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THE AVOCADO

IN

GUATEMALA.

By

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This bulletin treats of avocado culture in Guatemala, including a discussion of the climatic conditions in those parts of the republic where avocados are extensively grown, popular uses of the fruit, and the variation which occurs among seedlings. A descriptive list of selected varieties introduced into the United States from Guatemala in 1916 and 1917 is appended. The bulletin is intended for avocado growers and those interested in avocado culture in California, Florida, and the American dependencies in the tropics.

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## INTRODUCTION.

Probably no other country possesses such an abundance of fine avocados as Guatemala. It must not be inferred from this that all Guatemalan avocados are of exceptionally choice quality, for they are not; but among the thousands of trees scattered throughout the highlands of the republic there are many of unusual merit. There is also a wide range of variation in many characteristics. Some varieties produce fruits no larger than hens' eggs; others weigh fully three pounds. Many different shapes are represented, from long and slender to oblate. The surface is sometimes rough and warty, sometimes smooth. In color it may be green, maroon, purple, or almost black. Many varieties have proportionately large seeds, others small. Most important of all, there are numerous varieties whose deep yellow flesh is of the smoothest texture and the richest, most agreeable flavor imaginable.

Guatemala may be considered, in fact, the land of the avocado. Before the soil was cleared in the lower Motagua valley for banana plantations,--now thousands of acres in extent,--the avocado must have ranked as the most important fruit in the republic. Today the production is insignificant in comparison with that of bananas, but to the native Guatemalans, especially to the Indians, who represent more than half the total population of the country, the avocado still remains, in most regions, the most important of the two. Bananas are grown mainly for export, while the entire avocado crop is consumed locally.



It is difficult for residents of the United States, where the avocado is still looked upon as something of a luxury, to appreciate the rôle which this fruit plays among the Guatemalans. The abundance of avocados, their cheapness, and the long season during which they are available make it possible for even the poorest natives, in all the principal avocado regions, to use them as a daily article of food throughout more than half the year. And they are not slow to take advantage of this opportunity, since they recognize fully the high food value of the fruit, and its ability to replace meat, to a large extent, in their dietary. An avocado, four or five tortillas (small round cakes of coarsely ground maize) and a cup of coffee,-- by many Indians these are considered the constituents of a good meal. The cost of such a meal is rarely over two cents, for outside the larger cities avocados are rarely sold for more than half a cent each.

The three races of avocados at present cultivated in the United States are all found in Guatemala. The only one which is really common, however, is the Guatemalan race. The West Indian is limited to the lowlands up to 2500 feet, and even in this zone is much less abundant than the Guatemalan in the higher zone which it occupies,--extending from 2500 feet (rarely lower) to 7500 feet, and above this, in occasional instances, to 8500 feet. The Mexican race is found only in the highlands and is of no importance in Guatemala, few trees being found in cultivation. A distinct species of *Persea*, closely resembling the avocado and known as coyó or shucte, is as extensively grown in some sections of the country as the avocado itself.

Mexico, whose avocados have not yet been thoroughly studied,

is probably the only other country which offers conditions comparable to those which exist in Guatemala. The diversity of climates and soils, and the presence of all three cultivated races of avocados, render this latter country one of the most interesting in the world from the standpoint of avocado culture. The fact that a large proportion of its avocados are of the comparatively hardy and commercially valuable Guatemalan race makes Guatemala even more interesting to California and Florida avocado growers than Mexico.

#### EXTENT OF AVOCADO CULTURE IN GUATEMALA.

There are no orchards or regular plantations of avocados in Guatemala. Most of the trees occur singly or in small numbers around the houses of the natives. The avocado in Guatemala is essentially a dooryard tree. There are, however, certain regions in which considerable numbers of trees are found in coffee plantations. This is due, indirectly, to the custom of providing shade for coffee bushes. Quick-growing trees, such as the Australian silk-oak (Grevillea robusta) and several leguminous trees of the genus *Inga*, are planted throughout the fincas (coffee plantations) in straight rows at regular intervals. The lower limbs are trimmed off for several years, so that ultimately the coffee is shaded by a canopy of branches 15 to 20 feet above the ground. It commonly happens that avocado trees spring up in the plantations from seeds cast aside by laborers or coffee pickers after eating the fruit. Where they do not seriously interfere with other trees these avocados are frequently allowed

to grow, ultimately becoming a part of the shade tree system, and at the same time furnishing fruit of commercial value, except in those cases where the variety is too inferior to be marketable.

Under these conditions, it would be expected that the number of avocado trees in coffee plantations would be small, at least in comparison with the number of trees in the shade system. This is indeed the case. Even the largest fincas, which contain thousands of shade trees, do not contain more than one or two hundred avocados, and it is unusual to find more than fifty or seventy five in any one plantation. In comparison with a North American fruit orchard, this does not impress one as a large planting of avocados,--two hundred trees at the most,--but in the tropics, where orchards of fruit trees of any sort are almost unknown, the presence of two hundred trees in a single planting is worthy of note. Viewed from the standpoint of North American avocado growers, it furnishes an opportunity to observe the bearing habits of a considerable number of trees under the same environmental conditions (which, in coffee plantations, are comparatively favorable) and to find good chance seedlings for propagation in the United States. It must be understood, of course, that every avocado tree in Guatemala is a seedling, and hence a variety unto itself. The more seedlings, the greater is the possibility of finding one which is especially meritorious and worthy of propagation.

Unfortunately, there are no available data regarding the annual production of avocados in Guatemala. Judged by tropical standards, the quantity is great, but in comparison with the

output of even a small region in the United States where fruit culture is conducted commercially it is not large. Imagine that there were no orange groves in California or Florida, and the orange crop was derived solely from trees growing in the door-yards and gardens of the inhabitants, or scattered here and there among other fruit trees on a comparatively small number of farms. Perhaps the avocado is more common in the Guatemalan dooryard than the orange is in the Californian, but the comparison is sufficiently accurate to give a general idea of the conditions.

While avocados are grown in practically all parts of Guatemala, there are certain regions which are especially renowned for their product, and which supply most of the avocados sold in the larger cities and towns. These regions all lie at elevations above 2500 feet, and are not only the greatest producers of avocados, but the great horticultural centers of the republic. Favored by climatic conditions, and possessing an exceedingly fertile soil, they have long been cultivated intensively by the Indians.

Antigua, the former capital of Guatemala, which lies about 25 miles distant from the present capital, is one of the greatest avocado regions of the republic. Perhaps it deserves to be considered one of the greatest in the world, both for the quality and the quantity of the fruit it produces, though in this latter respect it is, or soon will be, outclassed by the avocado ~~regions~~ of Florida and California. Antigua lies in a

beautiful valley whose floor is about 5100 feet<sup>1</sup> above the level of the sea. It is protected on the north, east and west by towering volcanos and high hills, while to the south there is an opening toward the ocean, which permits warm breezes to enter from the Pacific and keep the valley at a fairly equable temperature throughout the year. The soil is of volcanic origin, deep, friable, moist, and very fertile. Under such conditions it is no wonder that practically every foot of ground ~~in the valley~~ is planted to some agricultural or horticultural crop. Coffee is the principal commercial product, but maize and black beans are grown extensively, and many fruits abound in the dooryards of the inhabitants. Beside the avocado, there are oranges, cherimoyas (called anonas in Guatemala), jocotes (Spondias purpurea L.), guavas, injertos (Achradelpha viridis O.F.Cook), loquats, matasanos (Casimiroa edulis LaLlave), and peaches. During the first six months of the year, large quantities of avocados are carried from the gardens and coffee fincas of Antigua to the markets of Guatemala City.

Another important center of avocado culture is Panajachél, on the northern shore of Lake Atitlán, at an elevation of about 5300 feet. This town lies on an alluvial plain at the mouth of a small valley, sheltered from cold winds off the highlands to the north by its position at the foot of high bluffs. It grows much coffee, and immense quantities of onions which are carried

<sup>1</sup> The elevations given in this bulletin, with a few exceptions, were obtained with an aneroid barometer of standard make. Frequent comparisons of barometer readings with railway levels at some of the more important stations in Guatemala showed the former to be dependable within a range of one hundred feet. This is a sufficient degree of accuracy for the practical purposes of this work.

to all parts of the republic on the backs of the Indians. Many avocado trees are scattered through the coffee plantations and gardens of this little valley, and from here the fruit is carried by the Indians to Sololá, Quezaltenango, and other towns of the highlands.

Far to the north of Guatemala City, in the great Verapaz coffee district, lies the town of San Cristóbal Verapaz, situated on the border of a small lake in a valley surrounded on all sides by high hills. The elevation is about 4500 feet, the climate warm and moist. Considerable numbers of avocado trees are found in the dooryards and coffee plantations of San Cristóbal. From here much of the crop goes to Cobán, which is the capital of the department of Alta Verapaz and one of the principal cities of the republic. Some of the avocados of San Cristóbal are among the very finest in all Guatemala.

Amatitlán, a small town about 25 miles from Guatemala City, at an elevation of 3900 feet, produces a large proportion of the avocados marketed in the capital, Antigua being the other principal source of supply. Due to the lower elevation, the avocados of Amatitlán ripen earlier than those of Antigua.

Momostenango, to the north of Quezaltenango, at an elevation of 7400 feet, is the highest point at which avocados are abundant, and they probably would not be so here were it not for the fact that the town is particularly sheltered by its location, and has a warmer climate than is usual in Guatemala at this altitude. A large part of the crop is marketed in Quezaltenango. Due to the elevation, the season of ripening is much later than at Panajachel, hence avocados from the two regions do not compete

in the Quezaltenango market.

Aside from the places mentioned, avocados are abundant in many other regions, but in some the quality of the fruit is uniformly poor. For example, the avocados of Senahú, in the Alta Verapaz, are small and have very large seeds.

The regions which have just been mentioned produce only the Guatemalan race of avocados. The West Indian is found along the coast and up the valleys of the principal rivers to elevations of about 2500 feet. Nowhere, however, are large numbers of trees grown. Here and there one is seen in a dooryard, and in such towns as Livingston there are quite a few, but they are never seen in such abundance as are trees of the Guatemalan race in places like Antigua and Amatitlán.

#### POPULAR USES OF THE AVOCADO.

In a country where avocados are so abundant and cheap as they are in Guatemala, it might be expected that they would be put to a great many uses. In consuming nearly all the products of the soil, however, it is the Guatemalan custom to prepare them in the simplest manner possible, hence little ingenuity is exhibited in devising new methods of utilising avocados.

The Guatemalan Indians, who are among the greatest consumers of avocados in the world, prepare the fruit for eating by breaking it in halves (rarely is it cut with a knife) and sprinkling a little salt over it. Even the salt is sometimes dispensed with, in which case the process of preparation is reduced to the simplest imaginable. The soft pulp,--it may be noted that the Indians rarely eat the avocado until the flesh

has lost its firmness,-- is then scooped out of the skin with the fingers or a bit of tortilla.

Among Guatemalans of European blood two methods of serving the avocado are in common use. The most important of these is the addition of the pulp to meat soups at the time of serving. It is the custom, in many hotels, to place a ripe avocado in front of each guest. The latter is expected to open the fruit, remove the pulp, and place it in his soup. The flavor imparted is exceedingly pleasant. This mode of serving the avocado is, in fact, one which seems worthy of adoption in the United States. The second method consists in the preparation of a salad called guacamol. This is composed of thoroughly mashed avocado pulp, vinegar, salt, pepper, and finely chopped onion. It is a popular and very tasty dish, though not an especially attractive one in appearance.

Among the minor uses of the avocado, the preparation of avocado oil is one of the most interesting. It does not seem, however, that this oil, which is said to be used as a pomade and as a remedy for burns, is regularly produced in any part of the country. While many Guatemalans profess to be familiar with it, none was found who could actually furnish a sample. By some it was said also to be used as a cooking fat, but this was never verified. The method of extracting the oil, as described by those who professed to be familiar with the process, is as follows: Slightly overripe avocados are selected, and the flesh is scooped out and thrown into a large kettle, which is then placed over the fire without the addition of water. <sup>after boiling</sup> ~~it is boiled~~ slowly for about two hours to exhaust most of the water contained



in the pulp, The kettle is ~~then~~ removed from the fire, and the pulp is placed in a muslin bag between two heavy stones, arranged so that the oil, as it percolates through the cloth, will run to one side of the lower stone and collect in a dish placed to receive it. The amount of oil obtained by this process is certainly only a small proportion of that contained in the fruit.

Among the Guatemalan Indians, avocado pulp is often rubbed upon the hair and scalp, it being considered highly efficacious in stimulating the growth of the hair. This practice has given rise to the manufacture of avocado soap, which is recommended for washing the hair. To prepare this soap, avocado pulp is mixed with some other fat which serves as a base. The product is manufactured commercially in Guatemala, but it seems open to question whether all the brands on the market really contain avocado pulp.

Among the Kekchi Indians of northern Guatemala the avocado is considered an excellent diet for caged song birds. Young birds, recently caught and caged, are fed daily on avocados that they may learn to sing promptly and well.

It is also considered, in certain parts of Guatemala, that avocados are excellent food for laying hens, greatly stimulating the production of eggs.

Hogs thrive on avocados. To North Americans, accustomed to paying 50 cents for a single fruit, this may seem an expensive diet for hogs, but where inferior avocados can be purchased for 6 or 7 cents a hundred, and lard is 25 cents a pound, it is a good investment to turn avocados into pork.

The medicinal uses of the avocado are few. For those suffering from acute rhinitis ("cold in the head") the fruit is considered by the Kekchi Indians to be an excellent food. The seed is sometimes used as a remedy for dysentery and diarrhea. For this purpose it is pulverised and boiled in a small quantity of water, after which the liquid is taken internally. Its beneficial effect is probably due to tannin, of which the seed contains large quantities.

Among Guatemalans of nearly all classes there is a firm and widespread belief in the aphrodisiacal and emmenogogic properties of the avocado. It is considered a powerful excitant when eaten to excess by young girls, and is eaten only in moderation by women.

