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Penstemon spinulosus Wooton and Standley: New Mexico endemic, error, or introduction?

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Penstemon spinulosus was described by Wooton and Standley (1913) on the basis of a George R. Vasey specimen (U.S. National Herbarium no. 156865), which was said to have been collected in June 1881 in the Magdalena Mountains, Socorro County, New Mexico. Since its description, this taxon has been variously treated --including as a full species (e.g., Wooton and Standley op. cit., 1915); a subspecies of *P. heterophyllus* Lindl. (Keck 1932, Lodewick and Lodewick 1987); and a synonym of *P. bridgesii* Gray [=*P. rostriflorus* Kellogg] (Tidestrom and Kittell 1941, Martin and Hutchins 1981, Roalson and Allred 1995). In other instances, its existence as a New Mexico taxon has either been overlooked/ignored (e.g., Nisbet and Jackson 1960; Kartesz 1998) or disputed (Bleakly 1998), assuming the latter's rejection of *P. heterophyllus* as a member of that flora actually refers to *P. spinulosus* --treated as a subspecies of that species. Given this range of opinions, a status review of this taxon would seem in order --if for no other reason than to summarize and update what is known about *P. spinulosus* for people interested in the plants of New Mexico.

In describing *Penstemon spinulosus*, Wooton and Standley (1913) gave the following diagnosis: "Stems slender, ascending, 20 to 30 cm. high, purplish, minutely puberulent; leaves linear-oblanceolate to linear-lanceolate, numerous, obtuse or acute, slightly reduced upward, glabrous, narrowed at the base to sessile, 5 cm. long or less; bracts linear-lanceolate, 1 to 2 cm. long; inflorescence few-flowered; pedicels short, stout; sepals 7 mm. high, the lobes lanceolate, rather abruptly acuminate, not scarious, glabrous, the tips spreading; corolla 3 cm. long, dilated in the throat, not bearded, the spreading limbs 2 cm. wide; stamens included; anthers sagittate, dehiscent for half their length, finely spinulose along the sutures." They also stated that "This is more closely related to *P. bridgesii* than to any other southwestern species, but it may be separated by the glabrous instead of glandular inflorescence and the much dilated corolla tube. Whether the corollas are red as in that species cannot be told from the faded dried specimens." Although not stated as such, the basis for this presumed relationship undoubtedly had to do with the means by which the anthers open (dehisce) to disperse pollen in these two species. In both, dehiscence occurs via a short suture, slit, or orifice across the connective, with the free tips of the anthers remaining closed (e.g., Nisbet and Jackson 1960). By contrast, in other New Mexico penstemons the anthers open from the free tips all or part way to the connective region. Incidentally, I assume that Wooton and Standley (op. cit.) selected the name *spinulosus* for this taxon because of the spines along this suture, as quoted above.

As far as I am aware, the next serious taxonomic treatment of *Penstemon spinulosus* following its description was by David D. Keck (1932), in the first of a series of landmark papers on the genus published through 1945. In the former, he accepted *spinulosus* as a valid taxon, but assigned it subspecific status under *P. heterophyllus* Lindl. of California. This determination was based on his study of the type specimen, which he cited as being from the Santa Magdalena Mountains of New Mexico. In discussing his findings, Keck (op. cit.:410) indicated that *spinulosus* was most like *P.heterophyllus* ssp. *purdyi* Keck of central and northern California, but differing in having the "teeth [spines] margining [the] orifice of the anthers stout, subulate, often curved, not crowded, [and] as much as 0.40 mm long." He further stated (op. cit.: 410 and 413) that "It cannot be said that *spinulosus* has any discernable strong morphological characters on which to stand. But it should be recalled that the only known collection came from a little-frequented portion of New Mexico so many years ago that it would seem certainly to be native to that region rather than an introduction by man. The type specimen is well faded and scarcely complete enough to assure a complete comparison with purdyi. [However,] no California collection has been observed to have anthers directly comparable to those of spinulosus, so that the differences which at first appear trivial seem to be definite. Other characters have failed to disclose themselves but may be noted when the subspecies is recollected in New Mexico. Apparently this is a migrant from California at an early time when the desert region was a less imposing barrier to such a migration. At all events, *spinulosus* connects definitely with [*P.*] *heterophyllus* of California, rather than with any of the Utah or Great Basin species of the Section [*Saccanthera*]."

