A History and Description of the *Prunus persica* Plant Introduction Collection

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Peach is the second most widely planted temperate-zone tree fruit in the world, after apple. In contrast with apple, where a few major cultivars comprise a majority of commercial production, hundreds of peach cultivars are grown commercially worldwide. Most of these cultivars are closely related genetically, their origin tracing to 'J.H. Hale' or 'Elberta', and ultimately to 'Chinese Cling'. Many peach breeding programs in the United States have been largely based on 'Chinese Cling' germplasm since their inception. Remarkable advances have been made using this germplasm, and breeders can be proud of the fruit size and quality found in current peach cultivars. However, breeders worldwide realize that new sources of germplasm must be used in breeding efforts to meet the future needs of both the peach industry and consumers, and to develop new and novel cultivars that represent significant improvement over those currently available. One important source of germplasm for breeders in the United States is the U.S. Dept. of Agriculture (USDA) peach plant introduction (PI) collection.

Beginning in 1899 with PI 2679, the USDA imported from around the world >2100 clones or seed lots of peaches and nectarines as plant introductions. A collection of such introductions, once numbering ≈700 accessions, was housed at the USDA Plant Introduction Garden at Chico, Calif., until the late 1960s, and consisted of clones that were introduced into the United States from China, the center of origin of peach, and from other parts of the world in the first part of the 20th century. Little use was made of this germplasm by most public and private breeders, who continued to focus on germplasm derived from 'Chinese Cling'. Exceptions included the use of germplasm to develop canning clingstone cultivars for California, the use of several clones for variety development by breeders at Rutgers Univ., and use by USDA and other breeders to develop rootstocks resistant to root-knot nematodes (*Meloidogyne* sp.). The collection was gradually reduced in numbers during the 1950s and 1960s, and eliminated with the closing of the Chico station in the late 1960s. As this was occurring, knowledge of virology and heightened concerns about introduction of injurious pests and diseases brought about stricter quarantine regulations, which dramatically reduced importation except for seed. W.H. Ackerman worked closely with the collection at Chico, and contributed much to our understanding of resistance to peach leaf curl [*Taphrina deformans* (Berk.) Tul.] and time of flowering (see literature cited). Unfortunately, most of the collection was lost with the closing of the station, with the exception of ≈60 accessions that were transferred to other USDA facilities, particularly Byron, Ga., and Beltsville, Md. A limited number of accessions also were retained at Rutgers Univ. The senior author obtained most of the extant peach introductions in 1982. They have been used in the breeding programs at both North Carolina State Univ. and the USDA Laboratory at Byron, Ga., and both authors have observed their characteristics and performance over many years. In addition to their breeding value, these clones have unique traits not found in germplasm descended from 'Chinese Cling', and may be useful for fundamental genetic and physiological studies.

No single reference provides a thorough coverage of the history and characteristics of the accessions in the peach PI collection. Limited information on their history and characteristics is found in obscure government documents. A brief description of each new peach PI accession, as well as PI accessions of other species, was provided in plant inventory bulletins regularly published by the USDA [see U.S. Dept. of Agriculture (1924) for a representative citation of a plant inventory bulletin].

This manuscript describes the history and characteristics of the PIs introduced prior to the release of a new wave of imports in the 1980s as a result of an improved plant quarantine process. Information presented here is based on previously published information, together with the authors' observations. The common and scientific name, and the taxonomic authority for all diseases, mites, and nematodes referred to in the text are given in Table 1.

The history and dates of PI introduction were obtained from original government plant inventory documents (USDA, 1924). Information on susceptibility to fungal gummosis [*Botryosphaeria dothidea* (Moug. ex Fr.) Ces & de Not. = *B. ribes* Gross and Dugg.] was obtained from studies by Okie and Reilly (1983). Information on peach leaf curl resistance and spur-type growth habit was obtained

Table 1. Common name, scientific name, and taxonomic authority of the disease, spider mite, and nematode species referred to.

Common name	Scientific name
Diseases	
Bacterial spot	*Xanthomonas arboricola* pv. *pruni* (Smith, 1903) Vauterin, Hoete, Kersters & Swings 1995
Brown rot	*Monilinia fructicola* (Wint.) Honey
Cytospora canker	*Leucostoma persoonii* Fr. (Nits.) Hohn. *Leucostoma cincta* (Pers. ex Fr.) Hohn.
Fungal gummosis	*Botryosphaeria dothidea* (Moug. ex Fr.) Ces & de Not. = *B. ribes* Gross and Dugg.
Leaf curl	*Taphrina deformans* (Berk.) Tul.
Oak root rot	*Armillaria tabescens* (Scop.) Dennis, Orton, and Hora
Mites	
Twospotted spider mite	*Tetranychus urticae* (Acari: Tetranychidae)
Nematodes	
Southern root-knot nematode	*Meloidogyne incognita* (Kofoid and White) Chitwood
Javanese root-knot nematode	*Meloidogyne javanica* (Treub) Chitwood
Root-lesion nematode	*Pratylenchus vulnus* (Allen and Jensen)
Ring nematode	*Criconemella xenoplex* {[*Mesocriconema xenoplex*] (Raski) Loof and DeGrise}

