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A NEW COMBINATION AND A NEW VARIETY IN *ARTEMISIA TRIDENTATA*

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ABSTRACT.—The combination *Artemisia tridentata* Nutt. ssp. *spiciformis* (Osterhout) Goodrich & McArthur comb. nov. is made. This high elevation taxon was originally described at the species level and more recently has generally been treated as a form of *A. tridentata* ssp. *vascyana*. The subspecies designation is supported by its parallel nature to the other *A. tridentata* subspecies and by its relatively widespread and locally abundant populations. Also, a new variety of *A. tridentata* ssp. *vascyana* is proposed.

Artemisia spiciformis Osterhout was described (Osterhout 1900) from specimens collected at North Park, Jackson County (Larimer County on the label of Osterhout's type specimen, 2011), Colorado. *Artemisia rothrockii* Gray was described (Brewer et al. 1876) from specimens collected at Monache Meadows, Tulare County, California. Plants of these taxa are marked by large heads with about 10–18 flowers, by narrow spicate panicles, and by apically dentate or lobate leaves and often with some entire leaves, especially on the flowering stalks. They are mostly found at subalpine and alpine elevations. Both are members of the endemic North American subgenus *Tridentatae* (McArthur et al. 1981).

Hall and Clements (1923) reduced *A. rothrockii* to a subspecies of *A. tridentata* Nutt., and they reduced *A. spiciformis* to a synonym or a minor variation of *A. tridentata* ssp. *rothrockii*. They listed a distribution for this complex that included Washington to California and east to Wyoming and Colorado. However, they mentioned that the specimens from Colorado including the type specimen of *A. spiciformis* are more gray or white and more densely cinereous, whereas the type specimen of *A. rothrockii* is viscid and less densely cinereous. They listed two specimens from Colorado that had partial features of typical *A. rothrockii*, and further mentioned that most Sierra Nevada plants of the complex were cinereous-canescens and scarcely

viscidulous. They maintained that perplexing combinations render impossible the recognition of *A. spiciformis*. We agree that these two taxa are similar, but Ward (1953), Beetle (1960), Shultz (1983), and Welsh (1983) have treated *A. rothrockii* and *A. spiciformis* separately.

Ward (1953) maintained *A. rothrockii* at the species level and included in this taxon only plants of the Sierra Nevada and San Bernardino Mountains of California. He suggested that *A. rothrockii* is composed of three races that possibly have arisen independently and include considerable variation in pubescence, stature, purple pigment in the involucre, reduction in the inflorescence, leaf form, and habitat. He suggested that *A. cana* Pursh, and either or both *A. tridentata* and *A. arbuscula* Nutt. have contributed to the chromosome complement of *A. rothrockii*. This taxon (Sierra Nevada and San Bernardino Mountain *A. rothrockii*) is polyploid (4x–8x) (Ward 1953, McArthur et al. 1981). Ward (1953) suggested that more work might show *A. spiciformis* as a species or as a form of *A. rothrockii*. With the information available at the time, however, he gave it consideration as a local hybrid that is reasonably fertile due to its presumed tetraploid nature. He suggested *A. cana* and *A. tridentata* as the parents and stated that he had not seen it extend its range beyond the areas in which both putative parents occur. Beetle (1960) maintained *A. rothrockii* at the species level, as did

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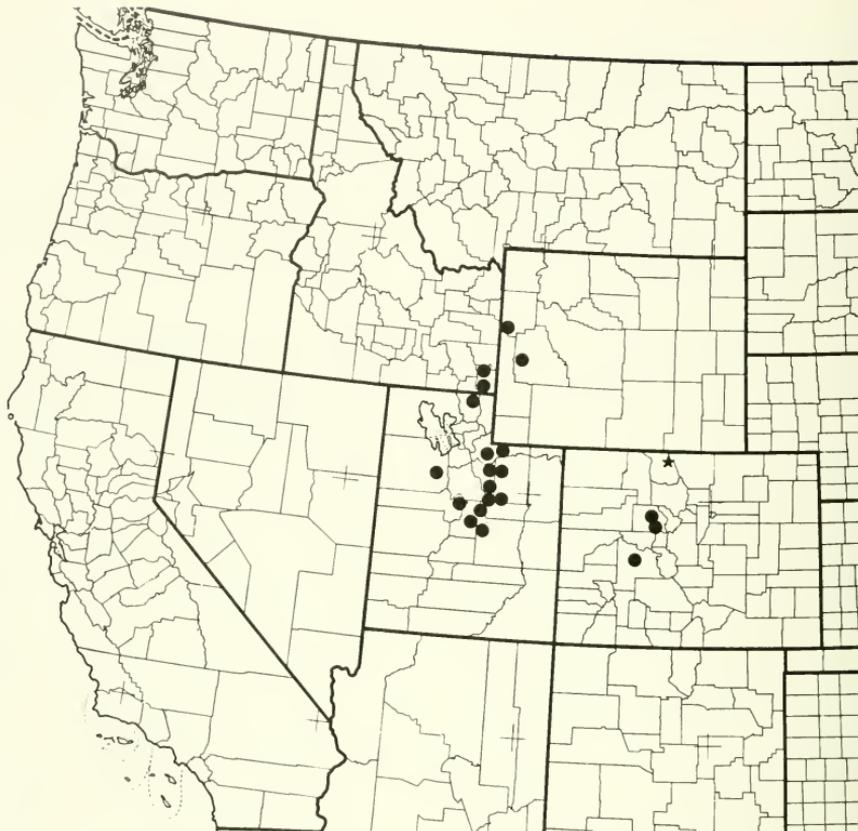


