Identification and Taxonomy of *Tamarix* (Tamaricaceae) in New Mexico

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Abstract
The identity and distribution of *Tamarix* in New Mexico is reviewed, with keys and distribution maps. Four species are found in the state: *T. aphylla*, *T. chinensis* (including *T. ramosissima*), *T. gallica*, and *T. parviflora*.

Introduction
Species of the genus *Tamarix*, variously known as salt-cedar, tamarisk, or tamarix, first came to the American southwest in the mid- to late 1800s as an ornamental, being promoted as such by nurserymen, and later as an erosion-control plant. It had been brought from the Old World to the eastern United States in the early 1800s, being offered for sale in New York City in 1828. From this modest beginning it spread through the United States via the nursery trade, appearing in catalogs in California in 1854 and in the Department of Agriculture Arboretum stock listings in the 1870s (Horton 1964; Robinson 1965). Robinson (1965) suggested that it probably began its escape from cultivation into the wild in the 1870s.

The earliest documented occurrence of *Tamarix* in New Mexico of which I am aware is from 1892, when E.O. Wooton of the New Mexico College of Agricultural & Mechanic Arts (now New Mexico State University) gathered *T. gallica* Linnaeus from "Mesilla, introduced from Galveston Island" (label information from Wooton 1118, in the Biology Herbarium at New Mexico State University). Other species soon followed, undoubtedly planted originally as ornamentals or for erosion-control. The U.S. National Herbarium has a salt-cedar from Nara Visa in 1911 and from Hope in 1917 (Robinson 1965, the specimens not seen by me). Of specimens that I have seen, *T. chinensis* Loureiro appears in the herbarium record in 1932, and *T. parviflora* A.P. deCandolle in 1936.

This "wolf in sheep's clothing" was touted as a desirable ornamental plant for New Mexico: "One of the most satisfactory introduced plants in cultivation in this State is this shrub, which is also known by the name of tamarisk... It will endure large quantities of alkali in the soil, and is exceedingly drought resistant... It is most easily propagated from cuttings, and when once established it is almost impossible to kill it. As a plant to be used upon alkaline soils where other plants do poorly or in situations where too little water is available, there is no other plant which is quite so satisfactory" (Wooton 1913, p. 124, italics added).

Tamarisks were also planted along streams and tributaries for erosion control, and were put to such use along the Rio Salado and Rio Puerco drainages in 1926 and 1927 (Harris 1966).

The aggressive spread of *Tamarix* in New Mexico and the southwest is illustrated by its occurrence in the Pecos River valley. A few adventive seedlings were found at Lake McMillan in 1912; by 1915 the shrub covered 600 acres and was expanding up and down the water course. It had stretched to 12,300 acres by 1925, and to 57,000 acres by 1960 (Robinson 1965). It now infests the entire Pecos River valley from its junction at the Rio Grande northward to beyond Santa Rosa (Harris 1966). A similar story can be told for nearly every major drainage in New Mexico (e.g., Everitt, 1998). Further introduction into the biology and ecology of salt-cedar may be found in Di Tomaso (1998).

Identification
The identity of *Tamarix* plants in New Mexico has been problematic from their earliest occurrence. Early on, only *T. gallica* was reported for the state (Wooton & Standley 1915). Subsequent floristic or taxonomic works have referred New Mexico tamarisks to *T. chinensis*, *T. parviflora*, and *T. ramosissima* (Baum 1967; Di Tomaso 1998), to *T. chinensis*, *T. gallica*, and *T. pentandra* (Martin & Hutchins 1981), or to *T. gallica* and *T. ramosissima* (Roalson & Allred 1995).

In addition to the nomenclatural puzzlement, there has been confusion about how to identify the species. As stated by McClintock (1951, p. 77) in her study of California tamarisks, "There is probably not another genus of plants as well known as the tamarisks in which the species are so poorly understood or separated on more obscure characters." For most of the species, vegetative features are useless in distinguishing the species, and one must turn to the tiny floral organs, which are difficult to dissect and interpret, and impossible to do so without a microscope or at least a hand lens.

