Luther Burbank's Plums

David Karp¹

Department of Botany & Plant Sciences, University of California, 900 University Avenue, Riverside, CA 92521

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Abstract. The 113 named varieties of plums introduced by Luther Burbank (1849–1926) were by far the most numerous and arguably the most significant of his horticultural accomplishments. He began by importing 12 seedlings from Japan in 1885, including ‘Abundance’ and ‘Satsuma’ (*Prunus salicina*). The cultivars he released in the late 19th and early 20th centuries played a crucial role in developing commercial cultivation of Asian-type plums in California, the United States, and much of the world; they also served as founding clones for later breeders. His crowning achievement was ‘Santa Rosa’ (introduced 1906), which in 1945, ‘Santa Rosa’ accounted for 36% of the California plum harvest. Many of Burbank’s other cultivars of primarily *P. salicina* ancestry were extensively cultivated in California in the early and middle 1900s, including ‘Beauty’ (introduced 1911), ‘Burbank’ (1888), ‘Duarte’ (1911), ‘Eldorado’ (1904), ‘Formosa’ (1907), and ‘Wickson’ (1895). His most important introductions of European plum (*P. domestica*) were ‘Improved French’ prune (1898), ‘Sugar’ prune (1899) and ‘Standard’ prune (1911). Some of Burbank’s more obscure introductions never received general distribution and have disappeared; others such as ‘Santa Rosa’, ‘Shiro’ (1899), and ‘Elephant Heart’ (released posthumously in 1929) still are commonly cultivated today in home gardens and for sale at local markets.

In the history of horticulture it is rare to find an individual who almost single-handedly created a new commercial industry based on a novel fruit type as Luther Burbank (1849–1926) did for Asian-type plums (*Prunus salicina*) in the United States. The 113 named varieties of plums and prunes that he introduced in the late 19th and early 20th centuries were by far the most numerous and arguably the most significant of his horticultural accomplishments. They played a crucial role in developing commercial cultivation of Asian-type plums in California, the United States, and much of the world; they also served as founding clones for later breeders.

Plums are native throughout the northern hemisphere, primarily in the temperate zones of Asia, Europe, and North America. *P. salicina* is native to China, where it has been cultivated since antiquity; *P. simonii* is another species native to China (Ramming and Cocui, 1990). For millennia, Native Americans harvested indigenous wild plums, which generally grow on shrubs or shrub-like trees. Compared with modern commercial cultivars, most native plums are small and tart and have astringent skins (Bailey, 1906). Settlers in the United States imported plums from their homelands, mostly *P. domestica*, which includes prunes, greengages, and egg plums, and *P. insititia*, which includes damsons and bullaces. The first named cultivars of plums were brought to California in 1851. Until 1870 only European and American plums were grown in California (Butterfield, 1938).

EARLIEST ASIAN PLUMS BROUGHT TO CALIFORNIA

In that year a Mr. Hough of Vacaville, which was then one of the leading plum-growing

areas of the state, imported plum trees from Japan through the U.S. consul, paying \$10 each. A nurseryman in Berkeley, John Kelsey, bought the stock in 1874 and fruited the variety in 1876 and 1877. When the variety started to be widely propagated in the 1880s, another nursery, W.P. Hammond Co. of Oakland, named the variety ‘Kelsey’ (Butterfield, 1938). It was large and heart-shaped with skin that ranged from green to yellow or red when fully ripe (Fig. 1), a small pit, and firm yellow, juicy flesh.

In the late 1870s M.A. Chabot of Oakland started importing Japanese plants, including a plum cultivar that was round or heart-shaped with red skin over yellow ground, mottled with russet, and golden yellow, very juicy flesh. Luther Burbank, who arrived in California in 1875, obtained this cultivar and introduced it as ‘Chabot’; different sources give the date of this introduction as 1881 (Butterfield, 1938) or 1885–86 (Hedrick, 1911).

One other Asian plum cultivar was present in California by the time that Burbank began breeding plums, the ‘Simon’ (*P. simonii*) or Apricot plum. This was obtained in China by a French consul, Eugene Simon, and sent to Paris in 1867; it was offered for sale by eastern U.S. nurseries as early as 1881 (Burbank, 1914; Hedrick, 1911). Burbank later described it as “a large, flat, tomato-shaped plum, with dark brown, hard flesh, purplish-red skin, and a small stone...sometimes eatable and sometimes classed as good when grown in the hot, dry climates of the interior valleys of California.” It was not a “perfect fruit to begin” but valuable as a breeding parent because of its “small stone, delightful aroma, and desirable tree characters” (Burbank, 1914). [It also seems to have contributed firm flesh to its progeny, a characteristic exemplified by later cultivars such as ‘Friar’ (1968) and ‘Blackamber’ (1980).] Burbank said he used ‘Simon’ to breed many plum cultivars including ‘Bartlett’, ‘Chalco’, ‘Challenge’, ‘Climax’, ‘Combination’, ‘Eldorado’, ‘Late Shipper’, ‘Maybard’, ‘Royal’, ‘Santa Rosa’, and ‘Wickson’ (Howard, 1945).

