

**Observations on the comparative morphology of
Boechea horizontalis (Greene) Windham & Al-Shehbaz
and some of its nearest relatives**

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Report submitted to Rogue-Siskiyou National Forest, 20 May 2010 and revised 13 July 2010

OBJECTIVES OF WORK:

The project was designed to provide information to aid rare plant management within Fremont-Winema National Forest, Rogue River-Siskiyou National Forest, and Crater Lake National Park, and specifically to provide useful comparisons of plant morphology to be used to distinguish *Boechea horizontalis* (the Crater Lake rockcress previously named *Arabis suffrutescens* var. *horizontalis*) from *Boechea lemmonii* (*Arabis lemmonii*), *Boechea suffrutescens* (*Arabis suffrutescens* var. *suffrutescens*), and other rockcresses with which it could be confused. A second objective was to gather and evaluate available evidence of the Crater Lake rockcress occurring in California or parts of Oregon outside of Crater Lake National Park.

WORK PERFORMED:

Literature was reviewed for *Boechea horizontalis* and related taxa. The most recent publication revising this genus is *Flora North America*, Volume 7, 2010, *Boechea*, by I.A. Shehbaz and M. Windham, available on line at:
http://www.efloras.org/flora_page.aspx?flora_id=1; search on *Boechea*

Nomenclature used in this report follows this treatment by Al Shehbaz and Windham. See Table 1 for synonymy.

Herbarium specimens of *Boechea horizontalis* and related taxa were examined from the following herbaria: CAS, CLRA, JEPS, OSC, ORE, UC, USNH, WILLU, and WTU (See Table 2). Specimens at WSU were not reviewed as they were on loan to Windham. Only the type specimens of *Arabis horizontalis* (= *Boechea horizontalis*) were borrowed from USNH (the United States National Herbarium, at the Smithsonian, Washington DC) and examined (see Figure 1).

Field studies were made with Wayne Rolle on 17 July 2009 to Liao Rock and Cloud Cap populations of *Boechea horizontalis* and to the Crater Lake National Park herbarium. Numerous photographs were taken on this date, both of field specimens and of herbarium material. A selection of these photographs were used in figures 3-9.

RESULTS:

Comments on *Boechea horizontalis* populations

Based on the examination of herbarium specimens and the Crater Lake visit on 17 July 2009, it was determined that the most recent *Flora North America* (referred to hereafter as FNA) treatment of *Boechea* cited above (Al Shehbaz and Windham, 2010) accurately describes the *Boechea horizontalis* morphology and geographic range, except for three items. Their description of this species is as follows:

45. ***Boechea horizontalis*** (Greene) Windham & Al-Shehbaz, Harvard Pap. Bot. 11: 266. 2007.

Arabis horizontalis Greene, Leaflet Bot. Observ. Crit. 2: 74. 1910; *A. suffrutescens* S. Watson var. *horizontalis* (Greene) Rollins

Perennials; long-lived; (ces-pitose); apomictic; caudex woody. **Stems** usually 1 per caudex branch, arising from center of rosette, near ground surface or somewhat elevated on woody base, or 1-3.5 dm, sparsely pubescent proximally, trichomes short-stalked, 3-6-rayed, 0.1-0.3 mm, glabrous distally. **Basal leaves**: blade narrowly oblanceolate, 1-5 mm wide, margins entire, ciliate near petiole base, trichomes (simple), to 0.4 mm, surfaces densely pubescent, trichomes short-stalked, 3-6-rayed, 0.1-0.3 mm. **Cauline leaves**: 3-13, often concealing stem proximally; blade auricles 0.5-1.5 mm, surfaces of distalmost leaves glabrous. **Racemes** 5-32-flowered, usually unbranched. **Fruiting pedicels** horizontal to descending, straight or slightly curved downward, 4-11 mm, glabrous. **Flowers** divaricate-ascending at anthesis; sepals pubescent; petals lavender to purple, 5-6 × 1.5-2 mm, glabrous; pollen spheroid. **Fruits** horizontal or descending, not appressed to rachis, secund, straight, edges slightly undulate (not parallel), 2-4 cm × 2-3 mm; valves glabrous; ovules 40-54 per ovary; style 0.2-0.5 mm. **Seeds** uniseriate, 2-2.5 × 1.7-2 mm; wing continuous, 0.5-1 mm wide.

Flowering Jul-Aug. Dry pumice slopes; Oreg.

Morphological evidence suggests that *Boechea horizontalis* is an apomictic species that arose through hybridization between *B. lemmonii* and *B. suffrutescens* (M. D. Windham and I. A. Al-Shehbaz 2007). *Boechea horizontalis* is known only from the vicinity of Crater Lake in south-central Oregon.

Observed difference 1: The basal leaves of this taxon can be glabrate to glabrous, as seen in specimens from near Cloud Cap, shown in Figure 4.

Observed difference 2: The fruits and fruiting pedicels can be divaricately ascending as well as spreading, secund, to divaricately descending. See Figure 4.

