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AVOCADO MATERIALS AND OBSERVATIONS IN COSTA RICA, ECUADOR AND PERU

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One of the gifts of America to the world of horticulture is the avocado. The fruit was apparently widespread through Central America and parts of South America in pre-Columbian times. Since the discovery of the New World the avocado has become widely known and has been grown in nearly all countries throughout the world where climatic conditions permit. Although the avocado of commerce, characterized by its comparatively large fruit, is apparently indigenous to the general area of Guatemala and southern Mexico, it is difficult to locate or precisely demonstrate the progenitors and point of origin of the species. Slowly we are able to locate and successfully introduce into our stockpile of horticultural research materials more of the primitive, borderline and intermediate forms so that some day perhaps we can piece together all the evidence and realize how and where the avocado, as we know it, came to be.

This is a progress report of an attempt to locate and introduce new materials for botanical studies and for utilization in the horticultural research program at the University. Previous reports by Popenoe, Zentmyer, Schroeder, Griswold, and others found primarily in the previous Yearbooks of the California Avocado Society describe the earlier endeavors in this field of avocado exploration.

It was my good fortune to spend six months on sabbatical leave during the period February through July of 1957 at the Inter-American Institute of Agricultural Sciences, Turrialba, Costa Rica. My primary objective there was to investigate the developmental morphology of the cacao fruit. Time was afforded, however, on week-ends and occasional trips into the field to look for the so-called wild avocado and its close botanical relatives in this part of Central America.

The major avocado growing area of Costa Rica is located along the northwestern coastal plain in the region of Guanacoste. Here West Indian seedlings and West Indian-Guatemalan hybrids dominate the general production which is marketed primarily in San Jose, the capital city. In all areas throughout the country except the very highest and coolest mountains the avocado is a common dooryard plant.

One of the dominant plant families in many parts of Central America is the Lauraceae or laurel family to which belong the avocado, the camphor tree, the common laurel, sassafras, the California bay, and other familiar plants. In the tropics this botanical family is represented by many species and forms which contribute several tropical woods of importance and several horticultural products. An attempt was made to secure some of these forms most closely related to the avocado which are known locally as "aguacatillos" or "laurels" for use in our horticultural research program. The fruits of

such species generally are small, from one quarter of an inch to two inches in diameter, and are infrequently utilized as food by some people. As in previous explorations, attempts were made to introduce both seed and scionwood. Collections in Costa Rica were made from several areas in Guanacoste, near the volcano Irazu, and from the Institute property near Turrialba. Only botanical relatives were selected with no attempt to obtain any of the edible, selected local seedlings which are primarily of West Indian types.

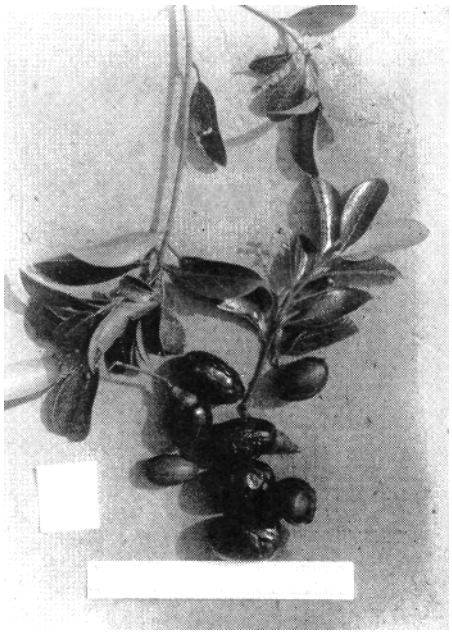

Figure 1. Botanical relative of avocado from Volcano Irazu, Costa Rica.

One particular specimen obtained near Robert's Hotel on the side of the volcano Irazu was a species unidentified as yet, which grew as a moderately large tree some 25 feet high. It had black oval fruits about two inches long, thin skinned and with little flesh. A large red cup-like structure at the base of the fruit formed the attachment.

An opportunity to visit Peru and Ecuador during June 1957 for the specific purpose of collecting materials in those areas was afforded by a grant from the Rockefeller Foundation of New York. With the most excellent collaboration and assistance of the departments of agriculture of these countries it was possible to visit and collect within a short time a considerable amount of avocado materials from some areas. Because these countries are comparatively large and many areas are inaccessible, only a few specific locations were visited in the time available.