HISTORY AND METHODS OF BURBANK’S PLUM BREEDING

Burbank moved from Massachusetts to California in 1875 and in 1878 opened a small nursery business in Santa Rosa, 50 miles north of San Francisco. He first took a serious interest in plums in 1881, when he propagated 20,000 trees of the recently introduced ‘Agen’ prune (Smith, 2009). Only two or three named cultivars of Asian plum were present in California at this time and, as described previously, Burbank bought or traded for these. He had read of a blood plum in Japan, and in 1883, he had Isaac Bunting, a dealer based in Yokohama, ship him a dozen Japanese plum trees. He was hoping to find a novelty that he could market profitably, but all trees of this first shipment arrived dead. He tried again in 1885 and on 20 Dec. of that year received “12 sturdy, healthy Japanese plum seedlings.” Two of them, ‘Burbank’ and ‘Satsuma,’ were of such exceptional quality that he sold buds and trees within a few years. The others, of varying quality and importance for the future, included ‘Berckmans’, ‘Chase’, ‘Heikes’, ‘Late Blood’, ‘Long Fruit’, ‘Maru’, and ‘Willard’, which were also sold under various synonyms. In 1887 Burbank sent fruits from the original trees to H.E. Van Deman of the U.S. Department of Agriculture, to local and national newspapers, and to be exhibited at a fruit growers’ convention that met in Santa Rosa. In addition, he offered the new

Fig. 1. ‘Kelsey’ plums grown in Dinuba, CA.

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¹To whom reprint requests should be addressed; e-mail dkarp@ucr.edu.

Japanese plums in his nursery catalog, charging \$1 dollar per tree or 75 cents for dormant buds (Burbank, 1914; Butterfield, 1938; Dreyer, 1993; Smith, 2009).

Burbank began breeding plums, he wrote, because he “was impressed with the demand all about me for better varieties of plums and prunes, especially for drying and shipping purposes.” He started gathering a collection of Japanese plums with desirable characteristics: “rapid growers, with early and abundant bearing qualities, and unusual adaptability to wide ranges of climate” and fruit “large in size, with a high percentage of flesh to stone, and with both skin and flesh of high color.” His basic method was to “take the characteristics from the plums...and combine them in different varieties; to eliminate the faults as far as possible; to select and test the best among the millions of seedlings produced from the various combinations.” To accelerate his progress, he used the original seedlings as stocks for grafting the scions of new seedlings, as many as 20 sets of grafts per tree (Burbank, 1914).

Burbank visited A.D. Pryal’s nursery in Oakland, where he learned about pollination. A little more than a week later, after the first shipment of Japanese plum trees arrived, he purchased an 18-acre property in Sebastopol, near Santa Rosa, which he called the Gold Ridge Farm. As soon as the new Japanese plum trees flowered, he started making crosses with other Japanese, European, and native plums and growing seedlings of his own. As these seedlings started to produce fruit, he offered stock and control of the most promising selections in his nursery catalogs. The first of his plum creations to go on the market, in his catalog named *New Creations in Fruits and Flowers*, issued in June 1893, included ‘Perfection’ (which would later be renamed ‘Wickson’); ‘Hale’ (‘Kelsey’ × ‘Satsuma’); and ‘Juicy’ (‘Robinson’ × ‘Abundance’). Burbank continued making crosses until his death in 1926 (Burbank, 1914; Butterfield, 1938; Dreyer, 1993; Howard, 1945). In all he released 113 cultivars of plums and prunes, accounting for more than half of his fruit introductions (Howard, 1945).

Burbank’s Asian-type plum introductions had larger fruit size, better shipping qualities, and showier appearance than the European cultivars previously grown in California, and they rapidly displaced them in plantings for fresh market. His crowning achievement was ‘Santa Rosa’ (introduced 1906), which appears to have derived its reddish flesh from ‘Satsuma’; firmness and acidity from the apricot or ‘Simon’ plum (*P. simonii*); and a rich, wild aroma, very likely from *P. cerasifera*. The American species used by Burbank in breeding plums contributed disease resistance, tough skin, and aromatic quality (Okie and Ramming, 1999).

As of 1914, Burbank estimated that he had devoted approximately one-tenth of his experimental work to plums, accounting for as much time any other crop; only the spineless cactus took more labor. At that time, he

claimed that his plums accounted for one-third of the plums exported from California and also one-third of the “commercial value” generated by his breeding efforts (Burbank, 1914).

In 1945 his cultivars accounted for seven of the top 10 cultivars grown primarily for fresh fruit in California, including ‘Santa Rosa’ (36%), ‘Beauty’ (14%), ‘Duarte’ (10%), ‘Wickson’ (5%), ‘Giant’ (4%), ‘Burbank’ (2%), and ‘Formosa’ (2%), adding up to an astounding 73% of the market (Faust and Surányi, 2011). None of Burbank’s plum cultivars are grown commercially on a wide scale in the United States today, but several such as ‘Santa Rosa’ and ‘Shiro’ are still important for local and home garden use. Some, like ‘Inca’ (1919) and ‘Elephant Heart’ (1929), are much appreciated by fruit connoisseurs, although they have significant flaws (both have gum pockets and ripen over an extended period; ‘Elephant Heart’ tends to have astringent, tart skin unless perfectly ripe) for commercial production.

