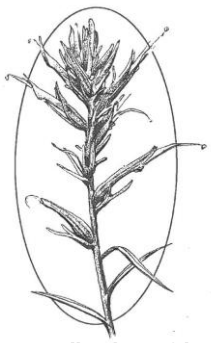

Castilleja linariifolia

Castilleja

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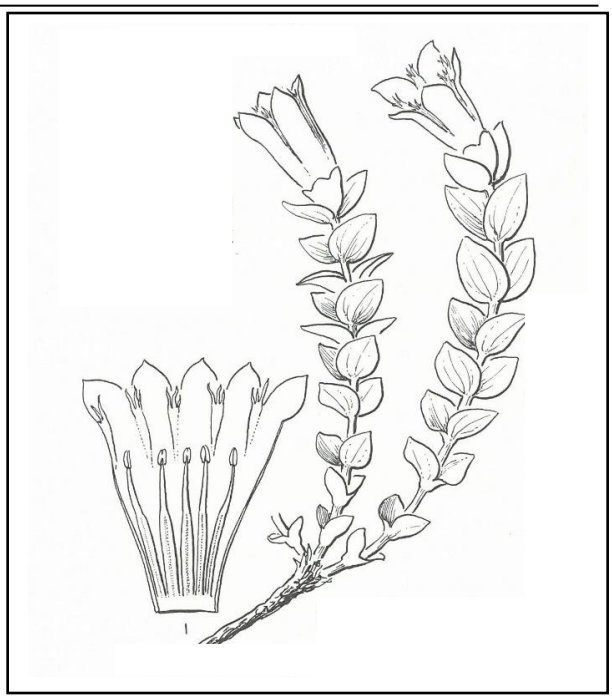
In this issue:



Above: Explorer's gentian (*Gentiana calycosa*). Illustration by Jeanne R. Janish. From: Hitchcock, C. L., A. Cronquist, and M. Ownbey. 1959. Vascular Plants of the Pacific Northwest, Part 4: Ericaceae through Campanulaceae. University of Washington Press, Seattle, WA. Reprinted with permission. See p. 4 for a plant profile of this species.!

The Secret Life of Lichens

Lichens occupy some of the harshest habitats in Wyoming and the world – how do they do it? "Lichens are fungi that have discovered agriculture", according to lichenologist Trevor Goward, lichen curator at the University of British Columbia (Grice 2010). They represent perhaps the oldest known symbiosis in science, a close relationship between a fungus species (almost always an ascomycete) and a photosynthesizing alga species, taking on a macrolichen growth form.

…At least that was the paradigm until scientists discovered a third party in the picture that had eluded science all these years. Spribille et al. (2016) discovered that North American beard-like lichens are comprised of ***three*** symbiotic partners that include basidiomycete yeasts. These single-celled associates may actually account for some of lichen gross morphology, and for production of secondary metabolites that have baffled scientists for years.

Two putative *Bryoria* species of Montana were the first subjects of study, including *B. fremontii* (tree hair lichen). They are common in the Rocky Mountains, and have chemical contrasts but provisional taxonomic equivalency. Hypothesizing that the chemical differences between the two species would be explained by differential gene expression, the scientists analyzed -messenger RNA (also called the transcriptome). Results revealed no systematic differences between the ascomycete fungi of the two species…but a startling difference when the taxonomic range of analysis was expanded to include basidiomycetes. Both species contained the same unknown basidiomycete, but it was much more abundant in one of the species.

