

# Exotic Pest Plant Introduction in the American Southwest

Barbara Tellman

Water Resources Research Center  
The University of Arizona  
350 N. Campbell Avenue  
Tucson, Arizona 85721

## The Earliest Exotic Plant Introductions

People have been moving plants from one part of the world to another for thousands of years. A Sumerian inscription from about 2500 B.C. tells about Sargon crossing the Taurus Mountains to Central Asia and bringing specimens of trees, vines, figs and roses for acclimatization back home. In about 1500 B.C. Queen Hatshepsut ordered that frankincense (*Boswellia* sp.) and other plants be brought by ship from Punt on the East African coast. Thirty-one trees were successfully established in the temple gardens at Karnak, according to the hieroglyphs. A monument in Fukushoji, Japan, commemorates Tajima Mori, who brought citrus fruits from China for establishment in Japan over 800 years ago. The Polynesians spread breadfruit and other food plants throughout the Pacific Islands hundreds of years before Europeans arrived in the area.

For more than 2000 years, Native American peoples farmed with plants which they had domesticated such as cotton, squash, agave, chilies, devil's claw and beans and spread them far from their original location. Agriculture was an important component of the Spanish conquest. Columbus brought with him on his second voyage not only cattle, sheep, goats, swine and domestic fowl, but also lemons, bergamots, orchard fruits and sugar cane. In 1493 the first American plants were sent back to Spain. The earliest known Spanish intentional introduction of crops to Arizona was in 1540 when Alarçon distributed to the Indians wheat and "other seeds" along the Colorado River. With the spread of the missions, crops gradually moved up from Mexico. In 1763 Juan Nentvig, a Spanish soldier and explorer, recorded a lengthy list of herbs and edible plants growing in Sonoran desert mission gardens. By 1795 Ignaz Pfeffercorn described a host of exotic plants cultivated in Sonora including rye, oats, flax, hemp, wheat, pomegranates, peaches, quinces, figs and many others. Even in the dry regions of Baja, California, the Spaniards grew crops, utilizing elaborate water harvesting irrigation systems which captured most of the water that fell on the missions.<sup>1</sup>

As early as the 17th century, European scientists were traveling the world over seeking new species of plants and bringing back specimens, seeds and cuttings. Queen Hatshepsut's plants had to travel on only a short voyage through a climate similar to that of Karnak, but more modern plant hunters had to find ways to keep plants alive during long sea voyages where fresh water was at a premium. One plant explorer lost several years work when his plants were watered with seawater. Even seed collections tended to be spoiled by the humid air on long sea voyages.

Development of a portable greenhouse increased the success rate enormously. Explorers traveled throughout the world, with great enthusiasm, often braving extreme danger. One scholar estimated that 6,746 exotic plant species were introduced to England during the 59-year reign of King George III, who died in 1820. It was during this period that Europeans and later Americans built enormous greenhouses for their collections and developed systems for seed and plant distribution. A major U.S. grower was William Hamilton, who had a 300-acre estate in Philadelphia and was the first to grow Tree of Heaven (*Ailanthus altissima*) in the United States.<sup>2,3</sup>

## Plant Introduction in the United States

As settlers (often immigrants from other lands) moved west, they took favorite seeds and cuttings with them. With the arrival of the railroad in the western United States, it became easy to transport plants and young trees. People could place orders with mail-order nurseries from California to the east coast. The great age of exotic plant introduction in the west had begun.

The United States government played a major role in plant introduction starting in 1817, when a Congressional grant was made to a group of French colonists to introduce the olive and the grape. In 1827 President John Quincy Adams requested of all consuls that they send foreign seeds and plants back to the United States, however, he offered no funds for this purpose. The circular included complete instructions for packing and shipping, including protection from salt spray, "especially when the waves have white frothy curls upon them." Naval commanders were ordered to assist with this endeavor. Starting in 1836, the U.S. Patent Office took responsibility for plant introduction. "The Patent Office is crowded with men of enterprise seeking ... especially new and valuable varieties of seeds and plants. ... The great desideratum at this present time seems to be, that some place shall be designated and known as the depository of all articles of this kind, and from when they may be dispersed to every part of the United States." Finally in 1839 Commissioner Ellworth obtained an appropriation from Congress of \$1000 for collection and introduction of seeds and plants and agricultural information. Plants were established in a new greenhouse on the Washington Mall, which became the National Botanical Garden and later the National Arboretum.

