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**Taxonomic and nomenclatural rearrangements in *Artemisia* subgen. *Tridentatae*, including a redefinition of *Sphaeromeria* (Asteraceae, Anthemideae)**

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**Taxonomic and nomenclatural rearrangements in *Artemisia* subgen. *Tridentatae*, including a redefinition of *Sphaeromeria* (Asteraceae, Anthemideae)**

**Authors**

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TAXONOMIC AND NOMENCLATURAL REARRANGEMENTS IN  
ARTEMISIA SUBGEN. TRIDENTATAE, INCLUDING A REDEFINITION  
OF SPHAEROMERIA (ASTERACEAE, ANTHEMIDEAE)

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Stewart C. Sanderson<sup>2</sup> and Joan Vallès<sup>4</sup>

ABSTRACT.—A recent molecular phylogenetic study of all members of *Artemisia* subgenus *Tridentatae*, as well as most of the other New World endemic *Artemisia* and the allied genera *Sphaeromeria* and *Picrothamnus*, raised the necessity of revising the taxonomic framework of the North American endemic *Artemisia*. Composition of the subgenus *Tridentatae* is enlarged to accommodate other North American endemics and is organized into 3 sections: *Tridentatae*, *Nebulosae*, and *Filifoliae*. This paper deals with the combination of one section, the amendment of 2 more sections, and the combination in or the reversion to *Artemisia* of some *Sphaeromeria* and *Picrothamnus* species. The new names given for previous *Sphaeromeria* species are *Artemisia macarthurii* (for *S. argentea*), *A. albicans* (for *S. cana*), *A. constricta* (for *S. compacta*), and *A. inaequifolia* (for *S. diversifolia*). The other *Sphaeromeria* we studied (*S. capitata*, *S. potentilloides*, *S. ruthiae*, and *S. simplex*) had been formerly considered *Artemisia* (respectively, *A. capitata*, *A. potentilloides*, *A. ruthiae*, and *A. simplex*), and their previous nomenclature is therefore recommended.

RESUMEN.—Un estudio reciente sobre la filogenia molecular de todos los miembros del subgénero *Tridentatae* de *Artemisia*, así como de la mayoría de las otras especies de *Artemisia* endémicas del Nuevo Mundo y los géneros afines *Sphaeromeria* y *Picrothamnus*, hizo ver la necesidad de revisar el marco taxonómico de las especies de *Artemisia* endémicas a Norteamérica. La composición del subgénero *Tridentatae* se ha ampliado para dar cabida a las otras especies endémicas de Norteamérica, y está organizado en 3 secciones: *Tridentatae*, *Nebulosae* y *Filifoliae*. El presente artículo trata sobre la combinación de una sección y la enmienda de 2 más, y propone la incorporación o reversión a *Artemisia* de algunas especies de *Sphaeromeria* y *Picrothamnus*. Los nuevos nombres de las especies previamente asignadas a *Sphaeromeria* son *Artemisia macarthurii* (para *S. argentea*), *A. albicans* (para *S. cana*), *A. constricta* (para *S. compacta*) y *A. inaequifolia* (para *S. diversifolia*). Las otras especies de *Sphaeromeria* estudiadas (*S. capitata*, *S. potentilloides*, *S. ruthiae* y *S. simplex*) habían sido previamente consideradas como miembros de *Artemisia* (*A. capitata*, *A. potentilloides*, *A. ruthiae* y *A. simplex*, respectivamente), por lo que se recomienda utilizar su nomenclatura anterior.

*Artemisia* L. is the largest genus of tribe Anthemideae Cass. (Asteraceae Martynov), comprising around 500 species (Vallès and McArthur 2001, Vallès and Garnatje 2005, and references therein), many of them ecologically and economically relevant. *Artemisia* has a very large distribution in the Northern Hemisphere but a limited number of species (around 10) in the Southern Hemisphere. The genus *Artemisia* has classically been structured in 5 large groups treated as sections or subgenera. In the latter case, the infrageneric names are *Artemisia*, *Absinthium* (Miller) Less. (these 2 are merged into a single entity, *Artemisia*, by some authors, e.g., Shultz 2006a, 2009), *Dracunculus* Besser, *Seriphidium* (Besser) Poljakov, and *Tridentatae* (Rydb.) McArthur. These subgenera are further divided into sections and/or