Burbank also devoted serious attention to breeding *P. domestica* selections for the drying and fresh markets, beginning with ‘Splendor’ prune (a seedling of ‘Agen’) and ‘Long-leaved Wonderful’, both introduced in 1893, and ‘Giant’ (‘Agen’ × ‘Pond’) in 1894. The historical record is not complete, but a seedling of ‘French’ (‘Agen’), which Burbank named ‘Miller’ and sold in 1898 to a nurseryman in Morgan Hill, appears to have been the cultivar later known as ‘Improved French’, which accounts for nearly the entire commercial prune industry in California today. Several of the other cultivars he introduced over the years were planted with great hopes, but none were ultimately successful as drying prunes; ‘Sugar’, a seedling of ‘Agen’ introduced in 1899, was the most widely planted, being grown on 4228 acres in 1949, although many of the shipments were as fresh plums. ‘Standard’, a cross of ‘Sugar’ and ‘Tragedy’ introduced in 1911, was widely planted in the beginning but disappeared for drying within a decade (Hansen, 1951; Howard, 1945; Wickson, 1921).

One of the oddest and most intriguing of his introductions was ‘Miracle’, a cross of *P. institia* × *P. domestica* released in 1901, which was almost seedless and was widely planted as a curiosity. In 1911, after several generations of crosses, he introduced ‘Conquest’, which had an even smaller rudimentary seed and was widely planted by amateurs as a plum but never dried as a prune (Howard, 1945). Although these two cultivars are no longer available, germplasm undoubtedly derived from Burbank’s program still exists and is being used currently by researchers to fulfill Burbank’s vision of a stoneless or seedless plum (Callahan et al., 2015).

Burbank made use of at least 11 plum species, including hybrids and selected seedlings of such native species as *P. maritima* (‘Improved Beach’, 1897; ‘Maritima’, 1899; ‘Peach’, 1901), *P. subcordata* (‘Nixie’, 1911), and *P. munsoniana* (‘Juicy’, 1893; ‘America’, 1898; ‘Victory’, 1911) (Howard, 1945).

Until recent decades, when studies of molecular markers became possible, the pedigrees of virtually all of Burbank’s plums could not be affirmed with confidence, because he kept most of his records of crosses in his head rather than making meticulous notes. In addition, his technique for hybridizing consisted of waving blossoms of the pollen parent next to the flowers of the seed parent, but did not involve emasculating the flowers of the female parent or sequestering them from insect pollinators that could bring foreign pollen. He or his representatives claimed that several of his introductions such as ‘Honey Moon’ and ‘July Fourth’ involved hybrids of the diploid species *P. salicina* with the hexaploid *P. domestica* (Butterfield, 1938), a cross that subsequent generations of breeders have found does not result in adequate fertility.

However, the broad outline of his claim to have introgressed the genes of multiple species in his plum introductions was verified by a modern study. In an analysis of the random amplified polymorphic DNA markers of five typical California cultivars of Asian-type plums (including ‘Eldorado,’ which was bred by Burbank, and four others that were in large measure bred from his cultivars), Boonprakob et al. (2001) concluded that *P. salicina* contributed 36% of their genetic ancestry; *P. cerasifera* contributed 28%; *P. simonii* contributed 26%; and *P. americana* contributed 10%.

Burbank offered stock and control of his prized cultivars to private owners such as ‘Golden’ plum for \$3000 in 1893 and ‘Perfection’ (later called ‘Wickson’) for \$2000 in 1895. He eventually realized that he could greatly increase his earnings if he were able to charge a royalty for each tree rather than making a one-time sale, and a letter that he wrote to nurseryman Paul Stark shortly before his death helped persuade the U.S. Congress to pass the Plant Patent Law of 1930, which for the first time made possible the protection of rights for plant breeders (Dreyer, 1993). Sixteen patents were awarded to Burbank posthumously, and many plums were among the earliest awards, including numbers 12, an unnamed variety with crimson skin and light golden yellow flesh; 13, ‘Great Yellow’; 16, ‘Mammoth Cardinal’; and 18, an unnamed variety with yellow skin and flesh (Brooks and Olmo, 1997).

The following sections list and describe the plum cultivars introduced by Burbank, which were of greatest significance, either because they were widely planted in the United States or other countries or because they played a key role as founding clones for later breeders. This includes cultivars obtained either through importation or breeding and collates and updates the information found in the leading primary (Burbank’s writings and nursery catalogs) and secondary sources. The cultivars are described in approximate chronological order, although it is not possible to be completely consistent, because in some cases, only the date of crossing is known, whereas in others, just

the date of introduction is available. Descriptions include the pedigree, history of introduction, tree and fruit characteristics, season, history of cultivation, and availability of germplasm and nursery trees.