In the 1860s the establishment of land grant colleges began and a new U.S. Department of Agriculture was separated out from the Patent Office. One of the seven major duties of the Department was the collection, testing and distribution of seeds and plants. William Saunders personally oversaw the propagation and distribution of thousands of species of trees and shrubs, including the navel orange. The land grant colleges, with their Agricultural Extension offices (established in 1887) played a major role in plant introduction. A letter in The University of Arizona Extension archives thanks the Department of Agrostology in the U.S. Department of Agriculture, for sending seeds of 150 kinds of forage plants (mostly grasses), and reports that they were divided into numerous packets and sent to farmers and ranchers around the state for testing, as well as being planted out in the University's experimental farms in Tucson, Tempe and Yuma.

Negative aspects of exotic plant introduction began to be felt in the United States by the 1890s. Agricultural agents who had been instrumental in disseminating exotic species began to give advice about fighting plants such as tumbleweed. Many states passed laws to control noxious weeds. The appearance of some plants that were problems did not, however, slow down the pace of plant introduction.<sup>4</sup>

### The Sources of Nine Exotic Species

The following sections describe nine exotic species which have naturalized in Arizona and surrounding states. Three are herbaceous plants – tumbleweed, camelthorn and filaree. Three are trees – saltcedar, Russian olive and Tree of Heaven. Three are grasses – bermuda grass, Johnson grass and buffel grass. Most of the species discussed here were probably introduced more than once and have been introduced in similar ways in many parts of the world. The sources discussed here are well documented. Other introductions are undoubtedly lost in history. All except *Ailanthus altissima* have become naturalized in the Grand Canyon.

### Filaree (*Erodium cicutarium*)

Some introduced plants actually preceded the Spaniards. Ships that docked off the California coast brought seeds in their ballast, packing materials or on the fur of animals. Plants established near the shore were spread by birds on the great migratory flyways. In this way, the plants spread inland years before the people did. Filaree is a good example of this. It was found in California when the first missions were built and was plentiful enough to be incorporated into the adobe bricks such as in the missions in Jolon (1771) and Soledad (1791). George Hendry spent more than two decades making detailed studies of plant content of historic adobe brick and found three species whose introduction preceded the Spanish, *Erodium cicutarium*, *Rumex crispus* and *Sonchus asper*. He inferred that these preceded Spanish settlement because they appear in the earliest bricks made before 1769, but without remains of agricultural crops which were only present in adobe bricks at these and other sites much later. These findings were consistent in sites separated in time and space.

In March 1844, Captain John Fremont found filaree as he came down from the California foothills towards the valley. He wrote, "... we discovered three squaws in a little bottom, and surrounded them before they could make their escape. They had large conical baskets, which they were engaged in filling with a small leafy plant (*Erodium cicutarium*) just now beginning to bloom and covering the ground like a sward of grass." By April 12 he had descended into the valley and again reported filaree saying "instead of grass the whole face of the country was closely covered with *Erodium cicutarium*, here only two or three inches high."

In 1886, the Leitch brothers introduced filaree to Arizona as fodder on their ranch. Filaree quickly became a popular range plant and was promoted in Agricultural Extension bulletin. It was found in Arizona long before that, having come on the wings of birds, the wool of sheep and via many other paths. Filaree is now common all over Arizona.<sup>5</sup>

### Bermuda Grass (*Cynodon dactylon*)

Bermuda grass was considered a sacred plant in the Veda, the sacred writings of ancient India, where it was called "the preserver of nations" and the "shield of India," because of its forage value. It also has a long history in African medicinal lore and was probably introduced to Africa on Arab merchant ships before 500 A.D. It is now found worldwide and on every continent except Antarctica.

Georgia Governor, Henry Ellis, introduced bermuda grass to Savannah in 1751. (Actually his neighbor, a man we know only as Mr. C., an ardent plant collector who frequently traveled to distant places such as Bermuda probably gave it to the Governor). It spread rapidly and within 50 years a botanist found it "frequent on roadsides and cultivated ground" in the East and Southeast. In 1856 it was sold in San Francisco for five dollars a flat. By 1880 it had become a troublesome weed near San Bernardino, in Southern California. Rivers and canals were ideal dispersers, as the seeds spread rapidly in water. By 1911 it had become a serious problem as it invaded fields and canals.

Extension agents recognized bermuda grass as a problem before 1911, but believed they had found a way to control its spread, writing in a special bulletin "Following the practice outlined above, we have ceased to dread Bermuda grass at Yuma, finding it not only possible but practicable to keep it in subjection." It is now found throughout the lower elevations of Arizona.<sup>6</sup>

### Johnson grass (*Sorghum halapense*)

Johnson grass first appeared in Southern states under the names Guinea grass, Means grass, Bankruptcy grass and many others before 1840. The South Carolina Means family played a major role in its introduction. One family story relates that a relative, John Davis, brought back "fine Swiss watches packed in Johnson grass seed." Another story says that John Means introduced it in contaminated hemp seed from Egypt

shortly after the Revolutionary War. One of the Means daughters became Mrs. Johnson and moved to Alabama. In 1880 Herbert Post stated that he had managed the Johnson farm near Selma, Alabama on which Johnson grass had been grown for 40 years. In areas where frost didn't kill it, it became a noxious weed, which could survive drought, grazing and even a little freezing.