series. Recent molecular studies (Watson et al. 2002, Vallès et al. 2003, Sanz et al. 2008, Tkach et al. 2008, Garcia et al. 2011) only partially support the traditional, mostly morphology-based classifications; none of the classical subgenera are monophyletic in a strict sense, especially upon increased taxon sampling. Apart from infrageneric structuring problems, several genera have been established from species segregated from *Artemisia*. These genera, which are small (with the exception of *Seriphidium*) and often monotypic, are in general not supported as independent by the molecular phylogenies, in which they appear perfectly embedded in a monophyletic genus *Artemisia* (Sanz et al. 2008 and references therein). Some of these genera (such as *Seriphidium*) are considered by most authors as members of

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*Artemisia*, but others are usually regarded as independent (Oberprieler et al. 2009 and references therein). The objective of the present work is to provide the taxonomic and nomenclatural arrangements necessary to reflect the phylogenetic results revealed by molecular analyses in these endemic North American species.

TAXONOMIC CONSIDERATIONS ON SUBGENUS  
*TRIDENTATAE* AND ALLIED TAXA

*Tridentatae* were first considered, without specifying any rank, within subgenus *Seriphidium* (Rydb. 1916). McArthur et al. (1981) raised *Tridentatae* to the rank of subgenus and explained the similarity with *Seriphidium* as a result of convergent evolution. This observation is supported by chemical data (Jeffrey 1995) and by recent molecular phylogenetic studies of the genus (Watson et al. 2002, Vallès et al. 2003, Sanz et al. 2008, Tkach et al. 2008, Garcia et al. 2011).

As for classification below the subgeneric level (see Table 1 for comparison of previous arrangements with the classification proposed herein), 2 groups without taxonomic recognition (the *A. cana* and the *A. tridentata* lineages) were put forth by several authors with different research emphases (Ward 1953, Beetle 1960, Shultz 1983). Shultz (2009), in her recent monograph of the *Tridentatae*, advocates an extended concept of the subgenus and recognizes 2 sections: *Tridentatae* and *Nebulosae* L.M. Shultz, the latter created to include some other North American endemic *Artemisia* species on the basis of molecular studies (Watson et al. 2002, Riggins 2008). Molecular cytogenetics and genome size data (Garcia et al. 2007, 2008, 2009) have also shed light in particular cases and supported a more restrictive concept of the section *Tridentatae*, the “*Tridentatae* core” or true sagebrushes, which may be partly equivalent to section *Tridentatae* sensu Shultz (2009). Additionally, 2 North American endemic genera, the monotypic *Picrothamnus* Nutt. (Shultz 2006b) and *Sphaeromeria* Nutt. (9 species; Holmgren et al. 1976, Lowrey and Shultz 2006), have also appeared embedded in the North American endemic *Artemisia* clade (Watson et al. 2002, Vallès et al. 2003, Riggins 2008, Sanz et al. 2008, Garcia et al. 2011). In addition to several similar morphological characters (the most outstanding being the discoid and homogamous capitula) and ecological

features (e.g., dry habitat), they share the presence of interxylary cork (Holmgren et al. 1976), which is typical of *Tridentatae* species (Moss 1940).

Our recent and comprehensive molecular phylogenetic research (Garcia et al. 2011), concerning all members of *Artemisia* subgenus *Tridentatae*, as well as most of the other New World endemic *Artemisia* and the allied genera *Sphaeromeria* and *Picrothamnus*, has raised the necessity of emending the current taxonomic framework of endemic North American *Artemisia*. The constitution of subgenus *Tridentatae* is enlarged to accommodate other North American endemics and is organized, partially following Shultz (2009), into 3 sections: *Tridentatae*, *Nebulosae*, and *Filifoliae*, the last 2 hosting species and other genera that have been considered closely related to the core sagebrushes in undefined ways. This has taxonomic-nomenclatural consequences, since the genera *Sphaeromeria* and *Picrothamnus* should be best treated as *Artemisia* species, and new nomenclatural combinations must be proposed.