Observed difference 3: The geographic range may extend into California, as evidenced by the CAS specimen L. Ahart 5356 (see Figure 2 and Table 2). I agree with the Al-Shehbaz and Windham annotation that this probably is a plant of *Boechea horizontalis*, but think that a field visit is warranted in order to check the field population for floral characters and variability of fruit position, etc.

Comparison of *Boechera horizontalis* morphology with similar *Boechera* species

The FNA treatment also accurately describes the morphological differences between taxa considered in this report. However, due to the scope of the treatment and large number of taxa considered in the FNA treatment, this author will present simplified comparisons and images that will facilitate Rare Plant Botanists to differentiate between *B. horizontalis* and similar taxa which occur in the same environments.

For example, excerpting from the FNA treatment, *B. horizontalis* is compared with *B. lemmonii* as follows:

- 44. Cauline leaves with auricles 0.5--1.5 mm; petals 1.5--2 mm wide; fruiting pedicels 4--11 mm; fruits 2--3 mm wide; ovules 40--54 per fruit; seeds 2--2.5 x 1.7--2 mm; sc Oregon
44. *Boechera horizontalis* (in part)
- 44. Cauline leaves with auricles to 0.5 mm; petals 1--1.5 mm wide; fruiting pedicels 2--6 mm; fruits 1.6--2.3 mm wide; ovules 28--44 per fruit; seeds 1.3--2 x 1--1.5 mm; widespread in w North America 52. *Boechera lemmonii* (in part)

but is not directly compared with the other taxa (Table 1) considered in this report. Even in the example above, it is not readily apparent which are the critical characters one uses in order to differentiate these two taxa, but in the field *B. horizontalis* and *B. lemmonii* are readily distinguished from one another.

Presented below are suggested morphological characters to compare in order to differentiate between the taxa considered in this study. These comparisons are presented in Table 3; photographic images taken from Crater Lake populations of all taxa considered in this report are shown in Figures 3 through 9.

Boechera horizontalis* compared with *Boechera suffrutescens

The first comparison is logical, in that *B. horizontalis* was considered a subspecies of *B. suffrutescens* (see Table 1). Although the two taxa have similar leaf and fruit shapes, the two taxa can be readily distinguished by the elongate branching caudex found in *B. suffrutescens* (Figure 6b), but absent in *B. horizontalis* (Figure 3b, 4a, 4c, 5c), and by the "horizontal", or at least near-horizontal fruit position in *B. horizontalis* compared with that of *B. suffrutescens* (Figures 3f and 2g compared with Figures 6a, 6b, and 6d).

Boechera horizontalis* compared with *Boechera retrofracta

Boechera retrofracta is not represented in this report with images as it is easily distinguished from *B. horizontalis*: the former has pendant fruits (usually straight and numerous)

arising from strictly reflexed pedicels. In contrast *B. horizontalis* fruits are less numerous, broader, and their position is spreading ascending to horizontal or spreading descending.

Boechea horizontalis* compared with *Boechea lemmonii

It would be difficult to confuse these two taxa: fruits *Boechea horizontalis* (Figures 3a, 3f, and 3g) are wider, straighter, and usually less numerous compared with those of *B. lemmonii* (Figure 7a). In addition the leaves of *B. horizontalis* (Figures 3c, 3d, 4c, and 5b), while varying from hairy in the Llao Rock populations to glabrate in the Cloud Cap populations, are never whitish hairy with the fine white vestiture typically seen in the leaves of *B. lemmonii* (Figure 7b).

Boechea horizontalis* compared with *Boechea lyallii* and *Boechea platysperma

Boechea lyallii and *B. platysperma* each are very similar in form to *B. horizontalis* with respect to overall aspect, leaf shape, vestiture, and fruit shape, but *B. lyallii* and *B. platysperma* have ascending to erect fruits and pedicels (Figures 8b and 9d respectively). It is difficult to distinguish between *Boechea lyallii* and *B. platysperma* except for the broader fruits in *B. platysperma* (Figures 9e) and the relatively showy pink flowers of *B. lyallii* (Figure 5a).

Some plants of *Boechea horizontalis* were seen with spreading to ascending fruits (see Figure 4b). These may be distinguished from *Boechea lyallii* plants by the larger flowers with broader petal blades found in *B. lyallii* (see Figure 8a). They may be distinguished from plants of *B. platysperma* by the broader fruits found in *B. platysperma* (see Figure 9e).

SUMMARY AND COMMENTS:

Based on examination of herbarium specimens and especially of plants studied in the field, it is concluded that *Boechea horizontalis* is a valid taxon, and very rare: known only from the vicinities of Crater Lake and Mount McLoughlin. The only specimens seen of this taxon outside of this region was the Ahart 5356 collection (see Figure 2 and Table 2); I recommend field checks of this population, and recommend further protection of the Crater Lake habitat and study of *Boechea horizontalis* genetic background.