Although my review is not exhaustive, Keck's views on the taxonomic status of *Penstemon spinulosus* have apparently been accepted by most serious students of this genus. For example, in the most recent American *Penstemon* Society checklist (Lodewick and Lodewick 1987), *spinulosus* is listed as one of four accepted subspecies of *P. heterophyllus* --the others being restricted to California. However, for reasons that are not clear to me, Nisbet and Jackson (1960) made no mention of *spinulosus* in their monumental treatise on the penstemons of New Mexico. It is difficult to believe they overlooked it, for it certainly would have been noted in consulting Wooton and Standley (1913, 1915) during the course of their study. Perhaps instead they assumed that the taxon was described from an erroneously labelled specimen, i.e., one that had come from California rather than New Mexico. In fact, F.S. Crosswhite (pers. comm., Sep. 30, 1984) indicated to me that Keck may have later concluded this himself --although I have not found such a conclusion in print. Later works on New Mexico plants by Tidestrom and Kittell (1941), Martin and Hutchins (1981), and Roalson and Allred (1995) did treat *Penstemon spinulosus*, although all placed it in the synonomy of *P. bridgesii* Gray [=*P. rostriflorus* Kellogg]. I suspect this resulted from oversight rather than any disagreement with views expressed by Keck (1932), for these two taxa have little in common beyond the way their anthers dehisce. Finally, in a publication I have not seen (i.e., U.S.D.A. 1994--or is it 1997?), *P. heterophyllus* is listed as a New Mexico species--presumably based on Keck's (op. cit.) inclusion of spinulosus in that species. However, Bleakly (1998) rejects *P. heterophyllus* as a New Mexico species, whether the name is applied to the California species (as discussed above) or the Utah endemic *P. sepalulus* A. Nels. (of which he regards *P. heterophyllus* S. Wats. as a synonym; however, Lodewick and Lodewick [1987] consider the latter synonymous with *P. azureus* Benth. of Oregon and California).

Based on what is now known, I believe Keck's (1932) taxonomic assessment of *Penstemon spinulosus* is fundamentally correct --notably that this taxon is so similar to *P. heterophyllus* Lindl. as to be conspecific and thus included under that older name. As to whether *spinulosus* is a valid subspecies, it should be recalled that Keck found this taxon to differ in only minor degree from *P. heterophyllus* ssp. *purdyi*. In addition, *spinulosus* apparently remains known only from the unique type, which means its distinguishing characteristics rest on a single collection. As such, these could represent individual variation rather than the characteristics of an entire population. Thus, it seems safe to say that the infraspecific status of *spinulosus* is less certain than that at the species level. Beyond this, it should be empahsized that except for *spinulosus*, *P. heterophyllus* is otherwise a strict endemic of California. There, it is occupies an area extending from the southwestern to northwestern sections of the state (west of the Sierra Nevada), with an elevational range of 50 to 1600 m (Kartesz 1998). (It seems likely the species would also occur in northwestern Baja California, based on the availability of seemingly habitat there.)

Given the species's distributional metropolis in California, the authenticity of an alleged New Mexico specimen of *Penstemon heterophyllus* is certainly open to question --even if it does represent a distinct subspecies. Not only has *spinulosus* never been recollected, but *P. heterophyllus* is not known to occur in Arizona (Kearney and Peebles 1960) or even most of eastern California (Kartesz op. cit.). Surely, if the species were indeed relictual in western New Mexico (as presumed by Keck 1932), one would expect at least scatttered populations in the intervening area. In fact, a number of penstemons do display such a distribution, including *P. rostriflorus*, *P. eatonii* Gray, and *P. pseudospectabilis* M.E. Jones --which reach their eastern limits in western New Mexico. It should also be noted that *P. heterophyllus* is a member of the Section *Saccanthera* of the genus *Penstemon*, which contains 18-20 species found primarily in California and the Great Basin--with none in Arizona and only *P. heterophyllus* ssp. *spinulosus* allegedly from New Mexico (Lodewick and Lodewick 1987, Kartesz 1998). Taken together, this body of evidence suggests that regardless of its subspecific validity, it seems unlikely the type of *spinulosus* actually came from New Mexico. As a consequentce, the most likely explanation for the record is that the specimen was indeed mislabelled --having actually been taken in California rather than New Mexico.