Of critical importance is the shape of the nectary disk and the insertion of the filaments associated with this disk (fig. 1). Baum (1967, 1978) and McClintock (1951) have clearly illustrated for us the variation among the species in this respect (fig. 1). Two main patterns should be noted: I (*gallica* & *parviflora*): the staminal filaments are confluent with the lobes of the nectary disk, which are attenuate and pass gradually into the filaments, and II (*aphylla* & *chinensis*): the staminal filaments are inserted between the lobes of the nectary disk, which are truncate-emarginate.
Baum (1967, 1978) distinguished some species, particularly *chinensis* and *ramosissima*, on whether the filaments in pattern II (above) were inserted at the edge of a somewhat irregular or asymmetric disk or slightly below a symmetrically shaped disk. The filament insertion is extremely difficult to determine with any accuracy, though the shape of the disk is quite easily observed. A common condition encountered in our plants is a mingling of these two patterns, particularly in the development of the lobes of the nectary disk, which are often emarginate, truncate, and rounded on the same disk, with a concomitant placement of filaments both at the edge or under the disk. Few examples were found where all filaments were unequivocally placed under a symmetric disk.

Flower color varies for all the species, from white through pinkish to reddish. There seems to be no correlation with species or even with a single plant, as it is not uncommon to find white, pink, and red flowers on the same plant, and even on the same flowering branch.

Of the three species found escaped in the wild in New Mexico, two (*gallica* and *parviflora*) are known to flower only in the spring, though the literature indicates they may also flower in the summer, and one flowers in both spring and summer (*chinensis*) (Table 1, p. 29).

Other than the very different *Tamarix aphylla*, with its distinctive sheathing leaves, I found no way to distinguish among the remaining species in New Mexico using any vegetative feature. The scale-like leaves vary among all the species from lanceolate to ovate, and from strongly overlapping on the twigs to not at all overlapping.

**Taxonomy and Distribution in New Mexico**

Descriptions of morphologic features and distributions within New Mexico are based upon examination of herbarium specimens (see Specimens Examined). The actual distribution of some of the species, particularly *Tamarix chinensis*, is certainly greater than that illustrated by the maps.

*Tamarix* Linnaeus [Sp. Pl. 1:270. 1753.]

Mostly shrubs or shrub-like trees with numerous large basal branches, the bark of larger trunks brown or reddish brown to dark brown or blackish or dark purplish. Leaves scale-like, alternate, sessile or sheathing, with salt-secreting glands that appear as tiny pits on dried material. Inflorescence a panicle, appearing in the spring (vernal) or summer (aestival), the flowering branches (mostly primary or secondary branches) termed racemes. Flowers small, 4- or 5-merous, perfect, subtended by a small bract. Sepals distinct or slightly connate at the base, with two outer and two-three inner. Petals white, pinkish, or reddish, different colors often on the same plant or even the same flowering branch, surpassing the sepals, persistent or deciduous after anthesis, elliptic through obovate. Stamens distinct, emerging from a central nectary disk. Pistil pyramidal or vase-shaped, with 3-4 stigmas; capsule many-seeded, loculicidal. Seeds tiny, with an apical pappus.

**Key to Tamarix Species in New Mexico:**

1. Leaves conspicuously sheathing the stems, not scale-like; branchlets drooping, the foliage generally persistent; not known outside of cultivation in New Mexico.
   1. *Tamarix aphylla*

1. Leaves not at all sheathing the stem, scale-like; branchlets spreading in all direction, the foliage generally deciduous; cultivated or occurring in the wild.

2. Flowers with 4 sepals and 4 petals; panicle branches short and not rebranched, the longer ones 1-2 cm long; flowering mostly in the spring; rarely encountered.
   4. *Tamarix parviflora*

2. Flowers with 5 sepals and 5 petals; panicle branches long, usually rebranched, the longer ones 3-8 cm long (sometimes shorter and not rebranched); flowering spring to fall.

3. Lobes of the star-shaped nectary disk attenuate, gradually passing into the filaments; not common in the wild or in cultivation.
   3. *Tamarix gallica*

3. Lobes of the nectary disk truncate-emarginate, the filaments abruptly extending from between the lobes; very common in the wild and in cultivation.
   2. *Tamarix chinensis*


Trees or large shrubs to 10 m tall or more; bark of larger trunks gray to reddish brown. Leaves sheathing the stems, abruptly mucronate at one side, not scale-like, 1.5-2 mm long, the foliage conspicuously drooping and persistent through the winter. Racemes 3-6 cm long, 4-5 mm wide (in flower, wider in fruit). Flowers 5-merous. Sepals about 1.5 mm long. Petals 2-2.3 mm long, persistent or deciduous. Stamens 5, the filaments emerging from between the emarginate lobes of the symmetrical nectary disk. [Inflorescence and flower features are taken from Baum (1978), as I have not seen flowering material from New Mexico.]