The wood of the avocado tree has little value. It is light in color, and does not check (crack or split) upon drying, for which latter reason it is used by one factory in Antigua for the manufacture of potato mashers, rolling pins, and such articles. It burns rapidly and gives off little heat, hence it is not even esteemed as firewood, though it is commonly used by the Indians for this purpose.

#### CLIMATIC ZONES OF GUATEMALA.

In Guatemala, as in Mexico and some other parts of tropical America, three climatic zones are generally recognized. These are the tierra caliente (hot region), extending from sea level to about 2000 feet; the tierra templada (temperate region) comprising the territory between 2000 and 6500 feet; and the tierra fria (cold region), which extends from 6500 feet to the

upper limit of cultivation, which is, in Guatemala, about 10,000 feet.

To one not familiar with climatic conditions in Central America the names "temperate region" and "cold region" are apt to be misleading. It must not be inferred that the temperate region has a climate similar to that of the Temperate Zone proper, but only that it is cooler than the lowlands of the hot region. The cold region, in turn, is not necessarily visited by snowstorms in winter, but is merely cooler than the temperate region, due to its greater elevation. The lower and upper limits of each zone are exceedingly indefinite and are variously fixed by different writers.<sup>1</sup>

For the study of a particular horticultural product, such as the avocado, a clearer idea of conditions can perhaps be obtained if the climatic zones are based upon the presence of certain fruit trees, whose requirements in regard to temperature are fairly well known to residents of the warmer portion of the United States. Working from this angle, it seems more appropriate to term the three zones tropical, subtropical, and semitropical, thus indicating more accurately the character of their climates as

<sup>1</sup> Pittier's classification of the climatic zones, based upon the distribution of vegetation in relation to temperature, though applying primarily to Costa Rica, will doubtless hold good in Guatemala as well. It seems one of the most accurate of these classifications, though as explained by Pittier himself it is artificial, the transition from one zone to another being quite unnoticeable. It is given here for comparison with the classification based upon the presence of characteristic fruit trees, which is followed in this bulletin:

Lower zone	From sea level to 3300 ft (approximately)
	Mean temperature 82 to 70 degrees Fahr.
Intermediate zone	From 3300 to 8500 ft
	Mean temperature 70 to 57 degrees Fahr.
Upper zone	From 8500 feet to the highest summits
	Mean temperature 59 to 41 degrees Fahr.

(From "Plantas U  
suales de Costa Rica")

viewed from a horticultural standpoint. However, it is impossible to fix definitely the limits of each zone, since the characteristic trees will occasionally be found in sheltered situations considerably above the ordinary limits of the zone, just as some of the tropical fruit trees, which can not be grown in ordinary situations in California or Florida, occasionally succeed in a protected spot. The limits must be fixed at the altitude where, under ordinary conditions, the characteristic trees commonly cease to be grown. With this understanding, the three zones of climate, or more properly of temperature, since rainfall does not yet enter into the discussion, may briefly be described as follows:

Tropical zone. This includes the seacoast, the coastal plains, and the valleys of the larger rivers for a considerable distance back from the coast. It includes practically the entire department of El Peten, in northern Guatemala, but this region is very sparsely inhabited and of little horticultural importance. The characteristic trees of this zone are those which are commonly found on tropical seacoasts, and which will not tolerate cool weather. The breadfruit tree (Artocarpus incisa L.) is one of the best known. The most tropical of the annonas, such as the custard-apple (A. reticulata L.) and the soursop (A. muricata L.) are at home in this zone, and the tamarind (Tamarindus indica L.), although it can be grown in the lower edge of the subtropical zone, reaches its greatest development only in this. The same is true of the mango. The star-apple (Chrysophyllum Cainito L.) is found only in this zone. All the commercial banana plantations of Guatemala lie within this zone, but the banana is cultivated

on a small scale in the subtropical zone up to 5500 or 6000 feet. The pineapple is grown commercially only in this zone. The only race of avocados commonly cultivated is the West Indian. The mamey (Mammea americana L.) and the sapote (Lucuma mammosa Gaertn.) are two other characteristic fruits.

The upper limit of this zone may be placed between 2500 and 3000 feet. The breadfruit tree is not cultivated quite as high as 2500, but on the other hand the mamey and the sapote are sometimes found above 3000. The highest point at which the West Indian race of avocados has been found is 2500 feet.

Subtropical zone. This may be considered, in general, the principal horticultural zone of the republic. It begins at the upper limit of the tropical zone, between 2500 and 3000 feet, where the climate is decidedly warm, but without the intense heat of the coast. At 4000 to 6000 feet it is rarely hot enough to be uncomfortable, but on the other hand there are never severe frosts. Toward the upper limit of the zone, which can be placed at 7000 to 7500 feet, frosts are more common, but rarely severe. Only in the semitropical zone are killing frosts experienced.

It is in this zone that the orange is most extensively grown. It is also the most important zone of avocado culture in Guatemala, being the one in which the Guatemalan race is cultivated. This race ascends occasionally into the semitropical zone, but most of the important centers of avocado culture lie between 3000 and 6500 feet. The loquat is commonly seen in gardens throughout this zone. The cherimoya (Annona Cherimola Mill.), the jocote (Spondias purpurea L.), and the matasano (Casimiroa edulis LaLlave) are other fruits which may be considered

characteristic.

The climate of certain parts of this zone will receive more detailed consideration under the discussion of the Guatemalan race of avocados.

Semitropical zone. In this zone the principal fruits are those which have been introduced from the north, and are well known in the Temperate Zone. The peach, the apple, the pear and the quince are abundant, replacing the avocado, the lognat, the orange and the ~~other~~ fruits of lower elevations. The upper limit of orange culture seems to be about 7500 feet. Taking this as the boundary of the subtropical zone, it is found that several of the characteristic fruits of that zone extend into the lower edge of the semitropical. Ascending above 7500 feet, the cherimoya is the first to disappear, 8000 feet seeming to be its uppermost limit; the avocado follows next, growing as high as 8500 feet, and finally the matasano, which reaches 9000 feet at the town of San Francisco el Alto, but was not found at greater elevations.

The fig is also grown in this zone, and the indigenous cherry (*Prunus salicifolia* HBK), which is very common in gardens, <sup>*The latter*</sup> ~~it descends~~ into the subtropical zone, but is most frequent at elevations of 7000 to 9000 feet.

The upper limit of this zone is the upper limit of cultivation. One of the highest towns in Guatemala is San Francisco el Alto, north of Quezaltenango, at an elevation of 9000 feet, but above this there are occasional huts around which a few fruit trees may be found, and grain fields extend to 10,000 feet or higher.

Summing up the characteristics of the three zones, it may be said that the lower or tropical zone is a region of comparatively high temperatures throughout the year, never experiencing cold weather, and hence adapted to the cultivation of those fruits which horticulturists term "strictly tropical" in their requirements. The subtropical zone, due to its greater elevation, is free from the extreme heat of the tropical zone, but is never subjected to severe freezing. The lower levels of this zone are fairly warm throughout the year, while toward the upper limit the winters are decidedly cool, strongly resembling those of southern California. The uppermost zone, here called the semitropical, is too cold for the orange and the lemon, yet does not experience the type of winter weather familiar to residents of the eastern United States. Its minimum temperatures probably more closely approach those of southern Texas, Louisiana, and northern Florida. The principal fruits grown in this zone are the apple, peach, and pear.

In regard to rainfall, the quantity varies greatly in different parts of Guatemala, but the season during which it occurs is more or less the same throughout a large part of the country. Figures for several regions are given in the discussion of the Guatemalan race of avocados. In general, it may be said that the rainy season begins in May, continues until October, being at its maximum during August and September. In the Verapaz district of northern Guatemala, however, it rains during most of the year, the only dry months being March and April. On the coast the precipitation is usually much heavier than in the highlands, and in certain regions, such as the valley of the

Motagua river between El Rancho and Gualan, there is comparatively little rainfall at any time of the year. In the highlands the dry season is often severe, practically no rain falling from November until April or May. The roads become deep in dust, herbage turns brown, and many of the woody perennials drop their foliage.

#### CLASSIFICATION OF AVOCADOS.

The classification of avocado varieties has been the object of much investigation in California and Florida during the past few years. As with many other cultivated fruits, it has been found that the horticultural varieties fall into several distinct groups. Three of these, termed generally the Guatemalan, West Indian, and Mexican, are now recognized by most investigators.

Material on which to base a classification has been somewhat inadequate in the United States. Hence it has been thought that when the great avocado regions of tropical America came to be explored, groups or races not yet known in the United States might be discovered. A canvass of the avocado producing regions of Guatemala, however, has failed to bring to light any new groups, the investigations tending only to confirm the classification already in use in the United States. Mexico, with its vastly greater amount of territory, may perhaps yield groups as yet unknown to horticulturists, but no critical study of the avocados of that country has yet been undertaken.

Perhaps the horticultural groups have been derived from distinct species of *Persea*. If not, they have at least become differentiated through the accumulation of variations during



a long period of cultivation under different environmental conditions. In order to determine their exact status, it becomes highly desirable to locate the wild prototype of each, if such a wild prototype still exists. This has not yet been done by anyone having in mind the classification of the cultivated avocados. The task is made difficult by the fact that the south Mexican and Central American region, where the wild prototypes are probably to be sought, has been the scene of intense agricultural activity for centuries. The primitive forest has been leveled to the ground to make way for maize fields; the maize fields have been abandoned, the inhabitants of the region have emigrated to other parts, and the forest has again taken possession. After a period, new peoples have arrived upon the scene, and the process has been repeated. This is indicated by archaeological remains in many parts of the region in question.

Under these conditions, the wild species from which our cultivated avocados are derived may have disappeared altogether, or on the other hand, trees which are found in the forest at the present day and have every appearance of being indigenous, may have been placed there by the hand of man.

Lacking exact knowledge of the wild prototypes of these cultivated races, a comparison of the most primitive forms of them which can be found at present will bring out more racial characters, or at least emphasize existing ones more strongly, than will a comparison of the highly developed varieties found in cultivation, for cultivation tends to conceal the racial characters by bringing the various races to a common level. Thus the exceedingly thick and hard outer covering of the fruit which

is typical of the Guatemalan race, and which is conspicuously present in the primitive avocados of the Alta Verapaz, becomes thinner in many of the cultivated varieties and closely approaches the skin of the West Indian race in character. The fruit increases vastly in size, assumes various shapes, and the seed becomes proportionately smaller. Since cultivation tends to work the same changes in all of the races, it tends at the same time to conceal many of their distinguishing characteristics.

The term race, which is here applied to the groups of varieties known in cultivation, seems more appropriate than the term type which is commonly used. The word type, in this connection, means nothing; the word race, on the other hand, has a definite horticultural meaning which seems applicable here. A race is a group of seedlings which possess certain well-defined characteristics in common, and will transmit these characteristics to their seedling progeny. This applies to the avocados under consideration, for each race has certain characteristics which never fail to be inherited by its seedlings.

The three cultivated races may be distinguished by the following characters:

#### Guatemalan Race.

The foliage is not anise scented, hence easily distinguished from the Mexican. It is usually deep green in color, somewhat deeper than that of the West Indian. The flowers are not so heavily pubescent as those of the Mexican. The fruit varies greatly in form and size, but always has a woody outer covering, 1/16 to 1/4 inch thick. In some of the cultivated forms the skin or outer covering is scarcely thicker than in the West Indian

race, but it is rarely so soft and pliable. The seed is comparatively smooth, and the two thin, closely united seed coats adhere closely to it. The seed is very rarely loose in the cavity within the fruit.

West Indian Race.

Foliage slightly lighter in color than in the Guatemalan, but like the latter devoid of anise scent. Flowers sometimes less pubescent than those of the Guatemalan, never more so, and always less pubescent than the Mexican. Fruits variable in form and size, but with the outer covering soft and pliable, rarely more than 1/16 inch thick. The seed is often rough, the two seed coats thick and separated, at least over the distal end of the seed, one adhering to the cotyledons and the other loose or adhering to the lining of the seed cavity.

Mexican Race.

Foliage and sometimes the fruit distinctly anise scented, and both usually smaller than in the Guatemalan and West Indian races. Flowers more heavily pubescent than in either of the latter. Fruits with a very thin, often membranous skin. Seed commonly smooth; the seed coats thin, closely united and adhering to the cotyledons, as in the Guatemalan, or separating, as in the Mexican.

AVOCADO CULTURE IN THE GUATEMALAN HIGHLANDS.

In the discussion which follows, it must be kept in mind that the Guatemalan race of avocados is being considered. None other is grown to any extent in the highlands, the Mexican race rarely occurring in Guatemala, and the West Indian being

continued to the lowlands. Separate paragraphs will be devoted to these two races farther on.

#### How Have the Choice Varieties of the Present Day Originated?

The splendid avocados of today are doubtless the product of centuries of more or less conscious selection on the part of the Guatemalan Indians, just as the choice fiberless mangos of East India have been produced through selection by the Hindus. In the case of the mango, however, the Hindu has been enabled to perpetuate an unusually choice variety by resorting to vegetative propagation. This appears never to have been practiced in Guatemala, hence when a choice avocado tree grows old and dies the variety is lost.

Due to the moist climate of the Alta Verapaz an avocado seed dropped by the roadside nearly always sprouts and develops into a tree. This has led to the avocado being found in a semi-wild state throughout that region, often in the edge of the forest and at such distance from any present habitation as to suggest that the species is truly indigenous. The suspicion always arises, however, that a seed may have been dropped by some passing Indian, or that a hut may have stood close to the spot at some past time. When going to work in their clearings, the Indians commonly carry avocados with them as part of their noonday lunch. These seeds of these fruits, cast aside wherever the Indian chances to be at midday, give rise to many avocado trees in little-frequented places.

While a careful search was made in the most promising sections of the Alta Verapaz for the wild avocado, no trees were found which it was felt could safely be considered indigenous. The

primitive, half-wild forms so commonly seen, however, can without doubt be looked upon as the nearest approach to the wild species, insofar as character of fruit is concerned, and a comparison of these forms with the choicest varieties in cultivation brings out some striking differences.

