

## HAWAII AGRICULTURAL EXPERIMENT STATION,

E. V. WILCOX, Special Agent in Charge.

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Bulletin No. 25.

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## THE AVOCADO IN HAWAII.

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UNDER THE SUPERVISION OF

OFFICE OF EXPERIMENT STATIONS,

U. S. DEPARTMENT OF AGRICULTURE.

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## HAWAII AGRICULTURAL EXPERIMENT STATION, HONOLULU.

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## LETTER OF TRANSMITTAL

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HONOLULU, HAWAII, *April 27, 1911.*

SIR: I have the honor to transmit herewith, and to recommend for publication as Bulletin No. 25 of this station, a paper on the Avocado in Hawaii, prepared by J. E. Higgins, C. J. Hunn, and V. S. Holt. The good quality of avocados in this Territory has attracted some attention and promises to make a market for the fruit on the mainland. It is an important matter to establish uniformity in the avocado orchard and for this purpose a knowledge of best methods of propagation is highly desirable. The work of the horticultural staff of the station for the past two or three years is well summarized in the bulletin. The various points connected with this work require the illustrations which are submitted for the best understanding of the text.

Respectfully,

E. V. WILCOX,  
*Special Agent in Charge.*

Dr. A. C. TRUE,  
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# THE AVOCADO IN HAWAII.

## INTRODUCTION.

In the present-day development of agriculture and horticulture in the Tropics, whereby new food products are being brought to the notice of the people of the Temperate Zone, there is no new fruit that is coming into prominence more rapidly or with greater assurance of becoming the basis of a profitable industry than the avocado. To many this delicious fruit is still unknown, but its reputation is being more widely established each year and it is not improbable that in a few years it will become as well known in the fresh-fruit market as the grapefruit or the pineapple. Its unique character reduces to a minimum its competition with other fruits, while its rich, nutlike flavor is almost universally enjoyed among those who have known it long enough to become familiar with its peculiar charm. It is a fruit and yet so unlike other fruits as to suggest a class of its own, and for this reason it has been called a "salad fruit." But this term seems too limiting because it is used in so many other ways (see pp. 35-37). It is true that the taste for the avocado is an acquired one, yet there are few, if any, food products which so quickly overcome any prejudice and become so highly esteemed. The novice may pronounce the first fruit worthless, but the second is tolerable, the third good, the fourth better, the fifth a delight, and after that the difficulty of learning to like them usually gives place to that of getting them often enough.

The demand for the avocado has always kept in advance of the supply in the few American cities where this fruit has been placed, as evidenced by the high prices paid for it, ranging usually from 30 cents to 50 cents each at retail. Although the markets are at present limited, there does not seem to be any immediate danger of overproduction. In fact, the growing of this fruit is only an infant industry. For a long time it was impossible to develop it because of the lack of a ready means of rapidly multiplying a good variety and thus establishing the uniformity in product which is necessary in all market fruits. This difficulty has now been removed and development is in progress. There are probably more than 100 acres now planted in orchard in Florida, and inquiries are coming to Hawaii from California for thousands of seeds to start nurseries. An increasing num-

ber of inquiries for information relating to the avocado are being received at this station, not only from correspondents in Hawaii, but from many parts of the world. This also indicates an awakening to the possibilities in the commercial cultivation of the fruit. The present paper is intended to meet this demand for information and to present the results of work on the avocado that has been done here. It is hoped also that the plain statement of our present knowledge on the subject may deter some from planting, extensively, strictly tropical varieties of the species in untried localities where frosts occasionally occur.

## THE BOTANY AND HISTORY OF THE AVOCADO.

It is not within the sphere of this bulletin to discuss at length the botany or the history of the avocado, but a brief presentation of these to the readers who are not familiar with the species may seem desirable.<sup>1</sup>

### GENERAL DESCRIPTION.

The avocado varies greatly in habit of growth. It grows from 20 to 60 feet in height and varies from an erect tree with no large branches from the main trunk to one of widespreading habit, occupying an area 50 feet in diameter. The leaves are from 4 to 16 inches in length and from 2½ to 10 inches broad and are quite unlike each other in texture and general appearance. The fruits are found in many shapes, from oblate, through spherical and pyriform, to long bottle-shaped, and in color, light green, dark green, purple, brown, and red. The center is occupied by a single large seed. The rind may be very thin and delicate or thick and woody. The fleshy portion between the rind and the seed is the part which is eaten and affords the flavor so highly esteemed. This flesh, when properly ripened, is about the consistency of firm butter and, in texture, should be smooth and free from fiber, but unfortunately many seedling fruits are quite fibrous. The variableness of the species in productivity is quite equal to that of its other characters just mentioned. Some seedling trees produce a good crop each year, some in alternate years, and some seem quite barren. All these variations in form of tree, in foliage, in fruit, and in productivity may be found in a single seedling orchard.

### COMMON NAMES.

The fruit under discussion has been made the victim of many names, such as midshipman's butter, butter pear, vegetable marrow, palta, aguacate, and alligator pear. The last of these has become

<sup>1</sup> Those who wish to pursue this phase of the subject further are referred to U. S. Department of Agriculture, Bureau of Plant Industry Bulletin 77, and the numerous authorities cited therein.

too common in English-speaking countries and is unfortunate in that it is misleading and a most unattractive appellation with which to introduce so excellent a fruit upon new markets. It is believed by some to have originated as a corruption of the Spanish "aguacate," and, because of its shape, it is easy to understand how the misnomer "pear" was applied to it. The term "alligator pear" may have arisen because of the peculiar marking of the rind of occasional specimens by slightly elevated ridges which sometimes form large irregular checkings. Adding to this the roughened appearance due to many elevations in the rind of certain varieties, it is not difficult to believe that the name "alligator pear" may have been applied because of a suggested resemblance to the hide of an alligator and, at the same time, to distinguish it from the true pears with which the early European settlers in tropical America were familiar. Whatever may have been the origin of this misnomer, its use should be discontinued. The name "avocado" has now been adopted and has the sanction of the United States Department of Agriculture, the American Pomological Society, and other horticultural organizations. Objections may be raised to this name also, but probably none can be found wholly unobjectionable, and "avocado" is growing in popularity. Its general use should be encouraged.

#### BOTANICAL RELATIONSHIPS.

The avocado is a member of the family Lauraceæ and is designated botanically as *Persea gratissima*. The forms are so widely different, as indicated elsewhere, that some of them may seem to warrant specific distinction, but at present they are all brought together under one species. Other members of the family, which may be found in the gardens of Hawaii, are the camphor (*Cinnamomum camphora*) and the cinnamon (*Cinnamomum cinnamomum*).

At least four species of *Persea* have been introduced by the Office of Seed and Plant Introduction of the United States Department of Agriculture, some of which may prove valuable as stocks upon which to work the avocado. These are *Persea lingue* (S. P. I. Nos. 3393, 9128, and 24208); *Persea pumila* (S. P. I. No. 4753); *Persea indica* (S. P. I. Nos. 9870, 14498, 16133, 16169, and 19371); and *Persea meyeniana* (S. P. I. No. 28636).

#### HISTORY AND DISTRIBUTION.

The avocado is indigenous in tropical America from Mexico to Peru. Its home has been commonly supposed to include also the West Indies, but Mr. G. N. Collins<sup>1</sup> produces considerable evidence to

<sup>1</sup> The Avocado, A Salad Fruit from the Tropics, U. S. Department of Agriculture, Bureau of Plant Industry Bulletin 77, p. 14.

show that this view is incorrect. It is probable, however, that to these islands it made its first migrations, which have now been extended to almost all parts of the Tropics, and it is now being cultivated even in subtropical countries, such as Florida, southern California, and the Mediterranean region. Its spread has been quite recent, however, and in not a few parts of the Tropics it has not yet come into general cultivation. In the Philippine Islands the avocado has not yet demonstrated its adaptability, although the trees from seeds recently introduced from Hawaii are said to be growing vigorously. In Java good avocados are rare and in India the cultivation of the fruit has not become general.

Of the date of the earliest introduction of the avocado into Hawaii, there is no definite record in available publications. The credit for the first introduction is probably due to Don Marin or "Manini,"<sup>1</sup> who enriched the cultivated flora of these islands by many species of economic importance which were first planted in his gardens in Pauoa Valley, near Honolulu. Dr. W. T. Brigham states in his article referred to elsewhere<sup>2</sup> that the avocado was in these islands in 1825. In reply to an inquiry for further data relating to this early introduction, the following was received in a letter from Dr. Brigham:

The reference was from the private journal of Dr. Bloxam, the naturalist of the *Blonde*, the vessel that brought the remains of Kamehameha II and his wife to Honolulu. His son, now a resident of New Zealand, loaned the journal to me and I found therein a list of the fruits found growing in Honolulu and vicinity at that time, probably in Manini's garden. In this list was the avocado pear. He must have been familiar with this fruit, as he had found it in the South American ports the ship visited.

No general distribution seems to have been made from this original stock, since, when introduced again in 1853, the fruit appears to have been a novelty to those who had been long in Hawaii. In relation to this later introduction the following from Mr. Luther Severance is of importance:

In June, 1853, the United States ship of war *Portsmouth* arrived in Hilo from Central America. The paymaster, Mr. Bridge, brought some plants from that country and planted them in Hilo, viz, avocado and rose apple. I was present when both were planted in the old Coan premises. The pear tree is still growing and I think bears pears. This was the first time these plants were introduced into Hilo, possibly on the Hawaiian Islands. The *Portsmouth* went to Honolulu the same month from Hilo and I believe placed some slips there.

Mrs. Bishop, widow of the late Dr. Sereno Bishop, is authority for the statement that, in 1853 or 1854, a ship of war called at Lahaina, Maui, and an officer gave to them avocados which were the first known to Dr. and Mrs. Bishop in Hawaii. It is not improbable that this ship was the *Portsmouth* en route from Hilo to Honolulu.

<sup>1</sup> The Hawaiian form of Marin.    <sup>2</sup> Hawaiian Forester and Agriculturalist, 3 (1906), No. 5, p. 144.

This introduction of 1853 appears to have been the first which had a wide influence upon the distribution of the avocado in Hawaii. That the stock of an earlier introduction, probably that of Marin, had not become wholly extinct is shown by the statement of Judge Sanford B. Dole to the effect that he saw the fruit at an exhibition held under the auspices of the Hawaiian Agricultural Society in the year 1852 or 1853.

Since the year 1853 repeated introductions have been made from various parts of tropical America and, to-day, the tree is to be found in almost every garden and dooryard, and in varieties almost innumerable.

## **NATURAL REQUIREMENTS.**

### **CLIMATE.**

The avocado is a tropical tree, yet it does not require the intense heat that is demanded by many Torrid Zone plants. It will prosper in a temperature which is not sufficiently high to bring the mango into profitable fruiting, and will flourish where the cacao would be a failure. Most of its varieties are injured by frost, but some types are reported which are said to endure several degrees below freezing. In the Territory of Hawaii the species is successfully grown from sea level to about 700 or 800 feet elevation, but in particularly sheltered districts, such as Kona, the tree is found fruiting as high as 1,600 feet.

Soil moisture is not demanded so exactly by the avocado as, for example, by the orange, but it is by no means a dry-land plant, and its cultivation should not be attempted for profit on any lands which are not supplied with a generous rainfall or which can not be brought under irrigation.

High winds are decidedly inimical to the tree. The wood is brittle and is liable to be broken by winds. The flowers also are destroyed by severe winds, and the fruit, which hangs from pendulous branches and fruit stems, is easily blown about, bruised, or broken from the tree. For this reason, commercial culture should not be attempted in localities of high winds unless it is possible to provide protection by windbreaks.

### **SOILS.**

The avocado is not exacting as to its soil requirements. Probably the best soil would be one rich in organic material, but the tree succeeds in heavy soils as well as in those of open texture. One characteristic in soil is demanded—good drainage. The tree is very impatient of standing water about its roots. Soil that is underlain by an impervious layer should not be chosen for the orchard. If a tree or two is to be planted in a garden which is unfortunately underlain by an impervious stratum, fair success may usually be attained by blasting an opening through this layer.

### LOCATION OF THE ORCHARD.

Because the avocado is a perishable fruit, those who intend planting for commercial purposes should seek a location close to rapid transportation facilities. Fruit from Hawaii for the mainland markets must have, at the best, a five or six days' journey and should not be gathered from the trees very long before being placed within the refrigerated compartments of the ship.

Hawaii offers special opportunities for the profitable marketing of this fruit because of the possibility of maturing the product at practically any month in the year by the selection of early and late varieties. Those countries which have sufficiently cold and dry weather during December, January, and February to prevent the growth of the tree, are necessarily limited in the seasons during which they can mature avocados. Hawaii can easily place the fruit on the mainland markets in the early spring before the Temperate Zone fruits have appeared and before the consumers who now purchase this fruit have left the city for Europe or the seaside resorts.

In selecting a site for the avocado orchard, it is important to bear in mind the direction of the prevailing winds. A severe slope toward the trade winds would render it very difficult to protect the orchard by windbreaks. If, however, the slope is in the opposite direction, it is usually an easy matter to furnish the necessary protection.

### CULTURAL REQUIREMENTS.

#### PROPAGATION.

The avocado may be propagated by seeds, by budding or by grafting, and by cuttings.

#### SEEDS.

Propagation by seeds is the simplest and commonest method in vogue. The seeds must be fresh, as they soon lose their vitality if exposed to the air. It is possible to transport them a considerable distance, in fact, to almost any part of the world, if they are properly packed while fresh. One of the best means of transportation which has been employed by the station consists in shipping the seeds in the fruits in refrigeration where such facilities are available. It is best to plant seeds within a few days or a week from the time when they are removed from the fruits, whether or not they have been in refrigeration.

There are two methods of germinating the avocado seed, the one in water, the other in soil. Germination in water is not to be recommended, but forms an interesting process for study, as the development of the root system can be observed in the water. When



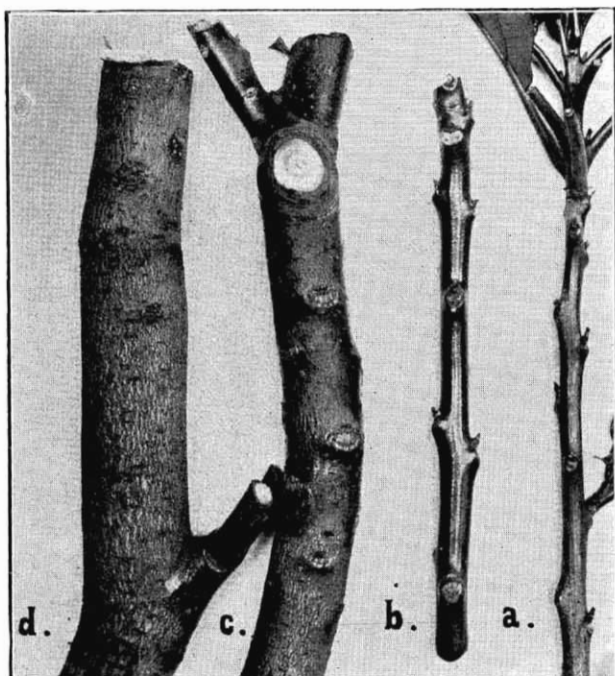


FIG. 1.—TYPES OF BUDWOOD OF FOUR STAGES OF MATURITY.

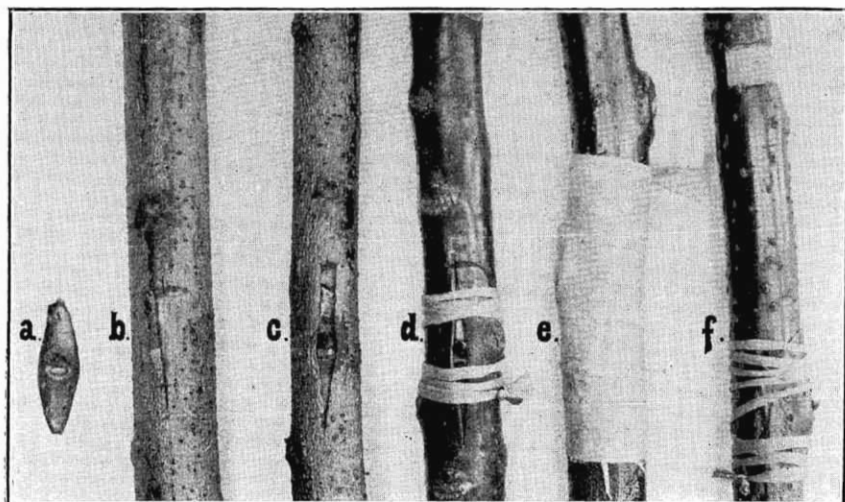


FIG. 2.—BUDDING THE AVOCADO. a, BUD SHIELD; b, "T"-SHAPED INCISION; c, BUD INSERTED; d, BUD TIED; e, BUD WRAPPED; f, BUD UNWRAPPED AND THE STOCK PARTLY GIRDLED.

planted in soil, as they should be, they may be placed in pots or in nursery row or in permanent position in the orchard. They should not be planted too deeply. The best success is attained by placing them in the soil so that the upper portion just protrudes above the surface. The best results usually follow planting the seeds in pots and transplanting them to the orchard after they have germinated. A very convenient and inexpensive pot for this purpose is made of two leaves of the "ti" plant (*Cordyline terminalis*) formed into the shape of a pot by being bound over the end of a bottle, bent back upon themselves and retied. After these are filled with soil and the seeds placed in them, they are set in flats or low boxes close to each other so that they form a mutual support. The pots will last until the plants have grown nearly a foot high, when they can be transplanted to the nursery. This method of planting has the advantage of placing the seeds where they can be closely watched, given part shade if the weather is bright and hot, and water if they require it. The time required for germination is about four weeks, but varies with the freshness of the seeds.

