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The taxonomy of *Chenopodium desiccatum* and *C. nitens*,
sp. nov.¹

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The taxonomy of *Chenopodium desiccatum* and *C. nitens*, sp. nov.¹

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BENET-PIERCE, N. AND M. G. SIMPSON (Department of Biology, San Diego State University, San Diego, CA 92182-4614, USA). The taxonomy of *Chenopodium desiccatum* and *C. nitens*, sp. nov.: J. Torrey Bot. Soc. 141: 161–172. 2014.—Fruits and seeds of the genus *Chenopodium* have been considered taxonomically important but have not been fully studied or utilized. We discuss the importance of describing fruit and seed morphology at low magnification to improve the identification and taxonomy of North American taxa of *Chenopodium*, which in a large part remains unresolved. A new species, *Chenopodium nitens* Benet-Pierce & M. G. Simpson, is described, integrating these reproductive characters with general vegetative characters.

Key words: Chenopodiaceae, *Chenopodium*, *Chenopodium leptophyllum* var. *oblongifolium*, fruits, seeds.

Chenopodium, of the Chenopodiaceae (= Amaranthaceae s.l. in APG III, 2009), a genus of approximately 150 species worldwide, includes species of economic importance such as the South American *C. quinoa* Willd., an important “pseudocereal.” Phylogenetic studies of the Chenopodiaceae have demonstrated that *Chenopodium* as traditionally treated is not monophyletic (Kadereit et al. 2010). In the most recent molecular phylogenetic analyses (Fuentes-Bazan et al. 2012a, b), species of several clades formerly treated in *Chenopodium* have been transferred to the genera *Blitum* L., *Chenopodiastrum* S. Fuentes, Uotila, & Borsch, *Lipandra* Moq., and *Oxybasis* Kar. & Kir. In addition, the largest clade of the traditional *Chenopodium* s.l. is treated as a monophyletic *Chenopodium* s.s. This study also confirmed the genus *Dysphania* Mosyakin & Clemants, with its distinctive glandular trichomes, as a well-supported clade. The taxa from North America discussed in this paper are all included in the *Chenopodium* s.s. clade.

Whether treated in the broad or narrow sense, *Chenopodium* has often been considered taxonomically difficult, particularly its North

American species. Part of this difficulty arises from the highly variable vegetative features of these plants. *Chenopodium* species are well known for being able to fruit as small plants if conditions are less than optimal, contributing in part to their variation in stem habit and other vegetative features. In addition, they present similar leaf characteristics across taxa, and most mature plants lose primary leaves as they enter the fruiting stage, making it difficult to find fruits and primary leaves to aid in identification. Incomplete taxonomic treatments have added to the confusion. At present, we lack descriptions detailed enough to fully differentiate some taxa present in North America, as not all is known about the variation in each. With incomplete descriptions and the absence of clear identification keys, many determinations remain controversial.

Historically, fruits and seeds of *Chenopodium* have been deemed highly relevant and even essential for identification, but have been underutilized in taxonomic keys. A number of new fruit characters have been recently defined and investigated with success for their taxonomic value across *Chenopodium* s.l. (Sukhorukov and Zhang 2013). Fruits and seeds of North American *Chenopodium* s.s. have not been properly described even for well-known species, having been considered exceedingly variable or difficult to assess, possibly as the result of hybridization. For some species that are still poorly known, fruit characteristics have yet to be detailed at all. Most of the characters we are using here are new, and some others we define somewhat differently for North American taxa.

Mature fruits and seeds of *Chenopodium* s.s. from North America are generally somewhat

¹ Our most sincere thanks and appreciation to the following herbaria for allowing us to examine and sample material, including type specimens, and for the use of their images: ASU, CAS-DS, CDA, CHSC, GH, JEPS, MO, NY, OBI, PAC, RM, RSA-POM, SD, SDSU, TEX, UC, UNM and US. We especially want to thank our reviewers for their help in improving this paper. We thank Lee M. Simpson for acquiring most of the images.

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lenticular, small at ca. 1 (0.6–2.4) mm in diameter, and exhibit variable shapes, fruit wall, and seed coat reticulation; these characters may all be observed with a field lens at 20× but preferably with a microscope, with no further preparation required. The seed is always horizontal, with very few exceptions, and varies across taxa in a number of additional features, including size (diameter), outline shape in face view (oval to round), level of compression as seen in side view (from flat to globose), three-dimensional shape of the basal face (adjacent to the attachment of the hilum) and of the upper face (apical or stylar, frequently evident as the sepals open), sculpturing of the seed coat and degree of shine, and the presence, shape, and thickness of a marked equatorial margin.