These half-wild avocados of the Alta Verapaz are nearly always round, small in size, with a hard, thick outer covering and a very large seed, leaving but little flesh. The smallest of them are no larger than walnuts. The majority are little more than two inches in diameter. The shell,--for it can be called such,--is either green or purple and rough externally; in texture it is so hard and brittle that it breaks irregularly when an attempt is made to cut it. Occasionally it is as much as a quarter of an inch thick. The flesh is of good quality, but the quantity is very small. The seed is tight in the cavity, with the cotyledons smooth and the thin seed coats adhering closely. The fact that nearly all of these fruits are round would indicate that this can be considered the primitive shape, the pyriform and elongated avocados being the result of cultivation.

When such fruits as these are contrasted with the splendid varieties of Antigua fincas, for example, the development which has been brought about in the avocado appears quite equal to that which has taken place in the northern fruits. The latter have been in the hands of horticulturists who have called to their aid not only the art of grafting but much skill in cultivation. The improvement of the avocado, on the other hand, has scarcely been a conscious process, and has been carried on by a people who are preeminently agriculturists and not horticulturists.

Cook and others have spoken of the intimate knowledge which the Indians of Central America possess concerning the plants among which they live, and their specialised methods in the cultivation of staple food crops. They have a name for nearly every tree in the forest, they are familiar with the habits of many plants, and possess well defined beliefs concerning the medicinal uses of a large number. Their agricultural practices, though based upon tradition, are in many respects admirable. They have highly specialised varieties of maize to meet the various conditions of climate which are found throughout the region which they occupy, and they are intimate with the particular merits of these varieties.

They seem, however, to have devoted all their energies to the cultivation of field crops, fruits having received very little attention. In regard to the avocado, for example, it does not appear that the Indians cultivate the soil around the base of the tree, apply fertilisers of any sort, prune the tree, or bestow any care whatsoever upon it. Ideas regarding the age at which seedling trees come into bearing are nearly always vague and rarely based upon accurate observation of even a single instance. It is rather remarkable, in fact, that the Indians should have so few definite ideas regarding a fruit which plays such an important part in their daily life as the avocado, for they are an intelligent and in many ways capable people.

It cannot be doubted, however, that the avocado has been planted by the Indians in their dooryards since a remote day. The native name for the fruit, oh, okh or on in the principal Maya dialects of Guatemala<sup>1</sup>, and many other circumstances indicate that

<sup>1</sup> The aboriginal names of the avocado in the dialects of

it has been known to the Guatemalan Indians since the earliest times. The evolutionary processes which can be observed at the present day have doubtless been going on for centuries, and could the Indians have taken advantage of vegetative propagation to perpetuate the best varieties obtained by selection, avocados even more remarkable than those of today would certainly have been the result. Seed propagation has prevented the perpetuation of choice varieties, and it is only by raising the general level of the whole species that improvement has been accomplished.

Among the several factors working in unison toward the horticultural development of the avocado, the first which must be mentioned is the change brought about by removing the tree from its native home in the forest and planting it in dooryards and gardens, where the struggle for existence is eliminated and more favorable conditions for growth are supplied. This in itself would undoubtedly tend to increase the size of the fruit. Among many trees seen in a half wild state in northern Guatemala, growing among thick scrub along the roadside or maintaining a foothold in the edge of the forest, not one produced

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southern Mexico and Guatemala, according to Dr. Karl Sapper (Das Nordliche Mittelamerika) are as follows: ju (Huesteca, according to Stoll); on (Chicomulcelteca); on (Maya of Yucatan, according to Stoll); on (Maya of Peten, according to Stoll); un (Chol); un (Chorti); un (Chontal, according to Stoll); on (Tzentel); un (Tzotzil, according to Stoll); on (Tozolabal); on (Motozintleca); oj (Mam); on (Jacalteca); oj (Aguacateca); according to Stoll); oj (Quiché, according to Stoll); oj (Cakchiquel, according to Stoll); oj (Tzutuhil); oj (Uspanteca); o (Quekchi); oj (Pokonchi, according to Stoll); oj (Pokomam of Jilotepeque); oj (Pokomam, according to Stoll).

fruits of large size. It is not reasonable to believe that all of these trees are from seeds of inferior fruits, since many of them have their origin in avocados brought from the villages by the Indians. Unfavorable conditions of growth must have an important effect in limiting the development of the fruit.

Once removed from the forest, and planted around the huts of the Indians, where the struggle for existence is eliminated and larger supplies of plant food are available, other factors come into play. The most important of these, as far as can be observed at the present day, are (1) the destruction of trees producing inferior fruit and the preservation of good ones, and (2) the carrying to market of nothing but the best fruits, thus disseminating seeds of good parentage and limiting the dissemination of poor ones. Both these factors can be considered conscious selection on the part of the Indians, though the second is not the result of a desire to improve the avocado by disseminating good seeds, but is due to the market demand for good fruits.

Both factors can often be seen in operation at the present day. In coffee plantations, when it is necessary to cut down avocado trees to make room for coffee or other crops, the trees known to produce inferior fruits are taken first, and the best ones are often spared. The Indians, when cutting out old trees around their houses, will frequently save the avocado which bears the best fruits.

During the ripening season, the fruit from the best trees is the first to be picked and taken to market, many of the poorer trees going unpicked, in which case the fruits fall to



the ground and are eaten by the *sopilotes* (buzzards). The fruits purchased in the market are often carried many miles, since the Indians come into the small towns of Guatemala from great distances. When the fruits are eaten the seeds are cast aside. The climatic conditions are so favorable, at least during a part of the year, that a seed dropped upon the ground will sprout, take root, and develop into a tree. Once sprouted and established, the Indian is loth to destroy it. Hence many new trees are started each year. It appears that comparatively few avocados are intentionally planted by the Indians, most of the trees being volunteers.

#### Soils.

The principal avocado districts of the highlands differ considerably in their soil types. Clays, alluvial loams, and loose soils of volcanic origin are the principal ones encountered.

The Alta Verapaz is a limestone region, in which most of the soils are clays or clay loams of reddish, tawny or blackish color. When wet, many of these soils have an almost greasy consistency. They are usually of considerable depth. In the valley of San Cristóbal, the most important avocado center in northern Guatemala, blackish clays predominate. In many spots there is a surface deposit of rich loam washed off the hillsides.

The clay soils of the Verapaz seem to produce a large and long-lived tree. In no other part of Guatemala were larger avocados seen than in the vicinity of Cobán and San Cristóbal. If not well drained, these soils would be objectionable, but the Verapaz is of such rough, rugged contour that it is rare

to find an avocado standing on level ground.

Typical alluvial loam occurs at Panajachél, on the border of Lake Atitlan. This town lies at the mouth of a small valley, scarcely more than half a mile broad, with the mountains rising abruptly on both sides. When viewed from above, it can plainly be seen that the sediment carried down this valley is gradually building a delta out into the lake. Most of the gardens which contain avocado trees are situated about half a mile up the valley from the present shore of the lake. The valley floor at this point is level, the soil varying from a fine black alluvium to gravelly loam, most of the cultivated area possessing rich black loam, easily worked and well adapted to the growing of truck crops and coffee, for which it is used. The avocado succeeds excellently here.

At Momostenango, north of the city of Quezaltenango, a curious mixture of red clay and volcanic tufa is encountered. Large masses of tufa, many feet in depth, are frequently exposed by erosion.

In the Antigua district the soil is more uniform in character than in many other sections of Guatemala. It is a loose, black, sandy loam of volcanic origin, mixed with alluvium and becoming a true loam on the valley floor, while on the slopes it is often so loose and coarse in texture as to suggest cinders. In most of the coffee plantations the soil seems to be of uniform character to a considerable depth. It is easily worked, fertile, and from several points of view an admirable avocado soil. Even at the end of the long dry season it is found to be moist a short distance below the surface, and it never becomes hard and

cracks open like the heavy clays. It does not seem to produce quite so large a tree as the clay soils of the Verapaz.

As to which of the several soil types encountered in Guatemala is best adapted to avocado culture, it seems, everything considered, that the clay loams or light clays can probably be chosen. The others, however, give good results. It has been shown in the United States that the avocado will succeed under a wide range of soil conditions; witness the excellent growth which is made in Florida on very sandy soils, and in California on heavy clays of the adobe type. No clay as heavy and tenacious as the California adobe has been seen in Guatemala.

#### Growth and Habit of the Avocado Tree.

At elevations of 4000 to 5000 feet in Guatemala the growth of the avocado tree is not so rapid as it is in California and Florida. This is mainly due to the mildness of the climate; there is none of the hot summer weather which produces such rapid growth in the United States. Another cause is the prevailing lack of cultural attention. Naturally a tree which is manured regularly, and irrigated when rainfall is lacking, will make more rapid growth than one which is supplied with an abundance of water during part of the year, is forced to withstand a long drought during the remainder, and which never receives manures or fertilizers in appreciable quantities. In Guatemala, it must be remembered, many avocados are not even planted in favorable situations, but spring up from seeds cast aside by the natives. Under these conditions the first few years are often a sever struggle with the surrounding vegetation.

It is difficult to obtain an accurate idea of the age at which seedlings commonly come into bearing. So rarely is any record kept concerning the age of the tree, and so unobserving are the majority of the natives, that it is usually impossible to ascertain the age of a particular tree and the year in which it commenced bearing. Under the comparatively favorable conditions of coffee plantations the most trustworthy accounts place the bearing age at six to eight years. In a few instances it was possible to verify the age at which certain trees produced their first fruits; this was never found to be less than five years, and sometimes as much as ten. It is interesting to note, however, that even where a seedling does not come into bearing at an early age, it nearly always bears eventually. In the ripening season, many large trees with no fruit may be seen in practically any district, but on investigation it will be found that these trees have borne in previous years, and the present lack of fruit is merely the result of the universal tendency to irregularity in bearing.

Granting, then, that a seedling avocado in Guatemala, under favorable conditions, comes into bearing between six and eight years from the seed, how long will it continue in profitable production? There are many large trees in Guatemala, still in profitable bearing, which are said to be 50 or 60 years old. How much older they may become before commencing to decline cannot be ascertained. Fifty-year-old trees seem to yield just as good fruit as younger ones. Indeed, it is affirmed by some of the avocado growers that a tree does not produce its best fruit until it has attained an age of 20 or 25 years.

In habit of growth there is considerable variation. Perhaps it can be said that there are two types of trees, the slender erect type and the broad spreading type. This classification is more or less artificial, however, since there is no lack of intermediate forms.

The majority of trees seen in Guatemala have straight trunks which do not branch within six feet of the ground, and the crowns are broad, dome-shaped, and fairly dense. The erect, slender type of tree, with an open crown, is less common. The average size of mature trees,--those 15 to 25 years of age,-- as seen in coffee plantations and gardens, is 30 to 40 feet in height, with a spread of equal distance when the trees are of the broad, spreading type, or with a spread of about 20 feet when they are of the slender type. Such trees as these have trunks 12 to 18 inches thick.

A tree 50 feet in height may be considered large, and one which is 60 feet has probably reached its maximum development, under most conditions. The trunk of such a tree may be four feet thick, and the crown may be 50 or 60 feet in spread. Probably these dimensions are not attained until a tree is at least 50 years old.

There are differences in the character of the growth,-- its stiffness, brittleness, size, and so on,--which do not appear of importance in old trees, but which will stand out more prominently when young budded trees are planted in the orchard and must be trained to desirable form. In some trees the growths are long and slender, supple, and scarcely able to bear their own weight. Ultimately these growths tend to produce descending

branches, keeping the crown close to the ground. Other trees make very short, weak growths, seeming to indicate a lack of vigor. In still others the wood is so brittle that the branchlets snap off when bent. The best trees make strong, healthy-looking growths, smooth and round (angular branchlets frequently indicate a weak grower) with the leaves placed about an inch apart and the axillary buds short, plump, and well developed.

#### Cultural Practices.

Little can be said regarding the cultural practices of Guatemalan avocado growers, since the amount of systematic attention given the trees is almost negligible. It is of interest, however, to consider the cultural conditions under which the trees occur, and the apparent effect of these conditions upon growth as well as fruit production.

It has already been stated that comparatively few avocados in Guatemala are intentionally planted, the majority being volunteer seedlings which spring up by the roadside or wherever a fruit happens to have been eaten. It speaks well for the climate and soil that trees which develop under such conditions can reach large size and produce fruit. They do not receive the least attention from anyone; the ground is never cleared of weeds or undergrowth, and the tree must in some instances carry on a constant struggle for existence.

In coffee plantations or in the dooryards of the natives, however, conditions are more favorable. Especially is this true of coffee plantations, since the cultural attention given the coffee bushes necessarily affects the nearby avocado trees as well.

Twice or three times a year the ground is cleared of weeds with a heavy hoe. It is never cultivated deeply, and in fact the surface beneath avocado trees is not even scratched in many instances, since a heavy mulch of leaves collects and few weeds require to be removed.

The only pruning practiced is the removal of the lower branches when the trees are young, in order that the crown may be formed above the tops of the coffee bushes. This means that the trunk frequently does not give off any branches less than eight to 12 feet from the ground, and the lowest limbs in the crown are far out of reach. In a country such as Guatemala, where high winds are unknown, this method is not disadvantageous except that it greatly reduces the amount of fruiting wood, and makes it somewhat difficult to pick the fruit. Even when not grown in coffee plantations, the trees are usually encouraged to branch high, the crown being formed at least six or eight feet above the ground.

During the dry season, which is long and severe in Antigua and several other regions, no irrigation is given the trees and it attests the resistance of the avocado that they do not often show the effects of drought. Apparently the soil in Antigua is retentive of moisture, but it is a common occurrence, toward the end of April, to see orange trees in Antigua gardens yellow and wilting from lack of water, while avocados in the same garden appear in perfect condition. This is not saying, of course, that avocado trees in the United States (or in Guatemala, for that matter) should not be abundantly irrigated during the dry season, for experience indicates that they should.