REARRANGEMENTS IN THE SUBGENUS  
*TRIDENTATAE* AND THE GENERA *PICROTHAMNUS*  
AND *SPHAEROMERIA*, INCLUDING  
NOMENCLATURAL NOVELTIES

Structuring of *Artemisia*  
Subgenus *Tridentatae*

Subgenus *Tridentatae* (Rydb.) McArthur emend. S. Garcia, Garnatje, McArthur, Pellicer, S.C. Sand. & Vallès-Xirau. This includes the taxa considered in the classical circumscription of the subgenus (McArthur et al. 1981), plus other North American *Artemisia* species (*A. argilosa* Beetle, *A. filifolia* Torr., *A. pedatifida* Nutt., *A. porteri* Cronquist), as well as the species of the former genera *Picrothamnus* and *Sphaeromeria*.

Section *Tridentatae* L.M. Shultz emend. S. Garcia, Garnatje, McArthur, Pellicer, S.C. Sand. & Vallès-Xirau. This includes the taxa formerly considered in the classical conception of subgenus *Tridentatae* (McArthur et al. 1981), excluding *A. bigelovii* A. Gray, *A. pygmaea* A. Gray, and *A. rigida* (Nutt.) A. Gray.

Section *Filifoliae* (Rydb.) S. Garcia, Garnatje, McArthur, Pellicer, S.C. Sand. & Vallès-Xirau comb. nov. (*Artemisia* [unranked] *Filifoliae* Rydb. N. Amer. Fl., 34: 257, 1916;

TABLE 1. Comparison of different hypotheses of interspecific relationships and taxonomy within *Artemisia* subgenus *Tridentatae*.

SUBGENUS	Rydberg (1916)	Ward (1953)	Beetle (1960)	Shultz (1983)	Shultz (2006a)	Shultz (2009)	Garcia et al. (2011)
		<i>Tridentatae</i>	<i>Tridentatae</i>	<i>Tridentatae</i>	<i>Tridentatae</i>	<i>Tridentatae</i>	<i>Tridentatae</i>
SECTION	Section <i>Pugnatae</i>	<i>A. tridentata</i> lineage <sup>a</sup>	<i>A. tridentata</i> lineage	<i>A. tridentata</i> lineage	<i>A. arbuscula</i>	Section <i>Tridentatae</i>	Section <i>Filifoliae</i>
OR LINEAGE	<i>Artemisia pugnatae</i>	<i>A. arbuscula</i>	<i>A. bigelovii</i>	<i>A. nova</i>	<i>A. bigelovii</i>	<i>A. arbuscula</i>	<i>A. bigelovii</i>
		<i>A. arbuscula</i> ssp. <i>longiloba</i>	<i>A. longiloba</i>	<i>A. tridentata</i>	<i>A. californica</i>	<i>A. bigelovii</i>	<i>A. filifolia</i>
	Section <i>Rigidae</i>	<i>A. arbuscula</i> ssp. <i>nova</i>	<i>A. nova</i>	<i>A. cana</i> lineage	<i>A. cana</i>	<i>A. cana</i>	<i>A. pedatifida</i>
	<i>A. rigida</i>	<i>A. tridentata</i>	<i>A. pugnatae</i>	<i>A. cana</i>	<i>A. filifolia</i>	<i>A. nova</i>	<i>A. porteri</i>
		<i>A. cana</i> lineage <sup>b</sup>	<i>A. cana</i> lineage	<i>A. cana</i>	<i>A. nesiotica</i>	<i>A. pugnatae</i>	<i>A. rigida</i>
	Section <i>Tridentatae</i>	<i>A. cana</i>	<i>A. cana</i>	<i>A. cana</i>	<i>A. nova</i>	<i>A. rigida</i>	<i>Picrothamnus</i>
	<i>A. angusta</i>	<i>A. tripartita</i>	<i>A. cana</i>	<i>A. tripartita</i>	<i>A. pugnatae</i>	<i>A. rothrockii</i>	<i>desertorum</i>
	<i>A. arbuscula</i>		<i>A. rigida</i>	<i>A. rothrockii</i>	<i>A. rigida</i>	<i>A. spiciformis</i>	( <i>A. spinescens</i> )
	<i>A. bolanderi</i>		<i>A. tripartita</i>	<i>A. rothrockii</i>	<i>A. rigida</i>	<i>A. tridentata</i>	<i>S. argentea</i>
	<i>A. cana</i>			<i>A. spiciformis</i>	<i>A. rothrockii</i>	<i>A. tripartita</i>	( <i>A. macarthurii</i> )
	<i>A. nova</i>			<i>A. tridentata</i>	<i>A. rothrockii</i>		<i>S. capitata</i> ( <i>A. capitata</i> )
	<i>A. parishii</i>			<i>A. tripartita</i>	<i>A. tripartita</i>		<i>S. compacta</i>
	<i>A. rothrockii</i>						( <i>A. constricta</i> )
	<i>A. spiciformis</i>						<i>S. potentilloides</i>
	<i>A. tridentata</i>						( <i>A. potentilloides</i> )
	<i>A. tripartita</i>						<i>S. ruthiae</i>
	<i>A. vasejiana</i>						( <i>A. ruthiae</i> )
							<i>S. simplex</i>
							( <i>A. simplex</i> )
							Unranked
							<i>A. argiflora</i>
							<i>A. pugnatae</i>
							<i>S. cana</i> ( <i>A. albicans</i> )
							<i>S. diversifolia</i>
							( <i>A. inaequalifolia</i> )
QUESTIONABLE PLACEMENT	<i>A. palmieri</i> <sup>c</sup>	<i>A. palmieri</i>		<i>A. pugnatae</i>		South American taxa	Circumboreal taxa
		<i>A. pugnatae</i>		<i>A. rigida</i>		<i>A. copa</i>	<i>A. comata</i>
						<i>A. echeagaraji</i>	<i>A. flava</i>
						<i>A. mendocana</i>	<i>A. furcata</i>
						var. <i>mendocana</i>	<i>A. hyperborea</i>
						<i>A. mendocana</i>	—
						var. <i>paramilloensis</i>	<i>Sphaeromeria</i>
							<i>martirensis</i> <sup>d</sup>