The fruit wall (pericarp) is also variable and, in many taxa, among the most informative of all characters. Fruit wall attachment to the seed varies in that it may be (1) fully adherent, if it can only be removed forcefully or not at all, (2) semi-adherent, if it remains mostly attached to the seed but partially falls off in big pieces or is relatively free at the upper (stylar) or basal (funicular) region, or (3) free, if it falls completely off the seed coat when rubbed with fingers or touched with forceps. The pericarp may also vary in thickness, dryness, hardness, sculpturing (ranging from somewhat smooth to highly reticulate), texture, color, and color patterning. Usually, the fruit wall texture is variously papillate, but these papillae dry and collapse, remaining as a membranous or a dry pericarp if not adherent or as a series of pits or reticulations that take many forms and levels of breakdown if it remains attached to the seed.

Taxonomic treatments of the genus *Chenopodium* in North America (including Watson 1874, Nelson 1902, Rydberg 1912, 1917, Standley 1916, Aellen 1929, Aellen and Just 1943, Wahl 1954, Bassett and Crompton 1982, Mosyakin and Clemants 1996, Clemants and Mosyakin 2003) and phylogenetic studies of the Chenopodiaceae (Kadereit et al. 2003, Kadereit et al. 2010, Fuentes-Bazan 2012a, b) have greatly added to our knowledge of the classification of the group; however, enhanced taxonomic precision is still needed for many species in the western United States, an area rich in *Chenopodium* taxa. An enormous amount of work, including numerical, morphological, flavonoid chemistry, and other

studies (Crawford and Reynolds 1974, Crawford 1975, Crawford and Julian 1976, Crawford and Wilson 1979, La Duke and Crawford 1979, Reynolds and Crawford 1980), has gone into trying to conclusively distinguish what have been called the “narrow-leaved” *Chenopodium* taxa, mainly present in this region. Even authors of recent phylogenetic molecular studies (Fuentes-Bazan et al. 2012a) concluded that more morphological studies of *Chenopodium* are needed to better resolve its taxonomy. The detailed study of fruits and seeds could open new avenues for more accurate circumscription of taxa.

In this study, we describe a set of fruit and seed morphological characters that are stable and can be observed at relatively low magnification in order to obtain more reliable identifications. We employ a subset of these characters in delimiting *Chenopodium desiccatum*, which is one of the most misidentified taxa in North America and is among the “narrow-leaved” *Chenopodium* of the western United States, a loose group in which many species remain mired in confusion. We assess and confirm the usefulness of fruit and seed characters to improve the taxonomy of this group, and also present the discovery of a new species, identified and circumscribed using seed morphological features.

Materials and Methods. We observed and sampled numerous specimens from herbaria at ASU, CAS-DS, CDA, CHSC, GH, JEPS, MO, NY, OBI, PAC, RM, RSA-POM, SD, SDSU, TEX, UC, UNM and US (Holmgren and Holmgren 1998, onwards), including type specimens. In addition to making observations of vegetative features, we photographed fruits and seeds of many specimens at high magnification and resolution using a Visionary Digital BK Plus photomicroscope and prepared composite images with Helicon Focus. All specimens were conventionally photographed and, when possible, images of sampled herbarium specimens were digitized on an inverted, flat-bed scanner in order to have good reference images. The identity of herbarium specimens was assessed employing original taxon descriptions, past floristic treatments (cited below), and the key of the *Flora of North America* treatment of *Chenopodium* s.l. (Clemants and Mosyakin 2003). We used inflorescence and other vegetative characters to confirm or help with conclusive

identification, but always in conjunction with seed and fruit characters, as the latter are proving more reliable.

We studied the primary literature in order to elucidate the delimitation of ambiguous *Chenopodium* taxa. In addition, we collected original material from localities in western North America corresponding to the type specimen of a new species (described below).

Results and Discussion. THE TAXONOMY OF *CHENOPODIUM DESICCATUM*. The value of using fruits and seeds for determinations proved useful when it became necessary to distinguish *Chenopodium desiccatum* A. Nelson (probably the most misidentified *Chenopodium* taxa in North America) from the recently described *C. littoreum* (Benet-Pierce and Simpson 2010).

The type specimens of *Chenopodium desiccatum* [Holotype: *E. Nelson 5048*, 12 August 1898, RM 12545, barcode 0002236 (Fig. 1A); Co-type: *J. H. Cowen s.n.*, 29 July 1896, RM 8460, barcode 0002235) were collected in Wyoming and Colorado, respectively, where the plant is abundant. From our examination of herbarium specimens, including the types, *Chenopodium desiccatum* is a relatively low plant (up to 2 dm tall) with a very short primary stem, profuse branching with the lateral branches originating usually at a height of ca. 1–2 cm from the base, and inflorescence axes surpassing the leafy axes. Branches and leaves have a white-mealy excrecence, and the leaves are oblong to elliptic. The sepals become scarious and, at maturity, mostly cover the fruit. The fruits have a free (non-adherent), whitish pericarp. Nelson did not describe the seeds in detail, other than as more than 1 mm and “shining-black.” Our observations indicate that seed characters provide a robust way to further delimit and identify *C. desiccatum*. Seeds are indeed ca. 1 mm in diameter, round in face-view outline, but characteristically conical basally and relatively flat apically. The seed equatorial margin is differentiated, and the seed coat is usually smooth and shiny at the apex of the cone only (Fig. 1B, C). There is some variation of *C. desiccatum* in branching pattern (erect versus more spreading), but the seed of all is unmistakably conical, smooth, and with a somewhat shiny seed coat.