As opposed to such conditions as those of Antigua, the climate

of the Alta Verapaz is exceedingly moist, the rainfall being over 100 inches in some sections, distributed throughout ten or eleven months of the year. The avocado seems perfectly at home in such a climate. Evidently it is able to stand extremes of moisture or drought without suffering.

As to the effect of unfavorable conditions upon fruit production, it is noticeable that trees growing by the roadside or in waste places are often very productive, but their fruit is never as large as that from trees grown in the more favorable environment of the coffee plantations ~~and~~ in the dooryards of the natives. Half-wild trees nearly always produce small fruits containing very large seeds. Often the fruits are so inferior that the natives do not even pick them.

#### Regularity of Bearing.

It is admitted by practically all Guatemalan avocado growers that the trees do not bear regularly. That is to say, a good crop is not produced every year. It is generally considered that a heavy crop will be followed by a light one or even by a crop failure, but observation shows that no rule can be laid down which will apply to all trees. Regularity in bearing seems to vary in different trees. Some have been seen which bore a heavy crop one year and nothing the next; others which bore a heavy crop one year and an equally heavy one the next. While it may perhaps be stated, as a general principle, that a heavy crop will usually be followed by a lighter one, the question must be studied from the standpoint of each particular variety.

Irregularity in bearing is doubtless encouraged in Guatemala



by failure to practice thinning when an unusually heavy crop is produced, and by inattention to cultural details. In the spring of 1917 there was a prolonged dry spell at the time when the young avocados were the size of marbles, and many trees cast their fruit. It seems quite probable that irrigation at this time would have saved the crop. In another case, a crop was lost through the attacks of some insect at the time the fruits were about one-third grown. In many instances trees are allowed to overbear one season, crop failures the following year being the natural result.

Doubtless much can be done in the United States to control this matter. There is everything to indicate, however, that the most important thing is to plant a variety which bears fairly regularly. There is certainly a wide range of variation in this respect.

#### Yield.

Very large trees of the smaller varieties, whose fruits weigh 6 to 8 ounces, produce as many as 3000 fruits in a single crop. Larger varieties, whose fruits are 18 ounces in weight, may produce as many as 1000 fruits, provided the tree is of mature size. A few examples of good production may be cited to illustrate what can be expected of Guatemalan varieties. A young tree in Amatitlan, not over 20 feet high, produced in 1916 a crop of 125 fruits, each weighing 16 to 18 ounces. In 1917 this tree produced double the number. A young tree in Antigua, scarcely 20 feet high, very slender, and with little fruiting wood, produced 300 fruits weighing eight to 12 ounces each. Another young tree in Antigua, about 25 feet high, produced 100 fruits weighing 20 ounces each. This also was

a very slender tree with little fruiting wood. Another, 35 feet high, with a broad, well branched crown, produced 300 fruits each weighing 14 to 16 ounces.

It must be remembered that the above trees are not branched close to the ground, as they would be grown in the United States, and hence have much less fruiting wood than trees of similar height in a California or Florida orchard. They are commonly branched about 10 feet from the ground. A count of numerous trees ranging from 30 to 40 feet in height, which is about the average size for 15 to 25-year-old trees, showed that they were producing from 50 to 500 fruits each. The average was about 200 or 250, and the average size from 12 to 14 ounces. This can be considered a very satisfactory yield, considering the small amount of fruiting wood which these trees possess.

Most of the Guatemalan avocados produce their fruits singly, but there are occasional ones which produce clusters of two to five fruits. No very large varieties have been observed to fruit in clusters, but the small and medium sized ones, whose fruits are from six to 15 ounces in weight, occasionally do so.

#### Season.

It has been remarked by travelers that avocados are present in the markets of Guatemala City every month in the year. This observation, accurate enough in itself, has led to the assumption that the avocados of Guatemala must exhibit unusually wide variation in season. The fact that Guatemala City is supplied with avocados from several different regions has been overlooked, and

this oversight has been responsible for a misconception; for these several regions lie at different elevations, and elevation, in Guatemala, is the factor which determines the ripening season of avocados.

In any given avocado district of Guatemala it is not possible to market ripe avocados throughout more than six or seven months of the year. There may be an occasional tree which lengthens this period (it may be mentioned in passing that these occasional trees which fruit out of season are the very ones which are of greatest interest to avocado growers in the United States), but such trees are so scarce that their influence is not felt in the market. By picking immature fruits, a common practice in Guatemala, the market is often supplied during two months more.

The variation in the ripening season, due to differences in elevation, ~~may best~~ be shown by the following list of important avocado districts, with their main seasons of ripening,--that is, the periods during which fully ripe fruits are available in abundance:

Senahú, Alta Verapaz	3200 ft.	Nov. to Feb.
Amatitlan	3900 ft.	Jan. to April
San Cristóbal Verapaz	4600 ft.	Feb. to May
Antigua	5100 ft.	Mar. to June
Purulá, Baja Verapaz	5150 ft.	Mar. to June
Panajachél, Sololá	5300 ft.	Feb. to May
Chimaltenango	6000 ft.	April to July
Momostenango, Totonicapan	7400 ft.	May to August

Ascending from 3000 to 7000 feet, the change in climate from warm to comparatively cool produces a corresponding retardation

in the ripening season. For every thousand feet of elevation, ripening is retarded at least one month, except in those rare cases where unusual conditions come into play. Panajachél, for example, at an elevation of 5300 feet, has an earlier season than Antigua, at 5100 feet; this can be accounted for by the peculiar situation of Panajachél, in a sheltered valley opening toward the south on a large body of water, whose influence upon the climate must be considerable. This section is doubtless much warmer than most other towns in Guatemala which lie at similar elevations.

In general, the ripening season at various elevations may be considered approximately as follows:

3000 feet	Nov. to Feb.
4000 feet	Jan. to April
5000 feet	March to June
6000 feet	April to July
7000 feet	May to August

To what elevations in Guatemala do the climates of southern California and south Florida correspond? It appears that the climate at 6000 to 7000 feet in Guatemala corresponds very closely, insofar as its effect upon the development and ripening of avocados, <sup>is concerned</sup> to that of the citrus-growing regions of California. The maximum temperature may not be as great as in California, but the time required for avocados to develop and ripen appears to be about the same. South Florida, on the other hand, seems more nearly to approximate an elevation of 3000 to 4000 feet in Guatemala.

If an avocado which ripens at Senahú (3200 ft.) from November to February is planted in California, it would be an error to assume that it will ripen during the same months in that state. It would probably be at least three months later, making its season January to April. If planted in Florida, however, it would be expected to ripen only slightly later than at Senahú.

In any given section of the Guatemalan highlands the vast majority of avocados ripen at approximately the same season. Very early or very late varieties are exceedingly rare. Considering Antigua, as an example, only a very few trees were found, out of the hundreds in that region, which commenced to ripen their fruits in October and November. Most of the trees do not begin to ripen any fruits until late in February, and the height of the season is during March, April and May.

The length of time avocados will remain on the tree after they have reached maturity depends mainly upon two factors, (1) the variety, and (2) the condition of the soil as regards moisture. Some trees carry their fruits much longer than others in the same location. In very moist regions, such as Senahú, however, no trees carry fruit after maturity for as many months as do the trees of Antigua, a much dryer section. At Senahú rainfall is abundant from November to February, and avocados fall quickly after reaching maturity. At Antigua, it is quite dry from November to May, and after that it is not excessively moist until August. As a result, many trees carry their fruits until late in July.

The earliest varieties are, as a rule, of inferior quality, not having the rich flavor possessed by some of the later sorts.

Occasionally an early variety of satisfactory quality is encountered. The very best avocados, in point of flavor, are the midseason and late sorts, when they have been allowed to hang on the tree three or four months after reaching maturity.

#### Picking, Ripening, and Marketing the Fruit.

When is an avocado ripe? Because of the fact that the fruit does not soften while it remains on the tree, not, in the case of green-fruited varieties, change its color appreciably upon maturing, it is often difficult to determine when it is ready to be picked. Among the Guatemalans there is a rule covering this point, which, if experience proves it will hold good in the United States, may be useful to avocado growers. The earliest moment at which avocados may be picked is when the tree has come into full bloom. At this time they are usually mature enough to be of satisfactory flavor, and do not wilt or shrivel on softening, but the flesh becomes of deeper yellow color and much richer flavor if the fruit is allowed to remain on the tree two to four months longer. T

In the case of purple varieties, there is another indication of maturity. When immature, the fruits are green in color, and only assume a purple shade on approaching maturity. At the first appearance of this purple color they are considered ready for picking, but are not at their best until the color has become deep and pronounced over the entire fruit.

In order to supply the markets of Guatemala City during October, November and December many fruits are picked in Antigua while still immature. On softening, these fruits wilt and often

shrivel around the stem end, while the flavor is sweetish, lacking in richness, and at times almost unpalatable. Thousands of these immature fruits are picked every year. This practice is one which must be guarded against in the United States. Unless evidences of wilting are present, the purchaser, even though he be familiar with avocados, cannot distinguish with certainty an immature fruit from a mature one solely by examining its exterior. The only exceptions are those varieties known to change color on ripening.

The methods of picking employed in Guatemala are primitive, and can offer nothing but negative suggestions to North American orchardists. Frequently the fruits are knocked from the tree with a club thrown by a person standing on the ground, or they may be broken off with a long bamboo pole, and allowed to fall to the ground. It is fortunate that the avocado can stand such severe treatment without serious injury.

When the fruit must be carried several miles to market it is usually shipped as soon after picking as possible, since it would be impossible for the Guatemalans, with only the most primitive means of transportation in many cases, to ship it without bruising if it had commenced to soften. The commonest means of transportation, in regions remote from the railway, are ox carts, pack-animals, and Indian cargadores, men who carry on their backs a load of about 150 pounds.

When picked for marketing in the immediate vicinity, the fruits are ripened in the house and carried into the plaza on market day in a fully ripened condition.

It is almost universally believed in Guatemala that avocados must be picked when the moon is full. If not, it is believed that

they do not ripen evenly, one end remaining hard after the other is soft and ready for eating. Many growers will refuse to pick an avocado if the moon is not in the right phase.

Ripening is commonly effected by placing the fruits among straw, litter, pine needles or leaves in large wooden boxes, which are kept in a warm place. Even when the fruits are from the same tree, however, they do not all ripen at the same time, hence the box is gone over every day or two and the ripe ones are picked out. The time required for ripening is three to ten days, fully mature fruits commonly requiring five or six days. Much depends on how warm the fruits are kept.

If ripened in a moist place, the fruits often develop rot, fungus spores probably getting a foothold through bruises or injuries to the skin, the result of careless picking. If ripened in the sun, the fruits commonly soften on one side while remaining hard on the other. If ripened in a very cool place, they take a long time to soften. In order to keep them warm they are sometimes placed upon the rafters in the Indians' huts, directly over the fireplace. Here the smoke and heat reach them very effectively.

In the larger cities of Guatemala, avocados are sold in the public markets by all the fruit dealers, and throughout the city in the small tiendas or shops which deal in foodstuffs. In the smaller villages, the Indian women bring in small baskets of avocados on the regular market days, which are commonly Thursday and Sunday. In the cities, where avocados are sometimes brought from great distances, single fruits sell from two reales to four reales each, or the equivalent of  $5/8$  to  $1-1/4$  cents; in the villages the price is rarely more than two reales. It may truth-



fully be said that when avocados are sold in Guatemala at more than one cent each, they are very high in price.

#### The Fruit.

The character of the fruit is subject to nearly as much variation in the Guatemalan race as it is in the West Indian and Mexican. It is impossible, in fact, to find two seedlings whose fruits are identical in every respect. In order to present in detail the range of variation which has been encountered in Guatemala, it is well to discuss each of the important fruit characters separately.

Form. In the primitive or semi-wild state, avocados of the Guatemalan race seem to be more or less round in form. This has been mentioned in an earlier paragraph. Under cultivation, a variety of shapes are encountered, ranging from oblate through spherical, broadly oval, obovoid, elliptical, pyriform, and slender pyriform to slender, almost oblong. The majority of small fruits are round, while among the large fruits oval and pyriform are the prevailing shapes. The largest ones found were pyriform.

Considering the fruits of medium size, which constitute the vast majority of those seen in the markets, round and pyriform are the two predominant shapes. In the Alta Verapaz there are a good many more round fruits than pyriform ones, while in Antigua oval and pyriform are the most common.

Size. The smallest variety seen in Guatemala weighed three ounces, while the largest weighed three pounds. Between these two extremes there are many weighing eight to 16 ounces, and quite a few from 16 to 24 ounces. Avocados weighing less than six

ounces are not common in cultivation, but trees growing in abandoned clearings or by the roadside frequently produce fruits weighing no more than four or five. The majority of fruits seen in the markets weigh from 10 to 14 ounces. Varieties weighing more than 24 ounces are very rare.

In some sections of the country large varieties are unknown. In the Senahú district of the Alta Verapaz, for example, no fruits were seen which weighed more than 10 ounces.

In Antigua, in Amatitlán, and in the vicinity of Guatemala City, on the other hand, large varieties are comparatively common.

To the average Guatemalan, the value of an avocado depends mainly upon its size. The largest fruits are the most highly prized, even though they may have very large seeds. The quality of the flesh, however, is justly given much consideration. If a tree produces large fruits of good quality it usually gains a local reputation.

Surface. The rough surface which is often considered typical of the Guatemalan race occurs almost invariably in small, half-wild fruits, but in the large varieties found in the coffee fincas of Antigua and in other regions the surface is often quite smooth. It must not be assumed, therefore, that an avocado which does not have a rough surface is not a Guatemalan.

Roughness of surface is correlated with thickness of skin. The thickest skinned varieties, such as the small round avocados of the Verapaz, are usually quite rough and even warty externally. In medium sized or large varieties the skin is often much thinner, and at the same time smoother on the surface. No avocados were seen in which the skin was very thick and yet smooth on the surface.

and conversely, no thin skinned forms were observed which had very rough surfaces. The surface of the thinner skinned varieties is sometimes pebbled or very slightly roughened, especially around the base of pear-shaped or elongated fruits.