As indicated earlier, the collector of the type of *P. spinulosus* was George R. Vasey (1822-1893), a respected botanist especially known for his studies of North American grasses (e.g., Vasey [and Richardson] 1889). As for his collecting plants in New Mexico, there is no question that he indeed did so between May and September 1881 (e.g., Wooton and Standley 1913). In fact, in addition to *Penstemon spinulosus*, that material also provided types for seven other plants described by Wooton and Standley (op. cit.). Moreover, additional of his 1881 collections were cited by those authors in discussing distribution in other New Mexico plants, including from Socorro and the Magdalena Mountains (Socorro Co.), Glorieta (Santa Fe Co.), and the Organ Mountains (Doña Ana Co.). Except for the type of *spinulosus*, I find no case in which Vasey's collection localities are at variance with those now known for plants in the state. Illustrative of this are other penstemons he collected there in 1881, of which I examined specimens of six species and subspecies (plus one hybrid) at the U.S. National Herbarium in 1991. These included material from what Vasey called "Santa Magdalena Mountain," namely a specimen of *P. jamesii* ssp. *ophianthus* (Penn.) Keck and another of the hybrid *P. thurberi* Torr. X *P. ambiguus* Torr. The latter bore the additional term "plain" after the locality, no doubt in reference to grasslands north of the Magdalenas --where such a population was later studied by Nisbet and Jackson (1960).

Although suggestive, the above obviously does not preclude the possibility that Vasey incorrectly labelled some of the New Mexico plants he collected in 1881, most notably in the case of the type of *Penstemon spinulosus*. The fact is that virtually all collectors occasionally mislabel specimens, and quite likely Vasey was no exception to this rule. In fact, other evidence might do more to advance this possibilty, such as a revelation that Vasey was a chronic mislabeler of specimens, or that some of his 1881 material became intermixed with other collections. On the other hand, in the absence of such findings and given that Vasey did indeed collect plants in the Magdalenas that year, it is possible he actually did secure the type of *spinulosus* there. If so, this would fit Keck's (1932) perception of this taxon as a naturally-occurring population of *P. heterophyllus*, as disjunct from others in California it might be. However, another possibility is that the Magdalenas occurrence of this species resulted from an introduction by 19th-century humans.

While Keck (1932) believed the early date of collection mitigated against *Penstemon heterophyllus* having been introduced into the Magdalenas, he may have underestimated the potential for this to have occurred. While there were certainly no easy means of transit or largescale human movements from California to the Magdalena region as of 1881, horseback and wagon travel by a select few was another matter. For example, prospectors, miners, and their ilk had been moving about the western U.S. since the 1840-1850's searching for mineral riches, and that travel was certainly not limited to an east-to-west direction. In fact, Stanley (1973) wrote that "soldiers from California stationed in New Mexico during the Civil War made unsuccessful efforts to locate gold, silver, [and] copper" [in the Magdalena Mountains] --which would have been 15-20 years before Vasey's visit . By 1866, a promising mineral discovery had been made in the range, and an 1879 boom led by silver and then zinc resulted in the establishment of the mining town of Kelly (Julyan 1996). Miners and others flocked to the area from a variety of places, including California. By the beginning of 1880, at least 200 people were working in the area (Stanley op. cit.), and the

population of Kelly eventually reached 3000 (Julyan op. cit.). Given these events, it is conceivable that seeds of *P. heterophyllus* could have found their way into wagons or packs in California, then been transported to establish a population of this species in the Magdalena Mountains. If this produced even a temporary population of the species there, Vasey could have collected specimens and never had an inkling the occurrence was anything out of the ordinary.

If 19th-century humans indeed brought *Penstemon heterophyllus* from California into the Magdalena Mountains, this would constitute the earliest introduction of a non-native penstemon into the wild in New Mexico. However, it would not be the only or last such instance, and in fact the process may be escalating --as discussed below. Among other likely examples was a population of *P. palmeri* Gray documented by Nisbet and Jackson (1960) in 1959, growing along U.S. Highway 66, some 70 miles east of Albuquerque in the Pedernal Hills, Torrance County. This occurrence represented the first confirmed state record of this species, but even earlier may have been a population in eastern Santa Fe County. The latter was along the Santa Fe Trail east of Santa Fe, where pointed out to me in the 1980's by a longtime resident (and wildflower enthusiast) --who said the species had been there for decades and had not been planted by anyone to his knowledge. In both cases, the New Mexico "colonies" were some 300 miles east of central Arizona, the nearest place where natural populations of the species occur (Kearny and Peebles 1960). Another obvious introduction is that of *P. cobaea* Nutt. of the humid southern Great Plains and vicinity, wild populations of which have been found 150 or more miles to the west in Sandoval, Taos, and Santa Fe counties (occurrences in Quay County might represent a natural population). These records date from the 1970's and 1980's, which coincides with rising local popularity of penstemons as cultivated plants --a factor that obviously increases the potential for non-native species to spread into the wild. (An even earlier arrival of this species at Flagstaff, Arizona led to the collection of what became the type for *P. hansonii* A. Nels. [Kearney and Peebles 1960]!). Finally, road and highway departments have also become agents in the extralimital dispersal of penstemons, namely through the inclusion of the seeds in mixes broadcast to stabilize and beautify transportation corridors. For example, there are several collections of *P. strictus* Benth. from along roadways in Catron and Grant counties, where this Rocky Mountain species is certainly not native and was unknown in the wild before the 1970's.