In 1890 it was written in The Arizona Gazette, "In the last two years farmers in the Salt River Valley have been greatly annoyed by the appearance of Johnson grass on their ranches. The grass is far more of a pest to the farmer than is sour clover or foxtail grass (both introductions from the Old World) to a blue grass lawn. Investigation as to the cause of the grass spreading over the valley developed the fact that there are two ranches away up at the head of the Salt River, above the Tonto Basin, which are covered with Johnson grass, and from these ranches the seed has been carried down by the water to the farms."<sup>7</sup>

One anonymous Arizona farmer did not succeed in preventing its spread in 1897. "Early this spring I observed a small patch (Johnson grass) in the corner of my orchard and immediately sent a man to dig it out. That patch has been dug out four times this season and it is now about three times as large as when I first began to tamper with it." In 1914, the Reclamation Service had no better success when it bought 2000 head of sheep to graze the ditch banks. The grass still thrives and is considered a major problem today throughout Arizona below 6,000 feet elevation. When under stress, such as frost or drought, the grass can become toxic to cattle and other wildlife.<sup>7</sup>

#### **Tree of Heaven (*Ailanthus altissima*)** (Figure 1, p. 10)

Father Pierre Nicholas de Chevron d'Incarville was sent to Peking in the 1740s as a Jesuit missionary. For ten years he labored on both his religious mission and his personal mission to introduce hitherto unknown plants to Europe. Because of China's strong isolationist policies, seven years passed before he was allowed to travel to areas where plants could be collected. Shortly before his death, he entrusted some seeds to a confidant in a Russian caravan, making the long trek across Siberia and finally to England.

From those seeds Philip Miller grew the first successful European *Ailanthus* trees in all of Europe in 1751 at the Chelsea Physic Garden. William Hamilton's plantings of offspring of those trees on American soil in 1784, were viewed as "great novelties from a far distant land." Soon they became common throughout the eastern U.S. About 75 years later the tree was introduced far more easily to the west coast by Chinese gold miners who planted them along California streams. It has naturalized in Arizona along the Verde River, Sonoita Creek and elsewhere and is rapidly becoming a problem species.<sup>8</sup>

#### **Saltcedar (*Tamarix ramosissima*)** (Figure 2, p. 10)

The genus *Tamarix* appears to have originated in India, from where it spread out to Asia and the Middle East. *Tamarix ramosissima* is one of the more primitive species and first appeared somewhere in the India-Central Asia region. Saltcedar appears in the Bible under the name Eshel, and in ancient Arabic literature as Asul. It was valued for its manna, a sweet exudate produced by a scale insect. This species has at various times been labeled *chinensis*, *ramosissima*, *pentandra* and *gallica*. Botanists still argued these distinctions in 1951, although Thornber believed he had set the matter straight in 1916. As one botanist said, "There is probably not another genus of plants as well known as the tamarisks in which the species are so poorly understood." Thus, early references to specific species of tamarix are suspect. The most common 19th century distinctions were between French, German and African tamarisk. "French tamarisk" was probably generally *ramosissima*.

Some early researchers believed the Spanish introduced *Tamarix* to Mexico, but National Herbarium specimens do not support this hypothesis. While Spaniards certainly traveled to places where tamarix is common, the pattern of distribution does not show a spread from Mexico as a central source location. Father Escalante reported "teray" near the Utah-Arizona border in 1776, but this term has several translations and probably does not mean "tamarisk." Travelers in the 1870s did not report it in Utah or Arizona, reporting instead cottonwood-willow forests in some places where tamarisk now prevails.

Although the original collector is unknown, several species were advertised by U.S. nurseries by the 1820s. The Old American Nursery of New York offered French tamarisk for sale in 1823 and Bertram's Botanical Garden and Nursery listed French and German tamarisk "much admired" for 37 cents. By the 1830s many nurseries were offering *Tamarix*, but seldom made clear which species they had.

The U.S. Department of Agriculture grew *Tamarix* at the National Arboretum in Washington and in 1868 reported that six species had become established. It released *Tamarix pentandra* for cultivation in 1870.