Next, the lichen research team analyzed the correlation and global distribution pattern of basidiomycete taxa in relation to ascomycete taxa from many different macrolichens sampled on six continents, finding basidiomycete yeasts ubiquitous among macrolichens, with apparent taxonomic consistencies in the associations between the two different types of fungi. Most of the basidiomycetes (Continued, p. 3)

WYNPS News

New Members: Please welcome the following new members to WYNPS: Ron Bice, Cody; Blair & Nancy Butterfield, Dubois; Lori Clark-Erickson, Jackson; Eugenie Copp, Dubois; Janice Hansen, Alpine; Jennifer Howland, Elko, NV; Sam Jordan, Laramie; Earle F. Layser, Alta; Janet Marschner, Cheyenne; Bobbie McCrackin, Atlanta, GA; Janice McKee, Cheyenne; Lillian McMath, Dubois; John Mionczynski, Lander; Nathaniel Moy, Elko, NV; Rob Outka, Rozet; Danita Sayers, Dubois; Mae Smith, Greybull; Georgi Still, Wilson; Nancy Thomas, Star Valley Ranch; Kathy Treanor, Dubois; Trudy Trevarthen, Dubois; American Wilderness Botanicals, LLC., Wilson; Gardening With Altitude, Cheyenne.

Treasurer's Report: Treasurer's report: Balance as of 15 Sept 2016: Scholarship = $1295.50; general fund = $7250.50; total = $8546.

WYNPS Board – 2016
President: Karen Clause, Pinedale (kdclause@centurytel.net)
Vice-President: Brian Sebade, Laramie (bsebade@uwyo.edu)
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Wyoming Native Plant Society
P.O. Box 2500
Laramie, WY 82073

Teton Plants Fall Program Event:
When: Tuesday, October 25, @ 6 p.m.
What: **Douglas Fir Fire History and Dynamics in Jackson Hole**
Who: Kevin Krasnow, Faculty and Research Specialist, Teton Science School
Where: Teton Public Library, Jackson
Watch for future program announcements at the homepage of the Teton Plants Chapter: http://www.tetonplants.org/

Laramie Event:
When: Thursday, October 27, @ 5:30 p.m.
What: **Historical Journey of Wyoming's Plant Explorers, from Horseback to Satellites**
Who: Robert Dorn, botanist and author
Where: Berry Biodiversity Conservation Center, Laramie, at 10th and Lewis Streets (U-WY)

Robert Dorn will talk about exploration of Wyoming's rich plant life. Advances in technology across three centuries have streamlined the process--from horseback to motorized vehicles, quill pens to computers, and unmapped wilderness to GPS. He received his PhD from the Botany Department (U-WY) and authored *Vascular Plants of Wyoming* (3rd ed., 2001), *The Wyoming Landscape*, 1805-1878 (1986), and co-authored with his wife Jane, *Wyoming Birds* (2nd ed., 1999) and *Growing Native Plants of the Rocky Mountain Area* (2007).
It is sponsored by Rocky Mountain Herbarium (RM) and Biodiversity Institute (U-WY). It is preceded by a RM Open House @ 4:30 pm. A Reception follows the talk.

Message from the President

Fall is here! As field season wind down, here's the news. Nominations are open for the "Ronald L. Hartman Wyoming Excellence in Botany Award", named after its first recipient in 2015. Send nominations to the award committee at the Society address (below).

I'm also appointing a nomination committee for Board positions – would you like to be on the committee or run for office? -Call or write!

Please enjoy the fall colors. Thanks again for a great annual meeting in Dubois. Last but not least, HURRAH for new members ☺.

~Karen Clause

Contributors to this Issue: Karen Clause, Eva Crane, Robert Dorn, Walter Fertig, David Giblin, Bonnie Heidel, Mae Smith, Lynn Stewart, Amy Taylor, Dorothy Tuthill.

2016 WYNPS Annual Meeting
Dubois, WY

About 70 people came to the 2016 Annual Meeting in Dubois. We also had an amazing showing in the Plant Kingdom! Thank you to Dubois hosts, and to one and all for coming!