Of the three scenarios discussed here, mislabelling is admittedly the most plausible explanation for the alleged occurrence of *Penstemon heterophyllus* in New Mexico's Magdalena Mountains in 1881. While this scenario may not be supported by evidence presented here, it certainly deserves further examination --including along a number of additional avenues of inquiry. For example, if Vasey kept a catalog, journal, and/or notes, these might contain some indication of whether he indeed collected this penstemon in New Mexico. In addition, a comparison of the type of *spinulosus* with other Vasey material might also prove useful, including to confirm this was indeed one of his specimens. Yet other insights might be gained from examination of the U.S. National Herbarium catalog, such as determining when, by whom, and other details concerning the accessioning of the type into that collection. In the case of the date, this obviously could have been any time after the type was collected (1881) and before *spinulosus* was described (1913). It may be the longer it took to accession the specimen, perhaps the more likely it may have been mislabelled. As for Vasey himself, it would be would be interesting to know when and if he ever collected plants within the range of *P. heterophyllus* --especially prior to the accession date of the type of *spinulosus*.

Clearly, if evidence emerges suggesting the type of *Penstemon heterophyllus* ssp. *spinulosus* did not come from New Mexico, then the taxon should be deleted from the flora of the state. However, if such is not forthcoming, then the possibility will remain that the record is valid on its face --which means the type could have indeed originated in New Mexico. Given this, what factors might help determine whether this represents a relictual or an introduced population? As indicated earlier, although Keck (1932) found only minor differences between *spinulosus* and other *P. heterophyllus* populations, he considered these adequate to accord the former subspecific status. However, a restudy of specimens might provide new insights into geographic variation in this complex, with particular emphasis applied to the anther characters used by Keck to distinguish *spinulosus*. Once completed, two possible outcomes might result --the first showing that *spinulosus* characters are also present in California populations of *P. heterophyllus*, and the second that they are not. If the characters hold up, this would support Keck's perception of *spinulosus* as a relictual population of this species. If they do not, this would argue for "spinulosus" resulting from a recent

introduction of *P. heterophyllus* into New Mexico (or a mislabelled collection). However, a possible complication is that some characters in this complex may vary ecotypically, e.g., the teeth around the anther sutures could be better developed in plants growing in more arid areas. If this were the case, then a population of *P. heterophyllus* in the Magdalenas could prove divergent but still be introduced!

My point is that no guarantee exists that further study will fully resolve questions concerning the origin of the type and thus the status of *Penstemon heterophyllus* ssp. *spinulosus* (Wooton and Standley) Keck. Thus, one may still end up having to choose among scenarios in seeking such resolution, which could then decide this taxon's place in the state's flora. Whatever the choice, hopefully it will be arrived at through the broadest and most objective approach possible, rather than subjective or arbitrary judgment. No taxon deserves the latter treatment, even though this has been the fate of *Penstemon spinulosus* by dent of its being ignored, incorrectly synonymized, or dismissed because of doubts about its legitimacy as a member of New Mexico's flora. Indeed, until and even after its status is resolved, both the type and the taxon it spawned should continue to be matters of interest --if not attention --for New Mexico botanists. After all, the process of determining the status and relationships of living organisms is ongoing, and today's dictum may be tomorrow's erroneous conclusion. If anyone doubts this, a case in point is *Penstemon metcalfei* Wooton and Standley, a taxon described from the Black Range and long relegated to the synonymy of *P. whippleanus* Gray (e.g., Keck 1945). Quite to the contrary, Todsen (1998) has shown that *P. metcalfei* is in fact a distinctive member of the *Oliganthi* alliance, which in New Mexico consists of four other nominal species (Crosswhite 1965). Oddly enough, no member of this group had previously been reported from the Black Range, and now we can see why! Who knows? Perhaps further inquiry will be equally revealing in the case of *Penstemon heterophyllus* ssp. *spinulosus*, which certainly populates New Mexico's botanical archives --if not a site somewhere in the wild.

