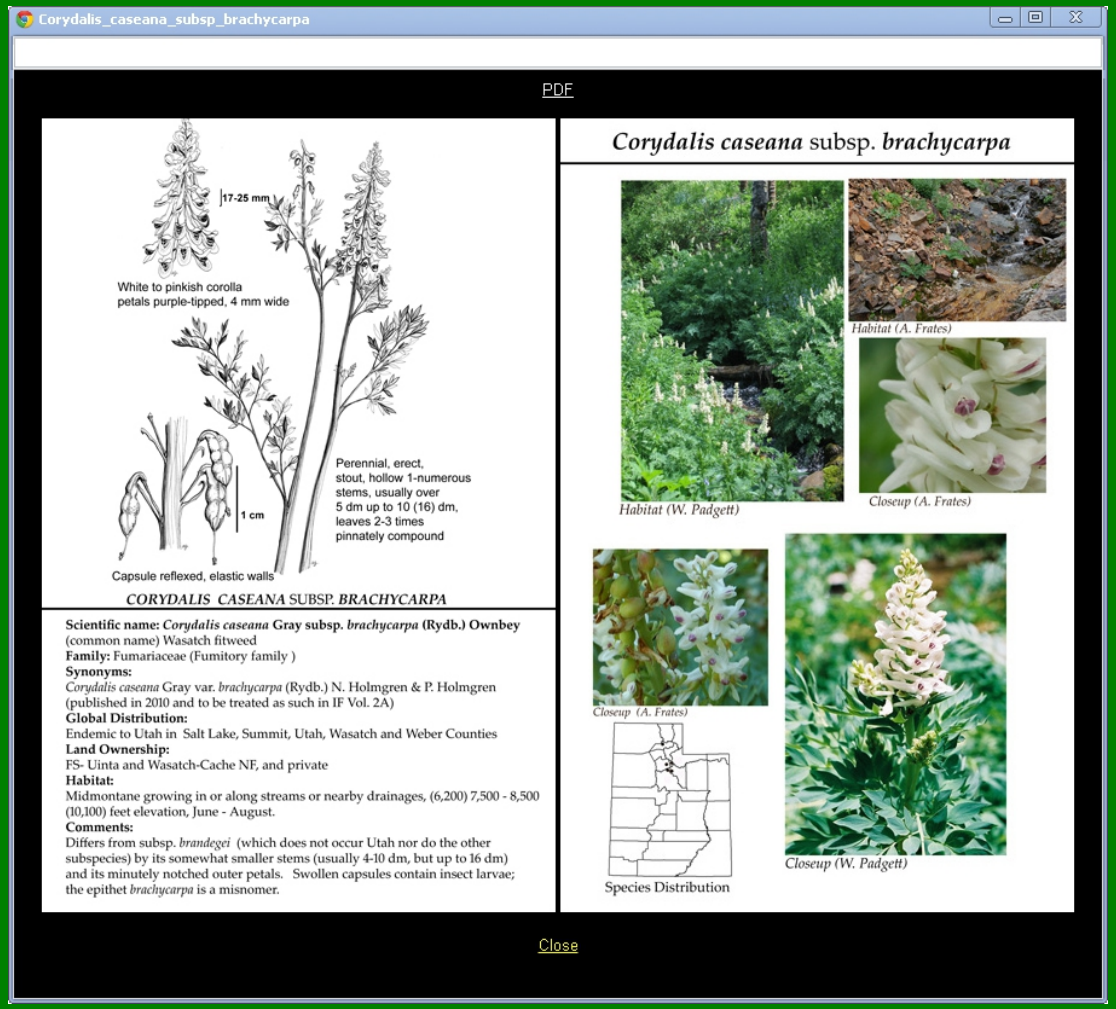
Wasatch fitweed pollinators

By Tony Frates, March 2013

March 5, 2013 Red Butte Garden-UNPS rare pant conference

COCAB related and assorted furry photos by Tony Frates

Corydalis caseana Gray subsp. *brachycarpa* (Rydb.) Ownbey is a rare northern Utah endemic found at mainly midmontane (sometimes higher) elevations along or near stream drainage systems (often on exposed, north-facing slopes and strongly associated with glacial deposits) in eastern Salt Lake County and adjoining Summit, Wasatch and Utah counties (and disjunct in Weber County). It was first added to the Utah Rare Plant Guide in August of 2005, is currently treated as a sensitive species by U.S. Forest Service (Intermountain Region, R4, March 2010), has been ranked as "High" priority by the Utah Native Plant Society's rare plant committee, and is tracked by the Utah Natural Heritage Program.



Utah Rare Plant Guide

www.utahrareplants.org

Taxonomic history

Some of the earliest Utah collections of Wasatch fitweed include those of M.E. Jones in 1879 (more below) and F.E. Leonard (July 31, 1884), both in Salt Lake County, Utah. Taxonomist (and at that time NYBG staff member) Per Axel Rydberg collected it himself at the “headwaters of Little Cottonwood Creek” above Alta in 1905. In his *Flora of Colorado* (1906), P.A. Rydberg treated both the Colorado and Utah plants as *Capnoides brandegei* (S. Wats.) Heller, known at that point only from high elevations in those two states.

Rydberg however in 1907 decided to treat Utah materials as *Capnoides brachycarpum*. The type was the Marcus Jones specimen collected on August 5, 1879 at Alta.

Capnoides caseanum had been earlier named by Asa Gray in 1874 based on a specimen collected in Cailfornia in 1873 by E.L. Case and J.G. Lemmon.

NYBG's first curator
1908-1931

P.A. Rydberg 1860-1931

M.E. Jones 1852-1934

DEPARTMENT OF THE INTERIOR.

UNITED STATES GEOLOGICAL AND GEOGRAPHICAL SURVEY OF THE TERRITORIES.

F. V. HAYDEN, U. S. Geologist-in-Charge.

THE FLORA

OF

SOUTHWESTERN COLORADO.

BY

T. S. BRANDEGEE.

EXTRACTED FROM BULLETIN OF THE GEOLOGICAL AND GEOGRAPHICAL SURVEY OF THE TERRITORIES, Vol. II, No. 3.

WASHINGTON, June 6, 1876.

Sierra La Plata, 10,000 feet altitude.

BERBERIS FENDLERI, Gray, Plant. Fendl., p. 5.
Valleys of the Rio Grande, Animas, and Mancos.

CORYDALIS CASEANA, Gray, Proc. Am. Ac., x, 69.
Piedra Mountains, 10,000 feet altitude.

SYNOPTICAL

FLORA OF NORTH AMERICA:

VOL. I.—PART I.

FASCICLES I AND II.

POLYPETALÆ FROM THE RANUNCULACEÆ TO THE POLYGALACEÆ.
(THALAMIFLORÆ ET DISCIFLORÆ.)

BY ASA GRAY, LL.D.,
LATE FISHER PROFESSOR OF NATURAL HISTORY (BOTANY) IN HARVARD UNIVERSITY,

AND OTHERS.

EDITED BY

BENJAMIN LINCOLN ROBINSON, PH.D.,
CURATOR OF THE GRAY HERBARIUM OF HARVARD UNIVERSITY.

1895–1897.

Brandegee later collected it in Colorado and included it in his flora but then later Watson in Gray named it as a separate species based on a Brandegee collection, and Watson included Utah materials within it.

Coulter, Man. Rocky Mt. Reg. 14.— Blue Mountains and Eagle Creek Range, along alpine watercourses, *Cusick*, 1877; W. Idaho, on the ridge above Clearwater, *Watson*, 1880. Largest leaves 3 feet long.

C. Brandegéi, WATSON, l. c. Stems 2 to 5 feet high: dorsal crest of the hoods obsolete and rounded summit not emarginate, but margins recurved: capsules short-oval to oblong, obtuse, reflexed on the ascending pedicels: seeds with a small arilliform crest.—Coulter, l. c.—Mountains of S. W. Colorado, *Brandegee*, 1874, *Lieut. McCauley*, 1877; Utah, in the Wasatch Mountains, at about 10,000 feet, on rather dry banks, *M. E. Jones*, 1879, *Hooker & Gray*, 1887.

By 1917, Rydberg was treating both under *Corydalis*:

petals; filaments united above the middle. Ovary with two parietal placentae; style filiform. Fruit an elongated 2-valved capsule. Seeds numerous, crested. [*Corydalis* Vent.]

Annuals or biennials.
- Plants low, ascending or diffuse; corolla yellow.
  - Pod glabrous.
    - Bracts narrowly lanceolate; pod pendulous, torulose. 1. *C. aureum.*
    - Bracts ovate-lanceolate, ovate, or obovate; pod erect, not torulose. 2. *C. montanum.*
  - Pod covered with translucent vesicles. 3. *C. crystallinum.*
- Plants erect, tall, usually 3–6 dm. high; corolla rose or purplish, with purple tips. 4. *C. sempervirens.*

Perennials with thickened roots; corolla white or tinged with purple.
- Bracts spatulate or oblanceolate, about 1 cm. long; dorsal crest of the hood narrow.
  - Sepals reniform, laciniate. 5. *C. Cusickii.*
  - Sepals narrowly hastate, with large toothed basal lobes. 6. *C. hastatum.*
- Bracts linear; dorsal crests of the hood obsolete.
  - Corolla 2 cm. long; sepals broadly ovate, obtuse, their auricles subentire; pod lance-obovoid. 7. *C. Brandegei.*
  - Corolla 1.5 cm. long; sepals ovate, acute, their auricles toothed; pod broadly obovoid. 8. *C. brachycarpum.*

From *Flora of the Rocky Mountains and adjacent plains*
Per Axel Rydberg, 1917.

Minnesotan flora expert G.B. Ownbey in turn treated them as subspecies of *C. caseana* in 1947. His masterful treatment of the complex in his monograph of the genus *Corydalis* remains the standard today and was remarkable given the relative lack of information that was available.

He and his older brother Marion* collected Utah materials at Alta on July 19, 1946.

*1910-1974
the Washington State University herbarium is named for him

Gerald B. Ownbey
1916-2010

www.intermountainbiota.org

Intermountain Herbarium (Utah State University)

UTC

Catalog #: UTC00074429
Taxon: *Corydalis caseana ssp. brachycarpa* (Rydb.) G.B. Ownbey
Family: Fumariaceae
Collector: Marion Ownbey; Gerald B. Ownbey 3057
Date: 19 July 1946
Locality: USA, Utah, Salt Lake, Wasatch National Forest ; About 1 mile above Alta Little Cottonwood Canyon Wasatch Mountains.
Habitat: Gravel bar just below falls.