ASIAN-TYPE PLUM CULTIVARS IMPORTED BY BURBANK

‘Burbank’ was a seedling of ‘Wassu’ imported by Burbank from Japan in 1883 (Hedrick, 1911) or 1885 (Howard, 1945), named in 1887, and introduced in 1888. The tree is vigorous, spreading, a precocious bearer, and self-sterile. Fruit are almost globular; skin is cherry red over deep yellow ground, dotted with yellow spots; flesh is golden yellow, juicy, very sweet, but not intense in flavor; it is clingstone; and the pit is very small. The season is late June and early July with a relatively long ripening period. It is an excellent shipper (Allen, 1929). In the first half of the 20th century ‘Burbank’ was one of the most popular cultivars for both commercial and home use (Allen, 1929; Hedrick, 1911; Wickson, 1926). In 1938 171,000 crates were shipped, but by 1945, it accounted for only 2% of shipments from California. Today it is no longer grown commercially, germplasm is not available from the National Clonal Germplasm Repository for Tree Fruit, Nut Crops and Grapes at Davis, CA (NCGR-Davis), and nurseries no longer carry this cultivar.

‘Abundance’ was imported from Japan by Burbank in 1884 (Howard, 1945) or 1885 (Butterfield, 1938) and introduced by John T. Lovett of Little Silver, NJ, in 1888. It was originally known as ‘Botan’ (Howard, 1945). The tree is large, vigorous, and hardy. Fruit are medium size and globular or irregular ovoid with a pointed apex; skin is cherry red over a yellow ground, covered with white bloom; it is clingstone; and flesh is yellow, juicy, and rich (Allen, 1929; Hedrick, 1911; Waugh, 1901; Wickson, 1926). Its season is early. Multiple strains of different appearance were sold under the name (Waugh, 1901). ‘Abundance’ was adaptable to a wide diversity of soils and, as its name indicates, was a prolific bearer (Hedrick, 1911). In 1910 it was popular for shipment from early regions (Wickson, 1910), but it was a poor shipper, susceptible to brown rot, and by 1926, it was disapproved for shipping (Wickson, 1926). In 1945 it was still “perhaps planted more widely than any other Japanese plum, although others, because of their shipping qualities, [had] a much larger acreage, especially in the South and on the Pacific Coast” (Howard, 1945). It is not grown commercially today. Germplasm is available from NCGR-Davis, where the accession number is DPRU 919. This cultivar currently does not appear to be available from nurseries. It was a parent of ‘Climax’.

‘Satsuma’ came from a tree received by Burbank from Yokohama, Japan, in Dec. 1885 and was first named “Blood Plum of Satsuma” after a province in Japan (Hedrick, 1911). Buds were sold under the original

name in 1887, and the trees were first sold in 1889. The tree medium to large, upright-spreading, vigorous, moderately productive, bearing heavier crops as the tree becomes older. Fruit are small to medium, round, or slightly flattened; skin is mottled dull red and green (Fig. 2), somewhat tough, and bitter (Ashton, 2008); it is semiclingstone; flesh is deep red, firm, juicy with a rich almond-like flavor (Hedrick, 1911). The season is mid- to late July to early August. It is partially self-fruitful, adapted to areas with low winter chill, and so popular in southern California; it is a probable parent or ancestor of ‘Mariposa’. It is never much cultivated commercially but important for local markets and home plantings; it is primarily used for cooking, canning, and preserves rather than fresh shipments (Allen, 1929). It is not represented at NCGR-Davis but widely available from nurseries.

ASIAN-TYPE PLUM CULTIVARS BRED BY BURBANK

‘Wickson’ resulted from a cross made by Burbank $\approx$ 1887 of ‘Burbank’ (*P. salicina*) $\times$ ‘Simon’ (*P. Simonii*) (Howard, 1945) or ‘Kelsey’ (Hedrick, 1911). Introduced in 1895, and first advertised for sale as ‘Perfection’, it was renamed after the eminent pomologist Edward J. Wickson. The tree vigorous, productive, upright, not very cold-hardy, and self-sterile. Fruit are very large for its era, heart-shaped like ‘Kelsey’, but more symmetrical; skin ripens to yellowish red or solid red (Fig. 3); the pit is small and clingstone; flesh is coarse, amber yellow, translucent, tender, and juicy; flavor is good but not the best (Allen, 1929; Hedrick, 1911; Howard, 1945). Season is mid-July in Fresno. In the 1910s and 1920s, it was one of the most important cultivars shipped from California (Allen, 1929; Hedrick, 1911); by 1940 it was still the fifth most important Burbank plum cultivar in California (after ‘Beauty’, ‘Duarte’, ‘President’, and ‘Santa Rosa’), but starting to decline, as some 2,000 acres were grown and 186,000 crates were shipped (Howard, 1945–46). By 2008 just 4000 packages were shipped, and today ‘Wickson’ is little grown commercially but still popular for farmers’ markets and home gardens. Germplasm is available from NCGR-Davis (DPRU 2135); trees are widely available from nurseries.

Fig. 2. ‘Satsuma’ plums grown in Littlerock, CA.