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An Investigation of *Salsola* L. (Chenopodiaceae) in New Mexico

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Abstract

There are currently only two verified species of *Salsola* in New Mexico: *S. collina* Pallas and *S. tragus* L. The former is a recent introduction characterized by elongate flowering branches, appressed flowering bracts, and wingless fruits. The latter has been known in New Mexico since 1894, has a checkered and difficult nomenclature, and is characterized by reddish stem striations, soft and semi-succulent seedling leaves, long narrow cauline leaves, recurved flowering bracts, central perianth segments that are rounded, lax, and spreading, and winged fruits. *Salsola paulsenii* Pallas is not known definitely from New Mexico, but a few specimens may represent hybrid derivatives or intermediates suggestive of this species.

Introduction

The genus *Salsola* L., in the family Chenopodiaceae, comprises as many as 150 species world-wide, with both herbaceous and shrubby members. Of the six or seven species occurring in the United States, all may be considered alien introductions from Eurasia, some perhaps naturalized (Kartesz 1994; Mosyakin 1996).

The species are widespread throughout much of North America, regularly occurring in disturbed, often dry and barren, habitats, and commonly considered undesirable or noxious weeds. They go by various common names, including Russian thistle, saltwort, saltbush, tumbleweed, wind witch, and Russian cactus.

The genus is characterized by the following features: flowers bisexual and solitary (rarely in 2s or 3s) in the axils of bracts; perianth segments 5 (corolla lacking), at maturity covering the fruit and in many species developing wings, or wingless; stamens 5; styles and stigmas 2; pericarp adherent; seed horizontal.

Until recently, it was thought that only a single species was present in New Mexico (Martin & Hutchins 1981). The report of a second in 1995 (Roalson & Allred 1995) and a third in 1996 (Mosyakin 1996) prompted this investigation. Our purposes were to verify what species were present in the state and to document their distributions. The investigation was not meant to be a taxonomic revision of the species, but more floristic in nature, as we were concerned strictly with New Mexico populations.

Historical Aspects

Salsola was first noticed in New Mexico in the fall of 1894. The October issue of "Southwestern Farm and Orchard" of that year carried an announcement that Russian thistle had been found at Santa Fe and included a warning to the farmers of the territory about its noxious character (Wooton 1895). A note affixed to a specimen (at NMC) collected in 1896 by S.S. McKibbin from Lamy, New Mexico, records that he "has

seen it for two years in this locality," corroborating the 1894 observation. An early agricultural bulletin identified the plants as *Salsola kali* L. var. *tragus* (L.) Moq. and reported its occurrence in New Mexico Territory only in Santa Fe County and perhaps Chaves County, near Roswell (Wooton 1895). By 1915 the plant was reported as "one of the commonest introduced weeds, …to be found in practically every locality in the State except in the higher mountains" (Wooton & Standley 1915). The most recent accounting for New Mexico characterized the distribution as "widespread" and mapped its occurrence in 19 of the state's 32 counties (Martin & Hutchins 1981).

Beatley (1973) called attention to an over-looked species in western United States, *Salsola paulsenii* Pallas, and reported it from Arizona, California, Nevada, and Utah. It was not reported for New Mexico by either Wooton and Standley (1915) nor Martin and Hutchins (1981), but a specimen from Luna County seemed to fit this species and it was listed for the state by Roalson & Allred (1995).

Salsola collina Pallas was first reported for the state by Mosyakin in 1996, but a search of herbarium specimens revealed the earliest collection of this species to be in 1952 from the Sacramento Mountains in Otero County, though it was not correctly identified until this review was undertaken.

Previous Work and A Synopsis of the Diagnostic Features

Uncertainty about the identity of *Salsola* species is presaged by a profusion of names and synonyms, at least for the common Russian thistle plant found throughout the state (Table 1). We follow here the classification scheme employed by Gleason and Cronquist (1991) and Mosyakin (1996), which recognizes the main taxa at the specific level, rather than a slightly more conservative approach that elaborates the variation at the subspecific level, as represented by Kartesz (1994).

Salsola collina. Beginning with the first report for the United States (Moore 1938) and in subsequent early reports (Cory 1948; Gleason 1952; Schapaugh 1958) there has been no confusion about the identification of *S. collina*. This species is characterized by the following features (Table 2): flowering branches noticeably elongate and virgate, hardly prickly; bracts imbricate and appressed to the flowering branches, only spreading at the tips; central perianth segments rounded at the apices, lax, and spreading; fruiting wings absent or essentially so. Plants of *S. collina* are rather easily determined, and the difference in growth form is conspicuous when growing with S. tragus. The lack of perianth wings in fruit is especially diagnostic.