On the eastern slope of the great Andean mountain chain and due east of Lima one descends into the Chanchamayo Valley, a "banana belt" just above the great flat jungle which forms the headwaters of the Amazon. This valley, which lies at 2500 feet elevation, consists of a series of smaller valleys in a generally mountainous area. San Ramon, a community of 5000 people, is the hub of agricultural activity. Chanchamayo

Valley is roughly 50 miles long by 10 miles wide. It is one of the important citrus and avocado production centers whose other crops, such as pineapple and banana, comprise a considerable part of its economy.

Although the avocado has been known in Peru for many decades, little has been done to exploit the fruit on an economical commercial basis, except during the past ten or fifteen years. All but a few trees are of seedling origin. In the Chanchamayo Valley seedlings of the West Indian race predominate in the orchard. Most of the trees and their fruits are strikingly similar and comprise a seedling group referred to as the Chanchamayo palta — palta being the local name for avocado. The Chanchamayo palta is typically a large tree bearing large green, thin-skinned fruits of relatively low oil content, typical of the West Indian group. The bearing behavior of the trees is quite variable, with a strong tendency toward the alternate bearing habit. The fruit is quite susceptible to fruit fly damage and frequently considerable losses are experienced from this cause.

Another group of seedling trees widely planted are referred to as hybrids. These possibly may represent natural crosses between the West Indian and perhaps a Mexican type, for the trees have a darker foliage and bear smaller dark fruits. The few fruits which were seen of this group had the general aspect of the variety Nabal, being round in form but dark when mature and with a relatively thin skin for the Guatemalan type. The Mexican race is practically unknown in the valley. Attempts have been made during the past ten years to introduce some of the more successful varieties from California and Florida such as Topa Topa, Nabal, Fuerte, Queen, Linda and others, but the trees are at present too young to judge their commercial adaptability in most instances. The Nabal has produced a few good crops of acceptable fruit, but Fuerte has yet to prove itself well adapted to the area. One of the problems encountered with both the Mexican types and Fuerte variety is a fungus which attacks the bloom. This fungus apparently does not develop during the season when the West Indian trees produce their flowers. No practical control for this floral problem has been developed.

The problem of avocado root rot caused by **Phytophthora cinnamomi** is prominent in all sections of the valley. It has resulted in the loss of many trees and the subsequent planting of bananas and citrus in the infected areas. Whereas in many areas coffee has proved very profitable, many of the former avocado orchards are being converted to coffee with Ingas, bananas, citrus and other large trees being replanted for shade as the avocados fail. At least one of the more progressive growers is searching for root-stocks of local "wild paltas" or wild avocados for rootstock sources for future plantings of his avocados. To date he has found one local wild form which is thought to show resistance to the **Phytophthora cinnamomi** fungus, but unfortunately has been unsuccessful when topworked with some of the locally commercially successful varieties. There are several other close botanical relatives of the avocado which are to be found in the mountains surrounding the valley.

Many areas in Peru remain unexplored by competent horticulturists in respect to the avocado and botanical relatives which are available there. One of these areas is the Quillabamba Valley, located northeast of Cuzco but somewhat lower in elevation at approximately 2,000 feet. This valley is reached by narrow gauge rail from Cuzco, passing alongside the Quillabamba River and the famous archeological site of Macchu

Picchu, the last stronghold or retreat of the Incas at the time of the Spanish conquest. Just at the base of the mountain below the Macchu Picchu site many specimens of the local "aguacatillo" or little avocado, a botanical relative possibly of the genus Nectandra, were found growing alongside the tumbling river and close to the railroad. Two or three rather distinct types of foliage were noted among the several specimens.

Close to the railroad station at Puente Ruinas, near the bus stop, was an avocado-like tree with a large pubescent leaf comparable to **Persea Schiedeana**, though without doubt it was not identical. Another large-leaved relative was collected at the nearby bridge. None of these materials were distinctive nor with fruit. The local people were unable to identify the trees nor had they observed fruit on these specimens at any time recently.

By mixed train one continues down the canyon from Macchu Picchu to the small town of Quillabamba some four hours or about thirty miles distant, where the narrow canyon broadens into a series of verdant valleys. Here citrus and avocado dominate the cultivated land. This area is widely known for its avocado, which appear to be primarily West Indian seedlings planted mostly at random in dooryard orchards or in a few cases in formal orchard pattern. A few Mexican types were noted in some orchards.