Flowering ?.

Distribution in New Mexico: Presently known only from Las Cruces.

Athel tamarisk is not known outside of cultivation as an ornamental in New Mexico, but it has escaped cultivation...
in adjacent states. This is a magnificent and arresting tree, easily identified by the sheathing leaves, and drooping foliage persisting through the winter. I have not found it flowering in New Mexico.

2. *Tamarix chinensis* Loureiro SALT-CEDAR

[Fl. Cochinch. 1:182. 1790.]

*Tamarix pentandra* Pallas [Fl. Ross. 2:72. 1788. nom. illeg.]

*Tamarix ramosissima* Ledebour [Fl. Altaica 1:424. 1829.]

Shrubs to 6 m tall; bark of larger trunks reddish brown to dark brown or blackish. Leaves scale-like, 1.5-3.5 mm long, the foliage deciduous. Racemes 2-7 cm long, 3-5 mm wide (in flower, wider in fruit). Flowers 5-merous. Sepals 0.5-1.3 mm long. Petals 1-2.3 mm long, persistent in fruit. Stamens 5, the filaments emerging from between the lobes of the nectary disk, which may be quite variable in shape, symmetry, and filament insertion. Pistil 2.5-4 mm long.

Flowering April-November.

Distribution in New Mexico: Essentially throughout the state, though some areas not represented by specimens.

This is the common salt-cedar that has over-run vast tracts of wetlands, riparian areas, and disturbed ground throughout the state, though *Tamarix gallica* and *T. parviflora* may rarely be found in these habitats as well. It is similar to *T. gallica*, and can be distinguished with certainty only by close examination of the nectary disk and filament insertion. In *T. gallica* the filaments appear as gradual extensions of the five nectary lobes, whereas in *T. chinensis*, they emerge abruptly from between the emarginate or rounded lobes. The actual attachment of the filaments in *Tamarix chinensis* is supposedly either below or at the edge of the disk (Baum 1978), but this distinction does not seem to be clearly or unequivocally expressed in New Mexico plants, as well as being difficult to determine. In addition, the disk may be asymmetrical and irregularly developed, and some lobes may be emarginate or some rounded or even attenuate, and the filaments borne at the edge or below the disk. Differences such as these have been used to differentiate *T. chinensis* and *T. ramosissima*, but I find it impossible to satisfactorily separate two distinct entities using these features for New Mexico material, though it must be said that expressions of both forms can be found. In addition, the shape of the petals seems to intergrades almost completely, obfuscating the distinction raised by Baum (1978) for these two taxa. John Gaskin and colleagues at the Missouri Botanical Garden compared chloroplast and nuclear DNA data and found identical cpDNA sequences for these two entities (Gaskin & Schaal, in prep.), supporting the merger of *T. chinensis* and *T. ramosissima*. These two names are also synonymized in the recent “A Utah Flora” (Welsh et al. 1993).

Horton and Campbell (1974) alluded to a 1968 study of *Tamarix* taxonomy by the USDA Forest Service in which cuttings from various locations in the United States and the Old World were grown and growth characteristics were compared. No data were presented, nor reference to any published works, but they concluded that “the botanical differences are not significant or constant enough to warrant species separation” and “the aggressive saltcedar should be considered as one species,” to which they applied the name *T. chinensis* Loureiro (p. 14-15). It is not known which species were involved in this study, or even if the sampling involved more than one species, but I reach a similar conclusion regarding the differentiation of *T. chinensis* and *T. ramosissima*.

This species of salt-cedar has been called *Tamarix pentandra* Pallas by numerous North American authors, but this name is illegitimate because Pallas cited *Tamarix gallica* Linnaeus as a synonym. The specific epithet is sometimes rendered as *sinensis*.

3. *Tamarix gallica* Linnaeus FRENCH TAMARISK

[Sp. Pl. 1:270. 1753.]