*Tamarix* escaped cultivation in 1880 in Utah and in 1897 in Texas. In 1901 it was "common in river bottoms," from the Salt River in Arizona. The Arizona Agricultural Extension Service recommended several species of tamarix for landscaping. *Tamarix* naturalized most rapidly from the 1930s to the 1960s, most often in areas disturbed by human activity, such as upstream and downstream of dams.

Local ranchers reported that *Tamarix* first appeared along the Gila River after the floods of 1916. It is now found along many rivers throughout the West and northern Mexico up to about 5000 feet in elevation, and sometimes even higher, especially in disturbed areas.<sup>9</sup>

**Russian Olive (*Elaeagnus angustifolia*) (Cover)**

The Russian Forestry Department conducted extensive research on the *Elaeagnus* and in 1887 published a pamphlet in which the tree was considered "a valuable tree for hedges in south Russian steppes. For snow-breaks along railroads I plant it where stock would kill other trees, as it is not browsed by stock. When I cut it down to the ground, the fifth year, a great mass of strong sprouts are produced which attain a height of seven feet the first year and are armed with long thorns. Rabbits, as well as domestic animals, do not attempt to go through such a hedge and it is shunned by various insects."

In the late 17th Century, Prussian Mennonites migrated to south Russia seeking religious freedom. Less than 100 years later, again under religious persecution, they again migrated to Canada and the northern United States. A small group settled in South Dakota and other Great Plains states, bringing with them not only their religion, but many crops and farming practices, including the Russian olive. N.E. Hansen, of the South Dakota Agricultural Extension office traveled to Russia, experimented with it extensively, and recommended it highly as a drought, animal, and frost tolerant ornamental plant in 1901. He said, "As a hedge it will turn any stock that Osage orange will. Horses or cattle will not attempt to go through it, and it does not sap the ground like Osage orange." It was easily available in South Dakota nurseries by 1900.<sup>10</sup>

In Utah and Arizona Mormon communities, Russian olive was widely used as a landscape plant after 1900, with cuttings passed from one community to another by plant lovers such as W.H. Crawford of St. George, Utah, who introduced hundreds of plant species in the Virgin River area.

Extension agents recommended Russian olive for Arizona in 1909. It remained a cultivated landscape plant for several decades, but escaped cultivation by 1941 in Oak Creek Canyon. The National Park Service planted Russian olive in Canyon de Chelly for soil stabilization in 1964. By 1974 *Elaeagnus angustifolia* was one of the dominant trees of the canyon bottoms.<sup>10</sup>

**Tumbleweed (*Salsola iberica* or *kali*)**

Another introduction to South Dakota from Russia was tumbleweed, probably brought by the same Mennonite farmers. One of their crops was flax, which did not develop into a major agricultural crop, but planting flax did have a lasting effect, as the seed was contaminated with tumbleweed, also called "Russian thistle," "Wind Witch," or "Leap the Field." It first appeared in Bon Homme County in southeast South Dakota. It spread from there within ten years to neighboring Nebraska. The Nebraska Extension Service published a bulletin in 1892, with a ten point plan for fighting the weed, including the last directive to familiarize "...every child in the public schools, with the appearance of this pest in order that he may destroy it wherever he finds it." Russian thistle became a noxious weed so quickly that its spread has been carefully documented.

Tumbleweed reached California and Oregon on the west and Minnesota and Ohio to the east by 1895. An 1898 Arizona Agricultural Bulletin reported that "there is no direct evidence that this weed has as yet found its way into Arizona," but it did quote a report from the Philadelphia Ledger which said, "Russian thistles, a patch of which has flourished for some time near Whipple, Arizona have overgrown well trodden paths there and made them impassable either for man or animals" and warned farmers to be alert for the appearance of tumbleweed. Within a few years *Salsola kali* was common.

The newly built railroad was an ideal vehicle for spreading tumbleweed throughout the west and tumbleweed's early distribution pattern shows it moving outward along railways and roadways. In at least two documented cases, new colonies were established after train wrecks in which wheat cars were overturned. Wind was also a good dispersal method, especially on the Great Plains with its high winds traveling for miles. One 19th century farmer claimed to have tagged a plant and within 24 hours found it had traveled 60 miles.

According to an 1891 USDA study, the form of *Salsola* in the U.S. was far more troublesome than its counterpart in central Russia where it could be found mingled with wormwoods, sages, mulleins, true desert thistles and a multitude of other plants. Along roadsides there, the plant was not allowed to ripen. In southern Russia the plant did cause problems and severe measures were taken to protect sugar beet fields. In the United States, however, no such measures were taken. By 1894 it was estimated to have caused over two million dollars in damages to wheat fields in the Great Plains states. A U.S. Congressman proposed spending one million dollars to eradicate the plant before it became further established, but the bill was defeated by State's rights advocates who believed this was a job for state and local governments. Tumbleweed is now so ubiquitous throughout the west that many people do not recognize it as an introduced species.<sup>11</sup>

**Camelthorn (*Alhagi camelorum* or *maurorum*) (Fig. 3, p.10)**

While it is tempting to relate the introduction of this legume to Beale's 1850 great camel expedition from Texas to California, and theorize that it accidentally came on the fur of those camels, there is no evidence that *Alhagi camelorum* entered Arizona or California before the twentieth century.