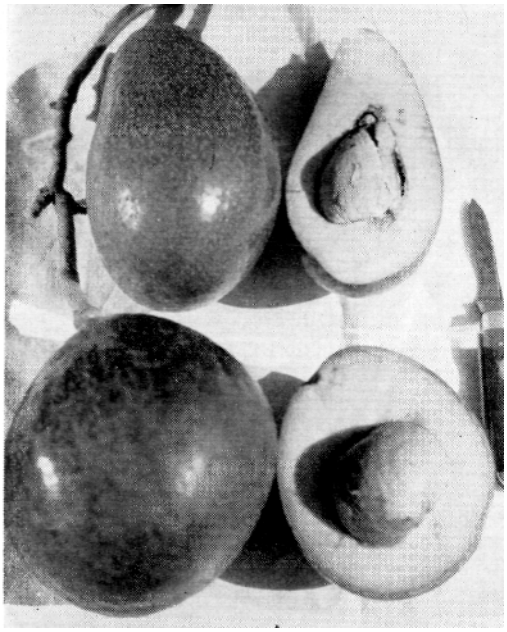

Figure 2. Seedling avocados from Chanchamayo Valley, Peru. Oval Chanchamayo-palta, and round hybrid.

A collection made at Maroneura consisted of a plant with an avocado-like leaf having only a trace of anise. Locally this is called palto-palto. It is a small tree which grows along the stream bed where the one specimen was collected. This tree, which ranges higher up into the mountains, has a fruit about two or three inches in diameter which is edible. I did not see the fruit. Insect damage to the foliage is quite widespread and in general the trees are not vigorous. Phytophthora root rot probably has been the cause

of death of the many trees now missing from the more formal plantings. Die-back of smaller branches is extensive on trees throughout the valley, a condition highly suggestive of those observed in Phytophthora infected soils in California.

A collection was made in the orchard of a church orphanage in the town of Quillabamba from a Mexican type seedling which appeared to be in good health, whereas adjacent trees were most certainly affected with Phytophthora. Propagation of avocados in this area is almost entirely by seed. Grafting and budding are practically unknown, though attempts to introduce these practices have been made during the past few years.

Huanaco is a modern city of perhaps 10,000 people situated at an altitude of approximately 6,000 feet in a direction northwest of Lima on the eastern slopes of the Andes. One can drive from Lima to Huanaco over good roads which wind through the Andean passes at times over 15,000 feet. In June the major portion of the highway through the alto piano passes near snow fields, from which the cold winds cool the air. The rarefied air makes nearly all activity difficult and uncomfortable for the visitor from the lowlands, though the local inhabitants may play such vigorous games as soccer with great speed and activity and still show no physical effect. Huanaco lies in an arid valley area, surrounded by high mountains. The countryside is comparable in general aspect to many parts of San Diego County, California, except that in the distance towering mountain peaks of the snow-covered Andes form a background up to 20,000 feet in some places. The very dry hillsides in June, their winter months, support very little vegetation. Rainfall is about 15 inches, hence irrigation is necessary for fruit crops and other commercial plantings. Here the avocado is grown widely and the types are similar to those found in California. The Mexican rootstock is utilized almost entirely for propagation in the valley. Several selections have been made of certain Mexican rootstocks. The Fuerte yields fairly well here. The varieties Queen, Linda, Nabal and Topa Topa are found to produce satisfactorily. Several clones of local origin, both Mexican and Guatemalan, also are widely grown. The majority of the larger Guatemalan type fruits are mature in November-December. Yields up to 200 per tree are expected nearly each year.

Concerted effort of the department of agriculture has introduced in the valley the practice of utilizing selected varieties as grafted or budded trees instead of seedling trees.

One very unusual variety propagated at Hacienda Mitopampa is the clone De-a-kilo. This is a West Indian type tree which apparently originated in Argentina. Production is exceptionally high on all trees, both young and old, throughout the orchard. While only comparatively immature fruit was observed it was noted to be of large size, relatively thin skinned with a smooth surface. The oil content was said to be low but the quality excellent.

Tip grafting in ceramic pots is widely practiced for the majority of propagations made locally. Some field budding or grafting is done. There are fewer seedling trees in this area compared with other parts of Peru, hence most of the orchards are comprised of clonal material. The area is widely affected by the root rot fungus, Phytophthora, and extensive losses due to the fungus were evident in many orchards. Little progress has been made toward the solution of the root rot problem in this area. Replants have been

temporarily successful in a few cases but, comparable to experiences in California, all commonly used rootstocks prove unable to tolerate the infected soils.