‘Shiro’ was said to be a seedling of ‘Wickson’, representing “a combination of Robinson (*P. munsoniana*), myrobalan, and ‘Wickson’” (Howard, 1945). It was developed in 1889 and introduced in 1898 (Butterfield, 1938) or 1899 (Ashton, 2008). The tree medium-large, moderately vigorous, hardy, and productive. Fruit are small to medium size; skin is light to deep yellow with a pale blush and numerous very small, inconspicuous dots (Fig. 4); it is clingstone; flesh is light yellow, semitransparent, juicy, sweet, and mild; flavor lacks character, and the skin is quite tart (Hedrick, 1911). The season is mid-June (San Joaquin Valley); early July (coastal valleys); or late July (mid-Atlantic). It can be shipped but quickly breaks down after ripening. It has been widely planted, but mostly for home and local markets (Howard, 1945); it is common in the Northeast and Midwest. The germplasm was formerly at NCGR-Davis (DPRU 2132) but is no longer present; trees are widely available from nurseries.

‘Climax’ was a cross of ‘Simon’ (*P. Simonii*) $\times$ ‘Abundance’, originally called ‘Royal’, introduced in 1899 (Hedrick, 1911). The tree is a precocious and prolific bearer, spreading, vigorous, thrifty, and self-fertile. Fruit are large, heart-shaped with a pronounced apex; skin is deep red; it is clingstone; flesh is yellow, juicy, subacid, somewhat fibrous, tender, and melting (Hedrick, 1911; Wickson, 1926); it tends to crack and ripens rapidly at the apex. It is very susceptible to brown rot and poorly adapted to Eastern conditions (Hedrick, 1911). The season is the second half of June (Allen, 1929). Widely planted in the early 20th century, it is still growing in favor in the late 1920s (Allen, 1929; Wickson, 1926), but in

Fig. 3. ‘Wickson’ plums grown in Kingsburg, CA.

Fig. 4. ‘Shiro’ plums grown in San Luis Obispo, CA.

decline by 1945, when there were ≈ 1000 bearing acres in California (Howard, 1945). Germplasm is not currently available at NCGR-Davis (was DPRU 1501, 2119); trees are not available from nurseries.

'Gaviota' was said to have originated in 1900 as a cross of *P. salicina* $\times$ *P. americana*, although Howard wrote that it "probably contains admixtures of other species"; first named 'Rice Seed', it was introduced 1909 by Fancher Creek Nurseries of Fresno (Howard, 1945) or in 1907 (Butterfield, 1938; Hedrick, 1922). However, from an analysis of its molecular markers, Boonprakob et al. (2001) concluded "it appears that 'Gaviota' has *P. simonii* in its background." The tree is variously described as vigorous (Allen, 1929) or weak (Howard, 1945) and prolific, tender to cold, blooming late, and self-sterile. Fruit are very large for its time; it is oval, dark red over yellow ground color; flesh is yellow, firm, sweet, with a distinct, characteristic flavor; seed is small; it shipped and stored well for its time (Allen, 1929). The season is late July and early August (Allen, 1929). It has been increasing in popularity since 1922 (Hedrick, 1922); shipped from the Vacaville, CA, district (Wickson, 1926); 44,000 crates marketed from California in 1940; was grown in Australia and South Africa; and is no longer grown commercially (Howard, 1945). 'Gaviota' was used by John Weinberger for size and is in the parentage of 'Friar' (= 'Gaviota' $\times$ 'Nubiana'). Germplasm is not present at NCGR-Davis; it does not appear to be available from nurseries; it may be available through rare fruit collectors (Mariani, 1994).

'Duarte' originated as a cross of seed parent 'America' (*P. munsoniana* $\times$ *P. salicina*) and pollen parent 'Climax'; Burbank said it "owes its flavor largely to wild American ancestors." It was developed in 1900 and introduced in 1911 by Pioneer Nursery Company of Monrovia, CA (Howard, 1945). The tree vigorous and upright with numerous fruiting branches (Allen, 1929); it is self-sterile. Fruit are large with dark or dull red skin, thickly colored with large cream or brownish dots; flesh is dark red; it somewhat resembles 'Satsuma'; it is semifreestone; flavor is very good (Allen, 1929). The season is mid- to late July; formerly it was the earliest blood plum (Wickson, 1926). It was important in the leading shipping sections in 1929 (Allen, 1929); in 1940, 2,000 acres were grown in California, and 254,000 crates shipped (Howard, 1945); it is no longer grown commercially. Germplasm was formerly at NCGR-Davis (DPRU 2821) but is no longer available; trees of 'Improved Duarte' are available from nurseries.

'Eldorado', also known as 'El Dorado', originated as a cross of *P. salicina* $\times$ *P. simonii*, introduced 1904 (Howard, 1945). "Many years ago a small black Japanese hybrid plum was produced on my Sebastopol place...ripening early in July...but too small...at last in 1904 Eldorado appeared, just like the little purple All Summer, but about ten times as large" (Howard, 1945,

citing Burbank catalog from 1918). The tree is medium-large, very upright, and self-infertile. Fruit are large; skin is reddish black (Fig. 5); it is clingstone; flesh is firm and amber yellow; it is said to store and ship well; it is good for canning (Facciola, 1998). It ripens midseason. It was grown commercially in California ≈ 1910 –60; 36,000 crates were shipped in 1939 (Howard, 1945); by 1965, it accounted for 10% of commercial plum shipments, but this share had declined to 3% in 1988 (Faust and Surányi, 2011), and 'Eldorado' is no longer grown commercially. Germplasm is available from NCGR-Davis (DPRU 2122); trees are not readily available from nurseries but may be obtained through rare fruit groups.

