

**A NEW VARIETY OF *EPHEDRA TORREYANA* (EPHEDRACEAE) FROM
WEST TEXAS AND CHIHUAHUA, WITH NOTES ON HYBRIDIZATION IN
THE *E. TORREYANA* COMPLEX**

Tom Wendt

Plant Resources Center, University of Texas, Austin, Texas 78713 U.S.A.

(Present Address: Department of Botany, Louisiana State University, Baton
Rouge, Louisiana 70803 U.S.A.)

ABSTRACT

Ephedra torreyana var. *powelliorum* is described as a new variety from the Río Conchos area of eastern Chihuahua, México, and the adjacent Big Bend area of Texas. Intergradation with the typical variety occurs in western Texas. *Ephedra torreyana* appears to be unusual among North American ephedras in its greater propensity for hybridization with other species, and this tendency must be taken into account in understanding the evolution of this complex.

KEY WORDS: *Ephedra*, Ephedraceae, Texas, Chihuahua, México, hybridization

RESUMEN

Ephedra torreyana var. *powelliorum* se describe como una variedad nueva, de la región del Río Conchos de Chihuahua y el área colindante del "Big Bend" de Texas. Se encuentra una zona de intergradación con la variedad típica en la parte occidental de Texas. Al parecer, *Ephedra torreyana* difiere de las demás especies norteamericanas del género por su propensión a la hibridación interespecífica, y hay que tomar en cuenta dicha tendencia para poder entender la evolución de este complejo de especies.

PALABRAS CLAVE: *Ephedra*, Ephedraceae, Texas, Chihuahua, México, hibridación

During the study of the species of *Ephedra* (Ephedraceae) of the Chihuahuan Desert for the preparation of a taxonomic treatment for the upcoming *Chihuahuan Desert Flora* (M.C. Johnston & J. Henrickson, eds.), a number of populations related to *E. torreyana* S. Watson were found to differ markedly in several respects from that species. These populations are here described as a new variety, and the justification for infraspecific rank is discussed, along with the apparent importance of hybridization in this complex.

***Ephedra torreyana* S. Watson var. *powelliorum* T. Wendt, var. nov.**

TYPE: MEXICO. Chihuahua: NE side of Sierra Cuchillo Parado, 29°35'N, 104°54'W, upper Cretaceous gypseous limestone outcrop, gypseous calcareous rocky soil, matorral desértico inerme of *Ephedra*, *Dasyllirion*, *Acacia*, *Larrea*, *Fouquieria*, 950 m, 4 Apr 1973, M.C. Johnston, T.L. Wendt, & F. Chiang C. 10579 (♀) (HOLOTYPE: TEX!; Isotypes: MEXU, NY!).

Ephedra torreyana S. Watson var. *torreyana* similis sed seminibus non scabris, tubulo integumentis interioris 0.3-1.0 mm ab integumento exteriori exserto, antheris 2-6(-7) sessilibus differt.

Spreading, intricately branched low shrubs 0.3-0.8 m tall; branches divaricate with angle 50-90°, 1-several per node, mostly stout, straight, terete, to 4.5 mm thick in green (younger) portions, these younger portions dull gray green to medium olive green, usually glaucous, glabrous; longitudinal ridges rather irregular and often not strongly marked, 15-45 at bases of green portions, moderately asperous to usually smooth; stomata obscure to moderately prominent at 10×, present both in furrows and on ridges; internodes mostly 1.5-4.0 cm long; bark of older stems light to dark gray. Leaves 3 per node, 1.1-2.5 mm long, united 2/5-3/5 their length, the free portions ovate or deltate to lanceolate with apices rounded to acute, green to light brown in center with scarious margins often overlapping at base, the margins erose to ciliate especially distally; basal leaves generally with relatively shorter free tips; sheaths soon splitting, leaving tattered pale gray remnants above the thin red-brown nodal line (old leaf bases rarely becoming swollen, black and persistent). Staminate cones 1-several per node, sessile or nearly so (scaly stipe to 1 mm), 4-7 mm long; bracts ternate (rarely binate distally), with 1-3 whorls of reduced sterile bracts at base and 2-7 whorls of fertile bracts, bracts of a whorl united at their bases; fertile bracts suborbicular above their fused bases, 1.5-2.5 mm long, pale red-brown, sometimes also greenish, with broad