FNA Vol. 3, 1997:

1	Outer petals with marginal wing narrow or absent, apex of unspurred outer petal acute; California.	2a subsp. caseana
+	Outer petals with marginal wing moderately to highly developed, apex of unspurred outer petal not acute; other than California.	(2)
2 (1)	Outer petals with marginal wing scarcely revolute, apex rounded, sometimes minutely apiculate or notched.	(3)
+	Outer petals with marginal wing distinctly revolute, apex distinctly notched.	(4)
3 (2)	Outer petals minutely apiculate; stems mostly 10--15 dm; Colorado and New Mexico.	2b subsp. brandegei
+	Outer petals not minutely apiculate, occasionally minutely notched; stems mostly 4--10 dm; Utah.	2c subsp. brachycarpa
4 (2)	Inflorescences profusely branching; outer petals with marginal wing moderately developed, minutely eroded; n Idaho.	2d subsp. hastata
+	Inflorescences not profusely branching; outer petals with marginal wing highly developed, not minutely eroded; ne Oregon and s Idaho.	2e subsp. cusickii

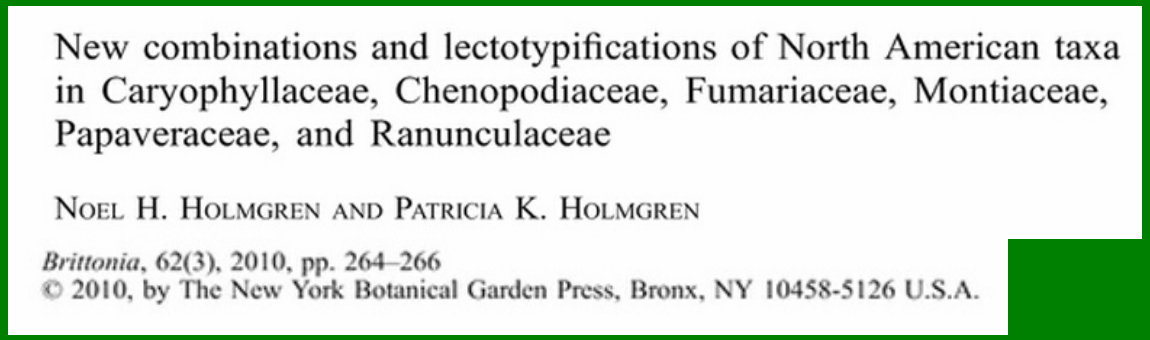
Stem height is actually not a terribly useful way to separate COCAB from COCAB2. They are however quite distinct.

Oregon's subsp. *cusickii*
marginal wing distinctly revolute, apex notched
Photo credit: Gene Yates

Utah's subsp. *brachycarpa*
outer petal not minutely apiculate, apex rounded

Colorado's subsp. *brandegei*
outer petals minutely apiculate, apex rounded to notched
Photo credit: Al Schneider

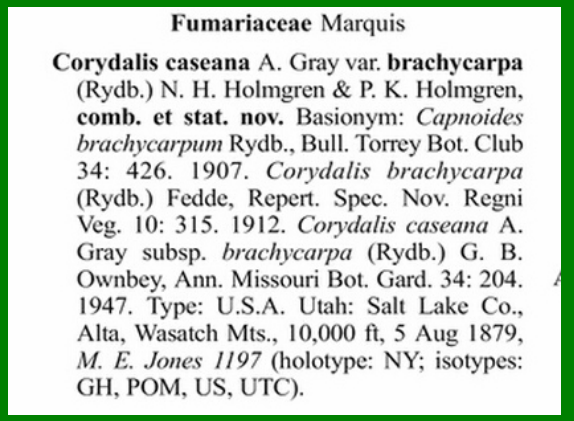
Some differences are harder to describe than to see.



New combinations and lectotypifications of North American taxa in Caryophyllaceae, Chenopodiaceae, Fumariaceae, Montiaceae, Papaveraceae, and Ranunculaceae

Noel H. Holmgren and Patricia K. Holmgren

Brittonia, 62(3), 2010, pp. 264–266



Fumariaceae Marquis

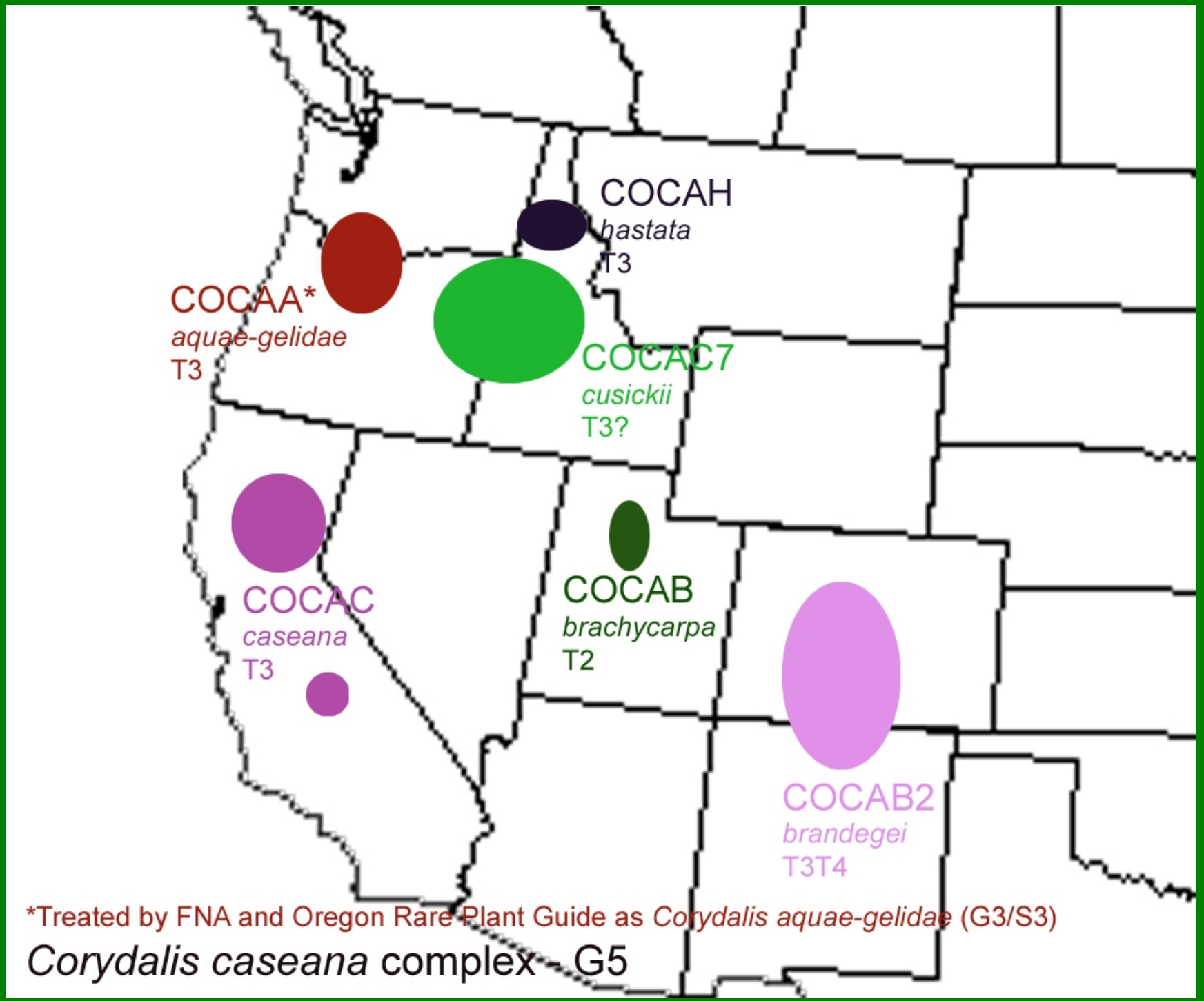
Corydalis caseana A. Gray var. **brachycarpa** (Rydb.) N. H. Holmgren & P. K. Holmgren, **comb. et stat. nov.** Basionym: *Capnoides brachycarpum* Rydb., Bull. Torrey Bot. Club 34: 426. 1907. *Corydalis brachycarpa* (Rydb.) Fedde, Repert. Spec. Nov. Regni Veg. 10: 315. 1912. *Corydalis caseana* A. Gray subsp. *brachycarpa* (Rydb.) G. B. Ownbey, Ann. Missouri Bot. Gard. 34: 204. 1947. Type: U.S.A. Utah: Salt Lake Co., Alta, Wasatch Mts., 10,000 ft, 5 Aug 1879, *M. E. Jones 1197* (holotype: NY; isotypes: GH, POM, US, UTC).

