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Bioprospecting in the Big Horn Mountains

(Editor's note: The following is excerpted from two publications and a manuscript in press.)

Podophyllotoxin is in high demand as chemical precursor for anti-cancer drugs, and other derivatives that have applications in treating psoriasis, malaria and rheumatoid arthritis. Currently, podophyllotoxin is extracted from the Himalayan mayapple (*Podophyllum hexandrum* Royle), an herbaceous perennial and endangered species of India.

Native North American species of junipers are alternative sources of podophyllotoxin (Cantrell et al. 2012). Initial screening work included Eastern red-cedar (*Juniperus virginiana*) and found promising levels in survey across two northern and two southern states. Later sampling of juniper species in the Big Horn Mountains, Wyoming found concentrations almost 2 or 3 times higher in Creeping juniper (*Juniperus horizontalis*) than in all prior species and samples (Zheljazkov et al. 2012) to date.

North American juniper leaves, as propagated in cultivation or as byproduct from logging or salvage operations, hold the promise of greater biomass and more readily renewable sources compared with *Podophyllum hexandrum*.

Literature Cited

Cantrell, C.L., V.D. Zheljazkov, W.L.A. Osbrink, A. Castro, V. Maddox, L.E. Craker and T. Astatkie. 2012. Podophyllotoxin and essential oil profile of *Juniperus* and related species. *Industrial Crops and Products* 43(2013): 668-676.
Zheljazkov, V.D., C.L. Cantrell, M.A. Donega and T. Astatkie. 2012. Bioprospecting for podophyllotoxin in the Big Horn Mountains, Wyoming. *Industrial Crops and Products* 43(2013): 787-790.

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Above: Creeping juniper (*Juniperus horizontalis*).
Illustration by Mary Vaux Walcott. From: Southwest School of Botanical Medicine: Paintings by Mary Vaux Walcott.
<http://www.swsbm.com/Images/Walcott.html>

WYNPS News

New Chapter! We doubled the number of WYNPS Chapters in the State - two! Plant enthusiasts of Sublette County formed the Sublette Chapter of WYNPS last spring, offering hikes, and now evening programs outside the summer months. To join, please contact Karen Clause (President; kdclause@centurytel.net) or Julie Kraft (Treasurer; jewelyjoe@hotmail.com); chapter membership is \$5. WYNPS renewal forms now have chapter check-offs so you can pay state+chapter dues at once.

New Address: Please make note - Wyoming Native Plant Society has a new post office box: P.O. Box 2449! A few years ago, we moved to the main post office in Laramie when the campus station closed. At that time, we claimed a box number (2500) that the postal service later assigned to a super-size box. We've finally been asked to change numbers ...or super-size our box at significant cost. So we changed. Mail will continue to be forwarded thru 2012.

Wyoming Native Plant Society
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Treasurer's Report: Balance as of 4 September:
Scholarship = \$1,875; General \$5,161; Total = \$7,036.

Contributors to this Issue: Ann Boelter, Karen Clause, Robert Dorn, Bonnie Heidel, Steve O'Kane, Drew King, Amy Taylor, and Andi Wolfe.

The next newsletter deadline is Nov. 28. Articles, announcements, and ideas are always welcome.

New Members: Please welcome the following new members to WYNPS: Nancy Barker, Hot Springs, SD; Russell Duncan, Wakefield, MA; Sally Dunphy and Eric Smith, Fort Collins, CO; R.T. Hawke, Big Bear City, CA; Mary Komodore, Lakewood, CO; Bonnie Krafchuk, Tetonia, ID; Wanda Peters, Casper; Beecher Ed Strube, Casper.



Message from the President

Fall greetings! Reflecting on the past summer, I think of both wildflowers and wildfires. Fortunately, the latter didn't interfere with many of the wonderful plant hikes that happened throughout Wyoming.