'Santa Rosa' was described as "a complex hybrid containing a mixture of *Prunus triflora* [*salicina*], *P. Simonii*, and *P. americana*, with the *salicina* characters predominating." The exact varieties will never be known, but the red flesh would indicate that the 'Satsuma' played a part" (Howard, 1945). However, Boonprakob and Byrne (2003) found that 'Santa Rosa' did not have *P. americana* in its parentage, but did have *P. cerasifera*. It was introduced by George C. Roeding of the Fancher Creek Nurseries, Fresno, CA, in 1906 (Howard, 1945) or 1907 (Butterfield, 1938). The tree is vigorous, upright, compact, and highly productive. Fruit set improved by cross-pollination; it is low chill (300 h). Fruit were large for its era (but small today) and roundish; skin is purplish red with conspicuous dots and whitish bloom; it is clingstone; flesh is yellow to dark red near the skin, rich, juicy and aromatic, and delicious (Allen, 1929); it is tart near the skin and pit. The season is 10 to 25 June in Fresno. It is Burbank's most celebrated and most widely grown plum introduction; it is among the top or a leading *salicina*-type plum in the United States, southern Europe, North Africa, South Africa, Australia, and New Zealand (Howard, 1945). For many decades it was the standard for the California plum industry; it was planted widely in the 1920s (Allen, 1929; Wickson, 1926); 5160 acres were grown in California in 1939 (Howard, 1945); it accounted for 36% of the California plum harvest in 1945, 35% in 1955, 31% in 1965, 20% in 1975, 10% in 1988, and 7% in 1994 (Faust and Surányi, 2011); by the mid-1980s it was considered too small and soft (Day et al., 2013), and today it is mostly grown for local sale and home use.

Fig. 5. 'Eldorado' plums grown in Visalia, CA.

Among the many cultivars developed as sports or mutations from 'Santa Rosa', or using 'Santa Rosa' as a parent or grandparent, were 'Bella-Rosa', 'Blackamber', 'Black Ruby', 'Casselman', 'Campagne', 'Explorer', 'Fire Queen', 'Fortune', 'Fresno Rosa', 'Gar-Rosa', 'July Santa Rosa', 'Laroda', 'Midrosas', 'Padre', 'Premier', 'Roysum', 'Queen Rosa', 'Queensland Bellarosa', 'Rosa Grande', 'Rosanna', 'Salsa-Pride', 'Santa Rosa-Two', 'Segundo', 'Showtime', 'Sierra', 'Star Rosa', and 'Weeping Santa Rosa' (Brooks and Olmo, 1997). Germplasm is available from NCGR-Davis (DPRU 2131); trees are widely available from nurseries.

'Formosa' was described as "a mixture of *triflora* [*salicina*] species and several others" (Howard, 1945). It was introduced 1907 by Fancher Creek Nurseries of Fresno, CA. Trees are thrifty but not always productive and are self-sterile. Fruit are large and heart-shaped; skin is smooth yellow with a pale bloom, turning cherry red as it ripens; it is nearly freestone; flesh is pale yellow, firm then melting, sweet and juicy, sweet with a rich apricot flavor (Allen, 1929; Wickson, 1926). The season mid-June with a relatively long harvest season; it ships and stores well for an older variety but shows bruise marks readily. It was already being discarded for shy bearing in 1926 (Wickson, 1926); shipments from California in 1940 amounted to 53,000 crates and 2,000 boxes (Howard, 1945); it is no longer grown commercially. Germplasm is available from NCGR-Davis (DPRU 924); trees do not appear to be available from nurseries.

'Beauty' was described as "the product of a very complicated heredity including several species" (Howard, 1945). It was introduced 1911 (Butterfield, 1938). Trees are self-fertile and bear prolifically. Fruit are medium size and heart-shaped; skin is crimson covered with white dots; flesh is amber streaked with scarlet (Allen, 1929). Fruits are very attractive; it was regarded in the 1920s as the best early plum for shipping (Wickson, 1926). Burbank considered it "perhaps the best of all" his plums (Burbank, 1914), and it is still appreciated by connoisseurs. Beauty is one of the earliest ripening of Burbank's releases, ripening 1 to 15 June in Fresno, 7 to 10 d before Santa Rosa. In the early 1940s, 200,000 to 250,000 crates were shipped annually from California (Howard, 1945); it is no longer grown commercially but is a home garden favorite. Germplasm is available from NCGR-Davis (DPRU 2120); trees are available from nurseries.

'Inca' was introduced in 1919, but no information about its pedigree is available (Howard, 1945). The tree is low chill. Fruit are large, oval, tapered toward the blossom end; skin is golden yellow with magenta specks (Fig. 6); it is clingstone; flesh is apricot-colored, very sweet, rich-flavored, juicy, and tender; a gum pocket is typical (Mariani, 1994). The season early August in Fresno and mid-August in Santa Clara Valley (personal observation). It is never commercial because of the gum pocket problem, but

it is a singularly beautiful and delicious cultivar with a cult following among fruit collectors (Mariani, 1994). It is a parent of 'Sierra'. Germplasm is no longer at NCGR-Davis (formerly DPRU 2820), but trees are available from nurseries.