Fig. 1. Distribution of *Artemisia tridentata* ssp. *spiciformis* based on specimens at BRY, OGDF, SSLP, and RM. Type locality indicated by the star.

Ward, but he included in the taxon plants of Colorado, Wyoming, and California. In *A. rothrockii* he included plants with leaves more or less viscid and not densely canescent that give the whole plant a dark green appearance. He pointed out the similarity of large heads in the type of *A. spiciformis* to those of *A. rothrockii*, but he included other plants with much smaller heads in his concept of *A. spiciformis*, and he reduced *A. spiciformis* to *A. tridentata* ssp. *vaseyana* (Rydb.) Beetle f. *spiciformis* (Osterhout) Beetle. He listed the range of f. *spiciformis* as throughout the range of *A. tridentata* ssp. *vaseyana*. He reported frequent confusion with *A. rothrockii*, and he mentioned that leaves of *A. rothrockii* are thicker and often more

deeply lobed, and the involucre bracts are dark and often purple. Beetle also suggested that *A. cana* and *A. tridentata* have had a part in the development of *A. spiciformis*.

Shultz (1983a, 1983b) also treated *A. rothrockii* as a species and included in this taxon only plants of California, as did Ward. She described *A. rothrockii* as a root-sprouting shrub with dark green, very resinous leaves, and with up to 20 flowers per head. She commented on frequent confusion in California between *A. rothrockii* and probably hybrids of *A. cana* ssp. *bolanderi* (Gray) Ward and *A. tridentata* ssp. *vaseyana*. However, she maintained unique anatomical features (gelatinous fibers and numerous resin ducts) for *A. rothrockii* as well as noting that the leaves were

darker green and viscid. She also treated *A. spiciformis* as a hybrid of *A. cana* and *A. tridentata*, as did Ward.

Based on the work of Ward and Shultz, we accept *A. rothrockii* as a plant of California. That being the case, we feel that *A. spiciformis* warrants recognition as more than a localized hybrid. Plants of *A. spiciformis* are too widespread (Fig. 1), and they form homogeneous stands that are too large and often too far removed from populations of one or both of the putative parents to be mere local hybrids (McArthur and Goodrich, in press). Welsh (1983) recognized *A. spiciformis* as a taxon with relationships running to both *A. cana* and *A. tridentata*, but he maintained this as a species and not as a hybrid. We do not dispute the probability of a hybrid origin, nor do we dispute the occurrence of intermediate plants where plants of this taxon and plants of either or both *A. cana* and *A. tridentata* come together. We think the large-headed plants of Utah and Wyoming that match Osterhout's type of *A. spiciformis* and other specimens from Colorado are worthy of taxonomic recognition, and we include them as a subspecies of *A. tridentata* to bring them in line with other taxa of the complex. We point out that the addition of ssp. *spiciformis* brings to five the number of subspecies described for *A. tridentata*. Four (ssp. *tridentata*, *wyomingensis* Beetle & Young, *vaseyana*, and *spiciformis*) are widely distributed but separate on the basis of moisture and elevational gradients and on morphological features (Beetle and Young 1965, McArthur 1983, Winward 1983). The other one, ssp. *parishii* (Gray) H. & C., is similar to and perhaps synonymous with ssp. *tridentata*. *Artemisia tridentata* ssp. *spiciformis*, with probably hybrid and polyphyletic origins, has similarities with ssp. *wyomingensis*. In the latter case, ssp. *tridentata*, *vaseyana*, and *A. nova* A. Nels. are thought to be involved (Beetle and Young 1965, Winward 1975, McArthur 1983), whereas in the former the putative parents are ssp. *vaseyana* and *A. cana*. Like *A. rothrockii* (sensu Ward and Shultz), ssp. *wyomingensis* is polyploid (4x-6x; McArthur et al. 1981). However, ssp. *spiciformis* is diploid (2x) and tetraploid (4x). Utah populations from the Wasatch Plateau and Uinta Mountains are diploid ($n=x=9$)