Above: Hold onto your hats! Whiskey Mountain hikes ran both Saturday and Sunday. Here's a view of some hikers at the blustery summit. Photo by Mae Smith

Left: *Aquilegia jonesii* (Limestone columbine; Jones' columbine, appeared in profusion to the glee of Whiskey Mountain hikers. Photo by Lynn Stewart

Left: *Androsace chamaejasme* (Sweet-flowered rock jasmine) contributed to the kaleidoscope of color on top with *Aquilegia jonesii*. Photo by Eva Crane

The Secret Life of Lichens, cont. from p. 1

belong to one (newly-recognized) order that appears to have a shared evolutionary history with the lichen-forming ascomycetes.

How did yeasts within lichens escape detection all these years? Their location and the previous techniques used by lichenologists are parts of the explanation. The breadth of results indicate that basidiomycete yeasts are essential partners for most lichens and may help explain the heretofore impossibility of reconstituting lichen symbiosis in the lab.

…Maybe lichens in their three-way partnerships provide a new paradigm for collaboration! BH and DT

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Spribille, T., V. Tuovinen, P. Resl, D. Vanderpool, H. Wolinski, M.C. Aime, K. Schneider, E. Stabentheiner, M. Toome-Heller, G. Thor, H. Mayrhofer, H. Johannesson and J.P. McCutcheon. 2016. Science 353: 488-492.

LICHEN PHOTOGRAPHY ON DISPLAY

Lichen photographs by Bruce Parkinson will go on display at the Berry Biodiversity Conservation Center (U-WY in Laramie) from October 24 thru the end of the academic year.

Plant profile:

Gentiana calycosa

By David Giblin
University of Washington Herbarium, Burke Museum
[Adapted from: *Douglasia* 40 (3). (2016)]

Thou blossom bright with autumn dew,
And coloured withe heaven's own blue,
That openest when the quiet light
Succeeds the keen and frosty night.

So begins the poem "Ode to a Fringed Gentian" by nineteenth-century write William Cullen Bryant. Though his musings were of *Gentianopsis crinita*, he might as well have been writing about *G. calycosa* (explorer's gentian, also called mountain bog gentian or Rainier pleated gentian), a native member of our flora commonly found throughout the subalpine and alpine meadows of the Cascades and Olympic mountains. Its broader range extends from British Columbia to California, east to Alberta, Montana, Wyoming and Utah.

Gentiana calycosa is in the Gentianaceae, a family of plants closely related to the dogbane family (Apocynaceae), the latter of which includes the milkweeds. The gentian family has a worldwide distribution and comprises some 100 genera and 1,800 species with growth forms ranging from annual herbs to small trees. The genus *Gentiana* itself is huge – about 360 species of herbaceous plants found on every continent except Antarctica, though the vast majority of them are found in Asia. The online Flora of China shows 317 species occur there.

The origin of the name *Gentiana* traces back to Gentius, a second-century king of Illyria, who according to legend discovered the medicinal value of *G. lutea*. The specific epithet *calycosa* is from the Latin *calyx*, seed pod, husk or outer covering, and the Latin *os*, here meaning "full." The reference to a full calyx is uncertain.

Taxonomically, *Gentiana* has presented serious challenges to researchers. Results from molecular studies over the past 30 years have warranted the recognition of serval genera to accurately capture the evolutionary relationships of many species that historically were placed in *Gentiana*.

Explorer's gentian is one of my all-time favorite mountain plants. I think part of it has to do with them being late-season bloomers (late July to September), squeezing in their reproductive cycle just before the impending end to the wildflower season. I also like that the flowers are presented at the tips of stems that are often are not higher than the surrounding vegetation. There is often an element of surprise when first encountering them each year.

Explorer's gentians are perennial herbs, typically with multiple stems originating from a common base (cespitose). The leaves are simple, opposite, and lack petioles (sessile). Overall the plants are quite striking, though they must be difficult to cultivate in a garden setting, as I've never seen them for sale in a nursery. Its flowers have sepals and petals in fives, with the petals fused into a broad tube. The five, rounded lobes at the top of the tube have the most remarkable greenish-yellow flecking. This flecking continues downward in the tube in patterning so dense as to form vertical guides for pollinators to locate the nectaries located at the base of the flower. You really need to see this if you haven't. The flowers are primarily bumblebee-pollinated. There are five stamens fused to the inner corolla tube, and the ovary is superior. Flower buds typically have a twisted appearance prior to opening.