TABLE 1. Continued

	Rydberg (1916)	Ward (1953)	Beetle (1960)	Shultz (1983)	Shultz (2006a)	Shultz (2009)	Garcia et al. (in press)
HYBRID ORIGIN		<i>A. rothrockii</i>	<i>A. arbuscula</i> <i>A. rothrockii</i>	<i>A. arbuscula</i> <i>A. rothrockii</i>		<i>A. arbuscula</i> ssp. <i>longicaulis</i> <i>A. argilosa</i> <i>A. tridentata</i> ssp. <i>xericensis</i>	
EXCLUDED TAXA	<i>A. bigelovii</i>	<i>A. bigelovii</i>	<i>A. palmeri</i>	<i>A. bigelovii</i> <i>A. palmeri</i>	<i>Sphaeromeria</i> <i>Picrothamnus</i>	<i>A. papposa</i> <i>A. pedatifida</i> <i>A. porteri</i>	<i>A. palmeri</i>

<sup>a</sup>Seldom root sprouts after fire; mostly *tridentata* leaves and serophytic.

<sup>b</sup>Root sprouts and layers after fire; leaves entire or deeply divided and mesophytic.

<sup>c</sup>*Artemisia palmeri* was placed in the monotypic genus *Artemisiastrum* by Rydberg (1916).

<sup>d</sup>*Sphaeromeria maritrensis* is considered of "questionable placement" until it is investigated in a phylogenetic context.

*Artemisia* ser. *Filifoliae* (Rydb.) Y.R. Ling in Hind, Jeffrey & Pope, *Advan. Comp. Syst.*: 272, 1995). The type species is *A. filifolia*. This section also hosts *A. bigelovii*, (excluded from the subgenus in previous treatments; Rydberg 1916, Ward 1953, Shultz 1983), *A. rigida*, (a species of unclear taxonomic position within the core sagebrushes; Shultz 1983), and most collateral members of subgenus *Tridentatae*, including the former genera *Picrothamnus* (its only species) and *Sphaeromeria* (most of its species).

Section *Nebulosae* L.M. Shultz emend. S. Garcia, Garnatje, McArthur, Pellicer, S.C. Sand. & Vallès-Xirau. This section is limited to *A. californica* Less. and *A. nesiotica* P.H. Raven, excluding *A. filifolia*, which is the type of the section *Filifoliae*.