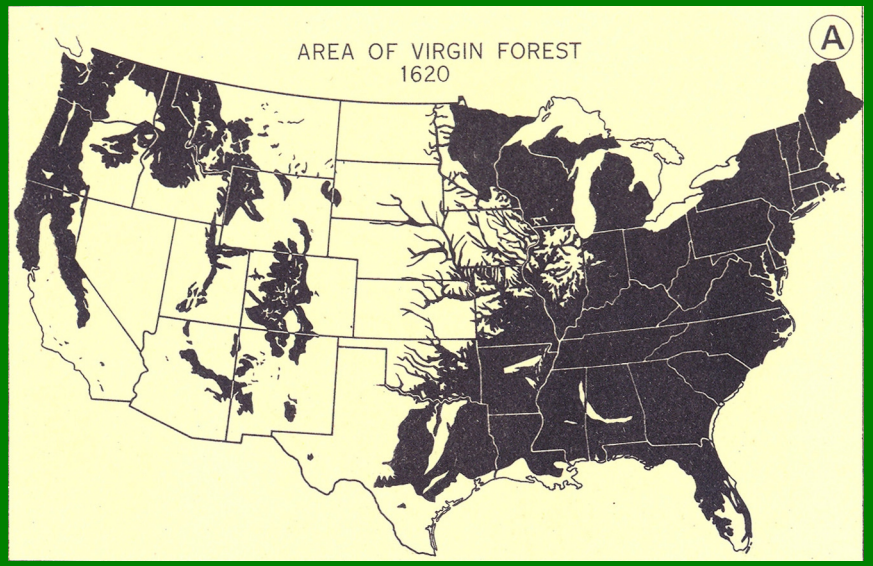
In preparation for *Intermountain Flora* Vol. 2A, Wasatch fitweed was treated as a variety in 2010 and can now be cited as:

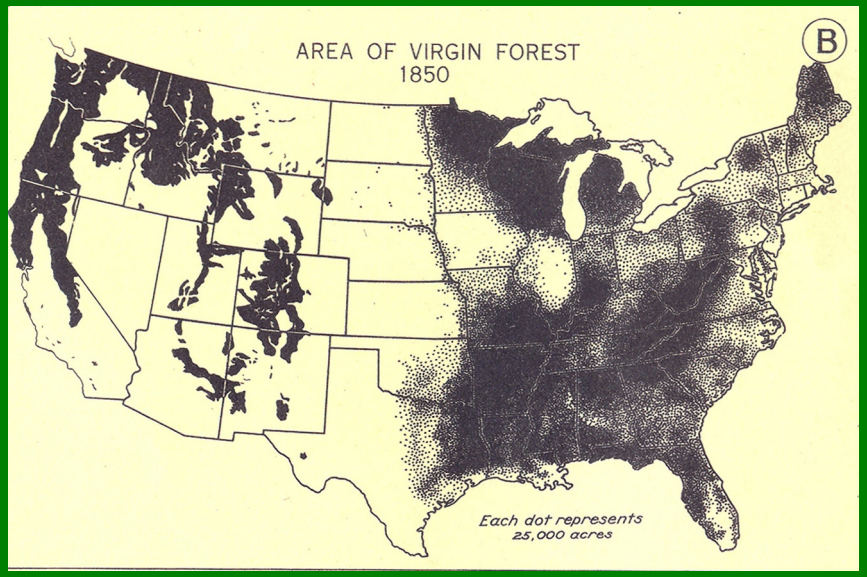
Corydalis caseana Gray var. *brachycarpa* (Rydb.) N.H. Holmgren & P.K. Holmgren

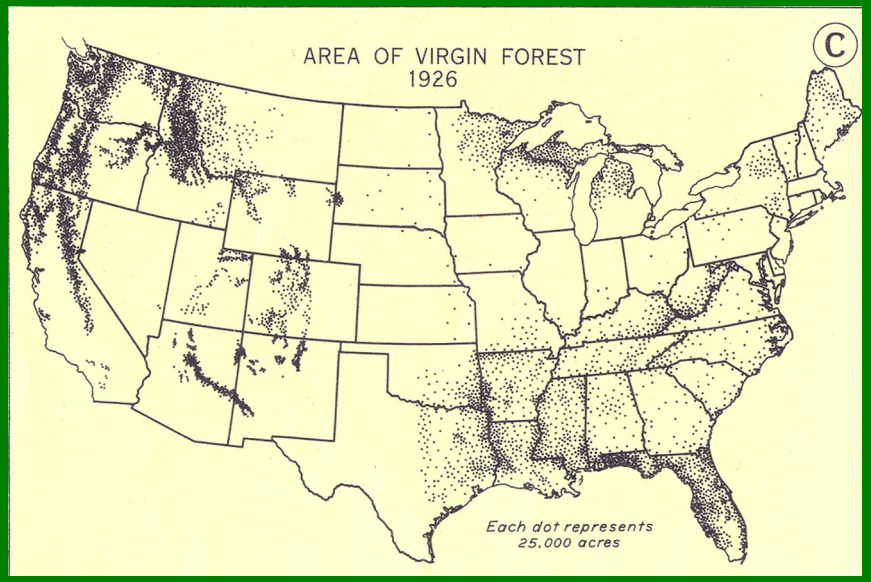
Until other entities in this complex have been also named as varieties (making it confusing to refer to our taxon as a variety particularly when comparing it to other members of the complex) and pending further study of the entire complex, I have elected to continue to refer to it as a subspecies (for now!).

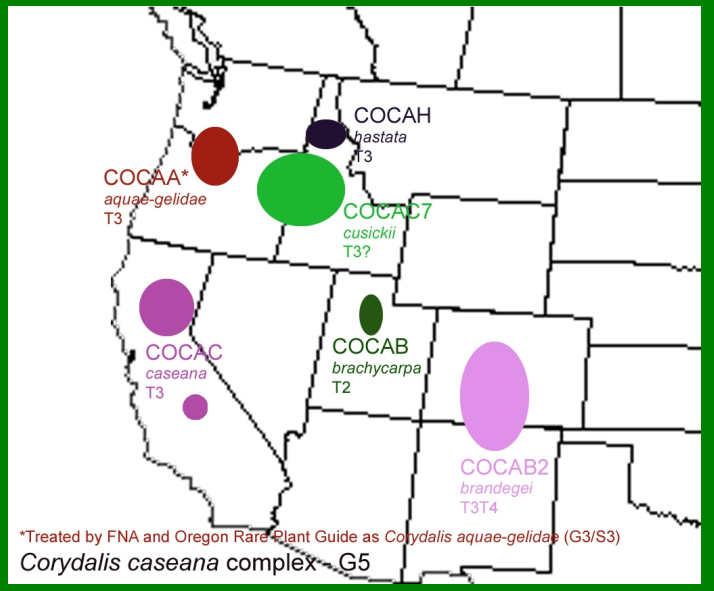
Currently the *C. caseana* complex includes six subspecies (or five subspecies and one closely related species depending on how one treats Oregon-Washington's *C. aquae-gelidae*).


COCAH
hastata
T3
COCAA*
aquae-gelidae
T3
COCAC7
cusickii
T3?
COCAC
caseana
T3
COCAB
brachycarpa
T2
COCAB2
brandegei
T3T4
*Treated by FNA and Oregon Rare Plant Guide as Corydalis aquae-gelidae (G3/S3)
Corydalis caseana complex - G5









Today: old growth forests: what remains is less than 1% in the East, 5% in West

While COCA might not be directly impacted by deforestation, indirect impacts of all kinds are likely and it is clearly strongly associated with healthy, ecologically rich, naturally forested areas.

William B. Greeley, The Relation of Geography to Timber Supply, Economic Geography, 1925, vol. 1, p. 1-11.
Maps A, B, C – Forest Service, Department of the Agriculture

Under *C. Caseana* are included several variants which hitherto have been regarded as distinct species. These variants are essentially identical with respect to coloration of the flowers and detailed morphology of the inner petals, stigmas, fruits, and seeds. They differ appreciably in what are better considered as minor characters, such as the development of a wing margin on the outer petals, length of spur, and length of pedicel. The leaves and gross size of the plants vary to some extent among the different elements of the species, but the taxonomic value of these must be discounted as about the same type and degree of variability are found in other species of the genus.

Corydalis Caseana is an excellent example of the type of morphological divergence commonly met with when component parts of a species are isolated geographically. The subspecies might be thought of as incipient species whose modified genetic make-up and consequent morphological divergence have not yet reached the species level. In another sense they might be thought of as remnants of a species which through isolation have lost a large portion of the genetic variability present in the ancient stock.

The members of this section have well-defined habitat requirements, any deviation from which is sufficient to prevent survival. The plants grow in or near a continuous source of fresh, running water, in springs, along small creeks, and in the case of ssp. *Brandegei* also in wet, open, subalpine forests. All require considerable sunlight for best development, but at the same time will tolerate some shade. Plants growing in the sun tend to have smaller, more firmly textured leaves. *C. Scouleri* grows at elevations of sea level to about 2500 feet. The subspecies of *C. Caseana* grow at elevations of 3000–11,000 feet.

The time required for these plants to reach flowering size is not known. At one locality I have seen seedlings of at least three size classes. These classes very likely correspond to age intervals of one year, yet the largest of the seedlings was still relatively small. It therefore seems probable that these plants do not attain flowering size until they are four years or more old.

Ownbey, 1947

2b. C. Caseana Gray ssp. **brachycarpa** (Rydb.) G. B. Ownbey, stat. nov.

Capnoides brachycarpum Rydb., in Bull. Torr. Bot. Club 34:426. 1907.
Corydalis brachycarpa Fedde, Rep. Spec. Nov. 10:315. 1912.

Subspecies *brachycarpa* is a well-marked unit. It is best distinguished morphologically on the basis of the broad, spreading wing margin of the outer petals which are commonly neither acute-tipped nor emarginate, but rounded, at the apex. The broad margin is very well developed even in the bud. The plant possibly is closest to ssp. *Cusickii*, but in addition to the above-mentioned differences, it is only about one-half as large. The leaves are very similar to those of ssp. *Cusickii* as found in Oregon.

The name *brachycarpa* is something of a misnomer if it was intended to call attention to a fruit difference between this and other members of the complex.