Remarkably, I was not able to locate a single scientific publication exclusively focused on the biology of *G. calycosa*. What this means is that we know precious little about the natural history, physiology, longevity, ecology, or pollination biology of a common member of our native flora. A study was conducted on a related member (*G. algida*) native to the Rocky Mountains, in which the researcher found that plants responded to oncoming thunderstorms by closing the petals of their flowers. This remarkable response improved reproductive output by keeping pollen and stigmatic surfaces dry (you can find an abstract of that study here: (http://www.amjbot.org/content/88/6/1088.abstract). Whether our own *G. calycosa* does this is unknown, but certainly something considering the next time you encounter it!

Are Herbaria Still Relevant in the 21st Century?

(Adapted from: *Sego Lily* 39:1 (2016)
By Walter Fertig, Arizona State University Herbarium

If herbaria are to survive, those of us who care about them need to do a better job of demonstrating their value to society. Herbaria are increasingly relevant in the fields of ecology, biogeography, and conservation biology, on top of important conventional taxonomic research. Specimens are also valuable for building public appreciation of plants and of botany in general. Rather than hiding our specimens behind cabinet doors, we need to make them more accessible, especially digitally.

In the past, users of specimen data had to either visit herbaria in person or arrange to borrow material. With the advent of digital databases, herbarium records are now readily available around the clock and from any home, office, or mobile device that has internet access (even in the field). On-line databases include standard label information (species name, collector, date, locality, habitat) and often have maps of collection sites and digital images of the actual specimen. These data can be queried in numerous ways to create local or rangewide distribution maps or customized species lists, e.g., at the Rocky Mountain Herbarium (RM) search page [http://rmh.uwyo.edu/data/search.php]. Individual herbaria are increasingly pooling their digital data into regional and national networks, such as SEINet (Southwest Environmental Information Network), the Consortium of Intermountain Herbaria, or the Consortium of Pacific Northwest Herbaria, allowing users to access millions of records with ease. Other digital products, such as image libraries and links to original botanical literature, are greatly increasing the utility and scope of herbarium information.

Brick-and-mortar herbaria (and the professional staff needed to maintain them) are still vital for plant identification services. Potential clients range from farmers and ranchers, government biologists, and industry consultants to home gardeners, amateur naturalists, and school children: essentially anyone who might need assistance identifying mystery plants. Sometimes herbarium staff are asked to provide expertise on plant fragments rather than whole specimens. Such "forensic botany" can help archeologists interpret prehistoric sites, paleoecologists infer past climates, and law enforcement officers solve crimes.

Herbaria can also be thought of as vast genetic libraries. Rather than having to travel around the world to gather samples, researchers have millions of collections at their disposal, already identified to species and with collection dates and localities provided. In the case of extinct or protected species, herbarium specimens may be the

Explorer's gentian (*Gentiana calycosa*), a specimen by David Scott, from Grand Teton Natl. Park, Coll. No. 4997, For on-line viewing see Rocky Mountain Herbarium Homepage.

Each herbarium sheet has three main pieces of information:

-The most obvious is the physical specimen itself: stems, leaves, roots, flowers, and fruits. From these, researchers can determine the identity of the species and recognize the diversity among individual plants within and between populations. Measurements and observations of specimens is the basis for species descriptions and identification keys.

-Additional information can be gleaned from the internal chemistry of the specimens, especially genetic data from nuclear and organelle DNA. Such data can be used to reconstruct phylogenetic relationships among species, genera, and families.