It has been proposed that *Boechea horizontalis* is of hybrid origin, and this hypothesis is now supported by Windham genetic research using microsatellites (personal communication via Wayne Rolle). Windham's comments are included below:

1) We got true *B. horizontalis* (similar to the type collection) at three locations: Llao Rock, Cloudcap, and Victor View. The microsatellite analyses reveal that all are apomictic triploid hybrids (as Ihsan and I had predicted based on pollen), but the parentage isn't quite what we expected. In Windham & Al-Shehbaz (2007), we hypothesized that *B. horizontalis* contained genomes from *B. suffrutescens* and *B. lemmonii*; it turns out that it also contains a genome derived from *B. lyallii*. Looking back at the morphology, this makes a lot of sense. Thus, *B. horizontalis* joins the ever expanding number of trigenomic triploids (a class of hybrids we originally thought were uncommon).

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2) The other "form" of *B. horizontalis* (the nearly glabrous type with more ascending fruits) that you pointed out along the access road to Cloudcap is very interesting. This turns out to be an apomictic diploid(!) hybrid between *B. suffrutescens* and *B. lyallii*...again, congruent with morphology. A genetically identical plant was collected by Wynd in 1929, suggesting that this unnamed taxon is capable of reproducing itself. Looking at range-wide microsatellite variability in the parents, it's pretty clear that this thing originated in the vicinity of Crater Lake...in fact, our collections of *B. lyallii* (Llao Rock) and *B. suffrutescens* (Rim Drive overlooking Kerr Valley) contain nearly all the alleles found in the hybrid.

3) Integrating items 1 and 2 above, the origin of a trigenomic triploid (Item 1) basically requires (predicts) the existence of a digenomic diploid hybrid (Item 2), which produces the trigenomic taxon by hybridizing with an unrelated sexual diploid. In the case of *B. horizontalis*, the unnamed diploid hybrid from Cloudcap could be a "stepping stone" that led to the formation of the triploid (by hybridizing with *B. lemmonii* which, interestingly, is present at Cloudcap). As with all trigenomics, however, there are three possible digenomic "stepping stones" leading to *B. horizontalis*: a) *suffrutescens* x *lyalli* [the taxon you found], b) *suffrutescens* x *lemmonii*, and 3) *lemmonii* x *lyallii*. The microsatellite data clearly indicate that the genotype of *suffrutescens* x *lyallii* that we have in hand was NOT involved in the origin of *B. horizontalis*. So, we still have some work to do (more intensive DNA sampling of local plants) with regard to the genomic diversity of Crater Lake *Boechea* and the origin of *B. horizontalis*.

My own hesitation at describing apomictic *Boechea* species or infraspecific taxa is that there are many small localized populations which may represent hybrid clones such as described above. I observed this for many taxa in my research (Vorobik, 1985. *Hybridization and reproductive isolation between sympatric Arabis (Cruciferae) in southwestern Oregon*. PhD Dissertation. University of Oregon, Eugene.), and of specimens or photographs which have been sent to me for determination. It would seem imprudent to name all of these populations, especially if each commanded Federal protection due to its small geographic range. I will leave this problem for others to weigh in on.

Table 1. Scientific Names, authorities, and latest publication for cited name of *Boechera* taxa considered for this report.

Taxonomy according to Shehbaz, I.A. and M. Windham, Flora North America, Volume 7, 2010, available on line (3/14/2010) at:
http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=104152

Boechera horizontalis (Greene) Windham & Al-Shehbaz, Harvard Pap. Bot. 11: 266. 2007

Previous name: *Arabis suffrutescens* var. *horizontalis*

Boechera lemmonii (S. Watson) W. A. Weber, Phytologia. 51: 370. 1982.

Previous name: *Arabis lemmonii*

Boechera lyallii (S. Watson) Dorn, Vasc. Pl. Wyoming ed. 3. 376. 2001.

Previous name: *Arabis lyallii*

Boechera platysperma (A. Gray) Al-Shehbaz, Novon. 13: 388. 2003.

Previous name: *Arabis platysperma*

Boechera retrofracta (Graham) Á. Löve & D. Löve, Taxon. 31: 125. 1982.

Previous name: *Arabis holboellii* var. *retrofracta*

Boechera suffrutescens (S. Watson) Dorn, Brittonia. 55: 3. 2003.

Previous name: *Arabis suffrutescens* var. *suffrutescens*

Table 2. Herbarium records, herbaria where *Boechea* specimens were examined, and notes on other location data.