If seeds are to be used as the sole means of propagation, they must be selected with great care, as they seldom reproduce the original type of fruit. If they are to be used only as a means of securing stock for budding, less care will be required, since it will be necessary only to secure them from vigorous trees.

It is a well-known fact, however, that seeds are a wholly unreliable means of reproducing the variety. It is a very common experience to plant seeds of a green-colored fruit and get the purple fruit in progeny, or to plant the seeds from a fruit of excellent texture and get a progeny full of fiber. Other characteristics, such as flavor, are reproduced with equal uncertainty. It therefore becomes necessary to resort to some form of asexual propagation.

#### BUDDING.

The most practical means of asexual propagation for most purposes is budding. Until very recent years it has been regarded as almost impossible to bud the avocado. Considerable attention has been given to the subject and methods have been perfected by which a high percentage of successful bud unions are formed (Pl. I, fig. 2). The method of budding usually followed is that known as shield-budding with the "T" incision or an inverted "T," and the investigations which have been involved in making this successful have consisted largely in devising adaptations to overcome difficulties. On vigorous stock, budded near the ground, from 75 per cent to 90 per cent will grow. The following is a general outline of the manner

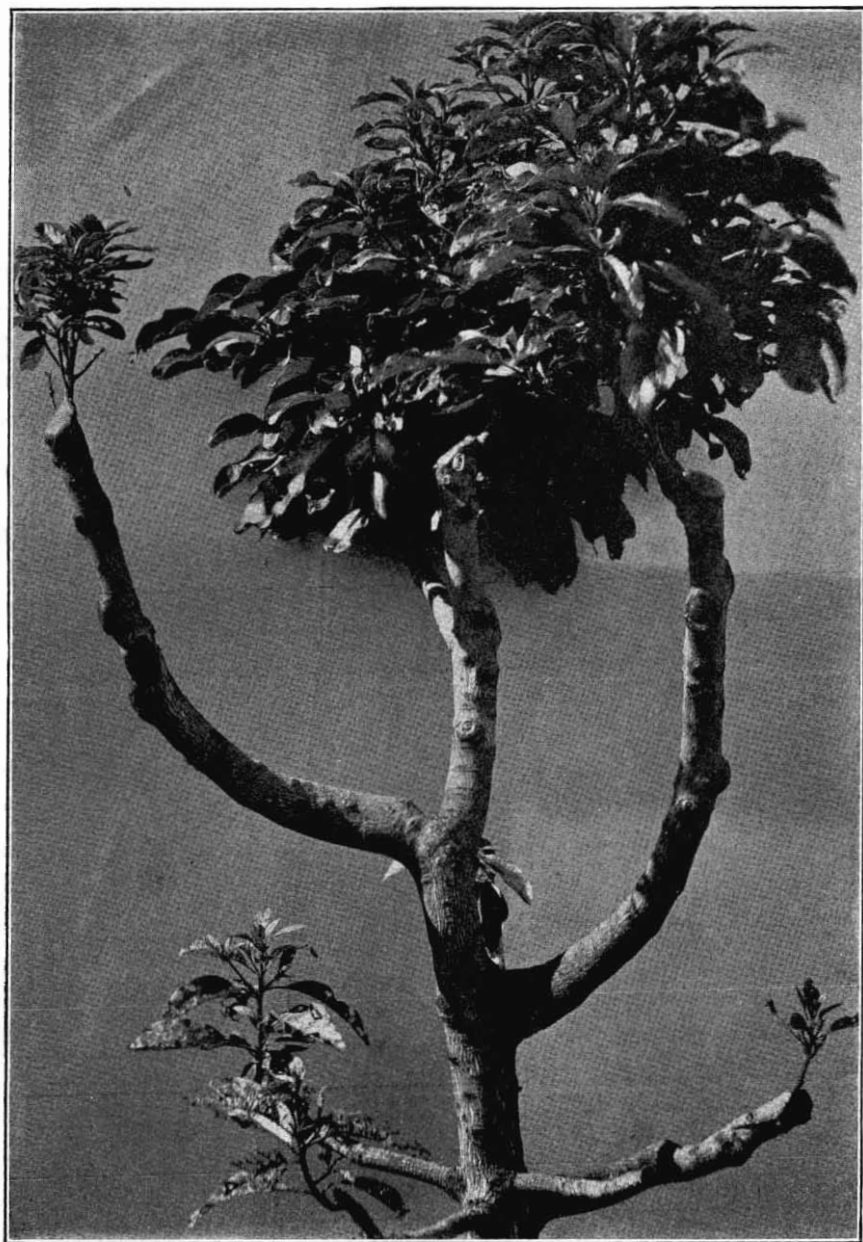
of budding the avocado which has been found most successful at this station:

Budwood has been used of four types, designated a, b, c, and d, respectively; a, being the first flush below the leaves; b, the second flush; c, the third; and d, old wood which has lost practically all its green coloring in the outer bark. Of these different types, that designated "b" has given best results and is to be recommended where long transportation is not necessary. The most mature wood could be preserved longer in transit. Plate I, figure 1, shows some of the types of budwood. The stocks used have varied from the light-green tender wood to that which has lost nearly all green coloring matter in the outer bark. The most essential feature in the stock appears to be not so much its maturity as its location in the direct line of the flow of the sap. Old side branches are not suitable to receive buds in the topworking of trees. Nursery stock is budded on the trunk, which carries all the sap that passes into the upper portion of the tree. Plate II shows an avocado tree topworked or changed to a new variety by budding the top.

The incision may be either a "T" or an inverted "T." No particular advantage has been observed in our experiments with either of these.

Tying is done with raffia, and it should be wrapped a few times above and below the bud. The whole is then wrapped with a bandage which has previously been dipped in warm paraffin or in grafting wax. The excess of paraffin should be squeezed out from the cotton bandage between two sticks, so as to prevent the waste of the material and to render the bandage more pliable. The wrapping should be done from the bottom upward, so as to prevent the entrance of water to the bud. Considerable advantage has been found in making this bandage cover the actual bud as well as the incision, thus preventing evaporation as well as the entrance of foreign moisture. One of the great difficulties which has been experienced arises from the fact that the avocado tree frequently gives off a large amount of sap through the incision, which evaporates and leaves a white deposit upon the bud, sometimes covering it completely. When the whole is covered by wrapping, little trouble has been experienced along this line.

Perhaps the greatest difficulty which has been experienced by those who have attempted the budding of the avocado has been in causing the buds to start into growth. It is a well-established practice to lop citrus stock and many other kinds of fruit trees a few inches above the bud after the latter has united, thus forcing the sap into the new bud. Lopping the young avocado is very difficult and sometimes impossible. If cut part way off the brittle tissue



A TOP-WORKED AVOCADO TREE.

breaks completely. This is likely to be followed by a dying back of the stock and the killing of the bud before it has developed into leaves. To force the bud into growth a process of incomplete girdling has been adopted. A portion of the bark about one-half to three-quarters of an inch wide is removed a few inches above the bud throughout the circumference of the stock, with the exception of about a quarter of an inch or less on the side opposite the bud. This conveys a portion of the sap upward and forces a large part of it into the bud. When the bud has opened the stock may be cut off where girdled. Cutting back close to the bud should not be done until the latter has made a growth of several inches. When cut the wounded surface should be carefully covered with grafting wax, or some anti-septic medium, which will keep out the air and rain.

As to the time for budding it may be said that we have budded successfully in every month of the year, but prefer the winter months or early spring, when growth is just beginning.

#### GRAFTING.

The avocado may readily be propagated by inarching or grafting by approach. This consists essentially in bringing together the parts of two plants and causing them to unite while each draws its sustenance from its own roots. The two branches brought into contact should be cut so that the two wounded surfaces will come into contact.<sup>1</sup>

This method is adapted to the growing of a few plants from a choice tree, but can not be considered as a commercial means of rapidly multiplying a good variety. It offers, however, a very convenient means of testing out seedling stocks which may have been originated in breeding work. For example, if certain crosses have been made or certain seed selections and it is desired to learn as rapidly as possible the characteristics of the progeny, planting in the orchard on their own roots will necessitate from three to six years to mature the first fruits. If grafted on a mature tree, fruit may be expected in two years.

#### CUTTINGS.

It has been found possible at this station to propagate the avocado by cuttings. The cuttings callus but are reluctant to strike root. With bottom heat a few can be made to do so. It appears to be an advantage to wrap the cuttings in sphagnum moss for some weeks before putting them into the sand. In the moss, they will form a good callus. This method, however, can not be considered as having any economic value at the present time.

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<sup>1</sup> For more detailed description of the method, see Hawaii Station Bulletin 12.

## PLANTING THE ORCEARD.

Preparing the soil for the planting of the avocado orchard is as important as in the case of other orchard trees. In Hawaiian soils thorough plowing and harrowing will be found profitable. For garden purposes, where plowing is impossible, a very large hole should be prepared with sufficient depth to insure good drainage and a desirable medium for the young roots to penetrate. This should be filled with surface soil.

Laying off the orchard with system and regularity should not be neglected. Detailed instructions for this work have been given in so many publications on orcharding that it is not necessary to repeat them here.<sup>1</sup> The space to be occupied by each tree will depend upon the habit of the variety, whether it is erect or spreading, upon the nature of the soil, and also upon the intention of the grower to have a seedling orchard or a budding orchard. Although a seedling orchard can not be recommended for commercial purposes, such may be planted as a means of testing a large number of new originations. For such purposes a distance of 15 by 15 feet or less may be adopted with a view of cutting out a considerable number of the inferior trees as they develop. For budded trees the distances will vary from 20 to 30 feet.

## TRANSPLANTING.

An orchard may be established by transplanting pot-grown seedlings, as mentioned above, or by transplanting nursery-grown trees. If the pot-grown seedlings are to be used the mistake should not be made of preparing only a small hole for them, since the roots will soon demand much greater space when they are in the open. The transplanting of larger trees from the nursery, which have already been budded, has been regarded as a very difficult process. With proper methods of handling, however, it seems quite feasible to transplant an avocado of several years' growth. The most essential point to be considered is the cutting back of the top to correspond with the shortening of the root system. Much has been said about the taproot of the avocado and the need of preserving it in transplanting. This does not appear to be well founded, so far as the experience of this station has developed. A number of trees grown from seeds germinated in the nursery and, therefore, undisturbed in the early stages of growth, have been removed from the soil when five years old. The soil was deep and not underlain by any impervious stratum. One of these trees from which the soil has been washed away, so as to secure as perfect an illustration of the root system as possible, is shown in Plate III, figure 1. It will be seen that

<sup>1</sup> Some instructions may be found in Hawaii Station Bulletin 9.

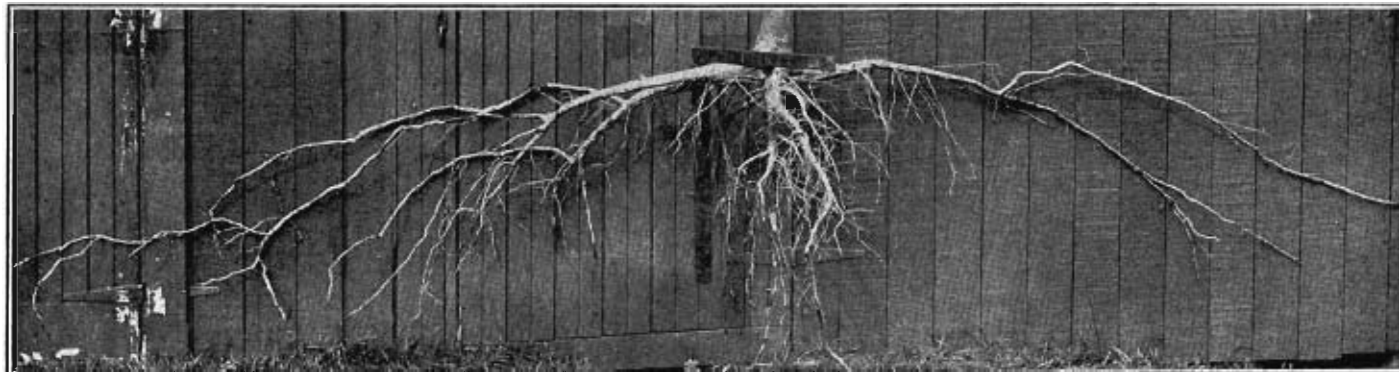


FIG. 1.—ROOT SYSTEM OF AN AVOCADO, FIVE YEARS OLD, IN NURSERY.

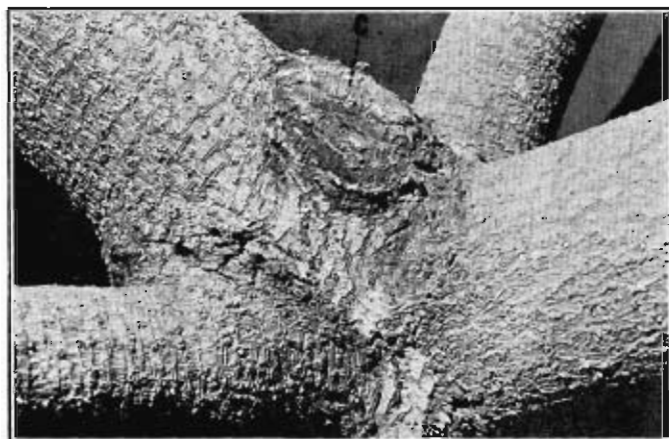


FIG. 2.—THE HEALING OF A WOUND MADE IN HEADING BACK A LARGE TREE.

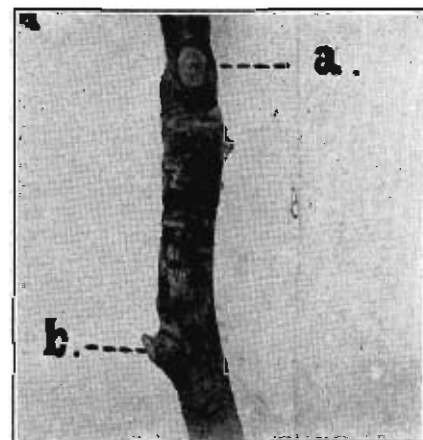


FIG. 3.—a, CORRECT CUT IN PRUNING;  
b, INCORRECT CUT.



while the horizontal roots strike downward the taproot is comparatively a small portion of the system. Trees removed from nursery to orchard several years ago show no injury resulting from the cutting of the taproot.

It is very essential in the transplanting of the avocado, as of most evergreen trees, to prevent the drying out of the roots. If the roots are not removed with a ball of soil, precautions must be taken to prevent exposure to the sun or wind as much as possible. The trees should be dug at the season of least growth, which in Honolulu is about November and December.

#### **TILLAGE, IRRIGATION, AND COVER CROPS.**

Most of the avocados that have been grown in Hawaii are in yards and gardens and are surrounded by sod, except the area immediately about the trunk, which is usually kept open for tillage and as a means of applying water. Under these conditions excellent fruit has been produced. The small orchard at this experiment station has been plowed at least once a year and the surface mulch has been maintained during the summer months when the weather is usually dry. Cover crops have been planted during the winter or wet season. Under this treatment the trees have made a satisfactory growth, but it is yet too early in their history to be able to make any statements regarding their bearing habits. During seasons of practically no rain irrigation about once in a month or six weeks, with the maintenance of a good soil mulch by means of frequent stirring with a disk harrow has been found sufficient. A more perfect mulch can be made by following this with a smoothing harrow. It is quite possible, on the other hand, that in regions of abundant and equally distributed rainfall, where there would be sufficient moisture to supply the demands of both trees and cover crops, the less frequent stirring of the soil and the maintaining of a green crop might not be undesirable. In general, it is a well-established principle with citrus and deciduous fruits that frequent surface tillage is best for fruit production under most conditions. It will be well to proceed upon this well-established basis until some good reason for abandoning it, in the case of the avocado, has been shown.