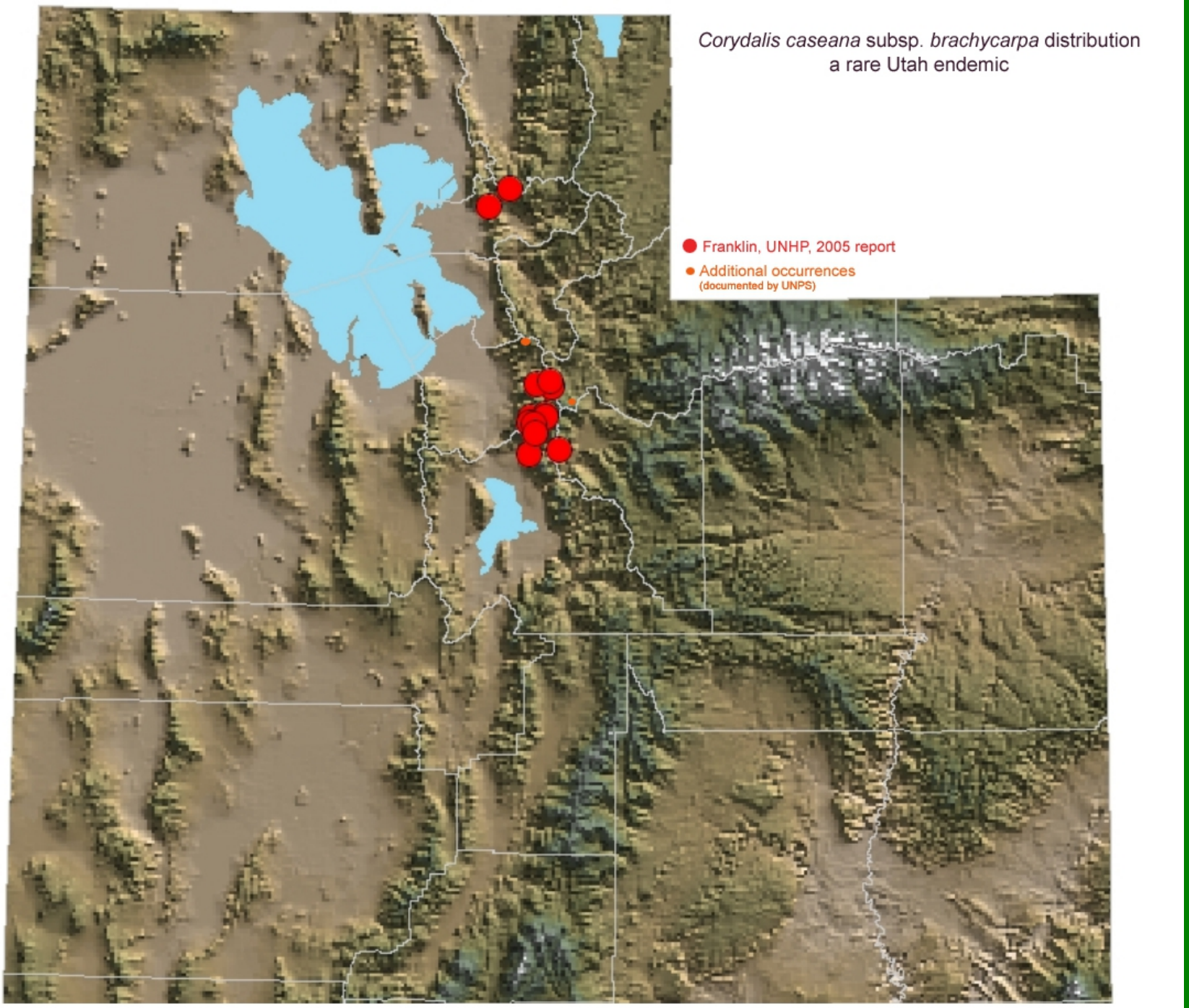
The normal fruits, although perhaps smaller than those ordinarily found in other subspecies, are in no way significantly different. It is probable that the name was applied because of a misinterpretation of the swollen fruits very commonly found on living plants. All such fruits examined were found to contain an insect larva, the adult counterpart of which has not been identified. The stimulation of growth of pathogenic tissue results in a globose, spongy, abnormal, sterile fruit. A similar situation is not uncommon in *C. aurea*.

This subspecies is of very limited distribution, and it is possible that the adult population numbers no more than a few hundred individuals.

On gravel bars along stream courses at elevations of about 8500–10,000 feet; Wasatch Mountains, Salt Lake and adjacent Utah counties, Utah. Flowers from about July 1 to July 30; fruits from about July 30 to August 30.

Utah: Salt Lake and Utah counties.

Ownbey, 1947. Lower elevation occurrences of COCAB have only been known relatively recently (slowly over the last 60 or so years).



Franklin, M.A. 2005. Plant information compiled by the Utah Natural Heritage Program:a progress report. Prepared for Utah Reclamation Mitigation and Conservation Commission. Publication No. 05-40, Utah DWR. Salt Lake City, Utah: Utah Department of Natural Resources, Divison of Wildlife Resources, Utah Natural Heritage Program. 334 pp

Excluding the disjunct Weber Co. occurrence, Wasatch fitweed is restricted to an area that is no more than 30 linear miles (north-south) and no more than roughly 12 miles wide (east-west).

Known element occurrences: **18** ◄

Weber County: 2 (disjunct)

Salt Lake County (eastern):
City Creek: 2
Lamb's Canyon: 2 (lower and upper/Lake Salamander)
Millcreek Canyon: 2
Big Cottonwood Canyon: 2 (Mill D North and Butler Fork)
Little Cottonwood Canyon: 3 (White Pine plus Alta area: 2)

Summit County/Park City area: 3

Wasatch County: 1

Utah County: 1

Total occupied acreage is very small (but size is unknown; could be less than 500 acres). Occurrences are limited to drainages as restricted elevations and typically for relatively short distances. Potentially highly susceptible to changes in hydrology.

Might be pollinator limited. And, seed production likely limited by insect parasite. Threats include resort, secondary home and recreational development (roads, structures), recreational use (low), and climate change impacts. Historically some impacts from mining in Alta area.

Typical habitat – north-facing slope, upper Millcreek Canyon, Wasatch Mtns, Salt Lake County, Utah
Geology of this area where COCAB occurs: glacial morraine, Park City Formation.

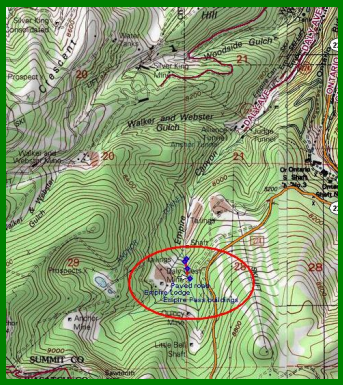
Empire Pass, Summit County, private property (Talisker), July 3, 2006.
About 8,270 ft. elev. North/northwestern facing slope. Vegetation denuded below.

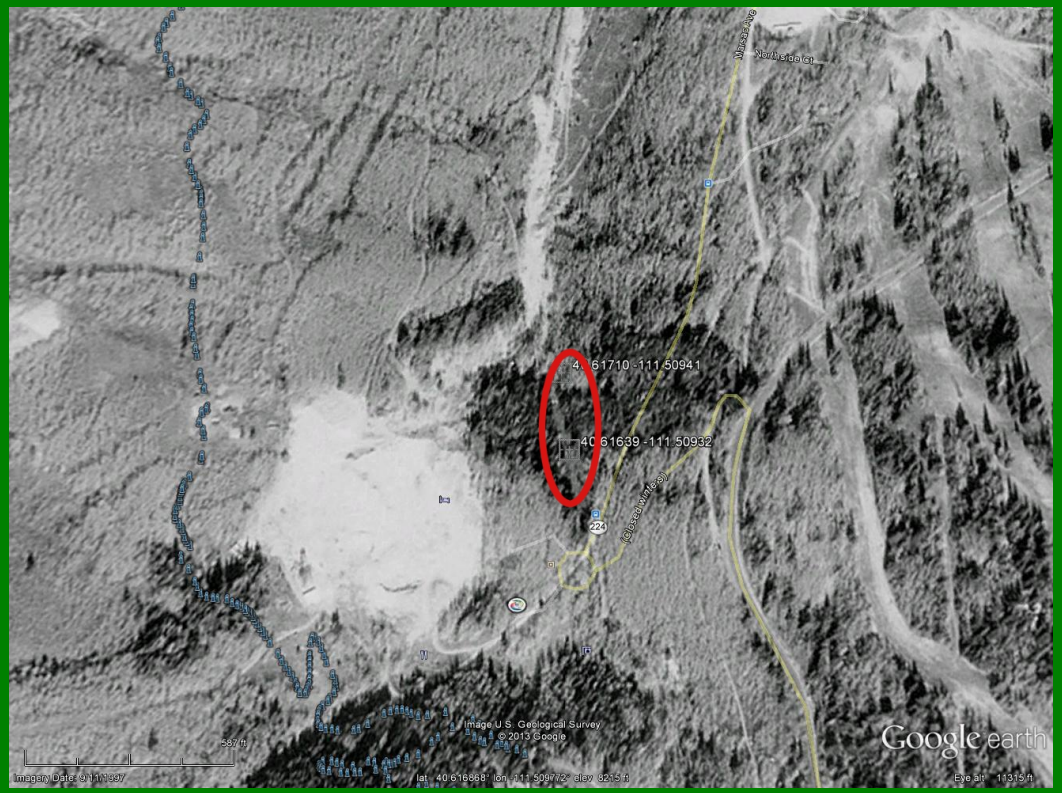
Park City resident Regina White at Empire Pass, Summit County, Utah, July 3, 2006. Regina notified UNPS about planned resort development and, as a result, some of this occurrence has been temporarily saved through voluntary efforts of the landowner.

Empire Pass, Summit Co., Utah, July 3, 2006. Not particularly wet and development above will no doubt change hydrology and/or possibly result in pollutants that may not be tolerated by this small, fragile occurrence. Summit County is largely privately owned. Restricted here to a small area, 8,260 ft. to 8,300 ft. elev.
A number of plants here were in the medium 10 to 12 dm height range. Mid-sized native bees mainly visiting *Mertensia* rather than the *Corydalis*.

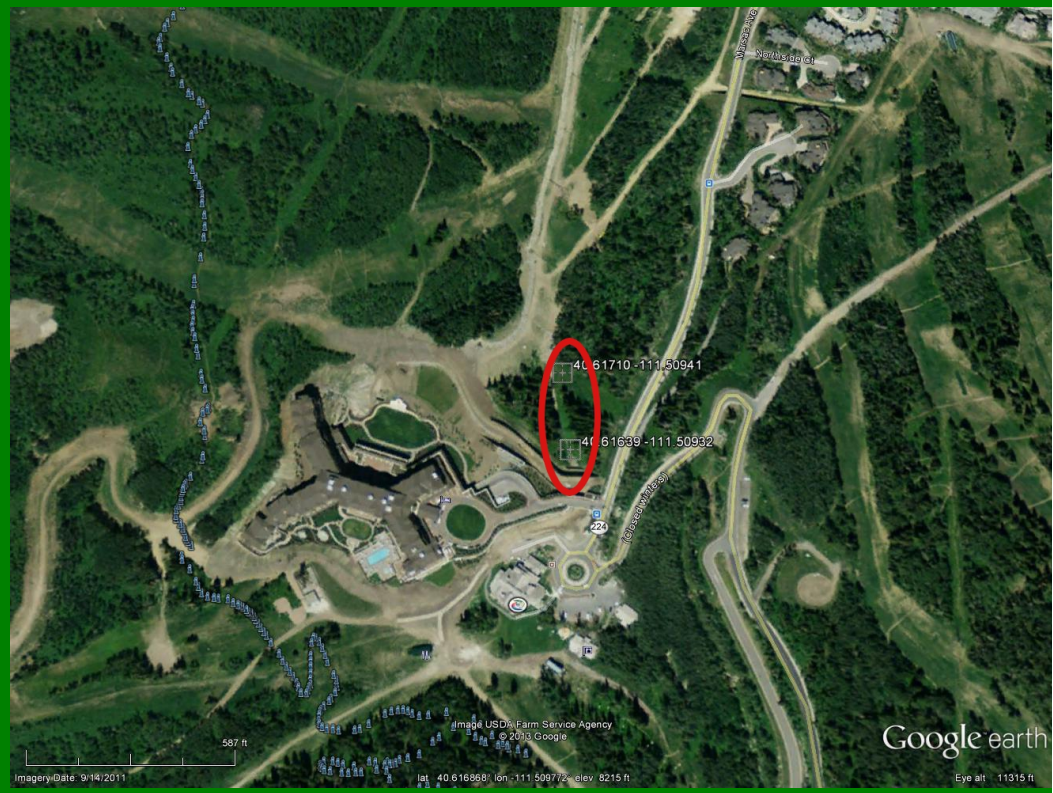
Talisker's Empire Pass/Montage development, Wasatch Fitweed in drainage at bottom right. July 3, 2006.