Part I. Herbaria where specimens were examined.

| Herbarium Acronym | Institution | Comments |
|-------------------|---|---|
| OSC, ORE, WILLU | Oregon State University | All specimens of <i>Arabis</i> and <i>Boechea</i> were examined as part of Oregon Flora checklist. |
| UC/JEPS | University of California, Berkeley | All specimens of <i>Arabis</i> and <i>Boechea</i> were examined; none were found of <i>Boechea horizontalis</i> . |
| CAS | California Academy of Science, San Francisco | All specimens of <i>Arabis</i> and <i>Boechea</i> were examined; data listed below. |
| CLRA | Crater Lake National Park herbarium, Crater Lake. | All specimens of <i>Arabis</i> and <i>Boechea</i> were examined; data listed below. |
| WSU | Washington State University, Pullman | All collections on loan to Windham. Not examined. |
| WTU | University of Washington, Seattle. | All collections were annotated by Vorobik in 1985; no <i>Boechea horizontalis</i> . |

Part II. Specific herbarium records.

| Taxon | Accession Number | Collector Number | Date | Locality | Stems | Leaves | Flowers | Fruit description | Fruit length | Fruit Width | Fruiting Pedicel |
|--|------------------|--------------------------------|-------------|--|------------|--|---------|--------------------------------|---------------------------|-------------|------------------------------------|
| <i>Arabis suffrutescens</i> var. <i>suffrutescens</i> | CAS 748150 | T.W. Nelson & J.P. Nelson 6094 | 17-Jul-1980 | CA. Sisk. Co: China Mtn quad | 36 cm | 9-12 mm, glab 10-28 mm, pub and cil w/simp to forked or stellate hrs | none | glab, strong midnerve below | (1.0) 2.3-4.3 cm | 2.5-4.0 mm | 5-9 mm, glab |
| <i>Arabis suffrutescens</i> var. <i>suffrutescens</i> | CAS 888002 | L. Ahart sn | 18-Jul-1979 | CA. Plum Co: 1 mi W of Pilot Rock | 23-32 cm | | none | glab, strong midnerve below | 23-48 mm | 2.8-3.0 mm | 6-14 mm, glab |
| <i>Arabis suffrutescens</i> var. <i>suffrutescens</i> | CAS 250967 | J.T. Howell 13632 | 29-Jul-1937 | CA. Sisk & Trin Co: Scott Mtn. | 16-39 cm | 10-15 mm, cil w/stell hrs to glab | none | glab, strong midnerve below | 39-54 mm, styles<.5 mm | 2.6-3.2 mm | 4-5 mm, glab |
| <i>Arabis suffrutescens</i> var. <i>suffrutescens</i> | CAS 376113 | P.A. Munz 16636 | 18-Jul-1951 | CA. Teha/Trin Co: n slope Yolla Bolly pk | 28-28.5 cm | 3-30 mm, ciliate with stell hrs | none | glab, strong midnerve below | 20-46 mm | 2.8-3.0 mm | 6-9 mm, glab |
| <i>Arabis suffrutescens</i> var. <i>suffrutescens</i> | CAS 886998 | L. Ahart sn | 20-Jul-1975 | CA. Sier/Plum Co: Nr. Mt. Etna | 15-22 cm | 10-14 mm, pub & ciliate, becoming glabrate | none | glab, strong midnerve below | 28-47 mm | 2.5-2.8 mm | 4-6 mm, glab |
| <i>Arabis suffrutescens</i> var. <i>suffrutescens</i> | CAS 797518 | J.T. Howell 50117 | 31-Jul-1973 | CA. Plum Co: Thompson Pk | 15.5-37 cm | 11-18 mm, ciliate to glab | none | glab, strong midnerve below | 37-62 mm | 2.8-3.1 mm | 6-14 mm, glab |
| <i>Arabis suffrutescens</i> var. <i>suffrutescens</i> | CAS 572535 | G. H. True 2142 | 30-Jun-1965 | CA. Nev. Co: W of Truckee | 43-49 cm | 18-32 mm, stell/cill to glab | none | glab, strong midnerve below | 52-72 mm | 2.8-3.0 mm | 9-13 mm, glab styles ~1.3 mm |
| <i>Arabis suffrutescens</i> var. <i>suffrutescens</i> | CAS 217821 | J.T. Howell 12537 | 10-Jul-1934 | CA. Lassen Co: Harvey Valley & Patterson Flats | 32-41 cm | 8-22 mm, glab | none | glab, strong midnerve below | 50-61 mm | 2.9-3.0 mm | 7-12 mm |
| <i>Arabis suffrutescens</i> var. <i>suffrutescens</i> | CAS 177674 | M.E. Peck 9685 | 28-Jul-1920 | OR. Crook Co: nr Paulina Lk. | 21-33 cm | 14-22 mm, cili/stell; to glab | none | glab, strong midnerve below | 42-51 mm | 2.8-3.2 mm | 6-11 mm, glab |
| <i>Arabis suffrutescens</i> var. <i>suffrutescens</i> | CAS 2257341 | M.E. Peck 17616 | 12-Jul-1933 | OR. Wallowa Co: nr mouth of Battle Ck. | 21-28 cm | 11-37 mm, glab to gland dotted? | none | glab, strong midnerve below | 41-63 mm | 3.0-4.0 mm | 5-12 mm, glab |
| <i>Arabis suffrutescens</i> var. <i>suffrutescens</i> | CAS 250989 | J.W. Thompson 13121 | 3-Jul-1936 | OR. Klamath Co: Lake of the Woods | 30-47 cm | 12-25 mm, glab | none | glab, strong midnerve below | 31-42 mm | 1.8-2.2 mm | 7-10 mm |

Table 2. Herbarium records, herbaria where specimens where *Boecheera* specimens were examined, and notes on other location data, continued.

