ARTEMISIA ESTESII (ASTERACEAE), A NEW DIPLOID SPECIES OF THE *ARTEMISIA LUDOVICIANA* COMPLEX IN THE PACIFIC NORTHWEST (U.S.A.)

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ABSTRACT

The new species described here, **Artemisia estesii,** belongs to the *Artemisia ludoviciana* Nutt. species' group in the Pacific Northwest. It was shown by J.R. Estes (1968a, 1969) to be a diploid member of an otherwise polyploid hybrid complex, with most of its related species and subspecies occurring at the tetraploid and hexaploid levels. *Artemisia estesii* is recognized by its underground and emergent, over-wintering, basal shoots, which are homologs of the elongate, underground rhizomes found in other herbaceous *Artemisia* species. Its regularly lobed leaf blades, with usually a broad rachis, differ from subspecies of *A. ludoviciana* in eastern Oregon. It occupies a narrow zone of streambank vegetation along the central Deschutes River and extends eastward along the lower Crooked River. Disjunct populations are known from Wheeler County and Lake County.

RESUMEN

Se describe aquí una nueva especie **Artemisia** que pertenece al grupo de especies de *Artemisia ludoviciana* Nutt. En el noroeste del Pacífico. J.R. Estes (1968a, 1969) mostró que es un miembro diploide de un complejo poliploide de híbridos, con la mayoría de sus especies y subespecies en los niveles tetraploides y hexaploides. **Artemisia estesii** se reconoce por sus vástagos invernantes basales subterráneos y emergentes, que son homólogos de los rizomas elongados subterráneos que se encuentran en otras especies herbáceas de *Artemisia*. Sus láminas foliares regularmente lobadas, usualmente con un raquis ancho, difieren de la subespecie de *A. ludoviciana* en el este de Oregón. Ocupa una zona estrecha de vegetación rivereña a lo largo del río Deschutes central y se extiende hacia el este a lo largo de la parte inferior del río Crooked. Se conocen poblaciones disyuntas de Wheeler County y Lake County.

INTRODUCTION

In the taxonomic treatment of *Artemisia* by Hall and Clements (1923), the 5 Pacific Northwest species assigned here to the *Artemisia ludoviciana* complex were classified as subspecies of *Artemisia vulgaris* L. *Artemisia vulgaris* subsp. *vulgaris* itself is native to the Old World and is introduced and widely established as a weed in disturbed sites in North America (Shultz 2006). Of the 14 native New World subspecies recognized by Hall and Clements, 7 occur in the Pacific Northwest and are now treated, at the species or subspecies level, as members of a group centered on *Artemisia ludoviciana* Nutt. A monograph of these taxa was published by David D. Keck (1946), whose classification, with only minor modifications, is widely accepted in current floras.

Biosystematic information was available to Keck (1946) in the form of transplant experiments (Clausen et al. 1940) and chromosome counts; however, his classification was principally derived from a review of herbarium specimens. A cytological and hybridization study of all the northwestern taxa was performed by Estes (1968a), who made chromosome counts and did crossing experiments between taxa of the same or different chromosome numbers. Keck (1946) had shown that the basic haploid number in *A. ludoviciana* and relatives is $n = 9$, and that diploid, tetraploid, and hexaploid numbers were present in his sample of taxa. These included *A. suksdorfii* Piper, $n = 9$, *A. ludoviciana* subsp. *ludoviciana* and subsp. *incompta* (Nutt.) D.D. Keck, $n = 18$, and *A. douglasiana* Besser and *A. tilesii* Ledeb. subsp. *unalaschcensis* (Besser) Hultén, $n = 27$. Estes (1968b) verified Keck's counts and added the following haploid numbers: *A. michauxiana* Besser, $n = 9, 18$, *A. lindleyana* Besser, $n = 18$, *A. ludoviciana* subsp. *candicans* (Rydb.) D.D. Keck, $n = 18, 27$, *A. douglasiana*, $n = 18$, *A. tilesii* subsp. *unalaschcensis*, $n = 18$, and a single population assigned to *A. douglasiana*, $n = 9$.

Taxa of the *Artemisia ludoviciana* complex are mostly widespread, and their morphological variation is marked. The characteristics of greatest use in taxonomy are size of parts, shapes of leaf blades, and the quality

and quantity of indument. *Artemisia estesii* is characterized, in addition, by erect, emergent, overwintering basal shoots (Fig. 4), unlike the widely spreading underground rhizomes found in most other taxa.