In the 1890s, University of Arizona horticulturalist, Robert Forbes, and others introduced dates to California and Arizona. The survival rates were very low during the long ship voyages and land journeys. A new packing method developed by Walter Swingle, using local plant materials, brought the survival rate up to about 90 percent, but it apparently was also ideal for dispersal of weed seeds, among which was *Alhagi*. Swingle described his new method in 1898: "The awkward wooden tub method was eliminated in favor of wrapping the roots of offshoots in cocoons of damp moss or palm fiber. The relatively light plants were then hauled by camel over 90 miles of desert to the town of Biskra where they



were...loaded into a special railroad car for another journey of over 200 miles to Algiers ..." just the beginning of a long journey.<sup>12</sup>

Camelthorn probably also came in alfalfa seed from Turkestan, which was a prime source of weeds. N. Wykoof of Napa Valley, California wrote in his diary: "In the winter of 1854, I sowed four acres with alfalfa or lucerne, as it was then called, seed brought from Chile. As far as I know, it was a part of the first parcel of seed brought into this country. My sowing proved so foul with weeds that I plowed it up and did not resow until 1864."<sup>12</sup>

Camelthorn spreads both vegetatively and by seeds carried in water. It quickly became a pest in the date-growing areas of California and Arizona, and later spread to the Gila River and as far north as the San Juan River in Utah. It was listed as naturalized near Gillespie Dam along the Gila River in 1940, and can still be found there along irrigation canals today, downstream from an abandoned ranch with many old palm trees as well as alfalfa fields. It recently reached the Grand Canyon. It was removed from the noxious weed list in California after successful eradication programs.<sup>12</sup>

#### Buffel Grass (*Pennisetum ciliare*)

Arizona's most recent invasive plant introduction is buffel grass. In the 1940s the Soil Conservation Service (SCS is now called Natural Resources Conservation Service) brought it to the United States from South Africa where it was being tested for its value as fodder. Buffel grass originated in the Turkana Desert of Kenya (where it was adapted to grazing by large herds of about 30 species of ungulates), as part of a major plant introduction program. It was formally released from the SCS nursery in San Antonio in 1946, as a forage crop for semi-tropical and tropical areas of the southern U.S. and Mexico. The plant was found to be cold-hardy up to about 3000 feet elevation. Attempts begun in 1983 to develop a cold-hardy strain from South Africa were dropped by SCS in 1991 due to lack of interest and increased environmental concern. Mexican ranchers have enthusiastically replaced thousands of hectares of Sonoran Desert vegetation with this invasive grass, which can now be found throughout southern Arizona and northern Sonora where winters do not get too cold. In some areas of Sonora, fires have increased many-fold and native vegetation has usually lost out to this aggressive grass, which is well adapted to fire. Cacti and other native plants have been almost eliminated from some areas.<sup>13</sup>

#### Some Closing Observations

One thing that stands out from this quick overview is the great enthusiasm for plant introduction, without any consideration for the possible negative consequences that seem obvious to us today. The eminent botanist J.J. Thorner highly recommended *Tamarix chinensis* and five other species in 1916, for reasons such as, "These plants appeared to succeed almost everywhere, though their growth was most

robust in alkaline soils...they are interesting because of their notable adaptability to arid and semi-arid regions...They are propagated readily from seeds and cuttings. No difficulty is experienced in starting them to grow."<sup>9</sup> He did not anticipate that the very qualities for which he recommended saltcedar were those which would make it a fearsome pest in riparian areas.

This was more than 50 years after John Means, whose family first introduced Johnson grass, well understood the law of unintended consequences. "I will not move," he said, "unless I can sell my lands for any price that would be an inducement for me to sell, for the big grass has inspired such a terror that no one will even look at it...When the grass runs me off, then I will seek a home in the west."<sup>7</sup>

Plant introduction has made major changes in the lifestyle of virtually every person on earth – from introduction of the potato from the Americas to Europe to the introduction of wheat to the Americas. As one scholar wrote, "Plant introduction can rightly be considered one of the important civilizing influences at work throughout our history."<sup>4</sup> In the case of the few invasive pest species, however, plant introduction has also wreaked havoc with native species throughout the world. A very recent goal of plant introducers is to find a way to predict which species will become problem species and which can remain under control.