Shrubs to 8 m tall; bark of larger trunks blackish brown or dark purplish. Leaves scale-like, 1.5-2 mm long, the foliage deciduous. Racemes 2-5 cm long, 4-5 mm wide (in flower, wider in fruit). Flowers 5-merous. Sepals 0.7-1.2 mm long. Petals 1.5-2 mm long, persistent in fruit. Stamens 5, the filaments emerging as extensions of and appearing continuous with the 5 lobes of the nectary disk. Pistil 2.5-3 mm long.

Flowering February-May.

Distribution in New Mexico: Of limited occurrence in the Las Cruces area, as well as a single recent introduction in Lincoln County.

*Tamarix gallica* is most easily confused with *T. chinensis*, which also has 5-merous flowers. The only sure way to distinguish them is by close examination of the nectary disk and filaments. In *T. gallica* the filaments appear as gradual extensions of the five nectary lobes, whereas in *T. chinensis*, they emerge abruptly from between the emarginate or rounded lobes.

Baum (1967, 1978) reported that the petals are caducous in this species. In the few plants known from New Mexico, the petals are definitely persistent, some remaining even after the segments of the pistil have fallen.

This species is uncommon, known from only eight collections in the state, all but two of which were taken for this study. The oldest collection of *Tamarix* in New Mexico is of this species, taken in 1892 by E.O. Wooton from Mesilla, which he stated was “introduced from Galveston Island” [Wooton 1118 (NMC)]. Of the remaining five
collections, four are from decidedly ornamental situations, such as the long line of French tamarisk along Union Street in Mesilla Park (Doña Ana County). The other two are likely invasions from seed: one along an irrigation canal near the Rio Grande and the other a young plant growing along I-25 north of Las Cruces. This species does not seem to be invasive, even though it has been in New Mexico for at least 110 years.


*Tamarix tetrandra* of North Amer. authors, not Pallas

Shrubs to 4 m tall; bark of larger trunks brown to dark purplish or blackish. Leaves scale-like, 2-2.5 mm long, the foliage deciduous. Racemes 1-2 cm long, perhaps sometimes a bit longer, 3-5 mm wide (in flower, wider in fruit). Flowers 4-merous. Sepals 1.2-1.5 mm long. Petals about 2 mm long, persistent in fruit. Stamens 4, the filaments emerging as extensions of and appearing continuous with the 4 lobes of the nectary disk. Pistil 3-5 mm long.

Flowering March-April.

Distribution in New Mexico: Of limited occurrence in the Albuquerque and Las Cruces areas and from southern Luna County.

*Tamarix parviflora* is easily recognized by the 4-merous flowers. In addition, the few inflorescences I have seen are composed of simple, short racemes 1-2 cm long and flowering apparently is restricted to the spring time in New Mexico.

Small-flower tamarisk is rarely encountered in New Mexico and is poorly known from only five specimens. All but one of the five are from evidently ornamental situations, but the collection from Sandoval County seems to be an escape. It has been in the state at least since 1936, and perhaps from 1917, but is hardly invasive.

Acknowledgements

I thank the curators of New Mexico State University, San Juan College, and University of New Mexico for the use of their material. Pat Holmgren kindly looked up specimens for me at the New York Botanical Garden (NY). John Gaskin very generously shared some of the molecular-systematic results of his investigations with me prior to publication, and Keith Duncan supplied me with *Tamarix* specimens from the Pecos River Valley near Artesia. Ron Mortensen helped with the distribution maps and Jerry Barrow allowed me to use his photo-dissecting scope.