In some smooth-surfaced varieties a decided tendency toward glossiness is notable in the ripe fruit. This adds greatly to its attractiveness, especially when the fruit is purple or maroon in color.

Color. The two common colors of ripe avocados are dull or deep green and deep purple. When immature, all Guatemalan avocados are green in color. As they become mature they may either remain green or turn purple, according to the variety. In all parts of Guatemala these two colors seem to be about equally common.

Besides the common green and purple, variations of these two colors are often seen. A light, yellowish green is not rare, and a bright maroon-purple is sometimes encountered. Very rarely a variety is crimson-maroon, and very rarely one is of such deep purple as to suggest black.

Seedlings grown in California from a tree producing green colored fruits have in some instances produced green, in others purple, fruits. It appears, therefore, that the color of a variety is not necessarily the same as that of its parent.

Skin. While its thickness may vary from a sixteenth to a quarter of an inch, the skin of all Guatemalan avocados is coarsely granular in texture, becoming hard and brittle when it is removed from the fruit and dried. It is always sharply differentiated from the flesh. If the fruit is at the proper stage of

ripeness, the skin can usually be peeled from it as in the banana; in some varieties the skin is so thick, however, that it is not sufficiently pliable to admit of peeling. In the vast majority of cases the skin peels readily if the fruit is fully ripe but still firm, with the flesh the consistency of soft cheese.

Commonly the skin of Guatemalan avocados is about one eighth inch thick. It is often thicker toward the apical end of the fruit than toward the base, but in some varieties the reverse is the case, and in others it is of about the same thickness throughout. The thickest skin seen was that of an avocado from Santa Cruz, Alta Verapaz. This skin measured slightly more than a quarter of an inch in thickness. Many of the Verapaz avocados have thick skins, and as these skins are very brittle and cannot easily be cut with a knife, the common practice is to open an avocado by breaking it in halves. When an attempt is made to cut such fruits, the hard, woody shell breaks indiscriminately, and a smooth cut cannot be made.

The thickest skins are not found at the highest altitudes, as has sometimes been thought. Thickness of skin seems to be in no way correlated with elevation. At 7500 feet there is the same range in thickness as at 4000 or 5000 feet. The thickest skin seen in Guatemala was at an elevation of 4500 feet.

No sharp distinction can be drawn between the thickest skinned and the thinnest skinned varieties of the Guatemalan race. Each is the extreme of variation in this particular character, and there are all intermediate stages between the two. There are no other characters which differentiate the thick skinned and the thin skinned, hence they must both be considered

nothing more than variations of the same race. A classification attempting to consider them as distinct groups is purely artificial.

Flesh. There is a great deal of difference in the color and texture of the flesh among Guatemalan avocados. Assuming that fully ripe specimens are being considered (immature ones are very common in the markets during a certain portion of the year) it will be found that in some the flesh is pale cream-colored, in others it is deep cream-colored, while in a very few it is of a rich, bright yellow color almost identical with that of creamery butter. In a general way, the color of the flesh indicates the flavor, for pale cream-colored varieties are nearly always lacking in richness. They may have, however, a peculiar nuttiness which is very agreeable.

It was noted that a few varieties which possessed deep yellow flesh, and promised at first glance to be of rich flavor, had a pronounced bitter taste which disqualified them for market use. These varieties could be distinguished, it was found, by a peculiar translucence of the flesh, a character which is not possessed by most avocados.

The very best varieties seen in Guatemala have flesh of deep cream-yellow or yellow color, quite opaque, firm, and when fully ripe cutting like soft cheese. The texture is dry, fine grained, and oily.

The remnants of the vascular system, which persist in many avocados in the form of fine, string-like fibers running through the flesh from the stem of the fruit to the base of the seed, are rarely encountered in Guatemalan avocados. The position of

these fibers can frequently be traced by slight discolorations in the flesh, but the presence of stringy fibers, which are often noticeable in the other ~~varieties~~ <sup>races</sup>, especially in the Mexican, was not noted in Guatemala among fruits of the Guatemalan race. Many varieties were found in which there was not even the slightest discoloration of the flesh. Those in which there is a slight discoloration are just as good for eating, but it must be acknowledged that they are not equal in appearance to those with perfectly clear flesh, and hence are less valuable commercially.

The percentage of Guatemalan avocados which have deep yellow flesh, free from all discoloration, is small. ~~The majority~~<sup>Many</sup> have cream colored flesh, oftentimes somewhat watery in texture. This is correlated with poor flavor and quality. No variety with pale, watery flesh has been found to be of excellent quality.

Flavor and Quality. These two closely related characters must be considered the most important of all, since an avocado of poor quality is undesirable, no matter how attractive its appearance may be. Fortunately, the best of the Guatemalan avocados, not only present an attractive exterior, but are nowhere excelled in texture and flavor of flesh.

The subtle differences which distinguish the flavors of many varieties are impossible of description. Inferior varieties, of which there are many, lack richness and may even have a rank or bitter flavor which is disagreeable. They may be watery and sweetish, especially if picked before fully mature. The best varieties, on the other hand, are characterized by a delicate richness which is highly pleasing to the palate. When combined

with a smooth, fine grained flesh of attractive appearance, the result is a variety of excellent quality. Many such varieties are found in Guatemala, yet they do not constitute more than a small percentage of the total number of trees. The proportion of good fruits varies in different localities; in some it is difficult to find a single one of really good quality; in others, such as Antigua and San Cristóbal Verapaz, as many as ten percent of the trees examined may be quite satisfactory in this respect.

Seed. The size of the seed and its condition in the seed cavity are the two points which interest horticulturists. In regard to the latter, it may be said that, with a single exception, all the avocados of the Guatemala<sup>n</sup> race which were examined had seeds which fit snugly in their cavities, with both seed coats adhering closely to the cotyledons. The exception noted was a variety from Amatitlán, in which the seed was loose in the cavity, as it often is in the West Indian race. Possibly this was not a true Guatemalan variety.

The size of the seed is commonly larger, than proportion to the size of the fruit, than is considered desirable by North American avocado growers. This defect, in fact, disqualifies more of the varieties than any other. Round or oblate varieties are especially likely to have large seeds, but in an occasional one the seed is medium sized or even small. It must not be assumed, as has sometimes been done, that every round avocado has a large seed. Until an examination has been made, however, a large seed may be expected.

Pyriform and elongated fruits are not so likely to have

objectionably large seeds as are round fruits, yet in many instances they do so. The proportion of such fruits with comparatively small seeds is not large.

The best means of judging the size of the seed is by comparing its weight with that of the entire fruit. If it is not over 10 percent that of the whole fruit it may be considered that the seed is ~~desirably~~ small; if it is 15 percent it is not objectionably large, but if it is 20 percent or more it is undesirably so.

The shape of the seed conforms to that of the fruit; oblate varieties have round or oblate seeds; round varieties the same; pyriform and oval varieties have ovoid or conical seeds. The great extremes in seed form which are found in the Mexican race are not seen in the Guatemalan, the range being from oblate to conical. The cotyledons are always smooth or nearly so, differing in this respect from those of the West Indian race, which are often rough and warty toward the apex.

#### Climatic Conditions in the Principal Avocado Regions.

Climatic conditions are by no means uniform throughout that portion of the Guatemalan highlands in which avocados are grown. Differences of elevation, the proximity of mountain ranges which interfere with the passage of moisture-bearing clouds, the presence of large bodies of water in the immediate vicinity, and many other factors are responsible for local variations in temperature and rainfall.

Antigua may be taken as one of the most interesting avocado regions of the republic. As has already been stated,



this town lies in a small valley, protected on the north, east and west by towering volcanos and high hills, while to the south there is an opening through which warm breezes enter from the Pacific ocean. This region is not a cold one, as shown by the presence of coffee plantations, and even more definitely by magnificent royal palms (Oreodoxa regia HBK) reaching 40 feet or more in height. As every one knows, the royal palm is not a species which withstands much frost.

Lacking meteorological observations, the temperature and rainfall of Guatemala <sup>City</sup> may be taken as offering a very close approximation to those of Antigua, since the two towns are at practically the same level, and not more than 15 miles apart, in a direct line. According to the observations of the Laboratorio Quimico Central in Guatemala City, the mean (average) maximum and minimum temperatures during each month of the year were the following in 1902:

January	72.1	50.9	F.
February	78.9	55.5	
March	82	55.7	
April	82.9	57.3	
May	81.3	60	
June	82	60	
July	78.9	59.7	
August	79.8	59.1	
September	78	68.2	
October	76.4	59.7	
November	75.7	57.5	
December	72.6	54.8	

The mean temperature for the entire year (1902) was 65.3, as opposed to a mean temperature of 65.1 for the year 1901. The highest temperature recorded during the year was 90.3, on the 4th day of April; the lowest temperature was 42, on the 1st day of January.

The above table, it must be remembered, contains mean temperatures. The absolute maxima and minima during the twelve months of the year are shown in the following table. The year under consideration is 1906:

January	83 F.	47 F.
February	88	49
March	90	48
April	89	50
May	92	52
June	92	58
July	85	58
August	83	57
September	86	59
October	82	53
November	78	50
December	82	41

The lowest temperature recorded at Guatemala City by the Laboratorio Químico Central during the past 15 years is 39 F.

As will easily be deduced from the above tables, the climate of this region is notable for the very limited range in temperature. The minima are not so low as in either California or Florida, nor the maxima nearly so high as in California.

The total amount of rainfall which fell annually in Guatemala City during ten years was as follows:

1894	41.13 inches
1895	38.07
1896	45.64
1897	51.36
1898	56.07
1899	41.57
1900	60.59
1901	52.06
1902	52.32

From these figures it will be noted that the rainfall is considerably greater than in the avocado growing districts of California, closely approaching the rainfall of south Florida.

The distribution of the rainfall during the twelve months of the year is also of interest. The following table shows the number of rainy days and the total precipitation during each month at Guatemala City:

<u>Month</u>	1915		1916	
	rainy days	precip.	rainy days	precip.
January	0	0.0	1	0.03 ins
February	1.	0.01	3	0.20
March	10	2.36	2	0.02
April	1	0.25	10	2.13
May	9	3.38	19	8.76
June	22	12.83	20	8.14
July	19	10.88	25	10.81
August	22	11.99	25	10.56
September	20	7.76	24	13.24
October	15	4.02	13	5.01
November	6	0.97	6	0.58
December	<u>3</u>	<u>0.11</u>	<u>0</u>	<u>0.0</u>
TOTAL	128	54.56	148	59.48

Most of the precipitation in this region occurs during the months of May to October, inclusive. Beginning with the first of the year, January is quite dry, there being nothing more than a light shower at most. February and March are about the same, but toward the end of March there are sometimes a few good showers. April is usually dry, and the heat becomes most intense in this month. In May the rainy season <sup>Commences.</sup> ~~sets in~~. Coincident with the first good rains comes a change in tem-

perature, the hot weather being dispelled not to return until the following year. The rainfall during June, July, August, and September is heavy. Toward the middle of October the rains cease almost suddenly.

The following notes on the climate of this region, taken from "La America Central Ante La Historia", by Antonio Batres Jauregui, are of interest in connection with this study:

"The temperature of the Capital of Guatemala is mild, with the well-marked characteristics of the intertropical regions. In 1797 there was a severe drought in all Central America, causing sickness and famine, and being followed in the south by a terrible plague of locusts. In 1802 the same disaster was repeated. In 1803 the rains commenced in March and ended in July, being followed by a terrible drought. In 1826 the extreme heat caused immense losses in Guatemala. In 1861 excessive rains resulted in very injurious floods. In 1864 extraordinarily strong north winds blew during January and February. In 1869 Quezaltenango suffered a disastrous flood. After three years of scanty rainfall, a plague of locusts overtook the country, until the present year (1915), when it seems to be disappearing, due to the heavy rainfall we have had. The seasons have varied somewhat, the weather occasionally being hot in November and December, and cold in February and March, contrary to the usual sequence. The minimum temperature is ordinarily 46 F., the maximum 82, and the mean 64. On the 24th of December, 1856, it went down to 39, and as low as 37 on the 29th of January 1863; but these are unusual cold spells, produced by northeast winds."

Turning now to a consideration of the conditions in other parts of the republic, the Alta Verapaz is one of the most interesting and important regions. Here the range of temperature is even less than at Guatemala City, and the rainfall is much greater. Observations of the temperature at San Cristóbal, the most important center of avocado culture in the Verapaz, are not available; lacking them, data from Cobán may be taken as offering a close approximation, since Cobán and San Cristóbal are at approximately the same elevation and but a few miles distant from each other. The following figures, covering a period of nine years (1892 to 1900) show the mean or average maximum and minimum during each month of the year:<sup>1</sup>

<u>Month</u>	<u>Mean Max.</u>	<u>Mean Min.</u>
January	73 F.	52 F.
February	75	52
March	77	53
April	78	55
May	79	58
June	77	60
July	76	59
August	77	59
September	77	60
October	75	59
November	72	56
December	75	53

The rainfall and the number of rainy days during each month at Cobán, averaged for a period of ten years, are shown in the following table:

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<sup>1</sup> The tables showing temperature and rainfall at Cobán, and rainfall at Senahá and San Cristóbal, are taken from "Die Alta Verapaz", by Dr. Karl Sapper (Mittheilungen der Geographischen Gesellschaft in Hamburg, Bd. XVII, 1902).