#### Sources of Information

Tracing down the origin of specific pest species is in some cases very straightforward and in other quite complex. Species which proved to be good for landscaping, such as *Ailanthus altissima*, have been well tracked, from the first boasting of successful nurserymen. Plants that quickly became agricultural pests, such as *Salsola*, were carefully tracked by Agricultural Extension agents as they invaded new territories. Other species such as *Eleagnus angustifolia* didn't attract the attention of landscape historians or of agricultural weed historians. These proved more difficult to trace.

The references section lists the works found most helpful. Standard works on plant introduction are of little help in tracking down invasive exotics, as they concentrate on those plants that became useful food or landscape plants. Histories of weeds are useful if the species in question became an agricultural pest. A fifty-year old study of exotic species in California is very useful for the species studied.

It should be clear from the references that State Agricultural Extension works are extremely useful. Extension agents played a major role in plant introductions, (both intentional and accidental) and in fighting weeds. Introduction of new forage grasses and crops was an important part of their mission. Historic Extension bulletins and files from all western states provide a wealth of information for the researcher for the period starting about 1890. W.W. Robbins (3) is a prime source for the pre-1940 introduction to the southwest.

## References

Sources of information are listed alphabetically by general topic.

### 1. Spanish introductions

- Delaney, Robert W. 1987. The Modification of Land Use by Plant Introduction: The Spanish Experience. *Journal of the West* (July), 26-33
- Hendry, George W. 1934. The Source Literature of Early Plant Introduction into Spanish America. *Agricultural History* 8(2): 64-71.

### 2. General historical sources

- Crosby, Jr, Alfred W. 1972. *The Columbian Exchange: Biological and Cultural Consequences of 1492*. Greenwood Publishing Co., Westport. 268 p.
- Crosby, Jr, Alfred W. 1993. *Ecological Imperialism: The Biological Expansion of Europe, 900-1900*. Cambridge University Press, Cambridge. 368 p.
- Jewett, Frances L. 1958. *Plant Hunters*. Houghton Mifflin. Boston. 230 p.
- Lemmon, Kenneth. 1968. *The Golden Age of Plant Hunters*. Phoenix House. London. 229 p.
- Lyte, Charles. 1983. *The Plant Hunters*. Orbis. London. 191 p.
- Ridley, Henry N. 1930. *The Dispersal of Plants throughout the World*. L. Reeve and Co., Ltd. Ashford, Kent. 744 p.
- Tyler-Whittle, Michael S. 1970. *The Plant Hunters*. Chilton. Philadelphia. 281 p.

### 3. Weed Histories

- Baker, Herbert G. 1972. Migrations of Weeds. In *Taxonomy, Phytogeography and Evolution*. D.H. Valentine. Academic Press London. 430 p.
- Dewey, Lyster H. 1964. Migration of Weeds. In *Yearbook of the U.S. Department of Agriculture*, Washington D.C. 263-287.
- Foy, C.L., D.R. Forney, and W.E. Cooley 1983. History of Weed Introductions. In Charles L. Wilson and Charles L. Graham, editors. *Exotic Plant Pests and North American Agriculture*, pp. 65-92. Academic Press, New York.
- Mack, R.N. 1986. Alien Plant Invasion into the Intermountain West: A Case History. Harold A. Mooney and James A. Drake, editors. In *Ecology of Biological Invasions of North America and Hawaii*, pp. 191-209. Springer Verlag, New York.
- Mitch, Larry W.; Orcutt, Deborah R. 1985. A History of Weeds in California. In 37th Annual Weed Conference. California Weed Conference, Sacramento.
- Parish, S. B. 1913. Plants Introduced into a Desert Valley as a Result of Irrigation. *Plant World*. 16: 275-279.
- Robbins, W.W. 1940. Alien Plants Growing without Cultivation in California. *Agricultural Experiment Station. University of California Bulletin #637*. Berkeley.
- Toumey, J.W. 1897. Something about Weeds. *Agricultural Experiment Station, Tucson*. 31 p.

### 4. Plant Introduction in North America

- Hedrick, U.P. 1950. *A History of Horticulture in America to 1860*. Timber Press, Portland, Oregon. 634 pages.

- Mooney, H.A. and James A. Drake (editors) 1986. *Ecology of Biological Invasions of North America and Hawaii*. Springer-Verlag, New York. 321 p.