Highlights for me included the joint annual meeting in Laramie with the American Penstemon Society, Wyoming Range botanizing with Orval Harrison, Teton Chapter high elevation hike through magenta meadows of fireweed, and family canoe trips at the height of huckleberry season.

I hope you had botanical adventures of your own. Wyoming Native Plant Society is a great way to stay connected with others who are passionate about our native plants and landscapes. Thanks for staying involved!
~Amy Taylor



2012 Wyoming Native Plant Society tshirts are available (Sm, Med, Lg, XLg) while the supply lasts. Cost (\$15) includes shipping. Place your order by mail to Wyoming Native Plant Society (P.O. Box 2449, Laramie, WY 82073), enclose check, and record size, quantity, and mailing address. On-campus pickups can be arranged (contact Drew King; drewski@uwyo.edu).

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Sublette Chapter: Karen Clause, President; Julie Kraft, Treasurer

Teton Chapter: Amy Taylor, Treasurer

Bighorn Native Plant Society: P.O. Box 21, Big Horn, WY 82833 (Jean Daly, Treasurer)

2012 Annual Meeting Highlights
 Joint Meeting with American Penstemon Society



Above: Quintessential fieldtrip pose*,
 by Andi Wolfe

Left pair of photos: Mobs at the
 Herbarium and the Berry Biodiversity
 Center, U-WY*, by Andi Wolfe



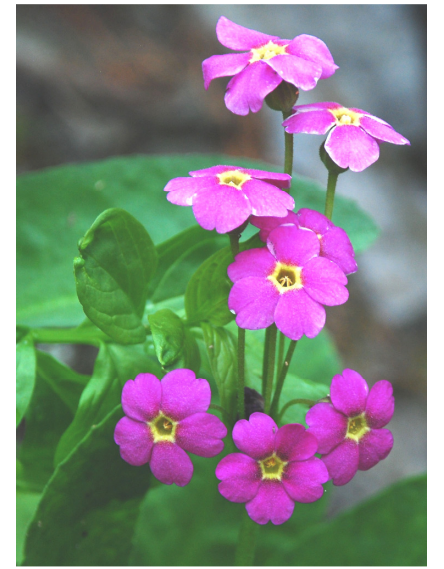
Upper right: *Penstemon strictus**,
 by Andi Wolfe

*More *Penstemon* and other plant photos
 at: <http://AndiWolfe.blogspot.com>

Right: *Penstemon haydenii* at the edge
 of blowout, by Bonnie Heidel



2012 Wyoming Range hike
 Joint hike with Star Valley Historical Society
 and The Nature Conservancy



Above and lower right: Orval Harrison, hike leader, by Bonnie Heidel
 Upper and far right: Susan Marsh capturing a primrose pose;
 upper right by Bonnie Heidel, far right by Susan Marsh

As American as Apple Pie

Bonnie Heidel



The apple is the most widespread of all fruits, accounting for about half of the world's deciduous tree crops (Small 2009). It has been cultivated for all of recorded history, possibly the earliest fruit to be cultivated, and has been found in archeological records of Europe and western Asia. So while picking apples in Laramie this fall, I wondered how it claims an American allegiance. Can we claim apples as native plants? The short answer is "almost"! The long answer is a primer in plant taxonomy at the interface with horticulture.

When it comes to apples, "graft" is wholesome! Most cultivated apple trees have a genetically-distinct rooting stock to which the aboveground, fruit-bearing stock is grafted. This vegetative propagation of prize fruit-bearing apples surpasses random out-crossing and single-genome trees in fruit production.

Why are there so many different apples? Most are cultivated varieties ("cultivars") that are mutants selected from many seedlings, and propagated by grafting to bear fruit. Experts differ in opinion whether there are 10,000 or closer to 20,000 different apple cultivars around the world. Here's where American ingenuity comes into play – almost half of modern cultivars originated in North America (Small 2009).