Chenopodium desiccatum was described and known as a low, spreading plant, and since its

original description, many *Chenopodium* specimens of similar habit have been identified as this species; however, fruit and seed morphology does not always support this determination. Several issues, we believe, contributed to *C. desiccatum* being immersed in taxonomic confusion since its inception.

Watson (1874) named *Chenopodium leptophyllum* (Nutt. ex Moq.) Nutt. ex S. Watson var. *oblongifolium* S. Watson, citing three specimens: *Fendler 717* (GH barcode 00263672), *Wright 1732* (US 43922 US barcode 00102549!, NY barcode 00007501!), and *Wright 1733* (Scan # NY barcode 00990680!). Of these, *Wright 1732* was designated as the type (Bassett and Crompton 1982, US 43922; Fig. 2A). Watson described this variety as “rather stout, 6–10 in high, branched ... leaves oblong ...” No seed features were mentioned. When Nelson (1902) described *C. desiccatum*, he cited it as a “form” of *C. leptophyllum* var. *oblongifolium* S. Watson “that by reason of its habit and other characters seems to deserve specific rank” (Nelson 1902, p. 362). Subsequently, Rydberg (1906a), without explanation, elevated *C. leptophyllum* var. *oblongifolium* to the rank of species, as *C. oblongifolium* (S. Watson) Rydb. [Note, however, that the name *C. oblongifolium* had already been used in an earlier, 1901 combination, as *Chenopodium oblongifolium* (Waldst. & Kit.) E.H.L. Krause, a taxon that we assume is unrelated to *C. oblongifolium* (S. Watson) Rydb. (Table 1); thus, this name was not available for Rydberg’s change in rank.] In his flora, Rydberg (1906b) includes both *C. desiccatum* A. Nelson and *C. oblongifolium* (S. Watson) Rydb. in the key to *Chenopodium*, with the distinguishing couplet:

Plant tall with nearly erect branches
 *C. oblongifolium*
 Plant low with spreading–ascending
 branches *C. desiccatum*

In successive years, Rydberg identified numerous specimens as *C. oblongifolium* (S. Watson) Rydb. (many seen by the first author at MO and NY), and those were of a plant larger than the types of *C. leptophyllum* var. *oblongifolium* [*C. oblongifolium* (S. Watson) Rydb., ined.]. In 1912, Rydberg described yet another species, *Chenopodium pratericola*, writing, “This has been included in *C. leptophyllum* (Moq.) Nutt. by some botanists



FIG. 1. A. Holotype specimen of *Chenopodium desiccatum* (E. Nelson 5048, RM 12545, barcode 0002236!). Note profuse branching. B–C. Seeds of *Chenopodium desiccatum*, from co-type specimen (J. H. Cowen s.n., RM 8460, barcode 0002235!), in side (B) and face (C) views. Note that seed is basally conical, apically flat.



FIG. 2. Lectotype of *Chenopodium leptophyllum* var. *oblongifolium* [*C. oblongifolium* (S. Watson) Rydb., ined.]; *C. Wright* 1732, 1851–1852 (US 43922, barcode 00102549), designated by Bassett and Crompton (1982). A. Herbarium specimen. Note erect stem and branching pattern. B–C. Seed in side (B) and face (C) views. Note seed morphology different from *C. desiccatum*.

Table 1. Three taxonomic entities of the genus *Chenopodium* recognized in this study, with synonymy.

<i>Chenopodium desiccatum</i> A. Nelson, <i>Bot. Gaz.</i> 34: 362 1902
<i>Chenopodium leptophyllum</i> (Nutt. ex Moq.) Nutt. ex S. Watson subsp. <i>desiccatum</i> (A. Nelson) Aellen, <i>Repert. Spec. Nov. Regni Veg.</i> 26: 136 1929
<i>Chenopodium leptophyllum</i> (Nutt. ex Moq.) Nutt. ex S. Watson var. <i>oblongifolium</i> S. Watson, <i>Proc. Amer. Acad. Arts</i> 9: 95. 1874
<i>Chenopodium oblongifolium</i> (S. Watson) Rydb., ined., <i>Bull. Torrey Bot. Club</i> 33: 137 1906 [not
<i>Chenopodium oblongifolium</i> (Waldst. & Kit.) E.H.L. Krause, <i>Deutschl. Fl.</i> ed. 2, 5: 177 1901]
<i>Chenopodium pratericola</i> var. <i>oblongifolium</i> (S. Watson) Wahl, <i>Bartonia</i> 27: 19 1954
<i>Chenopodium nitens</i> Benet-Pierce & M. G. Simpson, sp. nov.

although sometimes confused with *C. oblongifolium* (S. Watson) Rydb. on account of its broad leaf blades." By the time Rydberg's new treatment appeared in 1917, he was treating *C. oblongifolium* (S. Watson) Rydb. as a synonym of *C. desiccatum*. Furthermore, he stated that "*C. desiccatum* was described from a depauperate form" (Rydberg 1917, p. 241).