DESCRIPTION

Artemisia estesii K.L. Chambers, sp. nov. (**Figs. 1–2, 4–5**). TYPE: OREGON. DESCHUTES CO.: Cline Falls State Park, where Hwy. 126 crosses the Deschutes River between Sisters and Redmond; marshy edges of river, with *Typha latifolia, Ranunculus repens, Scirpus microcarpus, Euthamia occidentalis, Solanum dulcamara, Rorippa* sp., *Polygonum* sp.; in clonal clumps scattered in lush herbaceous vegetation; height 1–1.5 m, 7 Aug 1977, *K.L. Chambers 4408* (HOLOTYPE: OSC 249050; ISOTYPES: OSC 249051, ORE 109601, 109602, BRIT, MO, NY, UC, WTU). Chromosome number: *n* = 9 (*J.R. Estes 8*, OSU 243254).

Plants perennial, clump-forming, with spreading, scaly basal shoots whose tips arch upward and emerge from the soil 1–3 cm, overwinter, and produce the succeeding year's stems. **Stems** 5–15(–40, fide Brounstein 1996) dm, erect, densely white-floccose to tomentose, sometimes glabrate near the base, leafy throughout, usually unbranched below inflorescence, cauline branches, if any, slender. **Leaves** alternate, to 9 cm long, blades ± similar in shape throughout (Figs. 1–2), basals reduced, distals lanceolate, entire, sometimes with a pair of linear stipules at the base, blades bicolor, abaxially densely white floccose-tomentose, adaxially lightly tomentose to glabrous, the central portion of principal leaves (excluding lobes) lanceolate or oblanceolate, (5–)10–30 mm wide, (2–)3–6(–7)-lobed or toothed (Figs. 1–2), lobes acute, linear to triangular, to 4 cm long, 2–10 mm wide, sometimes reduced to teeth 1–5 mm long, margins entire or denticulate. **Inflorescence** 4–30+ cm, branched or unbranched, branches ascending, simple or rebranched, heads racemose or sub-spicate on main stem and branches, peduncles 0–4 mm, floccose-hairy. **Involucre** campanulate, 1.5–4 mm high, 1.5–4 mm diam., phyllaries linear-lanceolate, carinate, lightly tomentose, the outer gradually shorter in several imbricate series, the inner with membranous tip, herbaceous or with green midrib and membranous margins, apex acute or obtuse. **Florets** 20–40, equaling or exceeding involucre, disciform, the outer pistillate, the inner bisexual, corollas 1.5–2.25 mm, tube minutely glandular, throat glabrous, lobes recurved, anther tips slightly exserted from corolla, style branches recurved, exserted laterally from mouth of corolla.

Habitat limited to herbaceous or shrubby borders of riverbanks and lakes near or at high-water mark (see following section). Figure 5 is a map of the known distribution of *A. estesii*.

Etymology.—Named in honor of James R. Estes, the discoverer of the taxon.

Suggested Common Name.—Estes' Artemisia.

DISCUSSION

In his doctoral dissertation, Estes (1968a) referred to this taxon with an unpublished new species epithet; in his later publication (Estes 1969) he assigned it to *Artemisia douglasiana*, giving this species three chromosome levels: 2n = 18, 36, and 54. Keck (1946, p. 459) cited the collection *Leiberg 837,* from "Prineville Crook Co.," as *A. douglasiana* from the range of *A. estesii*. This is vouchered by ORE 88040, on which the label states only "Sand dunes in Crooked River, Or." The specimen likely belongs to *A. estesii,* but the cauline leaves are too dried and shriveled to verify its identification. Keck considered *A. douglasiana* to be "rare east of the Cascadean-Sierran axis except about Lake Tahoe where it extends slightly into Nevada." Ornduff and French (1960) probably referred to *A. estesii* when they remarked on the example of *A. douglasiana* as a western Oregon species that they found "growing along the Deschutes River in Jefferson County" (p. 229; *D.H. French 1496,* bank of Deschutes River, 0.5 mi S of Hwy. 26 bridge, UC). The most north-eastern probable location is 15 mi. E of Mitchell, Wheeler Co., *R.C. Andrews 701,* ORE 88123 (Fig. 5), which has the small pollen diameter characteristic of *A. estesii*. Shultz (2006) did not acknowledge any chromosome numbers in *A. douglasiana* except hexaploid, overlooking the publications by Estes of tetraploid and diploid numbers. Ward (1960) also considered *A. douglasiana* to be a hexaploid species.