Salsola paulsenii. Beatley's (1973) characterization of *S. paulsenii* for North American plants has been followed in essentially all subsequent treatments (Table 2): plants prickly from the seedling stage through maturity, yellow-green when young, pale to straw-colored when mature; stems not or hardly striated; cauline leaves short (< 2 cm) and thick (> 1, mostly 1.5-2, mm), strongly stiff and spinose even when young; central perianth segments acute at the apices, spinose, and erect; fruiting wings prominent, 6-12 mm in diameter.

Salsola tragus. As seen by the overabundance of scientific names applied to this taxon, *S. tragus* has been the source of confusion, both taxonomic and nomenclatural, since it was first found in the United States, having arrived with flax seed in South Dakota in 1873 or 1874. Although there is some overlap in features according to various authors who treat two or more of the species in question, this species has generally been characterized by the following (Table 2): plants soft and not at all prickly in the seedling stage, becoming stiff and prickly with maturity; stems with red striations; cauline leaves relatively long (2-8 cm) and narrow (< 1 mm), soft and succulent in young plants, rigid and spinose in mature plants; central perianth segments rounded at the apices, lax, and spreading; fruiting wings prominent, 3-6 mm in diameter (though Mosyakin [1996] allows up to 10 mm diameter in this species).

The Identification of New Mexico Plants

In an attempt to correctly determine which species occur in New Mexico, we examined all the specimens of New Mexico *Salsola* (132) from the herbaria at New Mexico State University (NMC and NMCR), San

Juan College (SJC), University of New Mexico (UNM), and White Sands Missile Range, as well as a few representative specimens of *S. paulsenii* from Missouri Botanical Garden (MO) that had been identified as such by Beatley or Mosyakin (none from New Mexico). Features emphasized by various authors as being diagnostic for one species or another (Table 2) were compared with the variation present in New Mexico plants, with the following observations.

Salsola collina. Three plants were determined as *Salsola collina*, from Lincoln, Otero, and Santa Fe counties. In addition, this species was seen by Forbes in southern McKinley County in October 1998, but not vouchered by an herbarium specimen. Each specimen was typical, with elongate inflorescence branches, appressed bracts, and wingless fruiting perianth.

Salsola tragus and *Salsola paulsenii*. Most of the remaining plants were easily identified as *Salsola tragus*, as characterized above. Many of the specimens were immature, without flowers or fruits, but with long, semi-succulent, soft leaves and prominent red striations on the stems typical of *S. tragus*. None of these immature specimens exhibited leaves or stems that resembled those of *S. paulsenii*: short, stiff, thickened leaves and pale stems lacking striations. Occasionally, a small (but mature fruiting) specimen may mimic a *paulsenii* seedling in size and in having prickly leaves, but the presence of fruits allows one to determine that the specimen is not a seedling and that the prickly leaves are not seedling leaves. This was the case with the plant that was the basis for the report off *S. paulsenii* in Roalson and Allred (1995).

None of the specimens with mature fruits exhibited the spinose, erect-appressed, acute central perianth segments that both Fuller (1986) and Mosyakin (1996) emphasized as characteristic of *Salsola paulsenii*.

Many authors (see Table 2) relied upon leaf width and fruiting perianth (wing) diameter to distinguish these two species. New Mexico specimens with both cauline leaves and mature fruiting structures were plotted for these two features (Fig. 1). Plants representative of *S. paulsenii* should fall in the larger circle, with wide leaves (> 1 mm) and large wing diameters (6-12 mm), and those representative of *S. tragus* should fall in the smaller circle, with narrow leaves (< 1 mm) and smaller wing diameters (3-6 mm). Most of the plants aligned with *S. tragus* on these features; only one plant fell within the *paulsenii* plot. This was a plant gathered from Taos County in 1907 (Adair s.n., UNM) that seemed to be intermediate between these two taxa. Lack of stem striations, short thick leaves, and large wings implied *paulsenii*, though the leaves were not as thick and stiff as typical *paulsenii*; central perianth segments that were blunt, lax, and not at all spinose suggested *tragus*. Beatley (1973) reported hybrid swarms between the two species where they grow together, but noted that *S. paulsenii* seemed to be the more common species at lower elevations. The Adair specimen is problematical. Perhaps it represents one of these intermediate hybrid derivatives that found its way to Taos in 1907 but has failed to survive? When compared with the verified specimens of typical *S. paulsenii*, we were unconvinced that it belonged to that species, and prefer to treat it as an intermediate form.