Standley (1916) listed both *Chenopodium leptophyllum* var. *oblongifolium* S. Watson and *C. oblongifolium* (S. Watson) Rydb. (ined.) as synonyms of *C. desiccatum* A. Nelson. He described *C. desiccatum* as "erect ... 1–4 dm tall ... leaf blades oblong or narrowly oblong to ovate-oblong ... seed horizontal, 1 mm broad, turgid, nearly smooth ... shining, the margin obtuse." His description seems to incorporate characters from *C. desiccatum*, *C. leptophyllum* var. *oblongifolium*, and *C. pratericola*. Subsequently, Macbride (1918) agreed with Standley in terms of the synonymy and priority to *C. desiccatum*, but only with regard to the original Fendler 717 specimen cited by Watson (1874) in the protologue of *C. leptophyllum* var. *oblongifolium*; however, Macbride indicated that the Wright 1732 and 1733 specimens also cited by Watson were different and "represent the broad-leaved form described by Rydberg (1912) as *C. pratericola*." Furthermore, Macbride stated that "*C. desiccatum* is only a starved condition of the typical form of *C. leptophyllum* and should be treated, as by Watson, as a variety, or according to the ideals of the N. A. Fl., reduced to synonymy." Macbride also demoted *C. pratericola* as "purely an herbarium species" Macbride's (1918) contributions did not have much impact on the taxonomy of *Chenopodium*, probably because he did not proceed to work on it any further. Some of his observations were correct, though, and he clearly recognized that *C.*

desiccatum was different from the type specimens for *C. leptophyllum* var. *oblongifolium*.

These conflicting viewpoints sealed *C. desiccatum* in taxonomic uncertainty, but the lectotype of *C. leptophyllum* var. *oblongifolium* S. Watson (*C. Wright 1732*, 1851–1852 (US 43922, US barcode 00102549); Fig. 2A) shows a plant that, although still small (approximately 1 dm tall) and with oblong leaves, clearly differs from *C. desiccatum* A. Nelson in its strictly erect habit and sparser branches and leaves. Most importantly, the seeds of *C. leptophyllum* var. *oblongifolium* lectotype and duplicate specimens are different from the holotype of *C. desiccatum* E. Nelson 5048, 12 August 1898, RM 12545, barcode 0002236 in being elliptic in side-view and lacking the shiny and smooth apical surface (Fig. 2B, C). *Chenopodium* scholars who followed dealt with these issues in different ways. Wahl (1954) treated *C. oblongifolium* (S. Watson) Rydb. as a variety of *C. pratericola* Rydb. and identified many specimens as *C. pratericola* var. *oblongifolium* (S. Watson) Wahl or as *C. desiccatum* var. *leptophylloides* (Murr) Wahl. Other *Chenopodium* scholars maintained the synonymy of both taxa, with priority given to *C. desiccatum* A. Nelson.

Based on our observations, the differences in seed morphology establish the distinctiveness of *C. desiccatum* from *C. leptophyllum* var. *oblongifolium* S. Watson [*C. oblongifolium* (S. Watson) Rydb., ined.] A. Nelson. Both should be treated as valid taxa, the former with basally conical and apically flat seed and the latter having an elliptic seed in side view. We now have evidence that specimens of the latter are not equivalent to *C. pratericola* Rydb. either, an issue we plan to treat at a later date.

A NEW SPECIES OF *CHENOPODIUM*. Among the specimens identified as *Chenopodium desiccatum* in North American herbaria, we found

many representatives of another taxon, which is somewhat similar in being frequently prostrate in habit (occasionally erect), with narrow leaves and a non-adherent pericarp. This taxon had remained unrecognized since the first known specimens were collected in 1916 or earlier. On close examination, however, it presented a very different, diagnostic seed, which is larger, lenticular (flattened on both sides), and has a highly shiny, finely "tessellate" seed coat. The seed of this taxon is highly distinctive, not only because of its uniform size and flatness, but particularly because of its sheen, a feature so distinctive that we think it should reflect in the choice of its epithet name: *nitens*, shiny.

Here we describe this new taxon and justify its distinctiveness from other named members of the genus.

***Chenopodium nitens*.** Benet-Pierce & M. G. Simpson, sp. nov. (Fig. 3 A–C, Fig. 4A).—TYPE: USA, Lassen County, California: Patterson Flats, *Pinus jeffreyi*, *Pinus ponderosa*, *Artemisia tridentata*; 40.740843° N, 121.165211° W, 1776 m elevation; July 10, 1934, *Howell 12543* (Holotype: CAS 391636!).