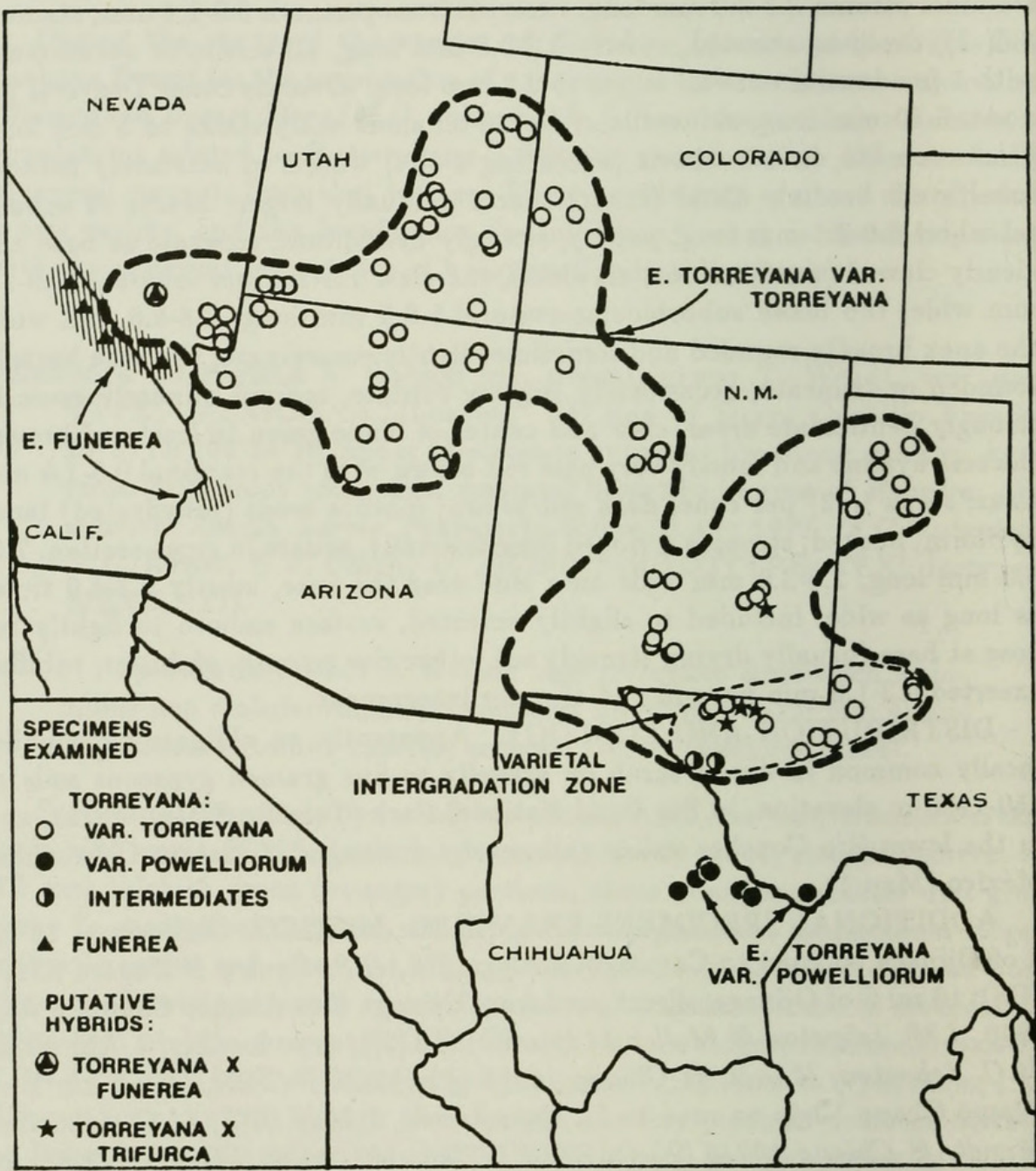
scarious minutely erose margins; "perianth" 1.6-2.5 mm long, barely included to barely exerted from bract, flattened obovoid, sometimes very broadly so; staminal column 2.3-3.2 mm long, exerted from perianth 0.3-1.4 mm; stamens 2-6(-7), ovoid to obovoid, mostly 0.3-0.5 mm long, all sessile or occasionally with 1-few central ones on stipes to 0.2 mm long. Ovulate cones 1-several per node, 6-10 mm long, subsessile or borne on short scaly stalks to 3 mm long; bracts ternate, in 4-5 whorls (excluding 1-3[-4] whorls of extremely reduced basal/stalk bracts); distal (inner) bracts gradually larger; bracts of subdistal whorl 6.0-8.5 mm long, papery, strongly cymbiform, separate at base and clearly clawed (rarely almost clawless), the claw 1.5-3.0 mm long and 1.0-1.5 mm wide, the blade suborbicular-ovate, 4.5-6.5 mm long, 3.8-6.0 mm wide, the apex broadly rounded and sometimes lightly emarginate, the base broadly rounded or truncate, occasionally slightly cordate, margin minutely erose to strongly denticulate erose, claw and center of blade green to light red-brown, the rest hyaline and mostly very pale red-brown with the marginal 0.5-1.0 mm clear; seeds 1(-2) per cone, dark red-brown; mature seeds (rehydrated) lance pyriform, beaked, strongly 4 ridged longitudinally, square in cross-section, 7.5-8.5 mm long, 2.0-3.0 mm wide on a side near the base, mostly 2.3-4.0 times as long as wide, included to slightly exerted, surface smooth to lightly rugose at base (usually drying strongly so), otherwise smooth, glabrous; tubillus exerted 0.3-1.0 mm beyond end of outer integument.