Part II. Specific herbarium records, continued.

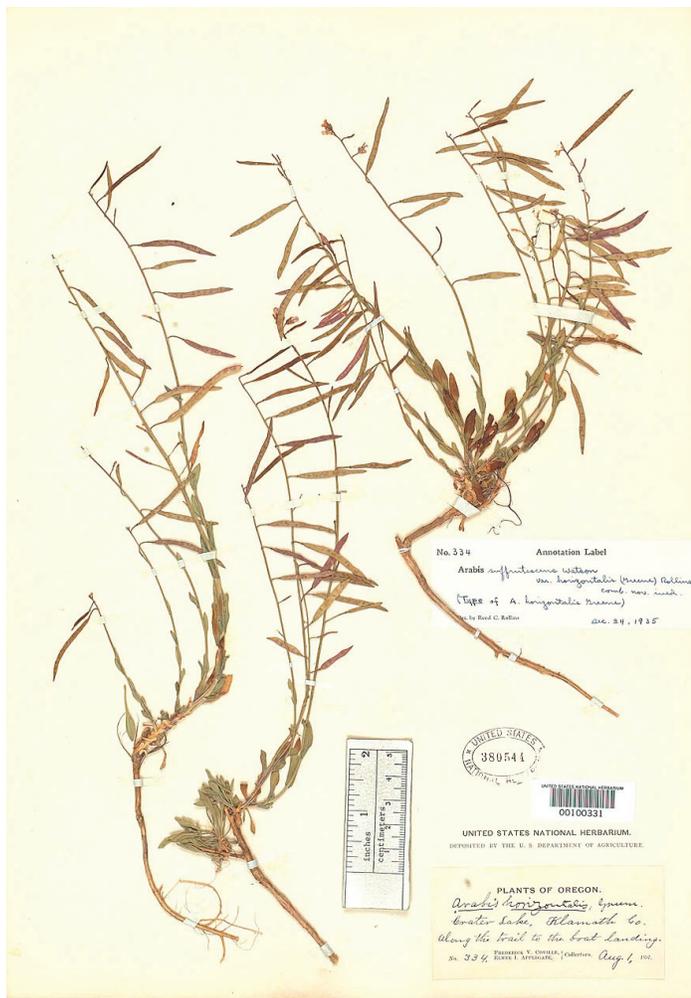
| Taxon | Accession Number | Collector Number | Date | Locality | Stems | Leaves | Flowers | Fruit description | Fruit length | Fruit Width | Fruiting Pedicel | |
|--|-----------------------------|---|-------------|--|-----------|--|-----------------------------------|-----------------------------|--------------|---------------------------|------------------|--|
| Note: <i>Arabis suffrutescens</i> var. <i>horizontalis</i> = <i>Boecheera horizontalis</i> | | | | | | | | | | | | |
| <i>Arabis suffrutescens</i> "var. <i>horizontalis</i> " | CAS 372340 | J.T. Howell 27713 | 28-Jul-1951 | CA: Plumas Co: Eureka Peak, 7200-7400 ft | | | | | | | | |
| Vorobik comment: | CAS 372340 | J.T. Howell 27713 | 28-Jul-1951 | mixed with plant that has been annotated by JTH as typical <i>Boecheera suffrutescens</i> ; looks like typical <i>Boecheera suffrutescens</i> to me [Vorobik] | | | | | | | | |
| <i>Arabis suffrutescens</i> var. <i>horizontalis</i> | CAS 108606 | A.A. Heller 13040 | 20-Jul-1918 | OR: Crater Lk NP: Mt Garfield | 5-8.5 cm | 5-10mm, stellate pubesc | none | glab, strong midnerve below | 22-39 mm | 2.2-2.8 mm,horiz | 4-7 mm, glab | |
| <i>Arabis suffrutescens</i> var. <i>horizontalis</i> | CAS 188441 | H.M. Hall 11972 | 16-Jul-1924 | OR: Crater Lk NP: Llao Rock, summit | 4.5-20 cm | 7-24 mm, finely stellate | sepals 4mm, petals 7-8mm, magenta | glab, strong midnerve below | 18-35 mm | 2.5-3.0 mm, horiz | 3-6 mm, glab | |
| <i>Arabis suffrutescens</i> var. <i>horizontalis</i> | CAS 5356 | L. Ahart 5356 | 8-Jul-1986 | CA: Plumas Co: Near an open bare serpentine area, ca. 1 mi NW of Pilot Peak, ca> 14 mi NE of La Porte. Red Fir Forest. On bare loose broken rock near cliffs. Uncommon and inconspicuous. 6400 ft. Flowers purple | 8-29 cm | 4-26 mm, stellate w/hrs more like A. s.s | none | glab, strong midnerve below | 28-41 mm | 2.1-2.7 mm, asc to spread | 4-6 mm | this population should be checked in the field |
| <i>Arabis suffrutescens</i> var. <i>horizontalis</i> | CLRA 4113 | E.I. Applegate 11885 | 9-Sep-1938 | OR: Near top of Garfield, Crater Lake National Park. | | | | glabrous, strong midnerve | | | | |
| <i>Arabis suffrutescens</i> var. <i>horizontalis</i> | CLRA 4111 | E.I. Applegate 11761 | 4-Aug-1938 | OR: Near top of Garfield, Crater Lake National Park. | | | | | | | | |
| <i>Arabis suffrutescens</i> var. <i>horizontalis</i> | ORE 35538 | Lyle Wynd 1547 | 17-Jul-1929 | Data not available: specimens examined when I annotated ORE/OSC/WILLU for Oregon Flora checklist | | | | | | | | |
| <i>Arabis suffrutescens</i> var. <i>horizontalis</i> | ORE 35539 | Lyle Wynd 1545 | 17-Jul-1929 | Data not available: specimens examined when I annotated ORE/OSC/WILLU for Oregon Flora checklist | | | | | | | | |
| Part III. Other records. | | | | | | | | | | | | |
| <i>Arabis suffrutescens</i> var. <i>horizontalis</i> | WSU | J.W. Thompson [no coll. No.] | 13-Jul-1936 | Oregon: Klamath Co. Lake of the Woods South, Lake of the Woods North, Brown Mountain, Mount McLoughlin. | | | | | | | | |
| Vorobik comment: | | NOT OBSERVED: specimens on loan. | | MIGHT be <i>Boecheera horizontalis</i> as specimens seen from this general locality was determined by Vorobik (see next record) to be <i>Boecheera horizontalis</i> . HOWEVER, Elevation much lower here (Rolle, personal communication: 5,000-6,000 ft), so this collection most likely not <i>Boecheera horizontalis</i> | | | | | | | | |
| <i>Arabis suffrutescens</i> var. <i>horizontalis</i> | Oregon Flora Project Record | Wayne Rolle; Samples determined by Vorobik as <i>Boecheera horizontalis</i> . | 15-Aug-1990 | OR: Jackson County. Mount McLoughlin. Latitude 422656N, Longitude 1221832W. 8,000 feet elevation. | | | | | | | | |