Unranked species at the sectional level, albeit members of subgenus *Tridentatae*, are *A. argilosa*, *A. pygmaea*, *Sphaeromeria cana* (D.C. Eaton) A. Heller, and *S. diversifolia* (D.C. Eaton) Rydb.

#### Rearrangements of the Former Genera *Picrothamnus* and *Sphaeromeria*

The only species of the genus *Picrothamnus* must be returned to *Artemisia*, thus restoring the previously applied name *Artemisia spinescens* D.C. Eaton. The genus *Sphaeromeria* must also be merged into *Artemisia*. To do so, some taxa need only be returned to the genus in which they were first described, while others have to be combined. In the latter case, since some of the *Sphaeromeria* specific epithets are already used in *Artemisia*, new names must be proposed. The names of the *Sphaeromeria* species in *Artemisia* are as follows:

***Artemisia macarthuri*** S. Garcia, Garnatje, Pellicer, S.C. Sand. & Vallès-Xirau, nom. nov. Basionym: *Sphaeromeria argentea* Nutt., *Trans. Amer. Philos. Soc. ser. 2*, 7:402. 1841. Synonym: *Tanacetum nuttallii* Torr. & A. Gray. A new name is necessary, since the specific epithet was already used in *Artemisia*: *A. argentea* L'Hér. The new name is given in honor of botanist and geneticist E. Durant McArthur, who fruitfully devoted a large part of his scientific career to the study of sagebrushes. We have adopted the form *macarthuri* instead of *mcarthuri* for the specific epithet following the recommendation 60C.5(a) of the International Code of Botanical Nomenclature (McNeill et al. 2006).

***Artemisia albicans*** S. Garcia, Garnatje, McArthur, Pellicer, S.C. Sand. & Vallès-Xirau, nom. nov. Basionym: *Tanacetum canum* D.C. Eaton, Eaton in King, *Rep. Geol. Explor. 40th Parallel* 5:179, pl. 19, 8–14. 1871. Synonym: *Sphaeromeria cana*



(D.C. Eaton) A. Heller. A new name is necessary since the specific epithet was already used in *Artemisia*: *A. cana* Pursh.

*Artemisia capitata* (Nutt.) S. Garcia, Garnatje, McArthur, Pellicer, S.C. Sand. & Vallès-Xirau, comb. nov. Basionym: *Sphaeromeria capitata* Nutt., Trans. Amer. Philos. Soc. ser. 2, 7: 402. 1841. Synonym: *Tanacetum capitatum* (Nutt.) Torrey & A. Gray.

*Artemisia constricta* S. Garcia, Garnatje, McArthur, Pellicer, S.C. Sand. & Vallès-Xirau, nom. nov. Basionym: *Tanacetum compactum* H.M. Hall, Muhlenbergia 2: 343. 1916. Synonym: *Chamartemisia compacta* (H.M. Hall) Rydb., *Sphaeromeria compacta* (H.M. Hall) A.H. Holmgren, L.M. Shultz & Lowrey. A new name is necessary, since the specific epithet was already used in *Artemisia*: *A. compacta* Fisch. ex DC.

*Artemisia inaequifolia* S. Garcia, Garnatje, McArthur, Pellicer, S.C. Sand. & Vallès-Xirau, nom. nov. Basionym: *Tanacetum diversifolium* D.C. Eaton, in King, Rep. Geol. Explor. 40th Parallel 5: 179, pl. 19, 8–14. 1871. Synonym: *Sphaeromeria diversifolia* (D.C. Eaton) Rydb. A new name is necessary since the specific epithet was already used in *Artemisia*: *A. diversifolia* Rydb.

*Artemisia potentilloides* A. Gray. Synonym: *Sphaeromeria potentilloides* (A. Gray) A. Heller, *Tanacetum potentilloides* (A. Gray) A. Gray, *Vesicarpa potentilloides* (A. Gray) Rydb.

*Artemisia ruthiae* (A.H. Holmgren, L.M. Shultz & Lowrey) S. Garcia, Garnatje, McArthur, Pellicer, S.C. Sand. & Vallès-Xirau, comb. nov. Basionym: *Sphaeromeria ruthiae* A.H. Holmgren, L.M. Shultz & Lowrey, Brittonia 28(2): 257. 1976.