DISTRIBUTION AND ECOLOGY: Apparently an obligate gypsophile, locally common in desert scrub on gravelly to fine grained gypseous soils at 850-1100 m elevation, in Big Bend National Park (Tornillo Flats), Texas, and in the lower Río Conchos valley and nearby drainages of eastern Chihuahua, México (Map 1).

ADDITIONAL SPECIMENS EXAMINED: MEXICO. Chihuahua: 16 mi S of Ojinaga on road to Camargo, 2 May 1973, *H.S. Gentry & Engard 23198* (US); 10 mi S of Ojinaga, direct road from Ojinaga S to Alamos Chapo, 8 Aug 1940, *I.M. Johnston & Muller 14* (sterile) (LL[2]); type locality, 4 Apr 1973, *M.C. Johnston, Wendt, & Chiang 10578* (♂) (MEXU*, TEX, NY); 6 km E of Alamo Chapo Viejo on road to La Consolación, 1 May 1973, *M.C. Johnston, Wendt, & Chiang 10746* (♀) (MEXU*, TEX), *10749* (♂) (MEXU*, TEX); 20 mi W of Ojinaga near Chih. highway 16, 7 Apr 1973, *Powell, Turner, & Sikes 2472* (♀/♂) (LL); 4.7 mi S then E from Falomir railroad bridge along road to Chilicote, 23 Mar 1975, *Wendt & Lott 770* (♂) (TEX), *770A* (♀) (TEX).

UNITED STATES. Texas: Brewster Co.: 6.9 mi N of Panther Junction, Big Bend National Park, 25 Apr 1987, *Powell & Powell 5395a* (♀) (SRSC); Tornillo Flats, Big Bend National Park, 5 Apr 1975, *Warnock s.n.* (♀) (TEX), *Warnock s.n.* (♂) (TEX). (*=*fide* H. Flores).

The name of the new variety honors Dr. A. Michael Powell and his wife Shirley Powell. Dr. Powell, author of *Trees & Shrubs of Trans-Pecos Texas* (1988) and many other botanical works, is director of the herbarium at Sul



MAP 1. Distribution of *Ephedra torreyana* varieties and related populations. Total distribution of var. *torreyana* based on Cutler (1939), Benson & Darrow (1981), Higgins (1987), and author's data; of *E. funerea*, Cutler (1939) and Butterwick (1989).