Cultivated apples were introduced by early immigrants to North America, treated as one species, *Malus pumila* (apple). Modern apples may have elements of more than one species but their original genomes are obscured by hybridization and introgression in the distant past, not reflected in taxonomic nomenclature (Small 2009). Getting to the bottom of apple genetics may be a global undertaking.

In colonial days, many rooting stocks used to graft Old World cuttings were native North

American species of *Malus*, also used in breeding; the closest claims to North American allegiance. None of the native North American *Malus* species grow wild in Wyoming, but apples have escaped from cultivation in almost half the counties of the state (Dorn 2001). It is more accurate to say that native North American apple species facilitated apple cultivation than to say that the cultivated apple is native.

Stories surround the origins of popular apple varieties. The McIntosh apple is the namesake of John McIntosh (Small 2009). About 200 years ago, McIntosh discovered 20 apple trees in southern Ontario, allegedly sprung from seeds discarded by an Indian. One of them produced exceptional apples, and McIntosh's son learned to take shoots from this special tree and graft them onto other trees. This is the origin of the McIntosh cultivar grown in orchards today.

Even the apple pie as an indigenous dessert is a stretch of the truth. There are references to apple pie that go back over 500 years in the Old World, though meat pies were more common in Europe compared to sweet pies (Mayer 2008). In all likelihood, if there were any pies on the table at the first Thanksgiving, they did not include apple or pumpkin ones. Later, as the colonies expanded, pies were baked to showcase local ingredients and there was a proliferation of new kinds of sweet pies. Pies became the local foods craze.

We can be sure of one thing – apple pie was on the menu when Wyoming Native Plant Society originated (see anniversary articles by Stromberg in *Castilleja* 30(4) and by White in *Castilleja* 20(2)). So your next slice of apple pie is a bite into a taxonomic cultivar, graft, and clouded species circumcision. Plus, it is a slice of American culinary and horticultural ingenuity topped by WYNPS lore – how sweet it is!

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Mayer, L. 2008. A brief history of pie. *Time Magazine*, November 26.

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***Physaria* Species of Wyoming: Part 2. *Physaria* Key**

By Bonnie Heidel¹ and Steve L. O’Kane, Jr.²

We return to the Wyoming *Physaria* (Brassicaceae) saga by presenting the *Lesquerella* and *Physaria* species of Dorn (2001) in a revised key of an expanded *Physaria* based on the *Flora of North America* treatment (O’Kane 2010). By the latter treatment, Wyoming has 26 taxa of *Physaria* (including three subspecies, but not including two “morphs”). They are presented in the following key, including the synonyms in Dorn (in brackets), and highlighting those of limited geographic distribution (set off by “*”). The expanded genus *Physaria* contains eight state endemic taxa³, the highest number among all genera in the state. Another ten *Physaria* taxa are regional endemics⁴.

The history of this taxonomic saga is detailed in Part 1 (Heidel and O’Kane 2010). Both treatments of *Physaria* (Dorn 2001 and O’Kane 2010) will be in use for years to come in Wyoming, and a little botanical fluency in translating between the two goes a long way! Users of this key will notice, especially, that several species have been carved out of a previously unwieldy and unnatural *Lesquerella alpina* (Grady and O’Kane 2007) and that *Lesquerella carinata* and *L. paysonii* are now subspecies of *Physaria carinata* (O’Kane 2007). More systematic work is needed in Wyoming among those species that were part of the “traditional” *Physaria* (the first lead of the first couplet in the key).