Cover crops must be planted during the wet season in practically all parts of Hawaii. An open soil subjected to the torrential rains, which are common in all parts of the islands, will suffer much by erosion. Another advantage in the cover crop is the green manuring which it will furnish, thus returning humus to the soil. If a leguminous crop is planted, the additional benefit will accrue from securing a supply of nitrogen without additional cost. In and about Honolulu



it has been found best to be prepared to plant the cover crop early in November, so as to have the ground covered when the first rains appear. This remains upon the ground until the heavier winter rains have passed, usually about April, when the orchard is plowed, covering the crop beneath the surface, and harrowing as soon as possible. Because of the uncertainty of the weather, even during the summer months, it is often advisable to have a few rows of cover crops through the orchard to minimize the effects of any sudden storm. These rows may be placed in line with the rows of trees so as not to hinder irrigation and tillage.

The plants used as cover crops may be any one of a number of legumes, such as cowpeas, jack beans, Mauritius beans, lablab beans, or soy beans. Each of these plants has its advantages and disadvantages. The cowpea and the jack bean have been more generally used at the station orchard than any others. The cowpea grows quickly, soon covering the ground and preventing erosion. It, however, matures before the end of the wet season, if planted early. It is severely attacked during the cool weather by aphid (*Aphis gossypii*). For this reason it should not be planted unless ladybirds are established in the orchard. With ladybirds, however, the aphid is a distinct advantage in that it furnishes an abundant food supply for its natural enemies, the ladybirds. The latter multiply by the thousands and, aided by other natural enemies and often by warm weather, they soon destroy the aphid. The ladybirds then turn their attention to the mealy bug of the avocado and do a very beneficial service in destroying this, the most troublesome pest of the trees. By this treatment only a few trees have required any fumigation or spraying.

The jack bean (*Canavalia ensiformis*) is slower in starting but remains green for a longer period. It also is attacked by the aphid but not so severely as the cowpea. These two crops may be planted together, the cowpea affording the first protection, the jack bean carrying it on to summer.

#### FERTILIZERS.

The avocado tree responds readily to judicious fertilizing. There is considerable evidence to show that the texture and flavor of the fruit may be very considerably improved by judicious fertilizing. On the other hand, the use of excessive amounts of nitrogen appears to increase the fiber content of the fruit and to detract from its flavor. No very definite data are yet available on the subject of fertilizing this tropical fruit, but it is safe to supply a complete fertilizer in Hawaii and one that is high in potash for bearing trees. It is safest

to supply potash in the form of sulphate, since the muriate is known to be injurious to some plants. Organic nitrogen is preferred by some but its superiority over other forms has not been demonstrated. There does not appear to be any definite data to discourage the use of nitrate of soda or sulphate of ammonia in reasonable amounts.

### PRUNING.

The current ideas about the pruning of the avocado in Hawaii are quite contradictory. On the one hand, there are those who claim that the tree will not stand any pruning with safety. Others prune their trees heavily without having any definite reason for the methods which they pursue. The facts appear to lie between these two extremes. A well-grown avocado tree requires but little pruning. This pruning can be done with perfect safety if it is properly performed. The idea that the avocado will stand no pruning has doubtless originated from the hatchet method, whereby large branches and small are chopped off, leaving a considerable stump protruding from the main branch, which dies and carries decay into the center of the tree. The wood of the avocado is very soft, and the tree will not stand the same abuse of hatchet and saw to which many trees in the islands are subjected. When a branch is removed it should be cut as close to its junction with the main branch as possible and in a line parallel to the direction of the main branch. (Pl. III, fig. 3*a*.) If the branch is not cut close (Pl. III, fig. 3*b*) the remaining part will die and carry decay into the tree. The wound should be covered with a heavy coat of paint made simply of white lead and linseed oil. Ready mixed paints are not advised, since their contents are not known. Good results have been obtained by covering large wounds with grafting wax. The pith of the avocado wood is rather prominent, and upon dying back may leave a hole to collect water and make a lodging place for the germs of decay. Plate III, figure 2*c*, shows the healing of the wound made in heading back a large tree.

The pruner should carefully consider the purpose for which he is using the knife or saw. Certain species of fruits require much pruning to bring them into proper form for greatest utility; others must be pruned to induce fruitfulness. It is found necessary to do much thinning in order to let sufficient light into some fruit trees.

Beginning with the young avocado some pruning to establish its form will be an advantage. This will consist chiefly in overcoming the habit of many varieties to shoot upward and not to spread out. By heading back such trees, while they are quite young, the energies may be thrown into the side branches, thus causing the tree to occupy more surface space. A great mistake is made by many people in

pruning off all the lower branches of the tree, giving it a high head several feet from the ground. Low heading has several advantages. It brings the fruit within more easy reach and facilitates all the orchard processes, such as spraying, thinning, and pruning. It also makes the tree much less subject to the effect of winds. A high headed tree has greater leverage on its trunk and is more difficult to protect by windbreaks. The lower branches shade the grounds conserving the moisture, and help to sustain the load of fruit upon the upper branches as they rest upon them.

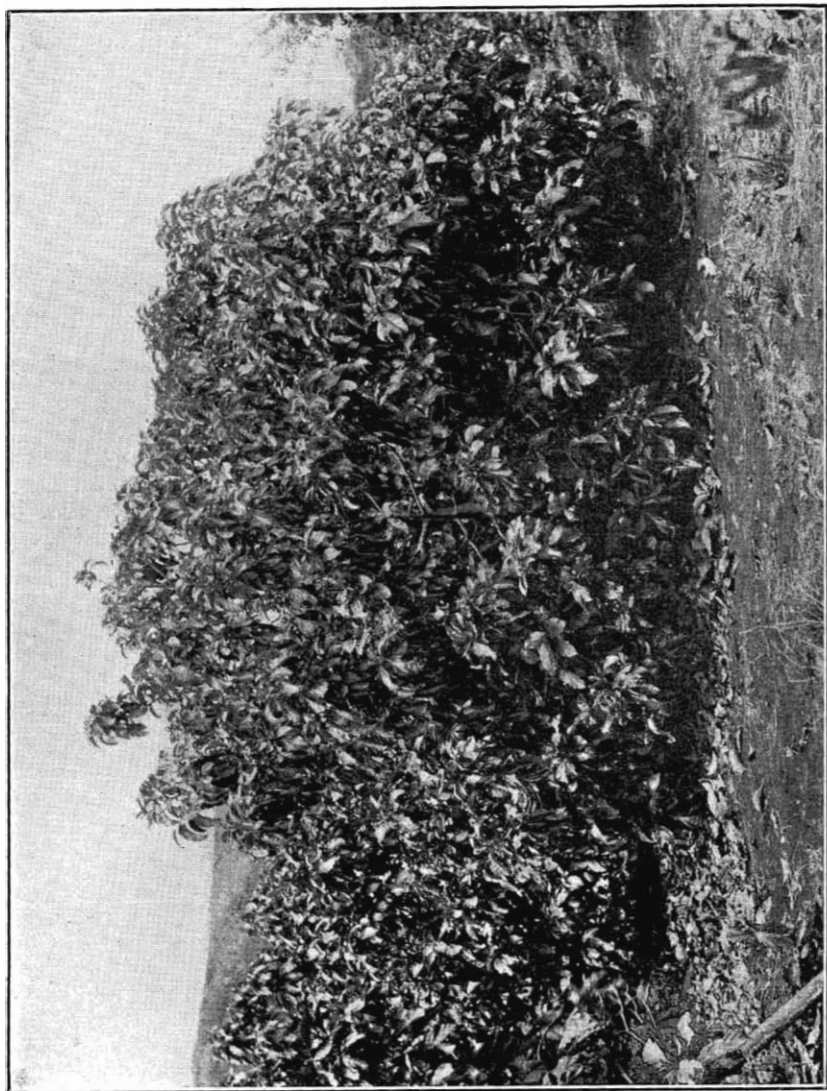
With the cutting back of the main trunk and the shortening of any branch which seems to be growing too far in one direction, little will be needed to establish the form of the tree. After this has been done, the later pruning will consist chiefly in cutting out failing wood before it has died and in removing an occasional branch which is not well placed. Plate IV shows a well formed avocado tree with a spreading and rather loose top.

#### THINNING.

It is well known that many avocados have the habit of bearing fruit in alternate years. In one year more fruit will be set than the tree can possibly bring to perfection. It struggles along with its excessive burden, dropping much fruit before it is matured, but all the while carrying a load to the full limit of its strength. Such fruit is usually small and the tree becomes so exhausted that the next year is spent in the process of recuperation, only to be followed by another year of excessive production. Much can be done to prevent this irregularity by severely thinning the fruit in the early stages of its development during the seasons of overproduction. The remaining fruit will be larger and finer and will probably bring in a larger money return than the whole crop of small fruits. This is not an excessive labor and is an established practice in the commercial production of many of our best kinds of fruit.

#### GIRDLING.

Some avocado trees produce almost no fruit. This is doubtless due, in a large degree, to varietal or individual characteristics of the tree. Where the habit persists it is sometimes advisable to resort to the practice of girdling to produce fruitfulness. This practice has been tried and has resulted in fruit bearing without noticeably injuring the tree. It can not be recommended, however, except in the case of trees which are persistently unfruitful. Girdling, if practiced, should not be performed upon the main stem of the tree but upon one of the branches. The process consists in removing a ring of bark about  $1\frac{1}{2}$  inches wide from the branches.



AN AVOCADO TREE OF GOOD FORM.

Probably the best season to do this is in the spring or early summer, which will give the tree the opportunity of storing up nourishment for fruit production in the branches so treated. The portion laid bare should be covered with a heavy coat of lead and oil paint to prevent the wood from drying out.

#### PROTECTION FROM WIND.

It has already been noted that the avocado requires protection from the wind because of its brittle wood and to prevent the flowers and fruits from being broken from the tree. Young orchards, if not protected by natural windbreaks, should be given a temporary protection, while the permanent windbreaks are being grown. It has been found at this station that a very efficient temporary windbreak for young trees in the orchard or nursery may be supplied by the pigeon pea (*Cajanus indicus*), Plate V, figure 3. A row of these plants in hedge form about 10 to 15 feet from the trees will give great protection. They should be planted before the trees and will make a rapid growth in a few months. Probably a single row of the pigeon pea between each two rows of orchard trees would be sufficient. Such plants will continue to do service for two or three years if necessary, after which time the permanent windbreaks should be fairly well grown.

Permanent windbreaks should be formed on the windward side of the orchard of some rapid-growing tree which will endure the wind. Some trees which have been found useful for this purpose are the *Eucalyptus robusta* and the ironwood. Monterey cypress may be used in combination with either of these, to inclose the space near to the ground. The latter species is quite subject to the attacks of a bark-eating cockroach, which destroys many of its branches and occasionally kills the whole tree. The ironwood itself may be compelled to fill in the space near to the ground by the process of heading back. It is often claimed that the eucalyptus is a soil-exhausting plant and that nothing can be grown near to it. This, however, is another way of saying that it has the power to readily convert soil substance into orchard protection. No orchard trees should be planted near the eucalyptus, but in an orchard of any size it will pay for the space which it occupies.

It is a very good plan to plant a double row, placing trees in each row about 8 to 10 feet apart and the trees alternating in the rows.

#### CONTROL OF INJURIOUS INSECTS.

Mr. D. T. Fullaway, entomologist of this station, has kindly contributed the following section relating to the injurious insects of the avocado and their control.

The insect pests of the avocado are fortunately few in number, but one, the avocado mealy bug (*Pseudococcus nipæ*), is very troublesome on account of its rapid increase and spread and its resistance to treatment with sprays, washes, etc. The symbiotic relationship between ants and mealy bugs is largely responsible for their dissemination and presents an added difficulty in attempting to cope with them. Unfortunately ladybirds, unless artificially propagated (see p. 18), make little impression on *P. nipæ*, and avocado trees when "blighted" with mealy bug not only present an untidy appearance but show an actual loss of vigor and health. Seedlings or young trees may succumb to a bad infestation of mealy bug or be so badly blighted as never to amount to anything.

This pest has received attention in previous publications of the station<sup>1</sup> and there is at present little to add to the information

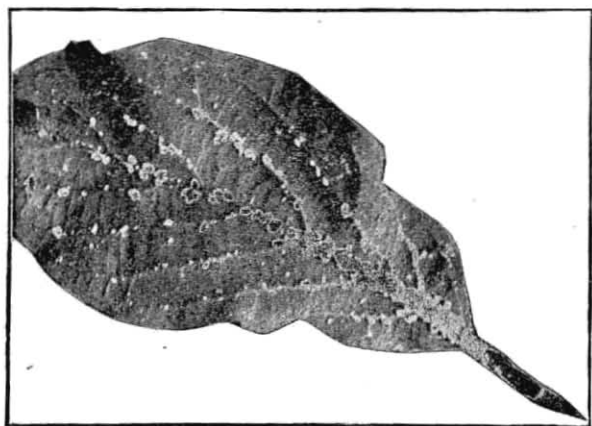


FIG. 1.—The avocado mealy bug (*Pseudococcus nipæ*).

there given. It is found on guava, palms, figs, mulberry, sour sop, and magnolias, as well as on avocado. Its commonness makes any description unnecessary, but the accompanying figure (fig. 1) will insure its recognition at once.

The application of oil-emulsion sprays will help to keep dooryard and garden trees clean. Orchards or plantations can be better and more cheaply treated with hydrocyanic acid gas fumigation. Some good results have been obtained by using a proprietary carbolic acid mixture, but care must be taken to prevent burning. Often a little attention to the ants will prevent trees from becoming badly infested. A teaspoonful of carbon bisulphid poured into the entrance to an ants' nest or spraying the ground with a solution of cyanid of potassium in water will destroy the ants. Banding the trees with tangle-

<sup>1</sup> Hawaii Station Press Bulletins 8 and 16.

foot is often practiced. When this is done the trunk should first be wrapped with paraffin cloth to prevent bark injury.

A flat scale, *Fiorinia floriniæ*, is also found on avocado foliage, but is much less common than the mealy bug. This scale is very small (less than 1 millimeter long), flat, oval, and brown, and is usually thickly crowded on the under surface of the leaves. A soap or kerosene emulsion spray is recommended for treating trees infested with it.

Wood-boring beetles of the genus *Xyleborus* are frequently found injuring avocado trees. Three species are recorded, *Xyleborus immaturus* and two others not definitely determined. They bore the outer portion of stems where the wood is dead following an injury and are sometimes found working in the trunk beneath the bark; they have also been found in live wood. If neglected they will quickly kill a tree, but their injuries may be prevented if the trees are carefully watched. Branches showing their work should be cut off and burned; they may be dug out from the trunk if their work is not too extensive, and the wound will heal over. Where they are extensively present fumigation has been resorted to.

Recently a green caterpillar (larva of the tortricid moth *Amorbia emigratella*) has been doing considerable injury to avocado trees, attacking the fruit. This caterpillar usually feeds on foliage, and is a leaf folder, drawing the edges of a leaf together and eating just beyond its temporary shelter. When nearly full grown, however, it is likely to move on to the fruit of the avocado, which it attempts to bore. It usually desists after making merely superficial abrasions, but the slight injury is sufficient to render the fruit unmarketable. The moth is ochreous-brown, with some fuscous markings and rather large (about 1 inch in expanse of wings). The insect is of more than ordinary economic importance because of its habits and the fact that it is an introduction without recognized parasites. It has been rather fully treated in Bulletin 22 of this station, and experience has shown that it is necessary to spray avocado trees annually before the fruiting season with an arsenical mixture to protect the fruits.

*Minor pests.*—The following insects have been taken on avocado but are not regarded as especially attached to this plant or at all highly injurious:

*Phenacaspis eugenixæ*, the oleander scale, on foliage.

*Tetranychus* sp., a mite commonly found on seedlings in green-houses; easily gotten rid of by dusting with flowers of sulphur.

*Pseudococcus* sp., a mealy bug on roots.