Table 1. Flowering of *Tamarix* in New Mexico

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Specimens Examined

*Tamarix aphylla*:
- Doña Ana County: Las Cruces, corner of Plain and Solano streets, an ornamental, 4 May 2000, Allred, K. W. 8036 (NMCR).
- Lincoln County: 18 km east of Greentree, 19 Jun 2000, Allred, J. L. 7983 (NMCR); along Range Road 7, 2 miles north of Aztec, 14 May 1994, Castetter, E. F. 7532 (UNM); Rio Grande valley s of Albuquerque, 5 Jun 1962, Jones, C. B. 144-1 (UNM).
- Catron County: Dalt I, 11 Jul 1976, Fletcher, R. 510 (UNM).
- Cibola County: near Grants [due Bleekley 1994], Colfax County: along the Canadian River between Raton & Maxwell, 4 May 1994, Castetter, E. F. 7719 (NMCR); and same plant track, city park next to the river, 17 May 2000, Allred, Kelly W. 7749 (NMCR); along Terlingua Creek at jct with county road 5500, 31 May 2000, Allred, Brady W 777 (NMCR); near Sunland Park at the mouth of La Luz Canyon, 11 Aug 1981, Spellenberg, R. 7899 (NMCR).
- Luna County: Cook’s Range, Rattlesnake Canyon, 25 May 1957, Columbus, J.T. 1244 (NMCR); Columbus, in yard, 17 Apr 1986, Corley, C. 5 (NMCR); along the Rio Grande S of Columbus, 17 Apr 1986, Corley, C. 6 (NMCR).
- McKinley County: head of Peach Canyon, 10 Sep 1976, Powell, R. 222 (UNM); 30 mi w of Gallup by road, 14 Apr 1985, Spellenberg, R. 7808 (NMCR); McKinley Coal mine, 13 Jul 1974, Wagner, W. 223 (NMCR); 1 mile south of San Juan & McKinley county line, 15 Aug 1999, Heil, K. 13634 (DIC); pond near the Rio Grande, 14 Jul 1999, Demaree, D. 38335 (SJC); North of San Juan, 25 May 2000, Allred, Kelly W. 8012 (NMCR); "Lake Stinky," or Lake Holloman Mouth of La Luz Canyon (Laborcita Canyon) adjacent to dam, 25 May 2000, Allred, Brady W 95 (NMCR); along the Rio Grande S of Columbus, 17 Apr 1986, Corley, C. 5 (NMCR); along the Rio Grande S of Columbus, 17 Apr 1986, Corley, C. 6 (NMCR).
Refuge, 25 May 1996, Allred, Kelly W. 6345 (NMCR); w of atom bomb crater, 28 Aug 1948, Dunn & Lint 4642 (UNM); Rio Grande east of San Antonio, Dunn & Lint 4881 (UNM); 1 mi s of San Marcial, 22 Apr 1936, Schaffner s.n. (NMC); n of Socorro, 19 Mar 1932, Castetter, E.F. 7530 (UNM); Bosque del Apache Natl. Wildlife Refuge, 29 May 1949, Fleetwood, P.J. s.n. (UNM). Union County: all along the Dry Cimarron River from mouth to Kenton, Oklahoma, along the Trampeos from Harding county line to Texas line [fide David Graham, Union County Agent]. Valencia County: old pond near Rio Puerco n of Rt. 66, 26 Jun 1953, [no collector] (UNM); 6 miles west of Belen on banks of Rio Puerco, 20 Sep 1964, Baca, O. 144 (UNM).

*Tamarix gallica:* Doña Ana County: Mesilla Park, along Union Street west of Main, thick line of trees along road, 4 May 2000, Allred, Kelly W. 7715 (NMCR); Mesilla, near Rio Grande at junction with Calle del Norte, growing in canal adjacent to river, 4 May 2000, Allred, Kelly W. 7716 (NMCR); Las Cruces, nearly at corner of Solano and Plain streets, growing adjacent to T. aphylla, 4 May 2000, Allred, Kelly W. 7714 (NMCR); Las Cruces, New Mexico State University campus, lawn of Thomas Brown building, 4 Feb 1994, Allred, Kelly W. 6094 (NMCR); North of Las Cruces, along I-25, mile marker 17, growing on road bank, 5 May 2000, Allred, Kelly W. 7718 (NMCR); campus of New Mexico State University, adjacent to Knox Hall, an old tree with a trunk diameter of 3-4 feet, 9 April 2002, Allred, Kelly W. 8214 (NMCR); Las Cruces, at corner of Mesa and Espina streets, north side of the Hacienda restaurant, large tree with thick trunk, growing with T. parviflora, 4000 ft, 10 Apr 2002, Allred, Kelly W. 8215 (NMCR); Mesilla, introduced from Galveston Island, 10 May 1892, Wooton, E.O. 1118 (NMC). Lincoln County: Three Rivers campground, 30 May 1970, Hutchins, B. 2958 (UNM).


Tamarix aphylla (Kelly Allred)

Tamarix chinensis (Kelly Allred)

Tamarix gallica (Kelly Allred)