Key to the species and subspecies of *Physaria* in Wyoming

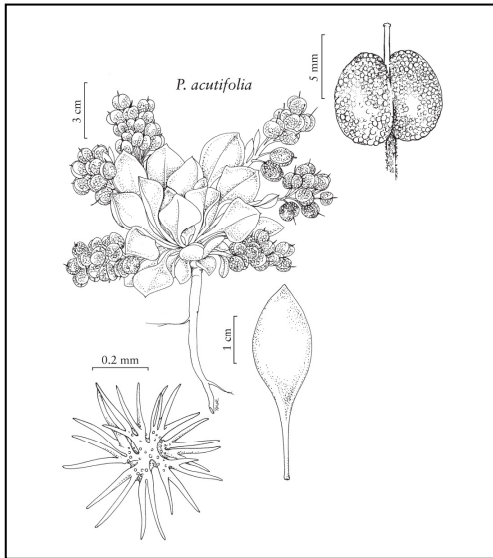
1. Fruits notched at tip, papery, inflated, appearing like two chambers grown together (didymous) - the traditional genus *Physaria* in the strict sense, as in Dorn (2001). See *Physaria acutifolia* illustration (next page)
 2. Petals white ...***Physaria eburniflora*** Rollins
*State endemic of Carbon, Fremont, and Natrona Counties
 2. Petals yellow
 3. Fruit basal sinus obscure or absent, apical sinus deeper
 4. Trichomes on mature fruits with spreading rays (ovaries and immature fruits fuzzy)
 5. Blades of younger basal leaves tapered to petioles, apical sinus of fruits usually broad
...***Physaria brassicoides*** Rydberg
*Regional endemic of the easternmost tiers of counties
 5. Blades of all basal leaves abruptly narrowed to petioles, apical sinus of fruits narrow
...***Physaria saximontana*** Rollins (ours is subsp. *saximontana*)
*State endemic of Fremont, Hot Springs, Park, and possibly, Carbon Counties
 4. Trichomes on mature fruits with appressed or spreading rays (ovaries and immature fruits silvery, not fuzzy) ...***Physaria vitulifera*** Rydberg – our material was annotated by Jennings (2004) to *P. acutifolia* and is not reported by O’Kane (2010) as occurring in Wyoming. Our material warrants more taxonomic work as it might be an undescribed taxon.
 3. Fruit basal and apical sinuses well-developed, more or less equal
 6. Plants compact from a condensed rosette; racemes barely exceeding the basal leaves
 7. Basal leaves mostly horizontal, blades 0.5-1.5 cm × 40-80 mm
...***Physaria condensata*** Rollins
*State endemic in Lincoln, Sublette and Uinta Counties
 7. Basal leaves ascending or erect, blades (1.5) 5-7 cm × 12-20 mm
... ***Physaria dornii*** Lichvar
*State endemic in Lincoln and Uinta Counties
 6. Plants looser, not condensed, racemes greatly exceeding the basal leaves

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³ State endemic species are found only in Wyoming.

⁴ Multi-state (regional) endemic species, as referenced here, are not restricted to Wyoming but their entire global distribution would fit into an area the size of Wyoming. . . some have a narrower distribution than state endemics!



Above: *Physaria acutifolia*. From O'Kane, S.L. 2010. *Physaria*. In: Flora of North America Editorial Committee. *Flora of North America North of Mexico. Volume 7. Salicaceae to Brassicaceae*. Oxford Univ. Press, New York. Pp. 616–665. Reprinted with permission.

8. Leaf blade margins usually dentate to repand, trichomes of mature fruits with ascending rays (fruits appearing fuzzy or wooly)

...*Physaria didymocarpa* (Hooker) A. Gray

a. Trichomes spreading, surfaces appearing woolly, particularly at petiole base, basal leaf blade margins dentate, ovules usually 2 per ovary ...*P. d. subsp. lanata* (C.L. Hitchcock) O'Kane & Al-Shehbaz [*Physaria lanata*]

*State endemic in Big Horn, Campbell, Johnson, Sheridan and Washakie Counties

b. Trichomes more appressed, surfaces somewhat fuzzy, basal leaf blade margins dentate to repand, ovules mostly 4(-6) per ovary

...*P. d. subsp. didymocarpa* [*Physaria didymocarpa* var. *didymocarpa*]

8. Leaf blade margins entire (rarely with two weak teeth in *P. acutifolia*), trichomes of mature fruits with appressed rays (fruits not appearing fuzzy)