In previous studies of polyploid species complexes, for example in *Symphyotrichum* (previously *Aster;* Dean & Chambers 1983, Allen et al. 1983), our practice has been to assign separate species status to the diploid entities that form the base of a polyploid complex, even if the taxa at higher chromosome levels are difficult to

Fig. 1. *Artemisia estesii*. Holotype, OSC.

Fig. 2. *Artemisia estesii*. Deschutes Co., Cline Falls State Park., *K.L. Chambers 2938,* cultivated at Corvallis, June 10, 2000.

separate morphologically due to interspecific hybridization. In the example of *Artemisia estesii,* the diploids of Central Oregon are easily recognizable by their erect, exposed, overwintering basal shoots (Fig. 4) and their broad, ± regularly lobed leaf blades, especially evident from base to apex of non-flowering stems (Fig. 2). These features distinguish them from other members of the *A. ludoviciana* complex in this region, which usually have subterranean, laterally extending rhizomes and leaves, if lobed, having a narrower central axis (Fig. 3). According to Brounstein (1996, quoting G. Sturtz, ined.), *A. estesii* also differs biochemically from other Northwest *Artemisia* taxa in being high in thujones, comparable to the oil of the European species *A. absinthium* L. (see Tucker et al. 1993). *Artemisia lindleyana* is known only as a tetraploid in Oregon; a single diploid count was reported for a plant of *A. lindleyana* from along the Columbia River in southern British Columbia (Taylor & Brockman 1966). Lesica (2012) treated *A. lindleyana* as a subspecies of *A. ludoviciana.* Other diploid members of this complex given species status by Keck (1946) are *A. michauxiana, A. suksdorfii,* and *A. carruthii* Wood ex Carruth, a species from farther east in North America.

Herbarium specimens provide data on plant taxa associated with *Artemisia estesii.* Taxa include: *Carex utriculata, Cicuta douglasii, Erigeron philadelphicus, Geum macrophyllum, Iris missouriensis, Juncus balticus, Lupinus polyphyllus, Phalaris arundinacea, Poa palustris, Polygonum bistortoides, Potentilla anserina, Salix exigua, Salix geyeriana,* and *Spiraea douglasii,* plus taxa cited above as growing with the type of *A. estesii.* On the Deschutes River north of Bend, water level fluctuates during the year. Nonetheless, Brounstein (1996) reported finding millions of stems of *A. estesii* in the region from Tumalo north to Lake Billy Chinook. Thick stands most often occur "on planar to slightly undulating, moist river-banks below the high water mark." This is a

Fig. 3. *Artemisia ludoviciana* ssp. *candicans*, in *Pinus ponderosa* forest, Meadows Picnic Area, Bend, Deschutes Co., OR.

Fig. 4. *Artemisia estesii*. Base of stem with overwintering erect basal shoots.

zone of herbaceous species, with a stand of shrubs, if present, between *A. estesii* and the high water mark. Farther south, on the Little Deschutes River near La Pine, Kathleen Cooper reported (in litt.) that the river is free-flowing, with little flooding during the summer, and she and her colleagues are "impressed by the profusion of Artemisia (i.e., *A. estesii*) in the areas (they) have observed."

The chromosome cytology of *Artemisia estesii* and other Northwest members of the *A. ludoviciana* group was discussed by Estes (1968a, 1969). Chromosome pairing relationships in the polyploid species and in intertaxon hybrids led Estes (1969) to refer to the group as an autoploid complex. He observed a high degree of genome homology in polyploid taxa such as 6× *Artemisia douglasiana,* indicated by the formation of chains and rings of 3, 4, 5, and 6 chromosomes at first meiotic metaphase. Tetraploid interspecific hybrids showed almost complete chromosome pairing plus occasional multivalents. A probable contributor to autoploidy was the ability of the plants to undergo meiotic irregularities leading to pollen grains having double the haploid number of chromosomes. Such unreduced pollen functioned to produce tetraploid offspring in some crosses of 2× "*A. douglasiana*" × 4× *A. lindleyana* and *A. ludoviciana* subsp. *candicans* These hybrids formed normal pairs as well as some multivalents at meiosis.