Empire Pass development, July 3, 2006, above Wasatch fitweed drainage





Empire Pass, Summit Co. – September 1997



Empire Pass, Summit Co. - October 2011. Construction to the west/left of the population has all occurred since July of 2006.

Worldwide: from 2000 to 2010, some 100 million acres of primary forest have been lost.

Lake Salamander, Lamb's Canyon, Aug. 12, 2009, UNPS field trip.
Wasatch fitweed habitat in north-facing/sloping drainages on opposite side of lake.
About 1/2 mile from Salt Lake Co.-Summit Co. border. 8,400 ft. elev.

Lake Salamander habitat, Lamb's Canyon, eastern edge of Salt Lake County – Aug. 2009

Upper City Creek Canyon habitat, near Salt Lake-Davis Co. line, new EO, UNPS field trip led by Bill Gray, late July 2007, elevation roughly 7600 ft.

Glory Hole Flats, Albion Basin, high elevation occurrence, Aug. 7, 2010.
EO: 9,600+ to just over 10,000 ft., and at or near the type locality.

9,950 ft. elev. Aug 7, 2010 growing with *Ranunculus adoneus* var. *caespitosus*

Juvenile, roughly 9,950 ft. elev. Aug 7, 2010.

COCAB seedlings near 10,000 ft. Seeds: small, dark brown, shiny, kidney-shaped and have eliasomes. Aug 7, 2010. Very short growing season here.

COCAB occurrences appear to strongly correspond with glacial morraines, more obvious here than at lower elevation sites where it seems to also be similarly correlated.

Early anthesis.

Some disturbance has been caused by ski lift access roads (and old mining roads).

Other than some hummingbirds flying into the willows at lower right, pollinators seemed to be mostly absent at the time of this visit, despite the floral display.

Gravel bar.

How many of our botanical pioneers have walked across these gravels . . . .

Waif of the rare endemic *Ivesia utahensis* growing on the gravel bar with COCAB. This was the only Utah Ivesia observed at this lower than typical elevation, here at 9,890 ft. *I. utahensis* is not normally sympatric with COCAB and grows usually well over 10,000 ft..

Also pictured: *Cirsium eatonii*, and *Epilobium anagallidifolium (*syn. *Epilobium alpinum*).

Mine tailings. Long lasting/permanent disturbance from 19th century mine activities

COCAB will grow on steep slopes where sufficient moisture has accumulated from snowpack.

Associated species here included *Dodecatheon alpinum*.

Geology of the area is complex. Tintic quartzite is a major component here. Not a typical habitat shot except that may help to explain how COCAB is able to thrive/become established where few other things can initially, and so why it occupies the relictual habitats where it is now found.

Utah's subsp. *brachycarpa*
Millcreek Canyon

Colorado's subsp. *brandegei*

Photo credit: Al Schneider
www.swcoloradowildflowers.com

Utah's subsp. *brachycarpa*
Millcreek canyon, Aug. 2005

Colorado's subsp. *brandegei*

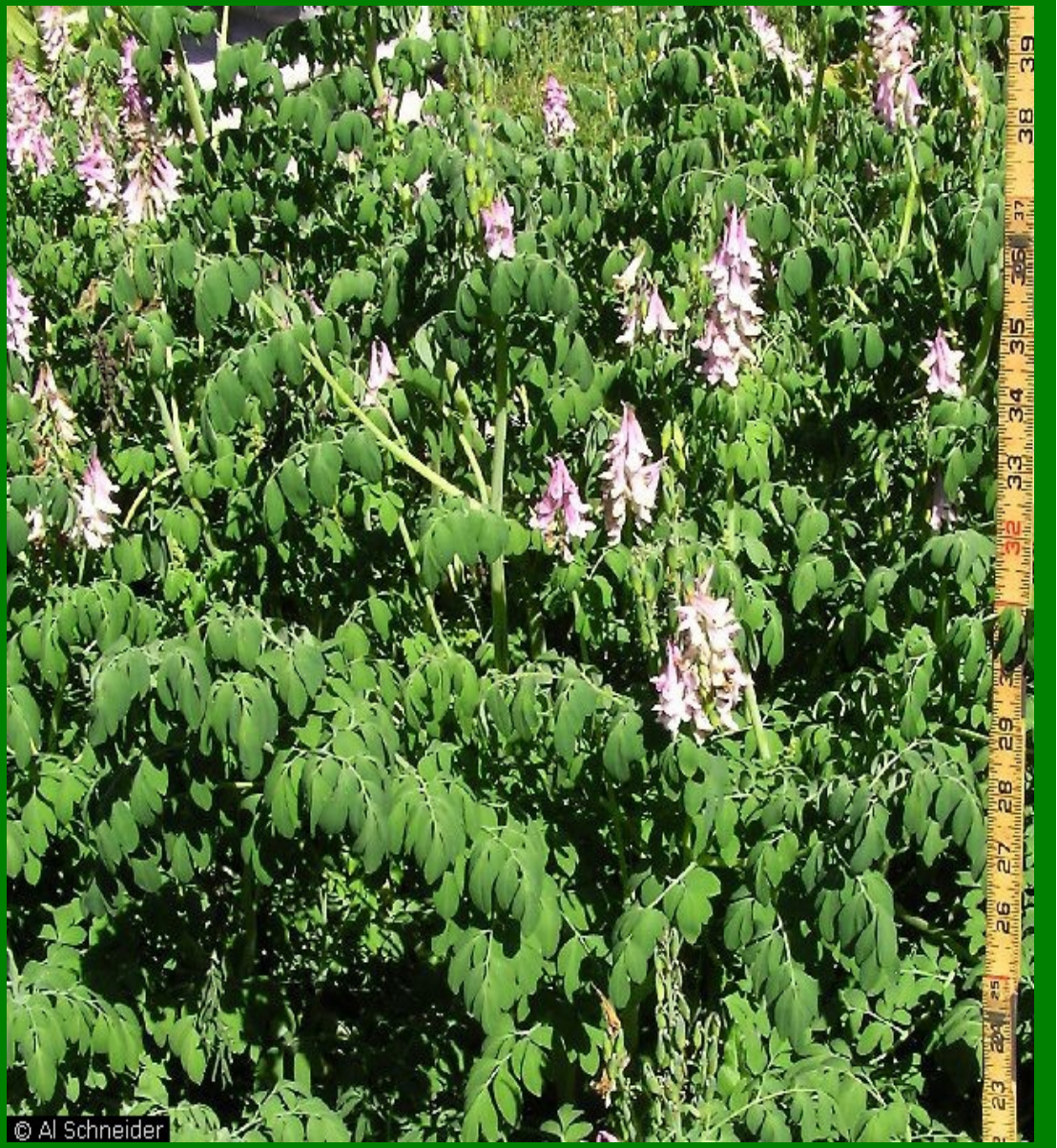
Photo credit: Al Schneider
www.swcoloradowildflowers.com

Utah's subsp. *brachycarpa*
Millcreek canyon

Colorado's subsp. *brandegei*

Photo credit: Al Schneider
www.swcoloradowildflowers.com

Empire Pass, Summit County,
Utah's subsp. *brachycarpa*



Colorado's subsp. *brandegei*

Photo credit: Al Schneider
www.swcoloradowildflowers.com

Why Utah is Better Than Colorado

We have more plant species

It is better to be notched than square.

No tornadoes (mostly).

It is cooler to border Nevada than Nebraska

Originality: you copied our state tree and then renamed it!
(Utah legislature: 1933; Colorado legislature: 1939)

Our subspecies of *Corydalis caseana* is a lot prettier than yours!

subsp. *brachycarpa* Millcreek Canyon

subsp. *brachycarpa*
Millcreek Canyon, Utah

subsp. *cusickii*
Elkhorn Mountains, west of Baker, northeastern Oregon, 2012

Photo credit: Gene Yates,
Forest Service botanist

subsp. *cusickii*, Wallowa Mtns, northeastern Oregon, July 12, 2009
Photo credit: Dave Dobak

subsp. *cusickii*, Wallowa Mtns, northeastern Oregon, July 12, 2009
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Photo credit: Dave Dobak

subsp. *cusickii*, Wallowa Mtns, northeastern Oregon, July 12, 2009 Photo credit: Dave Dobak

subsp. *brachycarpa* Millcreek Canyon, Wasatch Mtns, Utah

Empire Pass, Summit County. Note insect.

COCAB Upper Millcreek Canyon, Utah

Coiled trap-like seed propulsion means: pods have elastic walls. When touched, they explosively eject seeds. Seeds have eliasomes.

Millcreek Aug. 2005

Lake Salamander, Aug. 2009 – note what seems to be bug/larvae inside fruit (upper arrow). Also note the seed coil/propulsion mechanism (lower arrow) (elastic walls of pod). Plants here were seemingly not forming many fruits.

COCAB Lake Salamander Aug. 2009 – lack of pollinators?

Upper City Creek Canyon, northern edge of Salt Lake County.
Fruits here seem less parasitized than is typical, late July 2007.