-Perhaps the most useful information, however, comes from the specimen label which records the name of the species (and any subsequent changes or corrections), the collector, the date of the collection, locality, and other data on habitat, elevation, associated species, or abundance. These three datasets are the foundation of taxonomic research and can be especially useful in studies of ecology and conservation biology.

only material available for study. Older specimens can offer a window into changes in genetic structure in populations and evidence of ongoing evolution.

There have been challenges in utilizing herbarium collections in molecular research. Initially researchers had difficulty extracting sufficient quantities of DNA from old collections. DNA can also be altered if specimens were pickled or dried improperly. Recent advances in molecular techniques are resolving many of these problems. A recent study (Choi et al. 2015) found no relationship between the age of a specimen and the purity of DNA that could be extracted and later amplified. Ames and Spooner (2008) used DNA from 200-year old herbarium specimens of Irish potato in Europe to match unique genetic markers with their source populations in the Andes and lowlands of Chile and help determine the multiple points of origin of this important crop plant.

Herbarium specimens can also be time capsules of past environmental conditions. Atmospheric carbon dioxide levels have been recorded in herbarium specimens collected in the late 1700s and compared with recently collected plants to document changes in the concentration of greenhouse gases since the industrial revolution (Bonal et al. 2011).

For taxonomists, the most important specimens are the type collections, which provide the basis for species names and taxonomic concepts. When a new species is discovered, a holotype is designated and deposited in an herbarium to serve as the standard (or archetype) for which all other individuals of the species are compared. A recent study found that nearly one-quarter of all newly documented species were already found within existing herbarium collections but had been initially misidentified or unidentified (Bebber et al. 2010). The authors even suggested that as many as 70,000 undescribed plant species might still be lurking within the world's herbaria.

Herbarium specimens can also be a source for new records of pathogens and parasites. In the 1990s, the late John Baxter, a retired mycologist, discovered over 30 state records of rust and smut fungi growing on plant specimens in the Rocky Mountain Herbarium at the University of Wyoming. One of these was *Puccinia yosemitana*, a rust from California and Colorado that was new to Wyoming. Baxter found it growing on a specimen of Opal phlox (*Phlox opalensis*) that I had collected in SW Wyoming a few years earlier.

Specimen vouchers (deposited in herbaria) are important for documenting new occurrences of rare and unusual plants. Compared to observation records or photographs, physical specimens are easier to corroborate if there is any debate about a report's authenticity. This can be especially important in ecological studies or when developing checklists for protected areas, such as national parks or wildlife refuges.

Locality data from herbarium specimens is also useful in studying the spread of invasive weeds on one hand, and to identify gaps in the network of protected areas, on the other. In Wyoming, 10.6% of the state is "protected" (in national parks, wilderness areas, special botanical areas, and Nature Conservancy preserves), but these areas tend to be concentrated nonrandomly in the northwest corner of the state and at high elevations. Based on herbarium records, I found that 18% of the state's plant species were completely absent from these protected areas (Fertig 2011).

Digital locality data from herbarium specimens can be used in modeling the potential distribution of weeds, rare plants, and other species of high management interest. At the University of Wyoming, I used more than 325,000 digital records in the Rocky Mountain herbarium database to identify patterns in the presence and inferred absence of 200 randomly selected plant species with a mix of environmental variables (average monthly temperature and precipitation, bedrock geology, soil type, vegetation, etc.).

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Rocky Mountain Herbarium (U-WY)
- *at the forefront*

Yellowstone National Park would not be where it is today without the Rocky Mountain Herbarium (RM). Yellowstone National Park is the heart of the Greater Yellowstone Ecosystem and straddles three states. RM is invaluable for getting a broader ecosystem perspective for nonnative species as well as rare species. While Yellowstone does have a herbarium of its own, our records only represent the flora of Yellowstone National Park, not the entire ecosystem. In addition, our collection is very young with most of it more recent than 1950; earlier specimens were sent off around the country and world. Herbaria provide historical distributions for the native flora as well as the latest discoveries and taxonomic revisions. We rely heavily on this context from the Rocky Mountain Herbarium to meet our mandates for native plant conservation.