Artemisia estesii probably maintains its distinctness in nature by means of a high degree of self-fertilization and by adaptation to a habitat type (herbaceous streambank vegetation) not occupied by related taxa in the Central Oregon region. Some herbarium specimens from northern California are morphologically similar to *A. estesii,* but without knowing their chromosome numbers, it was decided not to include these in the range

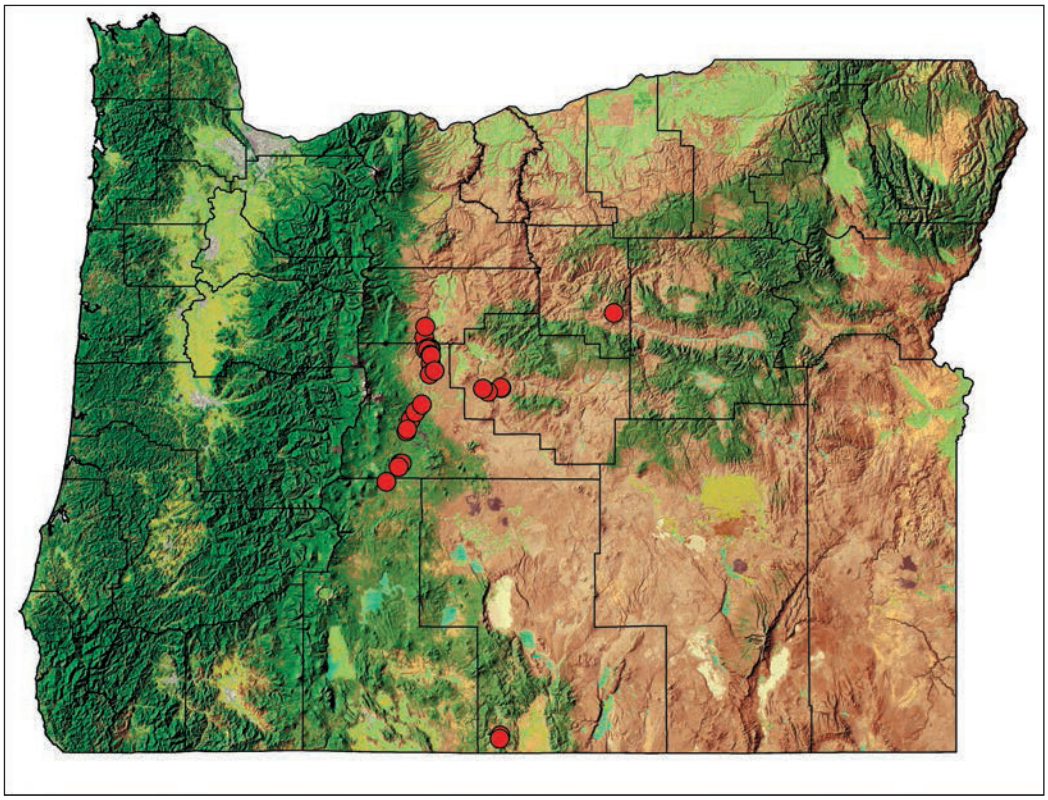

Fig. 5. Map of Oregon with known distribution of *Artemisia estesii*.

of the species (Fig. 5). Certain other members of the *A. ludoviciana* species complex such as *A. ludoviciana* subsp. *candicans* (Fig. 3) may occur in drier habitats adjacent to that of *A. estesii.* The taxa can be differentiated according to the following key.

KEY TO *ARTEMISIA LUDOVICIANA* AND RELATED TAXA IN OREGON

1. Plants usually suffrutescent, tap-rooted, without well-developed rhizomes; plants from rocky or sandy riverbeds and riverbanks below high-water mark, along Columbia River and Snake River in OR and WA, east to ID and MT _____ **Artemisia ludoviciana** Nutt. subsp. **lindleyana** (Besser) P. Lesica

1. Plants herbaceous, with well-developed rhizomes or underground basal shoots; plants from marshy riverbanks to dry grasslands, shrublands, ocean shores, alpine talus, and roadsides.
   2. Rhizomes lacking, underground basal shoots short, extending laterally and arching upward, emerging from the soil as overwintering scaly shoots; blades of principal leaves 2–6-lobed, the central portion (5–)10–30 mm wide; known principally from streambanks of Deschutes and Crooked Rivers, Central Oregon _____ **Artemisia estesii** K.L. Chambers
   2. Rhizomes elongated, remaining underground in winter; blades of principal leaves lobed or unlobed, the central portion of various widths; known from Pacific Coast to Rocky Mountains.
      3. Principal leaves with blades bicolor, entire, toothed, or lobed, central portion 10–50 mm wide, involucres 3 mm or less in diam., W or E of Cascade Range
         4. Involucres less than 2 mm in diam., pistillate flowers 3–7; blades of principal leaves 15–30 mm wide, margins entire or with a few short teeth or lobes; coastal, extending inland along Columbia River to Hood River County _____ **Artemisia suksdorfii** Piper
         4. Involucres 2–3 mm in diam., pistillate flowers 6–10; blades of principal leaves 10–30(–50) mm wide, margins entire or toothed, sometimes many-lobed in plants west of Cascade Range and in CA, ID, and NV; species principally W of Cascade Range and in Klickitat and Yakima Counties, WA, S to CA and Baja California, E to west- central NV and easternmost OR_____ **Artemisia douglasiana** Besser