We note also the numerous specimens with large wing diameters, but with narrow leaves (which were all longer than 2 cm) (Fig. 1). These would all be aligned with *S. tragus* by Mosyakin (1996), who extended wing diameter to 10 mm for this species and relied heavily on the spinose nature of the central perianth segments to identify *S. paulsenii*. As with the Adair specimen, these might represent hybrid derivatives (not hybrids themselves) between the two species.

There were a few other plants that might be mistaken for *Salsola paulsenii* because of their extremely prickly nature. These were all robust, mature plants with elongate inflorescences and well-developed fruits subtended by short thick flowering bracts suggestive of the cauline leaves of *S. paulsenii*. However, they had reddish stem striations, long narrow cauline leaves, small diameter fruiting wings, and non-spinose central perianth segments characteristic of *S. tragus*. None of their features in reality aligned with *S. paulsenii*; it was their extreme robustness that tended to confuse.

Nomenclature and Synonymy

We follow here the nomenclature and classification of Mosyakin (1996), and have taken the synonymy from him, Jones et al. (1997), and Kartesz (1994).

Salsola collina Pallas

Salsola tragus L., Cent. Pl. 2:13. 1756.

Salsola kali L. var. *tragus* (L.) Moquin-Tandon

Salsola kali L. subsp. *tragus* (L.) Celakovsky

Salsola kali L. subsp. *tragus* (L.) P. Aellen

Salsola australis R. Brown

Salsola kali L. subsp. *tenuifolia* I. Tausch, nomen nudum

Salsola kali L. var. *tenuifolia* Moquin-Tandon

Salsola kali L. var. *angustifolia* Fenzl

Salsola kali L. var. *leptophylla* Bentham

Salsola tragus L. subsp. *iberica* Sennen & Pau

Salsola iberica (Sennen & Pau) Botschantzev ex Czerepanov

Salsola kali L. var. *pseudotragus* G. Beck

Salsola pestifer A. Nelson

Salsola ruthenica Ilijin

Salsola kali L. subsp. *ruthenica* (Ilijin) Soó von Bere

Salsola kali L. var. *austroafricana* P. Aellen

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Table 1. Scientific Names[1] Applied to *Salsola* Species by Various Authors

	Salsola tragus	***Salsola paulsenii***	***Salsola collina***
Wooton 1895	*S. kali* var. *tragus*	-	-
Wooton & Standley 1915	*S. pestifer*	-	-
Tidestrom 1925	*S. pestifer*	-	-
Munz & Keck 1968	*S. kali* var. *tenuifolia*	-	-
Kearney & Peebles 1969	*S. kali* var. *tenuifolia*	-	-
Correll & Johnston 1970	*S. kali*	-	-
Beatley 1973	*S. iberica*	*S. paulsenii*	*S. collina*
Botschantzev 1974	*S. australis*	-	-
Martin & Hutchins 1981	*S. kali* var. *tenuifolia*	-	-
Crompton & Bassett 1985	*S. pestifer*	*S. paulsenii*	*S. collina*
Fuller 1986	*S. australis*	*S. paulsenii*	-

Gr. Pl. Flora Assoc. 1986	*S. iberica*	-	*S. collina*
Gleason & Cronquist 1991	*S. tragus*	-	*S. collina*
Weber & Wittmann 1992	*S. australis*	-	*S. collina*
Welsh et al. 1993	*S. pestifer*	*S. paulsenii*	*S. collina*
Hickman 1993	*S. tragus*	*S. paulsenii*	-
Kartesz 1994	*S. kali* subsp. *tragus*	*S. paulsenii*	*S. collina*
Mosyakin 1996	*S. tragus*	*S. paulsenii*	*S. collina*
Jones et al. 1997	*S. tragus*	-	-