Ross State University and an authority on the woody flora of trans-Pecos Texas. Shirley Powell has accompanied him on many of his collecting trips in the area, and together they have collected critical specimens related to the present problem.

The new variety can be distinguished most easily from the typical variety by the following characters:

- 1. Ovules/seeds 1-3 per cone, mostly 2-3 on any one plant; seed surface scabrous with numerous minute prominent hard papillae, these often in rows; tubillus (distal part of inner integument) exerted (0.5-)0.8-3.0 mm beyond outer integument, almost always at least some >1.0 mm on any one plant; anthers (4-)5-8 per sporangiophore, mostly 6-7, the central and usually the lateral anthers on stipes 0.2-0.6 mm long, rarely all sessile. var. *torreyana*
- 1' Ovules/seeds 1(-2) per cone, mostly or all 1 on any one plant; seed surface rugose at base but otherwise smooth; tubillus exerted 0.3-1.0 mm beyond outer integument; anthers 2-6(-7) per sporangiophore, mostly 3-5, all sessile or subsessile or occasionally the central ones on stipes to 0.2 mm long. var. *powelliorum*

Variety *powelliorum* also differs in its uniformly strongly divaricate branching and leaf bases which are only rarely persistent. In var. *torreyana*, there is a marked tendency toward more fastigiate plants with the leaf bases commonly becoming swollen, black, and persistent, although scattered plants throughout the range of the typical variety approach var. *powelliorum* in these characters.

The differences listed above are strong ones within the context of the taxonomy of *Ephedra*, and the two varieties are more easily distinguished from each other than are some North American species of the genus (see Cutler's [1939] monograph). Nevertheless, study of the two varieties throughout their ranges (Map 1) reveals that the populations of var. *torreyana* geographically closest to those of var. *powelliorum* show a marked tendency to display some of the characteristics of the latter variety, such as 1 seeded cones, nearly smooth seeds, or subsessile anthers. The area in which this tendency is marked within var. *torreyana* includes much of the northern trans-Pecos of Texas and the nearby high plains of that state (Map 1); these populations are referred to var. *torreyana* for convenience, but in some cases justifiably could be regarded as intermediates. Furthermore, a population near Sierra Blanca, Texas (listed below), of which only ovulate material is available, could be referred to var. *powelliorum* except for the very lightly scabrous nature of the mature seeds; this population is referred to as an intermediate in Map 1. Given this pattern of variation, it seems reasonable, at least at present, to recognize the new taxon at the varietal level within *E. torreyana* (this being the infraspecific rank traditionally used within *Ephedra* in North America—see Cutler 1939, and Benson

& Darrow 1981). Nevertheless, the understanding of this pattern—and indeed of evolution within the *E. torreyana* complex—is complicated by the frequency with which this species hybridizes with other species of *Ephedra*, as discussed below.

It seems clear that previous authors have not been aware of the existence of the new variety largely due to its poor representation in herbarium collections. Cutler (1939) cited no collections referable to the new variety. Johnston (1943) referred a single Chihuahuan collection (*Johnston & Muller 14*) to *Ephedra torreyana* without comment, but the duplicates I have seen of this collection are sterile. Texas collections of the new variety postdate the publication of Correll & Johnston's (1970) flora of Texas. Valdés & Flores (1987), in their treatment of the gypsophilous and halophytic gymnosperms of México, referred several Mexican collections of the new variety to *E. torreyana*, based in part on an earlier manuscript of the treatment of the genus for the *Chihuahuan Desert Flora* by the present author. Powell (1988) referred all trans-Pecos material (including that from Brewster Co.) to *E. torreyana*, but he apparently saw only one specimen of the new variety (*Powell & Powell 5395a* [SRSC]). On this specimen he noted that it seemed to differ from other specimens of trans-Pecos *E. torreyana* in some characteristics. In addition, this one specimen is somewhat atypical of var. *powelliorum* (more exserted seeds, more scabrous stems, etc.), and may represent a product of hybridization with *E. aspera* S. Watson (see below), with which it was found growing.

