliage and seeds are palatable and highly nutritious. They are eaten with relish by cattle, sheep, and goats (though not horses) as well as deer, elk, antelope, and bighorn sheep. Native browsers consume the plant mostly in winter when saltbush is especially rich in carotene and protein. Rodents, sage grouse, Gambel's quail and other nesting birds take advantage of the shrub's intricate branching for shelter from predators and the elements. If saltbush rangeland is well-rested in the summer (allowing fruits to ripen and seedlings to sprout) it can sustain relatively heavy grazing use in winter. Too much browsing, however, can

Celebrating Wildflowers: Plants of the Week

This essay is partly adapted from a biography of Four-wing saltbush prepared for the US Forest Service's Celebrating Wildflower's website (www.fs.fed.us/wildflowers/plant-of-the-week/index.shtml). Visit this website for a different native plant essay each week, and for other interesting and useful tidbits about pollinators, rare plants, wildflower events, and other happenings on US Forest Service lands.

lead to trampling of the brittle stems and eventually drain the seedbank.

Fortunately, Four-wing saltbush readily germinates from seed if given half a chance. Seeds ripen in late August and September and may remain on the female plant into December. Several months of cold stratification are required to induce germination in nature. Given some protection from insects, rabbits, rodents, and browsers, seedling fourwings can grow rapidly, adding as much as 18 inches of new growth.

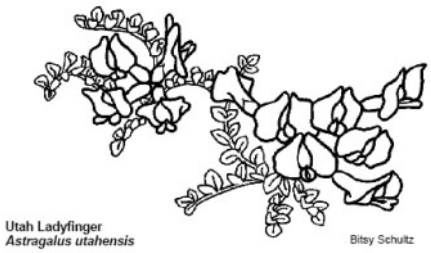
Because of its tolerance of cold weather, drought, and poor soils Four-wing saltbush has become a favorite species for use in reclamation projects. Once established, the plant's extensive root system is excellent for containing soil erosion. Four-wing is also becoming more popular as an accent plant in desert landscaping. In Utah, it is hardy in nearly all settings except high elevations and wetlands. Plants can be grown from stem cuttings or from seed. Stock is also increasingly available from commercial nurseries.

When growing from seed, experts recommend an after-ripening period of up to 10 months, followed by 30-50 days of cold stratification. Before planting, seeds should be soaked for two hours and the membranous wings removed (especially if being planted with a drill or mechanical seeder). Seeds should be planted

Above: Silvery foliage of Four-wing saltbush. The narrow leaves are an adaptation for water conservation in its semi-arid environment. Below: Four-winged pistillate bracts surround the one-seeded fruit. The bracts turn brownish-tan when ripe. When planting, the wings should be removed. Photos by Steve Hegji.

1/2 to 3/4 of an inch deep, depending on soil moisture and coarseness. Seedlings require little water and are tolerant of full sun and wind. They are best grown in dry sandy or slightly alkaline soil in late fall, early winter, or very early spring. Four-wing stands may take 3-4 years to become fully established, at which time they can become self-perpetuating through vegetative layering or seed.

I find Four-wing saltbush to be an enjoyable plant to have in my yard in Kanab. It requires almost no maintenance, other than periodic pruning of dead branches at the base of the plant (these old stems go in the woodstove). My covey of Gambel's quail hang out all year in the dense growth, and mule deer browse on the foliage in winter. It is also fun to keep tabs on which plants produce fruit each year, and which ones will perform a sex-change next year!



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