

## AVOCADO MATERIALS FOR HORTICULTURAL RESEARCH

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The early history of the avocado industry in the United States consists in large measure of accounts of introductions of seed and scion materials from Central America and Mexico. When the potential importance of the avocado as a commercial industry was realized in the first decade of this century, a concerted effort was undertaken by private and public agencies to explore the native haunts of this tree with the objective of introducing the very best and most promising varieties which were then available. The vivid descriptions of these early avocado explorations by Popenoe and others contain accounts of large trees bearing many fruits of large size, which they thought would be desirable for trial in the avocado industries of Florida and California. Those trees bearing small fruits—and thousands were of this type—were avoided in the field as being undesirable for further use. The near-relatives or wild avocados of this latter type, having small fruit and frequently small crops, were ignored almost completely except as botanical curiosities.

A very serious threat which now faces the avocado industry in California today is that of root rot, a condition closely associated with, if not the result of, a soil fungus, *Phytophthora cinnamomi*, which attacks the common avocado causing severe decline or death of the tree under some conditions. Confronted with this threat, the avocado grower and investigator must seek some solution to the problem either through the discovery of a method to kill or subdue the soil organism in place or otherwise find a rootstock which will withstand the organism.

Because of its inherent hardiness to cold, the Mexican rootstock (*Persea americana* var. *drymifolia*) has been most widely employed in commercial orchards in California. Seedlings of the Guatemalan race (*P. americana*) and of hybrids between the Guatemalan and Mexican races also have been used, but to a lesser extent. To date it appears that all the rootstocks which have been commonly employed are probably susceptible to attack by the root rot organism. There always remains the possibility that somewhere in an orchard a rootstock of the common avocado may be found which will have inherent resistance to *Phytophthora cinnamomi*. When this stock is discovered, it will be desirable to propagate it for further trial and possibly commercial use.

Another approach to the avocado root rot problem is to find some avocado species in a foreign country which is closely related botanically to the common avocado, but which may have inherent disease resistance. This wild form can then be used directly for rootstock investigations or can be utilized in a breeding program with an objective to produce a resistant, compatible rootstock.

The brief account included herewith is given primarily as a catalogue or inventory of avocado materials which have been introduced into California for the purpose of

horticultural investigations, especially those of rootstock and breeding studies. Most of these introductions have been established here only for a comparatively short time, hence little is known of their ultimate potentialities in respect to adaptation to climatic and soil conditions in California and to their horticultural value.

The objective of the present investigations is to study these materials as they are introduced from foreign sources, to note their tolerances to climatic and soil conditions, and to determine their affinity with our present commercial avocado varieties through budding and grafting experiments. The present report presents a summary of preliminary observations on some of these aspects. Additionally, concurrent investigations are being conducted by the plant pathologists to determine the inherent disease resistance of the species. Similarly some of the species are being utilized by the plant breeder for hybridization work in an effort to develop new varieties or strains of better fruit quality or of greater disease resistance.

The California bay, *Umbellularia californica*, is a member of the laurel family and therefore a relative of the common avocado. This bay grows in the canyons of the foothills of the Sierras throughout California. It has long been considered as a possible rootstock species for commercial avocado varieties, but repeated experiments in an attempt to bud the species have been unsuccessful. Its use in further horticultural investigations is problematical. Likewise the Grecian laurel, *Laurus nobilis*, frequently cultivated as an ornamental, is a distant relative of the avocado, but the botanical differences between these species apparently are too great to allow budding or grafting to occur with any degree of success. The camphor tree, *Ginnamomum camphora*, one of the common street trees in southern California, is another member of the Lauraceae. Grafting and budding experiments with the camphor also indicate a lack of affinity for the commercial avocado.

The botanists who collected materials in Central America and Mexico have reported many species of *Persea* more closely related to the common avocado than the ornamental species mentioned above. Some of these species were introduced into the United States not for their fruit but for the ornamental value of their foliage. These materials have become scattered in private collections and in the commercial trade. Hence an attempt is now being made to assemble all these introductions in one area with the objective to systematically study them in all aspects and to evaluate their horticultural potentialities.