9. Replum obovate to broadly oblong, funicles not restricted to the apex of the replum ...*Physaria integrifolia* (Rollins) Lichvar (includes "var. *monticola*" morph that reflects substrate conditions rather than taxonomic difference)

*Regional endemic in Lincoln, Sublette and Teton Counties

9. Replum oblong and ± constricted in the center, funicles restricted to the apex of the replum ...*Physaria acutifolia* Rydberg (includes the "*stylosa*" morph" documented from Sublette County – further work is needed on the taxonomic status of this morph)

1. Fruits rounded or pointed at tip, mostly firm, not or only slightly inflated (not didymous) – the traditional genus *Lesquerella*, as in Dorn (2001). See *Physaria carinata* illustration (next page)

10. Basal and cauline leaf blades similar in shape, usually narrow and less than 5 mm wide, indistinct from petioles

11. Fruiting pedicels usually recurved

12. Basal leaf blades flat, racemes secund ...*Physaria arenosa* (Richardson) O'Kane & Al-Shehbaz

a. Trichomes on mature fruits spreading ...*P. a. subsp. arenosa* [*Lesquerella arenosa* var. *arenosa*]

b. Trichomes on mature fruits closely appressed ...*P. a. subsp. argillosa* (Rollins & E.A. Shaw) O'Kane & Al-Shehbaz [*Lesquerella arenosa* var. *argillosa*]

*Regional endemic in Niobrara County

12. Basal leaf blades involute, racemes not secund ...*Physaria ludoviciana* (Nuttall) O'Kane & Al-Shehbaz [*Lesquerella ludoviciana*]

11. Fruiting pedicels ascending, sigmoid erect, spreading

13. Trichomes on mature fruits with erect or spreading rays, appearing fuzzy ...*Physaria nelsonii* O'Kane & Al-Shehbaz [*Lesquerella condensata*]

13. Trichomes on mature fruits with appressed rays

14. Basal leaves usually involute, linear to linear-oblongate or narrowly spatulate ...*Physaria parvula* (Greene) O'Kane & Al-Shehbaz [*Lesquerella parvula*]

*Regional endemic in Carbon, Sweetwater and Uinta Counties

14. Basal leaves not involute, spatulate to nearly rhombic, oblongate or elliptic

15. Racemes not or barely exceeding basal leaves, fruit compressed on margins and at apices ...*Physaria reediana* O'Kane & Al-Shehbaz [included within *Lesquerella alpina*]

15. Racemes exceeding basal leaves, fruits not compressed ...*Physaria curvipes* (A. Nelson) Grady & O'Kane [included within *Lesquerella alpina*]

*Regional endemic in Big Horn, Johnson, Natrona, Sheridan and Washakie Counties

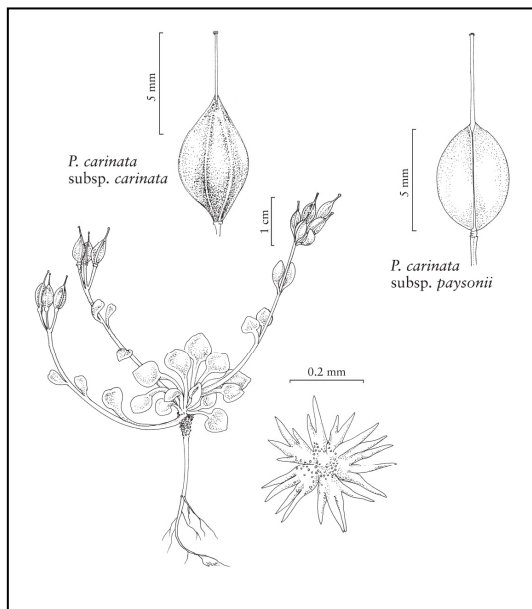
10. Basal and cauline leaves dissimilar in shape, blades sometimes greater than 5 mm, distinct from petioles