Upper Millcreek Canyon occurrence, Aug. 2005, ideal habitat

Upper Millcreek Canyon occurrence – tall plants, up to 16 dm, often 12-13 dm

Upper Millcreek Canyon occurrence, home of the tallest Wasatch fitweeds.

Adults are typically taller than how they have been traditionally described.

COCAB:

Plants of different age ranges as well as seedlings have been observed.

So, assuming the plants aren't self-compatible, something is pollinating these flowers.

But what?

Plant Species Biology (2000) 15, 281–288

REGULAR ARTICLE

Reproductive biology of a North American subalpine plant: *Corydalis caseana* A. Gray ssp. *brandegei* (S. Watson) G. B. Ownbey

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Abstract

Corydalis caseana ssp. *brandegei* (Fumariaceae) is a perennial plant that grows in moist, subalpine regions of south central Colorado, USA. Prior to this study, nothing was known of its reproductive biology. The most numerous visitors (59%), and the only known pollinators, were long-tongued bumblebees (*Bombus appositus*). Twenty-nine percent of visits were from short-tongued nectar-robbing bumblebees (*Bombus occidentalis*). Hummingbirds also visited the flowers but they did not pollinate them. *Corydalis caseana* flowers remained open and in good condition for approximately 4 days. During that time, in the absence of visitors, nectar containing 35% sugar accumulated at a rate of approximately 1 µL per day. *Corydalis caseana* has a mixed-mating system. It is self-fertile, but the self-fertilized flowers produce fewer seeds per fruit than the outcrossed flowers (a mean of 2.9 compared with a mean of 4.7). Results suggest a possibility of inbreeding depression.

Dr. Joan E. Maloof research – subsp. *brandegei*

Dr. Joan Maloof

Table 2 Breakdown of pollinator visitors ($N=214$) to *Corydalis caseana*, late June to early August 1996, Washington Gulch and Kebler Pass, Gunnison County, Colorado, USA

Pollinator visitors	Proportion of total (%)
Bombus appositus bumblebee	**59%**
Queens, visiting legitimately	50% (107)
Workers, secondary nectar robbing	8% (17)
Workers, visiting legitimately	1% (2)
Bombus occidentalis bumblebee	**29%**
Workers, primary nectar robbing	25% (54)
Workers, secondary nectar robbing	3% (7)
Queens, primary nectar robbing	1% (2)
Bombus flavifrons bumblebee	**8%**
Workers, secondary nectar robbing	7% (15)
Workers, visiting legitimately	1% (1)
Selasphorus platycercus and *Selasphorus rufus* Broad-tailed and Rufous Hummingbirds	**3%** (7)
Papilio zelicaon Gothic swallowtail butterfly	**1%** (2)

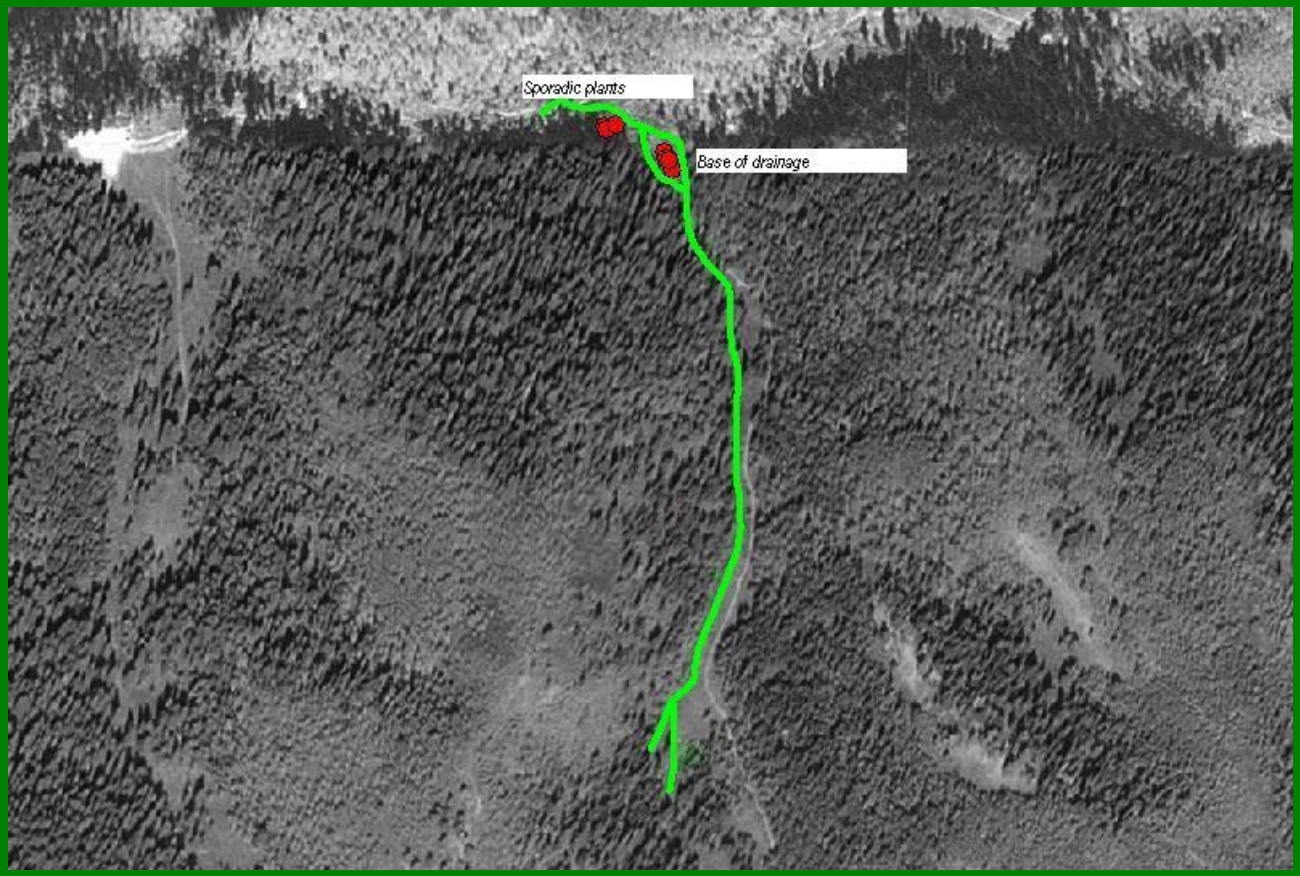
In 1996 *B. appositus* was the most numerous visitor and the only known pollinator in the study sites. *Bombus occidentalis*, the nectar robber, was the second most numerous visitor (Table 2). Drawing on what is known of other plant-pollinator relationships, I would expect the exact numbers and perhaps even the composition of the pollinator community to change through space and time (e.g. Heinrich 1976; Herrera 1988; Traveset *et al.* 1998). I have used 1996 as a 'snapshot' from which I have made the following assumptions: (i) long-tongued bumblebees are important pollinators of *C. caseana*, and (ii) *C. caseana* sometimes shows evidence of high rates of robbing. Additional experiments carried out at these study sites in 1997 and 1998 (Maloof 2000) lend support to these assumptions. In each of those years *B. appositus* was, again, the dominant visitor and at least 40% of the flowers were robbed.

So are the pollinators of subsp. *brachycarpa* similar or different than subsp. *brandegei*?

Do they follow the predictions of Maloof more or less?

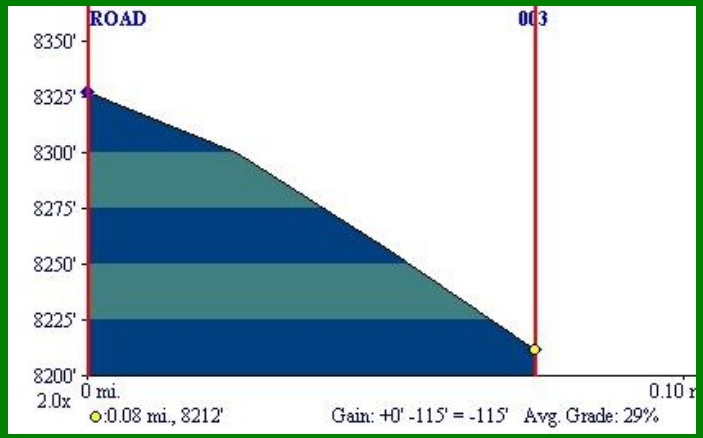
And whatever they are, what are the conservation implications?

So: after locating the Maloof research indicating that the Colorado subspeces was being almost exclusively visited by three species of *Bombus*, efforts were made starting in 2006 to determine what might be visiting the Utah subspecies.



N

Upper Millcreek Canyon occurrence
7,700 to 8,325 ft.



Bombus flavifrons. July 13, 2006, upper Millcreek Canyon, Wasatch Mtns, Salt Lake County, Utah, elev. approx. 7700 feet.

Maloof comment (2006): There appears to be a nectar robbing hole . . . (just above bee's leg - a backwards "C" shaped hole probably made by *Bombus occidentalis*)

Criminal activity occurred here.

Bombus flavifrons. Not the nectar robber.

Bombus flavifrons. Not the nectar robber.

Bombus flavifrons. Not the nectar robber.

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Bumble bees: western bumble bee (*Bombus occidentalis*)

The western bumble bee was once very common in the western United States and western Canada. The workers have three main color variations. These bees can still be found in the northern and eastern parts of their historic range, but the once common populations from southern British Columbia to central California have nearly disappeared. This bumble bee is an excellent pollinator of greenhouse tomatoes and cranberries, and has been commercially reared to pollinate these crops. In the past, it has also been an important pollinator of alfalfa, avocado, apples, cherries, blackberries, and blueberry.

Please contact us if you have any information on the current or recent distribution of the western bumble bee. If you do research on bumble bees, have incidental bumble bees in your collection, or have student insect collections from the past few years, it would help us to know if you have or have not seen these bees. It is as important for us to document where these bees were formerly common, but not recently collected, as it is to document where they were collected.

visit bumble bees in decline page

⊞ photo

western bumble bee by Derrick Ditchburn

Once common and widespread in west. Thought to be in decline.

The “primary” nectar robber!

Short tongue.

Various elevations.

Lower abdomen segments T4-5 are all or mostly white. (Look for the white tail.)