*Wild Avocado of Tecpan (P. nubigena)*—The original habitat of the Tecpan avocado is in the highlands of Guatemala near the picturesque town of Tecpan. Here Popenoe (2) found growing at an altitude of 9,300 feet this suspected progenitor type of the present-day Guatemalan avocado. The location of the original tree is among the highest in altitudes at which the avocado has been found in a natural state. The tree, as grown in California, has the general appearance of typical cultivated avocado but the individual leaves differ considerably. *P. nubigena* is characterized by leaves which are stiff, rough surfaced, and rather small. There is no anise odor in the leaf when crushed. The flowers are similar in general structure to ordinary avocado blossoms, but the clusters or panicles are stouter and smaller. The fruit varies in size from 1½ to 3 or more inches in diameter and is oval to round in form. It has a very large seed in proportion to fruit size and likewise an exceedingly thick, tough skin. Seedlings grown from this form have thus

far proved rather variable in stature and vigor, at least in the nursery row. The relationship between this species and the avocado is sufficiently close such that the two graft and bud easily onto each other.



Fig. 1 (top left) *Persea floccosa*. Fig. 2 (top right) *Persea indica*. Fig. 3 (bottom left) *Persea borbonia*. Fig. 4 (bottom right) *Persea nubigena*.

*Persea longipies*, another near-relative of the common avocado, is distinguished by its very long, narrow and glossy leaf. The branches are thin and willowy. Grafted and budded plants observed in California are rather bushy. The fruit is small, about 1½ inches in diameter, oval in form, black in color, with a large seed and thin skin. The species grafts readily on Mexican seedlings. *Persea longipies* was introduced into California in 1948 from Chocoman near Mt. Orizaba. The distinctive glossy leaves may result in the use of this plant as an ornamental in landscape design where soil conditions permit.

*Persea indica* has been used widely as an ornamental plant in southern California for many years. This species is said to have originated in the Canary Islands, a fact which is not well explained because most species of *Persea* have been found indigenous to the Western Hemisphere, namely in Central America and Mexico. *Persea indica* is a beautifully symmetrical tree which reaches a height of 20 to 30 feet. It has nearly oval, thick, leathery glossy leaves of rather light green color. The fruit is small, rarely attaining a size of more than 1 inch long, which consists mostly of seed. It is black-purple in color. The flesh thickness is approximately 1/16 inch. While some degree of resistance to *Phytophthora* may exist in this species, the fact that its grafting or budding affinity is somewhat limited might preclude its use directly in avocado rootstock. Many attempts to bud young seedlings have resulted in complete failure. Research concerning inherent disease resistance and methods of propagation involving this species is still in the preliminary stages.

The wild avocado of Aquila has been determined to belong to the species *Persea floccosa*, a near botanical relative of the common avocado. This species was introduced into California from Mexico in 1947. Preliminary investigations have disclosed that the wild avocado of Aquila has a high degree of affinity for the common avocado. Both buds and grafts have been successfully established in young trees of this species. While the experiments on which these observations have been made are few in number, they are encouraging and point to the possibility that this or other similarly closely related forms of *Persea* may be profitable to investigate in greater detail concerning their horticultural value.

The tree *P. floccosa* is an upright, pyramidal in stature and rather open or apparently sparsely foliated. While simulating the common avocado in general aspect, a close examination indicates that a sharp distinction exists between the two. The species exhibits considerable hardiness to cold. The presence of dense brown pubescence on the young twigs and leaves is a conspicuous characteristic of this species. The leaves are medium to small in size, lanceolate and exceedingly leathery in texture, and lacking in anise odor. A striking difference is found in the nature of the inflorescence. The flower cluster is rather small, very stout in general structure, the individual flowers being quite erect and at right angles to the axis of the floral cluster. The fruits are small and measure 1½ to 2 inches in length. They are oval or pyriform in form, green in color, and contain a large round seed. The fruit flesh is thin, from ¼ to ½ inch thick. The few fruit specimens which have been examined show a tendency toward the development of a crook-neck.

One of the most interesting *Persea* forms reported in the literature is that of *P. Schiedeana* (the coyo), which has been shown to have a high degree of resistance to soil-borne organisms, at least under conditions in Central America (1). The propagation of some avocado varieties on *P. Schiedeana* has in some cases not been entirely satisfactory in Central America, but investigations on this problem have not been pursued extensively under the conditions there and have not yet been attempted in California.