Watson (1879) cited four syntypes in the description of *Ephedra torreyana*, of which Cutler (1939) chose *Wright 1883* in part (GH), from Fronteras, Texas (near El Paso) as the lectotype. *Wright 1883* comprises two separate collections and two species (*E. torreyana* and *E. aspera*), both from the same locality (Cutler 1939; Shaw 1987); *E. torreyana* material under this number is thus lectotype material. I have not seen the lectotype material at GH, but I have examined the apparent islectotype collections at NY and US cited below. This, along with Watson's (1879) type description, Torrey's (1859) description of the Fronteras population and Parry's collections (cited below) from that area, clearly indicates that Watson's concept and material correspond to var. *torreyana* as here defined.

Of all species of North American *Ephedra*, *E. torreyana* seems to be the one most prone to hybridize with other species. Cutler (1939) reported only two apparent hybrids among the North American species, with *E. torreyana* being involved in both: $\times E. intermixta$ Cutler ($= E. torreyana \times E. trifurca$ S. Watson) in New Mexico, and $\times E. arenicola$ Cutler ($= E. torreyana \times E. coryi$ E. Reed var. *viscida* Cutler [*E. cutleri* Peebles]) in Arizona. In the present study, I have found more evidence of hybridization involving *E. torreyana*:

1. A series of quite bizarre collections of *Ephedra* (cited below), previously identified as *E. torreyana*, has been made in northern Culberson Co. of west Texas (Map 1). These populations include not only the ovulate and staminate

plants typical of any population of *ephedra*, but also plants which produce only morphologically bisexual cones. No mature seeds and very little apparently fertile pollen was noted in these cones. I know of no other similar case in the genus—it is certainly extremely rare—and it may indicate an imbalance in the genomes of these populations, one cause of which could be hybridization. These populations are also characterized by the ovulate bracts having a narrow bright red-brown center sharply contrasting with a very broad scarious margin, suggesting the ovulate bracts of *E. trifurca*, while the shape and erose margins of these bracts are closer to *E. torreyana*. Further suggestion of the influence of *E. trifurca* is found in the leaves. The leaves of *E. torreyana* var. *torreyana* in Texas and New Mexico are rarely over 4 mm long, with ovate to lanceolate free tips rarely over 2 mm long. In the unusual Culberson Co. populations, leaves over 4 mm long are relatively common (to 7.5 mm), with free ovate to usually lance linear tips often 2.0-3.5(-5.5) mm long. In all of the characteristics, these plants approach the longer leaved *E. trifurca*. The origin of these populations through hybridization between *E. torreyana* and *E. trifurca* seems possible, even though they differ in many respects from the New Mexican hybrid between these species reported by Cutler (see above). Numerous collections from the area show these populations to be quite uniform morphologically, suggesting that even if they are ultimately the product of hybridization, they now represent a stabilized genome capable of transmission to progeny (although not necessarily *via* sexual reproduction). Further studies may support taxonomic rank for these populations. For the time being, their presence in the apparent zone of intergradation between the two varieties of *E. torreyana* complicates the interpretation of variation within that species in this area.

2. A collection from New Mexico (Chaves Co.: 2 mi SE of Roswell, *Waterfall* 7749 [NY]), while best referable to *Ephedra torreyana* by most characters, has leaf characteristics apparently intermediate to *E. trifurca* (leaves to 5.5 mm long with linear-lanceolate free tips to 3.5 mm long). It may represent another product of hybridization between these species or simply an extreme of variation. It is morphologically dissimilar to other apparent hybrids between these species discussed here.

3. There is clear evidence of hybridization between *Ephedra torreyana* var. *powelliorum* and *E. aspera*. The latter species is characterized by, among other things, leaves two per node with persistent leaf bases, ovulate bracts smaller and less scarious than in *E. torreyana*, and seeds round to rounded trigonous in cross section, mostly less than twice as long as wide, and well exerted from the cone (compare to description above). An ovulate collection from the type locality of *E. torreyana* var. *powelliorum*, near which *E. aspera* also occurs, is clearly intermediate: leaves two to three per node with persistent leaf bases, ovulate bracts in general similar to *E. aspera* but two to three ranked, seeds mostly strongly 4 ridged, ca. 2.5 times as long as wide, and intermediate in

exsertion (*M.C. Johnston, Wendt, & Chiang 10580 [TEX]*).