*Artemisia simplex* (A. Nelson) S. Garcia, Garnatje, McArthur, Pellicer, S.C. Sand. & Vallès-Xirau, comb. nov. Basionym: *Tanacetum simplex* A. Nelson, Bull. Torrey Bot. Club 26: 484, 1899. Synonym: *Sphaeromeria simplex* (A. Nelson) A. Heller.

We are not proposing to transfer the species *Sphaeromeria martirensis* (Wiggins) A.H. Holmgren, L.M. Shultz & Lowrey (originally described as *Tanacetum martirensense* Wiggins) to *Artemisia* until its phylogenetic position has been assessed by molecular techniques similar to those employed on the other *Sphaeromeria* species (Garcia et al. 2011), as our DNA sample failed to amplify. The same applies for the variety *Sphaeromeria potentilloides* var. *nitrophila* (Cronquist) A.H. Holmgren, L.M. Shultz & Lowrey (described as *Tanacetum potentilloides* var. *nitrophilum* Cronquist), of which we could not obtain material.

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#### LITERATURE CITED

- BEETLE, A.A. 1960. A study of sagebrush, the section *Tridentatae* of *Artemisia*. Bulletin 368, University of Wyoming Experiment Station, Laramie, WY.
- GARCIA, S., M.Á. CANELA, T. GARNATJE, E.D. MCARTHUR, J. PELLICER, S.C. SANDERSON, AND J. VALLÈS. 2008. Evolutionary and ecological implications of genome size in the North American endemic sagebrushes (*Artemisia*, subgenus *Tridentatae*). Biological Journal of the Linnean Society 94:631–649.
- GARCIA, S., T. GARNATJE, O. HIDALGO, S. SILJAK-YAKOVLEV, AND J. VALLÈS. 2007. Extensive ribosomal DNA (18S-5.8S-26S and 5S) colocalization in the North American endemic sagebrushes (subgenus *Tridentatae*, *Artemisia*, Asteraceae) revealed by FISH. Plant Systematics and Evolution 267:79–92.
- GARCIA, S., T. GARNATJE, E.D. MCARTHUR, J. PELLICER, S. SILJAK-YAKOVLEV, AND J. VALLÈS. 2009. Ribosomal DNA, heterochromatin, and correlation with genome size in diploid and polyploid North American endemic sagebrushes (*Artemisia*, Asteraceae). Genome 52: 1012–1024.
- GARCIA, S., E.D. MCARTHUR, J. PELLICER, S.C. SANDERSON, J. VALLÈS, AND T. GARNATJE. 2011. A molecular phylogenetic approach to western North America endemic *Artemisia* and allies (Asteraceae): untangling the sagebrushes. American Journal of Botany 98:638–653.
- HOLMGREN, A.H., L.M. SHULTZ, AND T.K. LOWREY. 1976. *Sphaeromeria*, a genus closer to *Artemisia* than to *Tanacetum* (Asteraceae: Anthemideae). Brittonia 28: 252–262.
- JEFFREY, C. 1995. Compositae systematics 1975–1993. Developments and desiderata. Pages 3–21 in D.J.N. Hind, C. Jeffrey, and G.V. Pope, editors, Advances in Compositae systematics. Royal Botanic Gardens, Kew, U.K.
- LOWREY, T.K., AND L.M. SHULTZ. 2006. The Genus *Sphaeromeria*. Pages 499–502 in Flora of North America Editorial Committee, editors, Flora of North America North of Mexico. Volume 19. Oxford University Press, New York, NY.
- MCARTHUR, E.D., C.L. POPE, AND D.C. FREEMAN. 1981. Chromosomal studies of subgenus *Tridentatae* of *Artemisia*: evidence for autopolyploidy. American Journal of Botany 68:589–605.
- MCNEILL, J., FR. BARRIE, H.M. BURDET, V. DEMOULIN, D.L. HAWKSWORTH, K. MARHOLD, D.H. NICOLSON, J. PRADO, P.C. SILVA, J.E. SKOG, ET AL., EDITORS. 2006. International Code of Botanical Nomenclature (Vienna Code) adopted by the Seventeenth International Botanical Congress. Vienna, Austria, July 2005. A.R.G. Gantner Verlag, Ruggell, Liechtenstein.
- MOSS, E.H. 1940. Interxylary cork in *Artemisia* with a reference to its taxonomic significance. American Journal of Botany 9:762–768.