PARATYPES (see Fig. 4B for locality map). USA, CONONINO COUNTY, ARIZONA: Kaibab NF, Playa; 35.4175° N, 111.774° W, 2378 m elevation; September 17, 2004, *Nelson 63137* (RM 827645!). USA, LASSEN COUNTY, CALIFORNIA: Butte Lake, *Abies magnifica*, *Abies concolor*, *Artemisia* sp., *Lupinus* sp.; 40.54516° N, 121.315963° W, 1922 m elevation; August 18, 1938, M. K. *Bellue s.n.* (CDA 23383!). Poison Lake, Yellow Pine Forest, Dry sandy/ gravelly soil; 40.680141° N, 121.190131° W, 1717 m elevation; July 17, 2012, *Benet-Pierce 517* (SDSU 20366!). Spalding, Eagle Lake; *Amaranthus albus*, *Eriophyllum lanatum*, *Lupinus*, *Cryptantha*, Sandy; 40.663213° N, 120.77699° W, 1568 m elevation; July 8, 1934, *Howell 12499* (CAS 217241!). Lower Dry Lake, middle section, Sage-Brush Association; 40.596528° N, 120.667095° W, 1616 m elevation; July 15, 1978, *Ondricek 97* (CHSC 29910!). Lower Dry Lake, in dried, cracked mud, 40.611341° N, 120.675584° W, 1639 m elevation; August 6, 1978, *Ondricek 116* (CHSC 29946!). Long Lake on the S side of Hwy. 44 between Old Station and Susanville, 1.2 mi SE of County

Rd. A21; yellow pine forest-sagebrush scrub, in scattered groups on the dry bed of the lake; pericarp easily removed; 40.597539° N, 120.671992° W, 1647 m elevation; July 16, 1992, *Oswald 5103* (CHSC 58839!). Edge of Poison Lake, Route 44, Yellow Pine Forest; scattered plants in loose, dry soil along a low, stony ridge between the railroad and the lake; both prostrate and erect growth forms occur here; 40.679178° N, 121.189847° W, 1715 m elevation; August 7, 1993, *Oswald 5659* (CHSC 60892!). USA, MODOC COUNTY, CALIFORNIA: Lakeshore Res. Devil's Garden, Sage-Brush association; dry sunny, formerly submerged, adobe; 41.80436° N, 120.56291° W, 1524 m elevation; August 30, 1935, *Wheeler 3930* (MO 1174261! GH!). USA, DENVER COUNTY, COLORADO: Barnum, clay soil; 39.719166° N 105.035333° W, 1616 m elevation; *A. Eastwood 137a* (US 582385!). USA, WELD COUNTY, COLORADO: Kersey, in river bed; 40.395772° N, 104.532673° W, 1400 m elevation; July 18, 1916, *Johnston 611B* (US 837882!). West of Crow Creek (private land), margin of drying pond; 40.138342° N, 104.846566° W, 1520 m elevation; August 6, 1997, *Hazlett 10076* (NY 190171!). USA, HOOKER CO. NEBRASKA: On Middle Loup River, near Mullen, Flora of the Sand Hills, on sand hills; 42.090425° N, 101.110732° W; 970 m elevation; July 24, 1893, *P.A. Rydberg 1836* (US 210308!). USA, WASHOE COUNTY, NEVADA: Madelin Mesa, Pilgrim Lake at State line, sage-brush association; exposed mud flats at bottom of the dry lake; 40.881242° N, 119.99556° W, 1662 m elevation; July 10, 2001, *Tiehm 13686* (NY 572124!). USA, CULBERSON COUNTY, TEXAS: 3 m West of Kent along the Hwy., frequent in limestone depressions; 31.068° N, 104.226° W, 1291 m elevation; September 29, 1956, *Warnock 14312* (TEX 39846!). USA, SANTA FE COUNTY, NEW MEXICO: Santa Fe Creek, Santa Fe; 35.67° N, 105.93° W, elevation; Sept 4, 1847, *Fendler 717* (GH 00263672!). USA, AURORA CO, SOUTH DAKOTA: 43.276315° N, 101.026654° W, 770 m elevation; August 12, 1895, *E. N. Wilcox 73* (US 279295!). USA, PRESIDIO COUNTY, TEXAS: San Esteban Lake, Marfa; Plants of TransPecos TX, 30.16703° N, 104.029025° W, 1348 m elevation, September 1, 1940; *Hinckley 1361* (NY 1795671!, 1795672!). USA, ALBANY COUNTY, WYOMING: Wheatland Res. #2, edge