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from studies by Scorza (1992 and 1987, respectively). Response of some of the peach PIs to twospotted spider mites [*Tetranychus urticae* (Acari: Tetranychidae)] was described by Meagher and Werner (1992). Shi and Byrne (1995) characterized the tolerance of some of the peach PI accessions to iron chlorosis. In both of these studies, no superior accessions were identified, so no specific information is presented in this manuscript. Data on bacterial spot [*Xanthomonas arboricola* pv. *pruni* (Smith 1903) Vauterin, Hoete, Kersters & Swings 1995] resistance was obtained from field screening of the collection at the Sandhills Research Station, Jackson Springs, N.C. (Table 2). Estimates of chilling requirements (Table 2) were made by observing the flowering date of the PIs relative to that of numerous standard cultivars representing a wide range of chilling requirements. Information presented in this manuscript on isozyme genotypes was obtained from studies done by Mowrey et al. (1990) (Table 2).

Seedlings of many PI accessions, along with many commercial cultivars, were tested for root-knot nematode (*Meloidogyne* sp.) resistance during the 1930s and 1940s. Several PIs were highly resistant or immune (Day and Tufts, 1944; Long and Whitehouse, 1943; Weinberger et al., 1943), but no resistance was found in commercial germplasm. Although no reference was made regarding the nematode species used, later work showed that the two most resistant lines, PI 55776 ('Yunnan') and PI 63850 ('Shalil'), were resistant to southern root-knot nematode, *Meloidogyne incognita* (Koifoid and White), but not to Javanese root-knot nematode, *M. javanica* (Trueb) Chitwood (Lownsbery et al., 1959).

Much of the collection has been screened both in the greenhouse (Westcott et al., 1994) and field (Okie et al., 1994) for resistance to ring nematode, *Criconemella xenoplex* {[*Mesocriconema xenoplex*] (Raski) Loof and DeGrisse} and the associated Peach Tree Short Life (PTSL) syndrome. In the greenhouse, PI 65977 and PI 77876, among others, were slightly more resistant to ring nematode than the other 400 accessions tested, but all were good hosts. Okie et al. (1994) reported on the field longevity of numerous accessions of *Prunus*, including PI accessions. In long-term field trials, PI 134151 survived as well as 'Lovell', the commercial standard, but no PI was superior to 'Lovell', and some, including PIs 36126, 55776, 102705, 105362, 106062, 131209, and 151158, were much inferior. In this field trial, there were also apparent differences in mortality caused by oak root rot incited by *Armillaria tabescens* (Scop.) Dennis, Orton, and Hora (Okie et al., 1994; Okie et al., 1992), although the results were confounded by PTSL mortality. Root rot seemed less severe on PIs 55776, 43289, 65974, and 78544. In a subsequent PTSL trial (Beckman et al., 1994) using a range of 50 scions, including nine PIs, on a susceptible rootstock, PI 134151 showed survival superior to that of PIs 119839, 119844, 102705, 55836, or 62602.

In this manuscript, the term "quality" is used in a general sense to convey the overall eating attributes of the fruit, including, but not confined to, sugar and acid content, flesh and skin bitterness, flesh texture, and other organoleptic properties. Small fruit are those <57 mm (2-1/4 inches) in diameter, medium fruit those from 57 to 70 mm (2-3/4 inches), large fruit those from 70 to 76 mm (3 inches) in diameter, and very large those >76 mm in diameter. Comments on external fruit color are based on a subjective appraisal of the attractiveness of the red blush and the ground color on the fruit surface. Fruit with a bright blush and ground color are rated good to excellent, while fruit with a dull red color and/or a green ground color at maturity are rated poor to fair. Plant introductions producing fruit that are described as "physiologically clingstone" are those that are genetically freestone, but ripen so early that separation of the flesh from the pit is incomplete, hence the fruit behave as if they were clingstone.

Little is known of the virus status of most of the clones in the peach PI collection, and some of the characteristics described in this manuscript may be a consequence of, or influenced by, virus infections. We have recently learned that some of the clones in this collection are infected with Asian Prunus Virus.