<u>Month</u>	<u>Rainy days</u>	<u>Precipitation</u>
January	13. 5	5. 18 ins
February	10. 1	4. 36
March	9. 0	4. 09
April	9. 5	3. 39
May	16. 2	8. 03
June	22. 3	11. 03
July	24. 9	11. 31
August	22. 3	8. 50
September	23. 1	9. 82
October	23. 1	13. 09
November	20. 5	9. 02
December	17. 3	6. 78
TOTAL	211. 8	94. 60

The rainfall at San Cristóbal is slightly less than at Cobán. Few figures are available, but the following observations for the year 1900 may be compared with the figures given above for Cobán:

<u>Month</u>	<u>Precipitation</u>
January	1.01 ins.
February	1.48
March	1.87
April	3.68
May	9.04
June	10.35
July	19.34
August	7.48
September	12.71
October	7.52
November	4.05
December	1.79
TOTAL	80.34

San Cristóbal lies in the western part of the department of Alta Verapaz. In the eastern part the rainfall is much heavier than at Cobán or San Cristóbal. Since the town of Senahú has been mentioned several times in this bulletin, it may be worth while to present a table showing the average rainfall in that region during a period of two years:

<u>Month</u>	<u>Precipitation</u>
January	5.77 ins.
February	2.30
March	2.57
April	4.17
May	19.85
June	30.61
July	28.62
August	19.82
September	17.82
October	16.88
November	7.95
December	5.88
TOTAL	<u>165.24 ins.</u>

It is in the Senahú region that the avocado grows almost spontaneously, springing up everywhere from seeds dropped by the Indians. The appearance of the trees, however, is not so healthy and vigorous as it is in San Cristóbal, where the rainfall is approximately half as great.

The distribution of rainfall in the Verapaz seems to be less regular than it is in the vicinity of Guatemala City, at least during the first four months of the year. The rainy season in Guatemala City is well defined and nearly the same every year; the inhabitants are accustomed to expect the first heavy rains about the 15th of May, and the last ones about the 15th of October. In the Verapaz the "dry season", January to April, is sometimes characterised by a considerable amount of precipitation every month; in other instances there is almost no precipitation for one or more months.

The climate of San Cristóbal, besides being dryer than that of Senahú, is characterised by a greater range of temperature. It is considerably warmer during the first four months of the year (the dry season), and the minima are slightly lower, because of the greater elevation of San Cristóbal.

In neither of these regions, however, are freezing temperatures ever experienced.

Purulá (5150 feet) in the department of Baja Verapaz, is considerably cooler than San Cristóbal; much more so, in fact, than the comparatively slight difference in elevation would lead one to expect. It is considered by natives to lie within the "tierra fría" or cold zone, because it grows many peaches, quinces, and apples. It lies in a small mountain valley opening to the west. Judging from several visits to the spot during the coldest portion of the year, it experiences lower temperatures than Antigua, but the plants which are grown indicate that it cannot ordinarily be subjected to greater cold than 35 to 40 F. Clouds sweep up the valley and hang over the town much of the time, making it a very moist spot which receives much less sunshine than Antigua or Guatemala City. It never becomes very warm.

Returning across the Sierra de las Minas, which divides the moist Verapaz from the comparatively dry plateau of central Guatemala, the town of Amatitlán (3900 feet) comes up for consideration. This town lies but a few miles from Antigua, but is separated by the broad slopes of the Volcan de Agua. Its situation is such as to give it a warm climate, since it is in the upper end of a valley opening toward the Pacific Ocean, and is in close proximity to the lake of Amatitlán, a body of water ten miles or more in length. The presence of ~~the~~ soursop (Annona muricata) and the mamey (Mammea americana) in Amatitlan show that it must have a warmer climate than in usual



in Guatemala at this elevation. Its rainfall closely approximates that of Guatemala City.

Panajachél, westward from Guatemala City some 60 miles, has already been mentioned as enjoying a particularly favorable situation. Its climate seems to be slightly warmer than that of Antigua, though its elevation is practically the same. Its rainfall is in general that of Antigua and Guatemala City.

Momostenango (7400 feet), the highest point at which avocados are extensively grown in Guatemala, has a cooler climate than any of the other regions which have been considered, but it is not so cold as most towns in Guatemala which lie at this elevation, due to its protected situation. Little is known regarding its temperatures, since it is a remote spot. A mango tree of good size was seen at this place. It is safe, therefore, to assume that it does not get very cold.

Going to the other extreme, Mazatenango (1150 feet), on the west coast of Guatemala, and Chamá (1000 feet) in the Alta Verapaz, are the lowest situations at which Guatemalan avocados were seen in bearing. Both have hot climates, typically those of tropical lowlands, with no cold weather whatever and a heavy rainfall. It is generally believed that the Guatemalan race does not succeed at low elevations. The trees seem to grow well, but they are said to fruit very sparingly. Judging from the very few instances in which trees of this race were found at elevations lower than 2500 feet, it seems that there must be some basis for this belief.

Hardiness of the Guatemalan Avocado.

Severe frosts are not experienced in Guatemala at elevations lower than 7000 feet. In searching for avocados of the Guatemalan race likely to prove unusually hardy in the United States it is necessary, therefore, to ascend to 8000 or 8500 feet, at which altitude the winters are sufficiently cold to injure varieties not particularly frost-resistant, thus bringing to light the hardiest.

At 5000 feet in Guatemala avocados are subjected to a mild, and at times cool, climate, but never enough frost to test severely their hardiness. At 7500 feet, the upper limit of orange culture, severe frosts are probably occasional, but no meteorological data are available, to show the minimum temperatures experienced. It seems very doubtful if the temperature goes as low at this elevation as it does occasionally in the orange-growing districts of California and Florida.

Above 8000 feet it is cold enough to freeze large trees of the Guatemalan race, and trees at this elevation which show no frost injury after a hard winter must either be more resistant than the average, or grown in a protected situation.

It is unfortunate that there are no records of minimum temperatures at elevations of 8000 or 8500 feet in Guatemala, for they would show how much cold avocados have withstood without serious injury. In general, nothing was found to indicate that certain strains of the Guatemalan race are particularly hardy, or that certain individual trees appear to be characterized by greatly superior frost-resistance. One tree was found in Totonicapan (8500 feet) which gave evidence of being somewhat harder than the average, and on this evidence budwood

was obtained for introduction into the United States.

True it is that the avocado is cultivated in Guatemala a full thousand feet above the zone in which citrus fruits,-- even the orange,-- are grown. It must not be assumed, however, that this indicates greater hardiness in the avocado than in the orange. Experience in the United States does not lead to any such conclusion, and while the varieties found at high elevations in Guatemala may be slightly hardier than those at present grown in the United States, it may also be true that the Guatemalans have not pushed orange culture to its uppermost limit. It is the custom in California and Florida to grow tropical fruits right up against the frost line, so to speak,-- they are planted where protection is necessary in winter, and where severe losses are occasionally experienced from an unusual degree of cold. In Guatemala conditions are different. If the orange, when left to care for itself, did not succeed at 7000 feet, it would die off, and its culture would be restricted to lower levels. With attention and slight protection it might succeed far above 7000 feet, but since this attention and this protection are lacking in Guatemala, it would not be found far above 7000 feet by the traveler who chanced to pass through the country.

The question of hardiness, in the avocado, seems to depend to a much greater degree upon race than upon variety. No variety of the West Indian race has yet been found which is nearly as hardy as many of the Guatemalan, and no variety of the Guatemalan has been discovered which will stand as much cold as the

Chappelow or other varieties of the Mexican race. For this reason the proper classification of varieties is essential. Within the race there doubtless is a certain variation in hardiness, but experience indicates that the amount of variation is not so great, expressed in degrees of temperature, as the difference in the average hardiness of the three races now known to horticulture.

#### Enemies of the Avocado.

Everything considered, the avocados of Guatemala are less subject to the attacks of insect and fungous parasites than would be expected. Citrus trees in all parts of the highlands are commonly infested with scale insects (notably the purple scale, Lepidosaphes beckii) to a severe degree. Avocados in the same region are comparatively free from serious parasites. This is not saying that the avocado does not have insect enemies; it is merely stating that the tree seems to be less seriously affected by parasitic insects than are citrus trees under the same environmental conditions.

There is one insect which stands out above all others observed in Guatemala, both for the damage which it occasions and the apparent difficulty of controlling it. This is a small brownish gray moth, Stenoma sp., whose larvae are sometimes found in mature avocados purchased in the markets.

No external evidence of its presence is noticeable (at least to the unskilled observer), but on cutting the fruit in halves the seed is found to be more or less riddled with large round tunnels, and one to ten or more fat, wriggling, white larvae greet the eye. While the larvae are rarely seen working

in the flesh itself, they often burrow along the outside of the seed, in contact with the flesh, discoloring the latter with their brownish, powdery castings. In some specimens examined the seed had been so thoroughly honeycombed that it was almost reduced to powder.

Needless to state, a fruit attacked by this insect is rendered practically unfit for use. Even though the flesh itself may not have been damaged, the sight of the white larvae and their tunnels in the seed are sufficient to nauseate any housewife. The widely known Mediterranean fruit fly (Ceratitis capitata) produces no more disgusting results than this insect.

The distribution of this moth in Guatemala seems to be wide. It was found from El Rancho on the eastern slope to Mazatanango on the western, and from Antigua in central Guatemala to the Verapaz district in the north. The lowest elevation at which it was found was about 1000 feet, the highest 5300. It was seen most abundantly at Panajachél, where the majority of fruits offered in the market in early January, 1917, were found to be infested. Little is known of its life history. The larva is about one half inch long, with a brown head and 12 white segments composing its body. After tunneling in the fruit it works out through the skin and drops to the ground, where it pupates, the mature moth emerging some days later. Nothing has been learned in regard to the habits of the adult.

Next to this insect, which easily outranks all others in destructiveness, as far as was observed during the course of a year's work in Guatemala, one of the most troublesome pests is

the gallfly (Psyllidae) which is abundant in the Antigua region, and fairly common in several others. Probably more than one species is represented. These insects produce elongated conical galls which stand erect on the upper surfaces of the leaves. They are sometimes so thickly placed as scarcely to leave space for even one more. Unquestionably they must have an injurious effect upon the tree.

The avocado weevil, Heilipus lauri Boh., whose presence in Mexico has been the chief motive for the quarantine order prohibiting the importation of avocado seed from that country into the United States, was not observed in Guatemala, nor were any specimens found among more than 25,000 seeds shipped from Guatemala to Washington in 1916 and 1917. Two other weevils, however, were found in these shipments, one of them, the broad nosed grain weevil (Caulophilus latinasus Say) is already known in the United States. According to Chittenden (Bulletin 96, pt II, Bureau of Entomology) it appears to be permanently established in this country as an enemy of dried cereals and other food materials. In Guatemala it was observed to be exceedingly abundant in avocado seeds which had remained for some days upon the ground beneath the trees, and it was also common among seeds obtained from the markets, where they had been stored for two or three weeks. It bores in the seeds, leaving small tunnels.

In the same shipments of avocado seed four or five larvae of another weevil were found. According to E.R. Sasser, Chief Inspector of the Federal Horticultural Board, this appears to be an undescribed species of Conotrachelus. The injury which it occasions, according to Mr. Sasser, is similar to that

caused by the avocado weevil, and he judges that the species may be fully as destructive as the latter. A search for seeds attacked by this insect in Guatemala failed to bring any to light, hence it must be considered comparatively rare.

Numerous scale insects attack the avocado in Guatemala, though severe infestations are very rare. At Almolonga, near Quezaltenango, a tree was found rather badly infested with Pulvinaria floccifera West. Other scale insects which occur on the avocado in various parts of the country are the following: Aspidiotus lataniae, A. subsimilis, Chrysomphalus dictyospermi, C. perseae, C. personatus (masked scale), C. scutiformis, Diaspis boisduvalii, and Pseudoparlatoria ostreata. These were all determined by the officers of the Federal Horticultural Board, from material sent to Washington.

While none of the scale insects mentioned is very destructive in Guatemala, their introduction into the avocado groves of California and Florida must be strictly guarded against. Under the different environmental conditions which exist in those States, they might quickly become much more serious than they are today in Guatemala.

Of parasitic fungi three species were found on material sent to Washington from Guatemala. One of these, Colletotrichum gloeosporioides, is already well known in California and Florida, especially in the latter state, where it is particularly injurious to the mango. The two other species are Diplodia perseana and an undetermined species of Fusarium.

## THE WEST INDIAN RACE OF AVOCADOS IN GUATEMALA.

It is safe to state that 95 percent of all the avocados in Guatemala belong to the Guatemalan race. From this it will readily be seen that the West Indian race is of little importance. Its cultivation is limited to the lowlands, the highest point at which trees were seen being near Sanarate, Department of Guatemala, at an elevation of about 2500 feet. On the Pacific slope, a few trees were seen at Mazatenango, Coatepeque, and Ayutla. Doubtless they are to be found scattered here and there all along the coastal plain which stretches from Mexico to El Salvador. On the Atlantic slope occasional trees were seen in the Motagua valley from El Rancho down to the sea; in the Polochic valley they were seen at Panzós. The best varieties encountered were at Chiquimula; while of good quality, they were not equal to those grown in Florida and Cuba. Guatemala does not appear to possess any varieties of this race worthy of introduction into other countries.

In the Motagua valley trees of this race flower in February and mature their fruits from the latter part of June until the end of August. Both the flowering and the fruiting season correspond very closely, therefore, to those of the West Indian race in Florida.

The quantity of fruit produced is by no means sufficient to supply the markets of lowland towns, hence fruits of the Guatemalan race, brought from the highlands, are frequently seen in these towns. It is noteworthy, however, that the



avocado is not consumed so extensively in the lowlands as it is in the highlands; as previously stated, it is a staple article of diet in the latter, while in the lowlands its consumption is quite limited.

It is strange that the West Indian race is never seen in such towns as Amatitlán and Antigua. Experience in Florida indicates that the trees will withstand more cold than is experienced in either of these regions, and both of them are only a few miles from the tierra caliente where the West Indian race is grown. It must be assumed that during the long period in which both races have been grown in Guatemala each has become restricted to the zone in which it is most successful. The West Indian race might succeed in Antigua, but by nature it is much better adapted to the lowlands. The Guatemalan race, as has been noted, is occasionally seen at low elevations, and in some instances may be reasonably successful there; but only in the cooler climate of the highlands does it appear to be really at home.