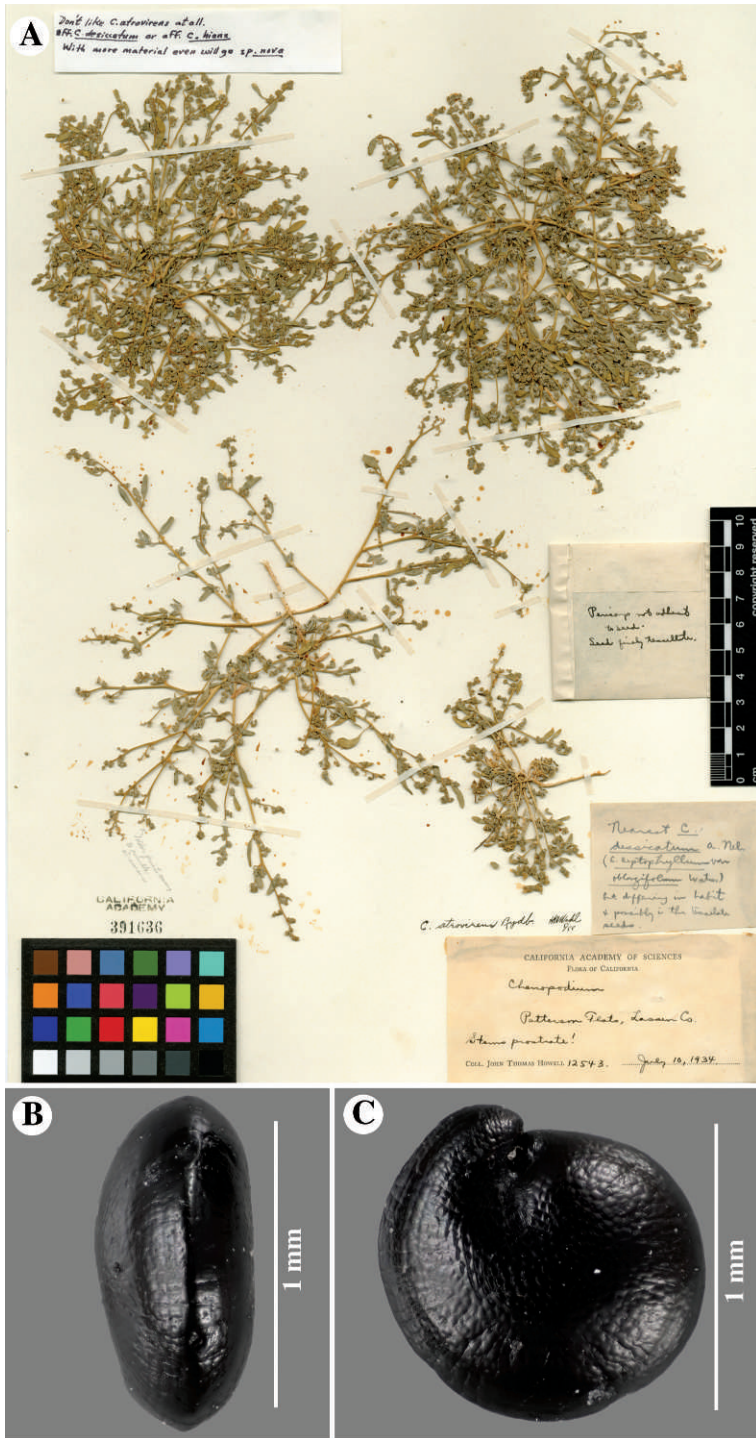


FIG. 3. Holotype specimen of *Chenopodium nitens* (Howell 12543, CAS 391636!). A. Herbarium specimen. B–C. Seeds of *Chenopodium nitens*, from holotype specimen, in side (B) and face (C) views. Note relatively flat shape on both basal and upper sides and shiny, finely tessellate surface.