(McArthur et al. 1981, McArthur and Sanderson, unpublished manuscript). A population in the Wyoming Range of west central Wyoming is tetraploid (McArthur et al. 1981). Because the whole of subgenus *Tridentatae* has a similar genome (replicated various times in polyploids) (McArthur et al. 1981), and hybridization is possible and in places common in the subgenus (Ward 1953, McArthur et al. 1979), ssp. *spiciformis* could and probably did arise independently several times at both the diploid and tetraploid levels. Apparently, genetic composition and selective pressures have led to a stabilized, well-adapted taxon.

For *Artemisia tridentata* ssp. *spiciformis* we accept extreme variability in size, thickness, and lobing of the leaves, and in the pigmentation of the involucre, and some variability in the inflorescence (spiciform to narrow-paniculate). We place the greatest emphasis on number of flowers per head (10-18) and in the size of the heads (5-7 mm long, 4-5 mm wide at maturity). These features seem diagnostic, and they place plants of similar morphology and ecology together. Plants with fewer flowers per head (4-11) and smaller heads that have been referred to as f. *spiciformis* belong to *A. tridentata* ssp. *vaseyana*. We feel that *A. tridentata* ssp. *spiciformis* is closer to *A. rothrockii* in head size, number of flowers, and in the tendency to root-sprout than it is to *A. tridentata* ssp. *vaseyana*, which does not root-sprout.

The variability in features of ssp. *spiciformis* may be a result of several independent origins, as we suggested earlier. This seems reasonable, considering the suggested hybrid origin for the taxon. The plants of California that Shultz reported as possible hybrids are suggested as crosses between *A. cana* ssp. *bolanderi* and *A. tridentata* ssp. *vaseyana*. *Artemisia cana* ssp. *bolanderi* is mostly known from California and Oregon, and *A. cana* ssp. *viscidula* Osterhout is the logical putative parent throughout much of the range of ssp. *spiciformis*. Apparently plants with features of ssp. *spiciformis* have not been found in the range of *A. cana* ssp. *cana*. Perhaps the name ssp. *spiciformis* is best reserved for plants in which *A. cana* ssp. *viscidula* and *A. tridentata* ssp. *vaseyana* are the logical parents, but we do not propose such reservation at this

time. The probably hybrid origin raises the question whether ssp. *spiciformis* should be included in *A. cana* or in *A. tridentata*. We have included it with *A. tridentata* because most of the persistent leaves are lobed and because an additional taxon of *A. tridentata* at the upper elevation range for the species makes for a logical and complete elevational and mesic gradient series for the species.

In addition to morphological features, phenology of plants of ssp. *spiciformis* may provide additional evidence that they are unique. Plants of ssp. *spiciformis* from high elevations of the Wasatch Plateau, Utah, and from the Wyoming Range, Wyoming, have been transplanted at low elevations at Provo and Ephraim, Utah. These plants come into full flower as early as the last of May and the first two weeks of June. Plants of *A. tridentata* ssp. *vaseyana* and *A. cana* ssp. *viscidula* have also been transplanted at these locations. They flower at the transplanted sites about the same time or later than they do in their more montane environments. This is about September or October or even into November. In its native habitat, ssp. *spiciformis* flowers from the first of August through September, but its phenology at the transplanted sites indicates a basic difference from either *A. cana* ssp. *viscidula* or *A. tridentata* ssp. *vaseyana*.

Rydberg (1916) described *Artemisia vaseyana* and designated a specimen from Washington (Vasey, 480) as the type. Hall and Clements (1923) examined the type specimen and listed 9–10 flowers per head. They discussed this taxon as a variation of *A. tridentata* ssp. *rothrockii*. Ward (1953) also examined the type specimen and listed 9–11 flowers per head. He discussed this as a form of *A. tridentata* ssp. *tridentata* but explained that it differed by having larger heads, larger leaves, and reduced inflorescences. He attributed the reduced inflorescences to environmental modification but indicated the large head size to be genetically controlled. He also listed several other collections from Washington, Oregon, and Idaho with 7–11 flowers per head. Beetle (1959) included *A. vaseyana* as a ssp. of *A. tridentata*. We agree with this combination.