16. Fruit usually strongly compressed, flattened at a right angle to partition ...*Physaria carinata* (Rollins) O'Kane & Al-Shehbaz

a. Fruit elliptic, not keeled ...*P. c. subsp. paysonii* (Rollins) O'Kane & Al-Shehbaz [*Lesquerella paysonii*]

*Regional endemic in Lincoln, Sublette and Teton Counties

- b. Fruit elliptic, suborbicular or broadly oblong, keeled ...***P. c. subsp. carinata*** [*Lesquerella carinata*]
 *Regional endemic in Teton and possibly Fremont County
16. Fruit usually not compressed or only slightly so at margins
17. Fruiting pedicels recurved, fruits pendent
18. Fruits papery and strongly inflated but not didymous, basal leaf blades orbicular to broadly obovate, abruptly narrowing to petioles ...***Physaria macrocarpa*** (A. Nelson) O'Kane & Al-Shehbaz [*Lesquerella macrocarpa*]
 *State endemic of Fremont, Lincoln, Sublette and Sweetwater Counties
18. Fruits firm, not or slightly inflated, basal leaf blades variably shaped and gradually tapering to petioles ...***Physaria fremontii*** (Rollins & E.A. Shaw) O'Kane & Al-Shehbaz [*Lesquerella fremontii*]
 *State endemic in Fremont County
17. Fruiting pedicels not recurved, fruits horizontal to erect
19. Stem prostrate or decumbent ...***Physaria prostrata*** (A. Nelson) O'Kane & Al-Shehbaz [*Lesquerella prostrata*]
 *State endemic in Lincoln and Uinta Counties
19. Stem ascending to erect



Above: *Lesquerella paysonii* as transferred to the *Physaria* genus and treated as a subspecies of *Physaria carinata*. From O'Kane, S.L. 2010. *Physaria*. In: Flora of North America Editorial Committee. *Flora of North America North of Mexico. Volume 7. Salicaceae to Brassicaceae*. Oxford Univ. Press, New York. Pp. 616–665. Reprinted with permission.

20. Basal leaves distinct from petiole, broadly elliptic to suborbicular, distinctly rhombic or deltate
21. Basal leaves rhombic ...***Physaria subumbellata*** (Rollins) O'Kane & Al-Shehbaz [included within *Lesquerella alpina*]
 *Regional endemic in Carbon, Natrona and Sweetwater Counties
21. Basal leaves spatulate to oblanceolate to broadly oblanceolate, usually noticeably thickened ...***Physaria pachyphylla*** O'Kane & Grady [not in Dorn 2001 or O'Kane 2010 (for Wyoming) but in RM online database and pending publication]
 *Regional endemic in Big Horn County
20. Basal leaves not distinct from petiole, narrowly oblanceolate or elliptic
22. Fruit somewhat compressed, apices ± acute
23. Sepals 5-8.5 mm, ovules (8-) 12-20 (-24) per ovary ...***Physaria montana*** (A. Gray) Greene [*Lesquerella montana*]
23. Sepals 3-5 mm, ovules 4-8 per ovary
24. Fruiting pedicels 4-7 mm, styles shorter than fruits
 ...***Physaria curvipes*** (A. Nelson) Grady & O'Kane [included within *Lesquerella alpina*]
 *Regional endemic in Big Horn, Johnson, Natrona, Sheridan and Washakie Counties
24. Fruiting pedicels 10-20 mm, styles +/- equal to fruits
 ...***Physaria spatulata*** (Rydberg) Grady & O'Kane [included within *Lesquerella alpina*]
22. Fruit globose or nearly so ...***Physaria multiceps*** (Maguire) O'Kane & Al-Shehbaz [*Lesquerella multiceps*]
 *Regional endemic in Lincoln County

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Growing Native Plants

Part 5. Medium Shrubs

By Robert Dorn

Medium size shrubs are used mostly for their attractive foliage, flowers, or fruits or for fall leaf color. A sampling of five species follows. To see the plants in color, go to the Society website.