- Ryerson, Knowles A. 1934. History and Significance of the Foreign Plant Introduction Work of the United States Department of Agriculture. *Agricultural History*. 8(1): 110-128.
- Vale, Thomas R. 1982. *Plants and People: Vegetation Change in North America*. Association of American Geographers, Washington, D. C. 88 p.

### 5. *Erodium* sp.

- Fremont, Capt. J.C. 1845. Report of the Exploring Expedition to the Rocky Mountains in the Year 1842 and to Oregon and North California in the Years 1843-44. U.S. Senate Document. Washington D.C. 242 and 253.
- Hendry, George W. 1931. The Adobe Brick as a Historical Source. *Agricultural History*. 53:110-127.
- Hendry, George W. and M.K. Bellue. 1936. An Approach to Southwestern Agricultural History through Adobe Brick Analysis. In *Symposium on Prehistoric Agriculture*, pp. 65-72. University of New Mexico Bulletin #296. Albuquerque.

### 6. *Cynodon dactylon*

- Anonymous. 1910. Timely Hints for Farmers. Bulletin #88. Agricultural Experiment Station. University of Arizona. Tucson. 4 p.
- Mitch, Larry W. 1989. History and Taxonomy of Bermuda grass. In 41st Annual California Weed Conference, pp. 181-187. Sacramento.

### 7. *Sorghum halapense*

- Anonymous. 1918. Johnson Grass Control. Bulletin #82. Agricultural Experiment Station, University of Arizona. Tucson. 16 p.
- Merrill, W.E. 1975. Invaders down the Salt. In *One Hundred Echoes from Mesa's Past*. Lofgreen. Mesa. 172-174.
- McWhorter, C.G. 1971. Introduction and Spread of Johnson grass in the United States. *Weed Science* 19: 196-500.

### 8. *Ailanthus altissima*

- Spongberg, Stephen A. 1990. *A Reunion of Trees*. Harvard University Press. Cambridge. 270 p.
- Swingle, Walter T. 1916. The early European History and the Botanical Name of the Tree of Heaven. *Journal of the Washington Academy of Science* 6:490-498.

### 9. *Tamarix* sp.

- Baum, Bernard R. 1978. *The Genus Tamarix*. Israel Academy of Sciences and Humanities. Jerusalem. 209 p.
- Douglas, E.. 1954. Water Hogs of the West. *Land Improvement*. Dec: 13-12
- Harris, D.R. 1966. Recent Plant Invasions in the Arid and Semi-arid Southwest of the United States. *Annals of the Association of American Geographers*. 56:408-422.
- Horton, Jerome S. Notes on the Introduction of Deciduous Tamarisk. U.S. Forest Service Research Note RM-16. 7 p.
- Ohmart, Robert. 1982. Past and Present Biotic Communities of the Lower Colorado River Mainstem and Selected Tributaries. Bureau of Reclamation. Boulder City. 5 vols.

Robinson, T.W. 1965. Introduction, Spread and Areal Extent of Saltcedar (*Tamarix*) in the Western States. Geological Survey Professional Paper 491-A. U.S. Government Printing Office. Washington D.C. 12 p.

Thornber, J.J. 1916. Tamarisks for Southwestern Planting. Timely Hints for Farmers #121. University of Arizona Experiment Station. Tucson. 8 p.

Turner, R.M. 1974. Quantitative and Historical Evidence of Vegetation Changes along the Upper Gila River, Arizona. Gila River Phytorecovery Project. Geological Survey Professional Paper 655-H. U.S. Government Printing Office. Washington. 20 p.

#### 10. *Elaeagnus angustifolia*

Hansen, N.E. 1901. Ornamentals for South Dakota. South Dakota Agricultural Experiment Station. Brookings. 31 p.

Garcia, Fabian. 1903. Shade Trees and other Ornamentals. Agricultural Experiment Station. Bulletin #47. Santa Fe.

Mulford, K.L. 1925. Trees for Roadside Planting. Farmers' Bulletin #1482. U.S. Department of Agriculture. Washington D.C. p. 36.

Welsh, S.L., C.R. Nelson, and K.H. Thorne. 1971. Naturalization of Plant Species in Utah - 1842 to Present. In Lynn F. James, John O. Evans, Michael H. Ralphs, and R. Dennis Child, editors. Noxious Range Weeds, pp. 17-29. Westview Press, Boulder.

#### 11. *Salsola iberica*

Bessey, Charles E. 1893. The Russian Thistle in Nebraska. Bulletin of the Agricultural Experiment Station of Nebraska. Vol 6 #31. 67-73.

Dewey, Lyster H. 1964. Migration of Weeds. Yearbook of the U.S. Department of Agriculture. Washington D.C. 263-286.

Shinn, Charles H. 1895. The Russian Thistle in California. California Agricultural Experiment Station Bulletin # 107. 16 p.