*Persea Schiedeana* has been introduced successfully into California and is being utilized in investigational work as quickly as propagation material becomes available. Exceedingly vigorous growth of scions of this species has been observed when grown

on Mexican rootstock. The species has been noted to be quite tender to frost, perhaps more tender than specimens of the West Indian avocado. While tenderness to frost is not desirable as a characteristic in a rootstock for avocado, it is possible that this adverse tendency could be compensated by burying the bud union under conditions where the frost hazard exists.

Growing in its native habitat in the highlands of Guatemala and southern Mexico, the coyo is a large tree in many respects similar to a typical Guatemalan avocado. The leaves of this species are exceedingly large, however, and are covered by a heavy coating of pubescence. The branches are comparatively thick in nature and likewise very densely pubescent. The fruits are fairly large, 8 to 14 ounces, and are similar to those which we associate with the Guatemalan race of avocado. The skin is rather thick, but smooth and somewhat glossy. The seed is large. The species has not been successfully fruited in California, to our knowledge.

*Persea lingue* was introduced into the United States from its native home, Chile. This species has certain virtues of hardiness in respect to cold, hence has been grown successfully as an ornamental as far north as Berkeley, California. The plant develops into a bushy small tree somewhat upright in habit and rather sparsely foliated. The leaves are small, very hard and rough, and somewhat oval or round in outline with a blunt point. The fruit ranges from  $\frac{3}{4}$  to 1 inch in length and resembles a large sized olive in general appearance. Preliminary observations and experience with the species indicates that it does not transplant well except as very small seedlings. Additionally all attempts to bud the commercial avocado onto it have been without success • thus far, but grafts can be established in older seedling trees. This species probably offers little promise for extensive future use in horticultural investigations, except in the breeding program.

A near relative of the avocado which has a natural habitat in southern United States is *Persea borbonia*, the swamp bay or bull bay. This plant is found in the swamp areas of the Gulf Coast states from Florida to Texas. The name swamp bay indicates the natural habitat, namely that of wet or swampy lowlands, where it grows as a small, bushy tree along the drainage ditches or on the edges of ponds.

Because the plant is adapted to conditions of high soil moisture for prolonged periods, its use as a rootstock was quickly visualized for avocados to be grown on soils of high water-holding capacity or relatively poor drainage. The practical approach to the problem, however, has offered some distinct difficulties. *Persea borbonia* is somewhat more remotely related to the avocado of commerce than such forms as *Persea indica*, judging from general resemblances and growth behavior. *P. borbonia* is characterized by a slow, rather bushy growth which tends to be chlorotic or with an appearance of lack of vigor when grown alongside of the avocado even in moderately fertile soil. The leaves are very long and slender, the stems very fine, and the branches and trunk are not large. Likewise, the bark is thin and does not slip well. Attempts have been made to bud this species. While the buds will "heal in" they are frequently displaced by excessive cork formation from beneath the shield, or after the development of a shoot  $\frac{3}{4}$  to 1 inch long growth ceases entirely. Grafting of older trees may prove more profitable. Experiments on this procedure are now under way. The fruit of *P. borbonia* is small like that of *P. lingue* and likewise worthless. Preliminary trials using this species in

pollination experiments have been unsuccessful.

The evaluation of the several *Persea* species in respect to their resistance to soil-borne organisms and especially *Phytophthora cinnamomi* is being conducted in cooperation with the Division of Plant Pathology. A summary progress report of this work is found in an accompanying article.

The avocado materials mentioned above have been successfully introduced into California and are being increased in number of individual plants for investigational purposes. Additional materials hitherto untried in California have been located in Central America and Mexico through cooperation of several people in that part of the world. Attempts are now under way to import these plants at the earliest opportunity so that the horticultural investigations can be pursued with increased vigor within the near future.

#### **LITERATURE CITED**

1. *Fiester, Don. The coyo: A rootstock for the avocado. Calif Avocado Soc. Yearbook 1949, p. 27-31. 1950.*
2. *Popenoe, W. Origin of the cultivated races of avocado. Calif. Avocado Soc. Yearbook 1935:184-194. 1936.*