Artemisia cana var. *cana*, Silver Sagebrush, is grown for its silvery foliage. The leaves persist through the winter but are more gray than silvery at that time. The plants grow to about 3 feet high and 4 feet across. It occurs naturally in the basins and plains. It likes sandy or gravelly soil in full sun and is drought tolerant. It does not tolerate over-watering. It is easy to grow from fresh seed and small specimens transplant readily. It is also in the nursery trade. A mountain variety, var. *viscidula*, is less silvery.



Artemisia cana, Goshen County

Cornus sericea, Red-osier Dogwood, is grown mostly for its red stems that add color, especially against snow in winter. It has an attractive cluster of small creamy-white flowers and white or blue-white berry-like drupes which can both be on the plant at the same time. The leaves often turn wine red in fall. It grows up to 10 feet high or more but is usually less than 6 feet. It can spread aggressively underground under ideal conditions. It occurs naturally along streams and in other moist places in the mountains. It prefers a moist, cool site in shade or full sun. It will

remain attractive if up to one-third of the length of the current stems are removed in late winter. This encourages new red-barked growth. It can be grown from rhizomes, semi-ripe wood, or hardwood cuttings and is in the nursery trade. There is also a yellow-barked cultivar.



Cornus sericea, top Missoula County, Montana, bottom Cheyenne Botanic Gardens

Ericameria nauseosa, Rubber Rabbitbrush, is grown for its yellow flowers which appear in late summer and well into the fall. The branches remain a light yellow-green through the winter. Its odor is not very pleasant for some people which is why it received its name "nauseosa." It grows to 6 feet high and wide. It occurs naturally in dry, open, well-drained places from the plains and basins into the mountains and is drought tolerant. It is easily grown from fresh seed or can be propagated from softwood cuttings treated with rooting hormone and placed in a moist medium. Small plants transplant easily. It is also in the nursery trade. There are many varieties, so if you propagate your own, choose the variety that meets your needs.



Ericameria nauseosa, Goshen County

Rhus glabra, Smooth Sumac, is grown for its compound leaves which turn bright red in the fall, but they do not persist for long after turning. The reddish terminal clusters of fruits tend to persist into the winter. It can reach 10 feet high or more but is usually less than 6 feet. It spreads aggressively by rhizomes to form large colonies. It occurs naturally mostly on the plains and into the foothills on the eastern edge of the state. It prefers a warm, well-drained, moist to dry area in full sun and is drought tolerant. It is easiest to grow from rhizome cuttings and is in the nursery trade.



Rhus glabra, Albany County



Rhus glabra, Albany County

Ribes aureum, Golden Current, is grown for its aromatic yellow flowers which appear early in the spring. The fruits may be yellow, orange, red, or black-purple when ripe, are sweet-tart and often used for jelly. The leaves turn wine red in fall. It can grow up to 10 feet high but is usually under 6 feet high and 4 feet wide. It often spreads by suckering. It occurs naturally in the basins, plains, and foothills along streams and other moist places. It prefers full sun or light shade and a moist location although it is somewhat drought tolerant. It can be grown from rootstock cuttings or from seed after 90 days cold stratification. It is also in the nursery trade.



Ribes aureum, Goshen County

New Wildflower App available: *Yellowstone and Grand Teton Wildflower* App. \$2.99

The wildflower app is a tribute to Richard Shaw who was a professor of botany at Utah State University and Naturalist for 30 years in Grand Teton and Yellowstone national parks. Son-in-law Todd Hugie and his family created the app using descriptions and photos from Shaw's books and his work with Rocky Mountain Wildflowers. It is for iPhone, iPod Touch and iPad use.

Visit <http://www.westernwildflowers.org>.

Download app at:

<http://itunes.apple.com/us/app/yellowstone-grand-teton-wildflowers/id543768085?ls=1&mt=8>

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 scholarship and small grants awards. Membership is open to individuals, families, or organizations. To join or renew, please return this form. See the return address below.

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