The government agricultural experiment station, La Molina, is located about 10 miles northeast of Lima. This station conducts investigations on a great number of crops, including avocado and citrus. Phytophthora root rot is not known to be present on the station, hence the avocado trees exhibit magnificent growth and vigor. Many of the standard varieties from California, such as Fuerte and Nabal, yield well here. Fuerte, considered to be a good producer in this coastal plain area, yields up to 300 fruits per moderate size tree. There is a strong tendency toward the production of seedless fruits in Fuerte. These "cukes" are of some economic importance in the local trade. Nabal is quite satisfactory in yield and quality. The variety Puebla, however, is not regarded very highly because of the comparatively thin and fragile skin, which creates difficulty in handling.

Some seedling selection has been conducted at the station during the past decade. One especially fine Fuerte seedling selection has proved of considerable promise locally as a commercial clone. The fruit is Fuerte-like in general character, slightly more oval with a small seed. Yields are equal or superior to Fuerte.

The seed of a rootstock selection called Rootstock No. 1 is utilized widely for propagation. This clone is a Mexican type of good vigor and yield. The fruit is large and green and is a reasonably satisfactory commercial variety as well as rootstock source.

Peru in general is practically unexploited for good commercial avocado production. There are many sections in the areas visited which appear quite suitable for good commercial production. The technical staff and extension men are slowly but definitely convincing the growers of the value of selected clones and the use of rootstocks for better results. The horticulturists are well informed of our experiences with avocado in California and Florida, and are applying this information where practicable to local situations. It seems highly probable that production of avocado in many parts of Peru will increase in the near future.

Tingo Maria is the Jungle Experiment Station founded during the war as a cooperative research station between the United States and Peruvian governments to investigate rubber sources and development. Since the reduction of efforts on rubber research the attention of the station has been directed to coffee, cacao, and tropical commercial timbers. Some investigations were conducted on avocado several years ago, especially on those aspects concerned with Phytophthora resistant clones, but no trace of the collections can be found. A few dooryard trees and an occasional miscellaneous specimen in the orchards are all that one can locate at the station. Of particular value, however, are the investigations on tropical timbers conducted at the station. These timbers include many botanical relatives of the avocado, hence a source of seed and information on the growth of these species may eventually prove of value to us.

Ecuador is a mountainous country practically untouched botanically or horticulturally. We have obtained the cherimoya, the naranjilla (**Solanum quitoense**) and several forms of papaya such as **Carica candamarcensis**, the mountain papaya, from Ecuador and without doubt many other fine horticultural materials are to be found there. Horticultural exploitation of any sort has not been practiced extensively in this country.

The rugged terrain makes extensive culture most difficult. In a few of the broader valleys a few orchards of moderate size are found, but most plantings consist of a few trees and are of comparatively limited size. The three general and major areas in which the avocado is planted are the Chota Valley northwest of Quito, and the Banos Valley in the central part of the country. The avocados of Chota Valley were described by Wilson Popenoe, who mentioned that they were primarily of the Mexican race. Several of these were introduced into the United States but none have proved of commercial value here. Along the Nanegal road one also finds the Mexican type fruit widely grown. Of particular interest in the present collections were some "wild trees" with small oval or round fruits borne on very large trees. These specimens were growing in an area of apparent high rainfall and humidity usually not well tolerated by the Mexican type.

The area near Baños is comprised of a series of narrow valleys surrounded by high, rugged mountains. Here the Mexican type seedling apparently has been grown for many years. One particular specimen in the town of Baños is the "Arbol de Montalvo," which was measured to be approximately 20 feet in circumference near the base of the multiple trunk. This tree has a plaque to commemorate the 120th anniversary of the birth of Don Juan Montalvo, a historical personality who "studied under its branches" as a child. There are other magnificent specimens nearby, though of smaller sizes. Moderately high rainfall and the probable presence of **Phytophthora cinnamomi** in the area have decimated the tree population. Symptoms of sparse foliation, die-back and poor vigor are highly suggestive of the presence of the fungus in the avocado orchards. Collections were made of the more vigorous or apparently healthy trees which were located.

Attempts are under way to improve the avocado industry in Ecuador. With the aid of technicians from the United States and the training of local men under our foreign aid program, new techniques such as budding and grafting are being demonstrated and introduced to the local growers. Varietal selection and the importation of improved varieties from California and Florida has made some progress, the results of which should be ascertained within the near future.