3. Principal leaves with blades bicolor or tomentose on both surfaces, entire or lobed, central portion 10 mm or less wide; involucres 2 or more mm in diam.; entirely E of Cascade Range.
   5. Principal leaves with blades entire or with subapical teeth, densely white-tomentose on both surfaces, 2–14 mm wide; Cascade Range to upper Midwest, sometimes adventive along Columbia River W of Cascade Range _____ **Artemisia ludoviciana** Nutt. subsp. **ludoviciana**
   5. Principal leaves with blades lobed, the central portion 10 mm or less wide, bicolor or tomentose on both surfaces; Cascade Range to Rocky Mountains.
      6. Principal leaves 4 cm long or less, blades pinnately or bipinnately divided, ultimate lobes with entire or toothed margins, rachis and lobes 1–2(–4) mm wide; high elevations of Steens Mountain and Wallowa Mountains in Oregon, N to Canada and E to MT and WY _____ **Artemisia michauxiana** Besser
      6. Principal leaves 2–13 cm long, blades pinnately divided, the lobes with entire or few-toothed margins, rachis 2–10(–15) mm wide; low to middle or subalpine elevations, Central Oregon to Rocky Mountains.
         7. Involucres loosely tomentose, 3.5–5 mm high, 4–7 mm in diam.; leaves tomentose on both surfaces, rarely bicolor, 4–13 cm long; mostly at low to middle elevations in Central and Eastern OR, adventive in Western Cascade Range, N to WA and E to MT, WY, UT _____ **Artemisia ludoviciana** subsp. **candicans** D.D. Keck
         7. Involucres subglabrous or thinly tomentose, 2.5–3.5 mm high, 2–4 mm in diam.; leaves usually bicolor, 2–7 cm long; principally montane, middle elevations to subalpine, Central and Eastern OR, E to MT, WY, CO, S to CA, NV _____ **Artemisia ludoviciana** subsp. **incompta** (Nutt.) D.D. Keck

As would be expected in a polyploid hybrid complex, the subspecies intergrade to some extent, and the exact taxonomic identification of particular plants or populations may be problematic.