### CONTROL OF DISEASES.

A parasitic fungus of the genus *Glœosporium* is prevalent on the avocado throughout the Hawaiian Islands and gives rise to a disease



which may be called rusty blight. It is apparent chiefly on the foliage and young branches. The leaves are attacked in any part of the blade, perhaps most often near the edge where they begin to turn a rusty brown often marked with concentric circles of lighter color. Later they fall, and, in extreme cases, the tree may become nearly defoliated. The young branches become darkened in color and may die back, carrying decay far into the tree. Plate V, figure 2, shows an avocado nursery severely attacked by the malady. It is probable that the excessive dropping of immature fruits is frequently caused by the same organism. The flowers are subject to attack also. In fact, it is sometimes through the flowers that an entrance is made to the tender branches. By what other means an entrance to the branches is effected has not been determined at this station or elsewhere so far as the available literature of the subject records. It is quite probable that the mycelium enters the branches through the leaf and possibly also through the leaf scars after the leaf has fallen.

Rolfs<sup>1</sup> records a *Glœosporium*, "probably an undescribed species," on the avocado in Florida. This disease is believed to be identical with that prevalent in Hawaii.

For several years Bordeaux mixture has been used at this station and elsewhere for the control of the disease and there seems to be no reason to doubt the efficacy of this old standard fungicide. It has been found that no foliage injury results from using the proportions known as the 6-6-50 formula.<sup>2</sup>

#### EXPERIMENTS IN PROGRESS.

It will be observed from the foregoing that there are in Hawaii three pests of the avocado of considerable economic importance, including two insects and one fungus disease. A series of experiments is now in progress with four different sprays to determine their combined insecticidal and fungicidal effect. With each of these sprays it is designed to combat at least one of the insect pests and also the fungus disease. These four sprays are as follows:

(1) Bordeaux mixture and arsenate of lead—for the control of the fungus disease and of the green caterpillar (*Amorbia*).

(2) Bordeaux mixture and lime-resin solution—for the fungus and the mealy bug.

(3) Self-boiled lime-sulphur and arsenate of lead—for fungus, green caterpillar, and mealy bug.

(4) Commercial lime-sulphur and arsenate of lead—for fungus, green caterpillar, and mealy bug.

The methods used in preparing these mixtures are indicated below:

(1) Dissolve 12 pounds of copper sulphate by suspending in a

<sup>1</sup> The Avocado in Florida, U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 61, p. 32.

<sup>2</sup> Hawaii Station, Report, 1908, pp. 47, 48.



coarse bag near the surface of 6 gallons of water. Take 12 pounds of unslaked lime and slake it gradually up to 6 gallons of water. This makes two stock solutions in which 1 gallon contains 2 pounds of the desired substance. When ready to spray, take 3 gallons of each solution and dilute each separately with 22 gallons of water. When thoroughly stirred, pour both solutions simultaneously into a third barrel, thus making a mixture of 50 gallons in the proportion of 6-6-50. Strain before using. It is best to use wooden barrels, for copper is easily deposited upon a metal surface. Danger arises from an excess of copper, since it burns the foliage when uncombined. This burning may be prevented by testing the mixture. Hold a clean steel knife in the mixture for a few moments. If a film of copper is deposited upon the blade, copper is in excess. Add lime stock and stir until the test indicates that all of the copper is combined. Another test to determine whether there is sufficient lime present is to place a few drops of potassium ferrocyanid solution (1 ounce of ferrocyanid of potassium in 8 ounces of water) into the mixture. A dark reddish-brown color signifies that more lime should be added. Arsenate of lead was added to this mixture in the proportion of  $3\frac{1}{2}$  pounds to 50 gallons of solution. In every case where arsenate of lead is used in a spray it is reduced from its sticky, adhesive nature by gradually adding 2 quarts of water per pound and rubbing it into a smooth paste. While spraying, these solutions need constant agitation.

(2) To make lime-resin stock, take pulverized resin, 5 pounds; potash lye, 1 pound; fish oil, 1 pint; and water, 5 gallons. Dissolve the resin in the oil, heating it in a kettle. When the resin has all dissolved cool the mixture and then slowly add the lye, stirring vigorously. Add 2 gallons of water and boil until the mixture will dissolve readily in cold water. Make the stock solution up to 5 gallons.<sup>1</sup> This resin-lime solution was added at the rate of 2 gallons of the stock to 50 gallons of Bordeaux mixture.

(3) To make self-boiled lime-sulphur, take flowers of sulphur, 6 pounds; fresh stone lime, 6 pounds; and water, 50 gallons. Place the lime in a barrel and add just sufficient water (2 to 3 gallons) to start it slaking. After it has formed a paste, and while the lime is boiling, slowly add the sulphur, passing it through a fine sieve to exclude lumps. Stir the mixture constantly to keep the sulphur off the bottom of the barrel. Allow the mixture to boil for about 15 minutes after adding the sulphur. Then add the water to prevent further boiling. This prevents the formation of injurious compounds.<sup>2</sup> Arsenate of lead was added at the rate of  $3\frac{1}{2}$  pounds per 50 gallons of water, as in the other formulæ.

<sup>1</sup> Connecticut, Storrs Sta., Bulletin 56, p. 226.

<sup>2</sup> U. S. Department of Agriculture, Bureau of Plant Industry, Circular 27.

(4) The fourth solution used was one of the commercial lime-sulphur mixtures, diluting it with water at the rate of 1 pound of the stock to 30 gallons of water. The hydrometer test of the stock showed a density of 31.5° Baumé at 75° F. Arsenate of lead was added at the rate of 3½ pounds per 50 gallons of solution.

The experiments have at present proceeded far enough to give definite data on some of the questions involved. The safety of the foliage appears to be assured with any of the mixtures in the proportions indicated. Experiments with more concentrated solutions indicate that there is danger of injury to the young foliage if the proportion of stock is much increased in the case of formulas (1), (2), and (4). No. (3) has not been tested at greater density.

In respect to adhesiveness, these sprays may be arranged in the following order: No. (2), most adhesive; No. (1), No. (4), and No. (3).

In the matter of the control of the avocado mealy bug, the experiments have not yet proceeded far enough to furnish definite data. In the experimental orchard all of the trees, including the checks, are comparatively free from this pest, natural enemies having destroyed nearly all of them.

All those mixtures which contain arsenate of lead (Nos. 1, 3, and 4) have had a decided effect in the control of the green caterpillar (*Amorbia emigratella*). Results in the control of this pest are encouraging.

It is too early in the progress of the experiments to record any definite data respecting the control of the fungus disease (*Glæosporium* sp.).

## THE CROP.

### BEARING AGE.

Seedling avocado trees come into bearing between the fourth and eighth year. An occasional tree bears in the third, but the average is probably about the sixth year. How long they will continue to retain their vitality and produce a profitable crop in Hawaii can not be stated. There are records of trees 80 or more years old in some parts of the American Tropics, but for commercial purposes it would probably be conservative to estimate the bearing life of the tree at not over 25 years.

### YIELDS.

The crop for a first-class tree might be estimated at about 500 fruits per year. Trees are known in Hawaii which have records of producing from 800 to 1,200 fruits annually, but this must be regarded as rather exceptional. Without doubt, by selecting buds from these more prolific trees, the average yield per tree can be very much increased. The individual record of a single tree for six years from

the time of first bearing may be of interest in this connection: Third year yielded 12 fruits; fourth year, 8 fruits; fifth year, 172 fruits; sixth year, 8 fruits; seventh year, 400 fruits; eighth year, 12 fruits.

It will be noticed that this tree has a decided habit of heavy yields in alternating years, with a year of very light yields between. This habit is rather common in the avocado, and considerable care is required to overcome it.<sup>1</sup> Some of the devices which may be followed to overcome this habit are the early thinning of the fruit during the year of heavy bearing, so as to prevent its exhausting its resources; liberal fertilizing during the year of heavy yields; and finally, avoiding breaking the branches in gathering the fruit. This latter practice is too common in gathering avocados. The fruit is carelessly torn from the tree, many of the terminal branches which would have borne fruit the following year being broken. The tree having been relieved of practically all fruit production during that year, gathers up all its resources for an excessive crop the following season, and thus the evil habit continues itself.

#### SEASONS.

The seasons in which the fruit of the avocado comes to maturity vary in different countries and in different localities of the same country. There are also early and late varieties, made even earlier or later by the locality or country in which they are grown. It has been estimated,<sup>2</sup> taking the whole crop from Peru to Florida and west to Hawaii, that there would be avocados on the market all seasons of the year. In some of these countries the climate appears to be such that a continuous local crop could not be expected. Hawaii has some advantages in this respect, as avocados are maturing here practically every month in the year. The large part of the crop in Honolulu comes in June, July, and August, but the market is well supplied from June 1 to September 30. The earliest fruits found in these markets come from the district of Kona and arrive in April or May. By a careful selection of varieties it would be possible to have the fruit almost any month in the year, even on the island of Oahu.

#### PICKING.

Great care is necessary in picking the fruit, if it is to be placed upon the market. Very many fruits are torn from the trees or knocked off with sticks or shaken to the ground. All such fruits are unfit to market, although they may show no marks at the time they are picked. Each fruit should be cut from the tree with orange clippers, leaving about three-eighths of an inch of the stem. Pruning shears may be used for a few fruits, but their sharp points are much more liable to injure the fruit than are the round-pointed orange

<sup>1</sup> See thinning, page 20.

<sup>2</sup> U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 77.

clippers. Attention has already been called to the need of preventing the breaking of the branches. Care should also be taken not to injure the bark of the tree by climbing, since the bark is quite tender and easily broken. If the tree has been well headed, as indicated above, a very large portion of the fruit can readily be gathered by standing upon the ground or upon a stepladder. The use of large, heavy ladders leaned against the trees can not be recommended, since the brittle wood is likely to be broken. Some of the mechanical fruit pickers might be so modified as to make them well adapted to picking avocados. Most of them, however, are so made that the fruit is pulled from the tree, and in this respect are not at all suitable. A good picker for those fruits which are high upon the tree would probably be one with a mechanical device for cutting the stem and provided with a long bag reaching to the lower end of the pole upon which the picker is mounted. There are already on the market some pickers with a bag of this kind into which the fruit falls, but so far as the writers have learned none of these are provided with the means of cutting the stem.

When gathered the fruit should be put into padded baskets or heavy canvas containers, from which they may be removed to the boxes to be carried to the packing house. The use of feed sacks to carry this delicate fruit to the packing house or the local market can not be too strongly condemned. In these they are sure to be bruised against each other and against the ground.

There are several means of determining the stage of maturity at which the fruit may be gathered. The avocado has a larger latitude of time in this regard than many fruits, but if picked too soon it will be insipid, and if left too long on the tree it will fall and become worthless as a market fruit. In those varieties which become purple or red in color when ripe, it is best to gather from the trees when the first tinges of these colorings appear. In green varieties there is sometimes a slight variation in the shade, which indicates the proper degree of maturity. Individual varieties also have certain markings, such as small dots with which the grower soon becomes familiar and which indicate maturity. In many varieties the seed becomes loosened within its cavity at maturity, so that if the fruit is shaken the seed rattles within. For commercial purposes it is best to select those varieties in which the seed occupies the whole of its cavity. A loose seed will bruise the interior of the fruit.

### MARKETING.

This station made a considerable number of experiments in the marketing of Hawaiian-grown avocados from the year 1904 to the year 1907. Fruits were placed in the Pacific coast cities as far north as Vancouver, British Columbia, in Chicago, New York, and

Washington, D. C. Some varieties arrived in good condition even in these cities of the extreme eastern part of the continent. It seems probable that with suitable shipping facilities and a careful selection of varieties the avocado can be successfully shipped to far distant markets. Much remains yet to be investigated relating to methods and varieties for marketing, but the experiments made justify the following suggestions to the intending shipper.<sup>1</sup>

#### VARIETIES TO SHIP.

The kinds of fruit to ship must depend upon two factors: First, the market demands; and second, the carrying qualities of the different varieties.

The peculiarities, one might almost say whims, of markets in their demands for avocados are not less pronounced than those of the egg markets. San Francisco prefers a green avocado, while some of the eastern cities are quite as well satisfied with a purple fruit. There is no intrinsic reason, so far as known, for the preferring of one color above another, for no constant correlation between color and flavor or texture has been discovered. From the standpoint of attractiveness, which is frequently the determining factor in the selling of fruits, some of the claret-colored avocados would be leaders. Some dealers raise the objection to the green color that it conveys to the uninitiated the idea of immaturity. The purple is objected to in some markets on the ground that it looks too much like an eggplant. Most of these objections should pass away as the fruit becomes better known, but attractiveness will continue to be an important characteristic.

The carrying or keeping qualities of the avocado vary greatly. Some varieties remain sound for only a few days, while others have been kept in good condition for two weeks or more without refrigeration. It will be necessary to make a study of each promising variety with reference to its keeping qualities. Some varieties<sup>2</sup> are provided with thick and even woody rinds, which protect them to a large degree from bruising, but too much dependence should not be placed in this character alone. Frequently it is merely the natural process of ripening which brings on the decay of the fruit and, so far as known, a variety with thick rind may ripen as rapidly as any other. In selecting shipping varieties therefore it will be necessary to find those which combine slow ripening qualities and a sufficiently thick rind to protect them from bruising. The process of ripening may be retarded by refrigeration and some varieties are better adapted to this treatment than others.

<sup>1</sup> Hawaii Station Bulletin 14, also Press Bulletin 21. Much of the following has been quoted without quotation marks from these two publications, which were written by one of the authors of the present bulletin.

<sup>2</sup> See variety No. 149, p. 43.

[Bull. 25]

## GRADING.

Careful grading is important. Nothing detracts more from the appearance or the selling price of good fruit than does poor grading. The few unusually large and fine fruits from a given lot, if picked out and packed by themselves, will generally sell at a fancy price. If they are put in the same package with average fruit not only is this special price lost, but by contrast they make good average fruit look poor and thus lower its price to that of inferior goods. Fruit that is rather second grade if neatly packed will often bring a reasonable price, but if placed with good specimens will destroy the whole package.

The fruits in a package must be uniform in size, form, color, and other characters. Otherwise they will not sell for a good price.

To do the grading and packing properly it is very desirable that there should be a packing house. A room, or even a part of a room will do where the business is small, but some place properly equipped and of suitable size should be devoted to this work. The chief essentials in the construction or selection of such a room are coolness, good ventilation, and convenience of approach. In equipment it is important that everything be arranged systematically, so that the packer may have crates, crate covers, wrappers, nails, and all the essentials within easy reach from his position in front of the packing table.

## PACKAGES.

It is a common error in packing to place the fruits in boxes entirely too large. The writer has seen avocados arrive in the San Francisco market in boxes as large as potato crates. This makes too much pressure on the fruit. An unnecessary amount of heat is generated and the fruit begins to ripen before it can be cooled in the refrigeration. A crate which was found to be very satisfactory for medium sized fruit was of the following dimensions: Thirteen inches by 14 inches by  $3\frac{3}{4}$  inches, inside measurement. Such a crate (Pl. VI, fig. 1) requires the following materials:

- 2 pieces  $\frac{3}{4}$  by  $3\frac{3}{4}$  by 13 inches for ends.
- 2 pieces  $\frac{1}{4}$  by  $3\frac{3}{4}$  by  $15\frac{1}{2}$  inches for sides.
- 6 pieces  $\frac{1}{4}$  by 3 by  $15\frac{1}{2}$  inches for tops and bottoms.
- 2 or 4 pieces  $\frac{1}{4}$  by  $\frac{3}{4}$  by  $11\frac{1}{4}$  inches for cleats.

The cleats may be put on the top and bottom or on the top only. This crate holds about 1 dozen avocados of average size. A convenient crate of double the capacity (Pl. VI, fig. 2) is made of the following materials:

- 2 pieces  $\frac{3}{4}$  by  $3\frac{3}{4}$  by 13 inches for ends.
- 2 pieces  $\frac{1}{4}$  by  $3\frac{3}{4}$  by 30 inches for sides.
- 6 pieces  $\frac{1}{4}$  by 3 by 30 inches for tops and bottoms.
- 1 piece  $\frac{1}{2}$  by  $3\frac{3}{4}$  by 13 inches for partition.
- 3 or 6 pieces  $\frac{1}{4}$  by  $\frac{3}{4}$  by  $11\frac{1}{4}$  inches for cleats.