#### 12. *Alhagi camelorum*

Bottel, A.E. 1933. Introduction and Control of Camelthorn. In Monthly Bulletin #22, pp. 261-263. California Department of Agriculture, Sacramento.

Colley, Charles C. 1975. Robert Humphrey Forbes of Arizona: the Frontiers of Arid Lands Agriculture. Ph.D. Dissertation, Arizona State University, Tempe. 329 p.

Colley, Charles C. 1983. The Desert Shall Blossom: North African Influence on the American Southwest. The Western Historical Quarterly (July), 277-290.

Groh, Herbert. 1940. Turkestan Alfalfa as a Medium of Weed Introduction. Scientific Agriculture 21:36-43.

Larson, Andrew K. 1961. Agricultural and Horticultural Improvement. In I Was Called to Dixie. Deseret News Press. Salt Lake City.

#### 13. *Pennisetum ciliare*

Munda, Bruce. 1995. Tucson Plant Materials Center Program for Southwest Deserts. Arizona Riparian Council Newsletter 8(2): 6-8.

Yetman, David. 1994. Buffelgrass - Sonoran Desert Nightmare. Arizona Riparian Council Newsletter 7(3) 1p.

### Arizona's Changing Rivers: How People have Affected the Rivers

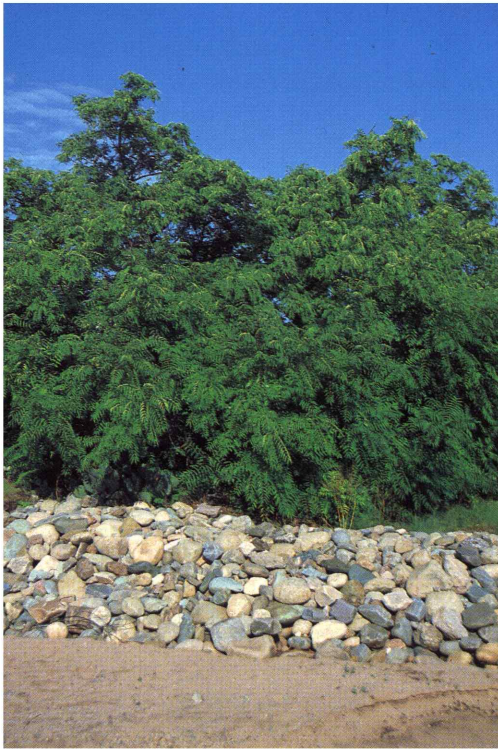
Barbara Tellman, Richard Yarde and Mary G. Wallace

This 200 page book is a user-friendly overview of ways in which people have impacted Arizona's rivers. It includes numerous historic photos and many other illustrations. A companion computer disk contains a self-executing bibliography of almost 2,000 references to the history of Arizona's rivers.

Copies may be purchased from:  
Water Resources Research Center  
College of Agriculture  
The University of Arizona  
350 N. Campbell Avenue  
Tucson, Arizona 85721  
(520) 792-9591  
FAX (520) 792-8518

Book copy	\$15.00
Bibliography Copy	\$ 5.00
combined	\$17.50
Mailing	\$ 1.00

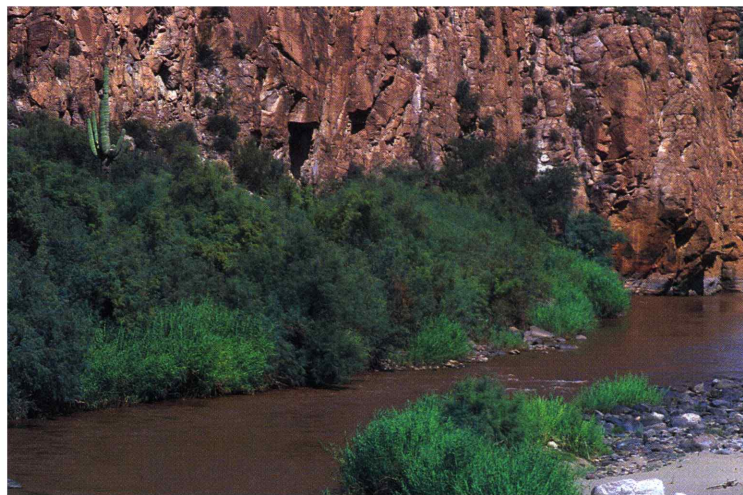




**Figure 1.** *Ailanthus altissima* escaping into a wash in Oracle Junction



**Figure 3.** *Alhagi camelorum* along the Gila River



**Figure 2.** *Tamarix ramosissima* along the Salt River