Specimens examined and cited (*Artemisia estesii*): **OREGON: CROOK Co.:** bank of Crooked River just downstream of Bowman Dam, T17S, R16E, Sec. 10, SW ¼ of NE ¼, *R.E. Brainard 139,* 21 Jul 2000, OSC 202793. Crooked River S of Prineville, N of Bowman Dam, N 44.13183°, W 120.83862°, 14 Aug 2007, *S. Garvin s.n.* (OSC 217190); Crooked River at Opal Falls, S end of Lake Billy Chinook, by base of The Peninsula, Oct 1991, *R. Halvorson s.n.* (OSC 249292); Jasper Point Boat Landing and Campground, E end of Prineville Reservoir State Park, T16S, R17E, Sec. 33, SE ¼ of SE ¼, 8 Jun 2000, *B. Newhouse 2000*-007 (OSC 249056). **DESCHUTES Co.:** Deschutes River ca. 6 air mi NW of Terrebonne, N 49.15739°, E 63.5772°, 22 Aug 2007, *J. Armson & S. Garvin s.n.* (OSC 217201); Deschutes River ca. 4 air mi W of Terrebonne near Steamboat Rock, T14S, R12E, Sec. 14, NW ¼ of NE ¼, 22 Aug 2007, *J. Armson & S. Garvin s.n.,* (OSC 217187); Deschutes River at Cline Falls State Park, 15 Jun 1969, *K.L. Chambers 2938* (OSC 130642), **topotype;** 5 air mi S of Bend, Deschutes River at Meadows Picnic Area, T18S, R11E, Sec. 23, NW ¼ of SW ¼, 1 Jun 1994, *K.L. Chambers 5787* (OSC 249047); Deschutes River at Steamboat Rock W of Terrebonne, T14S, R12E, Sec. 14, 18 Jun 1994, *K.L. Chambers 5683* (Coll. *H. Brounstein*) (OSC 249052); W bank of Deschutes River ca. 13 mi SW of Bend, T19S, R11E, Sec. 31, SW ¼ of NE ¼, 8 Jul 1994, *K.A. Cooper 500* (OSC 249059); E bank of Deschutes River, Bend, T18S, R12E, Sec. 6, NW ¼ of SE ¼, 28 May 2001, *K.A. Cooper 560* (OSC 249048); Cline Falls State Park, 1964, *J.R. Estes 8* (OSU 243254, *n* = 9), **topotype;** Deschutes River 0.5 mi NW of Odin Falls, NW of Redmond, N 44.32832°, W 121.26036°, 21 Aug 2007, *S. Garvin s.n.* (OSC 217200); Deschutes River ca. 4 air mi S of Redmond, N 44.21438°, W 121.26670°, 21 Aug 2007, *S. Garvin s.n.* (OSC 217194); Little Deschutes River just S of Stearn's Ranch, N of La Pine High School, T22S, R10E, Sec. 10, NE ¼, 12 Sep 1995, *R. Halvorson s.n.* (OSC 249046); Rosland Campground, W bank of Little Deschutes River, T22S, R10E, Sec. 2, NW ¼ of NW ¼, 15 Jun 1995, *P. Joslin 1002,* (OSC 249054, 249058); Deschutes River SW of Bend, ca. 6 river mi above Benham Falls and 3 river mi below mouth of Spring River, 5 Sep 1993, *R. & J. Mastrogiuseppe C.* (OSC 249045); Deschutes River SW of Bend, opposite Ryan Ranch Meadow, T19S, R11E, Sec. 4, NE ¼ of SW ¼, 19 Aug 1993, *J. Mastrogiuseppe 9195 with G. Milano & K. Cooper* (OSC 250889). **JEFFERSON Co.:** Deschutes River ca. 8.5 air mi NW of Terrebonne, N 49.20508°, E 63.4615°, 22 Aug 2007, *J. Armson & S. Garvin s.n.* (OSC 217188); Lower Bridge, at road crossing of Deschutes River W of Terrebonne, T14S, R12E, Sec. 16, 8 Jun 1991, *K.L. Chambers 5631* (OSC 249801); Crooked River, Opal Falls at S end of Lake Billy Chinook, by base of The Peninsula, T12S, R12E, Sec. 33, Oct 1991, *R. Halvorson s.n.* (OSC 249494). **KLAMATH Co.:** E bank of Little Deschutes River, T23S, R9E, Sec. 11, NE ¼, 15 Jun 1995, *K.A. Cooper 503* (OSC 249043, 249049). **LAKE Co.:** Dog Lake ca. 20 mi SW of Lakeview, T40S, R17E, Sec. 15 or 22, 18 Jun 1992, *G. Sturtz s.n.* (OSC 249055); moist ground near Dog Lake, 30 mi E of Lakeview, 7 Jul 1927, *M.E. Peck 15531* (WTU 14270). **WHEELER Co.:** 15 mi E of Mitchell, along a creek, 27 Jun 1936, *R.C. Andrews 701* (ORE 88123).

Table 1. Chromosome counts of *Artemisia estesii*.

Chromosome number	Accession	Collector/Number	Date
2*n* = 18	Deschutes Co.: Cline Falls State Park	*K.L Chambers 2938*	6/15/1969
2*n* = 18	Deschutes Co.: Lower Bridge W of Terrebonne	*K.L. Chambers 5631*	6/8/1991
2*n* = 18	Deschutes Co.: Meadow Picnic Area S of Bend	*K.L. Chambers 5787*	6/1/1994
2*n* = 18	Deschutes Co.: Steamboat Rock by Deschutes R	*Howie Brounstein s.n.*	6/18/1992
2*n* = 18	Jefferson Co.: Crooked R. at Opal Falls	*Ron Halvorson s.n.*	1/10/1991
2*n* = 18	Jefferson Co.: Crooked R. S of Lake Billy Chinook	*Ron Halvorson s.n.*	10/31/1991
2*n* = 18	Lake Co.: Dog Lake, 20 mi SW of Lakeview	*George Sturtz s.n.*	6/18/1992

Counts were obtained by flow cytometry, using living material harvested from collections cultivated at Corvallis, OR, June 2016.

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