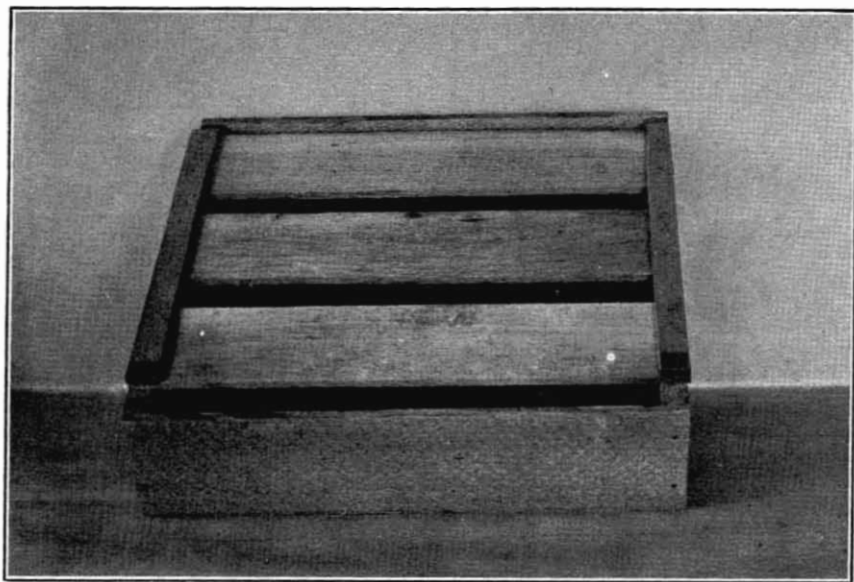


FIG. 1.—A SUITABLE CRATE FOR SHIPPING AVOCADOS; CAPACITY, ABOUT ONE DOZEN SELECTED FRUITS.

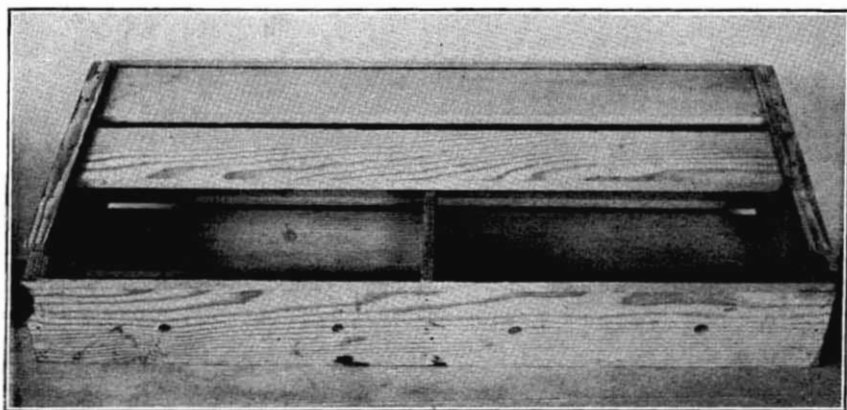


FIG. 2.—ANOTHER CRATE WHICH HAS GIVEN GOOD SATISFACTION; CAPACITY, ABOUT TWO DOZEN FRUITS.

[The illustration shows rather heavier material than is necessary. (See p. 31).]



The advantage of the cleats is in providing an air space between the boxes. They also aid in holding on the slats. Both of these crates, it will be seen, take only a single layer of fruit. For large-size fruit the depth must be increased to at least 4 inches. A slight adjustment to the depth of the crate can sometimes be made by tilting the avocado, supporting it in this position by the adjacent fruit.

#### WRAPPING AND PACKING MATERIALS.

Each fruit should be carefully wrapped in a piece of paper large enough to make a single covering and which has not been used for other purposes. Old newspapers and second-hand orange or lemon covers should never be used. A little excelsior above and below the fruit may be used, but appears to be unnecessary with reasonable handling. A few fruits which were shipped in individual compartments made of crimped or corrugated strawboard arrived at their destination in excellent condition, but scarcely better than those wrapped simply in paper. One hundred and sixty-seven fruits packed in this simple manner with nothing but paper wrappings arrived in Portland, Oreg., with a loss of only 2.9 per cent. Some fruits were packed in bottle covers of tulle. These appeared to be wholly unsatisfactory. They occupied more space, were far more expensive, and less attractive. The fruits packed in them showed a loss of 71.4 per cent.

#### PLACING THE FRUITS.

The fruits should be placed as closely together as possible. It does not appear to be advisable to put them under as much pressure as is produced in the packing of some Temperate Zone fruits, for example, apples; but there should be no loose avocados to shake about within the package. It is a mistake to fill with paper the spaces between the fruits because this retards refrigeration.

#### REFRIGERATION.

This is essential to successful shipping on the six-day trip which lies between Hawaii and its nearest large market. It is of great importance that refrigeration should be begun as soon as possible after picking, since it is difficult to arrest the ripening process when it has progressed far. The degree of temperature which is best for the preservation of avocados has not been determined. This may be said to be true of most tropical fruits. It is not improbable that a temperature higher than that to which Temperate Zone fruits are subjected would be desirable. Experiments made by this station, and which are confirmed by reports from elsewhere, show that pro-



longed storage in temperatures such as are used for peaches, grapes, plums, etc., results in the blackening of the interior of the avocado. These temperatures appear to be endured without injury for about three or four weeks. It is recommended that the mercury should not fall below 40° F. It is important that the room on the ship should be cooled as rapidly as possible so that the fruit will immediately give off its heat and a uniform temperature should be maintained throughout the voyage.

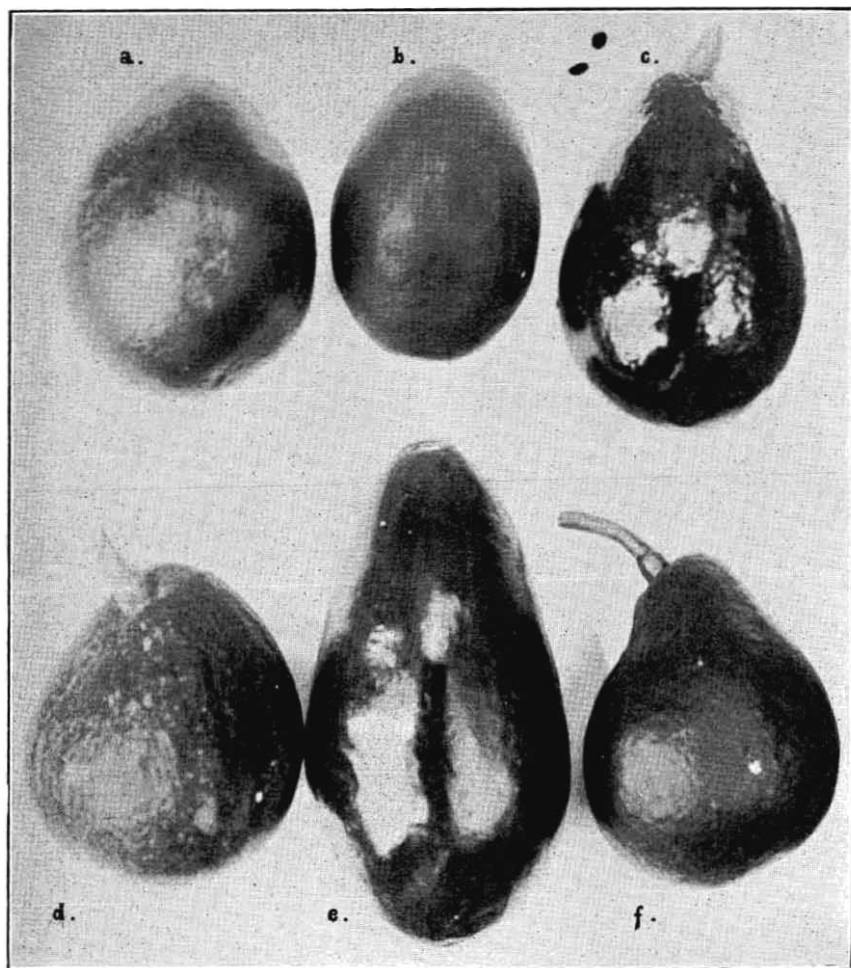
#### SELLING THE FRUIT.

Good avocados sell at wholesale in the San Francisco market for \$2 to \$3 per dozen and selected fancy stock is sold as high as \$5 per dozen. To bring a high price at wholesale it is essential that the fruit be hard. If any softening is apparent the dealers are afraid to buy because the fruit so rapidly deteriorates after this condition is reached. In most of the large American markets where the avocado is known the demand appears to keep ahead of the supply, unless overripe fruit is dumped upon the market. If the supply were constant even in season the demand would increase much more rapidly. It must not be expected, however, that these high prices will prevail always. As the industry becomes established lower prices will follow, which will put the fruit within the reach of a much larger class of consumers.

At the present time the avocado is a special fruit for a special market. As such, it does not seem that the present method of shipping it on consignment is most suitable unless the commission house makes a specialty of such rare products. The average commission house is rushed with larger business. One of the best methods of disposing of first-grade avocados is by direct sale to the large hotels, restaurants, and clubs. Here they can be made use of without undue delay and by this means that part of the public which is best able to pay for a high-priced fruit becomes familiar with it.

#### BREEDING THE AVOCADO.

There are several means available to him who would improve the avocado. First, he may select trees of unusual excellence already in existence and propagate them by asexual means. This phase of the subject is discussed elsewhere (see p. 12), and by it alone great progress may be made toward establishing fine varieties. It is not improbable that by this means the seedless avocado may be found. There is a tree in Honolulu which has for two years produced two or more seedless fruits (Pl. V, fig. 1). It has not been possible to learn whether these fruits were produced on the same branch in



PARENT AND PROGENY, SHOWING SOME RESULTS FROM SEED PROPAGATION. b, PARENT TYPE; a, c, d, e, f, SOME TYPES AMONG THE PROGENY.

[The differences in color, flavor, texture, and other characters are even more marked than those of form.]

both years. It is, therefore, quite uncertain whether the seedless condition was due to a bud variation or to other causes. Prof. P. H. Rolfs also records a seedless avocado.<sup>1</sup> Another important factor is good culture and judicious fertilization to which the trees respond readily (see p. 18). The next step in advance is thorough seed selection and by means of these two chiefly has the species been brought to its present status. Much seed selection has been carried on in Hawaii by amateur growers and credit is due to them for the many excellent kinds that now enrich Hawaiian gardens. Many interesting experiences have been related in conversation by those who have grown the fruit during a lifetime. The experience of Dr. William T. Brigham with seed selections of the avocado is one of the few that has been recorded by a scientific observer.<sup>2</sup> It is in part as follows:

In 1888 I was supplied with very good paltas of the purple variety grown by a friend in Pauoa Valley. As these were of one variety (Pl. VII, b.),<sup>3</sup> I selected the best fruits; that is, those that tasted best and had the best form, without consideration of the bearing qualities of the parent tree. In 1890 I took six of the most vigorous plants resulting from these selected seeds to my present residence on Judd Street and planted all but one in the ground on the lee side of the house, as this tree needs shelter from the winds, which are often strong in that part of Nuuanu Valley.

The soil was not originally good and the place was rocky, but by blasting out the most objectionable ledges and replacing them with earth removed from the site of the house, which was then enriched with both natural and chemical manures, a fair chance was given the young trees, which grew well. The fruiting results were curious. One on a more rocky bed produced a small green fruit much inferior to the parent, and as the tree was in the way I cut it down. Another tree in perhaps the richest part of the yard grew well, but the fruit of the first bearing was green, rough skinned, and watery. \* \* \* It was disappointing, but careful cultivation wrought a great change the next year, the product being shown [at "d" and "f" in Pl. VII], and the change was not merely one of size, but the quality of the fruit was entirely changed from a watery, tasteless fruit to a pale yellow, rich, custard-like fruit, not so oily as the average pear of the market. It is a good bearer yearly, and the fruit sets well, but does not keep as well as the purple varieties, although the skin is thick and tough.

My best tree, so far as growth and size and quality of fruit go, is one for which I had no very good place, and so left it in the box in which it was transported from the nursery. In time the bottom of the box rotted, the roots penetrated deep into a rich bed around a fountain basin, and as the tree grew very luxuriantly I left it to fruit and show its quality. The result was a long, smooth, green fruit, with a rich, dark orange, nutty-flavored meat and very small seed. The fruit shown [at "e," Pl. VII] is from this tree and weighed 32 ounces. So far as the quality of the fruit is concerned, I could ask for nothing better, but while the tree blossoms early with the greatest profusion very few fruits come to maturity, and these are apt to decay at the stem end if not picked promptly.

Another tree much resembled the parent, \* \* \* it was purple. The best all-round tree of the lot bears annually a good crop of well-sized (16 to 18 ounces) purple fruit shown [at "a" and "c," Pl. VII]. These \* \* \* have sufficient

<sup>1</sup> U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 61, p. 28.

<sup>2</sup> Hawaiian Forester and Agriculturist, 3 (1906), No. 5, pp. 144-147.

<sup>3</sup> The references are to a new plate, taken from plaster casts of the fruit, furnished by Dr. W. T. Brigham.

meat and medium-size seed. Keeping qualities are good, and they have been sent to Sydney, New South Wales, in good condition, and on the tree a succession of fruits has extended the season to six months (April to October).

The above experience corresponds in general with that of many growers, and calls attention to the extreme uncertainties of seed production, and also to the possibilities of improvement by this means. It is impossible to state whether this extreme divergence in form, texture, coloring, and other qualities was the expression of latent characters in the tree from which the seed was taken or the result of accidental cross-pollination.

This suggests the further step for the avocado breeder in the hand pollination of the flowers, by this means segregating the characters of certain individuals or combining them with those of other varieties. But this phase of the problem can only be touched upon here, since in its entirety it would lead far beyond the limits of the present paper.

The ideals which the avocado breeder should have in mind are form of tree, resistance to cold, disease resistance, yield, extension of season, shipping qualities, size, quality, flavor, color, texture, elimination of the seed,<sup>1</sup> and increasing the flesh. The breeder should endeavor to learn as early in the work as possible what correlation there may be between any characters. For example, if it can be determined that high fiber content is associated with certain foliage characters it will be possible to eliminate a large number of seedlings without further test, and thus greatly economize in time and in the orchard space required for trial purposes.

## THE AVOCADO AS FOOD.

### FOOD VALUE.

It is believed that the avocado has a fairly high food value in comparison with other succulent fruits. This is due in a large measure to its high content of fat, approximating from 10 per cent to 17 per cent of the total weight of the edible portion of the fruit. Mr. C. Alberto Garcia, of the Institute of Hygiene, Lima, reports<sup>2</sup> 34 per cent of fat, 3.8 per cent of protein, and no soluble carbohydrates, and further states that it is proposed to use the avocado for the alimentation of consumptives and diabetics.

Gross analyses of over 40 varieties of avocados have been made by C. J. Hunn, the results of which are recorded in the following table:

<sup>1</sup> See S. P. I., Numbers 14889 and 14890 (p. 40).

<sup>2</sup> Bulletin Assoc. Chim. Sucr. et Distill., 25 (1907), No. 5, pp. 516, 517; Chem. Abs., 2 (1908), No. 7, p. 1019.

*Analyses of avocados.*

Size.	Total weight.	Edible.	Seed.	Rind.
	Ounces.	Per cent.	Per cent.	Per cent.
Maximum.....	36	83.0	35.0	15.0
Minimum.....	5	55.0	10.0	6.0
Average.....	16.66	73.0	17.6	9.4

The Maine Experiment Station records<sup>1</sup> analyses showing edible portions, 71 per cent; seed, 20 per cent; and rind, 9 per cent. A later analysis<sup>2</sup> at the same station shows edible portion, 65 per cent; seed, 24 per cent; and rind, 11 per cent. It will be seen that in some varieties the seed constitutes too large a proportion of the fruit.

No chemical analyses of the avocado have been made at the Hawaii experiment station. The following table<sup>3</sup> shows the results of analyses made at the Maine and the Florida experiment stations, and includes, for purpose of comparison, similar data regarding a number of common food products:

*Composition of the edible portion of the avocado and other foods.*

Food products.	Water.	Protein.	Fat.	Carbohydrates.		Ash.	Fuel value per pound.
				Nitrogen-free extract.	Crude fiber.		
Avocado (analyzed at the Maine station).....	<i>Per cent.</i> 81.1	<i>Per cent.</i> 1.0	<i>Per cent.</i> 10.2	<i>Per cent.</i> 6.8	<i>Per cent.</i> .....	<i>Per cent.</i> 0.9	<i>Calories.</i> 554
Avocado (analyzed at the Florida station).....	72.8	2.2	17.3	4.4	1.9	1.4	854
Pickled ripe olives.....	65.1	15.7	25.5	3.7	.....	.....	1,201
Pickled green olives.....	78.4	16.9	12.9	1.8	.....	.....	680
Apples.....	84.6	.4	.5	13.0	1.2	.3	290
Bananas.....	75.3	1.3	.6	21.0	1.0	.8	460
Pears.....	84.4	.6	.5	11.4	2.7	.4	295
Coconuts.....	14.1	5.7	50.6	27.9	.....	1.7	2,760
Chestnuts, fresh.....	45.0	6.2	5.4	40.3	1.8	1.3	1,125
Potatoes.....	78.3	2.2	.1	18.0	.4	1.0	1,385
Wheat flour.....	12.0	11.4	1.0	74.8	.3	.5	1,650

<sup>1</sup> Including ash.