- OBERPRIELER, C., S. HIMMELREICH, M. KÄLLERSJÖ, J. VALLÈS, L.E. WATSON, AND R. VOGT. 2009. Anthemideae. Pages 632–666 in V.A. Funk, A. Susanna, T.F. Stuessy, and R.J. Bayer, editor, Systematics, evolution, and biogeography of Compositae. IAPT, Vienna, Austria.
- RIGGINS, C. 2008. Molecular phylogenetic and biogeographic study of the genus *Artemisia* (Asteraceae), with an emphasis on section *Absinthium*. Doctoral dissertation, University of Illinois.
- RYDBERG, P.A. 1916. (Carduales), Cardueae, Tageteae, Anthemideae in North American Flora 34:244–285.
- SANZ, M., R. VILATERSANA, O. HIDALGO, N. GARCIA-JACAS, A. SUSANNA, G.M. SCHNEEWEISS, AND J. VALLÈS. 2008. Molecular phylogeny and evolution of floral characters of *Artemisia* and allies (Anthemideae, Asteraceae): evidence from nrDNA ETS and ITS sequences. *Taxon* 57:66–78.
- SHULTZ, L.M. 1983. *Artemisia*, sagebrush. Pages 202–205 in J.C. Hickman, editor, The Jepson manual, higher plants of California. University of California Press, Berkeley, CA.
- \_\_\_\_\_. 2006a. The Genus *Artemisia*. Pages 503–534 in Flora of North America Editorial Committee, editors, Flora of North America North of Mexico. Volume 19. Oxford University Press, New York, NY.
- \_\_\_\_\_. 2006b. The Genus *Picrothamnus*. Pages 498–499 in Flora of North America Editorial Committee, editors, Flora of North America North of Mexico. Volume 19. Oxford University Press, New York, NY.
- \_\_\_\_\_. 2009. Monograph of *Artemisia* subgenus *Tridentatae* (Asteraceae–Anthemideae). American Society of Plant Taxonomists. Systematic Botany Monographs 89.
- TKACH, N.V., M. HEINRICH-HOFFMANN, A.A. KOROBKOV, AND K.B. VON HAGEN. 2008. Parallel evolutionary patterns in multiple lineages of arctic *Artemisia* L. *Evolution* 62:184–198.
- VALLÈS, J., AND T. GARNATJE. 2005. *Artemisia* and its allies: genome organization and evolution and their biosystematic, taxonomic, and phylogenetic implications in the Artemisiinae and related subtribes (Asteraceae, Anthemideae). Pages 255–285 in A.K. Sharma and A. Sharma, editors, Plant genome: biodiversity and evolution. Volume 1, Part B. Enfield, NH.
- VALLÈS, J., AND E.D. MCARTHUR. 2001. *Artemisia* systematics and phylogeny: cytogenetic and molecular insights. Pages 67–74 in E.D. McArthur and D.J. Fairbanks, compilers, Shrubland ecosystem genetics and biodiversity: proceedings; 2000 June 13–15; Provo, UT. Proc. RMRS-P-21, USDA Forest Service, Rocky Mountain Research Station Ogden, UT.
- VALLÈS, J., M. TORRELL, T. GARNATJE, N. GARCIA-JACAS, R. VILATERSANA, AND A. SUSANNA. 2003. The genus *Artemisia* and its allies: phylogeny of the subtribe Artemisiinae (Asteraceae, Anthemideae) based on nucleotide sequences of nuclear ribosomal DNA internal transcribed spacers (ITS). *Plant Biology* 5:274–284.
- WARD, G.H. 1953. *Artemisia* section *Seriphidium* in North America: a cytotoxic study. Contributions from the Dudley Herbarium of Stanford University 4: 155–205.
- WATSON, L.E., P.L. BATES, T.M. EVANS, M.M. UNWIN, AND J.R. ESTES. 2002. Molecular phylogeny of subtribe Artemisiinae (Asteraceae), including *Artemisia* and its allied and segregate genera. *BMC Evolutionary Biology* 2:17.

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