Upper segments:T1 is black, T2-3 black or yellow. Head black/yellow.

Black banded, mesopleura hairs are mostly black.

Corbicular fringes are red.

Some Bee factoids

BEES - # of species

20,000+ worldwide
4,000+ in North America
1,000+ in Utah

BUMBLE BEES (*Bombus*) - # of species

250 worldwide
50 in North America*
18 in Utah (three of which are parasitic on other *Bombus*)
(at least 11 bona fide species along the Wasatch Front)

Eusocial. More likely found in mountains than deserts.

*Possibly extinct: *Bombus franklini* known from one county each in CA and OR
Another western species, *Bombus occidentalis*, is thought to be in decline.

An estimated 65%+ of flowering plants require insect pollination.
Biodiversity of vascular plants likely related to insect pollinators.

Bees are often the most important pollinator providing pollination services.

Endearment character analysis
Bombus are mostly just small female cats with wings.

Hunt's Bumble Bee (queen, I think)

(Bombus huntii)

Tony's North American House Cat (queen, she thinks)

Furry throughout
Facial hair (always a huge +)
Female
Big eyes
Patient (mostly) and persistent
Largely aloof
Well-groomed
Mild-mannered
High overall levels of cuteness
Responds nicely to “Honey”

Note: nothing on this page has anything to do with *Corydalis caseana* subsp. *brachycarpa*.

Bombus flavifrons. July 13, 2006, upper Millcreek Canyon, Wasatch Mtns, Salt Lake County, Utah, elev. approx. 7800 feet.

Bombus flavifrons. Petals are 1.5-2.5 mm long. Good-sized bee. July 13, 2006, Millcreek Canyon, approx. 7800 ft. elev.

The call went out in 2006 to watch for *Bombus* (or anything) on COCAB.

That call did not go unanswered . . . .

Preliminarily identified as a male *Bombus appositus* (“White-shouldered bumble bee”) by Dr. Vince Tepedino (2006). The first sighting of *Bombus appositus* on COCAB! Photo credit: **Mindy Wheeler**, taken on July 30, 2006 in White Pine Canyon (Summit County) at approx. 7900 feet. Long-tongued bee, like *B. flavifrons*, and also like *B. flavifrons*, found in our area at higher elevations.

Small lower Millcreek Canyon occurrence at 7,200 ft. COCAB growing here along creek for a short distance and on exposed, steep, north-facing moist slope. July 22, 2011.

Bombus flavifrons, July 22, 2011, lower Millcreek Canyon EO at 7,200 ft. elev. Large bee, corbicular fringe black/red, long and uneven hair, black spot between wings, black/yellow head. T1-2 mostly yellow, T3-4 orange, T5 black, long yellow mesopleura hairs. Long tongue.

Bombus appositus, July 22, 2011, lower Millcreek Canyon EO at 7,200 ft. elev. White head. Large bee with long cheek. T1-5 yellow or orange-brown. Mainly black mesopleura hairs. Short/even hairs. Black band between wings, black corbicular fringe. Long tongue.

From 1996 to 1998 I also made casual observations of visitors to other *C. caseana* populations. At one population in Elkton, approximately 2 km north of the Washington Gulch study site, hummingbirds were more prevalent than they were in the regular study sites. At a population in Yule Basin (39.00°N, 107.06°W; 3346 m) *Bombus nevadensis* and *B. kirbyellus*, other long-tongued bumblebees, were observed foraging legitimately, and probably pollinating, alongside *B. appositus*. In the same area, but at a higher elevation (3474 m) a hawkmoth (*Hyles lineata*) was observed collecting nectar from *C. caseana*. Another subspecies, *Corydalis caseana* ssp. *cusikii*, was observed growing by Mores Creek Summit in the Boise National Forest, Idaho. Of the 15 visitors observed there on 24 June 1997, 10 were *B. appositus* (legitimate pollinators), four were *B. occidentalis* (nectar robbers), and one was a hummingbird. I found it interesting that this suite of visitors was similar to the suite observed in the study sites of *C. caseana* ssp. *brandegei*, approximately 1000 km away.

Maloof (2000), p. 286. *Bombus* clearly seem to be very important to plants in the *Corydalis caseana* complex.

So what are the conservation implications?

Abstract: Two sympatric bumble bee species partition nectar resources in a subalpine Colorado meadow: the larger bee with the longer proboscis, Bombus appositus, preferentially visits the species with the longer nectar spur, Delphinium barbeyi, while the smaller B. flavifrons prefers the shorter-spurred Aconitum columbianum. We tested whether per-flower foraging efficiency (nectar obtained per second spent in the flower) differs for the two bee species on the two plants, and whether efficiency differences can explain the observed visitation differences. In our exclosure, as in the field, the longer-tongued B. appositus foraged almost exclusively on Delphinium. Bombus appositus gained significantly more nectar per second on Delphinium flowers than on Aconitum. Although the smaller B. flavifrons visited Aconitum more frequently, there was no significant difference in nectar gained per second for these bees on Delphinium and Aconitum in the exclosure, where all flowers had full nectar. We hypothesize that the shorter-tongued bees may be displaced from the longer-spurred flowers by exploitative (consumptive) competition in the field, and therefore invest in learning how to forage efficiently from the more complex Aconitum flowers. Resource partitioning between these bee species can be explained, at least in part, by efficiency differences related to morphology.

Subject:	Bumblebees (Environmental aspects) Resource partitioning (Ecology) (Research)
Authors:	Graham, Liza Jones, Kristina N.
Pub Date:	10/01/1996
Publication:	**Name**: The American Midland Naturalist **Publishe** **Format**: Magazine/Journal **Subject**: Biological sc Department of Biological Sciences **ISSN:** 0003-0(
Issue:	**Date**: Oct, 1996 **Source Volume**: v136 **Source I**
Accession Number:	18915192

Some research is available concerning these same *Bombus* species and their preferences/needs.

A preference for local foods: bumble bee foraging decisions in a Rocky Mountain meadow

Monday, November 12, 2012: 11:15 AM
Lecture Hall, Floor Two (Knoxville Convention Center)

Jane E. Ogilvie *, Department of Ecology and Evolutionary Biology, University of Toronto, Toronto, Ontario, Canada*
Takashi T. Makino , Department of Biology, Faculty of Science, Yamagata University, Yamagata, Japan
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Pollinators must make decisions about where to forage in landscapes where floral resources are patchy at many spatial scales. The resulting foraging decisions can influence plant pollination and reproductive success. Despite this importance, we still have a poor understanding of how pollinators use patches which vary in floral abundance and isolation, particularly at an individual pollinator level. We marked and resighted known individual bumble bees (*Bombus* spp.) visiting 12 flowering *Delphinium barbeyi* patches that varied in size (small and large: 4 and 400 m^2, respectively) and isolation (near and far: 5 and 50 m distance, respectively) in a subalpine meadow in the Colorado Rocky Mountains. At the patch level, large and near patches received more bumble bee visits per flower than small and far patches. At an individual bee level, most marked individuals foraged only in one patch. *Bombus nevadensis*, *B. flavifrons* and *B. appositus* were the most common bumble bees seen, yet we saw very few marked *B. nevadensis* again, suggesting that this larger bee is less site faithful and may have a larger foraging range than the other two common smaller bumble bees. We show that individual bumble bees commonly forage very locally in a meadow and that they prefer to forage in large and near patches, which may have implications for the pollination of *D. barbeyi*.

Most importantly, the likely pollinators need to be given equal weight and consideration in connection with the management of this and other rare taxa.

Pollination Ecology of the Rare Orchid, *Spiranthes diluvialis*: Implications for Conservation

KIM PIERSON,[1] VINCENT J. TEPEDINO,[2] SEDONIA SIPES,[3] and KIM KUTA[4]

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[2]USDA ARS Bee Biology and Systematics Laboratory, Utah State University, Logan
[3]Department of Entomology, Cornell University, Ithaca, New York
[4]Stokes Nature Center, Logan, Utah

Abstract: We examined the pollination ecology of *Spiranthes diluvialis* Sheviak, Ute ladies-tresses, a federally listed, threatened orchid species known only from small, isolated populations in the western United States. The pollinator composition, male and female reproductive success, and demography of *S. diluvialis* populations were examined in 1995, 1997, and 1999. *Spiranthes diluvialis* sets fruit only when visited by pollinators and observations indicate that native bees, predominantly bumblebees (*Bombus* spp.), are the most important pollinators. Comparisons of male and female reproductive success were made between populations and years. Significant declines in fruit production and pollinia removal that occurred in 1999 in the Diamond Fork population may be related to changes in pollinator composition. Significant increases in fruit production were recorded in the Brown's Park population, an area in which native pollinators were released in 1999. Management plans to conserve this threatened orchid must provide for the pollinators, their nesting habitat, and pollen-producing plants (*S. diluvialis* provides no pollen to pollinators). We identified important pollen sources for pollinators in the Diamond Fork population and supplied several types of semi-natural nesting materials to promote nesting by *Anthophora terminalis*, another species thought to be an important pollinator. Successful preservation of this threatened orchid requires a community-level conservation plan.

Pierson, Kim; Tepedino, Vincent J.; Sipes, Sedonia; Kuta, Kim. 2001. Pollination ecology of the rare orchid, Spiranthes diluvialis: Implications for conservation. In: Maschinski, Joyce; Holter, Louella, tech. eds. Southwestern rare and endangered plants: Proceedings of the Third Conference; 2000 September 25-28; Flagstaff, AZ. Proceedings RMRS-P-23. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 153-164.

Table 1. Insect visitors of *Spiranthes diluvialis* in 1999. All observations are from Diamond Fork Canyon.

Taxon	No. of observ.	Pollinia carried	Foraged bottom-up
Hymenoptera			
Anthophora terminalis	2	yes (2)	yes (2)
Apis mellifera	13	yes (6)	yes (3)
Bombus appositus	2	yes (1)	yes (1)
Bombus griseocollis	12	yes (6)	yes (6)
Bombus bifarius	3	yes (3)	yes (2)
Bombus rufocinctus	3	yes (2)	yes (2)
Bombus occidentalis	2	yes (1)	yes (1)
Colletes sp.	1	no	no
Halictus sp.	1	no	no
Osmia sp.	1	no	yes (1)
Vespula maculata	2	no	no
Vespula sp.	1	no	no
Lepidoptera			
Unidentified skipper	1	no	no
Diptera			
Syrphidae	4	no	no

Discussion

Pollinator Visitation

The diversity and abundance of pollinators of *S. diluvialis* appears to fluctuate between populations and years. Bumblebees (*Bombus* spp.) were found to be the most important pollinators for both the Diamond Fork and Brown's Park populations in 1991 and 1992 (Sipes 1995, Sipes and Tepedino 1995), but in 1995 *A. terminalis* was most abundant and likely the most efficient pollinator for the Diamond Fork population (Sipes et al. 1996).