#### THE MEXICAN RACE OF AVOCADOS IN GUATEMALA.

Only two trees of this race were seen in Guatemala, one growing by the roadside near Santa Maria de Jesus (6900 feet) in the department of Sacatepequez, and the other at Chimaltenango (6000 feet). In the latter place the Cakchiquel Indians have a name for this race, matuloh, distinguishing it from the Guatemalan race, which is called simply oh. Conversation with the Indians brought out the information that a few trees of this race were known in the vicinity of Tecpan (7500 feet)

and Chimaltenango, and also on the slopes of the Volcan de Agua, but at best the race must be considered exceedingly rare in Guatemala.

The fruits of the two trees examined were primitive in character,--broadly obovoid in form and scarcely two inches long. The pronounced anise scent possessed by the foliage, the heavy pubescence on the flowers, and the membranous skin of the fruit left no doubt that they were of the true Mexican race. It is much easier to distinguish this race from the other two than it is to distinguish between the other two,--Guatemalan and West Indian,--themselves.

Among the Indians, who know this race its fruits seem to be held in very little esteem. This is not strange, in view of the fact that the varieties found in Guatemala are the most primitive imaginable. In the fruits examined the seed was so large that there was scarcely enough flesh to pay for the trouble of eating it.

Choice varieties of this race, such as some of those which have reached the United States from Central and Northern Mexico, would be of great value for cultivation in Guatemala at high elevations, where the Guatemalan race is injured by the cold.

#### THE COYO.

It is strange that a fruit so well known in northern Guatemala as the coyó should have escaped the attention of horticulturists in other countries, but aside from a brief reference to the species by Collins, in his bulletin on the avocado<sup>1</sup>,

1. "The Avocado, A Salad Fruit from the Tropics", Bulletin No.

nothing seems to have been written regarding it.

While the fruit so closely resembles that of the avocado as to deceive one at first glance, the tree is distinct in foliage and flower. The coyó and the avocado are two distinct species of *Persea*.

The coyó is found in Guatemala both wild and cultivated. Like the avocado, it varies greatly in the form and character of its fruit. Most coyós are very inferior in quality, having large seeds and many coarse fibers running through the flesh, but an occasional one is found which has a small seed and flesh quite free from fiber. A coyó of this character is a worthy rival of the best avocados. The flavor is distinct and agreeable. Indeed, it is considered by many people in the Alta Verapaz superior to that of the avocado.

#### Distribution and Common Names.

While adapted to a greater range of elevation than the Guatemalan race of avocados, the coyó is not so widely distributed in Guatemala as the latter. It is grown most extensively in the department of Alta Verapaz. It is frequently met with in the mountains of this part of Guatemala, where it grows among other trees in the forest and has every appearance of being indigenous. It is also common in most of the villages and towns, where it is planted in gardens and dooryards. In San Cristóbal Verapaz it is particularly abundant, there being about as many coyó trees as avocados in the dooryards of the inhabitants.

Directly south of the Verapaz, across the Sierra de las  
 77, Bureau of Plant Industry, 1905.

Minas, it is found in the Motagua valley from El Rancho down to Gualan. At Zacapa and Chiquimula it is well known. With the exception of a single tree at Amatitlán, however, it was not seen on the Pacific slope of Guatemala.

The lowest elevation at which the coyó was found was about 500 feet, the highest 5500. It seems to be quite successful at both these elevations. ~~From this it will be seen that it has a wider range than the Guatemalan avocado, insofar as elevation is concerned.~~

North of the Sierra de Las Minas, in the Verapaz, the species is known as coyó, coyocté, or kiyau. South of the Sierra de las Minas it is called shucte, chucte, or chaucte. It has been stated that the coyó and the coyocté are different fruits; a careful investigation in the Verapaz, however, indicates that they are not specifically distinct. Many Indians who were questioned on the subject were unable to define the difference between the two, and trees which were pointed out as coyó and coyocté proved to be of one and the same species. As far as could be determined, the difference in nomenclature is as follows: trees which are planted in dooryards or gardens are always called coyó, while those growing wild in the mountains are sometimes called coyocté. The coyocté or wild trees usually produce very poor fruit.

#### The Coyó Tree.

It is not difficult to distinguish the coyó tree from the avocado. In both habit and character of growth it is quite

distinct. While the tree is about the same size as that of the avocado, the branches have a tendency to extend horizontally from the trunk and the young branchlets are stouter and stiffer than in the avocado, with the leaves clustered toward the ends of ~~each~~ <sup>the</sup> growths. The tips of the branchlets as well as the lower surfaces of the leaves are covered with a heavy brown pubescence, not seen in the avocado. The leaves differ somewhat from those of the avocado in form, being broader and less pointed at the apex, as a rule.

The coyó flowers during the same season as the avocado, which is, in the Verapaz, February to April. As pointed out by Collins, however, it matures its fruit in less time than the Guatemalan avocado, hence coyós are all gone before avocados appear in the market. The flowers of the coyó are borne on shorter and stouter racemes than those of the avocado, and are easily distinguished from the latter by the blotch of deep orange or red at the base of each segment of the perianth (the perianth segments have the appearance of petals, but as the corolla is absent in this species they cannot properly be called by this name). All parts of the inflorescence are covered with a heavy pubescence.

When grown from seed, the coyó seems to come into bearing somewhat later than the avocado. While it was impossible to obtain accurate information on this subject, it is the general opinion among Guatemalans that the trees commence to bear when 8 to 10 years old. As with the avocado, all coyó trees in Guatemala are seedlings, hence nothing is known concerning the behavior of budded or grafted trees.

Unquestionably the trees live to great age. Old specimens, however, do not seem to bear so well as younger ones, i.e., those between 15 and 30 years of age.

#### The Coyó Crop.

It is noticeable that the coyó does not, as a general thing, produce such heavy crops as the avocado. For this reason coyós, even in a region like San Cristóbal Verapaz, where ~~there are~~ <sup>the trees</sup> ~~are so plentiful as those of the avocado,~~ ~~about as many trees as there are avocados,~~ are never so abundant in the market as avocados, and consequently never so cheap. It was noticed, however, that an occasional tree produced very heavily. From this it can be assumed that it will be possible to obtain varieties of satisfactory productiveness for cultivation in the United States.

In the Motagua valley, at elevations of 500 to 1500 feet, the coyó ripens from the latter part of June until August, the season thus corresponding to that of the West Indian race of avocados. In the Alta Verapaz, at elevations of 2000 to 5000 feet, the season is from July to October, with a few fruits available until the first of December. As in the avocado, there is a certain amount of variation in the season of ripening among different trees.

When mature, the fruits are picked and placed in the house to ripen. The ripening process requires less time than it does with avocados, three or four days usually sufficing. When the fruits yield to pressure of the thumb they are ready for eating, and are carried to the market for sale. In San Cristóbal

Verapaz they bring one to two reales each (one fifth to two fifths of a cent), while avocados rarely sell in the same town for more than a real, and often two for a real.

#### The Fruit.

A good coyó strongly resembles in appearance a medium sized avocado of the West Indian race, such as many of those grown in Florida and Cuba. The color of the flesh, however, easily distinguishes it from all avocados.

In form the majority of coyós are slender and bottlenecked, with a slender neck sometimes three inches long. The best varieties are broadly pyriform, somewhat like the Pollock avocado in shape. A few obovoid varieties were seen, but no round ones. Irregularly shaped and deformed fruits are much more common than they are in the avocado.

The size varies from about six ounces to more than two pounds. In the Verapaz the commonest size is six to 10 ounces. The best varieties in this region weigh 16 to 20 ounces. At El Rancho one variety was seen which weighed about two pounds. The 16 to 20 ounce fruits seem to be the most desirable.

Most coyós are light green in color when ripe, with numerous large yellowish green dots. Sometimes a bronze colored fruit is seen, or a deep brown one. The deep purple color found in the avocado has not been observed to occur in the coyó.

The skin is thick, but soft and pliable, resembling in texture the skin of the West Indian avocados, but approaching in thickness the thickest skinned varieties of the Guatemalan race. At the proper stage of ripeness, the skin peels readily

from the flesh.

The surface, like the texture of the flesh, is similar to that of the West Indian avocados. It is commonly slightly undulating, but never warty or very rough.

The color of the flesh, as has already been noted, is distinct from that of all avocados. It varies from brownish white to pale brown. In the best varieties it is brownish white, and free from fiber, but in 90 percent of the coyós seen in the Verapaz there are coarse, tough fibers running through the flesh from the stem end of the fruit to the base of the seed. When squeezed, a milky juice exudes from the flesh. The latter is commonly of about the same texture as the flesh of a good avocado. It is coarser in many of the inferior varieties.

In flavor the coyó is quite distinct from all avocados at present known in the United States. It has a peculiar and very agreeable richness similar to that of the avocado, but is characterized by a well marked flavor of ripe coconut. Good coyós are exceedingly rich in flavor, and for this reason are preferred by many Indians, as well as some of the American and European coffee planters of the Verapaz, to the best avocados. The coyó is eaten in the same way as the avocado.

The quality of 90 percent of the coyós seen in Guatemala is poor, due to the unattractive color of the flesh and the presence of objectionable fibers. In a few varieties, however, the quality is very good. Two grees were found in the Verapaz whose fruits would stand comparison with the best avocados.

As a rule, the seed is proportionately larger in the coyó than in the Guatemalan race of avocados. In many coyós the layer



of flesh between the seed and the skin is not one half inch thick. In the best varieties, however, the seed is proportionately no larger than in good avocados. In all the coyós seen in Guatemala the seed was tight in its cavity. The seed coats are much thicker than in the avocado, the outer one being somewhat corky in texture.

The coyó seed is much more perishable than that of the avocado, and can be kept or shipped only with great difficulty. It is quickly killed by drying in the sun. If kept too wet it rots very promptly. It must be kept moist, but not too much so; it was noticed that seeds lying on the ground beneath trees in the Verapaz kept for several weeks in good condition, finally sprouting and sending up a vigorous shoot. Such seeds were in the shade and were moistened practically every day by rain, but the drainage furnished by the fallen leaves upon which they lay, and the exposure to the air, kept them from rotting.

#### Cultural Requirements .

The coyó tree grows under a wide variety of conditions. In the valley of the Motagua, between El Rancho and Gualan, it is found near the banks of streams. There is little rainfall ~~in most of this region~~ *this part of Guatemala*, and the air is exceedingly hot and dry during a large part of the year. The hillsides are covered with typical desert vegetation, cacti, euphorbiads, and thorny leguminous shrubs. Contrasted with these conditions, the upper Polochic valley, in the Alta Verapaz, is a very moist region, with a rainfall of approximately 150 inches per annum.

Like the Guatemalan race of avocados, the coyó is abundant at elevations of 4000 to 5000 feet; unlike the former, it is fairly common in the tierra caliente or hot zone, at elevations of 500 to 1000 feet. Whether it will stand as much cold as the Guatemalan avocado cannot be stated, but everything indicates that it is reasonably hardy.

Judging from its behavior in Guatemala, the coyó ought to be successful in both California and Florida. It grows on soils of various types, from sandy loam, at El Rancho and Zacapa, to heavy clay in some parts of the Verapaz. It withstands the heat of the tropical zone and the cool climate of the subtropical equally well. It is a vigorous, robust tree requiring no more care than the avocado, and apparently subject to the attacks of no more enemies than the latter. The coyó can be recommended as a fruit worthy of attention on the part of horticulturists in the warmest regions of the United States, as well as in the tropics and subtropics generally.

GUATEMALAN AVOCADOS INTRODUCED INTO THE UNITED STATES.

The twenty-three avocados described on the following pages have been introduced into the United States for trial in California and Florida. They were carefully selected from a large number of trees examined in the Guatemalan highlands, especial consideration having been given to characteristics of commercial value. Some of them promise to ripen very early in the season; others are late. Fruits of various shapes and sizes are represented, as well as all the common colors found in Guatemala. The quality of every variety was critically tested, and no variety was included in the collection which did not appear entirely satisfactory in this respect.

In order to distinguish these avocados from varieties originated in the United States, they have been given names taken from one of the Maya dialects. Inasmuch as they come from the Maya territory this may not be inappropriate. Following the name of each variety is the number under which it was collected in Guatemala, these numbers running from one to thirty-six inclusive. It will be noted that several of the numbers are missing; the varieties originally represented by these were found, upon later examination, to have certain defects which disqualified them, and were dropped from the collection before they were introduced into the United States. Following the collection number is the serial number under which the introduction is recorded in the inventory of the Office of Foreign Seed and Plant Introduction.

LAMAT. (No. Three). S.P.I. No. 43476.

A variety combining unusual productiveness with good size, attractive appearance, and good quality of fruit. In addition, it seems to ripen earlier than many other avocados, which suggests it for trial as a winter ripening variety in California. It has no claim to unusual hardiness, since it is grown at an elevation where frosts are not experienced.

The parent tree is growing in the chacara of Angel Samayoa, in the town of Amatitlan (elevation 3872 feet). It stands close to the corner of a small field in which tomatoes and maize are planted annually. The soil is a loose sandy loam, apparently of excellent fertility and considerable depth. The age of the tree is not definitely known, but judging from its size it is probably 6 to 8 years old. It stands about 20 feet high, with an erect crown, extending almost to the ground, about 10 feet broad, and well branched. The trunk is 6 inches thick at the base. The tree shows every indication of being a strong, vigorous grower, as its branches are stout and shapely, and not so brittle as in many weak growing varieties. The budwood furnished by the tree is quite satisfactory; the growths are of suitable length, and the eyes are strong and well developed, showing no tendency to drop at an early date, as they do in some varieties.

During the period in which this tree was under observation, it showed a peculiarity in flowering which was not noticed elsewhere in Guatemala. In November, 1916, flowers were produced and a few fruits set. Since a heavy crop was

produced in 1916 it was thought that the fruits set from the November bloom were all that would be developed during 1917, but in January the tree flowered again and set a very heavy crop of fruit.