Table 3. General comparison of characters for taxa that might be confused with *Boechera horizontalis*.

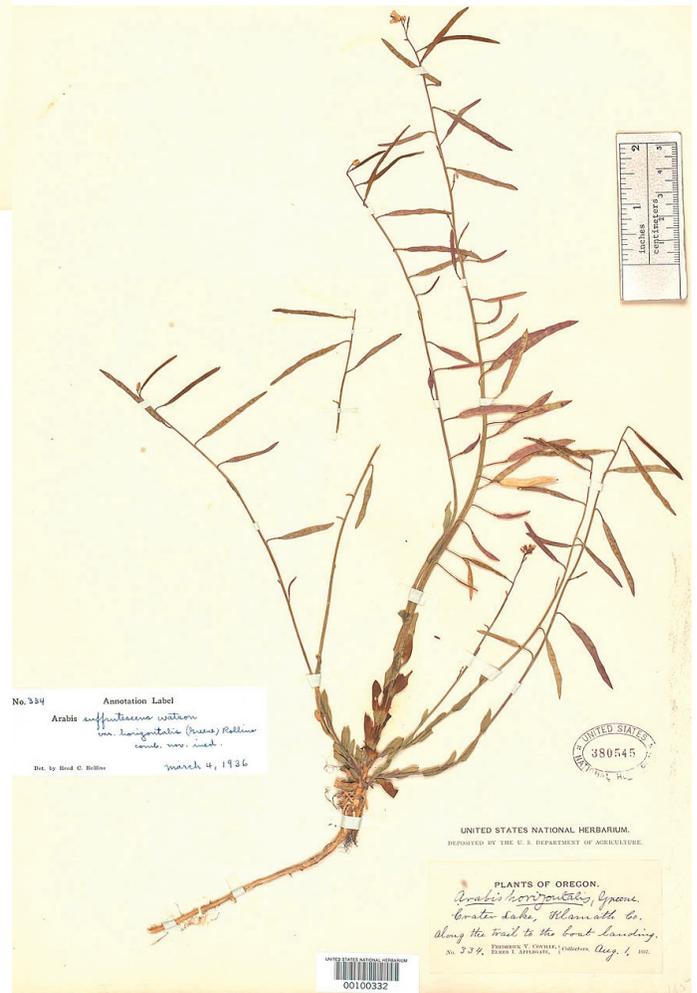
| Taxon | Overall Height* | Caudex | Basal Leaves | Fruit Position | Fruit Width* | Fruiting Pedicel |
|-------------------------------|------------------------------------|-----------------------------------|--|---|-----------------------------|---|
| <i>Boechera horizontalis</i> | short to medium (15-30 cm) | short branches or none | pubescent with short dendritic hairs or glabrate to glabrous | spreading ascending to horizontal or spreading descending | medium to broad (2-3 mm) | spreading ascending to horizontal or spreading descending |
| <i>Boechera suffrutescens</i> | medium to tall (15-45 cm) | long branched, well developed | usually glabrate to glabrous | descending | medium to broad (2-4 mm) | strictly reflexed to arched downward |
| <i>Boechera retrofracta</i> | medium to tall (15-45 cm) | short branches or none | usually densely pubescent with short dendritic hairs | descending | narrow (<2 mm) | strictly reflexed |
| <i>Boechera lemmonii</i> | most typically short (15-25 cm) | often with many short branches | usually densely pubescent with short dendritic hairs | spreading ascending to horizontal or spreading descending | narrow (<2 mm) | spreading ascending to horizontal or spreading descending |
| <i>Boechera lyallii</i> | most typically short (15-25 cm) | short branches or none | pubescent with short dendritic hairs to glabrous | ascending to spreading | medium (usually ~2 mm) | ascending to spreading |
| <i>Boechera platysperma</i> | short to medium (15-30 cm) | short branches or none | pubescent with short dendritic hairs to glabrous | ascending to spreading | medium to broad (2-4 mm) | ascending to spreading |