'Elephant Heart' is of unknown pedigree, but 'Satsuma' appears likely to have been a parent or ancestor. It was selected $\approx$ 1920 and introduced in 1929 by Stark Brothers Nurseries, Louisiana, MO (Brooks and Olmo, 1997). The tree is vigorous, hardy, and prolific. Fruit are large and heart-shaped; skin is thick, mottled purple, brown, and green with heavy bloom (Fig. 7); it is freestone; flesh is blood red, juicy with a rich, distinctive flavor (Brooks and Olmo, 1997; Facciola, 1998); when underripe, however, the fruit has a grassy aroma. The season is the first half of August. 'Elephant Heart' was grown commercially on a small scale from the 1940s; just 4000 cases were shipped in 2008, but the cultivar is popular at farmers' markets and home gardens and a favorite among fanciers of heirloom fruits. Germplasm is available from NCGR-Davis (DPRU 2123); trees are available from nurseries.

EUROPEAN (*P. DOMESTICA*) PLUM CULTIVARS BRED BY BURBANK

'Splendor' prune was a seedling of 'French' ('Agen') pollinated by 'Pond' ('Hungarian'); it originated in 1886 and sold as 'Cross-bred Prune A.P.-318' to Stark Brothers in 1893 and renamed by them and introduced as 'Splendor' in 1894 (Howard, 1945). The tree is partially self-fertile. Fruit are medium to large, larger than 'French' prune; the shape is oval with a distinct neck; skin is dark purple with small russet dots and

a heavy bluish bloom; it is freestone; flesh is yellowish, translucent, meaty, rich, and sweet (Howard, 1945). The season a week earlier than 'French'; it ripens its crop all together. It is considered unsatisfactory as a prune because it clings to the tree after ripening (Wickson, 1921). It is a successful plum but not extensively planted (Howard, 1945; Wickson, 1926). It is not available from NCGR-Davis or from U.S. nurseries; trees are available from Australian nurseries (Woodbridge, Yalca).

'Giant' prune was a cross of 'French' ('Agen') $\times$ 'Pond' ('Hungarian'), exhibited in 1888, and introduced in 1893 (Howard, 1945). Trees are vigorous and productive and self-fertile. Fruit are large, intermediate in size between its parents, long, oval, and the shape is slightly necked; skin is light to dark purplish red covered with numerous russet dots and a bluish bloom; it is freestone when ripe; flesh is light golden yellow, firm, dry, coarse, fibrous, and of very mild or insipid flavor (Allen, 1929; Hedrick, 1911; Wickson, 1926); it resembles 'Pond' in quality. The season is the first half of August; in its day, it was among the later varieties grown for fresh shipments. It was originally called a prune but rarely used as such. It was widely, but not extensively, planted as a shipping plum (Howard, 1945); it is not grown commercially today. It is not available from NCGR-Davis or from U.S. nurseries; trees are available from a few English nurseries.

'Improved French' appears to have originated from a seedling of 'French' ('Agen'), which Burbank named 'Miller' and sold in 1898 to Leonard Coates, a nurseryman in Morgan Hill, CA. Coates first called it the 'Improved French' prune and later 'Morgan-hill' (Howard, 1945). The cultivar resembled the original 'Agen' but was reported to be somewhat larger and more uniform in fruit size (Doyle et al., 2012). The tree upright and vigorous, self-fertile, with average precocity with a moderate tendency to alternate bearing; fruit matures uniformly throughout the tree. Fruit are medium-sized, ovate, and slightly necked; the skin is reddish purple to full purple with light grayish bloom; it is semifreestone; flesh is yellow to amber, typically ranging from 22 to 24° Brix; drying ratio commonly averages three to one (Doyle et al., 2012). The season is the second half of August in the Fresno area. It accounts for the great majority of the prune orchards grown in

California today. Germplasm is not currently available at NCGR-Davis; trees are widely available from nurseries.

'Sugar' was a seedling of 'French' ('Agen') and an unknown pollen parent introduced in 1899. The tree upright and can grow quite large; it is a heavy producer, but because of brittle wood, trees require annual pruning (Howard, 1945); it severely alternate bears (Hansen, 1951). Fruit size is medium to large, larger than 'French'; shape is oval and slightly flattened; skin is dark reddish purple covered with thick white bloom (Fig. 8; Hedrick, 1911; Howard, 1945); it is freestone; flesh is golden yellow, juicy, tender, sweet, and mild; high in sugar content both fresh and dried (Howard, 1945; Wickson 1926). It tends to dry into a somewhat coarse, stringy product; it is not of highest quality as a cured prune (Wickson, 1926). It is used fresh and for canning. The season is 1 week to 10 d earlier than 'French' prune (early August in Fresno). It quickly assumed commercial importance in the Californian prune districts (1903); was extensively shipped as a plum (Howard, 1945); grown on 4228 acres in 1949 (Hansen, 1951); no shipments were reported in 2009 and little grown today. 'Sugar' is the seed parent of 'Sutter' prune bred at UC Davis and released in 2000 (Doyle et al., 2012). It is not available from NCGR-Davis; trees are available from U.S. nurseries (Bay Laurel, Pacific Groves).