Many species of *Prunus*, including peach and nectarine, produce bitter seed, due to the accumulation of cyanogenic glucosides. Most of the PIs described in this report were tested for seed bitterness. All clones tested had bitter seed, except for PIs 34685 ('Quetta') and 129678 ('Stanwick'), both nectarines. Most accessions also were tested for male fertility by carefully examining anthers for evidence of pollen production at full bloom. Most clones were male fertile, except for PIs 72094 ('Hseuh Tao'), 106062 ('Killiekrankie'), 112032 ('Saharanpur No. 1'), 125025 ('China Flat'), 146137, and 240928.

In the descriptions that follow, four fruit characteristics are listed in abbreviated form. Symbols used are: P/N (peach or nectarine); S/M/L/VL (small, medium, large, or very large fruit size); W/Y (white-fleshed or yellow-fleshed); NC/MC/F (nonmelting clingstone, melting clingstone, freestone). Thus, P, S, W, NC indicates a peach that is small, white-fleshed, and nonmelting clingstone. Information on chilling requirement, date of ripening, leaf glands, flower type, resistance to bacterial spot, and isozyme genotypes are summarized in Table 2.

DESCRIPTIONS OF PEACH PIs

PI 34685 ('Quetta'). Seeds of PI 18235 were introduced from Quetta, India, in 1906. Seeds were collected by Lt. L.W. Maxwell, 127th Baluchistan Light Infantry, at an elevation of 1830 m. PI 34685, named in 1912, was a selected seedling of PI 18235 (Ackerman, 1959). 'Quetta' was the leading commercial nectarine grown in California in 1951 (Taylor, 1959). Fruit (N, S, W, MC) of 'Quetta' russets badly and is highly susceptible to brown rot. It is one of the two clones in the PI collection that have a sweet (nonbitter) seed (kernel). It was one of the two nectarine clones used in the original crosses in early California nectarine breeding programs, is found in the pedigree of most commercial California nectarines, and is the source of the sweet kernel trait found in these fruits. This trait (*sk*) is inherited as a single recessive gene and is closely linked (12 cM) to the nectarine (*g*) gene (Creller and Werner, 1997). Fruit quality is fair. 'Quetta' is resistant to root-knot nematode, but poor germination of seed precludes its use as a rootstock (Day and Tufts, 1944).

PI 36126 ('Bolivian Cling'). Seeds from trees planted by the "Franciscan padres" in Bolivia were introduced by Edward M. Ehrhorn in 1913. Fruit (P, M, W, NC) is of fair quality and has pale yellow skin with little red color. Trees produce more spurs (Scorza, 1987) and are smaller than standard trees, and flower bud density is very high (Blake, 1933). This PI occurs in the pedigree of 'Babygold 6' peach, released by the New Jersey Agriculture Experiment Station in 1961.

PI 43289 ('Ying Tsui Tao', 'Eagle Beak'). PI 43289 was introduced from Guangzhou (formerly Canton), China, in 1916. Government records state that it was grown mostly in Guangdong Province at Sunchuen, in the Panyu district at Pontang, in the Nanhal district, and also in the Fayun, Sahshui, and Tungkun districts. Fruit (P, S, W, F) has green skin with little red overcolor, is heavily pubescent, and has a pronounced curved tip resembling the beak of an eagle, hence the common name. The flesh is very mild and sweet, with low acid. The pronounced tip and low acidity both are dominant in F_1 hybrids. Leaf size is small, and flower bud density is high (Okie and Werner, 1996). PI 43289 has moderate resistance to fungal gummosis (Okie and Reilly, 1983).

PI 55776 ('Yunnan'). Seeds of PI 55776 were collected from the wild by J.F. Rock, agricultural explorer of the USDA, in 1922 ≈13 km from the city of Puerhfu, Yunnan Province, China, at an altitude of 1525 m. The only survivor of a group of accessions from Yunnan Province, it is often referred to as 'Yunnan'. Fruit (P, S, Y, F) is very astringent, with little red color. The tree has high flower bud density (Blake, 1933), and is resistant to root-knot nematode, which is controlled by a dominant gene (Day and Tufts, 1944; Long and Whitehouse, 1943; Weinberger et al., 1943). Some seedlings are moderately resistant to *Pratylenchus vulnus* (Allen and Jensen), the root-lesion nematode (Day and Serr, 1951).

PI 55836 ('Amarillo Tardio'). Seeds of 'Amarillo Tardio' were received from southern Spain in 1916 as PI 43570. PI 55836 was a selected seedling from this lot. The round fruit (P, L, Y, NC) has little red overcolor and the quality is fair to good. The flesh tends to break down around the pit prior to ripening, particularly in hot weather. PI 55836 is potentially useful for development of late-flowering and late-ripening peaches.

PI 62602 ('Pi Tao'). Scions of this accession were collected near the Fa Hua Ssu temple near Haitzu, Chihli Province, China, in 1925 by P.H. Dorsett, USDA explorer, who stated that flowering twigs of this clone were sold on