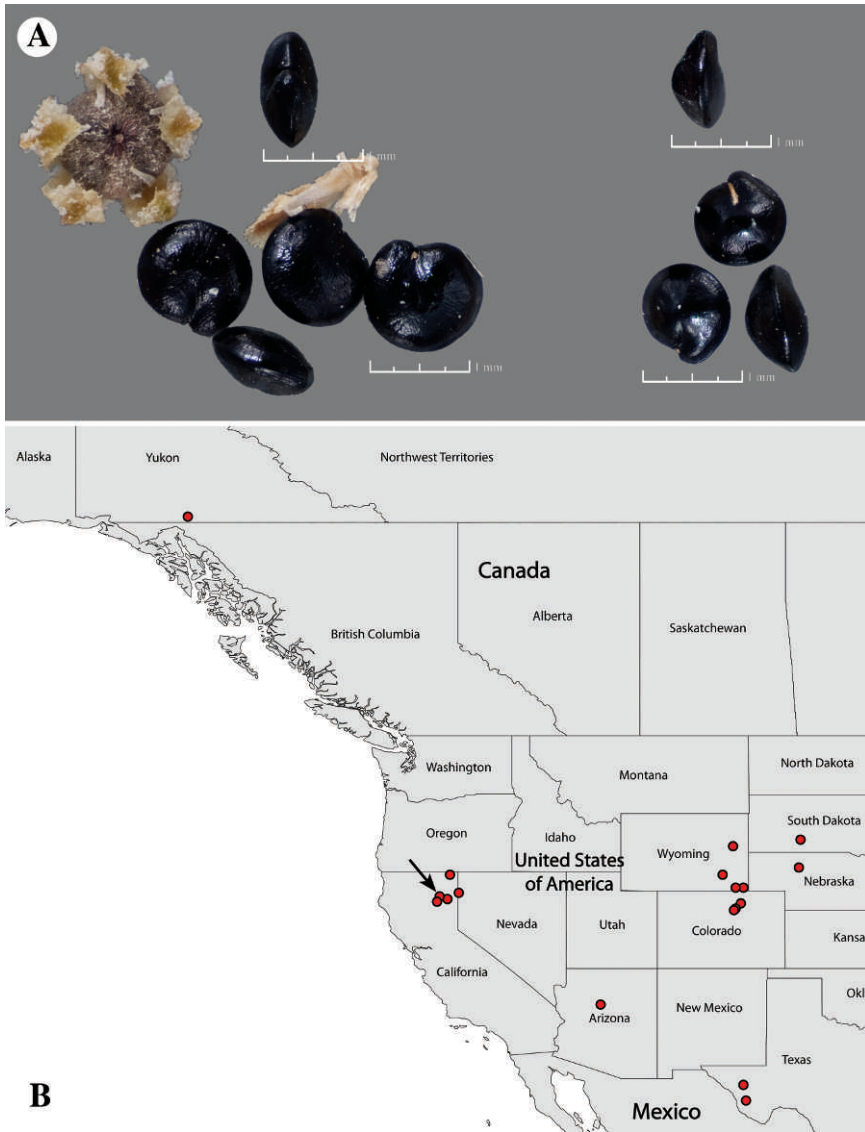


FIG. 4. A. Comparison of five seeds of *C. nitens* (at left, holotype, *Howell 12543*, CAS 391636!) and four of *C. desiccatum* (at right, co-type, *J. H. Cowen s.n.*, RM 8460, barcode 0002235!). Note differences in size, shape, and seed coat sculpturing. B. Distribution map of known collections of *Chenopodium nitens*. Arrow indicates location of designated holotype.

of water and sandy beaches; 41.81585° N, 105.628357° W, 2145 m elevation; July 21, 1981, *Hartmann 13761* (RM 531104!). USA, CONVERSE COUNTY, WYOMING: Thunder Basin National Grassland, outer limit of playa; 43.262092° N, 105.291928° W, 1460 m elevation; June 27, 2003, *Ebertowski 5425* (RM 827650!). USA, LARAMIE COUNTY, WYOMING: S. Powder River Basin, dry sandy gravelly creek bed and dry slopes and flats

above creek bed; 41.140566° N, 104.288187° W, 1653 m elevation; August 18, 1994, *Chumley 210* (RM 704732!). West of Cheyenne; disturbed area with *Amaranthus*, *C. berlandieri*; 41.139408° N, 104.848031° W, 1889 m elevation. August 12, 1988. *Dorn 4960* (NY 990872!). CANADA, YUKON: Carcross; 60.175° N, 134.711° W, elevation unknown; July 16, 1914, *Eastwood 713* (UC 851109!).

ENGLISH DIAGNOSIS. *Chenopodium nitens* is similar to *C. desiccatum* A. Nelson, differing in being mostly prostrate, occasionally erect, branching outwards to 40 cm, and having a highly shiny and flat, non-conical, finely tessellate seed.

DESCRIPTION. **Plant** an annual, mostly prostrate herb, occasionally erect, mostly branched from base, forming mats to ca 3 dm in diameter. **Leaves** alternate; petioles 2–3 mm long; blades narrowly elliptic or narrowly oblong to narrowly lanceolate, very rarely basally lobed, 6–14 (18) mm long, 2–4 mm wide, base cuneate or narrowly cuneate, apex acute, farinose abaxially, less so adaxially. **Inflorescence** cymes in axillary and terminal spikes, 1–7 cm long, bracteate below, ebracteate from midlevel to apex. **Flowers** perfect, radial, approximately 1 mm in diameter. **Perianth** uniserial; calyx synsepalous, with five lobes, distinct to near base; lobes apically obtuse, farinose abaxially. **Stamens** five, distinct, whorled, antisepalous; filaments terete, yellow, with laterally dehiscent, dithecal, sub-basifixed anthers. **Gynoecium** syncarpous, hypogynous; ovary superior, with two stigmas. Placentation basal with one curved ovule. **Fruit** horizontal; fruit wall not adherent to seed coat. **Seeds** flat, lenticular, ca. 1.1 (1.0–1.2) mm in diameter, margin acute; seed coat black, very shiny and finely tessellate.

DISTRIBUTION AND HABITAT. *Chenopodium nitens* occurs as scattered populations in a wide range of western North America, mostly west or near the Rocky Mountain divide (Fig. 4B). Populations are documented from northeastern California, central Arizona, western Nevada, west Texas, north-central Colorado, southeastern and central-eastern Wyoming, southwestern South Dakota, northwestern Nebraska and the Yukon in Canada.