*Note: measurements here are approximate.

Figure 1. Images of *Boechea horizontalis* type specimens.

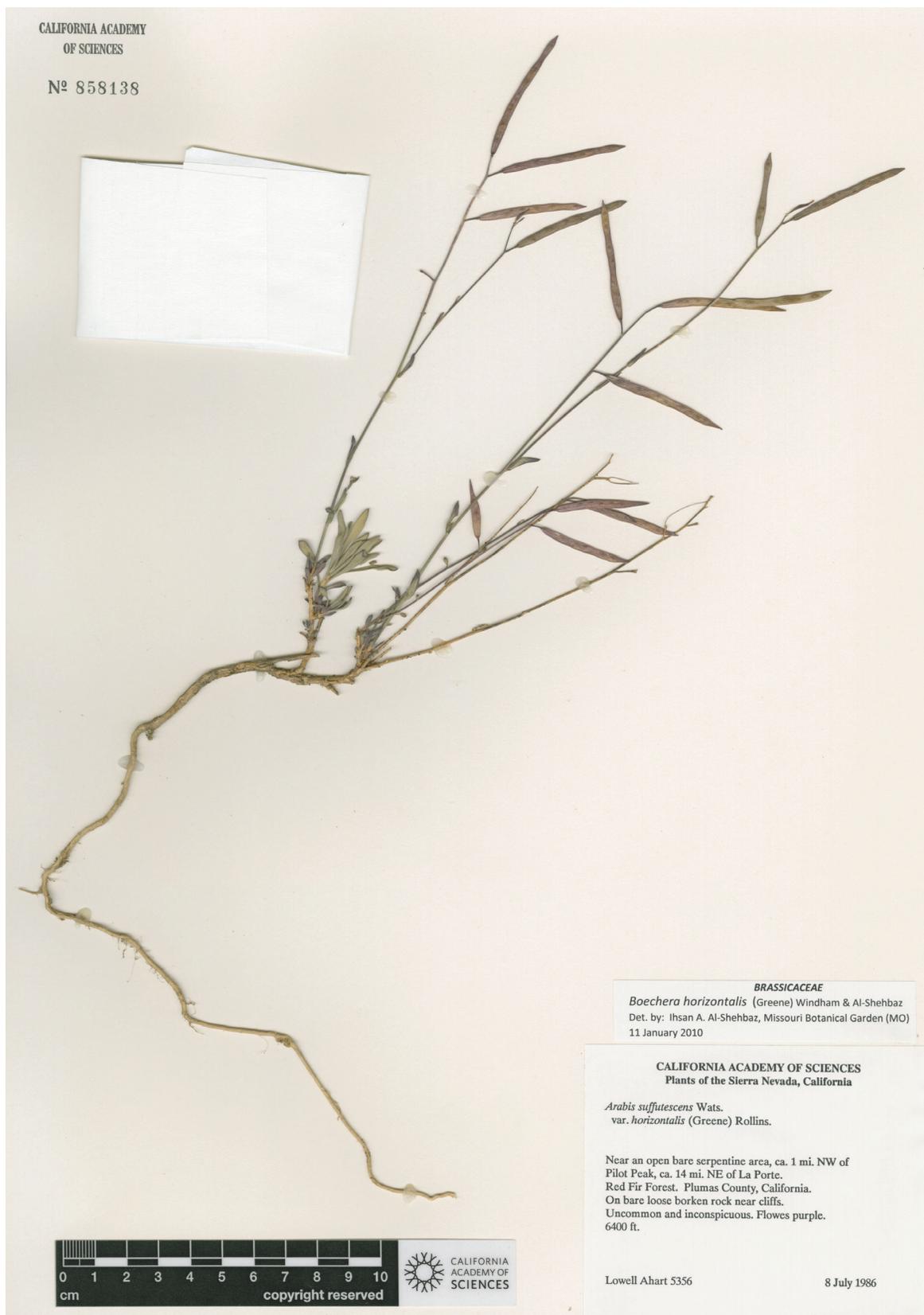


1a. HOLOTYPE of *Arabis horizontalis* Greene. USNH 380544. Collected by Coville and Applegate, 334, Crater Lake, Klamath County, Oregon, along trail to boat landing. Currently recognized as *Boechea horizontalis* (Greene) Windham & Al-Shehbaz.



1b. ISOTYPE of *Arabis horizontalis* Greene. USNH 380545.

Figure 2. California Academy of Sciences collection of *Boechea suffrutescens* from “bare serpentine area, ca. 1 mi. NW of Pilot Peak, ca. 14 mi. NE of La Porte. Red Fir Forest. Plumas County, California. On bare, loose, [broken] rock near cliffs. Uncommon and inconspicuous. Flowers purple. 6400 ft. Lowell Ahart 5356. 8 July 1986.”



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BRASSICACEAE

Boechea horizontalis (Greene) Windham & Al-Shehbaz
Det. by: Ihsan A. Al-Shehbaz, Missouri Botanical Garden (MO)
11 January 2010

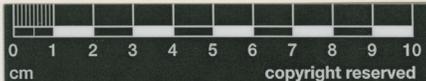
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Plants of the Sierra Nevada, California

Arabis suffrutescens Wats.
var. *horizontalis* (Greene) Rollins.

Near an open bare serpentine area, ca. 1 mi. NW of
Pilot Peak, ca. 14 mi. NE of La Porte.
Red Fir Forest. Plumas County, California.
On bare loose broken rock near cliffs.
Uncommon and inconspicuous. Flowers purple.
6400 ft.

Lowell Ahart 5356

8 July 1986



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Figure 3. Images of *Boechea horizontalis* from Llao Rock, Crater Lake National Park, by L. Vorobik, 17 July 2009.



3f. (above)

3g. (below)



3a.



3e.



3b.



3c.

3d.



3a. Plant habit: bottom of plant. 3b. Plant habit: top of plant. 3c. Basal and cauline leaves. 3d. Basal leaf with vestiture of fine dendritic hairs. 3e. Flowers. 3f. Infructescence. 3g. Fruits.