**METHODS OF SERVING.**

The avocado is primarily a salad fruit, but there are many ways in which it may be served. The simplest treatment is to cut open the fruit longitudinally, remove the seeds, and serve, affording everybody the opportunity to add salt, pepper, vinegar, olive oil, lime juice, or other seasoning in any combination to suit the individual taste. Some prefer it as a dessert with sugar, sugar and cream, or

<sup>1</sup> Maine Station Bulletin 75.

<sup>2</sup> Maine Station Bulletin 158.

<sup>3</sup> U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 77.

with wine and lemon or orange juice. It may be served on the side with soup, and in this way is delicious. By permission of the authors, the following recipes, indicating the manner in which the fruit is served in Hawaii, are here reproduced:<sup>1</sup>

**Avocado cocktail.**—1. Cut fruit into dice, or small pieces, and serve in glasses with cocktail sauce made of tomato catsup and lemon juice and season with salt and pepper. Serve ice cold with chopped ice.

2. Mash the fruit and beat it up with the cocktail sauce. Serve in the same manner.  
**Avocado salad.**—In preparing avocado salad one may either cut it into dice, scoop it with a spoon, or mash it and mix with the dressing.

**Avocado vegetable salad.**—Combine sliced avocado, cucumber, tomato, and a few shreds of Chili pepper and serve with mayonnaise or French dressing.

**Avocado salad with string beans.**—Combine equal parts of cooked string beans and avocado and serve with French dressing.

**Avocado salad in tomatoes.**—Push the avocado through a potato press, mix with mayonnaise dressing, strong with mustard, and fill peeled and partly scooped out tomatoes with the avocado.

**Avocado served in skin.**—Cut avocado in half, remove seed, and serve with one of these five dressings: (1) Sugar; (2) salt and vinegar; (3) tomato catsup; (4) salad dressing; (5) French dressing.

Or partly fill the cavity with sliced celery and sliced walnuts and cover with mayonnaise.

**Avocado aspic salad, 1.—**

$\frac{1}{2}$ box gelatin.	2 cups mashed avocado pulp.
$\frac{1}{2}$ cup cold water.	Juice $\frac{1}{2}$ lemon.
1 cup boiling water.	Salt, cayenne.

Soak the gelatin in the cold water one-half hour. Dissolve in the boiling water. Strain and add the fruit pulp, which has been flavored with salt, cayenne, and the lemon juice. Place on ice to harden. Serve with mayonnaise.

**Avocado aspic salad, 2.—**

$\frac{1}{2}$ box gelatin.	2 tablespoons sugar.
$\frac{1}{2}$ cup cold water.	Juice of 2 lemons.
$1\frac{1}{2}$ cups boiling water.	2 tomatoes.

1 good sized avocado.

Soak the gelatin in the cold water one-half hour. Dissolve in the boiling water. Strain and add sugar and lemon juice. Cut the avocado and tomato in cubes. Place a mold in ice water and pour in a layer of jelly, then avocado and tomato. Add a little jelly to keep the fruit in place and when set add more and more fruit. Place on ice to harden. Serve with mayonnaise. This and the preceding salad may be molded in individual molds and served in nests of lettuce leaves.

**Avocado sandwiches.**—Slice the fruit with chopped chili peppers or cayenne and place between thin slices of buttered bread.

**Avocado ice cream—**

Yolks 5 eggs.	2 cups sugar.
1 quart milk.	4 medium-size avocados.
Green maraschino cherries.	Almond and vanilla extracts.

Make a boiled custard with the milk, eggs, and 1 cup sugar, and flavor with vanilla. Mash the fruit to a pulp with 1 cup sugar and flavor with almond extract. When the custard is cool, add the fruit and freeze. Serve in mounds with a green maraschino cherry on top of each dish.

<sup>1</sup> Jessie C. Turner and Agnes B. Alexander, *How to Use Hawaiian Fruits*. Honolulu, 1910, pp. 7, 8.

## PRESERVING THE FRUIT.

Few references have been found to any attempts at preserving avocados. The Hon. W. Fawcett<sup>1</sup> refers to the successful sterilizing and bottling of the fruit: "The fruits were sterilized at 150 to 155° F. for four hours, the water being sterilized the previous day at 150° F. for one hour." Whether the process affected the flavor or texture of the fruit is not recorded.

## VARIETIES.

There are few established and well-known varieties of the avocado. In this respect it differs from the mango, its compeer among tropical fruits, and apparently for several reasons. First, the species seems extremely variable by nature, a fact to which attention has already been called. Further, it has been under cultivation by civilized man for only a few centuries, while the mango is the product of the hoary civilization of India, and even yet can not be relied upon to reproduce its varieties accurately by seed. Finally, there has been until recently no method of asexual propagation recognized as adapted to the avocado.

With few exceptions, the classifications hitherto have been of types rather than varieties. It was useless to talk of varieties when there was no means available for the perpetuation of the characters which constitute varietal differences. At the present time every seedling must be regarded as a variety, and the characters of each must be carefully scrutinized to determine which are worthy of being reproduced. This work is being carried on with a large number of individuals, and a few have been described, tested, named, and placed upon the trade lists of tropical fruit plants. Some of the better-known varieties are described below:

## TRADE VARIETIES.

**Chappelow.**—Form oblong, slender, pyriform, or bottle-necked; size medium to large for the Mexican type; cavity small, shallow, and wrinkled; stem stout; surface undulating, smooth, glossy; color dull purple, with reddish-brown dots; apex a mere dot; skin very thin, tender, adhering closely; flesh pale greenish-yellow, buttery; seed large in proportion to size of fruit, roundish conical, filling internal cavity; flavor pleasant, though less rich than the best varieties of the West Indian type. Season, July to October at Monrovia, Cal.

The tree is a vigorous, rather diffuse grower, with slender wood. It is productive, although being an early bloomer it is sometimes caught by frost. It is considered worthy of testing in the thermal belts of southern California, and for domestic use along the northern edge of the avocado districts of Florida, where its superior hardiness is likely to outweigh the disadvantages of relatively small size and early time of ripening.<sup>2</sup>

<sup>1</sup> Ann. Rpt. Bd. Agr. and Dept. Pub. Gard. and Plantations, Jamaica, 1905, p. 11.

<sup>2</sup> U. S. Department of Agriculture Yearbook 1906, pp. 364, 365.

**Pollock.**—Tree moderate grower, heavy bearer, profuse bloom, limbs rigid; blooms in February and March; ripens in September and October. Upright grower with strong central stem.

Fruit pear shaped, being about  $6\frac{1}{2}$  by  $4\frac{1}{2}$  inches; weight up to  $3\frac{1}{2}$  pounds; color greenish; rind medium; meat yellowish; flavor good; seed medium. Buds take readily, and this variety is desirable on account of very large fruits. Named for Mr. Pollock, of Miami, Fla., who owns the original tree. (Rolf.)<sup>1</sup>

**Trapp.**—Form roundish oblate to oblate pyriform; size medium to large; cavity regular, small, shallow, with gradual slope, somewhat furrowed; stem stout; apex slightly depressed; surface smooth and undulating, with numerous brownish dots, some of which are indented; color pale green, with faint and indistinct pale-yellow stripes; skin very thick and tough, separating readily from the flesh; flesh fairly thick, firm, but smooth and rather oily in texture, ranging from pale green near the skin to greenish yellow next the seed cavity; flavor mild, pleasant; seed large, oblate, with loose seed coats, and loose in the cavity, sometimes germinating in the fruit when allowed to remain late on the tree, though, so far as observed, without injury to either texture or flavor of flesh; quality very good. Season, from October 1 to January in south Florida, occasional specimens having remained on the tree in good condition until March.

The tree is reported to be a fairly vigorous grower and very productive.

The striking commercial characteristic of the variety is its lateness of ripening, which renders it remarkable for the midwinter holiday trade, when very high prices are realized. A large proportion of the budded trees thus far planted in Florida consists of this sort.<sup>2</sup>

#### VARIETIES UNDER TEST ON THE MAINLAND.

The Office of Seed and Plant Introduction of the United States Department of Agriculture has now under test a large number of promising varieties. So far as published this list consists of the following:

**S. P. I. No. 3390.**<sup>3</sup>—From Santiago, Chile. Received through Messrs. Lathrop and Fairchild, June, 1899. Said to be very hardy, standing a temperature of  $-5^{\circ}$  C. Even snows have not injured it. By some it is said to be indigenous to Chile, but it is certain that until 1874 it was quite unknown as a fruit here. This is a black-fruited hardy variety. Some of the fruits are stringy, while others are of fine quality. Scions of this variety sell in France for from \$1 to \$1.25 each. (D. G. Fairchild.)

**S. P. I. No. 9001.**<sup>4</sup> From Aburi, Gold Coast, Africa. Presented by the curator of the Botanic Gardens. Received September 5, 1902.

**S. P. I. Nos. 10615 to 10620.**<sup>5</sup> From Honolulu, Hawaii. Presented by Mr. Donald MacIntyre, Moanalua Gardens, Honolulu. Received April 22, 1904.

**No. 10615. Large Purple.** Flesh thick, of good, nutty flavor, yellow and fiberless; seed comparatively small, about one-fourth of fruit; crop medium; pear shaped; length and diameter over standard (4 by 6 inches). (No. 1.)

**No. 10616. Small Green.** Flesh not thick and without nutty flavor, but quite fiberless and rather sweetish; fruit roundish, length in diameter about  $4\frac{1}{2}$  inches; late, heavy bearer, constant cropper. (No. 4.)

<sup>1</sup> U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 97, S. P. I. No. 12936.

<sup>2</sup> U. S. Department of Agriculture Yearbook 1905, p. 510.

<sup>3</sup> Seed and Plant Introduction number. U. S. Department of Agriculture, Div. Bot. Inventory 7.

<sup>4</sup> U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 66.

<sup>5</sup> U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 97.



**No. 10617. Large Green Round.** Flavor good but not nutty; length and diameter about  $5\frac{1}{2}$  by 5 inches; crop uncertain. (No. 3.)

**No. 10618. Large Green.** Best of all in flavor; flesh smooth, firm, and fiberless; seed small; decidedly bottle necked; length 7 inches, diameter about 4 inches; late cropper, but crop fairly constant; ripening about middle of June; seed small. (No. 6.)

**No. 10619. Small Green.** A very early variety, not of best flavor, with fiberless fruit; seed large; not decidedly pear shaped; good grower and constant cropper; ripening about May 25; earliest variety in Honolulu. (No. 5.)

**No. 10620. Large Green.** Flavor decidedly nutty and good; flesh yellow, fiberless; length and diameter of fruit about standard; crop light, ripening about the middle of June. (No. 2.)

**S. P. I. No. 10978.<sup>1</sup>** From Guatemala. Presented by Hon. Alfred A. Winslow, consul general, Guatemala, Central America. Received May 23, 1904.

**S. P. I. No. 11724.<sup>1</sup>** From Durban, Natal. Presented by Mr. J. L. Elmore. Received September 30, 1904.

**S. P. I. Nos. 12933 to 12937.<sup>1</sup>** From Miami, Fla. Propagated by Prof. P. H. Rolfs, pathologist in charge of subtropical laboratory. Numbered February 21, 1905.

**No. 12933. Baldwin.** Tree a vigorous grower, with strong central stem; branches rather rigid; light bloomer, but heavy cropper. Blooms in February and March. Fruit at best in August; drops in September. Ripens uniformly. Shape of fruit approaching oblong, 4 by  $5\frac{1}{2}$  inches, not regular; color green, with a few yellowish streaks; rind smooth, thin; stem small; meat deep cream, one-fourth green, firm; flavor excellent. Seeds are rather large, firm in cavity. Buds do not take readily. Named for Mr. Baldwin, of Miami, Fla., who owns the original tree. (Rolfs.)

**No. 12934. Chappelow.** (See page 37.)

**No. 12935. Family.** A strong growing tree of spreading habits, being an abundant bloomer and moderate cropper. Blooms in late February and during March. Ripens fruit during July, August, September, and into October. Shape of fruit variable, from pear shaped to long oblong, nearly banana shaped; size, variable from 6 by  $3\frac{1}{2}$  to  $3\frac{1}{2}$  by  $1\frac{1}{2}$  inches; color purple, with scarlet streaks, very attractive; skin medium thick, smooth; stem large; meat yellow, free from fiber; flavor good, seed small, loose in cavity. The principal merit of this variety lies in extending its period of ripening over so long a time, being distinctly useful for family purposes, but should not be planted for commercial purposes, as the extended ripening period necessitates several pickings. Buds take readily. (Rolfs.)

**No. 12936. Pollock.** (See page 38.)

**No. 12937. Trapp.** (See page 38.)

**S. P. I. No. 13292.<sup>1</sup>** From Coban, Guatemala. Received through Mr. G. N. Collins and Mr. C. B. Doyle, March, 1905. This thick-skinned type of avocado is very distinct from the varieties commonly found on the markets and from those grown in Florida, the West Indies, and Mexico. It is believed that they will stand shipping much better than the thinner-skinned sorts, and as the quality is fine they should be a valuable acquisition for Porto Rico and Hawaii. (Collins.)

**S. P. I. Nos. 13729 to 13731.<sup>1</sup>** From Miami, Fla. Presented by Mr. George B. Cellon to the subtropical laboratory through Mr. S. B. Bliss. Received April 12, 1905.

**No. 13729. Baldwin.** (See above.)

**No. 13730. Haden.**

**No. 13731. Rico.**

**S. P. I. Nos. 14435 and 14463.<sup>1</sup>** From Mexico. Secured by Prof. P. H. Rolfs, in charge of the subtropical laboratory, Miami, Fla., while traveling in Mexico as agri-

<sup>1</sup> U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 97.

cultural explorer of the Office of Seed and Plant Introduction in April, May, and June, 1905.

**No. 14435.** A small quantity of budwood secured from a tree that blooms in January and ripens fruit in May. The special value of this particular tree lies in the fact that it ripens in so short a time after blooming. The fruit, although delicious and otherwise good, is too small to prove of value on the market. Its special value, however, lies in the fact that when it comes into bearing it can be used for hybridizing with the early forms that do have marketable fruit, and consequently the introduction is very desirable. (Lab. No. 295.) (Rolfs.)

**No. 14463.** Seed of the tree referred to under No. 295. (Lab. No. 339.) (Rolfs.)

**S. P. I. Nos. 14889 and 14890.**<sup>1</sup> From City of Mexico, Mexico. Presented by the American ambassador. Received July 13, 1905.

**No. 14889.** Seedless.

**No. 14890.** Seedless Butter.

**S. P. I. No. 15656.**<sup>1</sup> From Miami, Fla. Received through Col. G. B. Brackett, from Prof. P. H. Rolfs, September 5, 1905.

**S. P. I. No. 16170.**<sup>1</sup> From Monte, Grand Canary. Received through Mr. Alaricus Delmard, Hotel Santa Brigida, November 2, 1905.

**S. P. I. No. 16871.**<sup>2</sup> From Miami, Fla. Presented by Mr. S. B. Bliss. Received December 18, 1905. Trapp. (See p. 38).

**S. P. I. No. 18120.**<sup>2</sup> From Bayamon, P. R. Presented by Mr. A. B. Mitchell. Received March 19, 1906.

**Mitchell.** A very superior variety. Size, large; color of flesh, dark yellow; flavor, excellent. Base, usually slender. Seed, medium to large. (Barrett.)

**S. P. I. Nos. 18729 to 18731.**<sup>2</sup> From Bahama Islands, British West Indies. Collected by Mr. P. J. Wester in April, 1906.

**No. 18729. Johnstone.** Budwood secured through Judge R. S. Johnstone, who gave the following description of the fruit: "Pear shaped, but rather broad at basal end; skin smooth, thin; flesh yellow, almond flavored; seed large; famous as the best avocado in the Bahamas. Ripens in August and September." (Lab. No. 462.) (Wester.)