'Standard' prune was a cross of 'Tragedy' $\times$ 'Sugar' made $\approx$ 1897 and introduced in 1910 (Burbank, 1914) or 1911 (Howard, 1945). Fruit are large; skin is purple-black with blue bloom; flesh is amber, fine-grained, melting, juicy, and sweet; seeds are very small; it is freestone (Wickson, 1926). It is used for both drying and shipping; it is best sulfured before drying (Mariani, 1994). Burbank claimed that 'Standard' was the "the first prune ever produced that combined superior qualities of flesh" with a fully free stone (Burbank, 1914). It "ripens with the French prune in September" in Sonoma County (Burbank, 1914). It was disapproved for shipping by 1921 (Wickson, 1921) but still widely planted in plum-growing regions; it is more successful as a plum than as a prune, even in California (Howard, 1945). It is not available from NCGR-Davis (formerly present as DPRU 2610); trees are not available from nurseries but available from fruit collectors.

Fig. 6. 'Inca' plum grown in Morgan Hill, CA.

Fig. 7. 'Elephant Heart' plums grown in Dinuba, CA.

Fig. 8. 'Sugar' prune plums grown in Dinuba, CA.

Literature Cited

- Allen, F.W. 1929. Plum growing in California. University of California, Berkeley, CA.
- Ashton, R. 2008. Plums of North America. Third Millennium Publishing, Tempe, AZ.
- Bailey, L.H. 1906. The evolution of our native fruits. 2nd Ed. Macmillan, New York, NY.
- Boonprakob, U. and D.H. Byrne. 2003. Species composition of Japanese plum founding clones as revealed by RAPD markers. ISHS. Acta Hort. 622:473–476.
- Boonprakob, U., D.H. Byrne, C.J. Graham, W.R. Okie, T. Beckman, and B.R. Smith. 2001. Genetic relationships among cultivated diploid plums and their progenitors as determined by

- RAPD markers. J. Amer. Soc. Hort. Sci. 126: 451–461.
- Brooks, R.M. and H.P. Olmo. 1997. Brooks and Olmo register of fruit & nut varieties. 3rd Ed. ASHS Press, Alexandria, VA.
- Burbank, L. 1914. Luther Burbank: His methods and discoveries and their practical application. Luther Burbank Press, New York, NY, and London, UK.
- Butterfield, H.M. 1938. History of deciduous fruits in California. Blue Anchor, Sacramento, CA.
- Callahan, A., C. Dardick, R. Tosetti, D. Lalli, and R. Scorza. 2015. 21st century approach to improving Burbank's 'Stoneless' plum. HortScience 50:195–200.
- Day, K.R., R.S. Johnson, and T.M. Dejong. 2013. The history of plum growing for the fresh market in California. ISHS. Acta Hort. 985:27–32.
- Doyle, J.F., C.J. DeBuse, and T.M. DeJong. 2012. Varieties. In: Buchner, R.P. (ed.). Prune production manual. University of California, Richmond, CA.
- Dreyer, P. 1993. A gardener touched with genius: The life of Luther Burbank. 2nd Ed. Luther Burbank Home and Gardens, Santa Rosa, CA.
- Facciola, S. 1998. Cornucopia II. Kampong Publications, Vista, CA.
- Faust, M. and D. Surányi. 2011. Origin and dissemination of plums. In: Janick, J. (ed.). Origin and dissemination of *Prunus* crops: Peach, cherry, apricot, plum, almond. ISHS, Scripta Hort. 11:137–186.
- Hansen, C.J. 1951. Prune production in California. University of California, Berkeley, CA.
- Hedrick, U.P. 1911. The plums of New York. N.Y. State Agr. Expt. Sta. Rpt., Albany, NY.
- Hedrick, U.P. 1922. Cyclopedia of hardy fruits. Macmillan, New York, NY.
- Howard, W. 1945–46. Luther Burbank, a victim of hero worship. Chron. Bot. 9.
- Howard, W.L. 1945. Luther Burbank's plant contributions. University of California, Berkeley, CA.
- Mariani, A. 1994. Fruit varieties for the home garden. Privately published, Morgan Hill, CA.
- Okie, W.R. and D.W. Ramming. 1999. Plum breeding worldwide. HortTechnology 9:162–176.
- Ramming, D.W. and V. Cocui. 1990. Plums. In: Moore, J.N. and Ballington, J.R., Jr. (eds.). Genetic resources of temperate fruit and nut crops. ISHS, Acta Hort. 290:235–287.
- Smith, J.S. 2009. The garden of invention: Luther Burbank and the business of breeding plants. Penguin Press, London, UK.
- Waugh, F.A. 1901. Plums and plum culture. Orange Judd, New York, NY.
- Wickson, E.J. 1910. The California fruits and how to grow them. 5th Ed. Pacific Rural Press, San Francisco, CA.
- Wickson, E.J. 1921. The California fruits and how to grow them. 9th Ed. Pacific Rural Press, San Francisco, CA.
- Wickson, E.J. 1926. The California fruits and how to grow them. 10th Ed. Pacific Rural Press, San Francisco, CA.