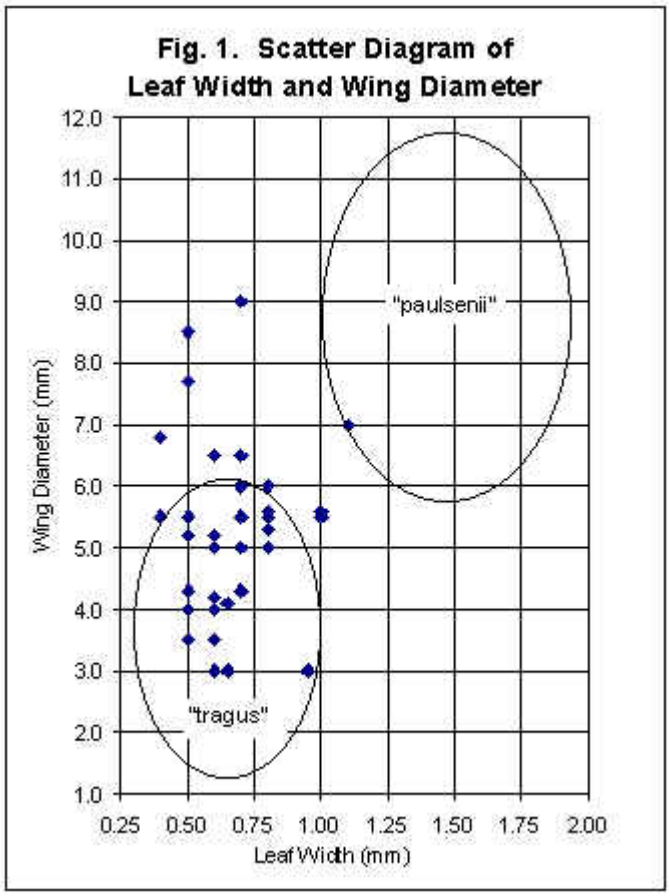
[1] Authorship of the names is supplied in the Nomenclature section.

Table 2. Characterization of the species of *Salsola* attributed to New Mexico based on representative sources prior to this study[1]

	S. tragus	***S. paulsenii***	***S. collina***
Plant color	Blue-green[a]	Yellow-green[ad]	Green[e]
Seedling form	Soft, lax, not prickly[ab] Branches not cruciform[a]	Stiff, rigid, prickly[ab] Branches cruciform[a]	-
Mature form	Stiff, prickly[ab]	Stiff, Prickly[ab]	Scarcely prickly[a]
Stem striations	Reddish[ace]	Lacking, or pale reddish[ae]	Green or red-streaked[ce]
Leaves, pre-fruiting	Lax, not rigid nor prickly[a]	Rigid & prickly[ae]	Lax, not rigid nor prickly[a]
Cauline leaf length (cm)	2[a] 2-8[c] 1.5-6[e]	0.5-1.5[a] 0.5-2[d]	2-6[ce]
Cauline leaf width (mm)	Commonly 0.5, < 1[ad] 1[c] 0.3-0.8[e]	1-1.5[ad] 1-2[d]	1[ce]
Flowering bracts, mature	Reflexed[cde]	Reflexed[d]	Appressed, imbricate[cde]
Calyx segment apices	Rounded, lax, spreading[bd]	Acute, spinose, erect[bd]	Lax, not spinose, spreading[d]
Fruiting calyx wing length (mm)	< 2[ae]	3-4[a] 2-4[d]	Not winged[acde]
Fruiting calyx wing diameter (mm)	3-4[b]	6-7[b] 7-12[d]	Not winged[acde]

	3-5(6)[c] 4-10[d]		

[1] According to [a]Beatley (1973), [b]Fuller (1986), [c]Great Plains Flora Assoc. (1986), [d]Mosyakin (1996), and [e]Welsh et al. (1993)



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Rare, Threatened, and Endangered Plants:

[There are numerous reports and discussions concerning rare New Mexico plants on the New Mexico Rare Plant Technical Council web site: http://biology.unm.edu/~chelo/nmrptc1.html]

Journals, Newsletters, Etc.:

Native Plant Society of New Mexico Newsletter. Editor: Tim McKimmie, 1105 Circle Drive, Las Cruces, NM 88005 🕮

New Plant Distribution Records

New records for New Mexico are documented by the county of occurrence and the disposition (herbarium) of a specimen.

— Robert Sivinski (Box 1948, Santa Fe, NM 87504), garden escapes:

Symphytum officinale L. (Boraginaceae): Santa Fe Co. (UNM).

Nepeta cataria L. (Lamiaceae): Santa Fe Co. (observation).

Pyracantha coccinea Roemer (Rosaceae): Bernalillo Co. (UNM).

— James McGrath (Box 2605, Tijeras, NM 87059)

Phytolacca americana L. (Phytolaccaceae): Eddy Co. (UNM)

Carex diandra (Cyperaceae): Rio Arriba Co. (UNM)

Juncus hallii Engel. (Juncaceae): Rio Arriba Co. (UNM)