**No. 18730. Largo.** Budwood presented by Mr. C. H. Matthews, from a large tree. He described the fruit as follows: "Egg shaped; very large,  $3\frac{1}{4}$  to 4 pounds in weight; skin green, very thin; flavor very good; seed small; ripens in August and September." (Lab. No. 464.) (Wester.)

**No. 18731. Grant.** Buds secured from a tree in Grantown, said by its colored owner to bear extra early fruit of good quality. The young fruits were well advanced in size for the season when the budwood was obtained, which seemed to substantiate the owner's assertion. (Lab. No. 465.) (Wester.)

**S. P. I. No. 19058.**<sup>3</sup> From Guatemala. Received through Mr. G. N. Collins, of the Bureau of Plant Industry, in the summer of 1906. Seeds of a thick-skinned variety.

**S. P. I. Nos. 19079 to 19082.**<sup>3</sup> See 19058. Plants.

**S. P. I. No. 19094.**<sup>3</sup> From Key Largo, Fla. Received through Mr. Edward Gottfreid, August 15, 1906. Seeds of a type of avocado described as follows: Shape, ovoid to roundish, obliquely marked. Seed medium, fitting very tightly in cavity and having a closely adherent seed coat which does not remain attached to cavity wall upon removal of seed. Flesh comparatively thick, practically fiberless; relatively large proportion of "green." Flavor medium to good. Skin more granular than leathery, thickish, separating readily from pulp. Name suggested for this variety, "Gottfreid." (Barrett.)

<sup>1</sup> U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 97.

<sup>2</sup> U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 106.

<sup>3</sup> U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 132.

**S. P. I. Nos. 19146 and 19147.**<sup>1</sup> From Querétaro, Mexico. Presented by Sr. M. M. Urquiza. Received September 4, 1906.

Cuttings of two unnamed varieties.

**S. P. I. No. 19151.**<sup>1</sup> From Campeche, Mexico. Presented by Mr. F. Foex. Received September 4, 1906. Though coming from a hot country, it was fine and delicate, very big, and of good shape. (Foex.)

**S. P. I. No. 19167.**<sup>1</sup> (See 19146.) September 7, 1906. Seed.

**S. P. I. No. 19196.**<sup>1</sup> From Parras de la Fuente, Coahuila, Mexico. Presented by Dr. A. Walther, through Mr. O. W. Barrett, September 17, 1906.

Cuttings of a hardy avocado.

**S. P. I. No. 19206.**<sup>1</sup> (See 19196.) September 20, 1906. Seeds of a green-fruited variety; probably identical with budwood sent under No. 19196. (Barrett.)

**S. P. I. No. 19297.**<sup>1</sup> From Coconut Grove, Fla. Propagated at the subtropical laboratory and garden, Miami, Fla., and numbered for convenience in recording distribution, November 3, 1906.

**Wester.** (Lab. No. 551.) The seed was planted 35 years ago (1871) by John Thomas Peacock, but he can not recollect from where it came—probably, however, from Key West. The tree is now (November, 1906) 25 feet tall, with a spread of 28 or 30 feet and a diameter of 15 inches 1 foot above the ground, and is vigorous and thrifty. According to Mr. Peacock, the tree has been a heavy bearer every year since it began to bear. (Wester.)

**S. P. I. Nos. 19377 to 19380.**<sup>1</sup> From Hawaii. Seedling avocados grown from seeds taken from fruits shipped to the office of pomological investigations of the Bureau of Plant Industry in 1904; turned over to the office of seed and plant introduction and distribution on November 7, 1906. The fruits from which these seeds were taken were of excellent quality, those of Nos. 19379 and 19380 being exceptionally fine. The quality of No. 19380 was, I think, the finest of any avocado I have tasted, notwithstanding its long journey in cold storage to San Francisco, express from there to Lodi, iced car from there to New York, and express from New York to Washington, which variable temperature and surroundings are, of course, likely to injure the flavor and quality of any such fruit. (Taylor.)

**S. P. I. No. 21699.**<sup>1</sup> From Lima, Peru. Presented by Mr. T. F. Sedgwick, director, Estacion Experimental, through Mr. O. W. Barrett. Received December 20, 1907.

**S. P. I. No. 24439.**<sup>2</sup> From Kingston, Jamaica. Received through Mr. William Harris, superintendent of public gardens, Department of Agriculture, Hope Gardens, January 5, 1909. Seeds.

**S. P. I. Nos. 25614 to 25617.**<sup>3</sup> From Chile. Received through Mr. José D. Husbands, Limavida, Chile, June 8, 1909. Paltos, Chile classes, of excellent quality, somewhat smaller than those of Peru. (Husbands.)

#### HAWAIIAN VARIETIES.

The Hawaii Experiment Station has under observation many of the Hawaiian varieties, of which about 65 have been described in detail by C. J. Hunn. The following tentative descriptive blank for the recording of data relating to avocado varieties has been devised.

<sup>1</sup> U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 132.

<sup>2</sup> U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 162.

<sup>3</sup> U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 168.

# A DESCRIPTIVE BLANK FOR THE AVOCADO.

PERSEA GRATISSIMA

AV. SER. NO.

VAR. NAME

LOCATION

GROWER

Origin

Bearing Age

Age

{seedling  
budded

True to Type

CONDITIONS:

Soil  
Moisture

Temp. {max.  
min.

Altitude

Sun  
Wind

Tillage

Fertilizer

Drainage

{space  
allotment

Distance from  
other Av. T.

TREE: {height  
spread

Shape {slender, open-headed, round,  
spreading, close-headed, irreg.

{weak  
vigorous

Trunk {slender, single,  
stout, divided

Bark

Foliage {sparse, deciduous  
dense, part. decid.

Branches {ascending, abundance  
drooping, dist. ground

Pruning {not pruned, thinned  
pruned up, beheaded

LEAVES: Shape

{base  
apex

{length  
breadth

Surface

{glabrous, tomentose, smooth, rugose,  
pubescent, lanate, rough, corrugated

Color {young  
mature

Flowers

{color  
abundance

{blooming period  
weather at—

Crop

{size  
season

{commercial value  
productiveness

Market

{place  
demand

{keeping quality  
shipping quality

Diseases  
Insects

{Remedies  
Remedies

{Success  
Success

FRUIT: {weight  
% edible

{% seed  
% rind

{size  
dim. (2)

Type

{round, bottle-necked,  
pyriform, oblong

{symmetry  
maturity

Uniformity

{shape  
size  
color

Fruit Cavity

{flaring, rounded, reg. depth  
abrupt, sloping, irreg. breadth

{color  
sp. gr.

Stem

{length  
thickness

{color  
persistence

Apex

{depressed, dot.  
flattened, opening

RIND

{hard, coriaceous, smooth, papillose, pitted,  
soft, granular, scabrous, ribbed, foveolate

Bloom

{scant.  
abund.

Color

{markings  
peeling qual.

Thickness {rel.  
act.

Dots

{color  
size

{shape  
abund.

{raised  
depressed

Pulp

{coarse, juicy  
fine-grained, dry

Fiber

{abundance  
dist. base

Thickness {rel.  
act.

Color

Consistency

{melting, oily  
buttery, watery

Flavor

{poor, mild, rich  
pleasant, nutty

Seed

{size  
dim. (2)

{shape  
color

Cavity

{loose  
tight

Surface

{smooth  
rugose

Plumule

{devel.  
locat.

SEED COATS

{number  
distinct.

{length  
form

{reticulated  
granular

{color  
thickness

Attachment

SEED CAVITY

{shape  
size

REMARKS:

SUMMARY:

{poor, fair  
good, excellent

Date

Place

Observer

Hawaii Experiment Station

Horticultural Department

The following varieties <sup>1</sup> of special merit are described or mentioned below.

**No. 149.**<sup>2</sup> About 20 years ago Admiral Beardsley, leaving Guatemala for Hawaii, carried with him a number of avocados for consumption on the way. He saved two seeds, wrapping them in cotton-wool and packing them in ice. Arriving in Honolulu, he gave one seed to Judge Wiedeman and the other to Mrs. E. K. Wilder. The former was planted at 1402 Punahou Street, now occupied by "The McDonald," and although both seeds grew, the "McDonald" is far superior in quality and blooms earlier.

Form roundish to spherical, size medium to medium large; cavity small, shallow, and flaring; stem somewhat slender and very long, varying from 6 inches to 15 inches in length; surface undulating, very hard; coriaceous and markedly pitted; color dark olive green to purple with small, very abundant, irregular-shaped yellowish dots; apex a mere dot, slightly depressed; skin very thick and woody, separating freely from the pulp; flesh yellow in color, running into green at the skin; fine grained, oily and somewhat buttery, 75 per cent of fruit; seed fairly large, roundish conical, just a trifle loose in the cavity; flavor rich and nutty. Season July to January.

The tree is quite vigorous, but tends to grow upward rather than to branch out, possibly due to confinement. This pear is especially noteworthy, since it will keep for a long time after being removed from the tree. Mr. G. P. Wilder reports that he has kept the fruit for two and one-half weeks after removal from the tree. The tree carried fruit over through the blossoming period of the following season. Height 40 feet, spread 20 feet.

Valuable as a late avocado. Its woody skin, which is really a shell, is in its favor for shipping.

**Moanalua.** A chance seedling 19 years of age growing on the estate of Hon. S. M. Damon, Moanalua.

Form pyriform; size small to medium; cavity flaring, deep; stem somewhat short, rather thick; surface undulating, hard, coriaceous and slightly pitted; color dark green with medium abundant, small, irregular-shaped yellowish dots; apex a mere dot; skin medium thick, separating readily from the pulp; flesh yellowish in color, running into green at the rind, fine grained, melting and somewhat buttery, 70 per cent of the fruit; seed medium large, conical, fitting tightly in the seed cavity; flavor rich and nutty. Season, July to September.

The tree is very vigorous. Height 30 feet, spread 25 feet.

**No. 150.**<sup>3</sup> A chance seedling whose origin and age are unknown.

Form pyriform; size small to medium; cavity shallow and somewhat rounded; stem short and medium thick; surface undulating, medium hard, coriaceous, slightly pitted; color green with reticulate-like markings, with medium large somewhat circular yellowish dots; apex a mere dot; skin very thin, separating readily from the pulp; flesh yellow, melting, but a trifle watery, 70 per cent of the fruit; seed medium large, conical, fitting loosely into the cavity; flavor pleasant. Season, middle of May to July.

Valuable because of its earliness. Height 30 feet, spread 20 feet.

**No. 145.**<sup>4</sup> A chance seedling about 15 years of age; origin unknown.

Form pyriform; size small to medium, cavity shallow and somewhat abrupt; stem medium long and quite thick; surface undulating, hard, coriaceous and slightly pitted and mottled; color green with small, very abundant yellowish dots; apex a lepressed dot; skin quite thin, separating fairly well from the pulp; flesh yellow, running into green at the rind, fine grained, oily, and somewhat buttery, 60 per cent

<sup>1</sup> These numbers represent Hawaii Experiment Station avocado series.

<sup>2</sup> Hawaii Station Report, 1910, p. 28.

<sup>3</sup> Hawaii Station Report, 1910, pp. 28, 29.

<sup>4</sup> Hawaii Station Report, 1910, p. 29.

of the fruit; seed very large, conical, fitting loosely in the cavity; flavor rich and nutty. Season, September to January.

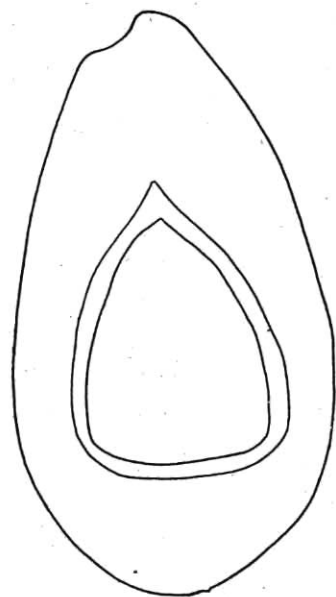


FIG. 2.—Variety 105.

This tree is very vigorous and very symmetrical. Height 25 feet, spread 25 feet.

**No. 105** (fig. 2). A seedling avocado about 15 years of age. It is quite similar to its parent except in that it is smaller.

Form pyriform; size medium; cavity large, shallow, abrupt, and regular; stem inclined to be short and thick, persistence good; surface undulating, hardness medium, slightly pitted and ribbed; color green with light green splashes; dots very abundant, small, depressed, irregular-shaped and yellowish; apex a mere dot; skin quite thin, separating readily from the flesh; flesh cream in color, running into green at the rind, thickness medium, fine-grained, medium dry and melting, fiber traces, flesh 73 per cent; seed medium large, conical, fitting loosely into the seed cavity; seed coats, one adhering to the seed and one to the flesh; flavor pleasant and nutty; quality excellent; season, July to August.

Tree, height 35 feet, spread 25 feet, open-headed, spreading, foliage dense, not vigorous.

**No. 106** (fig. 3). A seedling avocado about 12 years of age.

Form pyriform; size medium; cavity small, shallow, and flaring; stem short and thin, persistence poor; surface undulating, hardness medium, and somewhat scabrous; color olive green with light green stripes; dots numerous, small, raised, irregular shaped and yellowish; apex a mere dot; skin quite thin, separating fairly well from the flesh; flesh cream in color, running into green at the rind, thickness medium, fine-grained and dry, inclined to be a little buttery, fiber traces, flesh 68 per cent; seed small, conical, fitting tightly into the cavity; seed coats, one attached to the seed and one to the flesh; flavor pleasant and nutty; quality excellent; season, July to August.

Tree, height 25 feet, spread 20 feet, slender, open-headed, foliage scant, not vigorous, bearing small crops.

**No. 108** (fig. 4). A seedling avocado about 9 years of age.

Form pyriform; size medium; cavity small, deep, and rounded; stem short and thick, persistence fair; surface undulating, hardness medium, scabrous and pitted; color light green with yellowish green spots and splashes of yellow; dots very numerous, small, depressed, irregular-shaped, yellowish; apex a depressed dot; skin thick separating well from the flesh; flesh cream, running into green at the rind; thickness medium, coarse, juicy and watery, fiber quite abundant, flesh 73 per cent; seed large, conical, fitting tightly into the cavity; seed coats both attached to the seed; flavor mild; quality fair; season, August to October.

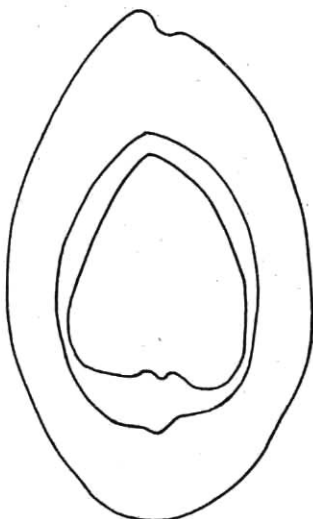


FIG. 3.—Variety 106.

Tree, height 15 feet, spread 12 feet, slender, open-headed, foliage dense, quite vigorous, and moderately productive.

This avocado is a very good keeper and shipper.

**No. 111 (fig. 5).** A seedling avocado about 8 years of age and much superior to its parent.

Form pyriform; size large; cavity medium, shallow, abrupt, and somewhat furrowed; stem medium length and quite thick, persistence very good; surface undulating, hard, smooth, and inclined to be ribbed; color green, with a few russet splashes; dots numerous, small, raised, irregular shaped and yellowish; apex a protruding point; skin, thickness medium, adhering somewhat to the flesh; flesh yellow, running into green at the rind, thick, fine-grained, dryness medium,

somewhat oily and buttery, fiber present, flesh 75 percent; seed large, conical, and a trifle loose in the

cavity; seed coats, one loosely attached to the seed and one adhering closely to the pulp; flavor rich and nutty; quality excellent; season August to October.

Tree height 30 feet, spread 25 feet, spreading, open headed, foliage dense, moderately vigorous, and very productive.

**No. 121 (fig. 6).**

A seedling avocado which has been in bearing since 1887.

Form pyriform; size medium, cavity quite large, deep, rounded, and slightly wrinkled; stem short and thick, persistence good; surface undulating, hard, abrous, and somewhat pitted; color dark; dots numerous, small, raised, irregular shaped, and reddish; apex dot; skin fairly thin, adhering quite firmly to the flesh; flesh yellow running into green at the rind, moderately thin, fine-grained, medium dry, and somewhat buttery, fiber traces, flesh 60 per cent; seed large, conical, loose in the cavity; seed coats, one attached to the seed and the other to the flesh; flavor rich and nutty, quality excellent; season July to October.