Figure 4. Images of *Boechea horizontalis* on Rim Drive, 12.8 miles from Park Headquarters towards Cloud Cap, Crater Lake National Park, by L. Vorobik, 17 July 2009.



4b.



4d.



4e.



4a.



4c.

4a. Plant habit: small plant with horizontal fruits. 4b. Inflorescence with ascending fruits. 4c. Glabrous to glabrate basal leaves. 4d. Flowers and developing fruits. 4e. Auriculate cauline leaf.

Figure 5. Images of *Boechea horizontalis* on Rim Drive at Cloud Cap Parking Area, Crater Lake National Park, by L. Vorobik, 17 July 2009.



5c.



5b.



5a.

5a. Plant habit showing infructescence with horizontal to slightly descending fruits. 5b. Basal leaves with dense pubescence. 5c. Lower stems and flower.

Figure 6. Images of *Boechea suffrutescens* from Crater Lake National Park, by L. Vorobik, 17 July 2009.



6b. (top left)

6a.

6c. (middle left)

6d. (bottom left)

6a. Plant habit. 6b. Plant habit: stems more reclined; plant with long caudex branches. 6c. Basal and cauline leaves with portion of long caudex branch of plant pictured in 6b. 6d. Fruits.

Figure 7. Images of *Boechea lemmonii* from Cloud Cap, Crater Lake National Park, by L. Vorobik, 17 July 2009.

7a.



7b.



7a. Fruiting stems. 7b. Basal leaves.

Figure 8. Images of *Boechea lyallii* from Cloud Cap, Crater Lake National Park, by L. Vorobik, 17 July 2009.

8a.



8b.



8a. Fruiting stems with flowers in background. 8b. Lower portion of plant with basal and cauline leaves.

Figure 9. Images of *Boechea platysperma* from Llao Rock and Cloud Cap, Crater Lake National Park, by L. Vorobik, 17 July 2009.



9a.



9c.



9d. (below)

9e. (above)

9b.



9a. Plant with a few flowers and immature fruits. 9b. Lower portion of plant in 9a with basal and cauline leaves. 9c. Flowers from plant in 9a. 9d. Plant with mature fruits. 9e. Fruits from plant in 9d.