Ward (1953) pointed out some ecological and cytological variations in this group. He

mentioned plants of intermountain areas (areas between mountains) "with rounded shape with the inflorescences mingled with the vegetative shoots and only partly exceeding them." We believe these plants are those Beetle and Young (1965) named as *A. tridentata* ssp. *wyomingensis*, the same tetraploid plants discussed by Ward (1953) that usually grow on poorer, rockier soils, and that are smaller and slower growing than diploid plants. He compared these plants with a form of sagebrush of "timbered or mountainous areas in which the plants are very uniform in size, usually about 2 feet in height, and of a rather spreading, flat-topped habit of growth, with the inflorescence extending upward like plumes above the rest of the bush." He further reported that the two forms retained their different growth rates under uniform conditions in a garden. He discussed these two forms simultaneously but separately from *A. vaseyana*, which he went on to discuss as another form with larger heads. For many years these montane, flat-topped plants with only 4–6 flowers per head have passed for *A. tridentata* ssp. *vaseyana*. We believe they constitute a separate taxon. This small-headed, few-flowered phase is widespread in most of the western states, whereas those matching the type of typical *A. tridentata* ssp. *vaseyana* are most common in the upper elevational sagebrush areas of Washington, Oregon, and Idaho. The morphological differences are striking enough in the extreme, but there is no clear-cut boundary, and we do not dispute that intermediate plants are often encountered. However, each of the phases form large, pure stands, and the geographic ranges are not entirely the same. Hironaka et al. (1983) recognized the two different phases, and designated separate habitat types based on the two phases. The differences will continue to be recognized, and names for both seem to be appropriate.

The following name is proposed for plants with smaller and fewer flowered heads and wider inflorescences:

Artemisia tridentata ssp. *vaseyana* var. *pauciflora* Winward & Goodrich var. nov.
Similis A. tridentata ssp. *vaseyana* var. *vaseyana* sed in capitulis parvis floribus paucis et inflorescence latis differt.

Type: Utah, Utah County, T7S R4E corner of sections 28, 29, 32, and 33, 9.7 km 85° east of Springville, Uinta N.F., Wasatch Mountains, Left Fork Hobbble Cr., 1582 m, sagebrush-grass community in a Gambel oak-big-tooth maple zone. Goodrich, Winward, McArthur, and Lewis 21492. Holotype BRY!, Isotypes ID, MO, NY, RENO, RM, SSSLP, UC, UT, and UTC. Paratype: Utah, Utah County T8SR3E51 SE¼ of NW¼, 5 km 112°

east of Springville, 1524 m, sagebrush-grass community. Goodrich, Winward, McArthur, and Lewis 21490. BRY, CS, MONTU, OGDF, OSC, and WTU.

The following key provides a summary for the taxa of *A. tridentata* listed above except for *A. tridentata* ssp. *parishii* (mostly of southern California), which is like *A. tridentata* ssp. *tridentata* except for usually arachnoid and short-villous achenes.

1. Unevenly topped shrubs with the inflorescence and vegetative twigs intermingled, the flower stalks rarely over twice as long as the subtending vegetative twigs; plants of valleys and lower mountains; fluoresces reddish brown in alcohol (Winward and Tisdale 1969) 2
- Evenly topped shrubs; flowering stalks well elevated above the leaves, mostly over twice as long as the subtending vegetative twigs; plants of low to high elevations in mountains; fluoresces bluish cream in alcohol 3
- 2(1). Plants mostly over 1 m tall, often with a discernible main trunk, diploids; length/width ratio of leaves 4.0 or greater *A. tridentata* ssp. *tridentata*
- Plants mostly less than 1 m tall, often quite branched from near the base and then without a readily discernible main trunk, mostly tetraploids; length/width ratio of leaves less than 4.0 *A. tridentata* ssp. *wyomingensis*
- 3(1). Head with 10–18 flowers; plants tending to root-sprout, of subalpine elevations, often in openings in aspen and spruce or fir woods, or where drifting snow accumulates, flowering in August and September in native habitats and in early June when transplanted at low elevations (1370 m), diploids and tetraploids, possibly of hybrid derivation involving *A. tridentata* and *A. cana* *A. tridentata* ssp. *spiciformis*
- Heads with 4–11 flowers; plants not root-sprouting, of medium to high elevations in mountains, flowering in September, October, and November when transplanted at low elevations 4
- 4(3). Heads with 7–11 flowers, over 1.5 mm wide; inflorescence narrow and spiciform with relatively few heads *A. tridentata* ssp. *vaseyana* var. *vaseyana*
- Heads with 4–6 flowers, less than 1.5 mm wide; inflorescence paniculate with numerous heads *A. tridentata* ssp. *vaseyana* var. *pauciflora*

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