Heidi Anderson, Wetland Ecologist and Botanist, Yellowstone National Park; Mammoth, MT

Are you a fan of the Rocky Mountain Herbarium? Become an official FRIEND at: http://www.uwyo.edu/botany/rm-friends/ for alumni, colleagues and public admirers at large!

The Rocky Mountain Herbarium (RM), and the online availability of the information held there, has been instrumental for understanding the distribution, habitat, and threats to some of our rarest plants and the plants that are impacted by Forest Service management. Similarly, the information held at RM provides critical information about the ecology of the plants that are the foundation of the ecosystems throughout the Rocky Mountains which the Forest Service manages. The information from RM is also used to determine which species are to be used in restoration after natural and artificial disturbance on national forests.

Tyler Johnson, Rocky Mountain Regional Botanist, U.S. Forest Service; Golden, CO

The Rocky Mountain Herbarium (RM) is a truly invaluable resource to the Bureau of Land Management in Wyoming. BLM WY regularly uses the RM resources to learn or confirm the identity of plants, which is a fundamental part of assessing resource conditions. RM provides important information on the location and distribution of common desirable plant species throughout Wyoming and this information is used to identify areas for the BLM Native Plant Materials Development Program to target for seed collection. Using these targeted local seed collections increases the chances of successful reclamation seeding efforts. The online herbarium database is extremely useful for the many seasonal interns and employees who often come from other regions of the country and have little familiarity with the plant communities of the Rocky Mountain region. And of course the BLM WY relies heavily on the RM for understanding the distribution, and identifying potential habitat, for rare and sensitive plant species. The RM is in the midst of digitizing all of the BLM Field Office herbaria specimens as part of a cooperative agreement. This will be yet another extremely valuable resource aiding the BLM WY resource protection efforts.

Tanya Skurski, BLM State Botanist, Cheyenne, WY

Growing Native Plants

Part 21. Trees

By Robert Dorn

In each of the previous parts we usually looked at five examples of native plants. This has tallied to around 100 species. There are many more native plants that are desirable to grow. In the next parts of this series I will present some of these additional species. I will begin with trees since these take the longest time to get to a desirable size.

Betula papyrifera, Paper Birch, is a fast growing deciduous tree that can reach 60 feet tall and 20 feet wide. It is usually less than half that tall. The root system is shallow. The bark is cream colored to chalky white marked with gray or black scars. The bark continually peels to expose new bark. This is the tree that the native peoples used to build their birchbark canoes. The leaves are ovate with pointed tips and to 3 inches long. They turn yellow in the fall. The flowers are inconspicuous and borne in catkins which appear from April to June. They grow naturally in Wyoming mostly in the Black Hills where they have persisted since the glacial period after being pushed south from the Northern Boreal Forest. They occur on cool, moist, north-facing slopes. They prefer cool, moist areas in well-drained soil with at least partial shade such as on the north side of a building. They do not tolerate drought nor excessive wind. They are generally short-lived and may be subject to birch borers. It can be grown from untreated seed. Surface sow to allow light exposure. It is also in the nursery trade.

Pinus flexilis, Limber Pine, is a slow growing, long-lived, evergreen tree that can reach 80 feet tall and 30 feet wide but is usually much smaller. The leaves are needle-like in clusters of 5 and to 2.5 inches long. The female cones are very resinous and to 8 inches long. The plants occur naturally on dryish, often wind swept and rocky ridges and slopes from rocky outcrops on the plains to subalpine areas in the mountains. They prefer moist to dry, open areas and are tolerant of drought, wind, cold, and heat. They are a good candidate for bonsai culture. It can be grown from seed which is best cold stratified for 21 to 90 days before planting. Barely cover with soil. Small trees can be transplanted. The foothills ecotype will do best at our lower elevations. There are many cultivars in the nursery trade.