The <sup>production</sup> ~~crop~~ produced in 1916 amounted to over 100 fruits, which can be considered a heavy crop when the size of the fruits and the small size of the tree are considered. The crop for 1917 promises to be considerably larger. In 1916 the fruits were practically all picked in November, at which time they were considered by the owner to be mature. Doubtless they would have been much better if left on the tree two or three months longer.

The fruit is broadly oval, quite uniform in shape, with a smooth green surface when ripe. The weight varies from 14 to 20 ounces. The skin is about as thick as in the average variety of the Guatemalan race, which is one-sixteenth inch or slightly more. The flesh is free from fiber, clear, of good texture, and of pleasant flavor. Specimens sampled in November, 1916, were not as rich as would be desired, but it may reasonably be assumed that they would have been much better if they had been left on the tree two or three months longer. Perfectly ripened specimens of this variety have not been tested, hence the quality of this fruit, when at its best, must remain somewhat in doubt until it comes into bearing in the United States. The seed is comparatively small, and always tight in its cavity.

A formal description of the variety follows:

Form uniformly oval; size above medium to large; weight 14 to 18 ounces; at times up to 20 ounces; length  $4\frac{1}{2}$  inches; greatest breadth  $3\frac{1}{8}$  inches; base rounded, with the stem inserted obliquely without depression; stem stout, about 6 inches long; apex rounded, with the stigmatic point to one side and slightly elevated; surface nearly smooth, slightly undulating and sometimes obscurely ribbed, deep green in color, almost glossy, with a few scattering, large, yellowish green dots; skin thick, slightly over  $\frac{1}{16}$  inch at base, nearly  $\frac{1}{8}$  inch at apex, coarsely granular, brittle; flesh cream color, pale green near the skin, of fairly rich flavor and free from fiber or discoloration; quality very good; seed rather small in comparison to the size of the fruit, almost spherical, about  $2\frac{1}{2}$  ounces in weight, with both seed coats adhering closely to the nearly smooth cotyledons, tight in the seed cavity.

KANOLA (No. SIX). S.P.I. No. 43560.

This variety possesses several valuable characteristics. It is the <sup>one of</sup> earliest ~~one~~ found in the Antigua region, commencing to ripen at the end of October. This makes it of particular interest to avocado growers in California, since early ripening varieties are much desired in that state. The tree is exceedingly productive, and the fruit, though small, is of desirable round form, and attractive glossy purple color. The flesh is yellow, free from fiber, and of

rich flavor, while the seed is comparatively small for a fruit of round or oblate form.

The parent tree is growing in the sitio of Victor Garcia, who keeps a small estanco on the road from Antigua to San Antonio Aguas Calientes, just above the church of San Lorenzo del Cobo. The elevation is approximately 5,600 feet. Beneath the tree, which stands on a rather steep hillside, coffee has recently been planted. The soil is a very loose, black, sandy loam, doubtless of volcanic origin. Judging from the crops grown in the vicinity, it must be quite fertile. The age of the tree is not definitely known. Victor Garcia says that it was already of large size when he was a lad, so it may be considered at least 40 years of age, most likely 50 or more. It stands about 35 feet in height, with a spreading but rather open crown 35 feet broad. The trunk is a foot and a half thick at the base. The first branches are about 8 feet above the ground. The young growths are stout, shapely, and vigorous. The indications are that the variety will be a strong grower. The budwood is excellent, having strong, well developed eyes well placed on the round, smooth, clean, young twigs. There is no tendency for the eyes to drop from the young twigs, as there is in some varieties. The wood is not unusually brittle.

Varieties growing at this elevation in Guatemala are not subjected to severe frosts, but should be as hardy as the average of the Guatemalan race.

The flowering season of the parent tree is from the end of October to the first of December. It flowers very profusely.

and in good seasons sets heavy crops of fruit. The crop which ripened at the end of 1916 was enormous. It was impossible to make an accurate count, but a conservative estimate would place the number of fruits at 1,500 to 2,000. After such a heavy crop, it is to be expected that a light crop will follow. Very few fruits <sup>were</sup> ~~are being~~ carried to ripen at the end of 1917. Victor Garcia states that at least a few fruits are always produced; <sup>that</sup> some seasons the crop is small, others it is very heavy, as it was in 1916. This is commonly the case with Guatemalan avocados.

As already stated, the fruits commence to ripen at the end of October. Maturity is indicated by the appearance of a purple blush on one side of the fruit. At this stage it is considered ready for picking, but its flavor is much richer if left on the tree some months longer, until the entire fruit is deep purple in color. Apparently this variety has an unusually long fruiting season, for a few fruits (which had been overlooked in picking) were found still hanging on the tree at the end of April, 1917. As observed during the past harvest, the ripening season appears to be as follows: first fruits maturing at the end of October; majority of crop maturing in November and December, but better if left on the tree until January; a few fruits, at least, remaining on the tree until March and April.

The fruit is uniformly oblate in form, resembling a grapefruit. In size it is small, weighing from 6 to 10 ounces. Under better cultural conditions, however, the weight will



probably go up to 12 ounces. The color when the fruit is fully ripe is deep purple. The surface is pebbled, not distinctly roughened. The skin is of good thickness, hard and brittle. The flesh is deep yellow in color, free from fiber but with slight fiber discoloration (not, however, of an objectionable nature), of fine texture, and rich, oily flavor. The quality can be considered excellent. The seed is round, not large for a fruit of round or oblate form. It is generally found that fruits of this shape have seeds considerably larger in proportion to the size of the fruit than is common in good varieties of pyriform or oval shape. As in nearly all Guatemalan varieties, the seed is quite tight in the cavity.

A formal description of the variety follows:

Form roundish oblate; size small to below medium; weight 6 to 10 ounces; length  $2\frac{3}{4}$  to 3 inches; greatest breadth 3 to  $3\frac{1}{2}$  inches; base truncate, the stem inserted squarely without depression; stem fairly stout, 4 inches long; apex flattened, sometimes slightly oblique; surface pebbled, deep purple in color, sometimes almost glossy, with numerous small yellowish dots; skin  $\frac{1}{16}$  inch thick at basal end of fruit, about  $\frac{1}{8}$  inch thick at apex, separating readily from the flesh, rather finely granular, woody, brittle; flesh deep cream yellow to yellow near the seed, changing to very pale green near the skin, quite free from fiber and with unobjectionable fiber discoloration, firm in texture and of rich, oily flavor; quality excellent; seed small in comparison to size of fruit, oblate, about  $1\frac{1}{2}$  ounces in weight, sometimes excentric, tight in the seed cavity with both seed coats adhering closely.

ISHKAL (NO. SEVEN). S.P.I. NO. 43602.

There are few avocados grown in Guatemala City which are considered to be of excellent quality. This tree is looked upon as one of the very best, and has a considerable reputation locally for the rich flavor of its deep yellow flesh.

The parent tree is growing in the patio of the Masonic building, Callejon Manchen number 4. The elevation here is approximately 4900 feet. Apparently the tree is quite old,-- at least 50 years, and probably nearer 75. It is about 60 feet high, with a trunk more than two feet in diameter at the base, branching about 15 feet from the ground. The crown is erect, dense, with abundant foliage of good color. The budwood is excellent, having well developed eyes which are not inclined to drop and leave a blind bud. ~~Everything is~~ seems to indicate that the variety will be a reasonably strong grower, as the branchlets are long, stout, well formed and vigorous.

Avocados growing at this elevation in Guatemala are not subjected to heavy frosts, but should be as hardy as the average of the Guatemalan race.

The tree did not produce any fruit in 1916, but bore a good crop from 1917 bloom. The great age of the tree, and the unfavorable conditions under which it is growing, seem to have resulted in the fruit becoming small and inferior of late years, according to the story of the caretaker. Specimens examined were not large in size, and had undesirably

large seeds, but under better cultivation the size of the fruit might be increased greatly without the seed becoming any larger. The quality of the fruit is so good, and its reputation so great, that the variety seems worthy of trial in the United States, though it cannot be recommended with as much confidence as many other varieties included in this set.

In productiveness the variety promises to be satisfactory. In season of ripening it is a little earlier than the average, the fruit<sup>s</sup> commencing to mature in January. They are not at their best, however, earlier than March. Some of them will remain on the tree until June or July.

The fruits which have been examined were small, but are said normally to be nearly a pound in weight. In form they are spherical to broadly obovoid. The surface is rough, and deep purple in color. The flesh is deep yellow, clear and free from fiber, and of very rich and pleasant flavor.

The fruit, as produced in 1917, may be described as follows:

Form spherical to obovoid; size small, weight 6 to 8 ounces; length 3 to 3-3/4 inches, greatest breadth 2-3/4 to 3 inches; base rounded to pointed, the stem inserted obliquely without depression; apex slightly flattened obliquely; surface rough, deep purple when ripe, with very few large yellowish dots; skin moderately thick, 1/16 to 1/8 inch, coarsely granular and woody; flesh deep yellow in color, free from fiber discoloration and of very rich and pleasant flavor; quali-

ity excellent; seed large, nearly spherical in form, 1-3/4 to 2 ounces in weight, tight in the seed cavity with both seed coats adhering closely to the smooth cotyledons.

COBAN (NO. EIGHT). S.P.I. NO. 43932.

This variety possesses something of a reputation in Coban as an avocado of unusually fine quality. In addition, it has a small seed and other good characteristics, which combine to make it a promising sort.

The parent tree stands in the sitio of Filadelfo Pineda, in Coban, Department of Alta Verapaz. The elevation is 4,325 feet. The ground beneath the branches is given over to a vegetable garden, with the exception of that to the east side, which is cut off by a tall hedge of chichicaste (Lonasa speciosa). The soil is a heavy clay loam, probably underlain by stiff clay. According to the owner, the tree is 30 or more years of age. It is about 40 feet high, with a dense, dome-shaped crown fully 40 feet broad. The trunk is 18 inches in diameter at the base, branching some 10 feet from the ground. At the present time the tree is badly attacked by several insect pests, and ~~does not appear to be~~ <sup>is</sup> in good condition. It appears normally to be reasonably vigorous in growth, the young branches being somewhat slender but not very brittle. The budwood furnished by the tree is fairly good, the eyes being well developed and showing no tendency to drop at an early age. The twigs are at times slender and angular.

The climate of Coban is mild, hence there is nothing to

indicate that this variety will be any hardier than the average of the Guatemalan race.

The flowering season is February and March. Up to a few years ago the tree is said to have borne large crops of fruit, but at present it does not seem to be doing so well, perhaps due to weakened condition as a result of the attacks of insects and other pests. When first examined in December, 1916, there were only a few fruits on the tree, perhaps a dozen, and after the flowers which were produced in 1917 had fallen only a few fruits were found to be left on the tree for the next season, most of them having fallen before they attained the size of walnuts. They were malformed as though from the attacks of some parasite. The ripening season is said to be February to March, a few fruits being picked in December and January, and some hanging on the tree until April or May.

This is a fruit of medium size, weighing about 15 ounces. In form it is pear-shaped, tending to obovoid. The surface is slightly rough, deep green in color, while the skin is moderately thick, hard and woody. The flesh is of unusually deep yellow color, quite free from discoloration of any kind, smooth and oily, and of unusually rich flavor. The seed is rather small in comparison to the size of the fruit, and perfectly tight in the seed cavity.

The variety may be formally described as follows:

Form obovoid, obovoid-pyriform or pyriform, slightly oblique; size above medium; weight 15 ounces; length  $5\frac{5}{8}$  inches; greatest breadth  $3\frac{3}{8}$  inches; base rounded, the

stem inserted obliquely without depression; apex rounded; surface slightly rough, deep green in color with few small yellowish dots; skin moderately thick, 1/8 inch or slightly more, coarsely granular, woody, and brittle; flesh deep yellow in color, changing to pale green near the skin, of fine, smooth texture and free from discoloration of any sort, the flavor rich and pleasant; quality excellent; seed rather small in comparison to the size of the fruit, roundish oblate in form, about 1 3/4 ounces in weight, with both seed coats adhering closely, and fitting tightly in the seed cavity.

KASHLAN (NO. TEN). S.P.I. NO. 43934.

In quality this is one of the finest avocados in the set. It has the additional advantages of good size, convenient shape for handling, and a seed which is unusually small. Taken all around it seems to be an exceptionally promising variety, and it ripens earlier than many others, which makes it particularly worthy of trial in California, where early ripening varieties of the Guatemalan race are greatly desired.

The parent tree stands among coffee bushes in the sitio of Diego Muns, in the town of San Cristobal Verapaz. The elevation here is 4,550 feet. Close to the tree, on the West, is a much larger avocado tree which crowds it considerably, and there is an Inga tree a few feet away on another side. The tree must be considered, therefore, to be growing under unfavorable ~~surroundings~~ <sup>conditions</sup>. The soil is a heavy clay loam, blackish, and very fertile. While the owner is not certain as to

the exact age of the tree, it is thought to be 8 or 10 years old. It stands about 25 feet high, with a slender, open crown rather sparsely branched. The trunk is 8 inches thick at the base, branching about 8 feet from the ground. The tree bears every indication of being a strong grower; the young branchlets are stout, long, and extremely healthy in appearance. The wood is no more brittle than the average. Budwood furnished by the tree is excellent, having strong, vigorous eyes which are not inclined to drop at an early stage. The twigs are smooth, round, stout, with the eyes conveniently placed for cutting buds, i.e., not too close together.

No frosts occur in San Cristobal, hence there is no means of determining whether varieties growing here are hardier than the average or not. Until further evidence is obtained in the United States, it must be assumed that varieties from elevations such as that of San Cristobal Verapaz are of average hardiness.

The flowering season is February. The tree is said to have come into bearing three years ago. It produced an excellent crop the past season, considering the size of the fruit and the unfavorable conditions under which <sup>it</sup> ~~the tree~~ is growing. In 1917 it set no fruit. The crop which developed in 1916 was picked in January and February, 1917, at which time the fruit was considered to be mature. None was left on the tree, so it is impossible to say how late the fruits might hang on if they were allowed to do so.

This fruit is broadly oval in form, slightly oblique,