Bumblebees have been shown to be among the most important pollinators of *Spiranthes* in several other studies (Ames 1921, Luer 1975, Catling 1983, Larsen and Larson 1990, Sipes and Tepedino 1995).

Bombus griseocollis on *Asclepias asperula*

Pierson, Tepedino et al (2001).

Spiranthes diluvialis

Implications for Conservation

To successfully conserve the existing populations of *S. diluvialis*, a community-based management plan is essential. Given the dependence of *S. diluvialis* on pollinators for sexual reproduction (Sipes and Tepedino 1995), an appropriate management plan must provide for the overall preservation of pollinating species and must incorporate their nutritional, provisional, and nesting needs. Understanding the biology of these species is vital to their preservation as well as to the continued conservation of *S. diluvialis*. Many efforts can be made to encourage the establishment of such bees within the ecosystem.

As outlined in Sipes and Tepedino (1995), the long activity period of bumblebees (spring to early autumn), renders their populations vulnerable to management decisions throughout the growing season. Populations of bumblebees are annual with only the young mated queens produced in late summer–early fall capable of overwintering or hibernation. The production of entire new colonies the following year is dependent upon the survival of these queens over winter. In spring, these queens will forage until the first progeny reach workerhood (Michener 1974, Alford 1975). The application of insecticides during these foraging and mating periods could prevent formation of entire colonies and could also jeopardize the health of a colony. Workers can become vectors of contaminated nectar or pollen. Because bumblebees can forage great distances (up to 3 miles), insecticide applications must be prohibited over distances much greater than the mandated 500 foot buffer around water courses.

By providing for the nesting requirements and nutritional needs of these bee species, maintenance of native pollinators is possible.

The nesting and foraging requirements of the pollinators of *S. diluvialis* are varied. *Bombus griseocollis* prefers to nest in dry aboveground locations such as downed logs, abandoned sheds, or farm buildings (Eshelman and Plowright 1972), whereas other species (*B. appositus*, *B. rufocinctus*, and *B. bifarius*) typically nest in belowground burrows or in abandoned rodent nests (Medler and Carney 1963, Hobbs 1965, 1966). *Bombus occidentalis* prefers to nest in open west-southwest slopes bordered by poplar trees and sites connected to the surface with downward-sloping tunnels (Hobbs 1968). These species are often attracted to legumes such as *Melilotus*, *Medicago*, and *Trifolium*, and members of the Asteraceae including *Solidago* and *Aster* (Plath 1927, Medler and Carney 1963, Hobbs 1965, 1966).

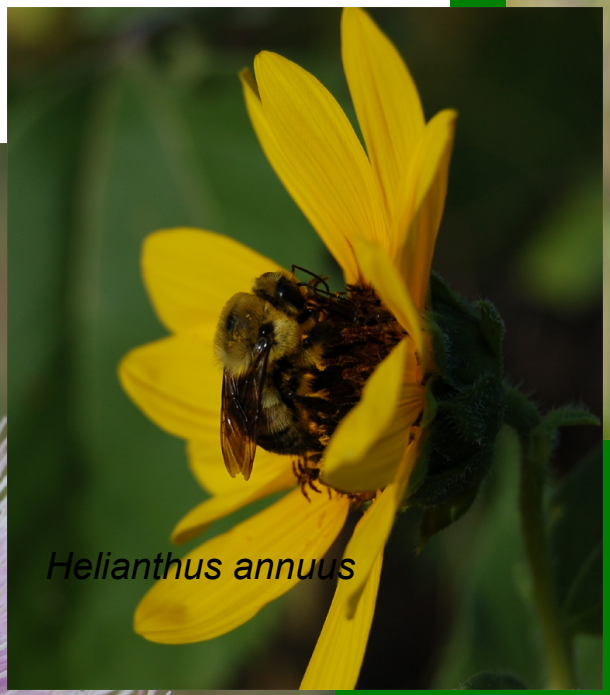
Because the pollinators of *S. diluvialis* appear to fluctuate from year to year and site to site, a larger scale conservation plan to preserve and encourage the establishment of all native pollinators would be extremely beneficial. Efforts to encourage the establishment of *A. terminalis* should be continued. Nesting sites such as logs, snags, shrubs, and downed wood should be encouraged rather than disturbed. Augmenting populations with such nesting material may also prove beneficial to the populations of *A. terminalis*. Bumblebees should be encouraged to establish or colonize areas surrounding the *S. diluvialis* populations. Subterranean nesting boxes that have been designed to promote ground-nesting bumblebees (Alford 1975) could be employed in the more mesic areas surrounding *Spiranthes* colonies. Additional nest-building material such as cotton batting, dried moss, or old bird nests could be provided to encourage colonization by such species. Bumblebees have also been observed nesting at ground level when large accumulations of dried moss or fine grass are available (Alford 1975).

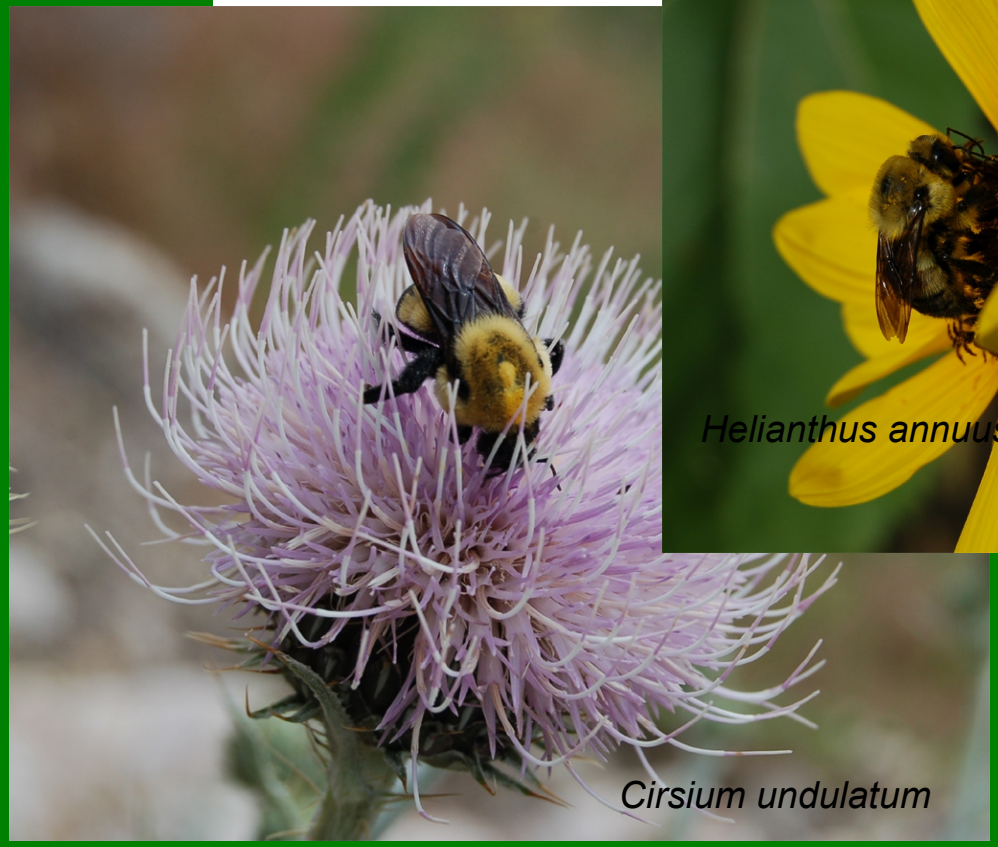
Must manage throughout growing season (insecticides prohibited within 500 ft buffer around water courses), consider nesting and foraging requirements, encourage other/all pollinators

Pierson, Tepedino et al (2001).

In addition to providing for the nesting requirements of these native pollinators, management plans must consider the importance of co-occurring vegetation. Pollinators cannot use *S. diluvialis* pollen and must therefore seek their pollen elsewhere.

Pierson, Tepedino et al (2001)





The Grizz. *Bombus grisceocollis*. Also known as the Brown-belted bumble bee. Lower elevation inhabitant (< 6,000 ft). Very short, even hair. Medium tongue. T1 yellow, T2 yellow or brown crescent, T3-5 black. Mesopleura hairs yellow. Head black. Yellow thorax with black spot between wings often faded but dense. Large. Protect at all costs. This species may be the savior of many lower elevation rare taxa.

Conclusions:

Based on preliminary observations to date, it appears that the same *Bombus* trio (*B. flavifrons*, *B. appositus* and likely also the nectar robbing *B. occidentalis) a*re visting/robbing Utah plants as in Colorado (but, and as hypothesized by Maloof, probably in a different mix here with perhaps *B. flavifrons* rather than *B. appositus* being of equal or greater importance, although variable based on elevation).

Conservation efforts associated with Wasatch Fitweed must take into consideration these *Bombus* species and their survival requirements.

Research/other needs:

Pollination ecology research is needed!

Genetic research seems to be desperately needed for this complex.
Subsp. *brachycarpa* and/or subsp. *brandegei* could be deserving of species rank.
Chromosome counts would e a basic start. Nothing more is known than Ownbey outlined in 1947.

Phenology: How long do plants live? When do they first start to flower?
How many seeds do fruits produce? What is normal? Ownbey and Maloof have made some initial comments and speculations, but the specifics are unknown for subsp. *brachycarpa*. My guess is that they are not necessarily fast growing and are long-lived.

Horticultural experiments with seed. Native plants are needed for all sorts of environments and not just dryscapes! What are its germination requirements?

Insect that is a parasite on Wasatch fitweed's fruit needs to be identified, and its impact studied.

". . . a biologically rich place is rich in relationships as well as in species."

Nabhan and Buchmann, *The Forgotten Pollinators*, 1998

Meow.