Betula papyrifera, Crook Co.

Betula papyrifera, Custer Co., SD

Pinus flexilis, Albany Co.

Pseudotsuga menziesii, Douglasfir, is a fast growing, evergreen tree, cone-shaped when young but becoming more irregular and open with age. They can reach 70 feet or more high and 30 feet wide but are

usually much smaller. The leaves are linear, flattened, blunt at the tip, to 1.5 inches long, and borne singly along the branches similar to a fir tree. The female cones are to 3 inches long with 3-lobed bracts protruding from the cone scales. They occur naturally on dry, often rocky slopes and ridges in the mountains. They prefer a well-drained site in full sun or part shade. They are drought and wind tolerant but are best grown on a north-facing exposure. At lower elevations they may be subject to winter sun burn and pests like gall aphids, tussock moths, and needle scale. It is an alternate host for spruce gall aphid so spruce and Douglasfir should not be planted in close proximity. It can be grown from fresh seed barely covered with soil. For spring sowing, cold stratify the seed for at least 60 days. There are many cultivars in the nursery trade.

Pseudotsuga menziesii, Meagher Co., MT

Quercus gambelii, Gambel Oak, is a slow growing deciduous tree (may be shrub-like) to 20 feet tall and as wide. It tends to sucker and form thickets. The leaves are lobed like typical oak leaves and to 6 inches long. They turn yellow, orange, or red in the fall. The flowers are inconspicuous appearing in March and April. The fruit is an acorn about 0.5 inch across. The plants occur naturally in Wyoming mostly on the west slope of the Sierra Madre Mountains in Carbon County. They prefer moist to dry, open or partly shaded areas. They are tolerant of wind and some drought. It can be grown from the acorn planted half an inch deep outside in the fall. It is difficult to transplant. It is also in the nursery trade.

(Continued, p. 10)

Quercus gambelii, Carbon Co.

Salix amygdaloides, Platte Co.

Salix amygdaloides, Goshen Co.

Growing Native Plants
(Continued from p. 9)

Salix amygdaloides, Peachleaf Willow, is a fast growing deciduous tree to 40 feet tall and 30 feet wide. The leaves are ovate with long pointed tips and to 3.5 inches long. They turn light yellow in the fall. The flowers are inconspicuous and borne in catkins from April to June. The plants occur naturally on flood plains, shores, and other wet places on the plains and in the valleys and basins up to about 7000 feet. They prefer moist to wet, sandy, gravelly, or silty soils in full sun. Ideally they should be planted along a pond or stream but will do well in a regularly irrigated lawn if the soil is not allowed to dry out. It may be desirable to prune out multiple trunks that it tends to develop. It is easy to grow from cuttings of small branches taken in late winter, treated with rooting hormone, and rooted in water or a moist medium. Fresh seeds germinate readily on a wet soil surface in direct light. *Salix amygdaloides* is commercially available.

Wyoming Native Plant Society is a non-profit organization established in 1981 to encourage the appreciation and conservation of the native plants and plant communities of Wyoming. The Society promotes education and research through its newsletter, field trips, annual student scholarships and small grants awards. Membership is open to individuals, families, or organizations. To join or renew, you can do it on-line (www.wynps.org) or return this form to:

Wyoming Native Plant Society
P.O. Box 2449
Laramie, WY 82073

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Check one: [ ] New member [ ] Renewing member
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[ ] WYNPS Lifetime membership: $300 ($150 for membership and $150 for Scholarship fund)
In addition to the statewide organization, we have two chapters. Membership in chapters is optional; chapter members must also be members of the statewide organization.
[ ] Sublette Chapter annual membership: $5.00
[ ] Teton Plants Chapter annual membership: $5.00
Total enclosed: _____ THANK YOU!

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