[Bull. 25]

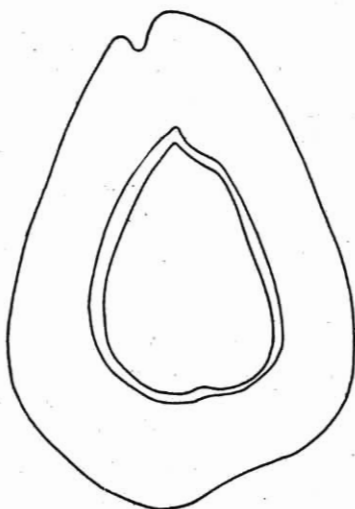


FIG. 4.—Variety 108.

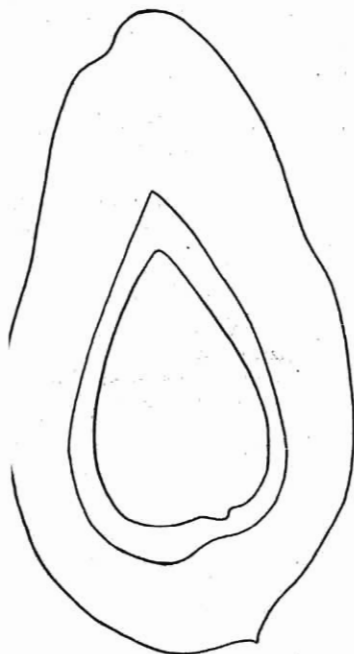


FIG. 5.—Variety 111.

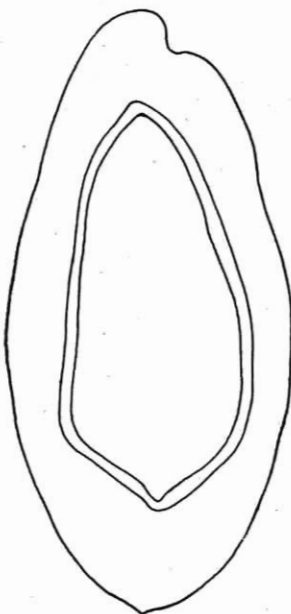


FIG. 6.—Variety 121.



Tree height 45 feet, spread 35 feet, slender, open headed, foliage dense, very vigorous and thrifty and very productive.

This avocado tree bears large crops of commercial value.

**No. 141** (fig. 7). A seedling avocado about 12 years of age.

Form pyriform; size large; cavity small, moderately deep, and abrupt; stem short and thick, persistence good; surface undulating, hard, scabrous, inclined to be ribbed, and quite pitted; color brown; dots very numerous, small, depressed, irregular shaped, and yellowish; apex a depressed dot; skin thin, separating readily from the flesh; flesh yellow, running into green at the rind, thick, fine grained, dryness medium, melting, and oily, fiber quite abundant, flesh 68 per cent; seed large, conical, fitting tightly into the cavity; seed coats, one adhering loosely to the seed and one closely to the flesh; flavor rich and nutty; quality excellent; season July to September.

Tree height 35 feet, spread 25 feet, spreading, open headed, foliage dense, very vigorous and thrifty, and very productive.

**No. 142** (fig. 8). Tree about 20 years of age, coming quite true from its parent stock, yet much larger.

Form round; size medium to large; cavity large, deep, and rounded; stem medium length and thick, persistence fine; surface undulating, hard, scabrous, and pitted; color purple, with russet splashes; dots small, numerous, raised, irregular shaped, and reddish; apex a depressed dot; skin thick, separating readily from the flesh; flesh yellowish, running into green at the rind, thick, fine grained, juicy, buttery, and oily, fiber present, flesh 65 per cent; seed large, conical, fitting tightly into the cavity; seed coats both adhering to the seed; flavor rich and nutty; quality excellent; season July to September.

Tree height 35 feet, spread 20 feet, spreading, open headed, foliage dense, very vigorous and fairly productive.

Although the individual fruits are not very large, this avocado is considered of superior quality.

**No. 143** (fig. 9). A seedling avocado of doubtful origin, about 10 years of age.

Form oblong to pyriform; size large to very large; cavity large, deep, and rounded; stem short and thick, persistence good; surface undulating, hard, scabrous, and pitted; color green; dots very numerous, small, depressed, irregular shaped, and yellowish; apex a depressed dot; skin thin, separating readily from the flesh; flesh yellow, running into green at the rind, thick, fine grained, juicy, a little watery, somewhat melting, and oily, fiber present, flesh 74 per cent; seed medium, conical, loose in cavity; seed coats, one adhering loosely to the seed and one adhering to the flesh; flavor pleasant and nutty; quality good; season July to September.

Tree height 40 feet, spread 20 feet, slender, open headed, foliage dense, vigorous, and very productive.

**No. 151** (fig. 10). A young seedling avocado tree about 7 years of age.

Form pyriform; size small to medium; cavity small, deep, and rounded; stem long and quite thin, persistence good; surface undulating, hardness medium, scabrous, and inclined to be ribbed; color reddish purple, with splashes of green; dots very numerous, small, depressed, irregular shaped, and yellow; apex a dot; skin thin, separating readily from the flesh; flesh yellow, running into green at the rind, thin, fine grained, juicy, melting, and buttery, fiber traces, flesh 70 per cent; seed large, conical, fitting loosely into the cavity; seed coats, one adhering to the seed, one to the flesh; flavor rich and nutty; quality excellent; season June to August.

Tree height 12 feet, spread 8 feet, slender, open headed, spreading, foliage dense, moderately vigorous, and productive.

Besides bearing fruit of superior quality, this avocado bears fruits in clusters of 3, 4, 5, and 6.

**No. 156** (fig. 11). A seedling avocado about 15 years of age.

Form bottle necked to pyriform; size medium to large; stem short and stout, persisting very well; surface hard, coriaceous, and scabrous; color dark claret; dots reddish yellow; apex a protruding dot; skin thick, adhering loosely to the flesh; flesh



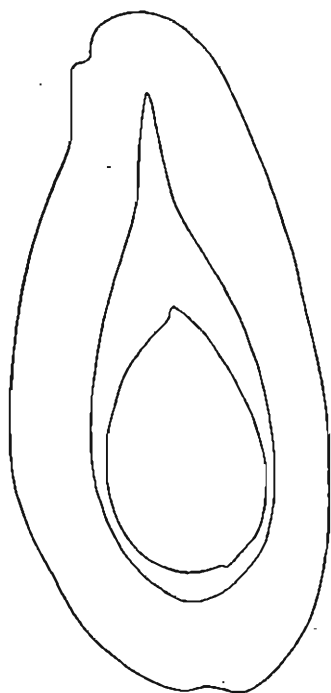


FIG. 7.—Variety 141.

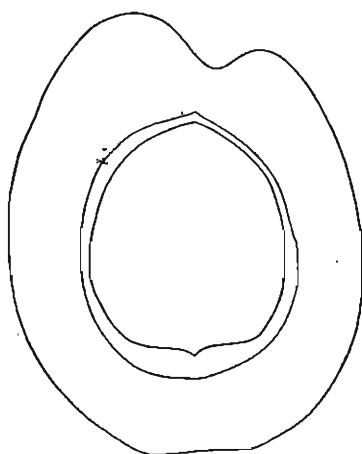


FIG. 8.—Variety 142.

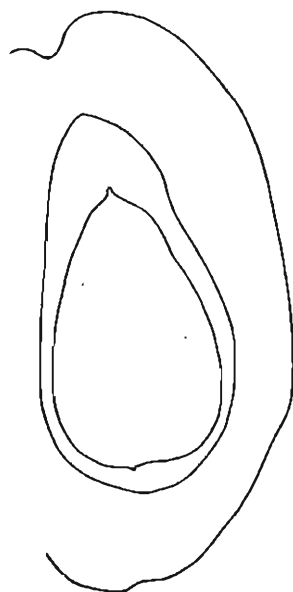


FIG. 9.—Variety 143.  
[Bull. 25]

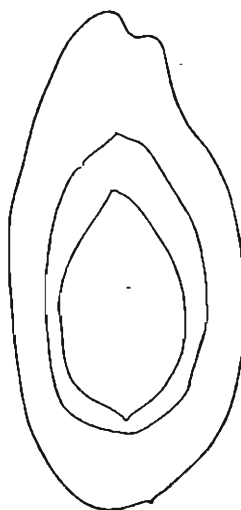


FIG. 10.—Variety 151.

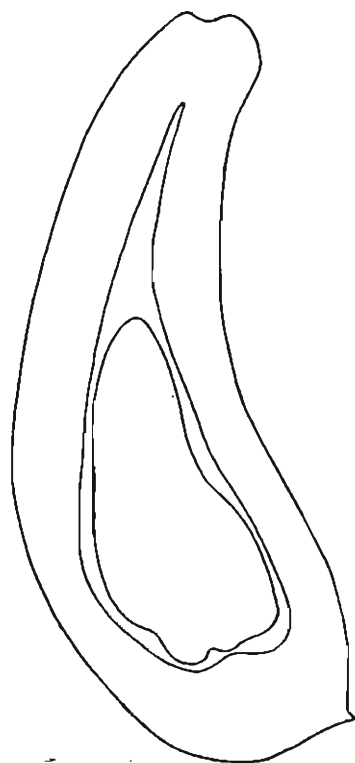


FIG. 11.—Variety 156.

yellow, running into green at the rind, thin, fine grained, juicy, melting, buttery, and a little watery, flesh 65 per cent; seed large, conical, and fitting tightly into the cavity; flavor pleasant and nutty; quality fair; season July to September.

**No. 157** (fig. 12). A seedling avocado planted in 1900. Similar to its parent but bearing smaller fruits.

Form round; size medium; cavity large, shallow, and abrupt; stem short and thick, persistence good; surface undulating, hard, coriaceous, scabrous, and pitted; color claret, with splashes of russet; dots very numerous, small, irregular shaped, and pinkish; bloom scant and bluish; apex a protruding dot; skin medium thick, separating readily from the flesh; flesh cream, running into green at the rind, thick, fine

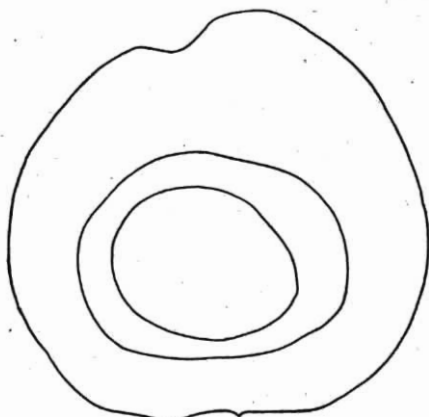


FIG. 12.—Variety 157.

grained, juicy, melting, buttery, and oily, fiber traces, flesh 80 per cent; seed small, oval to oblate, fitting loosely into the cavity; seed coats, one adhering to the seed and one to the flesh; flavor very pleasant; quality very good; season August to October.

Tree height 18 feet, spread 14 feet, spreading, open headed, foliage dense, vigorous, and moderately productive.

**No. 158** (fig. 13). A seedling avocado about 8 years of age.

Form oblong to pyriform, size large; cavity large, deep, and rounded; stem medium and somewhat slender, persistence fair; surface undulating, hard, coriaceous, scabrous, pitted, and inclined to be ribbed; color dark claret to purple, with russet splashes; dots very numerous, small, depressed, almost round, reddish; apex a depressed dot; skin thick, separating readily from the flesh; flesh yellow, running into green at the rind, very thick, fine grained, juicy, melting, buttery, and oily, fiber traces, flesh 83 per cent; seed small, conical, fitting tightly into the cavity; seed coats both adhering to the seed; flavor rich and nutty; quality excellent; season September to October.

Tree height 25 feet, spread 15 feet, spreading, open headed, foliage medium dense, vigorous, moderately productive.

**No. 224.** A seedling avocado tree bearing large crops of from 800 to 1,200 fruits per year, a regular bearer, good quality, and a good shipper. We have been unable to obtain a fruit thus far for descriptive purposes.

[Bull. 25]

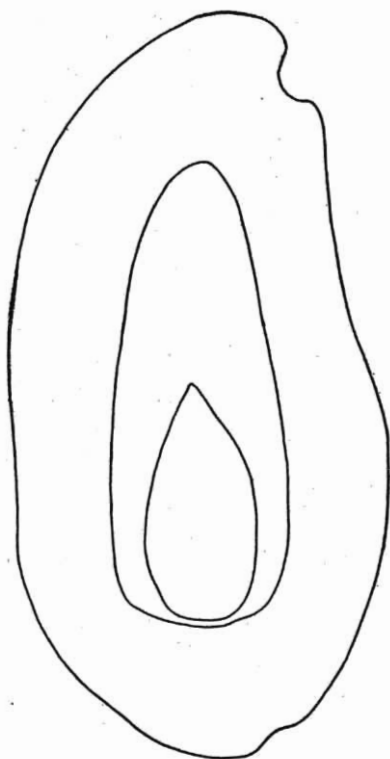


FIG. 13.—Variety 158.

yellow, running into green at the rind, thin, fine grained, juicy, melting, buttery, and a little watery, flesh 65 per cent; seed large, conical, and fitting tightly into the cavity; flavor pleasant and nutty; quality fair; season July to September.

**No. 157** (fig. 12). A seedling avocado planted in 1900. Similar to its parent but bearing smaller fruits.

Form round; size medium; cavity large, shallow, and abrupt; stem short and thick, persistence good; surface undulating, hard, coriaceous, scabrous, and pitted; color claret, with splashes of russet; dots very numerous, small, irregular shaped, and pinkish; bloom scant and bluish; apex a protruding dot; skin medium thick, separating readily from the flesh; flesh cream, running into green at the rind, thick, fine

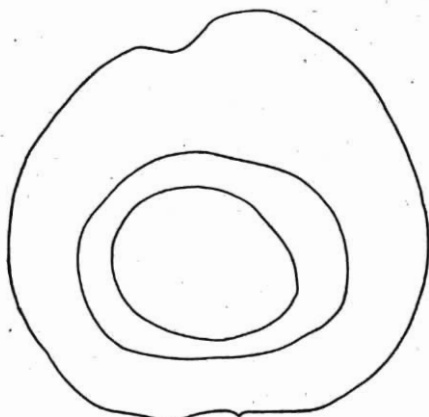


FIG. 12.—Variety 157.

grained, juicy, melting, buttery, and oily, fiber traces, flesh 80 per cent; seed small, oval to oblate, fitting loosely into the cavity; seed coats, one adhering to the seed and one to the flesh; flavor very pleasant; quality very good; season August to October.

Tree height 18 feet, spread 14 feet, spreading, open headed, foliage dense, vigorous, and moderately productive.

**No. 158** (fig. 13). A seedling avocado about 8 years of age.

Form oblong to pyriform, size large; cavity large, deep, and rounded; stem medium and somewhat slender, persistence fair; surface undulating, hard, coriaceous, scabrous, pitted, and inclined to be ribbed; color dark claret to purple, with russet splashes; dots very numerous, small, depressed, almost round, reddish; apex a depressed dot; skin thick, separating readily from the flesh; flesh yellow, running into green at the rind, very thick, fine grained, juicy, melting, buttery, and oily, fiber traces, flesh 83 per cent; seed small, conical, fitting tightly into the cavity; seed coats both adhering to the seed; flavor rich and nutty; quality excellent; season September to October.

Tree height 25 feet, spread 15 feet, spreading, open headed, foliage medium dense, vigorous, moderately productive.

**No. 224.** A seedling avocado tree bearing large crops of from 800 to 1,200 fruits per year, a regular bearer, good quality, and a good shipper. We have been unable to obtain a fruit thus far for descriptive purposes.

[Bull. 25]

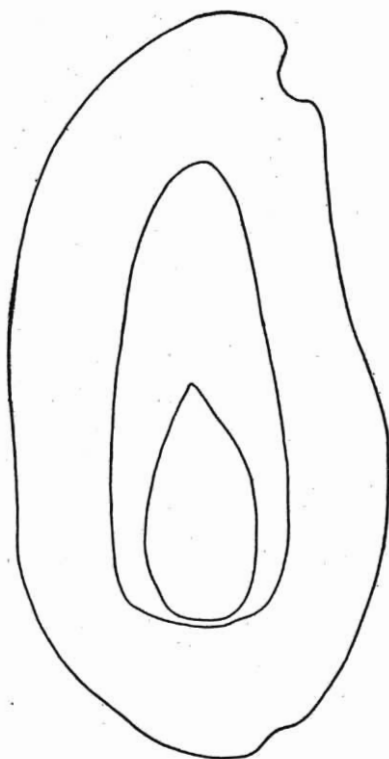


FIG. 13.—Variety 158.