4. The range of *Ephedra torreyana* var. *torreyana* is at least marginally sympatric with that of the related *E. funerea* Cov. & C. Morton in southern Nevada (Map 1). The two species remain for the most part quite distinct in that area. *Ephedra torreyana* in that part of its range is characterized by yellow, very scarious, strongly erose-denticulate ovulate bracts enclosing two to three very scabrous seeds, while *E. funerea* has yellow-red, thicker, minutely erose ovulate bracts enclosing a single smooth seed. However, collections from the Indian Springs area of Clark Co., Nevada (Map 1), are intermediate in these characters: yellow-red ovulate bracts intermediate in texture and margin characteristics, enclosing 1-3 scabrous to lightly scabrous seeds (with one often the predominant number). Unlike the case of the widespread varietal intergradation within *E. torreyana*, the intergradation between *E. torreyana* var. *torreyana* and *E. funerea* is apparent in one small area only and thus is not considered sufficient evidence to treat *E. funerea* as a variety of *E. torreyana*.

Ephedra torreyana seems to be unusual among ephedras in its tendency to hybridize with other species, although it may be that hybrids which involve this species are simply easier detect. In either case, the possible importance of hybridization in the origin of the patterns of variation and evolution in this complex cannot be ignored, and it is likely that a detailed biosystematic study of the complex with this in mind would be most rewarding.

OTHER MATERIAL EXAMINED FROM TRANS-PECOS TEXAS:

Ephedra torreyana var. *torreyana*: El Paso Co.: [Sand hills near Frontera, April 26, 1852, *fide* Shaw 1987], *Wright 1883* (in part) (Isolectotypes: NY (mixed with *E. aspera*), US); Frontera, Apr 1852, *Parry s.n.* (in part) (NY); near El Paso, Apr 1852, *Parry s.n.* (in part) (NY). Culberson Co.: along Pasotex pipeline, 23 mi E of Delaware Springs, *Correll & I.M. Johnston 22025* (LL,NY); West Dog Canyon, *Higgins 17610* (NY). Hudspeth Co.: 10 mi SE of Dell City, *Higgins 17544* (NY); ca. 12.5 mi E of Dell City, *Powell, Powell, & Weedin 2829* (LL,SRSC); along highway 62 at Salt Flats in "Culberson County" (*sic*), *Warnock 12191* (LL,SRSC[2]), *12192* (LL,SRSC[2]); 12.5 mi E of Dell City, *Worthington 11903* (NY). Reeves Co.: 9 mi E of Pecos at Toyah Lake, *Warnock 5239* (SRSC[2]).

Putative *torreyana/trifurca* hybrid populations from northern Culberson Co.: Rte. 84, 44 mi N of Van Horn, *Correll & I.M. Johnston 18466* (LL), *18470* (LL); N of Delaware Creek, *Correll & I.M. Johnston 19122* (LL); about 2.5 mi E of W end of Pasotex pipeline road, *Correll & Rollins 23914* (LL,SMU), *23915* (LL); 26 mi E of hwy. 62-180 along hwy. 652, *Higgins 6848* (NY); 2 mi SE of US routes 62 & 180 at New Mexico line, *McVaugh 8165* (SMU,SRSC,TEX[2]); 20 mi S of Whites City, ca. 2 mi E on state hwy. 1108 from U.S. 62, *Turner 5662* (TEX); 2 mi S of Texas-New Mexico line, N end of Rustler Hills, *Warnock*

5511 (LL,SMU,SRSC[2],TEX); 2 mi S of state line on road 1108, *Warnock & M.C. Johnston 16320* (SRSC), *16352* (SRSC).

Intermediates between var. *torreyana* and var. *powelliorum*: Culberson Co.: 9 mi SW of Van Horn, *Waterfall 4672* (sterile; putative intermediate based on location and vegetative morphology) (NY). Hudspeth Co.: 5 mi E of Sierra Blanca, *Warnock 7784* (♀) (LL,SMU,SRSC).

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