PHENOLOGY. *Chenopodium nitens* appears to flower as early as May, and is in fruit from late June to September.

ETYMOLOGY. The epithet *nitens* is Latin for “shining, polished,” after the lustrous, shiny seed coat of this species.

SUGGESTED COMMON NAME. Shiny-Seed Goosefoot.

KEY INCLUDING *CHENOPODIUM NITENS*. See Appendix 1.

Interestingly, a note attached to our designated holotype specimen of *Chenopodium nitens* by its collector, John Thomas Howell (1903–1994) of the California Academy of Sciences, suggests the possibility of this being a new species: “Nearest *C. desiccatum* [sic] A. Nels. (*C. leptophyllum* var. *oblongifolium* Watson) but differing in habit and possibly in the tessellate seeds. With more material even will go *sp. nova*” (Fig. 3A). We were able to confirm the occurrence of *C. nitens* near the type locality in the summer of 2012; however, we discovered it not in Patterson Flats (Lassen County, California), where the type specimen was collected (we found the vegetation there heavily trampled by cattle), but nearby at one end of Poison Lake in Lassen Co. (*Benet-Pierce 517*, SDSU 20366!). We also discovered several specimens of *C. nitens* in various herbaria (see Paratypes), variously identified as *C. atrovirens*, *C. desiccatum*, *C. leptophyllum*, *C. leptophyllum* var. *desiccatum*, *C. oblongifolium*, *C. pratericola*, or *C. p.* var. *oblongifolium*.

Chenopodium nitens seems to be a more widely occurring plant across the western United States than *C. desiccatum*; it is likely that more specimens will be discovered once this species is recognized (Fig. 4B). New collections of *C. desiccatum* must also be scrutinized to evaluate the continued occurrence of that taxon in some of the historical localities. Conversely, there are not many plants of *C. desiccatum* that we could confirm other than in Canada and in Wyoming, Colorado, and possibly New Mexico in the United States.

Very recently, we had the opportunity to examine Fendler’s specimen 717 (GH barcode 00263672) and concluded that Macbride was right to accept the synonymy on the basis of this specimen, which, previous to examination of the seeds, would have been identified as *C. desiccatum*. The seed of this specimen, however, conforms to *C. nitens*, constituting another specimen of this species (cited as a paratype here) that had been lumped until now with *C. desiccatum*. As established before, the seed of *C. desiccatum* differs from *C. nitens* in being very slightly smaller (ca. 1 mm versus ca. 1.1 mm), conical in shape, and in having a smooth and duller, not finely tessellate surface.

Conclusions. We have been able to confirm that the use of fruit and seed characters is

essential for conclusive identification of *Chenopodium* taxa. In conjunction with the leaf morphology and general architecture of the plant, these reproductive characters constitute an effective tool in improving our knowledge of the group. Fruits and seeds are both stable and diagnostic of taxa, a very helpful attribute in a genus considered exceedingly variable. Given their small size, study of fruits and seeds require relatively high magnification and careful observation, because some differences, e.g., sculpturing pattern, can be subtle. Even so, in this study alone, we describe one new species and clarify the taxonomy of two others. All three taxa are relatively small and have similar leaves, but when seed morphology is considered, we obtain unequivocal confirmation that these are different entities (Table 1).

We are continuing to study fruits and seeds of other North American *Chenopodium* taxa. As our studies progress, we hope that their features will allow for more precise descriptions and improved determinations as presented here, which, in turn, could translate into more accurate diagnostic keys.

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Appendix 1.

Dichotomous key to selected *Chenopodium* taxa, modified from Clemants and Mosyakin (2003)

- 16** Leaves 2–3 times longer than broad or longer, oblong or oblong-lanceolate
- 17** Fruit with pericarp adherent, minutely granular-roughened *C. hians*
- 17*** Fruit with pericarp separable
- 18** Plants spreading or erect; leaf blades usually unlobed
- 19** Plants spreading, all branches from base, reddish at maturity; leaves oblong to lanceolate; coastal *C. littoreum*
- 19*** Plants spreading or erect; primary and secondary branched, not reddish; leaves oblong; inland
- 20** Plants usually spreading; seed flat both sides, seed coat finely tessellate and very shiny *C. nitens*
- 20*** Plants usually erect and branching early; seed conical on one side, seed coat not tessellate nor very shiny *C. desiccatum*
- 18*** Plants strictly erect; primary leaves usually with basal lobes
- 21** Perianth spreading from fruit fully at maturity *C. pratericola*
- 21*** Perianth spreading half way from fruit at maturity *C. foggii*
- 16*** Leaves 2–3 times longer than broad, usually narrowly oblong-ovate, broadly oblong or deltoid rhombic
- 22** Plant sparsely branched; leaves mostly broadly oblong, entire or slightly basally lobed; inflorescence loose; pericarp free *C. atrovirens*
- 22*** Plant branching divaricately; leaves narrowly oblong and with prominent basal lobes; inflorescence profuse and roundish in appearance; pericarp attached *C. nevadense*